From: Sanborn, Scott Edward
To: Dennis, Suzanne; IP Expert Eval Team; Nanney, Steve (PHMSA); Luketa, Anay; Mohmand, Jamal Ahmed; LaFleur, Chris; Glover, Austin Michael; Skeen, David; Clark, Theresa
Subject: [External_Sender] RE: [EXTERNAL] IP Expert Full Team Meeting
Date: Thursday, March 26, 2020 3:08:02 PM

All,

SNL's draft memo documenting the independent evaluation has been uploaded to the BOX site.

Thanks,
Scott

-----Original Appointment-----
From: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Sent: Thursday, March 26, 2020 12:17 PM
To: IP Expert Eval Team; Nanney, Steve (PHMSA); Sanborn, Scott Edward; Luketa, Anay; Mohmand, Jamal Ahmed; LaFleur, Chris; Glover, Austin Michael; Skeen, David; Clark, Theresa
Subject: [EXTERNAL] IP Expert Full Team Meeting
When: Monday, March 30, 2020 2:00 PM-3:00 PM (UTC-05:00) Eastern Time (US & Canada).
Where: Skype Meeting

Hi all,

We wanted to get the whole team together (including SNL and PHMSA) to go over Sandia's independent evaluation, so we can make sure we have a common understanding before we finish writing up our draft report.

Let me know if this time doesn't work for you.

Thanks so much!
Suzanne

Join Skype Meeting

Trouble Joining? Try Skype Web App

Join by phone

301-415-0333, (b)(6) # (HQ) English (United States)

Find a local number

Conference ID: (b)(6)

Forgot your dial-in PIN? | Help

---

1. Use the first link if you are an NRC user
2. Use the second link if you are not an NRC user
3. Users who dial-in only via phone will not be able to join the meeting until another attendee has joined by completing step 1 above.
4. If using Skype over Citrix (which is not as optimal a service as VPN), choose the 3rd option “Don’t join audio” and dial into the meeting from a phone. You will be able to see the video presentation over the Skype and audio via the phone.

From: Sanborn, Scott Edward
To: Dennis, Suzanne
Cc: Luketa, Anay; Mohmand, Jamal Ahmed
Subject: [External_Sender] RE: [EXTERNAL] Phone Call Monday
Date: Thursday, March 26, 2020 1:01:58 PM

Hi Suzanne,

We will be ready to send a draft over this afternoon. Can we send the draft (it is OUO) and then have the discussion with PHMSA on Monday?

Thanks,
Scott

From: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Sent: Thursday, March 26, 2020 10:51 AM
To: Sanborn, Scott Edward <sesanbo@sandia.gov>
Cc: Luketa, Anay <aluketa@sandia.gov>; Mohmand, Jamal Ahmed <jamohma@sandia.gov>
Subject: [EXTERNAL] Phone Call Monday

Hi Scott,

Are you all available for a phone call on Monday with our PHMSA team member? We were thinking that before you all sent over the report, we could all meet together as team to make sure that everyone has the opportunity for questions, etc. I understand that this would push back when you all send the report, but I am ok with that.

Thanks!
Suzanne

Suzanne Dennis
Office of Research
U.S. NRC
301-415-0760

From: Mohmand, Jamal Ahmed
To: Dennis, Suzanne
Subject: [External_Sender] RE: RE: RE: RE: [EXTERNAL] transformer damage threshold
Date: Wednesday, March 25, 2020 11:44:37 AM
Attachments: image005.png
image006.png
image007.png
image008.png

Realized you asked about 15 kW/m^2.

Table A-4
Verification of Thermoplastic Heat Flux Exposures

Heat Flux (kW/m^2)	NUREG/CR-6805 Time to Damage (min)	Heat Soak Method Time to Damage (min)
7	19	19
9	10	10
10.5	6	6
12	4	4
15	2	2
18	1	1

Table A-5
Verification of Thermoset Heat Flux Exposures

Heat Flux (kW/m^2)	NUREG/CR-6805 Time to Damage (min)	Heat Soak Method Time to Damage (min)
12	19	19
15	12	12
71	6	6
19	1	1
21	1	1

From: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Sent: Wednesday, March 25, 2020 8:51 AM
To: Mohmand, Jamal Ahmed <jamohma@sandia.gov>
Subject: RE: RE: RE: RE: [EXTERNAL] transformer damage threshold

Excellent – this is helpful!

From: Mohmand, Jamal Ahmed <jamohma@sandia.gov>
Sent: Wednesday, March 25, 2020 10:46 AM
To: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Subject: [External_Sender] RE: RE: RE: [EXTERNAL] transformer damage threshold

This is what we should determine it by, this is a statement in 6850. That transformers, which are considered to be motor fires, is failure is limited by the failure of it's cables.
And the fact that thermoplastic cables would last 4 minutes at 12 kW/m^2 and 19 minutes for thermoset cables.

H.2 Other Equipment

For major components such as motors, valves, etc., the fire vulnerability will be assumed to be limited by the vulnerability of the power, control, and/or instrument cables supporting the component. For other cases, the following is recommended:

- If a scenario should arise involving solid-state control components as a thermal damage target, the failure criteria to be applied in screening are 3 kWm^2 (0.25 BTU/ft^2) and 65°C (150°F). The criteria for ignition of the components will assume properties similar to thermoplastic cables (0.5 BTU/ft^2 and 400°F).
- Pipes and water tanks constructed of ferrous metal will be considered invulnerable to fire damage.
- Passive components (e.g., flow check valves) will be considered invulnerable to fire.

From: Mohmand, Jamal Ahmed
Sent: Wednesday, March 25, 2020 8:12 AM
To: 'Dennis, Suzanne' <Suzanne.Dennis@nrc.gov>
Subject: RE: RE: RE: [EXTERNAL] transformer damage threshold

This is not exactly what we're looking for. This is a transformer fire causing a electrical panel failure (within less than a minute). Still looking for something more applicable.

Table 5-12
Electric Motor Detailed Fire Modeling Results

Target	Direction	Distance (m, [ft])	Critical HRR (kW)	Severity Factor	Time to Damage (min)
EC A	Horizontal	1.22 [4.00]	194	N/A	N/A
EC B	Horizontal	0.30 [1.00]	6.02	0.64	0.58
Tray A	Vertical	1.83 [6.00]	97.12	N/A	N/A

N/A – The target is outside of the 98th percentile ZOI of the ignition source and it can be screened from the fire PRA.

Table 5-14
Electric Motor Detailed Fire Modeling Results

Target	Nearest Target Direction	Distance (m, [ft])	Critical HRR (kW)	Severity Factor	Time to Damage (min)
EC A	Horizontal	1.22 [4.00]	194	N/A	N/A
EC B	Horizontal	0.30 [1.00]	6.02	0.25	1.0
Tray A	Vertical	1.83 [6.00]	97.12	N/A	N/A

N/A – The target is outside of the 98th percentile ZOI of the ignition source and it can be screened from the fire PRA.

From: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Sent: Wednesday, March 25, 2020 5:50 AM
To: Mohmand, Jamal Ahmed <jamohma@sandia.gov>
Subject: RE: RE: RE: [EXTERNAL] transformer damage threshold

These are the smaller onsite transformers. It is likely that the fire would not directly impact them due to shielding from both the landscape and buildings onsite.

Suzanne

From: Mohmand, Jamal Ahmed <jamohma@sandia.gov>

Sent: Tuesday, March 24, 2020 11:03 PM
To: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Subject: [External_Sender] RE: RE: [EXTERNAL] transformer damage threshold

To clarify are these transformers the large switchyard transformers (iso/multi phase), or are they the small transformers?

This is from volume 2 of Rachelle fire (which is still in public draft).
This section is regarding obstructed radiation, cables would last 19 minutes (thermoset cables) in an environment like that. But, the transformers would be exposed directly.

2.3.3.4 Time-Dependent Fire Results

Actual electrical cabinet fires are not steady-state fires as modeled in the prior section, but rather consist of a growth period, a sustained burning period, and a decay phase. The values for these periods for electrical cabinets from NUREG/CR-6850 [1] are 12 minutes, 8 minutes, and 19 minutes respectively. Figure 2-27 shows the normalized HRR for a cabinet fire along with the normalized increase in wall temperature. These values were obtained from a Consolidated Fire Growth and Smoke Transport (CFAST) [25, 26] calculation. At the threshold exposure values used in the prior section, it takes 19 minutes to damage a cable per the tables in Appendix H of NUREG/CR-6850. This time is indicated as a shaded region on the plot. As seen, the peak wall

Tables A-2 through A-5 has time to cable damage for thermoset and thermoplastic cables. A-2 and A-3 are in terms of temperature A-4 and A-5 are in terms of heat flux.
Thermoplastic cables would last 4 minutes at 12 kW/m^2 and 19 minutes for thermoset cables.

Still looking for information related to timing of failure of the transformer.

From: Mohmand, Jamal Ahmed
Sent: Tuesday, March 24, 2020 8:21 PM
To: 'Dennis, Suzanne' <Suzanne.Dennis@nrc.gov>
Subject: RE: RE: [EXTERNAL] transformer damage threshold

No, I'm not sure how far the transformers are.
Also not sure if the transformers saw 15 kW/m^2 for a few seconds.

I believe in either Nureg 6850 or in Rachelle fire there is a 15 minute delay for failure of electrical panels (both transient failure and cabinet to cabinet failure). Which is a 15 minute exposure at 317/1000 kW fires. (This is for obstructed radiation)
I would presume a transformer would survive a few seconds.

Jamal

From: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Sent: Tuesday, March 24, 2020 6:00 PM
To: Mohmand, Jamal Ahmed <jamohma@sandia.gov>
Subject: RE: RE: [EXTERNAL] transformer damage threshold

25kW/m^2 at the source or seen at the transformers? If the transformers only saw 15 Kw/m^2 for a few seconds?

Suzanne

From: Mohmand, Jamal Ahmed <jamohma@sandia.gov>
Sent: Tuesday, March 24, 2020 6:41 PM
To: LaFleur, Chris <aclafle@sandia.gov>; Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Subject: [External_Sender] RE: [EXTERNAL] transformer damage threshold

Typically in my experience in Fire PRAs is that any fire can typically take out any piece of equipment due to the cable impacts that occur between roughly 300-400 degrees C.

For example a large electrical panel is considered a 1000 kW fire, with a horizontal ZOI of roughly 5 feet for a 98% fire.
A transient would be 317 kW fire, with a horizontal ZOI of roughly 7 feet for a 98% fire.

Both fires would fail the transformer in a FPRA world.
Considering a giant fireball of roughly 25 kW/m^2 the transformers would fail.

Thanks,
Jamal

From: LaFleur, Chris <aclafle@sandia.gov>
Sent: Tuesday, March 24, 2020 3:42 PM
To: Suzanne Dennis <Suzanne.Dennis@nrc.gov>; Mohmand, Jamal Ahmed <jamohma@sandia.gov>
Subject: Fwd: [EXTERNAL] transformer damage threshold

Hi Suzanne

Because transformers cause so many fires, there's a ton of info on that risk that is drowning my attempts to find damage threshold info for the transformers as "victims" instead of causes. The attached document at least refers to this (see page 17). This may be a handy document to for you to have anyways.

Jamal - see if you are able to find any criteria for failure of transformers exposed to external fire. Maybe deeper in this document or in FM data sheets on transformer fire protection (like criteria for walls between transformers).

Thanks
Chris

Sent from my iPad

Begin forwarded message:

> **From:** Chris LaFleur (b)(6)
> **Date:** March 24, 2020 at 2:48:44 PM MDT
> **To:** "LaFleur, Chris" <aclafle@sandia.gov>
> **Subject: [EXTERNAL] transformer damage threshold**

From: LaFleur, Chris
To: Dennis, Suzanne
Cc: Mohmand, Jamal Ahmed
Subject: [External_Sender] Re: [EXTERNAL] EDG Power
Date: Tuesday, March 24, 2020 5:00:43 PM

Hi Suzanne

I am processing emails backwards, sorry. Yes, that is how I read the schematic below, all Diesel Generators go through the transformers prior to any loads.

Chris

Sent from my iPad

> On Mar 24, 2020, at 11:34 AM, Dennis, Suzanne <Suzanne.Dennis@nrc.gov> wrote:
>
> Hi Chris and Jamal,
>
> Just wanted to share what I found in the Unit 3 IPE for their EDG power. It looks like power from the diesels has to go through the onsite (open air) transformers before being distributed to any loads:
>
> <image003.jpg>
>
> Suzanne Dennis
> Office of Research
> U.S. NRC
> 301-415-0760

From: LaFleur, Chris
To: Dennis, Suzanne
Subject: [External_Sender] Fwd: electrical OUO
Date: Tuesday, March 24, 2020 4:55:02 PM
Attachments: Indian-Point-3-system-sourcebook.pdf
ATT00001.htm
Indian-Point-3-power-system-1.pdf
ATT00002.htm
Indian-Point-3-external-events-gas.pdf
ATT00003.htm
Indian-Point-3-tech-eval-ext-events.pdf
ATT00004.htm
Indian-Point-3-site-plan.pdf
ATT00005.htm

The third attachment is part of ML12332A210, which is publicly available in ADAMS.

Suzanne,

Cathy was able to look through our files for schematics for IP. This is what we have at Sandia. Maybe helpful.

Thanks
Chris

Sent from my iPad

Begin forwarded message:

From: "Farnum, Cathy Ottinger" <cfarnum@sandia.gov>
Date: March 24, 2020 at 1:21:42 PM MDT
To: "LaFleur, Chris" <aclafle@sandia.gov>
Subject: electrical OUO

~~Attachment: Third Party Proprietary~~

Hi Chris,

I did not find electrical schematics in either the room next to me or the cabinets in the hall near the Center office for Indian Point. I found a table of electrical equipment and locations, so I am sending the pages to you.

I found electrical schematics for some other plants but not for Indian Point.

Cathy
505-845-7033
cfarnum@sandia.gov

1.0×10^{-12}/ry. Therefore, the licensee concluded that the contribution of external flooding to CDF at IP2 is extremely small.

In consideration of the PMP, the buildings which contain safety-related equipment and which were also considered to be susceptible to ponding are the primary auxiliary building, AFW building, turbine building, and control building. Using the maximum allowable live loading for these buildings, an equivalent maximum allowable height of water accumulation was calculated and compared against the maximum height of accumulated rainfall on those buildings. Only the turbine building could experience loads at, or close to, yield. However, given the conservatisms in the hazard calculation and the remaining margin between yield and actual failure stress, the licensee judged that the structure would remain intact.

2.3.3 Transportation and Nearby Facility Accidents

2.3.3.1 Methodology

The IP2 IPEEE submittal has addressed aircraft crashes, as well as water, rail, and highway transportation accidents. Also, the submittal considers potential impacts of on-site hazardous material inventories.

Airports and airfields within approximately 25 miles of Indian Point were considered in the IPPSS study. The three closest airports were identified as Mahopac, Ramapo Valley and Peekskill Seaplane Base, out of which the Peekskill Seaplane Base was judged to pose the greatest hazard to the plant. Using the annual number of landing and take-off operations at the Seaplane Base, and general aviation accident statistics, the annual probability of an aircraft hitting any of the plant structures was estimated as 2.4×10^{-7}/ry. Federal airways in the vicinity of the plant were also examined. The annual frequency of an aircraft using the federal airways in the vicinity of the plant and accidentally hitting IP2 structures was estimated by the licensee to be 4.6×10^{-8}/ry.

The nearest rail facilities are located approximately 0.9 miles west and 0.6 miles east of the plant site. The closest distance to the rail lines from the plant is larger than the stand-off distance. Therefore, the licensee concluded that IP2 meets the 1975 SRP requirements for rail transportation.

The nearest major road is New York Highway 9 extending north/south and located between one to two miles east of the plant site. The distance to the road is much larger than the stand-off distance. Therefore, the licensee concluded that IP2 meets the 1975 SRP requirements for road transportation.

The potential consequences of accidents involving barges on the Hudson River are overpressure on the structures due to explosion, fire at the shoreline, and release of toxic chemicals. The annual frequency of a large, rapid spill resulting in a fire at the shoreline was estimated by the licensee to range from 1.0×10^{-6}/ry to 1.0×10^{-9}/ry. With respect to potential damage due to detonation of explosive gases, IP2 is located on the shore of the Hudson River and therefore cannot be screened using the safe stand-off distance criteria. The frequency of barge accidents resulting in overpressures exceeding 1 psi was determined to be 3.9×10^{-6}/ry.

There are two underground natural gas transmission lines (26-inch and 30-inch diameter) passing through the IP2 site about 1,000 feet from the closest plant structures. The frequency of failure of these pipelines which could pose a hazard to the plant was stated in the submittal to be about 5.0×10^{-7}/ry.

A number of toxic chemicals stored at IP2 were identified by the licensee. The major potential hazardous chemical emission sources are a 10-ton CO_2 cylinder at IP3, and a 1-ton chlorine cylinder at Peekshill Sewage

TECHNICAL EVALUATION REPORT ON THE "SUBMITTAL-ONLY" REVIEW OF THE INDIVIDUAL PLANT EXAMINATION OF EXTERNAL EVENTS AT THE INDIAN POINT UNIT 2 NUCLEAR GENERATING STATION

Draft Final Report

June 1998

M. Khatib-Rahbar
Principal Investigator

Authors:

J. Lambright[1] and S. Sholly[2]
Energy Research, Inc.
P.O. Box 2034
Rockville, Maryland 20847

Work Performed Under the Auspices of the
United States Nuclear Regulatory Commission
Office of Nuclear Regulatory Research
Washington, D.C. 20555
Contract No. 04-94-050

---

1 Lambright Technical Associates, 9009 Lagrima de Oro NE, Albuquerque, NM 87111

2 Formerly with Beta Corporation, Inc., 6719-D Academy Road, NE, Albuquerque, NM 87109; presently with Lambright Technical Associates, 9009 Lagrima de Oro NE, Albuquerque, NM 87111

Individual Plant Examination of External Events

for

Indian Point Unit No. 2

Nuclear Generating Station

Consolidated Edison Company of New York, Inc.

NUS Corporation

EQE International

December 1995

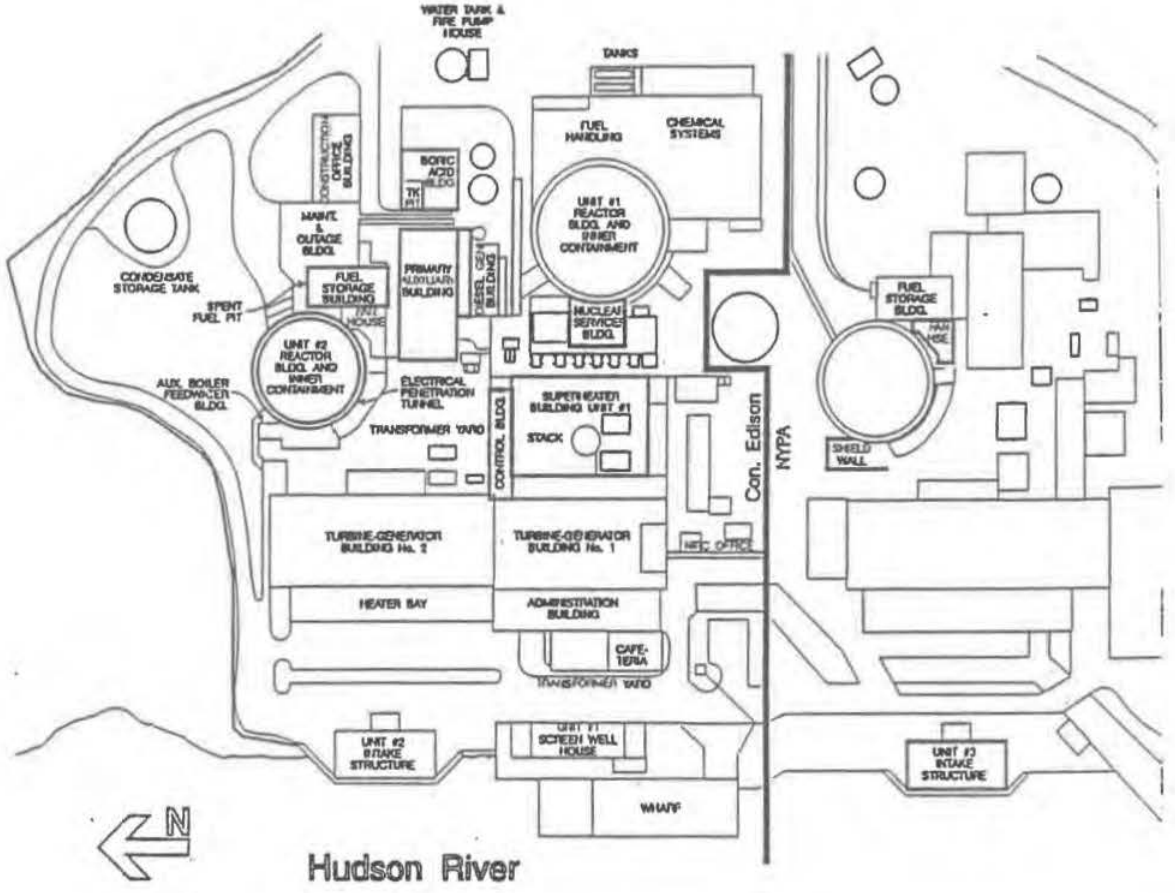
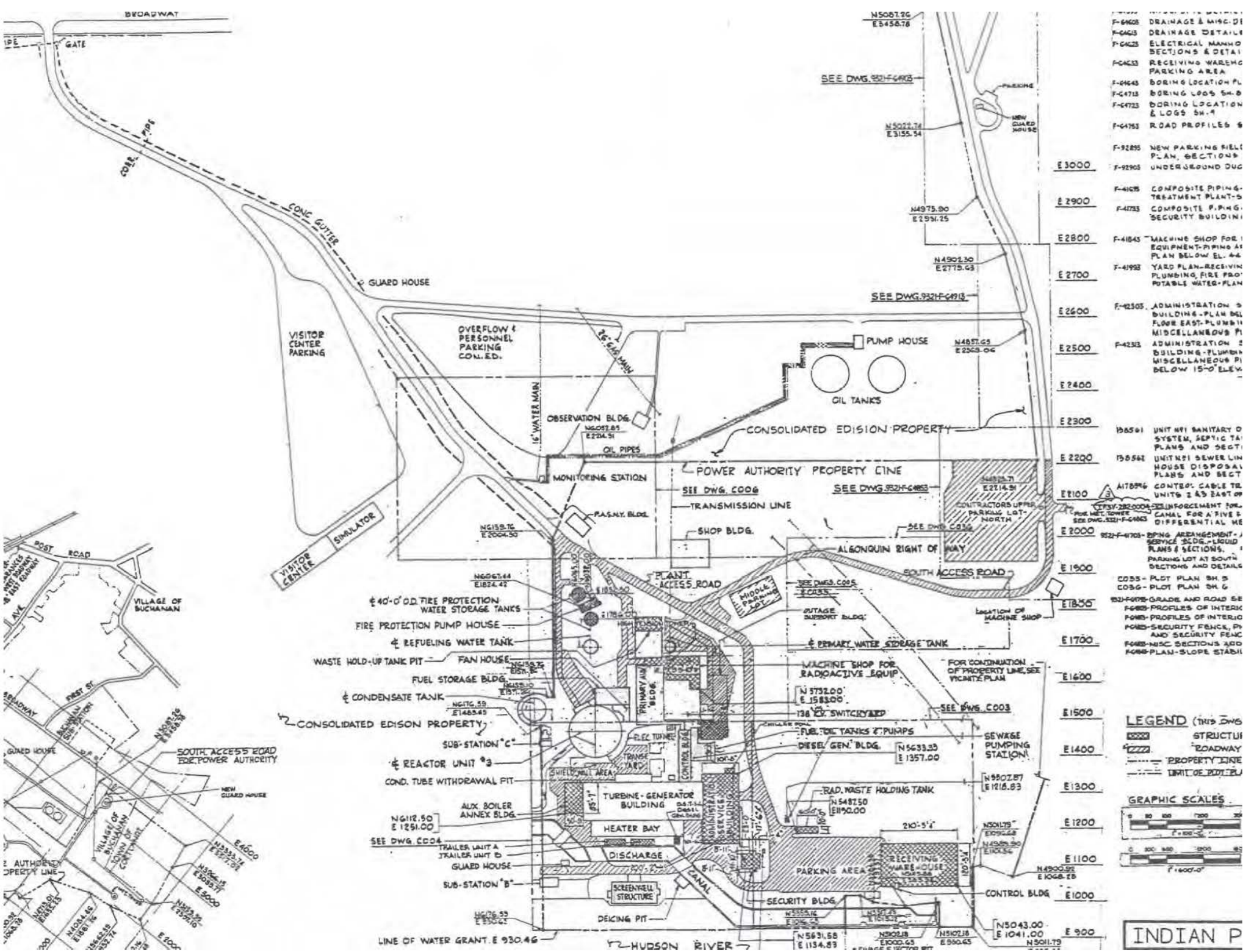


Figure 6.1-1
Indian Point Units 1 & 2
Site Layout Plan

TABLE 7.2-2

Examples of Independent/Inhouse IPEEE Review Comments and Resolution

Area of Review	Comment and Resolution
Seismic	COMMENT:The details of the Control Building bumper fix installed as a result of the IPPSS should be reviewed to assure that it provides the basis for screening out this building failure mode. RESOLUTION: The as built drawings for the bumper fix were reviewed. EQE confirmed that bumper fix as installed is appropriate and is adequate to allow this failure mode to be screened out.
Seismic	COMMENT: The structures with HPCLFs below .3g should be reviewed to determine if the analysis used generic assumptions rather than plant specific design information, and if so, whether use of plant specific information could show additional capacity. RESOLUTION: The two structures with calculated HPCLFs below .3g are the RWST and Superheater Stack. The stack is unique to Indian Point and the information used was therefore required to be plant specific. The RWST used plant specific information except for anchor bolts material which assumed standard bolts. A review of documents provided information which supported the assumption that standard material was used for anchor bolts. A field walk, performed by the Civil Section of the Con Edison Nuclear Power Engineering Department confirmed this.
Seismic / Fire	COMMENT: The risk associated with random failure of the Algonquin Gas Line has been evaluated in the IPEEE. The potential for damage due to seismic induced failure of the gas line should also be addressed. RESOLUTION: This gas line runs west to east through the plant site, south of the IP3 plant. A review of drawings, discussions with Algonquin Gas Transmission personnel and specific field walks were performed to address the potential for seismic induced gas line failure. Based on the information gathered through this process, EQE evaluated the the potential for seismic induced failure and demonstrated that this failure mode could be addressed by applying the screening guidance provided in NUREG-1407.


BROADWAY
GATE
CONC. PIPE
CONC. GUTTER
GUARD HOUSE
VISITOR CENTER PARKING
OVERFLOW & PERSONNEL PARKING CONC. ED.
VISITOR CENTER
SIMULATOR
16" WATER MAIN
OBSERVATION BLDG.
OIL PIPES
MONITORING STATION
P.A.S.N.Y. BLDG.
PUMP HOUSE
OIL TANKS
CONSOLIDATED EDISON PROPERTY
POWER AUTHORITY PROPERTY LINE
SEE DWG. C006
SEE DWG. 9321-F-64913
SEE DWG. 9321-F-64918
TRANSMISSION LINE
SHOP BLDG.
ALGONQUIN RIGHT OF WAY
SOUTH ACCESS ROAD
PLANT ACCESS ROAD
CONTRACTORS UPPER PARKING LOT-NORTH
MIDDLE PARKING LOT
OUTAGE SUPPORT BLDG.
LOCATION OF MACHINE SHOP
40'-0" O.D. FIRE PROTECTION WATER STORAGE TANKS
FIRE PROTECTION PUMP HOUSE
REFUELING WATER TANK
PRIMARY WATER STORAGE TANK
WASTE HOLD-UP TANK PIT
FAN HOUSE
FUEL STORAGE BLDG.
CONDENSATE TANK
MACHINE SHOP FOR RADIOACTIVE EQUIP.
FOR CONTINUATION OF PROPERTY LINE, SEE VICINITY PLAN
138 KV SWITCHYARD
SUB-STATION "C"
REACTOR UNIT #3
FUEL OIL TANKS & PUMPS
SEWAGE PUMPING STATION
DIESEL GEN. BLDG.
COND. TUBE WITHDRAWAL PIT
TURBINE-GENERATOR BUILDING
RAD. WASTE HOLDING TANK
AUX. BOILER ANNEX BLDG.
HEATER BAY
TRAILER UNIT A
TRAILER UNIT B
GUARD HOUSE
DISCHARGE
SUB-STATION "B"
SCREENWELL STRUCTURE
PARKING AREA
RECEIVING WAREHOUSE
CONTROL BLDG.
SECURITY BLDG.
DEICING PIT
CANAL
LINE OF WATER GRANT. E 930.46
HUDSON RIVER
NEW GUARD HOUSE
SOUTH ACCESS ROAD FOR POWER AUTHORITY
POST ROAD
VILLAGE OF BUCHANAN
FIRST ST.
LEGEND
STRUCTURE
ROADWAY
PROPERTY LINE
GRAPHIC SCALES
INDIAN P

SAIC 89/1037

NUCLEAR POWER PLANT SYSTEM SOURCEBOOK

INDIAN POINT 3

50-286

Editor: Peter Lobner
Author: Stephen Finn

Prepared for:

U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Contract NRC-03-87-029
FIN D-1763

3.6 ELECTRIC POWER SYSTEM

3.6.1 System Function

The electric power system supplies power to various equipment and systems needed for normal operation and/or response to accidents. The onsite Class 1E electric power system supports the operation of safety class systems and instrumentation needed to establish and maintain a safe shutdown plant condition following an accident, when the normal electric power sources are not available.

3.6.2 System Definition

The onsite Class 1E electric power system consists of four 480 VAC buses, designated 2A, 3A, 5A and 6A. There are three standby diesel generators connected to three of the four buses. Diesel generator 31 is connected to bus 2A, diesel generator 32 is connected to bus 6A, and diesel generator 33 is connected to bus 5A. Bus 3A is automatically connected to bus 2A during diesel generator operation, and the two buses are operated as a unit from a single diesel generator.

Emergency power for vital instruments, control, and emergency lighting is supplied by four 125 VDC station batteries. The batteries energize four DC distribution panels. Four 120 VAC instrument buses are connected to the distribution panels through inverters.

A simplified one-line diagram of the electric power system is shown in Figure 3.6-1. A summary of data on selected electric power system components is presented in Table 3.6-1. A partial listing of electrical sources and loads is presented in Table 3.6-2.

3.6.3 System Operation

During normal operation, the Class 1E electric power system is supplied by station service power from the main generator and the 138 kV switchyard. The normal source for buses 5A and 6A is the 138 kV system, via the station auxiliary transformer and 6900 volt buses 5 and 6. The normal source for buses 2A and 3A is the main generator, via the unit auxiliary transformer and 6900 volt buses 2 and 3. When the unit is not operating buses 2A and 3A are supplied by the 138 kV system, via switching at the 6900 volt level. The transfer from the preferred power source to the diesel generators is accomplished automatically by opening the normal source circuit breakers and then reenergizing the Class 1E portion of the electric power system from the diesel generators. Following a start command, each diesel generator is designed to reach rated speed and be capable of accepting loads within 10 seconds, and energizing essential post-accident loads within 30 seconds.

The DC power system normally is supplied through the battery chargers, with the batteries "floating" on the system, maintaining a full charge. Upon loss of AC power, the entire DC load draws from the batteries.

The 120 VAC vital buses normally receive power either from 480 VAC motor control centers through a step-down transformer or from DC distribution panels through an inverter.

Redundant safety equipment such as motor driven pumps and motor operated valves are supplied by different 480 VAC buses. For the purpose of discussion, this equipment has been grouped into "load groups". Load group 5A contains components receiving electric power from bus 5A. Load group 6A contains components powered by bus 6A. Load group 2A-3A contains components powered by either bus 2A or bus 3A. These two buses are connected to the same diesel generator and are operated as a unit.

3.6.4 System Success Criteria

Basic system success criteria for mitigating transients and loss-of-coolant accidents are defined by front-line systems, which then create demands on support systems. Electric power system success criteria are defined as follows, without taking credit for cross-ties that may exist between independent load groups:

- Each Class 1E DC load group is supplied initially from its respective battery (also needed for diesel starting)
- Each Class 1E AC load group is isolated from the non-Class 1E system and is supplied from its respective emergency power source (i.e. diesel generator)
- Power distribution paths to essential loads are intact
- Power to the battery chargers is restored before the batteries are exhausted

3.6.5 Component Information

A. Standby diesel generators (3)
   1. Maximum continuous rating: 1750 kW
   2. 2 hour rating: 1950 kW
   3. Rated voltage: 480 VAC
   4. Manufacturer: Alco

B. Batteries (4)
   1. Type: Lead-acid
   2. Cells: 60

3.6.6 Support Systems and Interfaces

A. Control Signals
   1. Automatic
      The standby diesel generators are automatically started based on:
      - Undervoltage on the normal bus
      - Safety injection signal (SIS, see Section 3.3)
   2. Remote manual
      The diesel generators can be started, and many distribution circuit breakers can be operated from the main control room.

B. Diesel Generator Auxiliary Systems
   1. Diesel Cooling Water System
      Heat is transferred from a jacket water system to the service water system. Each diesel receives redundant cooling water supplies from the SW "A", "B" and "C" headers.
   2. Diesel Starting System
      The air starting system for each diesel is capable of 4 start attempts without requiring AC power to recharge the starting air accumulators.
   3. Diesel Fuel Oil Transfer and Storage System
      A 175 gallon "day tank" supplies the relatively short-term (approximately 75 minutes) fuel needs of each diesel. The day tanks are automatically replenished from separate underground storage tanks during engine operation.
   4. Diesel Lubrication System
      Each diesel generator has its own lubrication system.

5. Combustion Air Intake and Exhaust System
   This system supplies fresh air to the diesel intake, and directs the diesel exhaust outside of the diesel building.
6. Diesel Room Ventilation System
   This system maintains the environmental conditions in the diesel room within limits for which the diesel generator and switchgear have been qualified. This system may be needed for long-term operation of the diesel generator.

C. Switchgear and Battery Room Ventilation Systems
   Details on switchgear and battery room ventilation systems have not been determined.

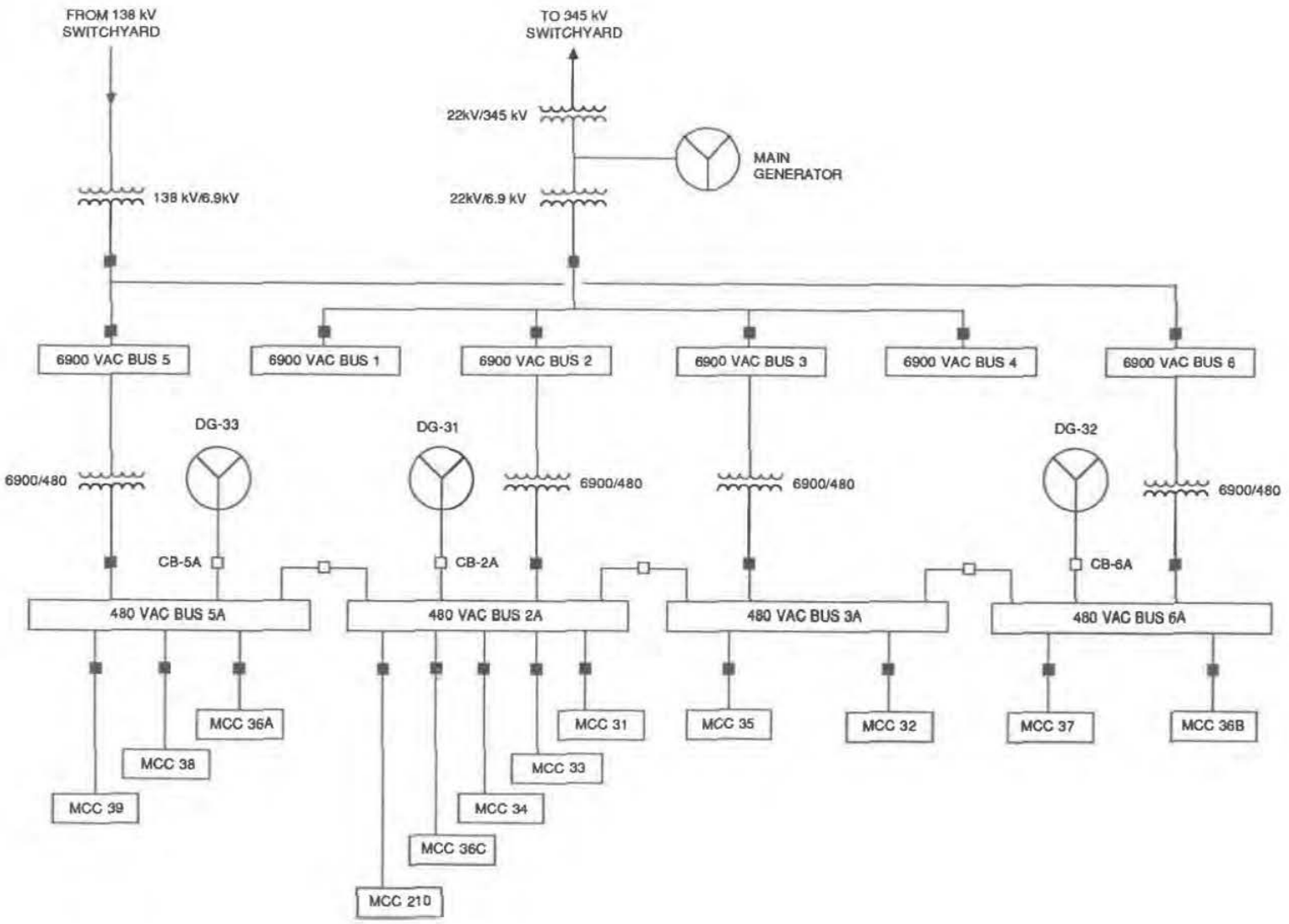


Figure 3.6-1. Indian Point 3 6900 and 480 VAC Electric Power System.

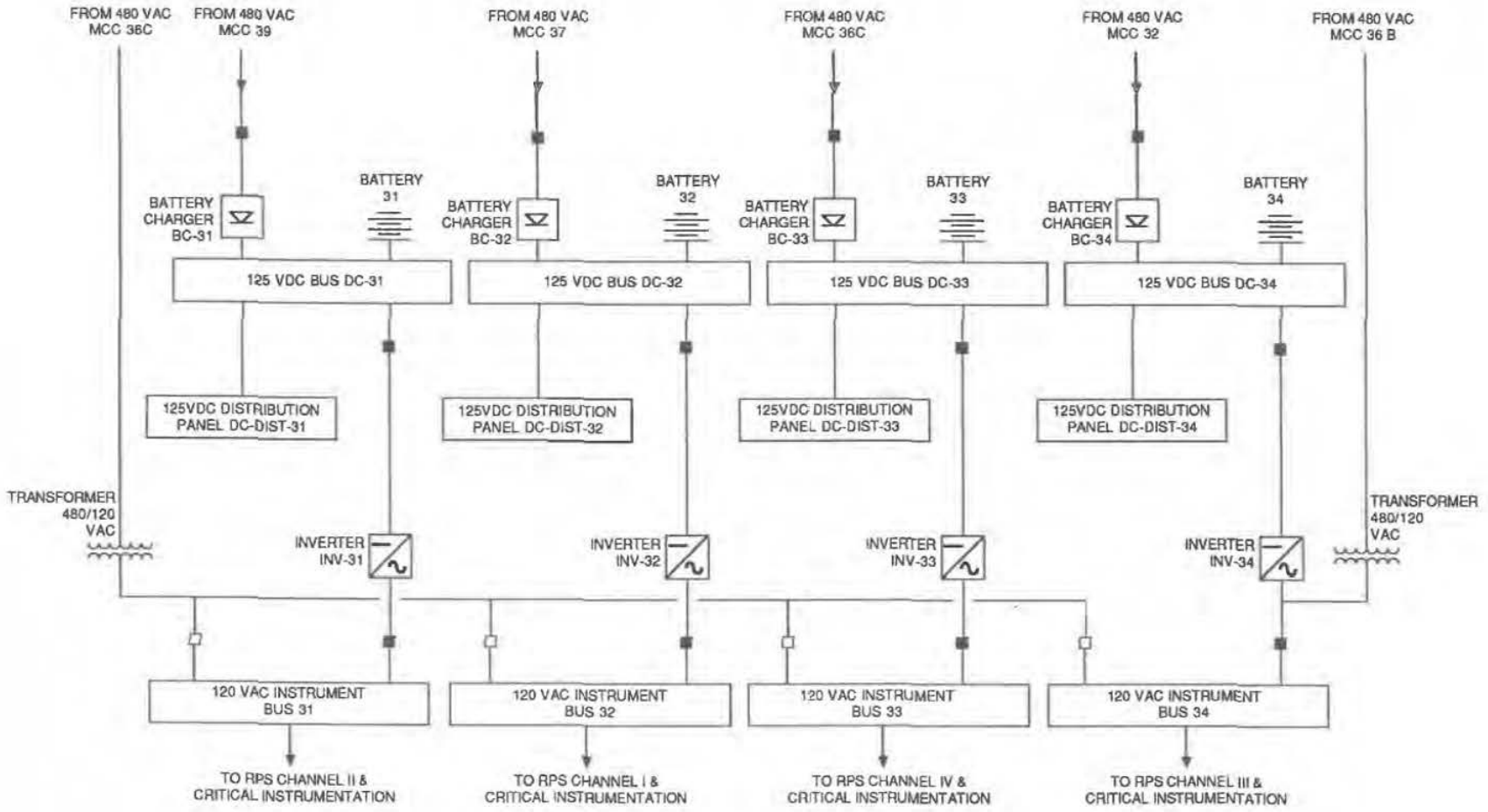


Figure 3.6-2. Indian Point 3 125 VDC and 120 VAC Electric Power System.

Table 3.6-1. Indian Point 3 Electric Power System Data Summary for Selected Components

COMPONENT ID	COMP. TYPE	LOCATION	POWER SOURCE	VOLTAGE	POWER SOURCE LOCATION	EMER. LOAD GRP.
BATT31	BATT	BAT31RM				DC/31
BATT32	BATT	BATRM32				DC/32
BATT33	BATT	DGRM31				DC/33
BC-31	BC	33CB	MCC39	480	33CB	AC/5A
BC-32	BC	33CB	MCC37	480	55PAB	AC/6A
BC-33	BC	15CB	MCC36C	480	15CB	AC/2A-3A
BUS2A	BUS	15CB	DG-31	480	DGRM31	AC/2A-3A
BUS3A	BUS	15CB	DG-31	480	DGRM31	AC/2A-3A
BUS5A	BUS	15CB	DG-33	480	DGRM33	AC/5A
BUS6A	BUS	15CB	DG-32	480	DGRM32	AC/6A
CB-2A	CB	15CB				
CB-3A	CB	15CB				
CB-5A	CB	15CB				
CB-6A	CB	15CB				
DC-31	BUS	33CB	BATT31	125	BAT31RM	DC/31
DC-32	BUS	33CB	BATT32	125	BATRM32	DC/32
DC-33	BUS	15CB	BATT33	125	DGRM31	DC/33
DG-31	DG	DGRM31				AC/2A-3A
DG-32	DG	DGRM32				AC/6A
DG-33	DG	DGRM33				AC/5A
INST-BUS-31	BUS	CR	INV-31	118	33CB	DC/31
INST-BUS-32	BUS	CR	INV-32	118	33CB	DC/32
INST-BUS-33	BUS	CR	INV-33	118		DC/33
INST-BUS-34	BUS	CR	INV-34	118		DC/34
INV-31	INV	33CB	DC-31	125	33CB	DC/31
INV-32	INV	33CB	DC-32	125	33CB	DC/32
INV-33	INV	33CB	DC-33	125	15CB	DC/33

Table 3.6-1. Indian Point 3 Electric Power System Data Summary for Selected Components (continued)

COMPONENT ID	COMP. TYPE	LOCATION	POWER SOURCE	VOLTAGE	POWER SOURCE LOCATION	EMER. LOAD GRP.
INV-34	INV	33CB	DC-34	125	33CB	DC/34
MCC36A	MCC	55PAB	BUS5A	480	15CB	AC/5A
MCC36B	MCC	55PAB	BUS6A	480	15CB	AC/6A
MCC36C	MCC	15CB	BUS2A	480	DGRM31	AC/2A-3A
MCC37	MCC	55PAB	BUS6A	480	15CB	AC/6A
MCC39	MCC	33CB	BUS5A	480	15CB	AC/5A

Table 3.6-2. Partial Listing of Electrical Sources and Loads at Indian Point 3

POWER SOURCE	VOLTAGE	EMERG LOAD GRP	POWER SOURCE LOCATION	LOAD SYSTEM	LOAD COMPONENT ID	COMP TYPE	COMPONENT LOCATION
BATT31	125	DC/31	BAT31RM	EP	DC-31	BUS	33CB
BATT32	125	DC/32	BATRM32	EP	DC-32	BUS	33CB
BATT33	125	DC/33	DGRM31	EP	DC-33	BUS	15CB
BUS2A	480	AC/2A-3A	15CB	AC	CC-32	MDP	CCWPMPRM
BUS2A	480	AC/2A-3A	15CB	ECCS	SI-32	MDP	SIPMPRM
BUS2A	480	AC/2A-3A	DGRM31	EP	MCC36C	MCC	15CB
BUS2A	480	AC/2A-3A	15CB	PAHRS	CRF-32	FCU	RC
BUS2A	480	AC/2A-3A	15CB	PAHRS	CRF-32	FCU	RC
BUS2A	480	AC/2A-3A	15CB	SW	SW-22	MDP	INTK
BUS3A	480	AC/2A-3A	15CB	AFW	AFW-31	MDP	18AFPB
BUS3A	480	AC/2A-3A	15CB	CVCS	CH-CH32	MDP	55PAB
BUS3A	480	AC/2A-3A	15CB	ECCS	RH-31	MDP	RHRPMPRM
BUS3A	480	AC/2A-3A	15CB	PAHRS	CRF-34	FCU	RC
BUS3A	480	AC/2A-3A	15CB	PAHRS	CRF-34	FCU	RC
BUS3A	480	AC/2A-3A	15CB	SW	SW-35	MDP	INTK
BUS3A	480	AC/2A-3A	15CB	SW	SW-38	MDP	ESWPLTF
BUS5A	480	AC/5A	15CB	AC	CC-31	MDP	CCWPMPRM
BUS5A	480	AC/5A	15CB	CVCS	CH-CH31	MDP	55PAB
BUS5A	480	AC/5A	15CB	ECCS	RE-31	MDP	RC
BUS5A	480	AC/5A	15CB	ECCS	SI-31	MDP	SIPMPRM
BUS5A	480	AC/5A	15CB	EP	MCC36A	MCC	55PAB
BUS5A	480	AC/5A	15CB	EP	MCC39	MCC	33CB
BUS5A	480	AC/5A	15CB	PAHRS	CRF-31	FCU	RC
BUS5A	480	AC/5A	15CB	PAHRS	CRF-31	FCU	RC
BUS5A	480	AC/5A	15CB	PAHRS	CRF-33	FCU	RC
BUS5A	480	AC/5A	15CB	PAHRS	CRF-33	FCU	RC
BUS5A	480	AC/5A	15CB	PAHRS	CS-31	MDP	PAB
BUS5A	480	AC/5A	15CB	SW	SW-31	MDP	INTK
BUS5A	480	AC/5A	15CB	SW	SW-34	MDP	INTK
BUS5A	480	AC/5A	15CB	SW	SW-37	MDP	ESWPLTF
BUS6A	480	AC/6A	15CB	AC	CC-33	MDP	CCWPMPRM

Table 3.6-2. Partial Listing of Electrical Sources and Loads at Indian Point 3 (continued)

POWER SOURCE	VOLTAGE	EMERG LOAD GRP	POWER SOURCE LOCATION	LOAD SYSTEM	LOAD COMPONENT ID	COMP TYPE	COMPONENT LOCATION
BUS6A	480	AC/6A	15CB	AFW	AFW-33	MDP	18AFPB
BUS6A	480	AC/6A	15CB	CVCS	CH-CH33	MDP	55PAB
BUS6A	480	AC/6A	15CB	ECCS	RE-32	MDP	RC
BUS6A	480	AC/6A	15CB	ECCS	RH-32	MDP	RHRPMPRM
BUS6A	480	AC/6A	15CB	ECCS	SI-33	MDP	SIPMPRM
BUS6A	480	AC/6A	15CB	EP	MCC36B	MCC	55PAB
BUS6A	480	AC/6A	15CB	EP	MCC37	MCC	55PAB
BUS6A	480	AC/6A	15CB	PAHRS	CRF-35	FCU	RC
BUS6A	480	AC/6A	15CB	PAHRS	CRF-35	FCU	RC
BUS6A	480	AC/6A	15CB	PAHRS	CS-32	MDP	PAB
BUS6A	480	AC/6A	15CB	SW	SW-33	MDP	INTK
BUS6A	480	AC/6A	15CB	SW	SW-36	MDP	INTK
BUS6A	480	AC/6A	15CB	SW	SW-39	MDP	ESWPLTF
DC-31	125	DC/31	33CB	EP	INV-31	INV	33CB
DC-32	125	DC/32	33CB	EP	INV-32	INV	33CB
DC-33	125	DC/33	15CB	EP	INV-33	INV	33CB
DC-34	125	DC/34	33CB	EP	INV-34	INV	33CB
DG-31	480	AC/2A-3A	DGRM31	EP	BUS2A	BUS	15CB
DG-31	480	AC/2A-3A	DGRM31	EP	BUS3A	BUS	15CB
DG-32	480	AC/6A	DGRM32	EP	BUS6A	BUS	15CB
DG-33	480	AC/5A	DGRM33	EP	BUS5A	BUS	15CB
INV-31	118	DC/31	33CB	EP	INST-BUS-31	BUS	CR
INV-32	118	DC/32	33CB	EP	INST-BUS-32	BUS	CR
INV-33	118	DC/33		EP	INST-BUS-33	BUS	CR
INV-34	118	DC/34		EP	INST-BUS-34	BUS	CR
MCC36A	480	AC/5A	55PAB	AC	CC-822A	MOV	PPEN
MCC36A	480	AC/5A	55PAB	CVCS	CH-BA31	MDP	55PAB
MCC36A	480	AC/5A	55PAB	ECCS	RCS-894A	MOV	RC
MCC36A	480	AC/5A	55PAB	ECCS	RCS-894C	MOV	RC
MCC36A	480	AC/5A	55PAB	ECCS	RE-1802A	MOV	RC
MCC36A	480	AC/5A	55PAB	ECCS	RE-885A	MOV	SERVWTRPIT

Table 3.6-2. Partial Listing of Electrical Sources and Loads at Indian Point 3 (continued)

POWER SOURCE	VOLTAGE	EMERG LOAD GRP	POWER SOURCE LOCATION	LOAD SYSTEM	LOAD COMPONENT ID	COMP TYPE	COMPONENT LOCATION
MCC36A	480	AC/5A	55PAB	ECCS	RH-744	MOV	PPEN
MCC36A	480	AC/5A	55PAB	ECCS	RH-745B	MOV	RC
MCC36A	480	AC/5A	55PAB	ECCS	SI-1810	MOV	SIPMPRM
MCC36A	480	AC/6A	55PAB	ECCS	SI-1852A	MOV	PAB
MCC36A	480	AC/5A	55PAB	ECCS	SI-747	MOV	RC
MCC36A	480	AC/5A	55PAB	ECCS	SI-887A	MOV	SIPMPRM
MCC36A	480	AC/5A	55PAB	PAHRS	CS-866A	MOV	PAB
MCC36A	480	AC/5A	55PAB	PAHRS	CS-889A	MOV	RC
MCC36A	480	AC/5A	55PAB	RCS	RCS-536	MOV	RC
MCC36A	480	AC/5A	55PAB	RCS	RCS-730	MOV	RC
MCC36B	480	AC/6A	55PAB	AC	CC-822B	MOV	PPEN
MCC36B	480	AC/6A	55PAB	CVCS	CH-112B	MOV	PAB
MCC36B	480	AC/6A	55PAB	CVCS	CH-BA32	MDP	55PAB
MCC36B	480	AC/6A	55PAB	ECCS	RCS-894B	MOV	RC
MCC36B	480	AC/6A	55PAB	ECCS	RCS894D	MOV	RC
MCC36B	480	AC/6A	55PAB	ECCS	RE-1802B	MOV	RC
MCC36B	480	AC/6A	55PAB	ECCS	RE-885B	MOV	SERVWTRPIT
MCC36B	480	AC/6A	55PAB	ECCS	RH-745A	MOV	RC
MCC36B	480	AC/6A	55PAB	ECCS	SI-1852B	MOV	PAB
MCC36B	480	AC/6A	55PAB	ECCS	SI-1869B	MOV	RC
MCC36B	480	AC/6A	55PAB	ECCS	SI-638	MOV	RC
MCC36B	480	AC/6A	55PAB	ECCS	SI-856B	MOV	RC
MCC36B	480	AC/6A	55PAB	ECCS	SI-856H	MOV	RC
MCC36B	480	AC/6A	55PAB	ECCS	SI-856J	MOV	RC
MCC36B	480	AC/6A	55PAB	ECCS	SI-882	MOV	PAB
MCC36B	480	AC/6A	55PAB	ECCS	SI-887B	MOV	SIPMPRM
MCC36B	480	AC/6A	55PAB	ECCS	SI-899B	MOV	RC
MCC36B	480	AC/6A	55PAB	PAHRS	CS-866B	MOV	PAB
MCC36B	480	AC/6A	55PAB	PAHRS	CS-889B	MOV	RC
MCC36B	480	AC/6A	55PAB	RCS	RCS-535	MOV	RC
MCC36B	480	AC/6A	55PAB	RCS	RCS-731	MOV	RC

Table 3.6-2. Partial Listing of Electrical Sources and Loads at Indian Point 3 (continued)

POWER SOURCE	VOLTAGE	EMERG LOAD GRP	POWER SOURCE LOCATION	LOAD SYSTEM	LOAD COMPONENT ID	COMP TYPE	COMPONENT LOCATION
MCC36C	480	AC/2A-3A	15CB	EP	BC-33	BC	15CB
MCC37	480	AC/6A	55PAB	CVCS	CH-PW31	MDP	PAB
MCC37	480	AC/6A	55PAB	CVCS	CH-PW32	MDP	PAB
MCC37	480	AC/6A	55PAB	EP	BC-32	BC	33CB
MCC39	480	AC/5A	33CB	EP	BC-31	BC	33CB

Table 4-1. Definition of Indian Point 3 Building and Location Codes

	Codes	Descriptions
1.	15CB	15' elevation of the Control Building
2.	18AFPB	18' elevation of the Auxiliary Feedwater Pump Building
3.	32AFPB	32' elevation of the Auxiliary Feedwater Pump Building
4.	33CB	33' elevation of the Control Building
5.	46AFPB	46' elevation of the Auxiliary Feedwater Pump Building
6.	55PAB	55' elevation of the Primary Auxiliary Building
7.	BAT31RM	Battery #31 Room, located on the 33' elevation of the Control Building
8.	BATRM32	Battery #32 Room, located on the 33' elevation of the Control Building
9.	CCWPMPRM	Component Cooling Water Pump Room, located on the 41' elevation of the Primary Auxiliary Building
10.	CR	Control Room, located on the 53' elevation of the Control Building
11.	CST	Condensate Storage Tank, located outside northeast of the Reactor Containment
12.	CWTRTK	City Water Tank, located outside approximately 1800' east of the plant.
13.	DGBLDG	Diesel Generator Building
14.	DGRM31	Diesel Generator #31 Room
15.	DGRM32	Diesel Generator #32 Room
16.	DGRM33	Diesel Generator #33 Room
17.	ELECTNL	Primary Auxiliary Building and Reactor Containment
18.	ESWPLTF	Emergency Service Water Pump Platform Structure located over the Unit #1 Discharge Tunnel approximately 100' northwest of the Turbine Building
19.	FSTORBLDG	Fuel Storage Building

Table 4-1. Definition of Indian Point 3 Building and Location Codes (Continued)

	Codes	Descriptions
20.	INTK	Intake Structure, located at the river - west of the Turbine Building
21.	MNSTMPPBRIDGE	Main Steam Pipe Bridge - outdoor structure between the Reactor Containment and the Turbine Building
22.	PAB	Primary Auxiliary Building
23.	PIPETNL	Pipe Tunnel from City Water Tank to the plant
24.	PPEN	Pipe Penetration Area - structure with Pipe tunnels between Primary Auxiliary Building and Reactor Containment
25.	PWST	Primary Water Storage Tank
26.	RC	Reactor Containment Structure
27.	RHRPMPRM	Residual Heat Removal Pump Room, located on the 15' elevation of the Primary Auxiliary Building
28.	RWST	Refueling Water Storage Tank, located outdoors approximately 200' east of the Reactor Containment
29.	SERVWTRPIT	Service Water Pit, valve pit located in the Primary Auxiliary Building
30.	SIPMPRM	Safety Injection Pump Room, located on the 34' elevation of the Primary Auxiliary Building
31.	SSTFMRYARD	Station Service Transformer Yard - outdoor area enclosed by the Turbine, Control, and Primary Auxiliary Buildings, and Reactor Containment Structure
32.	STAGE-AREA-N	Staging Area - North - outdoor area between the Auxiliary Feedwater Pump Building and the Condensate Storage Tank
33.	SWVP	Service Water Valve Pit, located outside approximately 50' northwest of the Turbine Building
34.	TB	Turbine Building

Table 4-2. Partial Listing of Components by Location at Indian Point 3

LOCATION	SYSTEM	COMPONENT ID	COMP TYPE
15CB	EP	DC-33	BUS
15CB	EP	BUS2A	BUS
15CB	EP	CB-2A	CB
15CB	EP	BUS6A	BUS
15CB	EP	CB-6A	CB
15CB	EP	BUS5A	BUS
15CB	EP	CB-5A	CB
15CB	EP	BUS3A	BUS
15CB	EP	CB-3A	CB
15CB	EP	BC-33	BC
15CB	EP	MCC36C	MCC
18AFPB	AFW	AFW-27	XV
18AFPB	AFW	AFW-1187	NV
18AFPB	AFW	AFW-31	MDP
18AFPB	AFW	AFW-33	MDP
18AFPB	AFW	AFW-32	TDP
18AFPB	AFW	AFW-1139	NV
18AFPB	AFW	AFW-405A	NV
18AFPB	AFW	AFW-406A	NV
18AFPB	AFW	AFW-30	XV
18AFPB	AFW	AFW-33	XV
18AFPB	AFW	AFW-64	XV
18AFPB	AFW	AFW-1188	NV
18AFPB	AFW	AFW-1189	NV
18AFPB	AFW	AFW-405B	NV
18AFPB	AFW	AFW-405C	NV
18AFPB	AFW	AFW-405D	NV
18AFPB	AFW	AFW-406B	NV
18AFPB	AFW	AFW-406C	NV
18AFPB	AFW	AFW-406D	NV

Table 4-2. Partial Listing of Components by Location at Indian Point 3 (continued)

LOCATION	SYSTEM	COMPONENT ID	COMP TYPE
33CB	EP	DC-32	BUS
33CB	EP	DC-31	BUS
33CB	EP	BC-31	BC
33CB	EP	BC-32	BC
33CB	EP	INV-31	INV
33CB	EP	INV-32	INV
33CB	EP	MCC39	MCC
33CB	EP	INV-33	INV
33CB	EP	INV-34	INV
55PAB	CVCS	CH-CH31	MDP
55PAB	CVCS	CH-CH32	MDP
55PAB	CVCS	CH-CH33	MDP
55PAB	CVCS	CH-BA31	MDP
55PAB	CVCS	CH-BA32	MDP
55PAB	CVCS	CH-278	XV
55PAB	CVCS	CH-230	XV
55PAB	CVCS	CH-283	XV
55PAB	CVCS	CH-235	XV
55PAB	CVCS	CH-284	XV
55PAB	CVCS	CH-236	XV
55PAB	CVCS	CH-364	XV
55PAB	CVCS	CH-360	XV
55PAB	CVCS	CH-366	XV
55PAB	CVCS	CH-267B	XV
55PAB	EP	MCC36A	MCC
55PAB	EP	MCC36B	MCC
55PAB	EP	MCC37	MCC
BAT31RM	EP	BATT31	BATT
BATRM32	EP	BATT32	BATT
CCWPMPRM	AC	CC-33	MDP

Table 4-2. Partial Listing of Components by Location at Indian Point 3 (continued)

LOCATION	SYSTEM	COMPONENT ID	COMP TYPE
CCWPMPRM	AC	CC-32	MDP
CCWPMPRM	AC	CC-31	MDP
CR	EP	INST-BUS-31	BUS
CR	EP	INST-BUS-32	BUS
CR	EP	INST-BUS-33	BUS
CR	EP	INST-BUS-34	BUS
CST	AFW	AFW-6	XV
CST	AFW	AFW-CST	TANK
CWTRTK	AFW	AFW-CWTR	TANK
DGRM31	EP	DG-31	DG
DGRM31	EP	BATT33	BATT
DGRM32	EP	DG-32	DG
DGRM33	EP	DG-33	DG
ESWPLTF	SW	SW-37	MDP
ESWPLTF	SW	SW-38	MDP
ESWPLTF	SW	SW-39	MDP
INTK	SW	SW-22	MDP
INTK	SW	SW-31	MDP
INTK	SW	SW-33	MDP
INTK	SW	SW-34	MDP
INTK	SW	SW-35	MDP
INTK	SW	SW-36	MDP
PAB	AC	CC-HX31	HX
PAB	AC	CC-HX32	HX
PAB	CVCS	CH-142	HV
PAB	CVCS	CH-110B	NV
PAB	CVCS	CH-111A	NV
PAB	CVCS	CH-PW31	MDP
PAB	CVCS	CH-PW32	MDP
PAB	CVCS	CH-110A	NV

Table 4-2. Partial Listing of Components by Location at Indian Point 3 (continued)

LOCATION	SYSTEM	COMPONENT ID	COMP TYPE
PAB	CVCS	CH-337	XV
PAB	CVCS	CH-BAT1	TANK
PAB	CVCS	CH-373	XV
PAB	CVCS	CH-BAT2	TANK
PAB	CVCS	CH-288	XV
PAB	CVCS	CH-112B	MOV
PAB	CVCS	CH-11	XV
PAB	CVCS	CH-16	XV
PAB	CVCS	CH-12	XV
PAB	CVCS	CH-15	XV
PAB	ECCS	SI-1852A	MOV
PAB	ECCS	SI-882	MOV
PAB	ECCS	SI-1852B	MOV
PAB	PAHRS	CS-866A	MOV
PAB	PAHRS	CS-31	MDP
PAB	PAHRS	CS-32	MDP
PAB	PAHRS	CS-866B	MOV
PAB	SW	CC-HX31	HX
PAB	SW	CC-HX31	HX
PAB	SW	CC-HX31	HX
PAB	SW	CC-HX32	HX
PAB	SW	CC-HX32	HX
PAB	SW	CC-HX32	HX
PIPETNL	AFW	AFW-49	XV
PPEN	AC	CC-822A	MOV
PPEN	AC	CC-822B	MOV
PPEN	ECCS	RH-744	MOV
PWST	CVCS	CH-PWST	TANK
RC	AC	RH-HX31	HX
RC	AC	RH-HX32	HX

Table 4-2. Partial Listing of Components by Location at Indian Point 3 (continued)

LOCATION	SYSTEM	COMPONENT ID	COMP TYPE
RC	CVCS	CH-204B	NV
RC	CVCS	CH-204A	NV
RC	ECCS	RCS-894A	MOV
RC	ECCS	RE-W1	TANK
RC	ECCS	RE-W2	TANK
RC	ECCS	RE-31	MDP
RC	ECCS	RE-32	MDP
RC	ECCS	RE-1802A	MOV
RC	ECCS	RE-1802B	MOV
RC	ECCS	SI-856A	MOV
RC	ECCS	SI-856B	MOV
RC	ECCS	RCS-VESSEL	RV
RC	ECCS	RH-745A	MOV
RC	ECCS	RH-745B	MOV
RC	ECCS	RCS-894B	MOV
RC	ECCS	RCS-894C	MOV
RC	ECCS	RCS894D	MOV
RC	ECCS	SI-856K	MOV
RC	ECCS	SI-856H	MOV
RC	ECCS	SI-856J	MOV
RC	ECCS	SI-1869B	MOV
RC	ECCS	SI-638	MOV
RC	ECCS	SI-899B	MOV
RC	ECCS	SI-747	MOV
RC	PAHRS	CS-889A	MOV
RC	PAHRS	CS-889B	MOV
RC	PAHRS	CRF-31	FCU
RC	PAHRS	CRF-31	FCU
RC	PAHRS	CRF-32	FCU
RC	PAHRS	CRF-33	FCU

Table 4-2. Partial Listing of Components by Location at Indian Point 3 (continued)

LOCATION	SYSTEM	COMPONENT ID	COMP TYPE
RC	PAHRS	CRF-34	FCU
RC	PAHRS	CRF-35	FCU
RC	PAHRS	CRF-32	FCU
RC	PAHRS	CRF-33	FCU
RC	PAHRS	CRF-34	FCU
RC	PAHRS	CRF-35	FCU
RC	RCS	RCS-VESSEL	RV
RC	RCS	RCS-730	MOV
RC	RCS	RCS-731	MOV
RC	RCS	RCS-536	MOV
RC	RCS	RCS-456	NV
RC	RCS	RCS-535	MOV
RC	RCS	RSC-455	NV
RHRPMPRM	ECCS	RH-31	MDP
RHRPMPRM	ECCS	RH-32	MDP
RWST	CVCS	SI-RWST	TANK
RWST	ECCS	SI-RWST	TANK
RWST	ECCS	SI-RWST	TANK
RWST	PAHRS	SI-RWST	TANK
RWST	PAHRS	SI-RWST	TANK
SERVWTRPIT	ECCS	RE-885A	MOV
SERVWTRPIT	ECCS	RE-885B	MOV
SIPMPRM	ECCS	SI-31	MDP
SIPMPRM	ECCS	SI-33	MDP
SIPMPRM	ECCS	SI-32	MDP
SIPMPRM	ECCS	SI-1810	MOV
SIPMPRM	ECCS	SI-887A	MOV
SIPMPRM	ECCS	SI-887B	MOV

From: Mohmand, Jamal Ahmed
To: Dennis, Suzanne
Subject: [External_Sender] RE: RE: [EXTERNAL] EDG Power
Date: Tuesday, March 24, 2020 2:26:07 PM
Attachments: image002.png

I believe it is separate from the Appendix R EDG.

Emergency Diesel Generator Electric Power System.

Function. The emergency diesel generator electric power system provides 480-Vac power to safeguard loads in the event of a loss of offsite power. This system is distinct from the stand-alone 10CFR50 "Appendix R" diesel generator which provides power in the event of fire.

From: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Sent: Tuesday, March 24, 2020 11:56 AM
To: Mohmand, Jamal Ahmed <jamohma@sandia.gov>
Cc: LaFleur, Chris <aclafle@sandia.gov>
Subject: RE: RE: [EXTERNAL] EDG Power

It's not modeled with that level of detail in the SPAR model.

From: Mohmand, Jamal Ahmed <jamohma@sandia.gov>
Sent: Tuesday, March 24, 2020 1:41 PM
To: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>; LaFleur, Chris <aclafle@sandia.gov>
Subject: [External_Sender] RE: [EXTERNAL] EDG Power

Is that how it's modeled in IPE SPAR model?

From: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Sent: Tuesday, March 24, 2020 11:34 AM
To: Mohmand, Jamal Ahmed <jamohma@sandia.gov>; LaFleur, Chris <aclafle@sandia.gov>
Subject: [EXTERNAL] EDG Power

Hi Chris and Jamal,

Just wanted to share what I found in the Unit 3 IPE for their EDG power. It looks like power from the diesels has to go through the onsite (open air) transformers before being distributed to any loads:

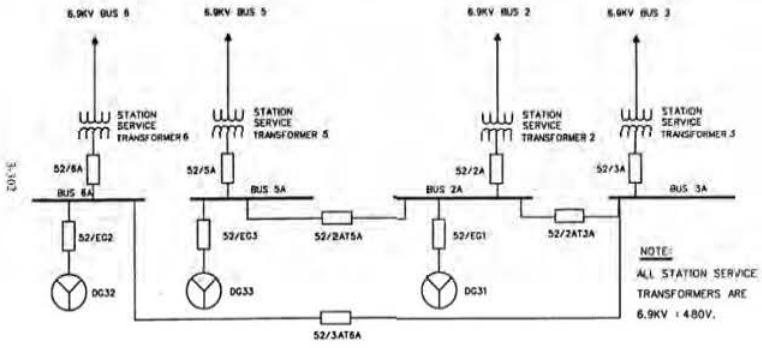


Figure 3.2.2.16 EMERGENCY DIESEL GENERATORS AND 480-Vac DISTRIBUTION SCHEMATIC

Suzanne Dennis
Office of Research
U.S. NRC
301-415-0760

From: Mohmand, Jamal Ahmed
To: Dennis, Suzanne; LaFleur, Chris
Subject: [External_Sender] RE: [EXTERNAL] EDG Power
Date: Tuesday, March 24, 2020 1:41:31 PM

Is that how it's modeled in IPE SPAR model?

From: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Sent: Tuesday, March 24, 2020 11:34 AM
To: Mohmand, Jamal Ahmed <jamohma@sandia.gov>; LaFleur, Chris <aclafle@sandia.gov>
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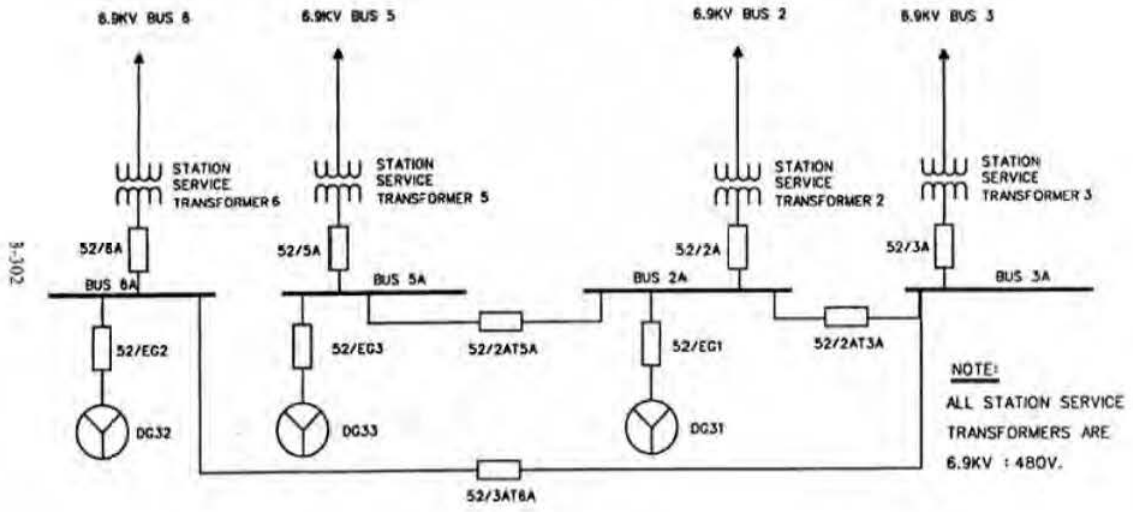

Figure 3.2.2.16 EMERGENCY DIESEL GENERATORS AND 480-Vac DISTRIBUTION SCHEMATIC

Suzanne Dennis
Office of Research
U.S. NRC
301-415-0760

From: Luketa, Anay
To: Dennis, Suzanne
Subject: [External_Sender] RE: [EXTERNAL] Quick Call?
Date: Tuesday, March 24, 2020 12:01:40 PM

Hi Suzanne,
I had connectivity issues yesterday, so sorry for the delayed response. The only information that I didn't get was the delay time used in ALOHA. I did work backwards to about match Rao's number using an 8 minute delay time. So, if he doesn't remember I'm just going to note this in the memo.
Anay

From: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Sent: Monday, March 23, 2020 1:42 PM
To: Luketa, Anay <aluketa@sandia.gov>
Subject: [EXTERNAL] Quick Call?

Hey Anay,

Are you available for a quick call? I just wanted to check-in after our call with Rao.

Thanks!
Suzanne
(b)(6)

Suzanne Dennis
Office of Research
U.S. NRC
301-415-0760

From: Mohmand, Jamal Ahmed
To: Dennis, Suzanne
Subject: [External_Sender] RE: [EXTERNAL] FW: Blast radius calculations
Date: Tuesday, March 24, 2020 11:32:45 AM

Suzanne,

Like we briefly discussed yesterday, I was able to replicate the results of both Rao's calculation of the 2300 feet as well as Paul/Joe's calculation of 4100 feet. The only difference between the two is the amount of gas released which results in largely different results.

In regards to Entergy's 1100 foot result using the same equations, it is unclear how they arrived at this number as they did not show the numbers they used. Through some mental gymnastics I can produce an 1100 foot result, but would require invalid math to arrive there.

I looked at both the Turkey Point and the Calvert Cliffs analysis and did not see the use of the same equations in the report specifically.

If it is deemed that the equation used is appropriate I would suggest including it directly into Reg. Guide 1.91.

Thanks,
Jamal

From: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Sent: Friday, March 20, 2020 7:11 AM
To: Luketa, Anay <aluketa@sandia.gov>
Cc: Mohmand, Jamal Ahmed <jamohma@sandia.gov>
Subject: [EXTERNAL] FW: Blast radius calculations

Hi Anay,

I know you're focused on the simulation right now, so I don't want to overwhelm you, but here are how other people have used RG 1.91. We're trying to see if there is a difference in assumptions or a problem with the RG. So, if you get a chance, take a look.

Jamal – if you can look these over too – that would be helpful!

Thanks!
Suzanne

From: Skeen, David <David.Skeen@nrc.gov>
Sent: Friday, March 20, 2020 9:03 AM
To: Clark, Theresa <Theresa.Clark@nrc.gov>; Harris, Brian <Brian.Harris@nrc.gov>; Dennis, Suzanne <Suzanne.Dennis@nrc.gov>; Li, Yueh-Li <Yueh-Li.Li@nrc.gov>

Subject: FW: Blast radius calculations

All,

FYI – Paul sent these calculations that several folks did using RG1.91. He will likely raise this issue during our call today.

This one of Paul's contentions - that the calculation performed by the NRC was not done properly.

I know Suanne and Renee have already been looking at the NRC's calculations. Hopefully, by reviewing these calculations by others we may be able clarify whether there is a problem with the actual guidance in RG1.91, or identify where there may be an error in assumptions used by either the NRC or these external stakeholders.

Thx!

From: Paul <pmblanch@comcast.net>
Sent: Friday, March 20, 2020 8:54 AM
To: Skeen, David <David.Skeen@nrc.gov>
Cc: Paul M. Blanch <pmblanch@comcast.net>
Subject: [External_Sender] Blast radius calculations

David:

Here are four independent non-QA calculations done by 3 PEs and David Lochbaum using the NRC's RG 1.91 equation.

Paul Blanch
135 Hyde Rd.
West Hartford, CT 06117
pmblanch@comcast.net
860-236-0326
Cell 860-922-3119

From: Mohmand, Jamal Ahmed
To: Dennis, Suzanne
Subject: [External_Sender] RE: [EXTERNAL] FW: SNL
Date: Tuesday, March 24, 2020 11:14:21 AM

I've added the table and write-up as an appendix to Anay's memo.

Jamal

From: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Sent: Tuesday, March 24, 2020 7:10 AM
To: Mohmand, Jamal Ahmed <jamohma@sandia.gov>
Subject: Re: [EXTERNAL] FW: SNL

Hi Jamal,

Yes, I think the EDGs at the 4000 kg/s is fine.

I agree that I think the RG should include a reference to this report. It's very valuable!

Suzanne

From: Mohmand, Jamal Ahmed <jamohma@sandia.gov>
Sent: Monday, March 23, 2020 11:04 PM
To: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Subject: [External_Sender] [EXTERNAL] FW: SNL

Do you want the EDGs also at the 4000 kg/s mass flow rate?

Something you might want keep in mind is that Entergy and the NRC both analyzed a 12.5 kW/m^2 fire but, that's not a requirement in 1.91 from what I see.
The 12.5 is roughly half what the nominal case is based on this NUREG. It may be beneficial to reference Nureg 3330 in 1.91 it seems relevant to this process and is not mentioned once.

It provides important siting guidance in the process of analyzing gas pipelines.
Maybe if the safe distance to XYZ is within X feet, do an analysis similar to one done in Nureg 3330.

Which might quell the question of are plants safe if an explosion calculation is wrong, or any unforeseen explosion occurs. I think if an analysis like this was provided or discussed in this process it would have stymied some of the issues.

Jamal

From: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Sent: Monday, March 23, 2020 6:34 PM
To: Mohmand, Jamal Ahmed <jamohma@sandia.gov>
Subject: RE: RE: RE: RE: RE: RE: RE: [EXTERNAL] FW: SNL

I think that the bounding flow rate is ok. Given that according to the NUREG, reinforced concrete buildings

can survive for 5 hours at 50 kW/m2, I think it's good to show that even a MUCH higher flow rate is still ok for safety systems. Could you add a row at 700 meters? That's close to how far away the closest EDGs are.

Suzanne

From: Mohmand, Jamal Ahmed <jamohma@sandia.gov>
Sent: Monday, March 23, 2020 7:12 PM
To: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Subject: [External_Sender] RE: RE: RE: RE: RE: RE: [EXTERNAL] FW: SNL

Suzanne,

I've prepared a write-up based on what we discussed today. In doing so I realized that the SOCA fence is only 482 meters from the pipeline according to Entergy (we were looking at 1500 m) earlier this morning.
I've put together this table, using the 4000 kg/s mass flow rate as a bounding value. Which is more than what is described in the nureg 2000-3200 kg/s. At 44 (50 kW/m^2) the exposure time is 5 hours.

Let me know if you would rather use a different bounding mass flow rate, or use more accurate distances to buildings.

Case	Distance (m)	Mass Flow Rate (kg/s)	Radiated Power (kW)	Fire Diameter (m)	Transmissivity	Incident Radiation (kW/m^2)
Sample	482	N/A	N/A	N/A	N/A	N/A
	500	1700	4.09E+07	295	0.7	19.6
	1000				0.63	4.6
	1500				0.57	2
NRC	482	1900	4.57E+07	312	0.7	23.1
	500				0.7	21.6
	1000				0.63	5.2
	1500				0.57	2.2
Bounding	482	4000	9.61E+07	452	0.7	44.1
	500				0.7	41.5
	1000				0.63	10.6
	1500				0.57	4.7

Thanks,
Jamal

From: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Sent: Monday, March 23, 2020 1:30 PM
To: Mohmand, Jamal Ahmed <jamohma@sandia.gov>
Subject: RE: RE: RE: RE: RE: RE: [EXTERNAL] FW: SNL

(b)(6)

From: Mohmand, Jamal Ahmed <jamohma@sandia.gov>
Sent: Monday, March 23, 2020 3:28 PM
To: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Subject: [External_Sender] RE: RE: RE: RE: RE: [EXTERNAL] FW: SNL

What's your number, I've got 30 minutes.

From: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Sent: Monday, March 23, 2020 1:19 PM
To: Mohmand, Jamal Ahmed <jamohma@sandia.gov>
Subject: RE: RE: RE: RE: RE: [EXTERNAL] FW: SNL

Hey Jamal,

I'm free anytime this afternoon. The same skype link should work, or you can give me a call.

Suzanne

From: Mohmand, Jamal Ahmed <jamohma@sandia.gov>
Sent: Monday, March 23, 2020 3:10 PM
To: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Subject: [External_Sender] RE: RE: RE: RE: [EXTERNAL] FW: SNL

Suzanne,

I've completed the calc, let me know when you have time to go over it.
This was a quick/rough reproduction of the paper, I included the calculation from the example.

Thanks,
Jamal

From: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Sent: Monday, March 23, 2020 12:07 PM
To: Mohmand, Jamal Ahmed <jamohma@sandia.gov>
Subject: RE: RE: RE: RE: [EXTERNAL] FW: SNL

Great! Thank you!

From: Mohmand, Jamal Ahmed <jamohma@sandia.gov>
Sent: Monday, March 23, 2020 2:05 PM
To: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Subject: [External_Sender] RE: RE: RE: [EXTERNAL] FW: SNL

I am working on re-producing the example calculation, once I do that I'll start applying the numbers related to the AIM pipeline.

From: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>

Sent: Monday, March 23, 2020 11:57 AM
To: Mohmand, Jamal Ahmed <jamohma@sandia.gov>
Subject: RE: RE: RE: [EXTERNAL] FW: SNL

Interesting! I'm looking at it and thinking about it too...it seems like something we should be able to use.

From: Mohmand, Jamal Ahmed <jamohma@sandia.gov>
Sent: Monday, March 23, 2020 1:09 PM
To: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Subject: [External_Sender] RE: RE: [EXTERNAL] FW: SNL

I forgot to mention that the Nureg specifically discusses pipeline explosions.
Stating that a 36 inch pipeline does not pose a significant hazard at 500 feet or greater. (5/60 PDF)

Starting on page 41 there are example calculations for a high-pressure natural gas pipeline.
Provides a flow rate of 2000-3200 (kg/s) for a 40 inch diameter pipeline. (table 3-1)

I'm trying to think or see if there is a way to adapt the method/equations used in this NUREG and apply them to our situation.
Let me know what you think about that.

Thanks,
Jamal

From: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Sent: Monday, March 23, 2020 9:07 AM
To: Mohmand, Jamal Ahmed <jamohma@sandia.gov>
Subject: RE: RE: [EXTERNAL] FW: SNL

Sure! 10:30 MDT works for me. You can give me a call (or vice versa) or I can set-up a quick Skype.

Whatever works best for you!

Suzanne
301-415-0760
(b)(6)

From: Mohmand, Jamal Ahmed <jamohma@sandia.gov>
Sent: Monday, March 23, 2020 11:04 AM
To: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Subject: [External_Sender] RE: [EXTERNAL] FW: SNL

Hi Suzanne,

I have found some related information in NUREG 3330, and shared that with Scott and Anay.
Do you have some time to go over what your concerns and we can discuss if what I found suffices?

Thanks,

Jamal

From: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Sent: Monday, March 23, 2020 7:12 AM
To: Sanborn, Scott Edward <sesanbo@sandia.gov>
Cc: Luketa, Anay <aluketa@sandia.gov>; Mohmand, Jamal Ahmed <jamohma@sandia.gov>; Glover, Austin Michael <amglove@sandia.gov>; LaFleur, Chris <aclafle@sandia.gov>
Subject: [EXTERNAL] FW: SNL

Hi Scott,

Is this something you all could help with? We're looking for big-picture numbers at this point.

Thanks!
Suzanne

From: Clark, Theresa <Theresa.Clark@nrc.gov>
Sent: Monday, March 23, 2020 8:15 AM
To: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Subject: SNL

Can you ask SNL to look at heat transfer through reinforced concrete walls of the thickness we are looking at? 12.5 KW on the outside based on some of the materials we are seeing... what's the inside?

We may have expertise in the NRC on this, but if SNL can do it, that may be even easier.

Thanks,
Theresa

From: Mohmand, Jamal Ahmed
To: Dennis, Suzanne
Subject: [External_Sender] RE: RE: RE: RE: [EXTERNAL] FW: SNL
Date: Monday, March 23, 2020 3:10:29 PM
Attachments: Nureg 3330 Calc.xlsx

Suzanne,

I've completed the calc, let me know when you have time to go over it.
This was a quick/rough reproduction of the paper, I included the calculation from the example.

Thanks,
Jamal

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Variable	Units	Example	AIM
P_r	kW	Solve for	Solve for
Mf	kg/s	1700	1900
N		1	1
Hc	J/kg	5.60E+07	5.60E+07
Tf	K	1500	1500
Ta	K	300	300
S		17	17
X		0.25	0.25
Cpa	J/kg	1150	1150
Cpf	J/kg	2200	2200
	Pr	4.09E+07	4.57E+07
surface area emittance	kW/m^2	150	150
surface area	m^2	2.72E+05	3.04E+05
radius	m	147.229881	155.6497
diameter	m	294.459763	311.2994
F_tf (in meters)	500	0.07978838	0.088346
F_tf (in meters)	1000	0.02121673	0.023654
F_tf (in meters)	1500	0.00954213	0.010653
F_tf (in meters)	2000	0.00538995	0.00602
Psu	kW/m^2	350	350
Qi (kW/m^2)	500	19.5481523	21.64476
	1000	4.64115982	5.795175
	1500	2.00384769	2.60993
	2000		

250000 pounds/min from RAO and Joe Carson

113398.1 kg/min

1889.968

rounded up from 1877 to 1900

used Transmissivity graph RH 20% (most cons)

From: Mohmand, Jamal Ahmed
To: Dennis, Suzanne
Subject: [External_Sender] RE: RE: RE: [EXTERNAL] FW: SNL
Date: Monday, March 23, 2020 2:05:39 PM

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Suzanne
301-415-0760

(b)(6)

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Hi Suzanne,

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Do you have some time to go over what your concerns and we can discuss if what I found suffices?

Thanks,
Jamal

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To: Sanborn, Scott Edward <sesanbo@sandia.gov>
Cc: Luketa, Anay <aluketa@sandia.gov>; Mohmand, Jamal Ahmed <jamohma@sandia.gov>; Glover, Austin Michael <amglove@sandia.gov>; LaFleur, Chris <aclafle@sandia.gov>
Subject: [EXTERNAL] FW: SNL

Hi Scott,

Is this something you all could help with? We're looking for big-picture numbers at this point.

Thanks!
Suzanne

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Sent: Monday, March 23, 2020 8:15 AM
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We may have expertise in the NRC on this, but if SNL can do it, that may be even easier.

Thanks,
Theresa

From: Luketa, Anay
To: Dennis, Suzanne
Subject: [External_Sender] RE: RE: RE: [EXTERNAL] FW: Gas Loss in a Pipeline - based upon pressure and mileage
Date: Thursday, March 19, 2020 5:49:01 PM
Attachments: image001.png

Hi Suzanne,
Yes, I should be available. -Anay

From: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Sent: Thursday, March 19, 2020 2:14 PM
To: Luketa, Anay <aluketa@sandia.gov>
Subject: RE: RE: RE: [EXTERNAL] FW: Gas Loss in a Pipeline - based upon pressure and mileage

Hey Anay,

It turns out our team has some questions for Rao too. Are you available for a meeting on Monday? We'll ask for the input files then.

Suzanne

From: Luketa, Anay <aluketa@sandia.gov>
Sent: Thursday, March 19, 2020 12:28 PM
To: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Subject: [External_Sender] RE: RE: [EXTERNAL] FW: Gas Loss in a Pipeline - based upon pressure and mileage

Hi Suzanne,

I find sometimes in discussion there can be misinterpretation, etc. I would actually prefer an e-mail with inputs in a table which is more straightforward for me. This hopefully should be pretty easy for Rao to do. Let me know it's a problem.

Thanks,
Anay

From: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Sent: Thursday, March 19, 2020 9:39 AM
To: Luketa, Anay <aluketa@sandia.gov>
Cc: Mohmand, Jamal Ahmed <jamohma@sandia.gov>
Subject: RE: RE: [EXTERNAL] FW: Gas Loss in a Pipeline - based upon pressure and mileage

Hey Anay,

I know we just got off the phone, but after thinking about it further, would you just like me to set-up a telecon with Rao? That way you can ask any questions you need, and nothing will get lost in translation.

Suzanne

From: Luketa, Anay <aluketa@sandia.gov>
Sent: Thursday, March 19, 2020 10:56 AM
To: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>; Mohmand, Jamal Ahmed <jamohma@sandia.gov>
Subject: [External_Sender] RE: [EXTERNAL] FW: Gas Loss in a Pipeline - based upon pressure and mileage

Hi Suzanne,

I have a few questions about the NRC analysis. On page 3, last paragraph, it states that ALOHA was used for an explosion calculation. It also states that a 5% yield factor was assumed. Using ALOHA I don't see an entry for that. Based upon what I read, I'm getting 1.8 miles, no 3054 ft. So, either I'm misunderstanding what was done, incorrect value was stated, or we're using different versions of ALOHA.

Can I be provided what inputs were used for this calculation? Also, can you find out what version of ALOHA was used?

Thanks!
Anay

From: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Sent: Thursday, March 19, 2020 7:55 AM
To: Luketa, Anay <aluketa@sandia.gov>; Mohmand, Jamal Ahmed <jamohma@sandia.gov>
Subject: [EXTERNAL] FW: Gas Loss in a Pipeline - based upon pressure and mileage

Good mornir g,

Steve shared the below equation from PHMSA. Not sure if it is helpful to you all, but I thought I would pass it along.

Suzanne

From: Nanney, Steve (PHMSA) <Steve.Nanney@dot.gov>
Sent: Wednesday, March 18, 2020 8:14 PM
To: Clark, Theresa <Theresa.Clark@nrc.gov>; Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Cc: Nanney, Steve (PHMSA) <Steve.Nanney@dot.gov>
Subject: [External_Sender] Gas Loss in a Pipeline - based upon pressure and mileage

Below is an equation for determining volume of gas loss in a gas pipeline.

Additionally, upgrading pipelines generally requires operators to empty the natural gas from the pipeline via a procedure called "blowdown" which entails releasing natural gas into the atmosphere. PHMSA calculated the amount of gas that would be released through this procedure per mile using **Equation 1**.

Equation 1: $$\boldsymbol{Vb = (28.798 * (Tb/Pb) * (Pavg/(Zavg * Tavg)) * D^2)/1000}$$

Where:

Vb = Volume of gas released per mile (thousand cubic feet; MCF)

Tb = Temperature at standard conditions (70 degrees F)

Pb = Pressure at standard conditions (14.7 pounds per square inch; PSI)

Pavg = Pressure at blowdown conditions (100 PSI for intrastate; 150 PSI for interstate)

Zavg = Compressibility factor at packed conditions (0.88)

Tavg = Temperature at packed conditions (70 degrees F)

D = inside diameter of pipeline in inches (29.25 for 30-inch pipes, 15.25 for 16-inch pipes, and 7.5 for 8-inch pipes)

Steve Nanney
PHMSA - Houston
(b)(6) **– mobile**

From: Sanborn, Scott Edward
To: Dennis, Suzanne
Subject: [External_Sender] IP deliverable
Date: Thursday, March 19, 2020 3:56:51 PM

Hi Suzanne,

I wanted to check with you on SNL producing a deliverable for the IP pipeline issue. I know you said in the past that nothing more than email is required. However, in thinking about some potential pit-falls with some information being taking out of context, we will plan to document our work in a memo to you by the 27th. Let me know if you see any concerns with us writing a memo and if you feel it should be marked OUO for pre-decisional purposes.

As a side note, most of SNL is working from home, so if you need to reach me either email or call my cell (b)(6)

Thanks,
Scott

From: Mohmand, Jamal Ahmed
To: Dennis, Suzanne
Subject: [External_Sender] RE: RE: RE: [EXTERNAL] Let me know if you have any questions. Thanks! (EOM)
Date: Thursday, March 19, 2020 2:16:33 PM

Yes as long as you don't lose multiple high level safety systems + switchyard there shouldn't be an issue.

From: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Sent: Thursday, March 19, 2020 12:13 PM
To: Mohmand, Jamal Ahmed <jamohma@sandia.gov>
Subject: RE: RE: RE: [EXTERNAL] Let me know if you have any questions. Thanks! (EOM)

Also, just FYI, we're looking at a risk analysis to see what the impact would be if we lose the switchyard. So, it's definitely something that we're looking at. (So far, it looks like you would need to lose the diesels for both units, the Appendix R diesels, and FLEX equipment for it to be a real problem.)

From: Mohmand, Jamal Ahmed <jamohma@sandia.gov>
Sent: Thursday, March 19, 2020 2:09 PM
To: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Subject: [External_Sender] RE: RE: [EXTERNAL] Let me know if you have any questions. Thanks! (EOM)

Haha agreed

From: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Sent: Thursday, March 19, 2020 12:04 PM
To: Mohmand, Jamal Ahmed <jamohma@sandia.gov>
Subject: RE: RE: [EXTERNAL] Let me know if you have any questions. Thanks! (EOM)

I don't think he has any knowledge of plant operations (that us).

From: Mohmand, Jamal Ahmed <jamohma@sandia.gov>
Sent: Thursday, March 19, 2020 1:59 PM
To: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Subject: [External_Sender] RE: [EXTERNAL] Let me know if you have any questions. Thanks! (EOM)

I was going to bring up the switchyard, and the ability to shutdown the plant (something we need to think about).

Is a vapor cloud travelling and then ignition a concern? Potentially entering buildings.

From: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Sent: Thursday, March 19, 2020 11:57 AM

To: Mohmand, Jamal Ahmed <jamohma@sandia.gov>
Subject: [EXTERNAL] Let me know if you have any questions. Thanks! (EOM)

Suzanne Dennis
Office of Research
U.S. NRC
301-415-0760

From: Mohmand, Jamal Ahmed
To: Dennis, Suzanne
Subject: [External_Sender] RE: [EXTERNAL] Let me know if you have any questions. Thanks! (EOM)
Date: Thursday, March 19, 2020 2:00:34 PM

I was going to bring up the switchyard, and the ability to shutdown the plant (something we need to think about).

Is a vapor cloud travelling and then ignition a concern? Potentially entering buildings.

From: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Sent: Thursday, March 19, 2020 11:57 AM
To: Mohmand, Jamal Ahmed <jamohma@sandia.gov>
Subject: [EXTERNAL] Let me know if you have any questions. Thanks! (EOM)

Suzanne Dennis
Office of Research
U.S. NRC
301-415-0760

From: Mohmand, Jamal Ahmed
To: Dennis, Suzanne
Subject: [External_Sender] RE: [EXTERNAL] RE: Pipeline External Fire at NPP
Date: Wednesday, March 18, 2020 2:38:37 PM

Thanks for the quick response!
That's what I was afraid of.

From: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Sent: Wednesday, March 18, 2020 12:37 PM
To: Mohmand, Jamal Ahmed <jamohma@sandia.gov>
Subject: [EXTERNAL] RE: Pipeline External Fire at NPP

Hi Jamal,

I've added Chapter 9 of the Unit 3 UFSAR to the BOX site.

We won't have access any EPRI documents that aren't publicly available, unfortunately. We have to go through their paywall too.

Suzanne

From: Mohmand, Jamal Ahmed <jamohma@sandia.gov>
Sent: Wednesday, March 18, 2020 2:23 PM
To: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Subject: [External_Sender] Pipeline External Fire at NPP

Hi Suzanne,

Not sure if we talking about the potential impact for an external fire or if it was someone else on the phone, but something the might be helpful to me would be the Fire Protection Program portion of the Indian Point USAR. I believe that's typically chapter 9, it might have some information on that but I have not specifically looked for.
I will also look for any EPRI documents regarding the topic, if I do find something from EPRI I won't have access to due to their paywall. I am not sure if the NRC would have access to that information.

Thanks,
Jamal

Jamal Mohmand
Fire, Risk, and Tranportation Systems (8854)
Sandia National Laboratories
~~+1-505-844-3282 (O)~~ | (b)(6) (C)
jamohma@sandia.gov

From: Luketa, Anay
To: Dennis, Suzanne
Subject: [External_Sender] RE: [EXTERNAL] Contact Info
Date: Wednesday, March 11, 2020 3:01:00 PM

Hi Suzanne,

Yes that would be fine. My number is (b)(6)

-Anay

From: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Sent: Wednesday, March 11, 2020 12:59 PM
To: Luketa, Anay <aluketa@sandia.gov>
Subject: [EXTERNAL] Contact Info

Hey Anay,

Can I give you a quick call this afternoon? It will probably be in an hour or two.

If so, can you send me your phone number?

Thanks!
Suzanne

Suzanne Dennis
Office of Research
U.S. NRC
301-415-0760

From: Luketa, Anay
To: Dennis, Suzanne
Subject: [External_Sender] RE: [External_Sender] RE: RE: RE: [EXTERNAL] ACTION: Questions for First Interview
Date: Monday, March 09, 2020 11:34:05 AM

Ok, thanks. I'll try that.

From: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Sent: Monday, March 9, 2020 9:33 AM
To: Luketa, Anay <aluketa@sandia.gov>
Subject: RE: [External_Sender] RE: RE: RE: [EXTERNAL] ACTION: Questions for First Interview

I had to restart my computer (who know why) for mine to work. Maybe that will help you too...

From: Luketa, Anay <aluketa@sandia.gov>
Sent: Monday, March 09, 2020 11:31 AM
To: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>; LaFleur, Chris <aclafle@sandia.gov>; Sanborn, Scott Edward <sesanbo@sandia.gov>; Mohmand, Jamal Ahmed <jamohma@sandia.gov>; Glover, Austin Michael <amglove@sandia.gov>
Subject: [External_Sender] RE: RE: RE: [EXTERNAL] ACTION: Questions for First Interview

I was able to sign up and download the documents but one that I downloaded showed 0 bytes. I went to log back in but I'm receiving an authentication error. I just sent Theresa an e-mail about this. -Anay

From: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Sent: Monday, March 9, 2020 9:26 AM
To: LaFleur, Chris <aclafle@sandia.gov>; Luketa, Anay <aluketa@sandia.gov>; Sanborn, Scott Edward <sesanbo@sandia.gov>; Mohmand, Jamal Ahmed <jamohma@sandia.gov>; Glover, Austin Michael <amglove@sandia.gov>
Subject: RE: RE: RE: [EXTERNAL] ACTION: Questions for First Interview

Great! Just FYI – we have the references used in several of the documents already "found," so if you need something, please reach out!
Suzanne

From: LaFleur, Chris <aclafle@sandia.gov>
Sent: Monday, March 09, 2020 11:22 AM
To: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>; Luketa, Anay <aluketa@sandia.gov>; Sanborn, Scott Edward <sesanbo@sandia.gov>; Mohmand, Jamal Ahmed <jamohma@sandia.gov>; Glover, Austin Michael <amglove@sandia.gov>
Subject: [External_Sender] RE: RE: [EXTERNAL] ACTION: Questions for First Interview

Box site works for me!
Chris

From: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Sent: Monday, March 9, 2020 9:21 AM
To: LaFleur, Chris <aclafle@sandia.gov>; Luketa, Anay <aluketa@sandia.gov>; Sanborn, Scott Edward <sesanbo@sandia.gov>; Mohmand, Jamal Ahmed <jamohma@sandia.gov>; Glover, Austin Michael <amglove@sandia.gov>
Subject: RE: RE: [EXTERNAL] ACTION: Questions for First Interview

We'll be taking notes and we will absolutely share that. Is the BOX site working for you all? We'll probably put the notes there, so you and Steve (PHSMA) can access them.

Suzanne

From: LaFleur, Chris <aclafle@sandia.gov>
Sent: Monday, March 09, 2020 11:15 AM
To: Luketa, Anay <aluketa@sandia.gov>; Dennis, Suzanne <Suzanne.Dennis@nrc.gov>; Sanborn, Scott Edward <sesanbo@sandia.gov>; Mohmand, Jamal Ahmed <jamohma@sandia.gov>; Glover, Austin Michael <amglove@sandia.gov>
Subject: [External_Sender] RE: [EXTERNAL] ACTION: Questions for First Interview

Hi Suzanne,

Yes, those questions seem pretty thorough for now. I am sure we would have some follow-on questions once we review his answers. Will there be a transcript of his answers? Or will notes be taken that we can read?

Thanks
Chris

From: Luketa, Anay
Sent: Monday, March 9, 2020 9:06 AM
To: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>; LaFleur, Chris <aclafle@sandia.gov>; Sanborn, Scott Edward <sesanbo@sandia.gov>; Mohmand, Jamal Ahmed <jamohma@sandia.gov>; Glover, Austin Michael <amglove@sandia.gov>
Subject: RE: [EXTERNAL] ACTION: Questions for First Interview

Hi Suzanne,

These are definitely a good list of questions. I don't have anything to add as of now. It will be interesting to see what he has to say.

-Anay

From: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Sent: Monday, March 9, 2020 8:49 AM
To: Luketa, Anay <aluketa@sandia.gov>; LaFleur, Chris <aclafle@sandia.gov>; Sanborn, Scott Edward

<sesanbo@sandia.gov>; Mohmand, Jamal Ahmed <jamohma@sandia.gov>; Glover, Austin Michael <amglove@sandia.gov>
Subject: [EXTERNAL] ACTION: Questions for First Interview

Good morning Sandians,

We are interviewing our first person this afternoon (1pm EST). If you have any questions you'd like to ask Rao (the Physical Scientist identified in the IG report), other than those listed below, please let me know asap.

Thanks!
Suzanne

****

- Can you tell us how you were involved in the review of the Indian Point 50.59 analysis or the 2.206 petition?
- We will have some specific questions as we go through this. Initially, could you walk us through your role in analysis or petition briefly?
- Have you had a chance to read the OIG event inquiry?
- Do you have any thoughts about the OIG inquiry? Any concerns? Parts that you agree with and parts where you think they made an error or misunderstood something about the IP analysis?

Specific questions:

- How did you select methodology?
- How did you chose meteorological conditions?
- How did you obtain pipeline data? (Licensee analysis? FERC?)
- Are you familiar with Kuprewicz's comments/concerns?
- There are several references to reanalysis/sensitivities - is this documented somewhere? Is it different than what was done for the inspection?
- 39Qs said maximum release rate was sustained and did not decline - how related to this? Basis for doubling the break?
- How were buried vs. above-ground pipelines considered?
- How were missiles considered (for both units)?
- Why was risk piece included given that this was a postulated break scenario? If yes, where was risk information obtained (PRA group)?
- Why assume that underground pipe explosion frequency would be an order of magnitude less?
- Why assume that above ground was conservative
- Similar to other reviews / analyses you conducted for NRC? Which?
- Input to selecting peer reviewer?
- Who was peer reviewer?
- Who is lead preparer of RG 1.91?
- RG 1.91 equation change mentioned in IG report - aware? Of concern to you?
- Any other documentation than the 6-page report?
- Also conducted reanalysis and sensitivities at PRB timeframe (60 minute) - how/where documented?
- Can you explain why the PRB responses to Mr. Blanch seem to reflect more conservatism than reflected in the inspection report? Was additional analysis conducted? Is there a record of that analysis? Did that additional analysis receive any peer review?
- Participated in meeting with FERC? What remember? Who was there?

- Reviewed/concurred on documents that referenced your analyses? Which? (For example, did not concur on 39Qs letter; may have reviewed. Congressional responses?)
- Management involvement in analysis, decisions, later use?

Suzanne Dennis
Office of Research
U.S. NRC
301-415-0760

From: Sanborn, Scott Edward
To: Luketa, Anay; Mohmand, Jamal Ahmed; Dennis, Suzanne; LaFleur, Chris; Glover, Austin Michael
Subject: [External_Sender] RE: [EXTERNAL] RE: FOR YOUR REVIEW: Indian Point documents
Date: Friday, March 06, 2020 5:25:45 PM

Anay,

Thank you. I was able to download the documents and place them in the OneDrive location https://mysite.sandia.gov/personal/sesanbo/Documents/Indian_Point_Pipeline .

Thanks,
Scott

From: Luketa, Anay
Sent: Friday, March 6, 2020 3:23 PM
To: Mohmand, Jamal Ahmed <jamohma@sandia.gov>; Dennis, Suzanne <Suzanne.Dennis@nrc.gov>; Sanborn, Scott Edward <sesanbo@sandia.gov>; LaFleur, Chris <aclafle@sandia.gov>; Glover, Austin Michael <amglove@sandia.gov>
Subject: RE: [EXTERNAL] RE: FOR YOUR REVIEW: Indian Point documents

All,
You should be receiving an mft email from me that has the documents Suzanne sent earlier. -Anay

---

From: Mohmand, Jamal Ahmed
Sent: Friday, March 6, 2020 1:38 PM
To: Luketa, Anay <aluketa@sandia.gov>; Dennis, Suzanne <Suzanne.Dennis@nrc.gov>; Sanborn, Scott Edward <sesanbo@sandia.gov>; LaFleur, Chris <aclafle@sandia.gov>; Glover, Austin Michael <amglove@sandia.gov>
Subject: RE: [EXTERNAL] RE: FOR YOUR REVIEW: Indian Point documents

Hi Suzanne,

I tried both files as well, and am having issues as well.

Thanks,
Jamal

From: Luketa, Anay <aluketa@sandia.gov>
Sent: Friday, March 6, 2020 12:47 PM
To: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>; Sanborn, Scott Edward <sesanbo@sandia.gov>; LaFleur, Chris <aclafle@sandia.gov>; Glover, Austin Michael <amglove@sandia.gov>; Mohmand, Jamal Ahmed <jamohma@sandia.gov>
Subject: RE: [EXTERNAL] RE: FOR YOUR REVIEW: Indian Point documents

Mmm...still isn't opening. If you don't want to set a password, I can send you a link to a secure

Sandia site that handles large files.

From: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Sent: Friday, March 6, 2020 12:19 PM
To: Sanborn, Scott Edward <sesanbo@sandia.gov>; LaFleur, Chris <aclafle@sandia.gov>; Glover, Austin Michael <amglove@sandia.gov>; Mohmand, Jamal Ahmed <jamohma@sandia.gov>; Luketa, Anay <aluketa@sandia.gov>
Subject: [EXTERNAL] RE: FOR YOUR REVIEW: Indian Point documents

Try 2.

From: Dennis, Suzanne
Sent: Friday, March 06, 2020 1:33 PM
To: Sanborn, Scott Edward <sesanbo@sandia.gov>; LaFleur, Chris <aclafle@sandia.gov>; Glover, Austin Michael <amglove@sandia.gov>; Mohmand, Jamal Ahmed <jamohma@sandia.gov>; Luketa, Anay <aluketa@sandia.gov>
Subject: RE: FOR YOUR REVIEW: Indian Point documents

Hi all,

Rather than waiting for the BOX site, here are some non-public files. I will send the password shortly.

Suzanne

From: Dennis, Suzanne
Sent: Thursday, March 05, 2020 5:54 PM
To: Sanborn, Scott Edward <sesanbo@sandia.gov>
Cc: LaFleur, Chris <aclafle@sandia.gov>; Luketa, Anay <aluketa@sandia.gov>; Clark, Theresa <Theresa.Clark@nrc.gov>
Subject: FOR YOUR REVIEW: Indian Point documents

Hi Scott! Thanks again for your support to our team. SNL's expertise will be a big asset to our team.

The documents you can start looking at now are listed below. The public ones are hyperlinked and all of them will be available in our BOX file-sharing site as soon as we get that set up. Hopefully, Chris and Anay (and anyone else you'd like) will get an automatic message tomorrow. A BOX "quick" reference guide (35 pages!) is attached, as well as login instructions.

1. Licensee (Entergy) analysis under 10 CFR 50.59 (Indian Point, Units 2 & 3 - Revised 10 C.F.R. 50.59 Safety Evaluation and Supporting Analyses Prepared in Response to the Algonquin Incremental Market Natural Gas Project [OUO – Security-Related Information to come; only on BOX]
2. NRC analysis summary [OUO – Security-Related Information to come; only on BOX]
3. Regulatory Guide 1.91, "Evaluations of Explosions Postulated To Occur on Transportation

Routes Near Nuclear Power Plants"

   a. Current Revision 2 (issued 4/2013)
   b. Draft Revision 2, DG-1270 (issued 7/2011 and mentioned in the OIG report)
4. OIG Event Inquiry OIG-16-24
5. Court filings (DC Circuit Court of Appeals Case #16-1081) from individuals who have raised concerns with the pipeline near Indian Point:
   a. Richard Kuprewicz declaration
   b. Paul Blanch declaration

As for schedule… in general, we would like your initial feedback by the end of next week (3/13) if possible. More specifically—

- We may be visiting the Indian Point site late next week. If there are specific things you would like us to look for, please let us know.
- We are planning interviews with various involved persons. If you have any specific questions, please let us know asap. The first interview is on Monday.

We would very much appreciate it if we can stay in touch and have calls / Skype sessions throughout next week as you all have ideas, questions, or concerns. We will be together in a team room most of the time and can patch you onto the speakerphone.

You can contact me anytime by email or personal cell (b)(6). As an FYI, Chris and Anay's names will be made public in our evaluation plan so it is possible you will get some calls. If you receive any media requests related to this project, please direct them to Scott Burnell, NRC Office of Public Affairs (Scott.Burnell@nrc.gov, 301-415-8204).

Suzanne
301-415-0760

From: Luketa, Anay
To: Dennis, Suzanne
Subject: [External_Sender] RE: RE: RE: [EXTERNAL] RE: FOR YOUR REVIEW: Indian Point documents
Date: Friday, March 06, 2020 5:18:07 PM

It worked. Thanks! I'll share with the others.

From: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Sent: Friday, March 6, 2020 3:04 PM
To: Luketa, Anay <aluketa@sandia.gov>
Subject: RE: RE: RE: [EXTERNAL] RE: FOR YOUR REVIEW: Indian Point documents

Done! Let me know if it works.

Thanks so much!

From: Luketa, Anay <aluketa@sandia.gov>
Sent: Friday, March 06, 2020 4:04 PM
To: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Subject: [External_Sender] RE: RE: [EXTERNAL] RE: FOR YOUR REVIEW: Indian Point documents

I just sent you a link. You'll have to create a user name and password. Let me know if you don't receive the link. I'll distribute the documents to the others at Sandia.

From: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Sent: Friday, March 6, 2020 1:16 PM
To: Luketa, Anay <aluketa@sandia.gov>
Subject: RE: RE: [EXTERNAL] RE: FOR YOUR REVIEW: Indian Point documents

That would be great!

From: Luketa, Anay <aluketa@sandia.gov>
Sent: Friday, March 06, 2020 2:47 PM
To: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>; Sanborn, Scott Edward <sesanbo@sandia.gov>; LaFleur, Chris <aclafle@sandia.gov>; Glover, Austin Michael <amglove@sandia.gov>; Mohmand, Jamal Ahmed <jamohma@sandia.gov>
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Subject: RE: FOR YOUR REVIEW: Indian Point documents

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From: Dennis, Suzanne
Sent: Thursday, March 05, 2020 5:54 PM
To: Sanborn, Scott Edward <sesanbo@sandia.gov>
Cc: LaFleur, Chris <aclafle@sandia.gov>; Luketa, Anay <aluketa@sandia.gov>; Clark, Theresa <Theresa.Clark@nrc.gov>
Subject: FOR YOUR REVIEW: Indian Point documents

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4. OIG Event Inquiry OIG-16-24
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b. Paul Blanch declaration

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Suzanne
301-415-0760

From: Sanborn, Scott Edward
To: Dennis, Suzanne
Subject: [External_Sender] RE: [EXTERNAL] RE: discuss IP Pipeline
Date: Thursday, March 05, 2020 3:09:53 PM

Great. Thanks Suzanne.

From: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Sent: Thursday, March 5, 2020 12:36 PM
To: Sanborn, Scott Edward <sesanbo@sandia.gov>
Subject: [EXTERNAL] RE: discuss IP Pipeline

Hi Scott,

I just got off the phone with our contracts folks and we are good to engage! We are in the process of setting up a BOX site, where we will put all the documents that you all will need.

Looking forward to talking to you tomorrow,
Suzanne

-----Original Appointment-----
From: Sanborn, Scott Edward <sesanbo@sandia.gov>
Sent: Thursday, March 05, 2020 1:53 PM
To: Sanborn, Scott Edward; IP Expert Eval Team; Dennis, Suzanne; LaFleur, Chris; Glover, Austin Michael; Mohmand, Jamal Ahmed; Luketa, Anay
Subject: discuss IP Pipeline
When: Friday, March 06, 2020 10:30 AM-11:30 AM (UTC-07:00) Mountain Time (US & Canada).
Where: Skype Meeting

-----Original Appointment-----
From: Sanborn, Scott Edward <sesanbo@sandia.gov>
Sent: Thursday, March 05, 2020 1:53 PM
To: Sanborn, Scott Edward; Dennis, Suzanne; LaFleur, Chris; Glover, Austin Michael; Mohmand, Jamal Ahmed; Luketa, Anay
Subject: [External_Sender] discuss IP Pipeline
When: Friday, March 06, 2020 10:30 AM-11:30 AM (UTC-07:00) Mountain Time (US & Canada).
Where: Skype Meeting

All,

This call is to discuss what is desired and what is technically feasible in the short turnaround time for the Indian Point pipeline analysis issue.

Thanks,

Scott

Join Skype Meeting

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(b)(6)	(Sandia)	English (United States)
	(Sandia)	English (United States)
	(Sandia)	English (United States)
	(Sandia)	English (United States)

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Conference ID: (b)(6)

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Service provided by Enterprise Collaboration Services

From: Dennis, Suzanne
To: Sanborn, Scott Edward; Luketa, Anay
Cc: Mohmand, Jamal Ahmed; LaFleur, Chris
Subject: Re: RE: [EXTERNAL] FYI: Indian Point report public
Date: Wednesday, April 15, 2020 1:18:21 PM

Hi Scott,

We couldn't have done it without you all!

I think at this point, we're just waiting to see what the Chairman's response is. All of the follow-up that the EDO recommended was for NRC-process work. I will keep you updated of any rumblings.

Thanks!
Suzanne

From: Sanborn, Scott Edward <sesanbo@sandia.gov>
Sent: Wednesday, April 15, 2020 11:49 AM
To: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>; Luketa, Anay <aluketa@sandia.gov>
Cc: Mohmand, Jamal Ahmed <jamohma@sandia.gov>; LaFleur, Chris <aclafle@sandia.gov>
Subject: [External_Sender] RE: [EXTERNAL] FYI: Indian Point report public

Hi Suzanne,

Thank you very much for sending out these links - I've been checking ADAMS almost every day to see what would come out of this work. A lot of effort went into this in a very short period of time and the Team Report reflects all this hard work. Also, I appreciate your flexibility to honor our requests to clearly communication our contributions to the Team Report and I think this has turned out well.

Regarding follow-up actions, we have spent nearly all of our funds completing the memo and reviewing the Team Report. We would need additional funding to perform more work. If you have an idea of what kind of support you need at this point, please let Anay and myself know and we can estimate the cost. We have the Task Order POP extension in place so getting additional funding placed on the Task Order is quick but not immediate.

Thanks,
Scott

From: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Sent: Wednesday, April 15, 2020 9:04 AM
To: Sanborn, Scott Edward <sesanbo@sandia.gov>; Luketa, Anay <aluketa@sandia.gov>; Mohmand, Jamal Ahmed <jamohma@sandia.gov>; LaFleur, Chris <aclafle@sandia.gov>
Subject: [EXTERNAL] FYI: Indian Point report public

Good morning,

Thanks again for all of your help. The evaluation team's report, as well as the transmittal memo to the NRC Commission are now publicly available. The two external transcripts below should be replicated momentarily. There are two styles of links to our public documents and one sometimes works before the other—both are included below to be safe.

EDO Transmittal Memo to Commission:

- https://www.nrc.gov/docs/ML2009/ML20099F775.pdf
- https://adamswebsearch2.nrc.gov/webSearch2/main.jsp?AccessionNumber=ML20099F775

Team Report:

- https://www.nrc.gov/docs/ML2010/ML20100F635.pdf
- https://adamswebsearch2.nrc.gov/webSearch2/main.jsp?AccessionNumber=ML20100F635

Interview Transcripts:

- Rick Kuprewicz:
  - https://www.nrc.gov/docs/ML2008/ML20087M164.pdf
  - https://adamswebsearch2.nrc.gov/webSearch2/main.jsp?AccessionNumber=ML20087M164
- Paul Blanch:
  - https://www.nrc.gov/docs/ML2008/ML20087M178.pdf
  - https://adamswebsearch2.nrc.gov/webSearch2/main.jsp?AccessionNumber=ML20087M178

We will continue to coordinate with you, as needed, on our follow-up actions.

Suzanne

From: Dennis, Suzanne
To: Sanborn, Scott Edward
Subject: RE: RE: RE: [EXTERNAL] FOR REVIEW: draft team report (by 4/1?)
Date: Thursday, April 02, 2020 11:10:00 AM

Hey Scott,

Just FYI – we removed all names from the front page and separated out the external bios with details on your contribution (i.e., Appendix B and insights on fire risk and pipelines).

Suzanne

From: Sanborn, Scott Edward <sesanbo@sandia.gov>
Sent: Wednesday, April 01, 2020 5:23 PM
To: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Subject: [External_Sender] RE: RE: [EXTERNAL] FOR REVIEW: draft team report (by 4/1?)

Hi Suzanne,

After checking with the team we do need our names removed from the front page of the document. The other changes look good.

Please call me (b)(6) if you have concerns or would like to discuss more.

Thanks,
Scott

From: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Sent: Wednesday, April 1, 2020 1:33 PM
To: Sanborn, Scott Edward <sesanbo@sandia.gov>
Subject: RE: RE: [EXTERNAL] FOR REVIEW: draft team report (by 4/1?)

Hi Scott,

Here's what we have right now:

NRC Participants:

- David Skeen, Office of International Programs (Team Lead)
- Theresa Clark, Office of Nuclear Material Safety and Safeguards (Deputy Team Lead)
- Dr. Yueh-Li (Renee) Li, Office of Nuclear Reactor Regulation
- Suzanne Dennis, Office of Nuclear Regulatory Research
- Brian Harris, Esq., Office of the General Counsel

External Support:

- Steve Nanney, U.S. Department of Transportation Pipeline and Hazardous Materials Safety Administration
- Dr. Chris LaFleur, Sandia National Laboratories
- Dr. Anay Luketa, Sandia National Laboratories
- Jamal Mahmand, Sandia National Laboratories

And then later in Section 1.3:

The NRC publicly released the team's evaluation plan on March 9, 2020, including team membership.[i] The team was led by David Skeen (Deputy Director, Office of International Programs) and Theresa Clark (Deputy Director; Division of Rulemaking, Environmental, and Financial Support; Office of Nuclear Material Safety and Safeguards). NRC members were independent of prior reviews in this area. The team included experts in NRC engineering reviews and risk analysis. The team also obtained insights from external experts independent of the NRC's prior activities on this subject. A pipeline safety analysis expert from the Department of Transportation's Pipeline and Hazardous Materials Safety Administration (PHMSA) independently reviewed the NRC and Entergy safety analyses. In addition, the NRC contracted for experienced researchers at Sandia National Laboratories (SNL) to provide expertise on natural gas modeling and fire risk; the results of SNL's efforts are presented in Appendix B. Biographies of the contributors, both NRC staff and those who provided external support, are included in Appendix F to this report.

From: Sanborn, Scott Edward <sesanbo@sandia.gov>
Sent: Wednesday, April 01, 2020 11:29 AM
To: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Cc: Luketa, Anay <aluketa@sandia.gov>; Mohmand, Jamal Ahmed <jamohma@sandia.gov>; LaFleur, Chris <aclafle@sandia.gov>
Subject: [External_Sender] RE: [EXTERNAL] FOR REVIEW: draft team report (by 4/1?)

Hi Suzanne,

The way this report is written it makes it seem like Sandia contributed to the entire report. It needs to be more clear that Sandia only contributed to the Appendix. To protect our technical integrity I'm requesting the following changes:

- Please remove our names from the Principal Contributors page;
- Please modify this sentence in section 1.3 with the addition in red "In addition, the NRC contracted for experienced researchers at Sandia National Laboratories to provide expertise on natural gas modeling and fire risk; their work is documented in Appendix B.
- Please remove our bios from the bio section, we can put those into our appendix.

The report needs to be clear that we did not contribute to the entire report, because we did not.

Anay and Jamal will have specific review comments.

Thanks,
Scott

From: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Sent: Tuesday, March 31, 2020 2:20 PM
To: Luketa, Anay <aluketa@sandia.gov>; Mohmand, Jamal Ahmed <jamohma@sandia.gov>; LaFleur, Chris <aclafle@sandia.gov>; Sanborn, Scott Edward <sesanbo@sandia.gov>
Subject: [EXTERNAL] FOR REVIEW: draft team report (by 4/1?)

Hi SNL team,

As promised, attached is a working draft of the team's report. There are a few areas outstanding (including a couple things you are working on) as noted in comments in the margin. We will be finalizing later this week, we hope.

Could you please review and give us any comments/edits as soon as you can? We would like them by the end of the day on April 1 or mid-day on April 2, if at all possible. We can discuss on the phone any time you like.

The report is quite long, so if your time is short I would recommend a detailed review of Section 2 where pipeline experience is heavily referenced, and a less detailed review in other areas where NRC processes are the focus.

Thanks again for all of your continuing help. You have been a tremendous support to us.

Suzanne

---

[i] Dated March 9, 2020; ADAMS Accession No. ML20069A759

From: Dennis, Suzanne
To: Mohmand, Jamal Ahmed
Subject: Re: RE: RE: RE: RE: [EXTERNAL] RE: NRC Report
Date: Thursday, April 02, 2020 10:29:30 AM

I'm free anytime now. Thanks!

From: Mohmand, Jamal Ahmed <jamohma@sandia.gov>
Sent: Thursday, April 2, 2020 10:14 AM
To: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Subject: [External_Sender] RE: RE: RE: RE: [EXTERNAL] RE: NRC Report

Hi Suzanne,

Let me know when you're free to discuss.

Thanks,
Jamal

From: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Sent: Wednesday, April 1, 2020 3:38 PM
To: Mohmand, Jamal Ahmed <jamohma@sandia.gov>
Subject: RE: RE: RE: RE: [EXTERNAL] RE: NRC Report

Hi Jamal,

I talked with Mo Sadollah here at the NRC (briefly involved in Indian Point's license renewal and electrical engineering guru), and he said that he did not think those cables would be damaged. He said that based on the senior resident's statements about the cables being underground and the layout of the plant that it wasn't credible to state that those cables are damaged.

Thoughts?

I'm signing off (b)(6) but I'm available in the morning.

Thanks so much again!
Suzanne

From: Mohmand, Jamal Ahmed <jamohma@sandia.gov>
Sent: Wednesday, April 01, 2020 2:24 PM
To: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Subject: [External_Sender] RE: RE: RE: [EXTERNAL] RE: NRC Report

Hi Suzanne,

I suggest adding something along these lines to the end of the sensitivity portion of the risk

assessment section.

This sensitivity only fails equipment located in non Category I structures and does not take into account any cable failure impacts that could exist. The potential of safety related cables passing through buildings that are assumed to collapse in this sensitivity was not addressed. The impact of this could be wide ranging and is very plant and site specific due to the spatial nature of how cable routing is conducted. A sensitivity analysis that takes this into account is an arduous and time intensive, if the information is not already available. The sensitivity as currently presented provides a best case scenario where there are no safety related cables that pass through the buildings that are assumed to collapse.

Let me know what you think.

Thanks,
Jamal

From: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Sent: Wednesday, April 1, 2020 11:12 AM
To: Mohmand, Jamal Ahmed <jamohma@sandia.gov>
Subject: RE: RE: RE: [EXTERNAL] RE: NRC Report

Hey Jamal,

I'm not sure of the status of Indian Point's fire PRA, but even if they did, I don't think the NRC could get access to it at this point.

Can you add some suggested wording to the report to caveat the results?

Thanks!
Suzanne

From: Mohmand, Jamal Ahmed <jamohma@sandia.gov>
Sent: Wednesday, April 01, 2020 11:20 AM
To: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Subject: [External_Sender] RE: RE: [EXTERNAL] RE: NRC Report

The only quick and easy solution is if Indian Point has a Fire PRA.
If they are familiar with their model it should be relatively simple to extract the basic events that would fail in non-safety related buildings.

If they don't have one, it would be time consuming to do.

From: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Sent: Wednesday, April 1, 2020 8:36 AM

To: Mohmand, Jamal Ahmed <jamohma@sandia.gov>
Subject: RE: RE: [EXTERNAL] RE: NRC Report

Now's good.
Suzanne

301-415-0760
(b)(6)

From: Mohmand, Jamal Ahmed <jamohma@sandia.gov>
Sent: Wednesday, April 01, 2020 10:04 AM
To: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Subject: [External_Sender] RE: [EXTERNAL] RE: NRC Report

Hi Suzanne,

Can I give you a call now?

From: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Sent: Tuesday, March 31, 2020 5:24 PM
To: Mohmand, Jamal Ahmed <jamohma@sandia.gov>
Subject: [EXTERNAL] RE: NRC Report

Hey Jamal,

Just seeing this. I'm available anytime tonight and in the morning (I have a meeting at 9:30 EDT, but after that I'm free).

Suzanne

From: Mohmand, Jamal Ahmed <jamohma@sandia.gov>
Sent: Tuesday, March 31, 2020 5:19 PM
To: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Subject: [External_Sender] NRC Report

Hi Suzanne,

Do you have a couple minutes to talk?

Thanks,
Jamal

Jamal Mohmand
Fire, Risk, and Tranportation Systems (8854)

Sandia National Laboratories
~~+1-505-844-3282 (O)~~ | (b)(6) (C)
jamohma@sandia.gov

From: Dennis, Suzanne
To: Sanborn, Scott Edward
Cc: Luketa, Anay; Mohmand, Jamal Ahmed
Subject: RE: RE: RE: [EXTERNAL] RE: SNL memo
Date: Thursday, April 02, 2020 9:46:00 AM

Great; thanks Scott!

From: Sanborn, Scott Edward <sesanbo@sandia.gov>
Sent: Thursday, April 02, 2020 9:45 AM
To: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Cc: Luketa, Anay <aluketa@sandia.gov>; Mohmand, Jamal Ahmed <jamohma@sandia.gov>
Subject: [External_Sender] RE: RE: [EXTERNAL] RE: SNL memo

Hi Suzanne,

Attached is the memo with the SAND number in Word and pdf format.

Thanks,
Scott

From: Sanborn, Scott Edward
Sent: Wednesday, April 1, 2020 9:36 AM
To: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Subject: RE: RE: [EXTERNAL] RE: SNL memo

Hi Suzanne,

No problem with the conversion but I need to get the SAND number assigned through Sandia's R&A process (it' in the queue now). I can send you the pdf at that point.

Thanks,
Scott

From: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Sent: Wednesday, April 1, 2020 9:27 AM
To: Sanborn, Scott Edward <sesanbo@sandia.gov>
Subject: RE: RE: [EXTERNAL] RE: SNL memo

Hi Scott,

I'm going to convert this to a PDF to make it easier to merge into our report...just wanted to make sure there wouldn't be any issues with that.

Suzanne

From: Sanborn, Scott Edward <sesanbo@sandia.gov>
Sent: Wednesday, April 01, 2020 10:15 AM
To: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Cc: Luketa, Anay <aluketa@sandia.gov>; Mohmand, Jamal Ahmed <jamohma@sandia.gov>
Subject: [External_Sender] RE: [EXTERNAL] RE: SNL memo

Suzanne,

Thanks. Attached is the version, with the editorial changes made based on NRC's comments/feedback, in our R&A system to get a SAND number. If you have any more comments/feedback please let us know as soon as possible.

Thanks,
Scott

From: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Sent: Wednesday, April 1, 2020 7:32 AM
To: Sanborn, Scott Edward <sesanbo@sandia.gov>
Subject: [EXTERNAL] RE: SNL memo

That sounds good!

From: Sanborn, Scott Edward <sesanbo@sandia.gov>
Sent: Wednesday, April 01, 2020 9:31 AM
To: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Subject: [External_Sender] SNL memo

Hi Suzanne,

Do you see any reason why the SNL memo should remain OUO? Jamal has made that change w.r.t. distance to be "Buildings that house Emergency Diesel Generators (EDGs) are approximately 700 meters from the pipeline". At present we are ready to mark the revised version to be unlimited release.

Thanks,

Scott

From: Dennis, Suzanne
To: Luketa, Anay
Subject: Call?
Date: Wednesday, April 01, 2020 3:52:00 PM

Hi Anay,

Can you give me a call when you get a chance?

Thanks!
Suzanne
(b)(6)

Suzanne Dennis
Office of Research
U.S. NRC
301-415-0760

From: Dennis, Suzanne
To: LaFleur, Chris
Subject: Call?
Date: Wednesday, April 01, 2020 3:50:00 PM

Hey Chris,

Can you give me a call when you get a chance?

Thanks!
Suzanne
(b)(6)

Suzanne Dennis
Office of Research
U.S. NRC
301-415-0760

From: Dennis, Suzanne
To: "Mohmand, Jamal Ahmed"
Subject: RE: Meetings this Afternoon
Date: Wednesday, April 01, 2020 2:22:00 PM

Also, Chris might be able to help. I meant to say that earlier – she's worked a lot with NRC and might be able to help answer some of your questions.

From: Dennis, Suzanne
Sent: Wednesday, April 01, 2020 2:21 PM
To: Mohmand, Jamal Ahmed <jamohma@sandia.gov>
Subject: Meetings this Afternoon

Hi Jamal,

I have meetings until 4pm this afternoon. I can chat after that.

Suzanne

Suzanne Dennis
Office of Research
U.S. NRC
301-415-0760

From: Dennis, Suzanne
To: "Sanborn, Scott Edward"
Subject: RE: RE: RE: [EXTERNAL] RE: SNL memo
Date: Wednesday, April 01, 2020 11:37:00 AM

Got – thanks!

From: Sanborn, Scott Edward <sesanbo@sandia.gov>
Sent: Wednesday, April 01, 2020 11:36 AM
To: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Subject: [External_Sender] RE: RE: [EXTERNAL] RE: SNL memo

Hi Suzanne,

No problem with the conversion but I need to get the SAND number assigned through Sandia's R&A process (it' in the queue now). I can send you the pdf at that point.

Thanks,
Scott

From: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Sent: Wednesday, April 1, 2020 9:27 AM
To: Sanborn, Scott Edward <sesanbo@sandia.gov>
Subject: RE: RE: [EXTERNAL] RE: SNL memo

Hi Scott,

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Suzanne

From: Sanborn, Scott Edward <sesanbo@sandia.gov>
Sent: Wednesday, April 01, 2020 10:15 AM
To: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Cc: Luketa, Anay <aluketa@sandia.gov>; Mohmand, Jamal Ahmed <jamohma@sandia.gov>
Subject: [External_Sender] RE: [EXTERNAL] RE: SNL memo

Suzanne,

Thanks. Attached is the version, with the editorial changes made based on NRC's comments/feedback, in our R&A system to get a SAND number. If you have any more comments/feedback please let us know as soon as possible.

Thanks,

Scott

From: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Sent: Wednesday, April 1, 2020 7:32 AM
To: Sanborn, Scott Edward <sesanbo@sandia.gov>
Subject: [EXTERNAL] RE: SNL memo

That sounds good!

From: Sanborn, Scott Edward <sesanbo@sandia.gov>
Sent: Wednesday, April 01, 2020 9:31 AM
To: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Subject: [External_Sender] SNL memo

Hi Suzanne,

Do you see any reason why the SNL memo should remain OUO? Jamal has made that change w.r.t. distance to be "Buildings that house Emergency Diesel Generators (EDGs) are approximately 700 meters from the pipeline". At present we are ready to mark the revised version to be unlimited release.

Thanks,

Scott

From: Dennis, Suzanne
To: Luketa, Anay; Mohmand, Jamal Ahmed; LaFleur, Chris; Sanborn, Scott Edward
Subject: RE: FOR REVIEW: draft team report (by 4/1?)
Date: Wednesday, April 01, 2020 9:25:00 AM
Attachments: Chapter 2 update.docx

If you haven't started your review yet, here's an updated Chapter 2. Sorry for the churn – there are a lot of moving pieces.

Thanks!

From: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Sent: Tuesday, March 31, 2020 4:20 PM
To: Luketa, Anay <aluketa@sandia.gov>; Mohmand, Jamal Ahmed <jamohma@sandia.gov>; LaFleur, Chris <aclafle@sandia.gov>; Sanborn, Scott Edward <sesanbo@sandia.gov>
Subject: FOR REVIEW: draft team report (by 4/1?)

Hi SNL team,

As promised, attached is a working draft of the team's report. There are a few areas outstanding (including a couple things you are working on) as noted in comments in the margin. We will be finalizing later this week, we hope.

Could you please review and give us any comments/edits as soon as you can? We would like them by the end of the day on April 1 or mid-day on April 2, if at all possible. We can discuss on the phone any time you like.

The report is quite long, so if your time is short I would recommend a detailed review of Section 2 where pipeline experience is heavily referenced, and a less detailed review in other areas where NRC processes are the focus.

Thanks again for all of your continuing help. You have been a tremendous support to us.

Suzanne

1. Conclusions Regarding Safety Analysis

Throughout its work, the team remained focused on the safety of Indian Point and whether new information revealed the need to take immediate regulatory action. The team did not identify any concerns that met this threshold. This section of the report describes how the team considered the safety of Indian Point in proximity to the AIM pipeline, from three perspectives: the likelihood of a pipe rupture and blowdown that could affect Indian Point, the consequences of a pipeline explosion (overpressurization and missiles), and the consequences of a pipeline-rupture-related fire (heat impacts). The team considered historical experience and conducted its own analyses of dynamic gas behavior following a pipe rupture and the risk of subsequent impacts at Indian Point. The subsections below address these topics in detail.

1.1. Pipe Rupture and Blowdown Likelihood

1.1.1. Design and Construction Enhancements

The team obtained information from Enbridge (the AIM pipeline operator) regarding the enhanced design and construction of the AIM pipeline near Indian Point. Similar information had been provided to Entergy, in support of its 10 CFR 50.59 evaluation, and other requesting parties. The measures taken by Enbridge exceed or meet the applicable Department of Transportation requirements under 49 CFR Part 192, "Transportation of Natural and Other Gas by Pipeline: Minimum Federal Safety Standards." For example, the enhanced protections for the pipeline adjacent to Indian Point include:

- A more stringent design factor, higher-grade pipe, and deeper burial than required
- Fusion-bonded epoxy coatings for corrosion control inside and outside the pipe, an abrasive resistant overlay outside the pipe, and no shrink sleeves or tape coatings on field weld joints
- 100-percent non-destructive examination of all girth welds; 100-percent inspection of all welding, coating, and backfilling activities; and "pigging" after construction to identify any dents exceeding code limitations

Enbridge also placed fiber-reinforced concrete slabs and warning tape above the pipeline near Indian Point to reduce the likelihood of construction digging or other activities inadvertently reaching and damaging the pipeline.

In general, these enhancements reduce the likelihood of a pipeline rupture due to known risk factors such as welding flaws, corrosion, and incidental damage. The team's peer reviewer (see **Error! Reference source not found.**) confirmed this reduction when reviewing the team's event frequency estimate discussed in Section 1.5 below:

> The method used to establish the initiating event frequency, although based on actual data, does not have a high degree of statistical confidence or relevance to the AIM pipeline. The data are a limited sample, and there were likely different causes and conditions associated with each of the fifteen rupture events (seam weld manufacturing defects/low toughness, external corrosion, stress corrosion cracking, and third-party damage are the more common ones). And these conditions are not directly applicable to the subject AIM pipeline. Most, if not all, of these failures were likely in legacy pipelines, manufactured to less rigorous standards than current practice and have been subjected to many years of potential in-service degradation. This is especially true for the ~4000 ft of enhanced AIM pipeline in

Commented [HB1]: I would leave out generally here. "Generally" implies that they don't

Commented [HB2]: Consider: I know what pig traps are and pigging. Members of the public may not be so familiar with the term. Should we define?

closest proximity to [Indian Point]. Therefore, although there is a high degree [of] uncertainty in the assumed initiating event frequency, **it is likely that the uncertainty is in the direction of making this estimate much higher than the true rupture frequency of that pipeline segment**. *(emphasis added)*

The team did not attempt to quantify a reduced pipeline rupture frequency for the AIM pipeline near Indian Point, given the uncertainties. In the team's view, optimistic estimates of failure *frequencies* (one in a million per year or less) often lead the licensee or the NRC to assess failure *consequences* in less detail. Therefore, the team continued with its analysis with a more general failure frequency.

1.1.2. Risk Assessment and Mitigation

After construction, pipeline operators continue to assess and mitigate the risks to their pipelines through "integrity management" programs. For high consequence areas,[ii] the relevant requirements are in 49 CFR 192, Subpart O. The AIM pipeline near Indian Point is identified as being in a high consequence area, so these requirements apply. Relevant requirements for this case include:

- **Having an integrity management program (49 CFR 192.911, among others).** These programs include identification of high consequence areas, plans for various assessments, processes for continual evaluation, and certain procedures. Operators must continually improve their programs. The team obtained information from Enbridge verifying that it has an integrity management program and risk assessment process that manages, monitors, and addresses various types of corrosion, defects in the pipeline, third-party damage, operations issues, and weather. Enbridge's program manual lays out the general approaches taken by Algonquin Gas Transmission.[iii]

- **Assessing threats to the pipeline and taking actions to mitigate the risks (49 CFR 192.917 and 192.935, among others).** "Threats" for purposes of this assessment include those listed in the American Society of Mechanical Engineers and American National Standards Institute (ASME/ANSI) Standard B31.8S,[iv] such as corrosion, construction defects, third party damage, and human error. Operators use this standard to assess the risks associated with each threat and prioritize what baseline assessments and reassessments are needed, as well as what preventive and mitigative measures will be taken. Preventive and mitigative measures are based on the risk assessment and can include installing remote control valves, replacing pipe segments with pipe of heavier wall thickness, operating below 30 percent of the specified minimum yield strength,[v] and conducting training and drills. [insert enbridge]

- **Conducting a baseline assessment and continuous assessments (49 CFR 192.921, 192.937, and 192.939, among others).** As appropriate for the pipeline segments, the operator conducts internal inspections to detect corrosion or other threats, pressure tests in accordance with 49 CFR 192, Subpart J, "Test Requirements,"[vi] and direct assessments for corrosion. Operators must conduct this baseline assessment within 10 years from the date a pipeline is installed. The pressure test under 49 CFR 192, Subpart J, can satisfy the requirement for a baseline assessment. Operators must continue to assess the pipeline, with a reassessment occurring no more than 7 years after the baseline assessment. The reassessments, similarly, can also include pressure tests or direct corrosion assessments. [insert enbridge]

The team also gained access to a risk assessment contracted by the State of New York to assess infrastructure near the AIM pipeline and the risks of damage to the pipeline.[vii] The risk assessment was based on experts' judgment and did not quantify probabilities and consequences of specific scenarios. This evaluation considered risks to pipeline integrity such as corrosion and other

Commented [CT3]: @Theresa to add information when received from Steve.

Commented [CT4]: @Theresa to add information when received from Steve.

material issues, excavation and other sources of damage, as well as equipment and operational failures. All risks specific to Indian Point were categorized as "unlikely." Mitigation and emergency response strategies were identified for each, including actions that the New York State Department of Public Safety would take. The appendix on Indian Point pipeline impacts summarized publicly available analyses related to the pre-existing and AIM pipelines and referenced prior conclusions by the NRC and licensees.

Collectively, these ongoing activities provided the team with further confidence that a pipeline rupture is unlikely, though (as noted above) the team did not attempt to quantify the risk reduction from such activities.

1.1.3. Isolation of a Pipeline Rupture

If a rupture occurs on the AIM pipeline near Indian Point, the effects on the nuclear power plant would depend on the volume of gas released. The volume of gas released is a function of the speed with which the pipeline operator isolates the ruptured pipeline. It is also a function of the length of pipeline that would be isolated, which determines the amount of gas available to flow out the break and feed a fire or other consequences. Entergy and the NRC made different assumptions regarding these variables. The team obtained updated information from Enbridge on the methods that the pipeline operator would use to isolate a rupture of the 42-inch AIM pipeline.

Enbridge informed the team that the 42-inch AIM pipeline is continuously monitored from a gas control center in Houston, TX. The control center monitors pressures, flows, and compressor station status (including discharge and suction pressures). The Supervisory Control and Data Acquisition (SCADA) system is used to detect ruptures and was specifically enhanced to include a schematic screen to expedite evaluation and isolation of the pipeline. Alarms include a rate-of-change alarm that detects a pressure drop on the line. If the data indicates a rupture requiring valve closures, gas controllers have the authority, autonomy, and ability to close valves to isolate the pipeline. They are also trained to isolate other affected facilities including shutting down the compressor station across the Hudson River.

Enbridge has procedures for emergency notification, emergency response, alarm management, and response to abnormal operations that it would apply in these cases. The procedures indicate that the operator may have enough information from his data system, alarms, and trends to enable emergency response actions. If the data is not clear, the operators can use reports from outside sources such as emergency services or public officials to justify isolating a line. However, the controller is not required to have such verification to isolate the line if the data is clear.

The mainline valves for the 42-inch pipeline are remote-operated from the Houston control center. The control center can also monitor pressures on the upstream and downstream sides of the valves. **Enbridge estimated, based on tabletop training and operating experience, that it would take up to eight minutes to identify a rupture using the Supervisory Control and Data Acquisition system, confirm that the valves need to be closed, and close the valves. Enbridge noted that three minutes (previously referenced by Entergy) would be a "best case"; and that confirmation of the event could add additional time to the assumed closure time.** The team notes that data from actual accident experience, as discussed in Section 1.4, indicates that ruptured pipelines have taken minutes to hours to isolate, depending on a number of factors, including whether valves can be remotely operated or must be manually closed.

Enbridge informed the team that these mainline valves on the 42-inch AIM pipeline near Indian Point were closer together (i.e., could isolate a smaller segment of pipeline) than required by DOT regulations. The team obtained schematics showing the location of mainline isolation valves near

Indian Point. As has been stated in multiple other evaluations, the nearest remote-controlled valves to Indian Point are about 2.8 miles apart. The next closest downstream valve—which is also remote controlled—is about 5.6 miles downstream. The next closest upstream valve is associated with the Stony Point compressor station, about 2.5 miles further upstream. Based on the PHMSA team member's experience, in some cases the pressure drop from a pipeline rupture may make it challenging to close the nearest valve to a rupture, and operators may need to close a valve further from the rupture. **The team concludes that the minimum pipeline length that could be isolated is about 2.8 miles, and depending on circumstances, the pipeline length could be 5.3, 8.4, or 10.9 miles.**

As a result of this new information, the team recommends that Entergy reevaluate its assumptions of a three-minute pipeline isolation time and a gas volume based on approximately 3 miles of isolated pipe, as discussed in Section 1.6, to determine if changes to these factors have a significant impact on its original external hazard evaluation related to the 42-inch AIP pipeline. The related OIG finding is also discussed in Section **Error! Reference source not found.**.

1.2. Pipe Rupture Consequences – Overpressurization and Missiles

Regulatory Guide 1.91 states that "[a] demonstration that the rate of exposure to a peak positive incident overpressure in excess of 1.0 psi (6.9 kPa) is less than 10^{-6} per year when based on conservative assumptions, or 10^{-7} per year when based on realistic assumptions, is acceptable." Additionally, the guide states that "[i]f this criteria cannot be met, then the applicant may show through analysis that the risk to the public is acceptably low on the basis of the capability of the safety-related structures to withstand blast and missile effects associated with detonation of the potentially explosive material."

In the 2014 and 2015 10 CFR 50.59 evaluations,[viii] Entergy found that the frequency of a peak overpressure may be more than 10^{-6} per year, so a detailed evaluation was needed to illustrate that the safety-related structures could withstand blast and missile effects. For missile effects, Entergy noted that 900 feet is the greatest distance noted in the literature, which is less than the distance to any plant systems within the SOCA. For blast effects, Entergy calculated that a vapor cloud explosion would not damage important-to-safety SSCs within the SOCA.

The NRC staff's inspection report[ix] stated that:

> The staff determined that the impacts to the SSCs important-to-safety outside the SOCA from the proposed new pipeline are bounded by the impacts from low probability events of extreme natural phenomena (including seismic activity, tornado winds, and hurricanes) which have been previously assessed and are addressed in the Indian Point Units 2 and 3 [updated FSARs].

The team could not verify the assumption that the Unit 2 and Unit 3 updated FSARs bounded the impacts for missiles. Additional information on this assumption is provided in Section **Error! Reference source not found.**. However, for missiles, the team did find that the largest distance that a section of ruptured pipe has been thrown is approximately 600 feet. (According to PHMSA, the 900 feet reported by Entergy for one incident was an initial estimate by accident investigators, but the final established distance was 564 feet, which did not exceed the potential impact radius for the pipe.) For overpressurization, the team was not able to verify that there was no impact to SSCs required for safe shutdown. A probabilistic risk assessment was done to determine the increased risk to the plant from a pipeline rupture. Section 1.5 provides more information on this risk assessment.

Commented [SD5]: Was the 564 ft within the PIR? If so, we should inlcude that fact.

Commented [SD6]: If we say the team could not verify there is no impact on SSCs required for safe shotdaown from overpressurization, does that mean there could be an impact from overpressurization?

Team members at Sandia National Laboratories (SNL) performed a more detailed analysis. SNL evaluated whether the models specified in the RG 1.91 were used appropriately, verified the NRC analytical model results, and performed a preliminary vapor cloud dispersion simulation. In replicating prior NRC analyses, SNL determined that certain assumptions made by NRC may not be valid. The two major assumptions challenged by SNL's analysis include the immediate positive buoyancy of the methane cloud and the use of the TNT equivalency model for this scenario. The team recommends that RG 1.91 be reviewed to determine whether changes are needed to account for these findings, and to address the agency's expectations when detailed analyses are needed. Section **Error! Reference source not found.** has more details on recommended changes to RG 1.91.

Commented [SD7]: We need to explain a bit more about "needing to address agency expectations for when a detailed analysis is needed IT isn't clear from the discussion in this paragraph

In the preliminary vapor cloud dispersion simulation (see **Error! Reference source not found.**), SNL showed that an unmitigated dense cloud could form and travel far distances. These distances are consistent with PHMSA's document for vapor cloud dispersion[x]; however, the PHMSA report is typically only applied to nonflammable gases.[xi] Based on these findings, the team consulted with PHMSA pipeline accident investigators. They noted that rich gases such as butane or propane which are heavier than air, may form gas vapor clouds, they were unaware of any large natural gas (which is methane) transmission pipe ruptures that have resulted in delayed vapor cloud explosions. They agreed that methane gas under high pressures would initially be denser than air when being released after a pipeline rupture, but in their experience the dense gas may initially pool in the crater resulting ightom the rupture, but the gas will become lighter than air once as it leaveexpands it s the crater. Additionally, the team reviewed an Oak Ridge National Laboratory study performed for PHMSA in support of a rulemaking on the use of automatic and remote controlled isolation valves that noted blast and overpressure effects were not evaluated because they occur immediately after the pipe break.[xii] In the team's interview with an independent gas pipeline expert, he noted that the heat flux would be the more controlling scenario.

Commented [DS8]: Need to cite...how do we want to?

As noted in the analysis assumptions, the SNL preliminary evaluation did not quantify plant impacts or overpressures that may be experienced, and local terrain was not considered. The local elevation change, river valley meteorology, and surface roughness would impact vapor cloud dispersion and generally preclude dispersion towards to the plant. If unmitigated dispersion were to occur, several ignition sources appear to exist between the pipeline and plant, such as the Buchanan switchyard. The team also notes that the concrete barrier above the pipe would likely create an ignition source, if a pipe rupture occurred. Given the accident experience from PHMSA, input from the independent pipeline expert, local terrain effects, and the presence of ignition sources, the team believes that there is reasonable assurance of adequate protection of the safety-related functions of the plant.

1.3. Pipe Rupture Consequences – Jet or Cloud Fires

Department of Transportation regulation 49 CFR 192.903, "What definitions apply to this subpart?" defines terms including "potential impact radius." The potential impact radius "means the radius of a circle within which the potential failure of a pipeline could have significant impact on people or property." The equation included in the regulation is:

$$r = 0.69\sqrt{p * d^2}$$

In this equation, r is the potential impact radius (ft), p is the MAOP of the pipeline (psi), and d is the pipeline diameter (in). This equation is associated with the heat-affected area,[xiii] as described further in the notice issuing the rule[xiv] and the technical basis provided in C-FER report prepared for the Gas Research Institute.[xv]

Based on the input from the team's PHMSA member and the team's interview with an independent gas pipeline expert, the potential impact radius is the radius for a person to get out of the area within 30 seconds and is not meant to be used to determine the survivability of buildings. They recommended multiplying the calculated potential impact radius by 1.5 to 2 as a "rule of thumb" to determine a safe distance for buildings. This aligns with the Oak Ridge National Laboratory report mentioned above[xv] that evaluated the thermal impacts of double-ended guillotine breaks. The report noted that severe damage could occur within 1.5 to 1.7 times the potential impact radius. This conclusion is consistent with the risk assessment performed by New York State.[xvii]

Commented [HB9]: Cite to Kuprewicz's transcript? R. Kuprewicz Transcript at 25-26 (Mar. 19, 2020).

Using this formula for the 42-inch, 850-psi 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 the SOCA; however, it would not impact any safety-related structures.

Entergy found that at the SOCA fence, heat fluxes would be below 10 kW/m^2, and that the heat flux at 2,028 feet (a location inside the SOCA fence but not impacting safety-related systems) is only 5 kW/m^2.[xviii]

NUREG/CR-3330[xix] discusses the survivability of reinforced concrete at various heat fluxes for varying points inside a wall, the closest point being six inches inside the wall. At Indian Point Unit 3, the diesel generator building has the thinnest walls of all safety-related buildings at 24 inches.[xx] The thinnest point of containment is 42 inches,[xxi] and the thinnest point of the auxiliary building above ground is 30 inches.[xxii] NUREG/CR-3330 notes that at a heat flux of 15 kW/m^2, it will take 11.6 hours for temperature at six inches inside the wall to exceed 350 degrees Fahrenheit (177 degrees Celsius) and 5 hours if the heat flux was 50 kW/m^2.

The team's independent analysis based on calculations in NUREG/CR-3330 found that heat fluxes at the closest safety-related structure would be 11 kW/m^2 for a mass flow rate of 1940 kg/s. For a bounding flow rate of 4000 kg/s, the heat flux would be 21 kW/m^2. Even at the bounding flow rate, the pipeline would not need to be shut off for over eight hours. This greatly exceeds the estimated time it would take for the gas pipeline to be shut off; therefore, the heat flux would have no impact on safety-related structures. An appendix to the Sandia National Laboratories report (included as **Error! Reference source not found.** to this report) presents this analysis in more detail.

The team concludes that a jet or cloud fire would not impact the plant's safety.

1.4. Historical Pipe Rupture Experience

To provide perspective for the team's analytical results, the team obtained information from PHMSA's accident investigation division on some actual pipeline ruptures. This information is summarized in Table 1. While this was a relatively small sample, it provided important background information to the team. In the table, the "impacted area" refers to the distance away from the pipeline where investigators found impacts as a result of the pipeline rupture. Impacted areas are generally an ellipse with a length parallel to the pipeline (and longer in the direction that had more compressed gas available) and a shorter width perpendicular to the pipeline. Most of these impacts were within or near the PIR, with none being further than 1.6 times the PIR. As noted above, isolation times can be relatively long in certain circumstances, such as when valves need to be locally operated or when shutting off the pipeline could have more significant consequences (e.g., for customers who need heating) than the fire. PHMSA staff stated that fires do not ignite in all cases, as both an arc and the correct atmosphere are needed to ignite the gas vapors.

Commented [CT10]: Confirm; Steve is checking whether the numbers are right for Artesia.

Table 1. PHMSA pipeline accident data showing pipe diameter and allowable pressure, calculated potential impact radius, impacted area, distance pipe was ejected, time to isolate the line, and duration of fire. "NR" is shown where data was not reported, and "N/A" is shown where the event did not occur.

Year	Location	Pipe Dia. (in.)	MAOP (psi)	PIR (ft.)	Impacted Area		Pipe Ejected (ft.)	Isolation Time (h:mm)	Fire Duration (h:mm)
					Length (ft.)	Width (ft.)			
1985	Beaumont, KY	30	936	633	700	500	NR	NR	NR
2003	Viola, IL	24	975	517	not reported (NR)		554	8:48	11:55
2008	Appomattox, VA	30	800	585	566	200	N/A	NR	NR
2010	San Bruno, CA	30	375	401	375	160	100	1:35	2:35
2017	Dixon, IL	20	800	390	365	163	N/A	0:31	3:06
2018	Batesville, OH	24	1440	628	50	50	N/A	0:00	1:04
2018	Moundville, OH	36	1440	943	250	250	100	0:25	3:05
2018	Hesston, KS	26	899	538	400	200	254	0:02	2:44
2018	Buffalo, OK	26	765	496	110	60	170	1:09	N/A
2018	Woodruff, UT	20	918	418	143	90	430	1:21	N/A
2018	Dixon Springs, TN	22	773	422	30	20	75	0:38	N/A
2019	Caldwell, OH	30	936	633	500	500	N/A	1:35	14:05
2019	Mexico, MO	30	900	621	437	286	125	1:12	1:31
2019	Hot Springs, AR	30	1000	655	252	114	306	2:12	N/A
2019	Danville, KY	30	936	633	704	645	600	1:52	3:07
2019	Artesia, NM	20	1000	436	687	60	360	3:23	N/A

This experience, which is mostly from the last few years since PHMSA formed its accident investigation division, is generally consistent with earlier information included in the C-FER report referenced above.[xxiii] The C-FER report collected information on incidents from 1969 to 1995 and compared actual incident outcomes to the proposed hazard area model—which became the potential impact radius under 49 CFR Part 192. **Error! Reference source not found.** shows the comparison of distances that was included in the C-FER report. In all but one case, the potential impact radius was larger than the burn area or distance where any injuries was seen. Where the burn area was larger (NTSBPAR711), it was about 1.1 times the potential impact radius.

Error! Reference source not found. shows four examples of pipeline ruptures, including those with and without fires. The elliptical nature of the most severe impacts is demonstrated in the two left-hand images, fire and debris damage can be seen in the bottom-right image, and a rupture crater is shown clearly in the top-right image.

The team discussed pipeline ruptures with the PHMSA accident investigation staff who prepared the more recent data. The PHMSA staff confirmed that, in their experience, that they had never seen explosions occurring away from the initial rupture site or any other damage outside the area damaged by heat or fire. Also, in their recollection, only one of these (San Bruno) occurred within a high consequence area, and pipeline construction contributed to that failure.

1.5. Pipe Rupture Risk Assessment

The NRC uses a variety of methods to determine the safety significance of postulated events. Two of these methods use the insights from probabilistic risk assessments. One is the significance determination process,[xxiv] which uses risk insights, where appropriate, to help the NRC determine the safety significance of inspection findings. The other is Regulatory Guide 1.174, "An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decisions on Plant-Specific Changes to the Licensing Basis."[xxv]

Both of these approaches use the metric of change in core damage frequency resulting from the situation to assess an inspection finding or a licensing basis change. These approaches define a small change to be less than one in a million years (10^{-6}). The NRC uses the agency's independent risk models to evaluate the change in core damage frequency. The team, with support from experts at the Idaho National Laboratory, modified the Indian Point models to reflect a pipeline failure and conducted a risk analysis. The team assumed that a pipeline failure would cause an unrecoverable loss of the Buchanan switchyard and cause loss of the city water tank. Based on these analyses, the team found that the change for both plants was an increase of one in 63 million years (1.6×10^{-8} per year), which is well below the agency's defined threshold for a "small" change in risk of one in a million years.

Because of the uncertainty associated with the consequences of overpressurization from an explosion, the team also performed a sensitivity analysis. This analysis assumed that all equipment not in a seismic Category I structure (i.e., not located in the primary auxiliary building, diesel generator building, or reactor containment) was lost upon the pipeline rupture. These Category I structures like reinforced concrete containment structures, diesel generator buildings and auxiliary buildings are robust, safety-related, concrete structures designed to resist the effects of tornado missiles, tornado high winds and seismic events and postulated internal accidents. Reinforced concrete containment structures are especially robust in that they are also designed to resist internal pressurization from design basis events, which in the case of the Indian Point nuclear power plant containments includes a design pressure of 47 psi above the atmospheric pressure. According to structural engineering experts at the NRC, it is a good starting assumption that these three structures will be capable to withstand the pressures from the explosion associated with rupture from a gas pipeline at a distance of 2300 feet or greater. This starting assumption needs to be validated using information on (1) the credible blast or deflagration loads from the pipeline accident, (2) the structural properties of the structures such as the thickness, spans and reinforcements of their walls and roofs, especially for the auxiliary building for which the thickness of the walls can decrease with height, and (3) the details of their relevant design loads such as the tornado design missiles and high wind pressure loads. As discussed in Section 1.3, the minimum thickness of the walls for the auxiliary building is 30 inches. Additionally, the seismic Category I buildings are designed to withstand a pressure drop of 3 psi.[xxvi] Based on the input from structural experts, the team assumed that the overpressurization will not damage these Category I buildings. The team primarily evaluated Unit 3 for this sensitivity, since it is closer to the 42-inch AIM pipeline and would experience more severe impacts. The change in core damage frequency for this scenario was one in 5.7 million years (1.75×10^{-7} per year). Again, this is below the agency's threshold for a "small" change in risk of one in a million years.

The team was concerned that PHMSA's data provided a national pipeline mileage that included all diameters of pipes, not just large pipes, which could be non-conservative if used to calculate an event frequency. The team independently reviewed publicly available data.[xxvii] Using the last ten years' worth of data, the team determined Class 2, 3, or 4 carbon steel transmission lines with pipe diameters greater than or equal to 20 inches and maximum operating pressures greater than or equal to 300 psig rupture with a frequency of 2.4×10^{-5} per mile per year. The team recalculated the change in core damage frequency using this higher frequency and concluded that the change in risk remained below the agency's threshold for a "small" change in risk. More information on the team risk assessment and the PHMSA data can be found in **Error! Reference source not found.** and **Error! Reference source not found.**, respectively.

The agency's independent models only consider reactor risk, so the spent fuel pools and the dry fuel storage location must be considered separately. The spent fuel storage pit for Indian Point Unit 3 is a seismic Category I structure and is designed for a pressure drop of 3 psi. Given this rugged

construction and the input from structural experts, the team concludes that a pipeline rupture would not negatively affect the spent fuel pit, though the surrounding building could be damaged. Indian Point Units 2 and 3 use the Holtec HI-STORM 100 dry cask storage system.[xxviii] The HI-STORM 100 dry cask storage system is also designed for for the same conditions as other Category I buildings. The team also concludes that the dry fuel storage location, which is much farther from the 42-inch AIM pipeline than the other structures evaluated, would not be negatively affected by a pipeline rupture.[xxix]

Commented [HB11]: Suzanne: Is this right term? I don't think I have seen described as such in other circumstances.

Commented [DS12R12]: Yes – that's how it's referred to. The fuel storage building that is above the pit isn't qualified, but the pit itself is.

1.6. Recommendation – Ask Entergy to Revisit its 10 CFR 50.59 Evaluation

Although the team did not conclude that immediate regulatory action is needed regarding Indian Point, the team does recommend further work be done by Entergy to show that its prior conclusions remain valid. **Based on concerns raised by external parties and substantiated by the team, the team recommends that the NRC request Entergy under 10 CFR 50.54(f) to submit updated information regarding the implications of the assumption that the 42-inch AIM pipeline could be isolated within 3 minutes and the length of pipe that would be isolated.** Entergy should either revisit its analysis applying an updated assumption or providing a basis for why the assumptions are not relevant to the conclusions previously presented.

During the NRC's review of the October 2014 petition referenced in Section **Error! Reference source not found.**, the petitioner raised a concern that Entergy provided inaccurate or incomplete information contrary to the requirements in 10 CFR 50.9, "Completeness and accuracy of information."[xxx] The petitioner also asserted that the licensee may have violated 10 CFR 50.5, "Deliberate misconduct."[xxxi] The petitioner's concern centered on whether it was appropriate to model the 42-inch AIM pipeline being isolated in 3 minutes.[xxxii] To this day, the petitioner continues to assert that the Entergy knew that the isolation times were inaccurate and material to the NRC determination.[xxxiii]

For purposes of addressing the issue raised by the petitioner, deliberate misconduct occurs when a licensee voluntarily and intentionally (1) engages in conduct that it knows to be contrary to a requirement, or (2) provides materially inaccurate or incomplete information.[xxxiv] Specifically, the requirements in 10 CFR 50.5 state, in relevant part, that licensees may not:

> Engage in deliberate misconduct that causes or would have caused, if not detected, a licensee or applicant to be in violation of any rule, regulation, or order; or any term, condition, or limitation of any license issued by the Commission; or
>
> Deliberately submit to the NRC, a licensee, an applicant, or a licensee's or applicant's contractor or subcontractor, information that the person submitting the information knows to be incomplete or inaccurate in some respect material to the NRC.
>
> …deliberate misconduct by a person means an intentional act or omission that the person knows: … Would cause a licensee or applicant to be in violation of any rule, regulation, or order; or any term, condition, or limitation, of any license issued by the Commission; or … Constitutes a violation of a requirement, procedure, instruction, contract, purchase order, or policy of a licensee, applicant, contractor, or subcontractor.

Similarly, 10 CFR 50.9 states, in relevant part, that:

> Information provided to the Commission … by a licensee … shall be complete and accurate in all material respects.

Please note that certain cross references within the footnotes did not properly download; however, the footnote references are reflected in the final report (ML20100F635).

Since the licensee's initial and revised 10 CFR 50.59 analysis, as described in Section **Error! Reference source not found.** above, additional information has been developed that questions Entergy's assumptions on pipeline isolation. Because some of these initial assumptions have had reasonable challenges to their validity, the licensee should revisit its 10 CFR 50.59 analysis to verify whether its conclusion remain valid in light of this new information.

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[i] Spectra (now Enbridge) informed Entergy that the pipe would have 0.72-inch wall thickness and be X-70 piping with 70,000 psi yield strength and 82,000 psig minimum tensile strength. The pipe would be procured from vendors who have passed a stringent quality audit, and full-time mill inspection would be performed by Algonquin Gas Transmission during pipe production. Specifications would require additional quality testing and integrity requirements beyond normal standards. These enhancements were discussed in a Spectra Energy (Algonquin Gas Transmission) memorandum to Energy regarding Response to Entergy Document entitled "Pipeline Enhancements Being Evaluated to Mitigate a Pipeline Failure," dated July 29, 2014.

[ii] Defined in 49 CFR 192.103; https://www.law.cornell.edu/cfr/text/49/192.903.

[iii] Spectra Energy, "Integrity Management Program (IMP) Manual," 09-0000, Revision 11, dated October 10, 2019. This manual is not publicly available, but Enbridge made it available to the team.

[iv] "Managing System Integrity of Gas Pipelines," published in 2018. Publicly available from https://www.asme.org/codes-standards/find-codes-standards/b31-8s-managing-system-integrity-gas-pipelines. The team had access to this standard through the NRC's subscription service.

[v] Specified minimum yield strength is defined in 49 CFR 192.3, "Definitions," https://www.law.cornell.edu/cfr/text/49/192.3. For the AIM pipeline near Indian Point, Enbridge specified that the piping would have a 70,000 psi yield strength.

[vi] https://www.law.cornell.edu/cfr/text/49/part-192/subpart-J

[vii] "Algonquin Incremental Market Pipeline Risk Analysis Report," transmitted from several New York State agencies to the FERC Chairman on June 22, 2018 (see note **Error! Bookmark not defined.** for a related letter). The report is marked privileged and confidential and may contain Critical Energy Infrastructure Information, as designated by the FERC. It is not available to the public.

[viii] See notes **Error! Bookmark not defined.** and **Error! Bookmark not defined.**.

[ix] See note **Error! Bookmark not defined.**.

[x] TTO-14, Derivation of Potential Impact Radius Formulae for Vapor Cloud Dispersion Subject to 49 CFR 192, January 2005; https://www.phmsa.dot.gov/pipeline/gas-transmission-integrity-management/derivation-potential-impact-radius-formulae-vapor

[xi] PHMSA Gas Integrity Management Insepction Manual, January 1, 2008; http://www.viadata.com/pipeliner/library_docs/GasIMP%20Protocols%20With%20Guidance%20(8%201%202008)%20w%20disclaimer.pdf

[xii] "Studies for the Requirements of Automatic and Remotely Controlled Shutoff Valves on Hazardous Liquids and Natural Gas Pipelines with Respect to Public and Environmental Safety," ORNL/TM-2012/411, dated October 31, 2012;

https://www.phmsa.dot.gov/sites/phmsa.dot.gov/files/docs/technical-resources/pipeline/16701/finalvalvestudy.pdf

[xiii] Regulatory Guide 1.91 does not include any guidance on calculating heat fluxes associated with blasts. The guide assumes that overpressurization is the limiting scenario.

[xiv] 68 FR 69778, issued December 15, 2003; https://www.govinfo.gov/link/fr/68/69817. Additional information on this rule can be found in the docket folder at https://www.regulations.gov/docket?D=PHMSA-RSPA-2000-7666.

[xv] Dated October 2000; https://www.regulations.gov/document?D=PHMSA-RSPA-2000-7666-0049.

[xvi] See note xii

[xvii] See note vii

[xviii] See Note **Error! Bookmark not defined.**

[xix] Published September 1983; ADAMS Accession No. ML062260290.

[xx] Response to a Request for Additional Information regarding Order EA-12-049 and Order EA-12-051, dated December 2, 2016; ADAMS Accession No. ML16350A103.

[xxi] Indian Point Unit 3 Individual Plant Examination, dated June 1994; ADAMS Accession No. ML110320477

[xxii] Letter from J. Knubel, NY Power Authority to NRC on Indian Point, Unit 3, Transmittal of Individual Plant Examination of External Events (IPEEE); ADAMS Accession No. ML11227A102

[xxiii] See note xv

[xxiv] IMC-0609 issued January 2019; ADAMS Accession No. ML18187A187

[xxv] Revision 3 issued January 2018; ADAMS Accession No. ML17317A256

[xxvi] UFSAR Section 16.2; ADAMS Accession No. ML17299A229

[xxvii] From PHMSA Gas Distribution Incident Data - January 2010 to present (ZIP); https://www.phmsa.dot.gov/data-and-statistics/pipeline/distribution-transmission-gathering-lng-and-liquid-accident-and-incident-data

[xxviii] 77 FR 41454, issued July 13, 2012; https://www.govinfo.gov/content/pkg/FR-2012-07-13/pdf/2012-17110.pdf

[xxix] FSAR for HI-STORM 100; ADAMS Accession No. ML081350153

[xxx] https://www.nrc.gov/reading-rm/doc-collections/cfr/part050/part050-0009.html

[xxxi] https://www.nrc.gov/reading-rm/doc-collections/cfr/part050/part050-0005.html

[xxxii] 10 CFR 2.206 Petition Review Board, RE: Indian Point Nuclear Generating Unit, Docket No. 50-247, Transcript, (July 15, 205), p. 14, 16.

[xxxiii] The petitioner raised this issue during his interview with the team, as well in multiple instances of correspondence with the NRC.

[xxxiv] *See* Enforcement Manual, Part II-1: General Topics, Section 1.5.

From: Dennis, Suzanne
To: Luketa, Anay
Cc: Sanborn, Scott Edward
Subject: RE: RE: [EXTERNAL] Additional Information for Consideration
Date: Tuesday, March 31, 2020 7:24:00 PM

Completely understand. Thanks for considering it.

From: Luketa, Anay <aluketa@sandia.gov>
Sent: Tuesday, March 31, 2020 5:28 PM
To: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Cc: Sanborn, Scott Edward <sesanbo@sandia.gov>
Subject: [External_Sender] RE: [EXTERNAL] Additional Information for Consideration

Hi Suzanne,
I'm not sure how to incorporate this since they're not providing any references or evidence to validate the statement that blast, overpressures, shrapnel occur immediately after the break. Also, I don't know what they mean by earthquake-type effects. -Anay

From: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Sent: Tuesday, March 31, 2020 7:46 AM
To: Luketa, Anay <aluketa@sandia.gov>
Cc: Sanborn, Scott Edward <sesanbo@sandia.gov>
Subject: [EXTERNAL] Additional Information for Consideration

Hi Anay,

We found this PHMSA report that states:

Blast, overpressure, shrapnel, and earthquake-type effects resulting from an unintended natural gas or hazardous liquid pipeline release are hazards that can adversely affect humans, property, and the environment. However, these effects are beyond the scope of this study because they occur immediately after the break and RCVs and ASVs, which typically require several minutes to close, cannot mitigate these hazards.

Can you address this ORNL report in your memo?

Thanks!
Suzanne

Suzanne Dennis
Office of Research
U.S. NRC
301-415-0760

From: Dennis, Suzanne
To: Luketa, Anay
Subject: Re: RE: [EXTERNAL] RE: Additional Information for Consideration
Date: Tuesday, March 31, 2020 4:39:46 PM

Sure - whatever you think is prudent!

From: Luketa, Anay <aluketa@sandia.gov>
Sent: Tuesday, March 31, 2020 4:39 PM
To: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Subject: [External_Sender] RE: [EXTERNAL] RE: Additional Information for Consideration

Hi Suzanne,

Thanks for sending this. I think this is confirming that the problem is more complex with regards to the scenarios/causes and that the cloud is not immediately buoyant and can ignite past 1 minute. I think it would be helpful to include reference to the NTSB Florida report and this paper in the report.

-Anay

From: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Sent: Tuesday, March 31, 2020 12:14 PM
To: Luketa, Anay <aluketa@sandia.gov>
Subject: [EXTERNAL] RE: Additional Information for Consideration

Hey Anay,

Here's another paper I found today on underground pipes...thoughts?

https://www.sciencedirect.com/science/article/abs/pii/S1875510015001560

Suzanne

PS: Sorry if I'm overwhelming you!

From: Dennis, Suzanne
Sent: Tuesday, March 31, 2020 9:46 AM
To: Luketa, Anay <aluketa@sandia.gov>
Cc: Sanborn, Scott Edward <sesanbo@sandia.gov>
Subject: Additional Information for Consideration

Hi Anay,

We found this PHMSA report that states:

Blast, overpressure, shrapnel, and earthquake-type effects resulting from an unintended natural gas

or hazardous liquid pipeline release are hazards that can adversely affect humans, property, and the environment. However, these effects are beyond the scope of this study because they occur immediately after the break and RCVs and ASVs, which typically require several minutes to close, cannot mitigate these hazards.

Can you address this ORNL report in your memo?

Thanks!
Suzanne

Suzanne Dennis
Office of Research
U.S. NRC
301-415-0760

From: Dennis, Suzanne
To: Luketa, Anay; Mohmand, Jamal Ahmed; LaFleur, Chris; Sanborn, Scott Edward
Subject: FOR REVIEW: draft team report (by 4/1?)
Date: Tuesday, March 31, 2020 4:20:10 PM
Attachments: 20200331-1610 - DRAFT - Full Team Report.docx

Hi SNL team,

As promised, attached is a working draft of the team's report. There are a few areas outstanding (including a couple things you are working on) as noted in comments in the margin. We will be finalizing later this week, we hope.

Could you please review and give us any comments/edits as soon as you can? We would like them by the end of the day on April 1 or mid-day on April 2, if at all possible. We can discuss on the phone any time you like.

The report is quite long, so if your time is short I would recommend a detailed review of Section 2 where pipeline experience is heavily referenced, and a less detailed review in other areas where NRC processes are the focus.

Thanks again for all of your continuing help. You have been a tremendous support to us.

Suzanne

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

Commented [CT1]: @Theresa – finishing check:
Accept changes
Run perfectIT
Update cross-references (F9)
Check for errors and duplicate figure numbers

Commented [CT2]: Reminder – ask Patti to declare transcripts at the same time that we declare this document (once it goes to Commission)

Principal Contributors:

- David Skeen, NRC Office of International Programs (Team Lead)
- Theresa Clark, NRC Office of Nuclear Material Safety and Safeguards (Deputy Team Lead)
- Dr. Yueh-Li (Renee) Li, NRC Office of Nuclear Reactor Regulation
- Suzanne Dennis, NRC Office of Nuclear Regulatory Research
- Steve Nanney, U.S. Department of Transportation Pipeline and Hazardous Materials Safety Administration
- Dr. Chris LaFleur, Sandia National Laboratories
- Dr. Anay Luketa, Sandia National Laboratories
- Jamal Mahmand, Sandia National Laboratories
- Brian Harris, Esq., NRC Office of the General Counsel

Completed:

[insert date]

Executive Summary

This report provides the results of a review by the U.S. Nuclear Regulatory Commission (NRC) staff of issues raised in the NRC Inspector General's Event Inquiry titled "Concerns Pertaining to Gas Transmission Lines at the Indian Point Nuclear Power Plant" (Case No. 16-024). In response to the Event Inquiry, the NRC's Executive Director for Operations tasked a team of NRC and external experts to review the findings in the Event Inquiry and to prepare a report that could be submitted to the NRC Commission by April 9, 2020. The team members were chosen to be independent from the previous work described in the Event Inquiry and included both NRC staff and external members with expertise regarding the concerns that were raised.

Indian Point is still safe, but that Entergy (the plant owner) has more work to do. The team drew three critical conclusions related to this statement.

- **The rupture of the newly installed 42-inch natural gas transmission pipeline that runs near Indian Point is highly 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 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 ever did occur 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—two or more times the "potential impact radius" that the U.S. Department of Transportation designates for protecting people from pipeline ruptures, and that generally bounds most pipe rupture impacts 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 fuel storage containers would be able to withstand the heat and pressure impacts of an explosion or fire that could follow a pipeline explosion. The safety-related equipment would sustain the capability 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 would be 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.
- **Entergy should be asked to revisit the assumptions it made regarding a postulated rupture of the 42-inch pipeline.** While the team is confident in its independent safety conclusions, Entergy's analysis used assumptions that do not appear valid. Specifically, Entergy assumed a highly optimistic timeframe to isolate the pipeline. Entergy may also have been optimistic about how close to the postulated rupture the pipeline could be isolated, meaning that a smaller than realistic amount of gas was analyzed. Entergy should be asked to assess the importance of these assumptions to its conclusions and change its analysis as needed.

The NRC also needs to improve its processes and practices for technical reviews, inspection support, petition reviews, pipeline analysis, and coordination with other agencies. Separate from the technical matters, the team substantiated many of the Inspector General's procedural

Commented [CT3]: Need to verify these after analyses are finalized.

findings. The team found several ways that the NRC should improve its processes. Highlights of these findings are summarized below.

- **Technical staff need better guidance to help them decide when confirmatory analyses are necessary or appropriate.** It is not always necessary to conduct such analyses—but when they do, the work needs to be done well and documented well.
- Along these lines, **peer reviews need to be done more rigorously and consistently**. Newly updated guidance should already be helping, as long as staff and managers are trained properly.
- **Inspectors and technical experts need better guidelines for arranging formal and informal support to inspections**. Understanding and documenting expectations up front, then providing clear responses to the initial queries, will make NRC inspections work even better.
- **The NRC needs to improve its petition review processes even more**. While the process was recently updated, the team still found weaknesses in the consistency and independence of reviews, documentation of decisions, and level of detail reviewed at each stage.
- **The NRC needs to improve how it supports other agencies' reviews.** When the NRC's expertise or decisions will be cited by another agency, the NRC should follow practices it already has in place for its own environmental reviews, formalizing and documenting the interactions across agencies. This approach should also provide for a mutual understanding of each agency's objectives and regulatory context.

The body of this report amplifies these topics in six main sections and nine appendices.

- **Section 1** and its accompanying **Appendix A** provide background information on Indian Point, the natural gas transmission pipelines that run near the plant, and analyses conducted of these pipelines.
- **Section 2** and its accompanying **Appendices B, C, and D** provide technical detail. The team assessed the NRC's prior analysis of the 42-inch pipeline. The team also conducted (1) its own transient analysis to quantify the natural gas that could be released in a pipeline rupture and (2) its own risk analysis to characterize the onsite effects at Indian Point.
- **Sections 3 and 4** of the report provide information on NRC processes. The team assessed the NRC's review of a petition regarding the new 42-inch pipeline near Indian Pont. Through this assessment and other team activities, the team developed recommendations for process improvements in five different areas.
- **Section 5** of the report focuses on the specific issues raised by the NRC Office of the Inspector General, many of which are also addressed in the other sections. The team considered each issue and determined whether the team agreed with the finding, agreed in part, or disagreed.
- **Section 6** summarizes the team's conclusions. It also presents additional issues that the team or external parties identified during the course of the team's review. While the team remained vigilant for issues that could pose an immediate safety concern for Indian Point, most of these issues could not be addressed within the scope or timeframe provided to the team. These issues are presented for further consideration by the NRC, as appropriate.
- **Appendices E through I** provide supporting information for the remainder of the report. Appendix E summarizes the peer review of this report conducted by a member of the Advisory Committee on Reactor Safeguards. Appendix F has short biographical information on each team member. Appendix G collects the figures referenced in the report. Appendix H and I both

include reference information in different formats—Appendix H with selected events and references in chronological order and Appendix I containing all of the endnotes referenced throughout the document.

Table of Contents

1. Background

1.1. Indian Point Energy Center and Preexisting Natural Gas Pipelines

The Indian Point Energy Center, located in the village of Buchanan, NY (Westchester County), has three reactors on site.

- Unit 1 was one of the earliest reactors licensed by the U.S. Atomic Energy Commission (AEC), the predecessor to the U.S. Nuclear Regulatory Commission (NRC). The Consolidated Edison Company submitted its initial license application to the AEC in 1955. Indian Point Unit 1 is permanently shut down, and only operated commercially from August 1962 until October 1974. Entergy (the NRC licensee for Indian Point) has moved all of the spent fuel from Unit 1 to dry storage in an independent spent fuel storage installation on the Indian Point site. The spent fuel pool for Unit 1 has been drained and cleaned.
- Unit 2 began commercial operations in 1974. It is a Westinghouse pressurized-water reactor with a large dry containment. Per a 2017 settlement agreement between New York State, Riverkeeper, and Entergy, Unit 2 is scheduled to be shut down by April 30, 2020, before the expiration of its license in 2025. Consolidated Edison owned and operated Unit 2 until 2001, when the NRC authorized transfer of the license to Entergy.
- Unit 3, a design very similar to Unit 2, began commercial operations in 1976. Under the same agreement between New York State, Riverkeeper, and Entergy, Unit 3 is scheduled to be shut down by April 30, 2021. In 1978, operating authority for Unit 3 was transferred from Consolidated Edison to the Power Authority of the State of New York, which operated Unit 3 until 2000, when the NRC authorized transfer of the license to Entergy, which joined the sites.

Figure 1 and Figure 2 provide aerial views of the site to orient the reader.

Underground natural gas pipelines have run below the Hudson River and part of the Indian Point site since the 1950s. In this report, these pipelines are referred to as the "preexisting pipelines," in contrast to the Algonquin Incremental Market (AIM) 42-inch pipeline that was constructed long after the units began operating (see Section 1.2 of this report). The preexisting pipelines run closer to Unit 3 than to Unit 2, but in both cases are outside the security owner-controlled area (SOCA), hundreds of feet away from safety-related plant equipment.

Three pipelines related to this preexisting natural gas transmission system run under the Hudson River today:

- A 24-inch pipeline, constructed between 1952 and 1954, with a 674 psig maximum allowable operating pressure (MAOP)[1] *(see Appendix I for all notes)*
- A 30-inch pipeline, constructed between 1965 and 1967, with a 750 psig MAOP
- A 24-inch auxiliary line installed in 1992, with a 674 psig MAOP

The two pipelines that run across the Indian Point site are the 26-inch and 30-inch pipelines, which are buried between 5 and 10 feet below the surface onsite.

Appendix A presents background information on how these preexisting pipelines were evaluated by the licensee and the NRC from initial licensing through 2015.

1.2. Algonquin Incremental Market Project

In February 2014, Algonquin Gas Transmission, LLC (a subsidiary of Spectra Energy[2]) applied to the Federal Energy Regulatory Commission (FERC) for a Certificate of Public Convenience and Necessity and related authorizations for the AIM Project.[3] The AIM Project, as described in the original application, would include installing 37.6 miles of take-up and relay, loop and lateral pipeline facilities and related facilities in New York, Connecticut, and Massachusetts; adding compression capability at stations in New York, Connecticut, and Rhode Island; and modifying or constructing multiple metering and regulating stations. The project would allow Algonquin to provide 342,000 dekatherms per day (Dth/d) from a receipt point near Ramapo, NY, to delivery points in Connecticut, Rhode Island, and Massachusetts. Figure 3 in this report provides an overview of the AIM pipeline.

The new pipeline facilities included:

> ... 20.1 miles of 42-inch diameter pipeline that will replace certain segments of 26-inch diameter pipeline, including approximately 6.8 miles in Rockland County, New York, approximately 8.8 miles in Westchester County, New York, approximately 0.1 miles in Putnam County, New York and approximately 4.4 miles in Fairfield County, Connecticut (including horizontal directional drills of 0.7 miles crossing the Hudson River and 0.7 miles crossing I-84/Still River)...
>
> ... Installation of a new 42-inch [mainline valve], cross over piping and a 26-inch receiver facility at MP 5.48 (Stony Point to Yorktown Take-up and Relay) in Westchester County, New York...
>
> ... Replace the existing 26-inch valve with a 42-inch valve equipped with Remote Control Valve (RCV) capability and install cross over piping at existing MLV 15 at MP 11.0 (Stony Point to Yorktown Take-up and Relay) in Westchester County, New York...

Algonquin's application also addressed concerns regarding Indian Point that had been identified in an October 2013 letter from Entergy to the FERC.[4] (Entergy's submittal was part of a FERC prefiling review, which included environmental scoping.) The relevant discussion is in Section 10.5.3 of Resource Report 10, "Hudson River Crossing Alternative."[5] Algonquin clarified in this section that none of the existing pipelines near Indian Point could be upgraded to a higher pressure, and that the existing pipelines needed to be retained for reliability—during a planned maintenance outage of the 30-inch or 42-inch lines, the 24-inch lines could be used at a lower pressure to minimize flow interruption. Algonquin evaluated Hudson River crossings in northern (using the existing right of way through the Indian Point site) and southern (farther away from Indian Point). Algonquin decided to use the southern crossing because it would present much less risk and a much higher likelihood of success. The figure showing these alternatives is reproduced in this report as Figure 4.

As part of its review, the FERC issued a draft environmental impact statement in August 2014.[6] The FERC docket shows multiple comments from Entergy, the NRC, and interested stakeholders regarding the potential impacts of the AIM pipeline on Indian Point. The Entergy comments discussed the design enhancements that Algonquin had committed to for the pipeline along the

southern route, the evaluation that it had to conduct for Indian Point, the NRC's ongoing inspection of this evaluation (see Sections 1.2.2 below), and its decision not to oppose FERC approval of AIM following the southern route.[7] The NRC comments referenced the NRC's inspection and a planned future interaction with the FERC, as discussed in Sections 1.2.2 and 1.2.3 below.[8]

The FERC issued its final environmental impact statement in January 2015.[9] Multiple sections of the final environmental impact statement, beginning with the Executive Summary, address Indian Point. The alternatives section (Chapter 3) of the environmental impact statement discusses the northern (not selected) and southern (selected) crossings and their effects on Indian Point. The land use section (4.8) discusses Indian Point, including comments received and actions taken by Entergy and the NRC. Algonquin noted that it would coordinate all construction activities with Entergy's Indian Point site manager.

The reliability and safety section (4.12) notes the enhanced mitigation measures for construction near Indian Point, which "exceed the most stringent Class 4 requirements," in a passage related to the nearby Buchanan-Verplanck Elementary School. The FERC further noted that this section of the pipeline would be designated a high consequence area, which means it would be included in Algonquin's integrity management program under the requirements of the U.S. Department of Transportation, Pipeline and Hazardous Materials Safety Administration in 49 CFR 192, Subpart O, "Gas Transmission Pipeline Integrity Management (IM)."[10] This section also addresses Entergy's comments on the pipeline routing, pipeline design enhancements, construction impacts on Indian Point, and overpressure protection, as well as the results of Entergy's and the NRC's related activities.[11]

A summary of the FERC's relevant findings and bases can be found at the end of Section 4.13 of the final environmental impact statement on cumulative impacts:

> As a result of consultation between Algonquin and Entergy, Algonquin has agreed to additional design and installation enhancements along approximately 3,935 feet of the AIM Project pipeline where it would lie closest to [Indian Point] (i.e., 0.5 mile from [Indian Point's] security barrier). These measures are described in section 4.12.3. Entergy has concluded that, based on the proposed routing of the 42-inch-diameter pipeline further from safety-related equipment at [Indian Point], and accounting for the substantial design and installation enhancements agreed to by Algonquin, the proposed AIM Project poses no increased risks to [Indian Point]and there would be no significant reduction in the margin of safety at the facility. The NRC conducted its own, independent review assuming a catastrophic pipeline failure, and concurred with these findings. As such, we find there would not be any significant cumulative impacts on safety or reliability associated with the proximity of the pipeline to the [Indian Point].

The FERC issued its approval order in March 2015.[12] Paragraphs 106 and 107 of the order address Entergy's and the NRC's activities regarding Indian Point and the FERC's conclusion that "the project will not result in increased safety impacts" at Indian Point. Spectra Energy placed the AIM Project into service in November 2016.[13]

1.2.1. Entergy Actions

As noted above, Entergy was aware of Algonquin's plans to construct a 42-inch pipeline near the Indian Point site, in addition to the preexisting pipelines. This change meant that Entergy needed to consider under 10 CFR 50.59, "Changes, tests, and experiments," whether there would be effects on Indian Point needing NRC approval.[14]

Entergy submitted its evaluation results to the NRC in August 2014, referencing the AIM pipeline application and draft environmental impact statement discussed above.[15] Entergy noted its plans to comment on the FERC draft environmental impact statement and concluded its letter with this passage:

> Entergy has determined that there are no increased risks to Indian Point and, pursuant to 10 CFR § 50.59, has concluded that prior NRC review and approval is not required. In our submittal to FERC we plan to point out that as part of the routine inspection program NRC always has the right to review and challenge any analysis done pursuant to 10 CFR 50.59. Unless NRC chooses to perform such a review we cannot guarantee that they would ultimately concur with our position. Therefore we will suggest that prior to approving the Project, FERC should consider conferring with the NRC before reaching a conclusion regarding the potential hazards posed by the AIM project on [Indian Point] and whether any additional mitigation is necessary. Accordingly, we are forwarding to the NRC the enclosed Safety Evaluation and Hazards Analyses and are prepared to answer any questions NRC may have on the Analyses or support inspections of the same.

Entergy, in its 10 CFR 50.59 evaluation, described earlier evaluations of the preexisting pipelines (all of which are discussed in Appendix A to this report), the routing and design of the planned AIM pipeline, and actions that the pipeline operator would take in the event of a rupture.[16] Entergy discussed application guidance in Regulatory Guide 1.70 and staff review guidance in Standard Review Plan Section 2.2.3 for considering design-basis events external to the plant, as well as guidance in Regulatory Guide 1.91 for evaluating postulated failures at nearby facilities and transportation routes.[17] Entergy used this guidance to evaluate the exposure rates (likelihood) of pipeline failures and effects (consequences) of such events. The analysis resulted in a list of distances from the pipeline beyond which damage was *not* postulated:

- 1,266 feet to withstand heat flux from jet fires (at 12.6 kW/m^2)
- 1,155 feet to withstand detonation of a vapor cloud (at 1 psi overpressure)
- 900 feet to withstand missiles generated by the rupture (based on the maximum distance observed)

Entergy then evaluated structures and equipment that was closer to the pipeline (either the enhanced pipeline nearest near the site or the closest non-enhanced portions offsite) than these distances. The switchyard and fuel oil storage tank for the Unit 2 and 3 emergency diesel generators, which are just over 100 feet from the nearest approach of the 42-inch pipeline, could be destroyed because of a pipeline rupture. Entergy clarified that the loss of offsite power that would result had already been analyzed and is a relatively high probability event for other reasons. The fuel oil storage tank is a source of fuel to the diesel generators beyond the onsite "day tanks" to ensure they have an overall 7-day supply of fuel. Offsite fuel could be obtained and provided to the site through alternative access routes. Entergy noted that it would move an associated tanker truck. Other equipment and structures were either significantly further away or had backup capability. Of note, the SOCA fence (which bounds all safety-related equipment onsite) is at least 1,580 feet away from the pipeline. Figure 5 shows views of the AIM pipeline right of way from near Indian Point to provide perspective on the distance and terrain.

Entergy also assessed the frequency of a pipeline explosion "using industry data and correlating it to more recent data." The resulting rupture frequencies for generic pipeline and enhanced pipeline were 1.32×10^{-5} per year per mile and 1.98×10^{-6} per year per mile, respectively.[18] Entergy also

estimated associated probabilities of jet fires, explosions, and missiles at various equipment locations.

Entergy concluded that the potential for increased risk to the public was acceptably low because no safety-related structures, systems, or components (SSCs) or security features would be damaged by a pipeline rupture, the effects on other SSCs from ruptures would not have a significant effect on plant safety, and the frequency of damage to such SSCs would generally preclude consideration of such. Entergy used these evaluations to answer the questions associated with 10 CFR 50.59 and determined that prior NRC approval was not needed to address these issues.

In April 2015, Entergy submitted a revised 10 CFR 50.59 evaluation to the NRC.[19] This revision reflected "additional tie-in details for certain limited above-ground segments of the gas pipelines" that Algonquin had shared with Entergy. Only a portion of the 26-inch pipeline is above ground at that location, where it ends at a receiving pig trap, and no portions of the 30-inch or 42-inch main pipelines are above ground. Several smaller-diameter pipe segments for valve actuators, equalizing lines, and pig tie-ins are above ground at that location. Figure 6 shows views of this above-ground area from a publicly accessible location.

In the 2014 analysis, Entergy had considered a sabotage event or rupture at an above-ground portion of the pipeline and concluded that this area was sufficiently far away from all important equipment not to pose a risk. In the 2015 analysis, Entergy reevaluated a rupture of all above-ground components during pigging of the 26-inch pipeline. The heat flux and overpressure were smaller than the previous calculation, so Entergy concluded that its previous conclusions regarding 10 CFR 50.59 remained valid.

Entergy updated the final safety analysis reports (FSARs) for Units 2 and 3 to reflect the analyses of the new 42-inch pipeline.[20]

1.2.2. NRC Response to Entergy Actions

As indicated above, the NRC conducted an inspection of Entergy's 10 CFR 50.59 evaluation using Inspection Procedure 71111.18, "Plant Modifications."[21] The NRC documented the results in a November 2014 quarterly inspection report for Indian Point.[22] As part of the inspection, NRC staff reviewed the Entergy documentation, "walked down" the proposed pipeline routing, and independently analyzed the potential hazards associated with failure of the proposed pipeline. These staff members prepared additional documentation to support the summary that was included in the inspection report.[23] The NRC concluded in the inspection report that "Entergy had appropriately concluded that the proposed pipeline does not introduce significant additional risk to safety-related SSCs and SSCs important-to-safety at Indian Point Units 2 and 3; and, therefore, the change in the design bases external hazards analysis associated with the proposed pipeline does not require prior NRC review and approval."

Since Entergy determined under 10 CFR 50.59 that NRC approval was not needed, and the NRC did not identify issues with this determination, the NRC did not conduct a licensing review or formally request additional information from Entergy (as might have been done in a licensing review).

1.2.3. NRC Coordination with FERC

Early in its review, the FERC offered the NRC the opportunity to participate formally with the FERC as a "cooperating agency" for the environmental review. Staff from both agencies discussed this option in April 2014 teleconferences.[24] As part of these interactions, the FERC shared public comments from the prefiling review and shared insights on the benefits of being a cooperating agency; the NRC explained Entergy's and the NRC's role in the process. The NRC determined that it

did not intend to become a cooperating agency, but would consider providing appropriate information, once available, on the impacts of the AIM Project.

As indicated above, the NRC commented on the FERC draft environmental impact statement in September 2014.[25] The NRC noted that its inspection of Entergy's hazards analysis was ongoing, with the results scheduled for issuance in mid-November 2014. The NRC recommended that it discuss the inspection findings with the FERC in October 2014 to allow more time for the FERC to prepare its final environmental impact statement.

This meeting occurred via teleconference on October 17, 2014.[26] In its meeting summary, the FERC made note of the Entergy and NRC analyses, as well as the additional mitigation measures that were part of the pipeline design. The FERC stated the following:

> Based on its review, the NRC came to the same conclusion that Entergy did in its [10 CFR] 50.59 submission. Therefore, NRC finds Entergy's 50.59 submission acceptable and has determined that no prior approval from the NRC is needed. NRC also indicated that the existing pipelines have been studied extensively, including as recently as 2008.

1.2.4. 10 CFR 2.206 Petition

During this timeframe, the NRC also reviewed a 10 CFR 2.206 petition that raised issues with the 10 CFR 50.59 evaluation conducted by Entergy. The petitioner requested that the NRC take enforcement action against Entergy for violating regulations and raised concerns regarding the NRC's inspection, oversight, and handling of several portions of his petition. The NRC rejected this petition, citing prior reviews of the issues raised by the petitioner. Additional information on the petition and the NRC's handling of it is presented in Section 3 of this report.

1.3. Event Inquiry and Expert Evaluation Team

On February 13, 2020, the NRC Office of the Inspector General (OIG) issued an Event Inquiry, "Concerns Pertaining to Gas Transmission Lines at the Indian Point Nuclear Power Plant" (Case No. 16-024).[27] In that report, the OIG raised concerns regarding (1) the NRC's safety analysis that supported the FERC determination to approve modifications to gas pipelines at Indian Point and (2) the NRC's response to a related 10 CFR 2.206 petition.

On February 24, 2020, the NRC Chairman directed the NRC staff to determine whether any immediate regulatory action was needed.[28] NRC staff promptly reviewed the OIG report and the technical aspects of the 42-inch gas line that runs near the Indian Point property. Based on this prompt review, the Executive Director for Operations (EDO) determined that there were no safety issues warranting immediate regulatory action at Indian Point.[29]

The staff was further directed to review whether any information in the OIG report demonstrates that the staff should revisit either the safety analysis or its response to the 10 CFR 2.206 petition, as well as to evaluate whether any modifications to agency practice or procedures are needed or appropriate based on the OIG report. On February 27, 2020, the EDO established an evaluation team to carry out the review directed by the NRC Chairman.[30] This report summarizes the results of that review.

The NRC publicly released the team's evaluation plan on March 9, 2020, including team membership.[31] The team was led by David Skeen (Deputy Director, Office of International Programs) and Theresa Clark (Deputy Director; Division of Rulemaking, Environmental, and Financial Support; Office of Nuclear Material Safety and Safeguards). NRC members were

independent of prior reviews in this area. The team included experts in NRC engineering reviews and risk analysis. The team also included external experts independent of the NRC's prior activities on this subject. A pipeline safety analysis expert from the Department of Transportation's Pipeline and Hazardous Materials Safety Administration (PHMSA) independently reviewed the NRC and Entergy safety analyses. In addition, the NRC contracted for experienced researchers at Sandia National Laboratories to provide expertise on natural gas modeling and fire risk. Biographies of the team members are included in 0 to this report.

As directed by the EDO, on March 18, 2020, the team identified modifications that may be needed to agency practices or procedures.[32] The team noted that peer reviews should be strengthened, guidance for supporting inspections should be clarified, the structure for reviewing 10 CFR 2.206 petitions should be revisited, and interagency coordination should be strengthened. Section 4 of this report provides additional detail on process improvements recommended by the team.

The results of the team's activities are documented in the following sections of this report. The major activities of the team between February 27, 2020, and April 9, 2020, were:

- Conducting one or more interviews each with:
    - 15 NRC staff and managers in Office of Nuclear Reactor Regulation (NRR) and Region I who were directly involved in the NRC's inspection, analysis, and petition review
    - 2 members of the public who had previously raised concerns with the NRC's handling of these issues[33]
    - 3 Entergy staff members who were involved in evaluations of pipeline hazards
- Reviewing numerous public and non-public documents, as referenced in the chronology that the team assembled (Appendix H) and the endnotes to this report (Appendix I)
- Visiting the Indian Point site to directly observe pipeline locations, plant safety systems, and equipment and structures that could be affected by a pipeline rupture
- Conducting various risk and consequence analyses for pipeline ruptures, as discussed further in this report (notably Section 2, Appendix B, 0, and Appendix D)
- Coordinating with NRC fire experts in the Office of Nuclear Regulatory Research to understand the bases for equations and references in Regulatory Guide 1.91[34]

During the team's review, the team or external parties identified issues separate from those included in the Chairman and EDO taskings. While the team remained vigilant for issues that could pose an immediate safety concern for Indian Point, most of the issues raised could not be addressed within the scope or timeframe provided to the team. Section 6.3 of this report collects these issues for further consideration by the NRC, as appropriate.

2. Conclusions Regarding Safety Analysis

Throughout its work, the team remained focused on the safety of Indian Point and whether new information revealed the need to take immediate regulatory action. The team did not identify any concerns that met this threshold. This section of the report describes how the team considered the safety of Indian Point in proximity to the AIM pipeline, from three perspectives: the likelihood of a pipe rupture and blowdown that could affect Indian Point, the consequences a pipeline explosion (overpressurization and missiles), and the consequences of a pipeline-rupture-related fire (heat impacts). The team considered historical experience and conducted its own analyses of dynamic gas behavior following a pipe rupture and the risk of subsequent impacts at Indian Point. The subsections below address these topics in detail.

2.1. Pipe Rupture and Blowdown Likelihood

2.1.1. Design and Construction Enhancements

The team obtained information from Enbridge (the AIM pipeline operator) regarding the enhanced design and construction of the AIM pipeline near Indian Point. Similar information had been provided to Entergy, in support of its 10 CFR 50.59 evaluation, and other requesting parties. These measures generally exceed the applicable Department of Transportation requirements under 49 CFR Part 192, "Transportation of Natural and Other Gas by Pipeline: Minimum Federal Safety Standards." For example, the enhanced protections for the pipeline adjacent to Indian Point include:

- A more stringent design factor, higher-grade pipe[35], and deeper burial than required
- Fusion-bonded epoxy coatings for corrosion control inside and outside the pipe, an abrasive resistant overlay outside the pipe, and no shrink sleeves or tape coatings on field weld joints
- 100-percent non-destructive examination of all girth welds; 100-percent inspection of all welding, coating, and backfilling activities; and "pigging" after construction to identify any dents exceeding code limitations

Enbridge also placed fiber-reinforced concrete slabs and warning tape above the pipeline near Indian Point to reduce the likelihood of construction digging or other activities reaching and damaging the pipeline.

In general, these enhancements mean that the likelihood of a pipeline rupture through known risk factors such as welding flaws, corrosion, and incidental damage is reduced. The team's peer reviewer (see Appendix E) observed this when reviewing the team's event frequency estimate discussed in Section 2.5 below:

> The method used to establish the initiating event frequency, although based on actual data, does not have a high degree of statistical confidence or relevance to the AIM pipeline. The data are a limited sample, and there were likely different causes and conditions associated with each of the fifteen rupture events (seam weld manufacturing defects/low toughness, external corrosion, stress corrosion cracking, and third-party damage are the more common ones). And these conditions are not directly applicable to the subject AIM pipeline. Most, if not all, of these failures were likely in legacy pipelines, manufactured to less rigorous standards than current practice and have been subjected to many years of potential in-service degradation. This is especially true for the ~4000 ft of enhanced AIM pipeline in closest proximity to [Indian Point]. Therefore, although there is a high degree [of] uncertainty in the assumed initiating event frequency, **it is likely that the**

uncertainty is in the direction of making this estimate much higher than the true rupture frequency of that pipeline segment. *(emphasis added)*

The team did not attempt to quantify a reduced pipeline rupture frequency for the AIM pipeline near Indian Point, given the uncertainties. In the team's view, optimistic estimates of failure *frequencies* (one in a million per year or less) often lead the licensee or the NRC to assess failure *consequences* in less detail. Therefore, the team continued with its analysis applying a more general failure frequency.

2.1.2. Risk Assessment and Mitigation

After construction, pipeline operators continue to assess and mitigate the risks to their pipelines through "integrity management." For high consequence areas,[36] the relevant requirements are in 49 CFR 192, Subpart O. The AIM pipeline near Indian Point is identified as being in a high consequence area, so these requirements apply. Relevant requirements for this case include:

- **Having an integrity management program (49 CFR 192.911, among others).** These programs include identification of high consequence areas, plans for various assessments, processes for continual evaluation, and certain procedures. Operators must continually improve their programs. The team obtained information from Enbridge verifying that it has an integrity management program and risk assessment process that manages, monitors, and addresses various types of corrosion, defects in the pipeline, third-party damage, operations issues, and weather. Enbridge's program manual lays out the general approaches taken by Algonquin Gas Transmission.[37]
- **Assessing threats to the pipeline and taking actions to mitigate the risks (49 CFR 192.917 and 192.935, among others).** "Threats" for purposes of this assessment include those listed in the American Society of Mechanical Engineers and American National Standards Institute (ASME/ANSI) Standard B31.8S,[38] such as corrosion, construction defects, third party damage, and human error. Operators use this standard to assess the risks associated with each threat and prioritize what baseline assessments and reassessments are needed, as well as what preventive and mitigative measures will be taken. Preventive and mitigative measures are based on the risk assessment and can include installing remote control valves, replacing pipe segments with pipe of heavier wall thickness, operating below 30 percent of the specified minimum yield strength,[39] and conducting training and drills. [insert enbridge]
- **Conducting a baseline assessment and continuous assessments (49 CFR 192.921, 192.937, and 192.939, among others).** As appropriate for the pipeline segments, the operator conducts internal inspections to detect corrosion or other threats, pressure tests in accordance with 49 CFR 192, Subpart J, "Test Requirements,"[40] and direct assessments for corrosion. Operators must conduct this baseline assessment within 10 years from the date a pipeline is installed. The pressure test under 49 CFR 192, Subpart J, can satisfy the requirement for a baseline assessment. Operators must continue to assess the pipeline, with a reassessment occurring no more than 7 years after the baseline assessment. The reassessments, similarly, can also include pressure tests or direct corrosion assessments. [insert enbridge]

The team also gained access to a risk assessment contracted by the State of New York to assess infrastructure near the AIM pipeline and the risks of damage to the pipeline.[41] The risk assessment was based on experts' judgment and did not quantify probabilities and consequences of specific scenarios. This evaluation considered risks to pipeline integrity such as corrosion and other material issues, excavation and other sources of damage, as well as equipment and operational failures. All risks specific to Indian Point were categorized as "unlikely." Mitigation and emergency

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response strategies were identified for each, including actions that the New York State Department of Public Safety would take. The appendix on Indian Point pipeline impacts summarized publicly available analyses related to the pre-existing and AIM pipelines and referenced prior conclusions by the NRC and licensees.

Collectively, these ongoing activities provided the team with further confidence that a pipeline rupture is unlikely, though (as noted above) the team did not attempt to quantify the risk reduction from such activities.

2.1.3. Isolation of a Pipeline Rupture

If a rupture occurs on the AIM pipeline near Indian Point, the effects on the nuclear power plant would depend on the volume of gas released. The volume of gas released is a function of the speed with which the pipeline operator isolates the ruptured pipeline. It is also a function of the length of pipeline that would be isolated, which determines the amount of gas available to flow out the break and feed a fire or other consequences. Entergy and the NRC have made different assumptions regarding these variables. The team obtained updated information from Enbridge on the methods that the pipeline operator would use to isolate a rupture.

Enbridge informed the team that the 42-inch AIM pipeline is continuously monitored from a gas control center in Houston, TX. The control center monitors pressures, flows, and station status (including discharge and suction pressures). The Supervisory Control and Data Acquisition system is used to detect ruptures and was specifically enhanced to include a schematic screen to expedite evaluation and isolation. Alarms include a rate-of-change alarm that detects a pressure drop on the line. If the data indicates a rupture requiring valve closures, gas controllers have the authority, autonomy, and ability to close valves to isolate the pipeline. They are also trained to isolate other affected facilities including shutting down the compressor station across the Hudson River.

Enbridge has procedures for emergency notification, emergency response, alarm management, and response to abnormal operations that it would apply in these cases. The procedures indicate that the operator may have enough information from his data system, alarms, and trends to enable emergency response actions. If the data is not clear, the operators can use reports from outside sources such as emergency services or public officials to justify isolating a line. The controller is not required to have such verification to isolate the line if the data is clear.

The mainline valves for the 42-inch pipeline are remote-operated from the Houston control center. The control center can also monitor pressures on the upstream and downstream sides of the valves. Enbridge estimated, based on tabletop training and operating experience, that it would take up to eight minutes to identify a rupture using the Supervisory Control and Data Acquisition system, confirm that the valves need to be closed, and close the valves. Enbridge noted that three minutes (previously referenced by Entergy) would be a "best case"; confirmation of the event could add additional time to the assumed closure time. The team notes that accident experience, as discussed in Section 2.4, indicates that ruptured pipelines have taken minutes to hours to isolate, depending on the issue and whether valves can be remotely operated.

Enbridge informed the team that these mainline valves on the 42-inch AIM pipeline near Indian Point were closer together (i.e., could isolate a smaller segment of pipeline) than required by regulations. The team obtained schematics showing the location of mainline isolation valves near Indian Point. As has been stated in multiple other evaluations, the nearest remote-controlled valves to Indian Point are about 2.8 miles apart. The next closest downstream valve—which is also remote controlled—is about 5.6 miles downstream. The next closest upstream valve is associated with the Stony Point compressor station, about 2.5 miles further upstream. Based on the PHMSA team

member's experience, in some cases the pressure drop from a pipeline rupture may make it challenging to close the nearest valve to a rupture, and operators could need to close a further valve. The team concludes that the minimum unisolated pipeline length is about 2.8 miles. Depending on circumstances, the length could increase to about 5.3, 8.4, or 10.9 miles.

As a result of these issues, the team recommends that Entergy reevaluate its assumptions on a three-minute pipeline isolation time and a gas volume based on approximately 3 miles of isolated pipe, as discussed in Section 2.6. The related OIG finding is also discussed in Section 5.1.5.

2.2. Pipe Rupture Consequences – Overpressurization and Missiles

Regulatory Guide 1.91 states that "[a] demonstration that the rate of exposure to a peak positive incident overpressure in excess of 1.0 psi (6.9 kPa) is less than 10^{-6} per year when based on conservative assumptions, or 10^{-7} per year when based on realistic assumptions, is acceptable." Additionally, the guide states that "[i]f this criteria cannot be met, then the applicant may show through analysis that the risk to the public is acceptably low on the basis of the capability of the safety-related structures to withstand blast and missile effects associated with detonation of the potentially explosive material."

In the 2014 and 2015 10 CFR 50.59 evaluations,[42] Entergy found that the frequency of a peak overpressure may be more than 10^{-6} per year, so a detailed evaluation was needed to illustrate that the safety-related structures could withstand blast and missile effects. For missile effects, Entergy noted that 900 feet is the greatest distance noted in the literature, which is less than the distance to any plant systems within the SOCA. For blast effects, Entergy calculated that a vapor cloud explosion would not damage important-to-safety SSCs within the SOCA.

The NRC staff's inspection report[43] stated that:

> The staff determined that the impacts to the SSCs important-to-safety outside the SOCA from the proposed new pipeline are bounded by the impacts from low probability events of extreme natural phenomena (including seismic activity, tornado winds, and hurricanes) which have been previously assessed and are addressed in the Indian Point Units 2 and 3 [updated FSARs].

The team could not verify the assumption that the Unit 2 and Unit 3 updated FSARs bounded the impacts for missiles. Additional information on this assumption is provided in Section 5.2.2. However, for missiles, the team did find that the largest distance that a pipe has been thrown is 600 feet. (According to PHMSA, the 900 feet reported by Entergy for one incident was an initial estimate by accident investigators, but the final established distance was 564 feet.) For overpressurization, the team was not able to verify that there was no impact to SSCs required for safe shutdown. A probabilistic risk assessment was done to determine the increased risk to the plant from a pipeline rupture. Section 2.5 provides more information on this risk assessment.

The team reviewed a study on valve closure timings conducted by Oak Ridge National Laboratory for PHMSA. The report notes that blast and overpressure effects were not evaluated because they occur immediately after the break, which could not be mitigated by different valve closure times.[44]

[SNL evaluation]

[TTO-14]

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Update to address SNL report:
- In replicating aspects of prior NRC analyses, found areas where assumptions may not be valid. (List/describe.) RG 1.91 should be updated to address these when detailed analyses are needed. (Refer to 4.4.)
- Conducted sensitivity study for dispersion of the gas volume that could come out of the break. Showed large distance to which a dense gas cloud could travel. Assumes wind conditions, ignition sources, etc. drive the cloud toward the plant without early ignition. Bounding case.
- Plant impacts of this gas cloud were not quantified and local terrain/weather was not considered, would be more detailed analysis.
- Not discounting potential physical phenomena, but accident experience is not consistent. (Refer to 2.4.) Also, experienced pipeline people (reference Kuprewicz transcript) emphasize that heat flux as the controlling impact.
- Maintain reasonable assurance of adequate protection.

Also, will need to add SNL report to appendix when we PDF this and correct page numbers based on the final page count.

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2.3. Pipe Rupture Consequences – Jet or Cloud Fires

Department of Transportation regulation 49 CFR 192.903, "What definitions apply to this subpart?" defines terms including "potential impact radius." The potential impact radius "means the radius of a circle within which the potential failure of a pipeline could have significant impact on people or property." The equation included in the regulation is:

$$r = 0.69\sqrt{p * d^2}$$

In this equation, r is the potential impact radius (ft), p is the MAOP of the pipeline (psi), and d is the pipeline diameter (in). This equation is associated with the heat-affected area,[45] as described further in the notice issuing the rule[46] and the technical basis provided in C-FER report prepared for the Gas Research Institute.[47]

Based on the input from the team's PHMSA member and the team's interview with an independent gas pipeline expert, the potential impact radius is the radius for a person to get out of the area within 30 seconds and is not meant to be used to determine the survivability of buildings. They recommended multiplying the calculated potential impact radius by 1.5 to 2 as a "rule of thumb" to determine a safe distance for buildings. This aligns with the Oak Ridge National Laboratory report mentioned above,[48] which evaluated the thermal impacts of double-ended guillotine breaks and noted that severe damage could occur within 1.5 to 1.7 times the potential impact radius. This also aligns with the risk assessment done by New York State, which referenced the Oak Ridge National Laboratory report as part of its basis for the area considered in the State's risk assessment.[49]

Using this formula for the 42-inch, 850-psi 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 impact the area inside the SOCA; however, it would not impact any safety-related structures.

Entergy found that at the SOCA fence, heat fluxes would be below 10 kW/m^2, and that the heat flux at 2,028 feet (a location inside the SOCA fence but not impacting safety-related systems) is only 5 kW/m^2.[50]

NUREG/CR-3330[51] discusses the survivability of reinforced concrete at various heat fluxes for varying points inside a wall, the closest point being six inches inside the wall. At Indian Point Unit 3, the diesel generator building has the thinnest walls of all safety-related buildings at 24 inches.[52] The thinnest point of containment is 42 inches,[53] and the thinnest point of the auxiliary building above ground is 30 inches.[54] NUREG/CR-3330 notes that at a heat flux of 15 kW/m^2, it will take 11.6 hours for temperature at six inches inside the wall to exceed 350 degrees Fahrenheit (177 degrees Celsius) and 5 hours if the heat flux was 50 kW/m^2.

The team's independent analysis based on calculations in NUREG/CR-3330 found that heat fluxes at the closest safety-related structure would be 11 kW/m^2 for a mass flow rate of 1940 kg/s. For a bounding flow rate of 4000 kg/s, the heat flux would be 21 kW/m^2. Even at the bounding flow rate, the pipeline would not need to be shut off for over eight hours. This greatly exceeds the estimated time it would take for the gas pipeline to be shut off; therefore, the heat flux would have no impact on safety-related structures. An appendix to the Sandia National Laboratories report (included as Appendix B to this report) presents this analysis in more detail.

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The team concludes that a jet or cloud fire would not impact the plant's safety.

2.4. Historical Pipe Rupture Experience

To provide perspective for the team's analytical results, the team obtained information from PHMSA's accident investigation division on some actual pipeline ruptures, summarized in Table 1. While this was a relatively small sample, it provided important background information to the team. In the table, the "impacted area" refers to the distance away from the pipeline where investigators found impacts as a result of the pipeline rupture. Impacted areas are generally an ellipse with a length parallel to the pipeline (and longer in the direction that had more compressed gas available) and a shorter width perpendicular to the pipeline. Most of these impacts were within or near the PIR, with none being further than 1.6 times the PIR. As noted above, isolation times can be relatively long in certain circumstances, such as when valves need to be locally operated or when shutting off the pipeline could have more significant consequences (e.g., for customers who need heating) than the fire. PHMSA staff stated that fires do not ignite in all cases, as both an arc and the correct atmosphere are needed to ignite the gas vapors.

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Table 1. PHMSA pipeline accident data showing pipe diameter and allowable pressure, calculated potential impact radius, impacted area, distance pipe was ejected, time to isolate the line, and duration of fire. "NR" is shown where data was not reported, and "N/A" is shown where the event did not occur.

Year	Location	Pipe Dia. (in.)	MAOP (psi)	PIR (ft.)	Impacted Area		Pipe Ejected (ft.)	Isolation Time (h:mm)	Fire Duration (h:mm)
					Length (ft.)	Width (ft.)			
1985	Beaumont, KY	30	936	633	700	500	NR	NR	NR
2003	Viola, IL	24	975	517	not reported (NR)		554	8:48	11:55
2008	Appomattox, VA	30	800	585	566	200	N/A	NR	NR
2010	San Bruno, CA	30	375	401	375	160	100	1:35	2:35
2017	Dixon, IL	20	800	390	365	163	N/A	0:31	3:06
2018	Batesville, OH	24	1440	628	50	50	N/A	0:00	1:04
2018	Moundville, OH	36	1440	943	250	250	100	0:25	3:05
2018	Hesston, KS	26	899	538	400	200	254	0:02	2:44
2018	Buffalo, OK	26	765	496	110	60	170	1:09	N/A
2018	Woodruff, UT	20	918	418	143	90	430	1:21	N/A
2018	Dixon Springs, TN	22	773	422	30	20	75	0:38	N/A
2019	Caldwell, OH	30	936	633	500	500	N/A	1:35	14:05
2019	Mexico, MO	30	900	621	437	286	125	1:12	1:31
2019	Hot Springs, AR	30	1000	655	252	114	306	2:12	N/A
2019	Danville, KY	30	936	633	704	645	600	1:52	3:07
2019	Artesia, NM	20	1000	436	687	60	360	3:23	N/A

This experience, which is mostly from the last few years since PHMSA formed its accident investigation division, is generally consistent with earlier information included in the C-FER report referenced above.[55] The C-FER report collected information on incidents from 1969 to 1995 and compared actual incident outcomes to the proposed hazard area model—which became the potential impact radius under 49 CFR Part 192. Figure 7 shows the comparison of distances that was included in the C-FER report. In all but one case, the potential impact radius was larger than the burn area or distance where any injuries was seen. Where the burn area was larger (NTSB-PAR-71-1), it was about 1.1 times the potential impact radius.

Figure 8 shows four examples of pipeline ruptures, including those with and without fires. The elliptical nature of the most severe impacts is demonstrated in the two left-hand images, fire and debris damage can be seen in the bottom-right image, and a rupture crater is shown clearly in the top-right image.

The team discussed pipeline ruptures with the PHMSA accident investigation staff who prepared the more recent data. The PHMSA staff confirmed that, in their experience, that they had never seen explosions occurring away from the initial rupture site or any other damage outside the area damaged by heat or fire. Also, in their recollection, only one of these (San Bruno) occurred within a high consequence area, and pipeline construction contributed to that failure.

2.5. Pipe Rupture Risk Assessment

The NRC uses a variety of methods to determine the safety significance of postulated events. Two of these methods use the insights from probabilistic risk assessments. One is the significance determination process,[56] which uses risk insights, where appropriate, to help the NRC determine the safety significance of inspection findings. The other is Regulatory Guide 1.174, "An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decisions on Plant-Specific Changes to the Licensing Basis."[57]

Both of these approaches use the metric of change in core damage frequency resulting from the situation to assess an inspection finding or a licensing basis change. These approaches define a small change to be less than one in a million years (10^{-6}). The NRC uses the agency's independent risk models to evaluate the change in core damage frequency. The team, with support from experts at the Idaho National Laboratory, modified the Indian Point models to reflect a pipeline failure and conducted a risk analysis. The team assumed that a pipeline failure would cause an unrecoverable loss of the Buchanan switchyard and cause loss of the city water tank. Based on these analyses, the team found that the change for both plants was an increase of one in 63 million years (1.6×10^{-8} per year), which is well below the agency's defined threshold for a "small" change in risk of one in a million years.

Because of the uncertainty associated with the consequences of overpressurization from an explosion, the team also performed a sensitivity analysis. This analysis assumed that all equipment not in a seismic Category I structure (i.e., not located in the primary auxiliary building, diesel generator building, or reactor containment) was lost upon the pipeline rupture. The seismic Category I buildings are designed to withstand a pressure drop of 3 psi[58], and it is assumed that the overpressurization will not exceed this value. The team primarily evaluated Unit 3 for this sensitivity, since it is closer to the 42-inch AIM pipeline and would experience more severe impacts. The change in core damage frequency for this scenario was one in 5.7 million years (1.75×10^{-7} per year). Again, this is below the agency's threshold for a "small" change in risk of one in a million years.

The team was concerned that PHMSA's data provided a national pipeline mileage that included all diameters of pipes, not just large pipes, which could be non-conservative if used to calculate an event frequency. The team independently reviewed publicly available data.[59] Using the last ten years' worth of data, the team determined Class 2, 3, or 4 carbon steel transmission lines with pipe diameters greater than or equal to 20 inches and maximum operating pressures greater than or equal to 300 psig rupture with a frequency of 2.4×10^{-5} per mile per year. The team recalculated the change in core damage frequency using this higher frequency and concluded that the change in risk remained below the agency's threshold for a "small" change in risk. More information on the team risk assessment and the PHMSA data can be found in 0 and Appendix D, respectively.

The agency's independent models only consider reactor risk, so the spent fuel pools and the dry fuel storage location must be considered separately. The spent fuel storage pit for Indian Point Unit 3 is a seismic Category I structure and is designed for a pressure drop of 3 psi. Given this rugged construction, the concludes that a pipeline rupture would not negatively affect the spent fuel pit, though the surrounding building could be damaged. Indian Point Units 2 and 3 use the Holtec

HI-STORM 100 dry cask storage system.[60] The HI-STORM 100 dry cask storage system is also designed for a pressure drop of 3 psi. The team also concludes that the dry fuel storage location, which is much farther from the 42-inch AIM pipeline than the other structures evaluated, would not be negatively affected by a pipeline rupture.[61]

2.6. Recommendation – Ask Entergy to Revisit its 10 CFR 50.59 Evaluation

Although the team did not conclude that immediate regulatory action is needed regarding Indian Point, the team does recommend further work be done by Entergy to show that its prior conclusions remain valid. **Based on concerns raised by external parties and substantiated by the team, the team recommends that the NRC request Entergy under 10 CFR 50.54(f) to submit updated information regarding the implications of the assumption that the 42-inch AIM pipeline could be isolated within 3 minutes and the length of pipe that would be isolated.** Entergy should either revisit its analysis applying an updated assumption or providing a basis for why the assumptions are not relevant to the conclusions previously presented.

During the NRC's review of the October 2014 petition referenced in Section 1.2.4, the petitioner raised a concern that Entergy provided inaccurate or incomplete information contrary to the requirements in 10 CFR 50.9, "Completeness and accuracy of information."[62] The petitioner also asserted that the licensee may have violated 10 CFR 50.5, "Deliberate misconduct."[63] The petitioner's concern centered on whether it was appropriate to model the 42-inch AIM pipeline being isolated in 3 minutes.[64] To this day, the petitioner continues to assert that the Entergy knew that the isolation times were inaccurate and material to the NRC determination.[65]

For purposes of addressing the issue raised by the petitioner, deliberate misconduct occurs when a licensee voluntarily and intentionally (1) engages in conduct that it knows to be contrary to a requirement, or (2) provides materially inaccurate or incomplete information.[66] Specifically, the requirements in 10 CFR 50.5 state, in relevant part, that licensees may not:

> Engage in deliberate misconduct that causes or would have caused, if not detected, a licensee or applicant to be in violation of any rule, regulation, or order; or any term, condition, or limitation of any license issued by the Commission; or
>
> Deliberately submit to the NRC, a licensee, an applicant, or a licensee's or applicant's contractor or subcontractor, information that the person submitting the information knows to be incomplete or inaccurate in some respect material to the NRC.
>
> …deliberate misconduct by a person means an intentional act or omission that the person knows: … Would cause a licensee or applicant to be in violation of any rule, regulation, or order; or any term, condition, or limitation, of any license issued by the Commission; or … Constitutes a violation of a requirement, procedure, instruction, contract, purchase order, or policy of a licensee, applicant, contractor, or subcontractor.

Similarly, 10 CFR 50.9 states, in relevant part, that:

> Information provided to the Commission … by a licensee … shall be complete and accurate in all material respects.

Since the licensee's initial and revised 10 CFR 50.59 analysis, as described in Section 1.2.1 above, additional information has been developed that questions Entergy's assumptions on pipeline isolation. Because some of these initial assumptions have had reasonable challenges to their

validity, the licensee should revisit its 10 CFR 50.59 analysis to verify whether its conclusion remain valid in light of this new information.

3. Conclusions Regarding 10 CFR 2.206 Petition

In October 2014, a member of the public submitted a 10 CFR 2.206 petition regarding the new 42-inch AIM pipeline near Indian Pont.[67] The petitioner requested that the NRC take enforcement action against Entergy for violating regulations at 10 CFR 50.9, "Completeness and accuracy of information," 10 CFR Part 50, Appendix B, "Quality Assurance Requirements," and 10 CFR 50.59. As part of the petition, the petitioner also raised concerns regarding the NRC's inspection, oversight, and the precise handling of several portions of his petition.[68] In January 2015, the petitioner met with the Petition Review Board (PRB) and presented his concerns.[69] Over the course of several months, the petitioner continued to supplement his petition with additional information and pursue additional insights through requests for agency documents.

In April 2015, the petitioner received documents from the NRC that, in his view, supported the petition's assertion that a material false statement was made with respect to Enbridge's ability to close the AIM pipeline isolation valves in three minutes. During a July 2015, PRB meeting, the petitioner and PRB discussed this additional information and agreed that the petitioner would submit any remaining concerns in writing.[70] Those 39 questions were submitted later in July.[71] In September and November 2015, the NRC rejected the 2.206 petition and provided responses to the 39 questions, respectively.[72]

3.1. Summary of the Current 10 CFR 2.206 Process

The 2.206 petition process allows the public and other interested stakeholders to request enforcement action against NRC licensees and license activities.[73] Subsequent to the October 2014 petition review described above, the process for reviewing 10 CFR 2.206 petitions was updated in March 2019.[74] The current implementation of the 2.206 petition process is established in Management Directive 8.11.[75] Additional guidance is available in a desktop guide.[76] Overall process flowcharts from the desktop guide are reproduced as Figure 9 and Figure 10 of this report.

Under most circumstances, a 10 CFR 2.206 petition review begins with a written request submitted to the EDO. The written request identifies the licensee, the activity, the enforcement action requested, and supporting evidence.[77]

Then, the NRC establishes a PRB to review the petition. The PRB is generally composed of a chairperson (a Senior Executive Service manager), the office 2.206 petition coordinator,[78] a petition manager, cognizant management and staff, a regional representative (branch chief or higher), a representative from the Office of Enforcement, and a representative from the Office of the General Counsel.[79] The PRB or the petition manager initially determines whether immediate action is necessary based on the safety or security issue raised by the petitioner; if so, the NRC pursues that action before taking further action to disposition the petition. If immediate action is not necessary, the PRB will prepare for an initial meeting that will include (1) a discussion of the safety significance, (2) a discussion of immediate actions taken (or needed, if new information has arisen since the initial determination), (3) a recommendation concerning referral for investigation, and (4) a proposed schedule.[80] At the initial meeting, the PRB also assesses whether the petition meets the acceptance criteria in Management Directive 8.11, could be consolidated with other petitions, or should be held in abeyance.[81]

In determining whether a petition should be accepted, the NRC first determines whether the petition specifies facts that support the requested action.[82] Second, the NRC determines that petition does not raise an issue that was previously resolved in a facility-specific or generic review. If the issue had been raised before, the PRB must determine (to accept the petition) that the specific issue was not resolved, the resolution does not apply to the current facts, or the petition provides

significant new information[83] that was not previously considered. After evaluating the petition against the acceptance criteria, the PRB will inform the petitioner of its assessment prior to a meeting and offer the petitioner an opportunity to meet with the PRB.[84]

Should the petitioner decide to meet with the PRB, the meeting will normally be conducted as a public meeting.[85] The meeting is an opportunity for the petitioner to provide any relevant additional explanation and support in light of the PRB's initial assessment. During the petitioner's presentation, the PRB members may ask questions to help clarify the assertions and concerns. The licensee is invited to participate but does not formally present.

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After considering any new information, the PRB will make an initial determination to either accept or reject the 2.206 petition. If the petition is rejected (as was the case for the October 2014 petition discussed above), the PRB issues a closure letter to the petitioner that explains why the petition was not accepted, acknowledges the petitioner's efforts in bringing issues to the staff's attention, explains any immediate actions taken, notifies the petitioner if the issue is being referred to another NRC program or process, and responds to the issues raised in the petitioner's request.[86] If the petition is accepted, a letter is sent informing the petitioner, and the petition review proceeds to a Director's Decision.[87] On its own initiative, the Commission may review the Director's Decision within 25 days of the date of the decision.[88]

3.2. Observations on October 2014 Petition Review

In his October 2014 request for enforcement action against Entergy, the petitioner asserted that Entergy's assumption regarding the time to isolate the new 42-inch natural gas transmission pipeline was mistaken.[89] He further asserted that the agency should not have accepted this 3-minute closure time and that Entergy knew the information was materially inaccurate or incomplete. The petitioner also challenged the licensee's and NRC's use of the Areal Locations of Hazardous Atmospheres (ALOHA) modeling software to model a postulated pipeline explosion.[90] The petitioner also raised concerns regarding the use of Regulatory Guide 1.91 and what he viewed as the staff's deviation from the guidance. The petition also questioned the quality assurance process used by the agency for its analysis of the AIM pipeline hazard.

During the NRC's evaluation of the petition, the PRB met with the petitioner twice to discuss the underlying facts, and the petitioner's concerns. Ultimately, the PRB determined the petition could not be accepted because the NRC had previously evaluated the concern.[91] To reach that conclusion, the PRB requested technical staff to conduct additional analysis.[92] The additional analysis was not thoroughly documented (Figure 11 and Figure 12 in this report are examples of handwritten sketches and results). As a result, the results were difficult for the PRB to review or verify, as indicated in interviews conducted by the team.

The team observes that the timing of the petition closure appears to be unusual, with the petition rejection occurring in September 2015 while the petitioner still had questions and concerns outstanding. The PRB promised to provide a response to his concerns at a later date and did so in November 2015. The team notes that the petitioner was planning "drop-in" meetings with members of the Commission[93] in September 2015, so there may have been urgency to resolve the petition.The PRB promised to provide a response to his concerns at a later date and did so in November 2015.

3.3. Team's Conclusion on 10 CFR 2.206 Petition Review Decision

Based on the guidance that was used to conduct the 10 CFR 2.206 petition review, the team concludes that the PRB appropriately dispositioned the petitioner's concerns. Under that guidance,[94] a petition could be rejected because:

> The petitioner raises issues that already have been the subject of NRC staff review and evaluation either on the cited facility, other plant facilities, or on a generic basis, for which a resolution has been achieved, the issues have been dispositioned, and the resolution is applicable to the facility in question.

The PRB's evaluation that the petitioner's concerns had been resolved in a prior staff review (i.e., the inspection report) met the criterion for rejecting a petition. The team's analysis, discussed in Section 2, provided additional information that supports the previous conclusions by Entergy and the NRC. The team does not recommend that the NRC reopen the 10 CFR 2.206 petition.

Nonetheless, the team observes that the PRB process could have been more rigorous, questioning, and well-informed about prior agency reviews. The OIG Event Inquiry identified some areas of concern with respect to the agency's analysis and communications with the petitioner. Recommendations to improve the 10 CFR 2.206 process are presented in Section 4.3.

4. Conclusions Regarding NRC Processes

During the review of the safety analysis, the 10 CFR 50.59 inspection, and the 10 CFR 2.206 petition, the team identified processes that could be improved. Four concern internal NRC processes and procedures, and one concerns NRC interactions with outside entities. For the four internal issues, the agency should (1) improve certain NRC technical work products, including peer reviews; (2) clarify guidance for regional inspection support by headquarters; (3) improve and clarify the 10 CFR 2.206 petition review process; and (4) update guidance for pipeline hazard analysis. In addition, a procedure should be developed to guide coordination between the NRC and other agencies to ensure clear documentation, communication, and consideration of agency needs.

4.1. Recommendation – Improve Certain NRC Technical Work Products, Including Peer Reviews

In March 2020, NRR revised its office instruction ADM-405, "NRR Technical Work Product Quality and Consistency."[95] This office instruction provides guidance for technical work products to meet expectations for quality. It specifies when peer reviews should be conducted, the qualifications for staff performing per reviews, the time and effort needed to perform an adequate peer review, and how to resolve peer review comments. The team identified these areas as weaknesses during interviews with those involved in the peer reviews of the NRC analyst's two main calculations. It appeared that the reviewer was identified almost by accident and was given little direction on what was expected. The resulting reviews were brief and, in the first instance, much more focused on the licensee's work than the analyst's given the responsibility of the licensee under 10 CFR 50.59.

The NRC staff and supervisors interviewed by the team uniformly expressed a lack of familiarity with the previous versions of this office instruction. Therefore, the team recommends that the roll-out of the new office instruction have a robust communication plan to ensure that technical staff and supervisors are familiar with the requirements. The team observes that training slides have already been prepared to accompany the issuance of the guidance.[96] **The team recommends that NRR consider how this guidance will be reinforced for new staff or supervisors who did not participate in training when the guidance was updated.** The team also notes that this guidance is specific to NRR. **Other offices may want to consider whether their peer review procedures provide for appropriate scope, process, and qualifications. The agency should consider implementing continuing training requirements for branch chiefs, other supervisors, and senior leaders on technical work product quality and consistency.** The continuing training requirements would ensure consistent work across the agency and supervisors. It would support NRC leaders as they transition to new positions and may become responsible for independent or confirmatory analysis.

The team also observed more generally that some of the challenges it documented in this report resulted from the NRC's decision, on multiple occasions, to conduct detailed analyses that required the NRC analyst to make critical assumptions. This approach appears to be unusual during inspections or petition reviews. Confirmatory analyses can be useful or even essential in supporting NRC decisions, if they are properly documented. When staff are faced with unusual or complex situations, however, conducting a confirmatory analysis may cause confusion. Conducting a rigorous and well-documented review of the licensee's work, or comparing a licensee's results to simpler rules of thumb, may be preferable. **The team recommends that the NRC give staff better guidance on when confirmatory analyses are necessary or appropriate.**

Finally, the team observed that the ways the NRC staff documented their analyses opened the door to later challenges. For example, calling an assumption "conservative" or "bounding" can be refuted

if others' calculations yield different results. It may be advantageous to make realistic or reasonable assumptions and document the basis appropriately. In addition, some important analysis documents are undated or do not designate who conducted the analysis. This makes follow-up questions related to these documents very challenging. Additional discussion on documenting decisions under the 10 CFR 2.206 process is provided in Section 4.3.4 below.

4.2. Recommendation – Clarify Guidance for Regional Inspection Support by Headquarters

The analyses that became the focus of the OIG Event Inquiry originated in a request for technical support from Region I. The regional inspection staff knew that this particular 10 CFR 50.59 evaluation would be of high interest and made, in the team's view, an appropriate decision in selecting it as a sample for their baseline "modifications" inspection. The onsite inspections and document reviews appear to have been thorough and reasonable. Furthermore, the team views favorably the region's decision to request technical support from headquarters to help review the licensee's unusually complex 10 CFR 50.59 evaluation.

The weakness of the inspection, in hindsight, was that Region I did not document its request for headquarters support through a document such as a Task Interface Agreement.[97] The relevant office instruction clarifies when such agreements are suitable and when an informal teleconference or email would suffice.[98] While the full Technical Interface Agreement process may not be warranted in all cases when inspectors need technical support, the team finds that better explanation and documentation would improve outcomes.

Inspectors should give technical experts supporting inspections appropriate context to support their review. The team heard from multiple individuals that inspectors focus on whether the licensee violated regulations and whether significant issues are found in the licensee's work. Inspectors are not reviewing and endorsing all aspects of a licensee's work. (In the case of a 10 CFR 50.59 inspection, the conclusion is whether the licensee appropriately determined that no prior NRC review is needed.) This approach contrasts with licensing reviews, in which NRC technical reviewers make an affirmative finding that an application or request meets requirements. Technical experts who are used to one approach may need orientation before using a different approach.

Inspectors should document specific focus areas for technical experts supporting inspections. The inspector may want to pose specific licensing or technical questions. The inspector may also have identified concerns or uncertainties with specific aspects of a licensee analysis that should be checked by confirmatory calculations. Reproducing a full licensee analysis is likely not necessary to make the conclusions expected during an inspection. The inspector should define the expected level of effort, timeframe, and response format at the beginning of the activity.

Therefore, **the team recommends that the NRC develop guidelines and good practices for inspectors and technical experts to use in arranging formal and informal technical support**. Such guidelines would also be referenced whenever technical support is needed, so that the inspector and the technical expert can reach agreement on expectations.

4.3. Recommendation – Improve and Clarify the 10 CFR 2.206 Petition Review Process

The team identified several areas where the 10 CFR 2.206 process should be further enhanced, as described in the subsections below. These enhancements should be included in the next update to the process guidance (either the Management Directive or the desktop guide).

4.3.1. Modernize Petition Review Boards

The team recommends that PRBs be improved by designating standing members for certain roles. Under the current process, membership in PRBs is an ancillary duty for each participant. PRB members interviewed by the team said that PRBs do not always have the expertise, ownership for the process, or the experience to effectively manage and tailor the process to the petition's underlying facts.

Under the current process, a PRB is established for each petition. For example, the PRB chair rotates through senior managers from the appropriate office. This rotation of leadership and participation can mean that leadership and staff do not develop a deep understanding of the process. This may result in some PRB members feeling bound by the process and unlikely to challenge assertions or exercise the appropriate questioning attitude.

The ancillary nature of the responsibility can make the petition process less efficient, discourage process improvements, and potentially suppress a questioning attitude. Efficiency is particularly harmed if PRB members are conducting the process for the first time or relearning the process after a long time. This may result in a focus on applying the process that discourages departures even when warranted, if PRB members cannot judge why certain procedures are in place and when procedures should be modified or are unnecessary. PRB members may not raise issues if they are concerned about being the lone holdout preventing others from returning to their main responsibilities.

4.3.2. Provide for Independent Petition Reviews

The team recommends that PRB members and support staff be independent from any previous substantive work on the issues raised in the petition. As noted above, one criterion for rejecting a petition is that the issue raised by the petitioner has been previously resolved on a facility-specific or generic basis. The desktop guide states that "[o]ffice management should avoid potential conflicts of interest when assigning staff and a chair to the PRB."[99] Several staff members associated with the review of the October 2014 petition were involved in the recently completed inspection of the licensee's 10 CFR 50.59 evaluation. This included the technical reviewer and the petition manager. The guidance and process applicable to that petition did specify that conflicts of interest should be avoided. It, however, did stress the importance of conducting an independent technical review.[100]

In this case, the technical reviewer was effectively tasked with determining whether the issues raised by the petitioner had been previously resolved through a facility-specific review. The petition was ultimately dispositioned based on a previous resolution that relied on the previous work of the technical reviewer. Because he was tasked with reviewing the petitioner's assertion, he faced an intractable problem. If he determined that the petitioner raised a valid issue, he would have had to determine that he erred in his earlier work. Simultaneously, the petition manager also served as the licensing project manager for Indian Point Units 2 and 3. He also would have had some familiarity with the licensee's 10 CFR 50.59 analysis and the NRC inspection. He, also, would have needed to determine that his prior involvement had failed to identify a problem with the licensee's actions.

This petition review also exposed that for certain skill sets, limited expertise is available internally to the agency. This weakness limits the agency's ability to assign staff as peer reviewers of agency calculations and independent reviews of agency decisions. The team's views on peer reviews are presented in Section 4.1.

The lack of independence and depth may cause concerns among petitioners, members of the public, and other interested stakeholders. Petitioners may remain concerned that petition reviews are not sufficiently rigorous. Licensees may worry that an issue will be raised over and over, occupying increasing resources and time by the NRC.

In the future, the NRC should ensure that the PRB members and support staff are independent of any previous facility-specific or generic disposition of the issues raised in the petition.

4.3.3. Take a Graded Approach to the Detail of Petition Reviews

After reviewing the events for this petition and interviewing many of the members and participants in this PRB, the majority believed that the petition should have been accepted and proceeded to a Director's Decision. Most, however, indicated that at the time it was difficult to understand how much additional work and analysis the staff was contemplating. The process proceeded iteratively with the petitioner supplementing his petition and seeking further information from the staff. As a result, the PRB may have perceived at each iteration that only a little extra work was needed. In hindsight, the PRB performed a significant volume of work to determine that the petition would not be accepted.

During the team's evaluation, a theme developed with respect the staff perception of the 10 CFR 2.206 process and the level of effort required for different aspects. The staff considers the work necessary to effectively participate in the 2.206 petition process to be considerable. That level of effort increases if a petition is accepted and proceeds to the Director's Decision. Despite this additional effort, a prior NRC staff analysis found that many 10 CFR 2.206 petitions *are* accepted and *do* result in NRC action, even if the specific actions requested by the petitioner are not taken.[101]

The team recommends that PRBs adopt a graded approach to the detail of review conducted at each petition review stage. If a PRB needs new analysis or lengthy discussions to decide whether to accept a petition, the petition should be accepted and that work should be done in preparing the Director's Decision. This approach would support proper documentation of the analysis, as discussed in the next section, and professionalizing PRBs, discussed earlier, would limit individuals' perceived disincentives.

4.3.4. Document Analysis Supporting Petition Decisions

The team recommends that any analysis or calculations used to support a 10 CFR 2.206 petition decision should be rigorously documented. This documentation is even more important when it is relied on in a decision to reject or deny a petition.

In the case of the October 2014 petition, the calculations used by the PRB to make its decision appear to consist of print-outs of ALOHA runs and hand calculations, with only one analysis being documented in a short undated summary that included scanned sketches and handwritten notes. These calculations appear largely to have been retained only by the technical reviewer, who provided his only copy to the OIG during its event inquiry.[102] Because these calculations formed the basis of the PRB's justification to reject the 10 CFR 2.206 petition, they should have been more formally captured and made publicly available where possible. When shared with the PRB, Federal records requirements would have also applied to what may formerly have been personal notes.

Calculations need to be appropriately performed, documented, and reviewed. The work needs to be retained in a retrievable form and drafted in a manner that would support a full understanding of the calculations that were performed, including any assumptions and engineering judgment, and make the work repeatable.

4.4. Recommendation – Update Guidance for Pipeline Hazard Analysis

The team recommends that the NRC review and update Regulatory Guide 1.91 to address several technical issues that the team identified and to enhance the review process for pipeline hazards. Regulatory Guide 1.91 was updated in 2013 to reflect gas pipeline hazards for the first time, based on approaches that the NRC staff had previously found acceptable. Regulatory Guide 1.91 should be revisited in an independent review to ensure its guidance reflects generically acceptable approaches for evaluating gas pipelines near nuclear power plants. The team has identified several specific technical issues in the following paragraphs that should be considered. The team reviewed other licensee or applicant analyses that referenced Regulatory Guide 1.91 and found that, in general, bounding assumptions were made. The team considers that those conclusions would likely still be valid even if Regulatory Guide 1.91 were updated to account for these issues.

As discussed in Section 5.1.6 of this report, Regulatory Guide 1.91 provides a formula to calculate the minimum safe distance by evaluating a potential explosion at the source based on the amount of explosive in terms of trinitrotoluene (TNT) equivalent. Beyond the minimum safe distance, no adverse effect would occur. That safe distance is proportional to the cube root of the mass of the explosive in the equation (in this case, the mass of flammable gas vapor released). Regulatory Guide 1.91 assumes equipment failures at specific levels of overpressure (1 psia). The guide recommends a detailed analysis if this safe distance criterion is not met, the guide but provides no suggestions for how this analysis should be conducted. As discussed in Sections 2.2 and 2.3 presented in more detail in Appendix B, detailed calculations conducted by Sandia National Laboratories raised concerns with some of the assumptions made when considering vapor cloud explosions, particularly buoyancy and dispersion. The team recommends that the NRC provide clearer expectations for the detailed calculations that would be conducted if the safe distance criterion is not met.

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A key element in these calculations is the mass of gas released following postulated pipeline rupture. The team observed a significant disparity in the calculated potential impact distances when different assumptions were used (e.g., how to account for the duration of gas release, the affected pipeline length, and the use of a yield factor as listed in Table 1 of the regulatory guide). The current revision of Regulatory Guide 1.91 does not provide clear guidance for determining the mass release. Different people can use the guidance and get very different results. Therefore, more guidance is needed on what assumptions should be made when determining the values to be used in the Regulatory Guide 1.91 formula.

The comment response associated with the draft Revision 2 to Regulatory Guide 1.91 discusses how the guide was changing from mass equivalence to energy equivalence and states that an energy equivalence (yield) "between 20% and 40% is recommended for hydrocarbons."[103] The comment response then goes onto to state that since the guide is not only for hydrocarbons, so values between 5 percent and 100 percent are recommended. This additional detail on appropriate yield values would be a beneficial addition to the guide. The team also noted that Reference 9 of the guide does not include information about different classes of unconfined vapors and recommend more guidance be added on how vapors should be classified.

In addition, the team recommends updating the TNT-equivalent equation in Regulatory Guide 1.91 to revert to the 4500 kJ/kg value that had been included in the draft Revision 2, as discussed below in Section 5.1.6.

Finally, Regulatory Guide 1.91 provides no guidance on heat flux, which is the subject of Department of Transportation regulations and, to some pipeline experts, is the controlling issue for

nuclear power plant impacts. This aspect should be addressed in an update to Regulatory Guide 1.91.

4.5. Recommendation – Formalize Coordination with Other Agencies

4.5.1. Documentation of Coordination

The team recommends that the NRC improve documentation of its interactions with other agencies, particularly when NRC expertise or decisions will be cited by the other agency.

As noted in Section 1.2.3, the NRC shared the results of its 10 CFR 50.59 inspection with FERC staff in an October 2014 teleconference.[104] The team interviewed several staff that the FERC had identified as participating in that meeting. Only one recalled the teleconference in any detail. This recollection was consistent with the OIG Event Inquiry statement that the NRC "did not provide calculations to FERC but talked them through the inspection report." The team reached out to the FERC and found that the FERC engineer who participated in the meeting had left the agency and the environmental contractor was no longer under contract. Also, the team's interviews with NRC staff indicated that the NRC licensing project manager for Indian Point had additional informal telephone conversations with FERC representatives, though the team could not find documentation of these conversations and did not interview the now-retired project manager.[105]

The team, therefore, was able to develop its views on the NRC-FERC interactions based only on what is in the public record. The NRC appears not to have provided any formal correspondence to the FERC beyond the September 2014 comment on the draft environmental impact statement. The OIG Event Inquiry states that "two FERC headquarters-based engineers assigned to the AIM Project revealed that FERC used NRC's November 7, 2014, inspection report for its [environmental impact statement] and FERC's Commission relied heavily on NRC's expertise to determine if [Indian Point] could be safely shut down in the event of a pipeline accident, for approval of the portion of the AIM Project that crossed [sic] [Indian Point] property."[106]

It is unclear whether the NRC provided any regulatory context for its review to the FERC in the October 2014 teleconference. The team views that the FERC would have benefited from a clear understanding of what findings Entergy was making in its 10 CFR 50.59 analysis, what findings the NRC was making in its inspection report, and how those findings differed from what might be done in a full licensing review. The FERC could also have benefited from a richer understanding of the analyses of the preexisting pipelines (which were mentioned in the October 2014 teleconference).

The team is not suggesting that FERC would have made different conclusions based on this information, but the NRC and FERC positions would have been clearer and better documented.

4.5.2. Formalization of Coordination

The team recommends that the NRC clarify guidance for when it should participate as a cooperating agency in other agencies' environmental reviews, as well as how it should engage with Federal or state agencies more generally.

The NRC policy for intergovernmental consultation[107] applies to "major interagency agreements, major organizational changes, major rules and regulations, statements of policy, guides, and standards, and major studies that may have a significant State or local impact." It specifically excludes "[c]onsultation with state officials and Federal agencies on individual licensing and enforcement decisions." The team did not identify guidance applicable to the NRC-FERC interactions described in this report.

For its own environmental reviews, the NRC considers during the scoping period whether there should be cooperating agencies.[108] Based on discussions with the environmental center of expertise, the team found that a memorandum of understanding is usually developed to describe the respective responsibilities, jurisdictional authorities, and expertise of each agency within the context of the applicable review. The memorandum also establishes a schedule and deliverables for the NEPA review. The NRC's document database includes multiple formal letters between the NRC and other agencies, inviting one party or another as cooperating agencies and accepting such invitations. For example, the NRC and the U.S. Army Corps of Engineers executed a memorandum of understanding in 2008 that establishes the Corps as a cooperating agency for NRC environmental reviews related to the issuance of authorizations to construct and operate power reactors.[109]

No such formality appears to have been applied to the FERC review of AIM pipeline. As noted in Section 1.2.3, the NRC declined to be a cooperating agency in FERC's environmental review and communicated this decision in an April 2014 teleconference between the FERC and NRC environmental and intergovernmental liaison staff. It is unclear what the basis for the NRC's decision was. In an interview with the team, the manager responsible for the intergovernmental liaison function at the time did not recall the exact reason but suggested that the NRC may have wished to focus on plant impacts rather than getting involved in the environmental impacts of the pipeline. The team observes that a more formal coordination such as a memorandum of understanding or cooperating agency status could have prompted both agencies to engage in the formal communications recommended in the previous section.

Therefore, the team concludes that additional guidance for interactions with both Federal and state agencies on specific matters would be beneficial to the NRC staff. The State Agreement and Liaison Programs Branch in the Office of Nuclear Material Safety and Safeguards may already have resources that would be helpful in this area. Additional information on cooperating agency activities can be found in the "One Federal Decision" memorandum of agreement for environmental reviews.[110]

5. Review of Key OIG Findings

5.1. Key Findings Related to NRC Analysis

The team reviewed key aspects of the OIG findings related to prior NRC analyses as described below. Many of these subjects are also addressed elsewhere in the report, but they are collected here for ease of reading, with cross-references to other sections.

5.1.1. Was use of ALOHA inappropriate?

The "Findings" section of the OIG Event Inquiry stated that "NRC's underlying independent analysis was conducted using a computer program that the National Oceanic and Atmospheric Administration (NOAA), which developed the program, said it was not designed for." OIG also noted that the staff did not conduct a verification and validation of the ALOHA code.

ALOHA performs calculations for chemical source terms and resulting downwind concentrations. Source term calculations determine the rate at which the chemical material is released to the atmosphere, release duration, and the physical form of the chemical upon release.

The ALOHA code allows for modeling the accident scenarios for gas release from a pipe source. The pipe source configuration represents gas discharges from a long pipe either (1) connected to a very large (infinite, for analytical purposes) reservoir or (2) isolated at its unbroken end. The analyst must specify a gas temperature and pressure are specified, along with pipe length and diameter and whether the surface is smooth or rough.

ALOHA uses the pipe length to predict the discharge rate from a ruptured pipeline. The length-to-diameter ratio of the pipe must be at least 200. The rupture area may be a size up to the cross-sectional area of the pipe.

ALOHA can model two different types of scenarios for a gas pipeline failure. The two types of scenarios differ in the state of the unbroken end. For the isolated scenario, a finite amount of gas is in the pipeline section. As gas is discharged at the broken end, the pressure drops, and the discharge rate slows over time. The release occurs over a finite time. For the infinite-reservoir scenario, pressure and discharge rate remain essentially constant, and the release occurs for an indefinite time.

In using ALOHA, the source duration is specified as either instantaneous or continuous. A continuous release refers to any duration lasting longer than a minute. ALOHA assumes an instantaneous release to last one minute. For an instantaneous release, the total quantity (mass or volume) released into the air is the residual gas mass in the pipeline (i.e., until the finite length of pipeline is emptied). For a continuous release, the mass or volumetric release rate is specified as well as the duration in minutes. The allowable input range for the duration is between 1 and 60 minutes. ALOHA calculates time-dependent release rates for up to 150 time steps. ALOHA then averages the release rates from the individual time steps over one to five averaging periods, each lasting at least one minute. The five averaging periods are selected to most accurately portray the peak emissions. ALOHA provides several results, including a 1-minute maximum release rate of mass and a total release of mass.

Based on its review of the above discussions, the team agrees with the OIG comment that ALOHA does not have the capability to model the scenario of manual closure of the isolation valves within 3-minutes. In addition, ALOHA cannot directly model a double-ended break where the pipe has broken in the middle and is leaking from both broken ends. The model can calculate the release from one side of the pipeline, but not both sides together. In addition, ALOHA does not model

supercritical flow which is applicable to this pipeline rupture release scenario. Therefore, the team agreed that there are concerns with using the ALOHA model to assess the Indian Point postulated pipeline rupture scenario. With support from experts at the Sandia National Laboratory, an independent analysis was performed to assess the postulated 42-inch pipeline rupture scenario. A summary of that analysis result was provided in Section 2 of this report.

5.1.2. Was the correct area analyzed?

The "Findings" section of the OIG Event Inquiry stated that "the majority of NRC's independent analysis described the impact of a potential rupture on an above ground point on [Indian Point] property that NRC believed presented the most credible risk due to its exposure; however, ultimately the as-built 42-inch pipeline does not come above ground anywhere on [Indian Point] property but does traverse the [Indian Point] property."

During multiple interviews with the review team staff, the analyst stated that he performed calculations for breaks postulated at two locations on the 42-inch pipeline: (1) at the above-ground "tie-in" east of Indian Point and (2) an underground middle section at the closest location to safety-related SSCs on site. The analyst also stated that he presented the results of the first case in his report, because he determined that it was the bounding case for assessing the postulated pipeline failure at Indian Point site.

The team determined that these locations were appropriate for evaluation. The difference between below-ground and above-ground breaks would not alter the effects of the pipeline explosion according to the team's PHMSA member and the team's interview with an independent gas pipeline expert. Additionally, the change in location was 21 feet, which would not have altered the conclusions of either Entergy or the NRC analyst.[111]

The team observes that the NRC did not reinspect or reanalyze the 2015 revision to Entergy's 10 CFR 50.59 evaluation. Since the change was relatively minor, the team considers that this would generally be a reasonable approach, enabling staff to focus on more significant change. In this case, however, since Entergy submitted the change at the peak of the NRC activities regarding the 10 CFR 2.206 petition (including reanalysis), it would have been helpful to review and document the change for completeness.

5.1.3. Were analyses documented properly?

The "Findings" section of the OIG Event Inquiry stated that managers had "differing understandings of the assumptions and factors driving the analysis" and that the analyst "did not have a basis" for engineering judgments and "did not document a basis or a methodology in [the analyst's] report."

The analyst documented his original calculation in October 2014, and Region I used it as a feeder to the inspection report issued in November 2014.[112] The analyst assumed a pipe rupture equivalent to the diameter of the pipe at a maximum operating pressure of 850 psig. The pipeline rupture was assumed to occur at the far end of the pipeline where the pipeline rises above ground level, releasing the full volume of gas within the 3-mile length of pipeline between the nearest isolation valves. Also, the analyst assumed that the isolation valves would be closed in 3 minutes. The ALOHA calculation for this scenario resulted in a maximum sustained methane release rate of 256,000 lb/min and estimated a total release amount of 354,651 pounds averaged over 9 minutes. The analyst assumed the maximum release over 1 minute (256,000 pounds of methane) and determined the TNT-equivalent (W_{TNT}) amount with a yield factor of 0.05. By using the Regulatory Guide 1.91 formula, the analyst determined that the minimum safe distance—beyond which there would be a less than 1 psi overpressure—was 2351 ft. The analyst noted that the pipeline at the far end above ground is located 2988 ft from the nearest safety-related SSCs within the SOCA. In

addition, the analyst noted that some SSCs designated as important to safety outside the SOCA were closer to the pipeline than 2351 feet, so those SSCs may experience greater than 1 psi overpressure and would be impacted. Furthermore, the analyst noted that a detailed discussion of the impact of these important-to-safety SSCs, which was reviewed by NRC inspectors, is included in the licensee's August 2014 10 CFR 50.59 evaluation.[113]

Subsequently, during the 10 CFR 2.206 petition review, there were concerns about whether remote pipeline operators would be able to recognize that a pipeline rupture occurred and then take timely actions to close the nearest pipeline isolation valves within 3 minutes. As a result, the analyst performed additional ALOHA modeling was performed as a sensitivity study to determine the significance of valve closure times.[114] (Section 4.3.4 of this report provides additional information on the documentation of these calculations.) The original scenario, modeled as discussed in the paragraph above, assumed a maximum 1-minute release in determining the minimum safe distance and the potential heat flux due to a jet fire. In the infinite-source scenario, the analyst assumed that the pipeline isolation valves do not close and gas continues to flow, as if there was an infinite source, for 60 minutes. The analyst stated that the maximum calculated release of natural gas determined by the ALOHA model for the infinite-source scenario only slightly varied from the prior analysis, and the calculated results were marginally changed. The distance that would be subject to a 1 psi overpressure increased, but the distance remained lower than the distance to the most limiting SSC inside the SOCA boundary. Therefore, the analyst concluded that pipeline isolation valve closure times were inconsequential. He continued to support the original conclusion that the 42-inch AIM pipeline at the Indian Point site does not represent an undue risk and that the plant could safely shut down following a postulated pipeline rupture.

The team noted that the analyst stated that it was conservative to use the 1-minute maximum gas release rate (rather than total mass released over the assumed duration) from ALOHA for both the 3-minute scenario and the 60-minute infinite-source scenario. However, the analyst did not provide a documented technical basis to justify the conservatism of that assumption. Therefore, the team was not able to confirm the validity of the analyst's conclusion that the pipeline closure times only minimally changed the peak overpressure calculation and the heat flux calculation.

5.1.4. Were pipeline enhancements credited appropriately?

The "Findings" section of the OIG Event Inquiry referenced statements by managers that suggested "backwards engineering" occurred when pipeline enhancements were increasingly credited and that the "use of credit for enhanced piping was inappropriate."

During multiple interviews with the team, the analyst stated that he only considered credit for the enhanced pipeline during his thought process for assessing the impact from postulated pipeline failures near Indian Point. He noted that at the closest point to the plant, the pipeline is thicker, is buried deeper, and is physically protected by reinforced concrete mats. Nevertheless, the analyst stated that he did not credit any pipeline enhancements were credited in the calculation documented in his report. Therefore, the team did not substantiate the findings in the OIG Event Inquiry related to enhanced piping.

The team also notes that pipeline enhancements such as thicker diameter, corrosion coating, concrete pads above the pipeline, warning signs to inform potential excavation, and deeper burial may reduce the likelihood of a failure, as discussed in Section 2.1.1. In addition, the team noted that the Indian Point site topography may influence the consequence of postulated pipeline ruptures. Specifically, the pipeline elevation is above plant grade but below the crest of a hillside overlooking the plant, as indicated in Figure 5. As a result, a portion of the jet flame would be absorbed by the hill, providing less energy available to heat structures onsite. The most likely spot for an explosion

would be near the postulated pipeline rupture location, as it would have the highest concentration of natural gas, assuming an ignition source was present or generated by the explosion. If the explosion were to occur in this location, a portion of the blast energy would be absorbed by the hillside surrounding the pipeline. For a blast to occur father away from the pipeline, the gas would need to remain in an explosive concentration.

5.1.5. How was the time needed to isolate the pipeline considered?

The "Findings" section of the OIG Event Inquiry raised issues with the assumption that pipeline isolation would occur in 3 minutes, noting that the pipeline operator "estimated it would take at least 6 minutes after the detection of a leak to close the valves." OIG noted inconsistencies understandings of the amount of gas that would be released.

The analyst originally assumed that the isolation valves for the pipeline could be closed in 3 minutes. As noted above in Section 5.1.3, however, the analyst performed a sensitivity study to support the 10 CFR 2.206 petition review. In the second scenario, the analyst assumed that following a complete pipeline rupture, the pipeline provides an infinite source of natural gas and the pipeline isolation valves do not close for an hour.

The team verified that ALOHA does have the capability to assess 60 minutes of gas release from an infinite source, as well as the gas released in the first minute. However, the team noted that analyst used the 1-minute maximum gas release rate (rather than total mass released over the assumed duration) from ALOHA for both the 3-minute scenario and the 60-minute scenario assessed. As discussed in Section 5.1.3 of this report, the analyst did not provide a documented technical basis to justify the appropriateness or conservatism for that assumption. Therefore, the team was not able to confirm the validity of the conclusion that the pipeline closure times only minimally changed the peak overpressure calculation and the heat flux calculation.

As discussed in Section 2.1.3, the team found conflicting information on the time it would take to isolate the ruptured pipeline and where the isolation would occur. As a result, as noted in Section 2.6, the team recommends that the NRC ask Entergy to revisit its 10 CFR 50.59 evaluation to apply an appropriate isolation timeframe or justify why the timeframe is not relevant.

5.1.6. Was Regulatory Guide 1.91 used correctly?

The "Findings" section of the OIG Event Inquiry stated that "NRC used a draft regulatory guide in lieu of the final, approved version (which had been issued approximately 2 years prior) and deviated from the approved version in a manner that was less conservative and had an impact on the analysis outcome."

The OIG Event Inquiry referenced the analyst's use of 4500 kJ/kg instead of 4420 kJ/kg for the denominator in Equation 4 of Regulatory Guide 1.91. The team found that the denominator used in the reference[115] where this equation originated is 4500 kJ/kg. In further discussions with fire experts in the Office of Nuclear Regulatory Research, the team verified that this 4500 kJ/kg value is appropriate and consistent with fire and explosion literature. It appears that the more precise value may have come from conversions between English and metric units, but it is not applied elsewhere in the literature. Therefore, the team found the analyst's use of this value acceptable, even though it did not match the latest revision of Regulatory Guide 1.91. The team recommends that a future update to Regulatory Guide 1.91 should revisit the change made in that denominator.

Additional recommended improvements to Regulatory Guide 1.91 are discussed in Section 4.4 above.

5.2. Key Findings Related to NRC Processes

5.2.1. Did FERC's approval represent the NRC analysis appropriately?

The "Findings" section of the OIG Event Inquiry stated that "NRC's independent analysis was incorrectly portrayed in FERC's approval document as significantly more conservative than it actually was."

The FERC issued its approval order for the AIM pipeline in March 2015.[116] Section k.2. of this order addressed safety issues related to Indian Point, and in paragraph 107, the FERC described the NRC's review. The team considered the accuracy of the FERC's approval order paragraph 107 as follows.

- **"The NRC reviewed the site hazards analysis performed by Entergy and performed an independent confirmatory analysis of the blast analysis as well."** The team agrees with this statement (while acknowledging the analysis could have been conducted differently, as discussed elsewhere in this report), and it is consistent with the NRC inspection report.
- **"The NRC's analysis did not account for the additional pipeline design measures identified by Entergy and committed to by Algonquin ..."** The team agrees with this statement. As discussed in Section 5.1.4 above, the NRC analyst did consider the pipeline enhancements but did not use them in his pipeline rupture consequence calculation.
- **"[The NRC's analysis ...] assumed a pipeline catastrophic failure."** The FERC uses a term "catastrophic" that is not included in the original October 2014 NRC analysis or November 2014 NRC inspection report. The term appears to have been introduced in the October 2014 NRC-FERC meeting summary. [117] The team considers that given the discussion in that analysis of a "hole equivalent to the diameter of the pipe" (i.e., a full guillotine break), the failure itself could be described as catastrophic for the pipeline. The team does not view this use as implying a catastrophe in terms of consequences.
- **"The review covered everything within the Security Owner Controlled Area, which encompasses everything inside the outermost fenced area of the facility including the area with the spent fuel rods."** This description of the SOCA, which also appeared in the October 2014 NRC-FERC meeting summary, could be viewed as inaccurate. The "outermost fenced area of the facility" could be read as the entire Entergy property, which is fenced, with a drive-up security post at the entrance. The SOCA encompasses a smaller area. It includes, among other things, the safety-related equipment, the spent fuel pools, and the spent fuel dry storage area. The Entergy and NRC analyses did consider equipment both inside and outside the SOCA, as well as equipment outside Entergy property (such as the switchyard). Therefore, the team considers this statement to be acceptable even if it might be confusing.
- **"The NRC concluded that a breach and explosion of the proposed 42-inch-diameter natural gas pipeline would not adversely impact the safe operation of the Indian Point facility."** This phrasing is less nuanced than the October 2014 meeting summary[118] and uses language that the NRC had used in the November 2014 inspection report in the context of Entergy's analysis, not the NRC's.[119] In this light, the statement could be viewed as partially inaccurate. In the team's understanding, the NRC focused on (a) whether Entergy complied with 10 CFR 50.59 in deciding NRC review was not needed (as concluded in the inspection report) and (b) that Indian Point could safely shut down and remain shut down after a pipeline rupture. "Safe operation," if read as continued full-power operation after a pipeline rupture, was *not* what the NRC assumed. The team, however, does not view this distinction as distorting the overall Entergy or NRC conclusions in 2014-2015 about the safety of Indian Point.

The FERC used this information to conclude "that the project will not result in increased safety impacts at the Indian Point facility." This conclusion is consistent with the purpose of a 10 CFR 50.59 review—that hazards would remain within what was previously evaluated for the facility. In summary, while the FERC phrasing could have been more nuanced and the NRC analysis could have been conducted differently (as discussed elsewhere in this report), the team does not agree with OIG that the FERC portrayed the NRC analysis as "significantly more conservative than it actually was."

Section 4.5 above includes the team's recommendations on how the NRC can interact better with other agencies, including how the context of an NRC inspection or review could be described better.

5.2.2. Was the NRC inspection report accurate?

The "Findings" section of the OIG Event Inquiry stated that "NRC's inspection report contained inaccuracies suggesting additional analysis had been conducted, when this was not the case." The OIG Event Inquiry noted that (1) the analyst did not calculate missile generation though Regulatory Guide 1.91 suggested it, and (2) the analyst believed that effects on important-to-safety SSCs were being "bounded by more severe accidents … already evaluated" in Indian Point's FSAR.

The team notes that Regulatory Guide 1.91 is not clear as to the scope of SSCs that should be evaluated for missiles. The guide makes a general statement that "[t]he effects of blast-generated missiles would be less than those associated with the blast overpressure levels considered in this guide." Therefore, missiles generally need not be evaluated where the overpressure levels are not exceeded—i.e., all safety-related equipment inside the SOCA, in the case of the NRC analyst's results.

The guide goes on to state that if "SSCs important to safety" are closer to the hazard than the 1 psi overpressure threshold distance, "the applicant may show through analysis that the risk to the public is acceptably low on the basis of the capability of the safety-related structures to withstand blast and missile effects associated with detonation of the potentially explosive material." The team read this passage as stating that if safety-related equipment (for these purposes, the equipment needed to safely shut down the reactor and maintain it in a safe state)[120] can be shown to be protected against blasts and missiles, the risk can be considered acceptably low. In the NRC analysis, this is the case—safety-related equipment is outside the 1-psi overpressure zone, so missiles would not be expected there.[121] Therefore, the team does not agree with OIG that a missile analysis was necessary or omitted.

Regulatory Guide 1.91 compares explosions to other natural hazards: drag pressure effects would be "much smaller than those resulting from the wind loading assumed for the design-basis tornado" and ground motion from overpressure "should be less than the vibratory ground motion associated with a safe-shutdown earthquake." The reader might draw the conclusion that these issues have been addressed uniformly for all facilities. The NRC analyst "believed" that extreme natural phenomena had already been evaluated for Indian Point and did not pursue the statement that pipe ruptures would be bounded by such phenomena. Every facility, however, has a unique licensing basis depending on when it was licensed, what requirements applied at that time, and what later requirements were imposed by the NRC.[122] The team agrees with the OIG that the analyst should not have referred to prior analyses of the facility—especially if they were not necessary as discussed in the paragraph above—without verifying the scope and results of those analyses. As noted in Section 2.1, the team could not verify that prior analyses in fact bounded pipeline impacts.

In general, however, the team observes that Regulatory Guide 1.91 is designed for licensees and applicants to use in developing their analyses of record. The NRC staff is not bound by its guidance when conducting confirmatory analyses to support inspections or licensing activities. While NRC

analyses should, as noted elsewhere in this report, be well documented and answer the questions that were asked, some aspects of the analysis may be more or less important to a given issue. The team has no serious concern regarding the specific question of whether the analyst followed Regulatory Guide 1.91 in all of its aspects.

5.2.3. Were quality standards applied appropriately?

The "Findings" section of the OIG Event Inquiry referenced remarks that the NRC does "not have a quality assurance program for these calculations, but [that] a peer review by a qualified NRC engineer was performed on NRC's independent analysis and follow-up analysis." OIG noted deficiencies with the peer review.

As discussed in Section 4.1, the team identified a weakness in the NRC's familiarity with the guidance for conducting high-quality analysis and calculations. The team identified that the agency personnel were unfamiliar with the agency guidance on peer reviews. As discussed in Section 4.3.4, documentation of confirmatory analyses and peer reviews is fundamental to assuring that calculations and peer reviews use appropriate standards, are effectively and efficiently reviewed, and support the agency's determination. The team does not consider a formal "quality assurance program" to be necessary to provide this assurance. Given the lack of staff familiarity with the quality standards that *do* exist at the NRC, the calculations analyzing the licensee's 10 CFR 50.59 analysis and supporting the PRB's decision to reject the 10 CFR 2.206 petition did not apply the appropriate standards.

The team recommends that the agency consider additional training regarding the technical work product quality and consistency. The team also recommends that the agency produce more formal documentation of technical calculations that are used to support an agency decision. These recommendations are discussed in more depth in Sections 4.1 and 4.3.4.

6. Conclusion and Recommendations

6.1. Summary of Conclusions Regarding Safety and Processes

[to be added during team/peer review after sections 2-3 are complete]

6.2. Summary of Recommendations

[to be added during team/peer review based on all recommendations]

6.3. Future Analysis and Activities

During the team's review, the team or external parties identified issues separate from those included in the Chairman and EDO taskings, particularly issues related to the preexisting pipelines discussed in Appendix A. While the team remained vigilant for issues that could pose an immediate safety concern for Indian Point, most of the issues raised could not be addressed within the scope or timeframe provided to the team. NRC management should consider whether further action by the NRC, other agencies, or Entergy is warranted to address these subjects. The team observes that, with respect to reactor safety, such decisionmaking should reflect the remaining plant operating time (mere days for Unit 2; about a year for Unit 3). A longer timeline would apply to the spent fuel, though the location of the dry fuel storage location makes it unlikely that there would be pipeline-related impacts at that site.

- On March 26, 2020, two representatives of the New York State Public Service Commission wrote to the team leads.[123] This letter included several recommendations for the team's activities, notably: (1) analysis and peer review by neutral, third-party experts (e.g., the National Academy of Sciences) and (2) a site-wide analysis of reactors and spent fuel at Indian Point that considers both the preexisting and AIM pipelines and uses updated seismic analyses. The team obtained independent membership and peer review to the extent feasible within 45 days, and its scope was focused on issues raised by the OIG regarding the 42-inch AIM pipeline. The team recommends that NRC management review the team's report and consider whether a broader analysis may be appropriate.
- On March 23, 2020, Paul Blanch (the petitioner for the October 2014 petition discussed in Section 3) wrote to the team lead with comments on the team's scope of review.[124] Mr. Blanch emphasized that a risk analysis under 49 CFR 192.917 needed to be done for the AIM pipeline. (Section 2.1.2 provides information on this risk analysis.) He also indicated that the team should address concerns he had previously raised to OIG, including NRC's use of its procedures, potentially false statements made by Entergy, processing of a prior allegation, and NRC's inspections and communications to FERC. Mr. Blanch supported calls from New York State (noted below) for an independent risk analysis reviewed by the National Academy of Sciences. Aspects of these requests were addressed by the team's activities and recommendations, as documented in this report. The team recommends that NRC management review the team's report and consider whether further evaluation is needed.
- On March 19, 2020, the Office of the Attorney General of the State of New York wrote to the NRC Chairman, FERC Chairman, and PHMSA Administrator asking for a joint evaluation of the AIM pipeline and Indian Point.[125] Specific to the NRC, this letter recommended that PHMSA and other pipeline safety experts assist the NRC in assessing the risk profile of the AIM pipeline and its proximity to Indian Point, that the NRC analyze both the preexisting and AIM pipelines and their proximity to the reactor and spent fuel, and that the NRC require a 10 CFR 50.59 review of all three pipelines. Aspects of these requests were addressed by the team's activities and

recommendations, as documented in this report. The team recommends that NRC management review the team's report and consider whether further response to these questions is needed.

- On March 13, 2020, U.S. Representative Nita Lowey wrote to the NRC Chairman requesting a personal briefing and public meeting on the OIG report and the NRC's response.[126] The team recommends that NRC management review the team's report and respond appropriate.
- On March 11, 2020, several members of the New York State Legislature wrote to the NRC Chairman expressing concern about the Event Inquiry by the OIG.[127] The letter requested that the NRC explain its past and future actions and retract prior analyses used by FERC. The team recommends that NRC management review the team's report and consider what response to this letter is needed.
- On March 9, 2020, the Chief Executive Officer of the New York State Department of Public Service wrote to the NRC Chairman and FERC Chairman expressing concern about the Event Inquiry by the OIG.[128] The letter requested that the agencies respond to issues raised in a June 2018 letter.[129] The June 2018 letter included questions regarding the Indian Point spent fuel pools, use of ALOHA and Regulatory Guide 1.91 to evaluate pipelines including the preexisting pipelines, the status of security reviews, the conclusions of the 2008 evaluation of pipelines, and whether seismic analyses were conducted of the pipelines. Several of these questions are addressed by this report. The team recommends that NRC management review the team's report and consider whether further response to these questions is needed.
- As noted by then-Chairman Burns in a November 2015 letter,[130] the Advisory Committee on Reactor Safeguards formed a working group to evaluate external man-made hazards (such as pipelines) at nuclear power plants. Based on a discussion with the Executive Director and Chairman of the Advisory Committee on Reactor Safeguards, the team understands that this work is ongoing. The NRC should remain apprised of the progress and results of this activity.

Appendix A. Historical Information on Preexisting Gas Pipelines

This appendix presents background information on how these preexisting pipelines were evaluated by the licensee and the NRC. This team's primary scope of work relates to the later-installed 42-inch AIM pipeline that is the main subject of this report. Some of the analyses for the 42-inch AIM pipeline referenced prior analyses of the preexisting pipelines. Reevaluating prior conclusions on the 26-inch and 30-inch preexisting pipelines is not within the scope of the team's work. The team summarizes this information for context without passing judgment on the prior conclusions.

A.1. Initial Licensing (1960-1973)

This section summarizes information readily available to the team in the Agencywide Documents Access and Management System (ADAMS) regarding the initial licensing of Indian Point Units 1, 2, and 3. It does not represent a comprehensive review of the licensing bases of these reactors. The summary, however, shows that the AEC and NRC were aware of and, in some cases, explicitly evaluated the preexisting gas transmission lines as part of the initial licensing of the facilities.

Indian Point Unit 1

In November 1960, as part of its operating license application, Consolidated Edison submitted a map of the area around Indian Point showing public utilities as Exhibit H-13.[131] This map shows the Algonquin gas transmission line as a dashed black line, crossing the Hudson River and passing within about 1,000 feet (the map scale is not precise) of the centerline of Indian Point Unit 1. A section of the map is reproduced in this report as Figure 13.

Consolidated Edison also submitted Exhibit H-14, a scale plot plan of the site showing the 26-inch gas main and the Algonquin right of way. A section of the plot plan is reproduced in this report as Figure 14. Consolidated Edison submitted Exhibit H-14, Revision 1, in September 1962 to add some details related to offices, material storage, and vehicle storage and maintenance, as well as removal of the "caretaker's house" and a temporary construction building.[132]

In February 1962, the Commission ordered the AEC staff to issue a provisional license for Indian Point Unit 1.[133] Paragraph 43 of that order stated that:

> Paragraph A-3 of Appendix A to the license as approved above limits more than the applicant would have it to do the utilization at the reactor site of Consolidated's natural gas facilities. The applicant proposed to include as site activities the transmission and distribution of natural gas, with no bulk storage there and no pressure above 50 psig within 600 feet of the reactor building. Cogent reasons for adopting the staff position have heretofore been discussed. Upon this point it has been shown that use of the natural gas facilities at the reactor site as described in the application is not inimical to public health and safety and constitutes no threat to the integrity and safety of the reactor facilities and utilization. Other now unknown and unevaluated possible uses of natural gas or natural gas installations at the site might portend hazards to reactor safety. Accordingly, the technical specification appropriately should limit the natural gas facilities and utilizations at the site to those which have been described and which consequently have been weighed in deriving the safety judgments herein expressed.

This paragraph in the order refers to Section A.3 of the technical specifications, which are in Appendix A to the provisional license.[134] Section A.3 states:

> The principal activities carried on within the exclusion area shall be the generation, transmission and distribution of steam (except by gas-fired power plant); the generation, transmission and distribution of electrical energy; and associated service activities. Such activities, among others, shall include in the case of the facility, the subject of this license, activities relating to the controlled conversion of the atomic energy of fuel to heat energy by the process of nuclear fission and the storage, utilization and production of special nuclear, source and byproduct materials. Transmission and distribution of natural gas shall be through the use of facilities located as described in the application.[135, 136]

The "exclusion area" was defined in Section A.2 of the original technical specifications as the area surrounding the facility for which access was under the full control of Consolidated Edison, approximately 1/3 of a mile.[137]

Consolidated Edison reported to the AEC in October 1964, that—consistent with the provisions in its license for changes it could make to the facility—Consolidated Edison was permitting the Algonquin Transmission Company to widen its right of way to install an additional gas transmission pipeline (i.e., the 30-inch line noted above).[138] Consolidated Edison noted that the total right of way would increase from 30 to 65 feet, but the minimum distance between the pipelines and the restricted area of the facility would be unchanged because the new pipeline would be farther away from the present pipeline. Consolidated Edison provided a new Exhibit H-14 (Revision 2).[139] A section of the plot plan is reproduced in this report as Figure 15. There are no records showing that the AEC disagreed with the licensee's determination that it could make this change without prior approval.

In November 1969, Consolidated Edison provided supplementary information that the AEC needed to authorize a full-term (rather than provisional) operating license.[140] The AEC had requested that Unit 1 be compared to the General Design Criteria that had been published in 1967 as a proposed amendment to the AEC's regulations.[141] Specific to proposed Criterion 2 on withstanding forces from local site effects, Consolidated Edison analyzed gas pipeline accidents.

Consolidated Edison clarified the pipelines that were near the site at the time:

> The first pipeline was installed in Indian Point in 1952; the second line in 1965. Both pipes are made of 52,000 psi minimum yield strength steel, conforming to the American Petroleum Institute Specification 5LX52.
>
> The 1952 pipe has an outside diameter and wall thickness of 26" and 0.281" respectively. Hoop stress calculations on a pipe of these dimensions and material show that the pipe is capable of withstanding internal pressures of 1125 psi before yield point stresses develop.
>
> The outside diameter and wall thickness of the 1965 pipe are 30" and 0.438", respectively. This pipe is calculated to withstand internal pressures of 1520 psi before yield point stress is developed.

The licensee discussed the American Standard Code and New York State Safety Code, noting that a small percentage of failures and fires of pipelines reported by the Federal Power Commission occurred in states with stringent safety requirements. The licensee also reported on the inspection procedures and operating history of the Algonquin Transmission Company. The licensee described the design, operation, and maintenance of the pipelines, noting that "conditions which might lead to a pipeline failure have either been provided for in the design of the pipes, or do not exist at the Indian Point site."

The licensee also considered a postulated pipeline failure, including the potential for explosions that could create missiles, as well as the potential for fire damage caused by burning gas and secondary fires. The evaluation of fires assumed that the "primary fire would be of short duration since automatic shut off valves would isolate the ruptured section of the main within 4 minutes." The valves were located on both banks of the Hudson River to the west of Indian Point and in Yorktown, NY, about 10 miles east of Indian Point. The licensee noted that it had already been concluded (as noted in the next section) "that the gas transmission line pose no danger to the safe operation of Unit No. 3." Since Unit 1 was north of Unit 3, the pipelines were further away "and therefore pose no problem."

In December 1973, the AEC's Directorate of Licensing completed the Section 2 (Site Safety) safety evaluation input for the Unit 1 full-term operating license.[142] This section has only a short passage on the pipelines: "Two natural gas lines cross the Hudson River and pass about 750 feet from the Indian Point 1 containment structure. Based on previous staff reviews, failures of these gas lines will not impair the safe operation of Indian Point 1." The details of these "staff reviews" could not be found.

The analysis effectively became moot in October 1974. Unit 1 shut down at that point when a "variance" issued regarding emergency core cooling systems at the facility expired and did not resume operating.[143]

Indian Point Unit 2

In December 1965, Consolidated Edison applied to the AEC for a construction permit to expand its Indian Point facility with Unit 2.[144] Section 1.2.3, "Site Ownership and Control," of the preliminary safety analysis report includes the following text:[145]

> The Algonquin Gas Transmission Co. has a right-of-way running east to west through the property, 3500 feet long and 65 feet wide. The proposed reactor is 1450 feet north of the Algonquin 26-inch gas main.

The 65-foot width is consistent with the widening noted in the 1964 Unit 1 document. That wider right of way would have accommodated the 30-inch pipeline, for which construction began in 1965. This PSAR chapter also included figures similar to those provided for Unit 1. Portions of these, dated August and November 1965, are reproduced in this report as Figure 16 and Figure 17, respectively.

The FSAR submitted to support the Unit 2 operating license application provides similar information on the pipeline right of way:[146]

> The Algonquin Gas Transmission Company has a right-of-way running east to west through the property, 2840 feet long and 65 feet wide. Unit 2 is 1450 feet north of the 26 inch Algonquin gas main.

The 1970 safety evaluation for the Unit 2 operating license does not reference the pipelines or any other nearby industrial facilities.[147]

Indian Point Unit 3

In April 1967, Consolidated Edison applied to the AEC for a construction permit to expand its Indian Point facility further with Unit 3.[148] Section 1.2.3, "Site Ownership and Control," of the PSAR includes the following text:[149]

> The Algonquin Gas Transmission Co. has a right-of-way running east to west through the property, 3500 feet long and 65 feet wide. The proposed reactor is 700 feet north of the Algonquin 26-inch gas main.

Because Unit 3 is southwest of Units 1 and 2, the pipeline right of way is several hundred feet closer to Unit 3 than to Units 1 and 2. This PSAR chapter also includes a site plot plan similar to those provided for Units 1 and 2. A section of the plot plan, dated April 1967, is reproduced in this report as Figure 18.

As part of the construction permit review, the AEC asked Consolidated Edison to analyze the ability of the facility to accommodate the consequences of an explosion or fire in the pipelines. In 1968, Consolidated Edison responded with an analysis submitted was very similar to what Consolidated Edison would provide for Unit 1 in 1969, as described above.[150] This evaluation led the applicant to conclude that the presence of the lines "does not endanger the safe operation of Unit #3."

This information was not specifically discussed in the AEC's safety evaluation for the Unit 3 construction permit.[151]

The FSAR submitted to support the Unit 3 operating license application provides information on the pipeline right of way very similar to that for Unit 2, without clarifying information on the Unit 3 location:[152]

> The Algonquin Gas Transmission Company has a right-of-way running east to west through the property, 2840 feet long and 65 feet wide. Unit 2 is 1450 feet north of the 26 inch Algonquin gas main.

In the 1973 safety evaluation for the Unit 3 operating license, the AEC stated that "two natural gas lines cross the Hudson River and pass about 620 feet from the Indian Point 3 containment structure. Based on previous staff reviews, failures of these gas lines will not impair the safe operation of Indian Point 3."[153] As for Unit 1, the details of these "staff reviews" could not be found.

A.2. Licensee FSAR Updates (1980-2014)

Initially, the NRC did not require licensees to maintain and resubmit the FSARs submitted as part of their operating license applications. In 1980, the NRC issued a rule—10 CFR 50.71(e)—requiring licensees to submit an updated FSAR within 2 years and annual updates thereafter.[154]

Indian Point Unit 2

In July 1982, Consolidated Edison submitted Revision 0 of the updated FSAR for Indian Point Unit 2.[155] The 26-inch gas pipeline was mentioned in Section 2.2.3, "Site Ownership and Control": "The Algonquin Gas Transmission Company has a right-of-way running east [to] west through the property, 2840 feet long and 65 feet north of the 26 inch Algonquin gas main." The 30-inch gas main (which is located farther away from Unit 2 and within the same right of way) was not specifically mentioned. Chapter 2 of the FSAR did not present further analysis of the natural gas pipelines or any other nearby industrial facilities.

Revision 0 omitted some words from the original FSAR, which had been clear that the right of way was 65 feet wide and lay 1,450 feet south of Unit 2. Consolidated Edison corrected the FSAR error in Revision 2, restating this passage as: "The Algonquin Gas Transmission Company has a right-of-way running east to west through the property, 2840 ft long and 65 ft wide. Unit 2 is 1450 ft north of the 26-in. Algonquin gas main."[156]

This text was substantially unchanged until 2008, when Entergy submitted Revision 21 to the Indian Point Unit 2 FSAR.[157] This revision included updated text in Section 2.2.3 (highlighted in gray below) associated with the pipelines, as well as a new Figure 2.2-3. No further analysis was included in Chapter 2. Section A.4 of this report describes analyses conducted by Entergy in 2008 that may have triggered this update.

> Entergy owns the Indian Point Units 1 and 2 Nuclear Power Plants. As shown in Figure 2.2-3, the Algonquin Gas Transmission Company has a 24 inch gas mainline and a 30 inch loop line on a 65 foot wide right-of-way running east to west through the property. Unit 2 is 1450-ft north of the 24-in. Algonquin gas mainline.
>
> The Georgia-Pacific Corporation has an easement, 1610-ft long and 30-ft wide, through the southerly part of the Indian Point site. The Georgia-Pacific easement is used for overhead electrical power and telephone lines and underground gas, water, and sewer lines. These easements permit Entergy to determine all activities within the right-of-way in order to ensure safe operation of the units.

This revision changed the diameter of the pipeline, added the figure included in this report as Figure 19, and clarified Entergy's ability to determine activities within the easements to ensure safe operation of the units.

Entergy revised the FSAR in October 2010 to correct and clarify the sizes of the preexisting pipelines, as shown in the highlighted text:[158]

> As shown in Figure 2.2-3, the Algonquin Gas Transmission Company has a 26 inch gas mainline and a 30 inch gas mainline on a 65 foot wide right-of-way running east to west through the property. Unit 2 is 1450-ft north of the 26-in. Algonquin gas mainline. One 30 inch main and 2-24 inch mains pass under the river to a pipeline facilities station on the easement near the river. One 24 inch main is available as a bypass alternative and ends in the pipeline facilities station while the other two continue as the 30 inch and 26 inch mains.

There were no further substantive changes to Chapter 2 of the FSAR regarding the pipelines until analysis of the AIM 42-inch pipeline was included, as discussed in Section 1.2 of this report.

Indian Point Unit 3

In July 1982, the Power Authority of the State of New York submitted Revision 0 of the updated FSAR for Indian Point Unit 3.[159] The 26-inch gas pipeline was mentioned in Section 2.2.2, "Site Ownership and Control":

> ...the Algonquin Gas Transmission Company has a 26 inch gas main on a right-of-way (approximately 1350 feet long and 65 feet wide) running east to west through the Authority's property. ... These easements permit the Authority to determine all activities within the right-of-way in order to ensure safe operation of the unit.

The 30-inch gas main (which is located farther away from Unit 3 and within the same right of way) was not specifically mentioned. Chapter 2 of the FSAR did not present analyses of the natural gas pipelines or any other nearby industrial facilities.

This text was substantially unchanged until the 2009 update to the Indian Point Unit 3 FSAR.[160] This revision included updated text in Section 2.2.2 (highlighted in gray below) associated with the pipelines. The referenced FSAR Figure 2.2-2 is similar to Figure 18 included in this report. Section 0 of this report describes the referenced analysis.[161]

> As shown in Figure 2.2-2, the Algonquin Gas Transmission Company has a 24 inch gas mainline and a 30 inch loop line on a right-of-way (approximately 1350 feet long and 65 feet wide) running east to west through Entergy's property. The threats posed by the rupture of these pipelines and the release of natural gas (essentially methane) from them were addressed in Item 7 of Supplement 1 to the original FSAR. The September 21, 1973 SER concluded the failure of these gas lines would not impair the safe operation of the plant.
>
> A subsequent evaluation in 2008, (Reference 1), discussed the consequences of a pipeline rupture and the potential impact of that event on the sites Protected Area, Vital Areas, the Security Plan, safe shutdown, and other non-safety related structures, such as the waterfront warehouse. The hazards created by a breach and explosion of the pressurized above ground portions of the pipeline include:
>
> a. potential missiles,
>
> b. an over-pressurization event,
>
> c. a vapor cloud or flash fire,
>
> d. a hypothetical vapor cloud explosion, and
>
> e. a jet fire.
>
> A simultaneous rupture and ignition of both gas mains at the above ground locations inside the owner controlled area (OCA) is postulated to be the worst case scenario since this event will result in the most significant release of gas volume and have the potential to contribute to the largest potential fire. An attempt to uncover, breach and ignite a buried portion of the pipeline was not considered feasible. The report concluded that the event would not damage any safety related structure and there are no adverse effects on the gas pipeline event on vital areas, safe shutdown equipment, IPEC Security Plan, or essential personnel. Some damage to non-vital structures or non-essential personnel in the area of the pipeline may occur.

Entergy next changed this section in the 2015 update to the Indian Point Unit 3 FSAR, relevant portions of which are shown in gray highlight below.[162] Section A.4 of this report describes a 2015 analysis that was likely the trigger for this update.

> A subsequent evaluation in 2008 (Reference 1) discussed the consequences of fire and explosion due to a pipeline rupture. ... An attempt to uncover, breach and ignite a buried portion of the pipeline was not considered feasible. The report concluded that the rupture of the natural gas pipelines that cross the Indian Point site and subsequent ignition of the methane released will result in a jet fire and injury or death to any people exposed to flames or intense thermal radiation. It will not, however, damage any safety related structure. Even in the unlikely event of a hypothetical vapor cloud explosion, structural damage to buildings other than the waterfront warehouse adjacent to the pipelines will not occur. A flammable vapor cloud fire that engulfs the plant is improbable because the turbulent momentum with which the methane exits the pipeline will confine flammable methane concentrations to the point of release.

There were no further substantive changes to Chapter 2 of the FSAR regarding the pipelines until analysis of the AIM 42-inch pipeline was included, as discussed in Section 1.2 of this report.

A.3. Indian Point Hearings (1979-1985)

In September 1979, the Union of Concerned Scientists petitioned the NRC to decommission Indian Point Unit 1 and suspend operation of Units 2 and 3. In February 1980, the Director of the NRC Office of Nuclear Reactor Regulation (NRR) issued his decision on the petition (referred to as a Director's Decision).[163] The Director's Decision granted a portion of the petition regarding Unit 1 (as noted at the end of Section 0 above). The Director's Decision, however, denied the request to suspend operation of Units 2 and 3, given the issuance of confirmatory orders to the licensees that required multiple important interim safety measures. While the Director's Decision did not address the gas pipelines near Indian Point, the extensive follow-up activities did include additional analysis of the pipelines.

After reviewing the Director's Decision and considering public comments, the NRC Commission in May 1980 announced a "four-pronged approach" to resolve issues raised by the petition:[164]

- Holding an adjudication on the safety issues for Units 2 and 3, with the Atomic Safety and Licensing Board making findings and recommendations for a Commission decision
- Holding an informal proceeding to determine the issues to be pursued in the adjudication
- Considering generically the question of reactors in areas of high population density
- Establishing a staff task force to review data and give the Commission information to decide the status of Units 2 and 3[165]

The Commission was interested in the risks of serious accidents at Indian Point Units 2 and 3, including accidents not considered in the plants' design bases. This topic was identified in the Commission's May 1980 order and amplified in additional orders issued later in 1981.[166]

The Atomic Safety and Licensing Board issued its findings and recommendations in October 1983.[167] This document does not refer specifically to the natural gas pipelines near Indian Point, other than noting that externally initiated events are the principal contributors to risk at Indian Point. In coming to its conclusions, however, the Board considered evaluations that do address the pipelines, including:

- The Indian Point Probabilistic Safety Study, prepared by the licensees
- "Letter Report on Review and Evaluation of the Indian Point Safety Study" by Sandia National Laboratories

The sections below describe these evaluations in more detail.

The Commission issued its decision in May 1985, addressing the risk of Indian Point—including ways to reduce risk and how the risk compared to other plants—as well as emergency planning and other topics.[168] The Commission considered the two analyses noted above, as well as other information, but did not explicitly reference the natural gas pipelines as a hazard or accident initiator. The Commission concluded that neither the shutdown of Units 2 and 3, nor imposition of additional remedial actions beyond those implemented voluntarily by the licensees, was warranted. As a result, the NRC rescinded some aspects of the confirmatory order that had been issued to the licensees for Units 2 and 3 in February 1980.[169] The Commission found that the risk reduction effect of those measures was "not sufficient to be termed substantial," and that they should not be imposed unless they were needed to fulfill generic requirements applicable to similar types of reactors or to meet other license requirements for Indian Point.

Indian Point Probabilistic Safety Study

The Indian Point licensees submitted the Indian Point Probabilistic Safety Study in March 1982 for use in the adjudicatory proceeding.[170] This was one of the earliest comprehensive risk assessments of a nuclear power plant. Based on the study's results, the licensees identified and implemented cost-effective risk reductions, including new tests and procedures and certain equipment and structural changes.

Volume 11 of the study, Section 7.7.4, documents the licensees' evaluation of the gas transmission lines near Indian Point.[171] The evaluation is not significantly more detailed than those submitted in 1968-1969 for initial licensing (in fact, it references a United Engineers and Constructors[172] analysis from April 1968 that likely was the input for those submittals), but it does include data and estimates in addition to the prior qualitative assessments. The licensees had also obtained additional information from the Algonquin Gas Transmission Company in February 1981. Several key assumptions and results from this section are summarized in the list below.

- ***Probability of pipeline failure:***
    - The 26-inch and 30-inch pipelines had been successfully hydrostatically tested in 1952 and 1965, respectively, to at least 92 percent of yield stress. Preventive maintenance included a twice-weekly aerial survey, a twice-yearly foot patrol with leak survey equipment, a monthly vehicle patrol, and weekly inspection of cathodic protection.
    - Data from the U.S. Department of Transportation and information from the Algonquin Gas Transmission Company were used to determine the failure frequency for large transmission lines. Only 30 percent of known failures (excluding the 70 percent resulting from damage by outside forces) were assumed to apply to these pipelines.
    - The estimated pipeline failure probability was approximately 5×10^{-7} per year. This estimate considered transmission line failures in the United States, length of pipe near site, fraction of failures that were large, fraction of time wind would blow toward the plant, fraction of failures due to original construction and corrosion, and fraction of leaks going undetected.
- ***Consequences of pipeline failure:***
    - Automatic shutoff valves were located at the east side of the Hudson River and in Yorktown, NY (10 miles away). They would isolate the 10-mile section passing near the plant. Gas would empty out in a little over an hour, supporting combustion for a total of 15 to 20 minutes.
    - If a fire occurred, destroying the offsite power lines, the plant could be shut down using diesel generator or gas turbine power.
    - Missiles had been found as far as 351 feet from a Louisiana pipeline explosion. Such missiles would "pose little threat" to the Unit 3 facilities at least 400 feet from the pipelines or the Unit 2 facilities "which might be more vulnerable, but which are located 1,000 feet from the line and which are protected by a number of other structures."
    - The possibility of a gas line fire leading to a core melt is "extremely small."

- ***Other issues:***
    - Smaller leaks were determined not to jeopardize the plant; the probability of wind blowing toward the plant was cited as 0.14. This was considered in the pipeline failure probability but could also be used in considering other consequences of pipeline leaks.

Sandia National Laboratories Evaluation

In August 1982, Sandia National Laboratories provided the NRC with a draft letter report documenting its review of the Indian Point Probabilistic Safety Study.[173] In Section 2.7.5 of the report, Sandia commented on the thermal hazards from a pipeline fire:

> A fire from such a large leak would have to burn for several hours before safety related concrete structure might be threatened. Such long exposures to high heat fluxes do not result in catastrophic failure of structures, but rather in the (conservative) thermal design criteria for reinforced concrete structures being exceeded.
>
> Thus, the probability of 5 x 10-7/year developed in [Indian Point Probabilistic Safety Study] Section 7.7.5 is a very conservative estimate for the loss of safety-related equipment. Based on this probability, the contribution to the risk arising from the failure of these exposed pumps due to offsite fires would be expected to be less than that due to tornado hazards. An expected probability of exceeding Part 100 exposure guidelines or of a core melt would be much smaller.
>
> In summary, the probability of thermal fluxes from large fires endangering the safety related structures and equipment is bounded by the failure of this equipment by tornado hazards. The already low probabilities of occurrance [sic] of the fires would be very conservative estimates of the probabilities for exceeding Part 100 guidelines or for core melt.

This letter report was followed by a formal NUREG report completed in December 1982.[174] The purpose of the review was to search for areas in the licensees' analysis where omissions and critical judgments were made that could impact the quantitative results. This report addressed pipeline accidents from two perspectives.

- **Thermal hazards.** The evaluation in the final report had the same conclusions as the draft report—that there would not be catastrophic failure of structures or a significant impact on the Indian Point plant damage states or risk.
- **Blast hazards.** The evaluation noted that pipeline fragments, which could be propelled about 350 feet, would pose minimal risks to reinforced concrete structures. They would penetrate only a very small distance compared to design-basis tornado missiles.

Atomic Safety and Licensing Board Hearing

The Atomic Safety and Licensing Board considered these pipeline evaluations in during a February 1983 hearing. Specifically, Dr. Robert Budnitz,[175] a consultant who supported the NRC and Sandia National Laboratories reviews, provided written and oral testimony.[176]

In his written testimony, Dr. Budnitz stated that he accepted most of the licensees' basic data, but had reservations about the estimates for large leak fraction and small leak growth. He noted that the NRC staff had produced its own analysis, with which he agreed, resulting in a value of about

8×10^{-5} per year per mile of pipeline for large leaks. He identified three issues of concern that were not analyzed in the Indian Point Probabilistic Safety Study, as summarized below.

- **Damage to the site electrical system from a pipeline accident.** Dr. Budnitz stated that it was conceivable that a pipeline rupture and large fire could compromise offsite power, since the transmission lines pass over the pipeline. Using the NRC staff's value of 8×10^{-5} per year per mile of pipeline, even if offsite power were compromised every time, this rate of failure of offsite power would be acceptably small. Dr. Budnitz indicated that the actual probability of power loss was probably much smaller.[177] Accordingly, he concluded that this problem was not an important contributor to risk.
- **Gas flowing toward the plant prior to ignition, being taken up in plant systems, and then igniting.** Dr. Budnitz identified two possible scenarios: (1) an unusual wind pattern could blow gas toward the site, overcoming the normally high buoyancy of natural gas, or (2) the high buoyancy of gas could be reduced because of expansion cooling during its escape from the pipeline, making its density higher than air. While Dr. Budnitz admitted this effect had not been quantified, he noted that the small orifice needed for significant expansion cooling was "probably very small compared to a size that could produce large volumes of gas." He also indicated that it was not likely that the gas could remain cold and dense (without mixing with air) while traveling several hundred feet to safety equipment at the reactor. Therefore, while the analysis "to allay this concern fully" had not been done, the issue seemed unlikely to produce a "major incremental risk."
- **Isolation valve failure that would lead to continuous pumping of natural gas out of the break, causing a much larger fireball.** Dr. Budnitz found that this issue could also be "bounded acceptably." Even if the valves failed in every pipeline break, such fireballs would occur based on the staff estimate "only every 12,000 years or so." Dr. Budnitz noted that the fire would "in all likelihood be localized to the region near the pipeline, with little chance of spreading to the plant except under the most unusual wind conditions." He stated that the overall threat seems "to be sufficiently infrequent that its contribution to overall risk can be considered small."

Dr. Budnitz concluded overall that the core-melt risk to Indian Point from gas pipeline failures was considerably less than the risks from other sources, and that omitting a full-scale quantitative risk analysis for pipelines at Indian Point was acceptable. In his hearing testimony, Dr. Budnitz acknowledged that there was not a realistic numerical analysis of the probability of core damage that would make him "comfortable by itself," but that he felt comfortable with the pipeline bounding analysis.

A.4. Additional Licensee Evaluations of Preexisting Pipelines (1980-2015)

Control Room Habitability Report

In 1980, as part of the response to the accident at Three Mile Island (TMI) Unit 2, the NRC issued NUREG-0737, "Clarification of TMI Action Plan Requirements."[178] Item III.D.3.4 of NUREG-0737 stated, in part, that licensees needed to assure that control room operators would be adequately protected against the effects of accidental release of toxic or radioactive gases. In response, the Power Authority of the State of New York submitted a control room habitability report.[179] It included the following text related to the preexisting natural gas pipelines:

> The Algonquin Gas right-of-way passes approximately 0.3 miles from the Indian Point Unit 3 Control Room Air Intake. Two pipelines carrying natural gas (96%

methane, 2.5% ethane, 0.5% propane) are installed in the right-of-way. Methane is not a toxic chemical. The pipelines are, therefore, deleted from further consideration in this study.

This information is not explicitly addressed in the relevant input to the NRC safety evaluation on this topic.[180]

Individual Plant Examination of External Events

In the late 1980s and early 1990s, the NRC assessed issues and guidance that were not within the licensing scope for facilities licensed before 1976 (including Indian Point Units 2 and 3).[181] In particular, in June 1991, licensees were asked to conduct an Individual Plant Examination for External Events (IPEEE).[182] The NRC concluded in 1993 that the IPEEE would address hazards posed by industrial facilities located near nuclear power plants licensed before 1976.[183]

Unit 2

In December 1995, Consolidated Edison submitted the IPEEE for Unit 2.[184] The licensee considered earthquakes that could damage the gas pipelines, as well as pipeline accidents in general.

The licensee noted several measures that enhanced the quality of the pipelines: stronger construction, random joint x-rays, recent inspection of the 26-inch line with "smart pigs," a coating and cathodic protection to prevent corrosion, and frequent surveys. The licensee also noted that there were manual shutoff valves located by the river crossing, and that a Supervisory Control and Data Acquisition (SCADA) system provides instant flow and pressure information, so that a leak could be quickly detected.

In the seismic assessment, the licensee cited multiple construction features that would support the pipelines and prevent slope failures. In one location 1,200 feet from the nearest Unit 2 structures, the licensee identified a slope that it could not screen out of its assessment. To address this location, the licensee considered three potential failure impacts.

- **Fires at the pipeline.** These were determined not to impact Indian Point Unit 2 given the 100-foot-wide firebreak around the plant.
- **Explosions.** The licensee referenced "extensive studies by the US Bureau of Mines and others" demonstrating that natural gas does not detonate unless confined, so a severe shock wave was deemed not credible.
- **Transport of a vapor cloud and fire at the plant site.** The licensee noted that natural gas readily disperses into the atmosphere, and it was unlikely that weather conditions would support a gas cloud that could travel 1,200 feet from the pipeline to Unit 2 and still support combustion or asphyxiation.

The licensee estimated a frequency of an earthquake that could cause the pipeline to fail, combined with wind in the direction of Unit 2, with the gas cloud not igniting until it reached critical safety systems and structures. This frequency was 6×10^{-7} per year. Since this was below the screening criterion of 10^{-6} per year, the scenario was screened from further analysis and the gas pipelines were determined not to be aseismic vulnerability.

The licensee evaluated gas pipeline accidents in general as well. The licensee contacted the Algonquin Gas Transmission Company for updated information on the performance and service history of the pipelines since the Indian Point Probabilistic Safety Study was conducted. The licensee noted that:

- The 26-inch pipeline was retested after installation.
- Pressure relief valves had been replaced with line pressure monitors, and automatic shutoff controls had been removed from all valves given a history of false closures.[185] Quick response to line breaks was expected because of the emergency response plan in place and the use of a SCADA system.
- Vehicle patrols were weekly rather than monthly as noted in the Indian Point Probabilistic Safety Study.

The licensee concluded that the analysis from the Indian Point Probabilistic Safety Study (estimating a 5 x 10^{-7} per year failure frequency) remained applicable, and the event could be screened out.

The NRC documented its review of the Indian Point Unit 2 IPEEE in May 1999.[186] The reviewers summarized the information on seismically induced failures without noting any objections. For pipeline accidents in general, the reviewers noted that hazard frequency arguments were used to screen these events from further consideration. The natural gas pipeline accident analyses, with a failure frequency of about 5 x 10^{-7} per year, were considered reasonable.

Unit 3

In September 1997, the Power Authority of the State of New York submitted the IPEEE for Unit 3.[187] The licensee referenced the Unit 2 IPEEE seismic analysis, making the same conclusion for Unit 3 that the pipelines could be screened as a seismic vulnerability. The licensee then noted that a pipeline explosion could result in damaging overpressures at Unit 3.

The assessment considered factors that reduced the likelihood failures of the pipelines that come within 400 feet of safety-related equipment for Unit 3. The licensee provided background on hydrostatic testing of the pipelines, internal inspections conducted every 3 years, pressure monitoring, and surveys used to detect leaks and possible threats. The licensee considered that overpressure failures were unlikely to pose significant risks given these design features and the distance to the plant (greater than the 351-foot distance missiles were thrown in a Louisiana pipeline failure). The licensee also stated that the pipelines were buried in a wide, clear, and well-marked right of way on site, so they were unlikely to be damaged by careless construction or excavation.

To consider pipeline failure consequences, the licensee examined a catastrophic event caused by a pipeline rupture and a vapor cloud explosion. The licensee estimated initial discharge rates from both pipelines and the jets that could be produced. Explosion of methane in those jets could result in a 1-psi overpressure at distances that "may cause major damage" to Unit 3. Formation of a plume of buoyant methane could create a flammable vapor cloud. If the entire contents of the 10-mile pipeline length between valves were included in the cloud and an explosion occurred, "a 1-psi overpressure may engulf" Unit 3.

The licensee, however, concluded that these vapor cloud explosions could be eliminated as a source of concern. Referencing data from a 1994 risk analysis text, the licensee estimated a failure frequency of large diameter pipelines: about 1.2 x 10^{-4} per year for the 5 miles of pipeline around Indian Point Unit 3. Assuming a 0.01 probability of a vapor cloud explosion following a pipeline failure and a 0.1 conditional probability of core damage, the resulting core damage frequency contribution was less than the 10^{-6} screening value.

The NRC documented its review of the Indian Point Unit 3 IPEEE in December 2000.[188] This review noted that the licensee did not estimate the core damage frequency from nearby facility incidents (which includes pipelines) to be greater than 10^{-6} per year. The NRC observed that the analyses "were done only to the level of detail needed to screen out" the event and concluded that the licensee appeared to have identified the significant initiating events. There was no discussion specific to the pipelines.

2008 Entergy Analysis

In March 2008, the NRC expressed a concern to Entergy regarding a potential security vulnerability associated with the preexisting natural gas lines. In two security-related responses submitted in April and September 2008, Entergy provided the NRC with information about the referenced location.[189] Entergy referenced an analysis of pipeline incidents by Dr. David J. Allen of the Risk Research Group, a consultant who also prepared the analyses of nearby facility hazards for the Indian Point Unit 3 IPEEE and conducted later analyses for Entergy discussed in this report.

The consultant noted that the Indian Point Unit 3 IPEEE did not assess the consequences of a natural gas release in detail given the predicted frequency of spontaneous ruptures. Considering instead intentional and malicious activity, it became necessary to reevaluate the consequences of natural gas releases. The consultant noted that a large line break would result in a remote low pressure alarm (in Houston, TX) and pushbutton isolation of about 6.5 miles of pipeline. Using the BREEZE and ALOHA codes, the consultant analyzed jet fires, vapor cloud fires, and hypothetical vapor cloud explosions (though they were deemed unlikely) from a particular point near Unit 3.

The resulting heat flux from jet fires, which could burn for over an hour depending on the scenario, was found to be low enough not to damage equipment except in the immediate vicinity of pipelines, with no major damage to facilities. (Section 0 below provides additional detail on heat flux calculations.) Vapor cloud fires were determined not "to be a real possibility" given the turbulence and high velocity with which the natural gas would exit the pipeline (making jet fires more likely). Vapor cloud explosions were found to be "most unlikely" given the little confinement near the pipelines. Assuming some confinement from nearby trees, the consultant calculated overpressures that would not damage safety-related structures on site.

The consultant noted that these results "differ at first sight from the conclusions drawn in the original IPEEE … about a vapor cloud explosion or flammable vapor cloud engulfing the plant." The consultant offered the following explanation:

> The re-evaluation of the consequences of this event and, in particular, the recognition of the effect of turbulent mixing as the methane exits the pipeline and of the fact that vapor cloud explosions involving methane do not occur in uncongested or semi-open spaces, leads us to conclude that the hypothetical engulfment of the plant in a vapor cloud explosion or vapor cloud fire is improbable. That said, a jet fire, ignored in the IPEEE, is likely to occur in the event a gas pipeline is ruptured. Such a fire might well endanger plant staff who are unable to shelter; it would not, however, damage safety structures or equipment.

2015 Entergy Analysis

In August 2015, the NRC expressed a concern to Entergy regarding the 2008 consultant report, particularly the heat flux calculations and the location where the rupture was assumed. The NRC also asked Entergy to provide details on the plant's licensing basis with respect to the pipelines.

In a security-related response provided to the NRC in October 2015,[190] Entergy clarified that the rupture location in the 2008 analysis was based on the issues raised by the NRC. Entergy also clarified that no time had been assumed in 2008 for isolation of the ruptured line because the duration did not affect the peak values calculated for overpressure and heat flux. The analysis assumed that the remaining gas would burn for a period of time after isolation. Entergy also noted that the Unit 2 IPEEE had referenced the change from automatic to remote (not automatic) isolation of the valves on the gas pipeline. Entergy determined that, since the most significant effects of a pipeline rupture are at the beginning of a release, "the timing of valve closure is not considered relevant" and no new analysis was needed to amend the licensing basis.

Entergy also noted that certain plant equipment had not been accounted for in the heat flux calculations in 2008, and these were addressed in the updated analysis. The 2015 analysis was conducted by the same consultant who performed the 2008 analysis, but it was independently reviewed by another individual not employed by Entergy. The consultant considered jet fires, delayed-ignition cloud fires, vapor cloud explosions, missile generation, and smoke. The 2015 analysis documented heat flux over 12.6 kW/m^2 and overpressure over 1 psi that could negatively affect certain safety-related or important-to-safety equipment or structures for Unit 3. The analysis concluded that the following important equipment could be affected, but that backup equipment would allow for safe shutdown of the plant. Other equipment was less important to the facility or unaffected because of shielding or distance.[191]

- **Emergency diesel generators (based on heat flux at the outside air louvers).** Also, some shielding is provided by other buildings and the downhill slope toward the plant.
- **Several tanks with exposed instruments within the protected area.** The level instruments were assumed to be lost based on heat flux, which could result in required actions under the plant technical specifications, but the tanks could still be used.
- **Equipment in the 138 kV yard.** The analysis discusses multiple ways to restore power, as well as alternative sources that could be manually aligned (which the plant has analyzed).
- **Offsite electrical switchyard and transmission lines.** Loss of the switchyard is postulated for certain rupture locations, and loss of offsite power (an analyzed event) is assumed.
- **Diesel fuel oil storage tank and tanker trailer.** Entergy noted that the tanker trailer, relatively close to the pipeline, was needed to move fuel from the storage tank (which was less likely to be affected) onto the site. Separately, the team verified that the tanker trailer was later moved much farther away from the pipeline and, combined with day tanks onsite, provides significant fuel oil supply for the emergency diesel generators.
- **City water tank.** This water supply provides cooling or backup cooling to various important plant equipment. Entergy noted that other water sources would be available in the scenarios that would affect this tank, though manual alignment may be needed.

Entergy concluded that "the highly unlikely—but assumed—loss of [the] adversely affected SSCs … would not prevent the safe shutdown of the plant." Entergy also stated that "exposure rates are sufficiently low to justify a conclusion that the original licensing basis (i.e., the gas line will not impair the safe operation of [Unit 3]) is met."

A.5. Additional NRC Evaluations of Preexisting Pipelines (2003-2015)

2003 Security-Related Review

At an NRC meeting in March 2003, a member of the public raised concerns about the safety and security implications of the natural gas pipelines that pass through the Indian Point site. In response, NRC staff reviewed prior evaluations of the pipelines and assessed the risks of large releases of natural gas, including through intentional acts.[192]

In assessing intentional acts, the NRC staff acknowledged that it was not valid to consider the pipe rupture frequency, but rather the pipeline failure had to be assumed as an initial condition. Postulating this rupture, the NRC staff considered the consequences of a major pipe rupture and the likelihood of detonation of an unconfined gas cloud.

First, using the 1 psi overpressure distances included in the Indian Point Unit 3 IPEEE, the NRC staff calculated the mass of the vapor cloud that could create such an overpressure. Using the IPEEE-referenced discharge rates, the NRC staff observed that a vapor cloud that could cause this overpressure could form within a minute. Another equation also indicated that a vapor cloud could form in a short time. (A prior study had shown a mean time between rupture and ignition of 6-7 minutes.) The NRC staff considered the peak overpressure capacities for the fuel handling building and diesel generator building and found that overpressures of 1 psi or less would not pose a significant threat, though higher pressures could pose damage.

The NRC staff noted multiple references showing that unconfined vapor clouds of natural gas are not easily detonated. In the IPEEE, the likelihood of detonation given a large rupture was estimated to be 0.01. Entergy and its contractor informed the NRC that more recent information would support an even lower likelihood.

The NRC staff also estimated radiant heat fluxes using the methodology from NUREG/CR-3330, "Vulnerability of Nuclear Power Plant Structures to Large External Fires."[193] This report estimated an equilibrium flow rate from a rupture in a 36-inch, 1,000 psig pipeline, which the NRC staff viewed as an upper bound since pipeline isolation would decrease the discharge rate over time. Using IPEEE discharge rates and calculations for the radiant heat from a resulting fireball, the NRC staff concluded that at least several hours of fire exposure would be needed to have detrimental effects on safety-related concrete structures. Some wood ignition and personnel injury would be expected depending on the distance.

The NRC staff used this information to suggest that intentional ruptures may be an impractical and unlikely choice for those seeking nuclear power plant damage. The staff recommended that a "definitive evaluation of this aspect" be conducted as a safeguards review.

2010 Petition Review

In October 2010, a member of the public submitted a petition under Title 10 of the *Code of Federal Regulations* (10 CFR), Section 2.206, "Requests for action under this subpart."[194] This petition raised issues with the preexisting pipelines on the Indian Point site. The NRC staff, in considering the petition, reviewed historical information regarding the pipeline, as well as publicly available technical data.[195] The historical references reviewed by the staff have all been described in the sections above in this report. A compiled report containing safeguards information was produced as a record of the review. In addition, the security staff developed questions for the licensee that were shared with regional security inspectors to address at the next baseline inspection.

The NRC staff also used the ALOHA modeling software to assess both the conclusions of the 2008 Entergy analysis (Section 0 above) and the conclusions of the 2003 NRC evaluation (Section 0 above). While details of the ALOHA calculations were not included in the summary memo, the NRC staff asserts in the memo that the 2003 and 2008 conclusions remained valid.

Considering all of this information, the NRC staff did not identify any violations of NRC regulations or any new information that would change the staff's previous conclusion that the pipelines do not endanger the safe or secure operation of Indian Point Units 2 and 3. The NRC did not accept the 10 CFR 2.206 petition for further review, stating that the issues raised had been previously resolved.[196]

Appendix B. Pipeline Rupture Analysis Results

The following pages show the letter report from Sandia National Laboratories on the analyses conducted in support of the evaluation team's activities. (Note: Page numbering resumes with Appendix C, accounting for the length of this report.)

Commented [CT12]: Will insert report into the PDF version of this document, once both are done. Need to fix page numbering of appendix C and beyond to account for however many pages that is (right now it is for an 18-page report based on the draft).

Appendix C. Indian Point Risk Significance Analysis Results

C.1. Executive Summary

Plant Name / Unit Number: Indian Point Energy Center, Units 2 & 3	**Summary Title:** Gas pipeline failure
EA Number (if applicable): N/A	**Result:** Very low safety significance (~10^{-8} ΔCDF)

On February 13, 2020, the U.S. Nuclear Regulatory Commission (NRC) Office of the Inspector General (OIG) issued an Event Inquiry, "Concerns Pertaining to Gas Transmission Lines at the Indian Point Nuclear Power Plant" (Case No. 16-024). In that report, the OIG raised concerns regarding (1) the NRC's safety analysis that supported the Federal Energy Regulatory Commission's (FERC's) determination to approve modifications to gas pipelines at Indian Point and (2) the NRC's response to a petition filed under Title 10 of the Code of Federal Regulations (10 CFR), Section 2.206 on this topic.

On February 24, 2020, the NRC Chairman directed the NRC staff review whether any information in the OIG report demonstrates that the staff should revisit either the safety analysis or its response to the 10 CFR 2.206 petition, as well as to evaluate whether any modifications to agency practice or procedures are needed or appropriate based on the OIG report. As part of this review, the staff initiated a risk assessment of gas pipeline rupture at both Indian Point Unit 2 and Unit 3.

During the review of the previous safety analyses, the team noted that risk was used numerous times, by both the licensee and the NRC to judge that there was no safety concern. The pipeline rupture failure probabilities reported by the Department of Transportation's Pipeline and Hazardous Materials Safety Administration (PHMSA) are higher than those listed in Entergy or NRC reports. This discrepancy pushes the gas pipeline rupture frequency higher than screening values (1×10^{-6} per year when based on conservative assumptions, or 1×10^{-7} per year when based on realistic assumptions) in Regulatory Guide 1.91.

C.2. Analysis Results

The risk analysis considers the additional risk associated with the gas pipeline rupture. This evaluation only considers the impact for internal events with the reactor at-power.

Change in Core Damage Frequency. The increase in core damage frequency (ΔCDF) for this event is 1.6×10^{-8} per year.

Dominant Sequence. Given the low risk contribution, the dominant accident sequences for the overall model are unchanged. The dominant accident sequence for the gas pipeline failure is simultaneous common-cause failure of all emergency diesel generators to run and failure of the operators to recover the diesels.

C.3. Risk Analysis Details

Analysis Type: An expert at Idaho National Laboratory created an event tree modeling effects of a pipeline rupture. Initiating event frequencies were generated based on data from PHMSA. The analysis also includes the likelihood and impacts of a pipeline rupture in response to all other modeled internal events during the 24-hour mission time.

Model Used: Indian Point Unit 2 Standardized Plant Analysis Risk (SPAR) Model, Version 8.59 and Indian Point Unit 3 SPAR model, Version 8.56

Software Used: SAPHIRE Software, Version 8.2.1

Exposure Time and/or Date of Occurrence: The analyst used the full 1-year exposure time.

Key Modeling Assumptions: The following modeling assumptions and associated basic event modifications were applied for this event analysis:

- **Failure mode:** A gas pipeline rupture causes an unrecoverable loss of switchyard and loss of city water. These failures were based on the results of the initial blast analysis done by Entergy.
- **Initiating event frequency:** The failure data provided by PHMSA (see Appendix D) shows that from 2002-2018, 15 ruptures occurred of pipe that (1) has a diameter greater than 20 inches; (2) has a maximum operating pressure of greater than 300 psig; and (3) is a Class 2, 3, or 4 pipeline. The initiating event frequency was calculated by using the bounding assumption that all 15 of these pipe ruptures resulted in detonation. The data shows that ignition only occurs approximately 50 percent of the time. Additionally, the data is for pipes greater than 20"; since 2002, no ruptures of onshore 42-inch diameter pipes have been reported (one 42-inch inch pipe ruptured offshore during Hurricane Ike). Furthermore, the initiating event frequency assumes that one mile of pipeline is affected; however, there is only 3,935 feet (0.75 miles) of pipeline that would have an impact on the facility. Using these assumptions, the initiating event frequency is calculated to be 1.94×10^{-5}.
- **Appendix R diesel alignment:** The analyst assumed that the Appendix R diesel for Unit 3 can be aligned within 13 minutes and that pumps from the chemical and volume control and component cooling water systems can be aligned to prevent reactor coolant pump (RCP) seal failure following a loss of offsite power and station blackout.
- **Seismic failures:** Seismic failure of the gas pipeline was not explicitly modeled as a cause of the pipeline failure.
- **FLEX:** FLEX equipment was not credited for these calculations; however, implementation of FLEX procedures and equipment would be beneficial in furthering reducing the risk impacts of a pipeline rupture, as the pipeline rupture could cause an extended loss of offsite power.
- **Ex-vessel core damage:** The analyst did not account for the impact of the performance deficiency on ex-core sources, such as spent fuel in the pool, dry fuel storage, or other sources. These sources are outside of the scope of the SPAR models. This risk has been evaluated in Section 2.5 of the report.
- **Human reliability analysis:** The gas pipeline rupture and detonation are expected to have minimal impact on the human failure events that are required to mitigate the accident, given the distance from the blast of the locations where these actions would be taken. Table 2 shows human failure events that are modeled as part of the gas pipeline rupture risk assessment.

Table 2. Human failure events used in the gas pipeline rupture risk assessment.

Event	Description
ACP-XHE-XM-RESET	Operator Fails to Reset MCCs [motor control centers] Following LOOP [loss of offsite power] Or SI [safety injection]
AFW-XHE-XM-HC405	Operator Fails to Operate Hc-405a_B_C&D
CCW-XHE-XM-AC810	Operator Fails to Isolate Non-Regenerative Heat Exchanger
CCW-XHE-XR-MDP31	Operator Fails to Restore CCW MDP-31 After T & M
CCW-XHE-XR-MDP32	Operator Fails to Restore CCW MDP -32 After T & M

Event	Description
CCW-XHE-XR-MDP33	Operator Fails to Restore CCW MDP -33 After T & M
EPS-XHE-XL-NR01H	Operator Fails to Recover Emergency Diesel In 1 Hour
EPS-XHE-XL-NR02H	Operator Fails to Recover Emergency Diesel In 2 Hours
EPS-XHE-XL-SEQ	Operator Fails to Recover DG [Diesel Generator] Load Sequencers
EPS-XHE-XM-APPR	Operators Fails to Start & Align Appendix R DG to Bus 5 Or Bus 6
EPS-XHE-XR-DG31	Operator Fails to Restore DG-31 Following T&M
EPS-XHE-XR-DG32	Operator Fails to Restore DG-32 Following T&M
EPS-XHE-XR-DG33	Operator Fails to Restore DG-33 Following T&M
HPI-XHE-XM-FAB	Operator Fails to Initiate Feed and Bleed Cooling
HPI-XHE-XM-RECIRC	Operator Fails to Start/Control High Pressure Recirc - PWR
MSS-XHE-XL-NITROGEN	Operator Fails to Align B/U Nitrogen to Advs
PWR-XHE-XM-DEPRCS	Operator Fails to Depressurize RCS/Secondary (SSC)
RCS-XHE-XM-RCPTRIP	Operator Fails to Trip RCPs after Loss of Cooling
SWS-XHE-XM-2930	Operator Misaligns ESS & Non ESS HDRs Valves SW-29 & 30
SWS-XHE-XM-NONESS	Operator Fails to Start SWS MDPs Given a LOOP Or SI

Uncertainty: The analyst performed an uncertainty quantification for the pipeline failure event tree using Monte Carlo sampling with 5,000 random samples. Table 3 below presents the results of this analysis. It should be noted that even the tails of the uncertainty analysis are well below actionable levels.

Table 3. Uncertainty quantification for risk assessment.

	Unit 2	Unit 3
Sample size	5,000	5,000
Events	177	196
Cutsets	917	846
Point estimates	1.63E-08	1.60E-08
Mean value	2.19E-08	2.02E-08
5th percentile	5.43E-11	3.89E-11
95th percentile	8.56E-08	8.31E-08
Median value	6.72E-09	4.86E-09

C.4. Sensitivity Studies

Two sensitivity studies were performed for this analysis: one on the consequences of overpressurization and the other on the initiating event frequency.

Overpressurization Study

Because of the uncertainty associated with the consequences of overpressurization from an explosion, the team conducted an analysis assumed more equipment and structural failures. Specifically, the team assumed that all equipment not in a seismic Category I structure (i.e., not located in the primary auxiliary building, diesel generator building, or reactor containment), such as balance of plant systems and the Appendix R diesels, was lost upon the postulated pipeline rupture. The seismic Category I buildings are designed to withstand a pressure drop of 3 psi[197], and it is assumed that the overpressurization at those locations would not exceed this value.

For Unit 2, the change in core damage frequency for this scenario was 1.6×10^{-8}. This remains well below the agency's threshold for a "small" change in risk of one in a million years.

For Unit 3, the change in core damage frequency for this scenario was 1.7×10^{-8}. This remains well below the agency's threshold for a "small" change in risk of one in a million years.

Frequency Study

Based on PHMSA's data, there was some concerns that because of the calculated frequency is based on a mileage that included all diameters of pipes, not just large pipes, that it may be non-conservative. The analyst performed an independent data analysis based on publicly available data.[198] For the last 10 years, the analyst determined that the failure frequency for ruptures in Class 2, 3, or 4 carbon steel transmission lines having pipe diameters greater than or equal to 20 inches and maximum operating pressure greater than or equal to 300 psig is 2.4×10^{-5} per mile per year. The failure data show that, over a period of 10 years, 26 ruptures occurred across 45501.75 miles of pipeline, and 42 percent of these ruptures occurred on pipes that were larger than 20 inches.

C.5. The risk results considering higher failure frequency value are still well below the agency's threshold for a small change. Summary

The analysis shows that the risk of a gas pipeline rupture is of very low safety significance both as defined in the significance determination process and based on the definitions in Regulatory Guide 1.174. The results for each model can be seen below in Table 4.

Table 4. Results of sensitivity studies.

Model	Δ CDF
Unit 2 base case	1.6×10^{-8}
Unit 2 frequency sensitivity	2.0×10^{-8}
Unit 2 overpressure sensitivity	1.6×10^{-8}
Unit 3 base case	1.6×10^{-8}
Unit 3 frequency sensitivity	2.0×10^{-8}
Unit 3 overpressure sensitivity	1.7×10^{-8}

Analyst: Suzanne Dennis Date: March 28, 2020

Reviewed By: Jeffery Wood Date: March 30, 2020

Appendix D. Pipeline Rupture Data from PHMSA

Table 5 below presents onshore gas transmission incident data for 2002-2019 obtained from the Department of Transportation's Pipeline and Hazardous Materials Safety Administration (PHMSA), as of March 3, 2020. The selected incidents are leaks or ruptures in Class 2, 3, or 4 piping having pipe diameters greater than or equal to 20" and maximum operating pressure greater than or equal to 300 psig. From 2002 to 2019, incidents were categorized as pipeline ruptures in the body of the pipe or pipe seam. From 2010 to 2019, incidents were categorized as pipeline ruptures in the pipe body, pipe seam, or girth weld.

Table 5. Pipeline rupture incidents obtained from PHMSA.

Year	LEAK	RUPTURE	LEAK or RUPTURE
2002	3	1	4
2003	1	1	2
2004	4	1	5
2005	2	0	2
2006	2	1	3
2007	2	2	4
2008	0	1	1
2009	2	0	2
2010	0	2	2
2011	1	0	1
2012	2	1	3
2013	0	0	0
2014	3	3	6
2015	0	0	0
2016	0	0	0
2017	1	1	2
2018	1	1	2
2019	0	0	0

Based on 2018 information (the most recent available), there were a combined 45,501.75 miles of pipeline in the United States categorized as Class 2, 3, and 4 piping, with a ratio of stress at maximum allowed operating pressure to specified minimum yield strength of greater than 30 percent. Pipelines of a diameter greater than 20" in diameter, as included in the incidents above, would be subset of this mileage. (See Section C.4 for a sensitivity study related to this data.) PHMSA does not have data on mileage of specific piping classes and diameters combined.

Appendix E. Peer Review of This Report

The evaluation team requested a peer review of this report by Dr. Peter Riccardella, a member of the NRC's Advisory Committee on Reactor Safeguards. Dr. Riccardella has more than 45 years' experience working on the structural integrity of nuclear power plant components. He is an authority in the application of fracture mechanics to nuclear pressure vessels and piping and has made significant contributions to the diagnosis and correction of materials degradation concerns at operating plants. He has been a principal investigator on a number of Electric Power Research Institute projects and served more than 20 years as a member of the American Society of Mechanical Engineers Subcommittee on Nuclear Power Plant Inservice Inspection. Dr. Riccardella earned his bachelor's, master's and doctorate degrees in mechanical engineering from Carnegie Mellon University, and is a Fellow and Life Member of the American Society of Mechanical Engineers.

The team incorporated most of Dr. Riccardella's detailed suggestions into the final version of this report. Dr. Riccardella's general comments on the report are included below for completeness.

As referenced in Section 2.1.1, Dr. Riccardella noted that:

> …the method used to establish the initiating event frequency, although based on actual data, does not have a high degree of statistical confidence or relevance to the AIM pipeline. The data are a limited sample, and there were likely different causes and conditions associated with each of the fifteen rupture events (seam weld manufacturing defects/low toughness, external corrosion, stress corrosion cracking, and third-party damage are the more common ones). And these conditions are not directly applicable to the subject AIM pipeline. Most, if not all, of these failures were likely in legacy pipelines, manufactured to less rigorous standards than current practice and have been subjected to many years of potential in-service degradation. This is especially true for the ~4000 ft of enhanced AIM pipeline in closest proximity to [Indian Point]. Therefore, although there is a high degree o[f] uncertainty in the assumed initiating event frequency, it is likely that the uncertainty is in the direction of making this estimate much higher than the true rupture frequency of that pipeline segment.

The team agrees. As noted in 0, the initiating event frequency used by the team is likely higher than a more detailed realistic data analysis would show. As the risk numbers are much lower than the agency's threshold for action, the team did not perform a detailed data analysis to estimate a lower pipeline failure frequency.

Dr. Riccardella also noted that:

> RG 1.174 also states that 'If the application clearly shows a decrease in CDF, the change will be considered to have satisfied the relevant principle of risk-informed regulation'. My understanding is that the 42" AIM pipeline replaced two existing legacy pipelines closer to the IPEC site, which were subsequently retired in place. If this is true, then the modification to the licensing basis clearly can be shown to satisfy this criterion, since the initiating event frequency would have been much higher for the legacy pipelines than for the new one, and the consequences were also likely to have been higher.

Appendix F. Biographies of Evaluation Team Members

David Skeen (team lead) is a member of the Senior Executive Service and has served as the Deputy Director of the Office of International Programs since June 2014. From 2011 to 2014, he served as the Director of the Japan Lessons-Learned Directorate leading the agency's response to the Fukushima Dai-ichi accident. He first joined the NRC in 1991 as a reactor systems engineer and served in a number of progressively responsible technical, policy, and management positions at the staff and Commission staff levels. Prior to joining the NRC, Mr. Skeen worked in the electrical construction industry for 15 years on large industrial projects, including both fossil and nuclear power plants. Mr. Skeen received a bachelor's degree in electrical engineering from West Virginia University.

Theresa Clark (deputy team lead) has served as the Deputy Director of the Division of Rulemaking, Environmental, and Financial Support since November 2017. She is a member of the NRC's Senior Executive Service Candidate Development Program. Ms. Clark joined the NRC in 2004 and has served in progressively responsible positions, including as an Executive Technical Assistant providing technical and policy advice to the agency's senior executives, the chief of the Mechanical Engineering Branch in the Office of New Reactors, and a reliability and risk analyst. Ms. Clark earned bachelor's and master's degrees in materials science and engineering from the University of Maryland.

Dr. Yueh-Li (Renee) Li is a senior mechanical engineer in the NRC's Office of Nuclear Reactor Regulation. She is an agency expert in the review of piping design and pipe break hazard analysis for new nuclear power plants. Dr. Li joined the NRC in 1980 as a mechanical engineer. Prior to joining the NRC, Dr. Li was a senior stress analyst and senior nuclear staff at Bechtel Power Corporation for four years. She earned a Ph.D. degree in mechanical engineering and a master's degree in nuclear engineering from The Catholic University of America and a bachelor's degree in nuclear engineering from National Tsinghua University in Taiwan.

Suzanne Dennis is a Risk and Reliability Engineer in the Office of Nuclear Regulatory Research. She joined the NRC in the Office of New Reactors as a Risk and Reliability Analyst in 2009 and has developed specialized expertise in the area of external hazard risk analysis. She holds a bachelor's degree in nuclear engineering from Missouri University of Science and Technology and a master's degree in reliability engineering from the University of Maryland.

Brian Harris, Esq. is the Deputy Assistant General Counsel for Reactor and Materials Rulemaking and was previously the Acting Assistant General Counsel for Operating Reactors. Mr. Harris joined the NRC in 2009 as a staff attorney and was the lead legal advisor for the agency's response to the accident at the Fukushima Dai-ichi nuclear power plant. Before joining the NRC, he was an associate at Townsend, Townsend & Crew and Pillsbury Winthrop Shaw Pittman. Mr. Harris's previous work experiences include the U.S. Navy as a nuclear-trained surface warfare officer and as part of the Joint Staff for the J-2, Director of Intelligence. Mr. Harris earned a law degree from the University of Richmond School of Law and bachelor's degree in chemical engineering from Brigham Young University.

Steve Nanney has worked in for the past 15 years in the Engineering and Research Division of the Pipeline and Hazardous Materials Safety Administration (U.S. Department of Transportation). Mr. Nanney has worked on the development and implementation of his agency's Integrity Management Program, rulemakings, special permits, stakeholder outreach, and pipeline research programs. He previously worked in industry for 29 years, including operations, design, construction, and marketing of gas and liquid pipelines. His industry experience also includes U.S. offshore drilling and gas production operations and several years of greenfield development of gas pipelines outside

the United States. Mr. Nanney has a bachelor's degree in civil engineering from the University of Mississippi and a master's degree in petroleum engineering from the University of Houston. He is a registered professional engineer in Texas.

Dr. Anay Luketa is a Principal Member of Technical Staff at Sandia National Laboratories in the Fire Science and Technology Department. She serves as test director of large-scale fire experiments and performs numerical analysis. Her area of expertise pertains to analysis, utilizing computational tools for applications that span turbulent reacting and non-reacting flow, solid mechanics, and shock-physics. Specific applications have involved pool fire, blast, and dispersion calculations for hazard analysis involving liquefied natural gas, as well as fires involving composites, propellants, and other hydrocarbons. She was the lead technical author of guidance reports addressing risk management of large liquefied natural gas carriers. She has bachelor's degrees in mathematics and in psychology from Seattle University, and a master's degree and Ph.D. in mechanical engineering from the University of Washington.

Dr. Chris LaFleur is the program lead for Hydrogen Safety, Codes, and Standards at Sandia National Laboratories in Albuquerque, NM, where she is responsible for the fire risk program activities and conducting research on the fire risks of emerging energy technologies. Before joining Sandia, she worked at General Motors and Parsons Engineering Science. Dr. LaFleur earned bachelor's degrees in geology and mechanical engineering from the University of Rochester, a master's degree in fire protection engineering from the University of Maryland, and a doctorate of engineering in manufacturing engineering from the University of Michigan. She is a licensed professional engineer.

Jamal Mohmand is a Member of the Technical Staffat Sandia National Laboratories. Mr. Mohmand has several years of experience of building fire risk models. In particular, Mr. Mohmand's expertise lies in plant partitioning, ignition frequency, fire scenario selection, quantification, uncertainty analysis, and model integration. Mr. Mohmand has helped build and maintain several fire risk models for plants across the country. Mr. Mohmand has participated in peer reviews, plant walkdowns, significance determination process responses, and safety reviews of probabilistic risk assessment models. He graduated from Texas A&M University with a Bachelor of Science in Radiological Health Engineering in 2017.

Appendix G. Figures

Figure 1. Aerial view of the Indian Point Energy Center on the east side of the Hudson River. This view shows the Unit 2 containment and turbine building on the left, the Unit 1 containment in the center, and the Unit 3 containment and turbine building on the right. (Some older aerial photos show a red and white stack associated with Unit 1; it has been removed and only the white base is showing to the left of Unit 1.)

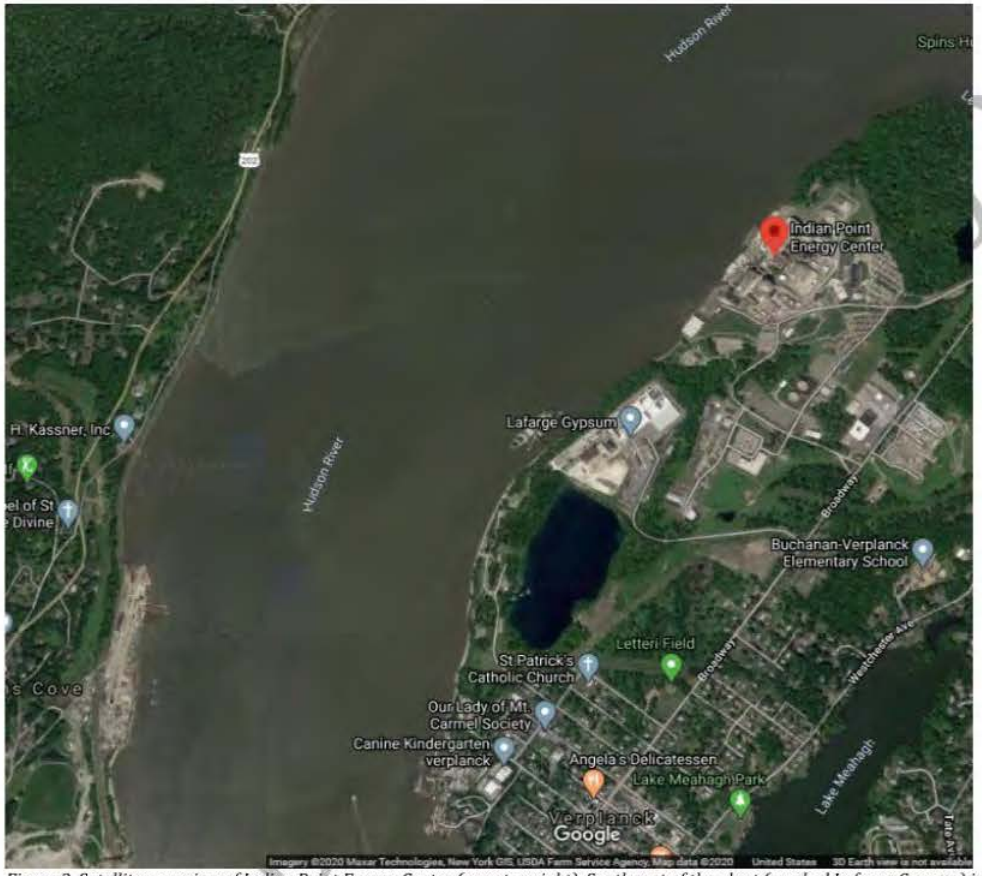


Figure 2. Satellite map view of Indian Point Energy Center (near top right). Southwest of the plant (marked Lafarge Gypsum) is a gypsum plant not associated with the nuclear power plant. (Imagery ©2020 Maxar Technologies, New York GIS, USDA Farm Service Agency, Map data ©2020 Google.)

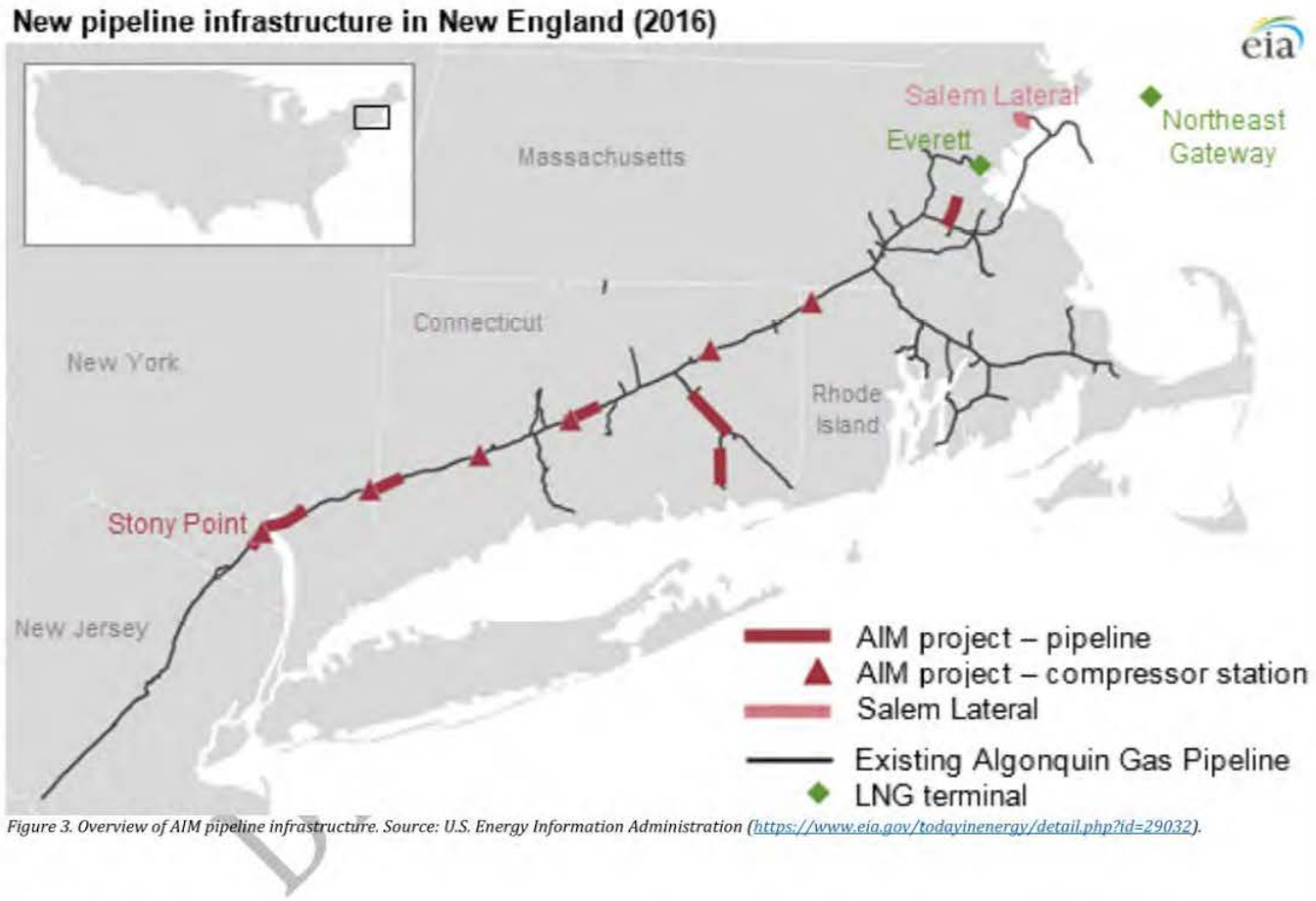


Figure 3. Overview of AIM pipeline infrastructure. Source: U.S. Energy Information Administration (https://www.eia.gov/todayinenergy/detail.php?id=29032).

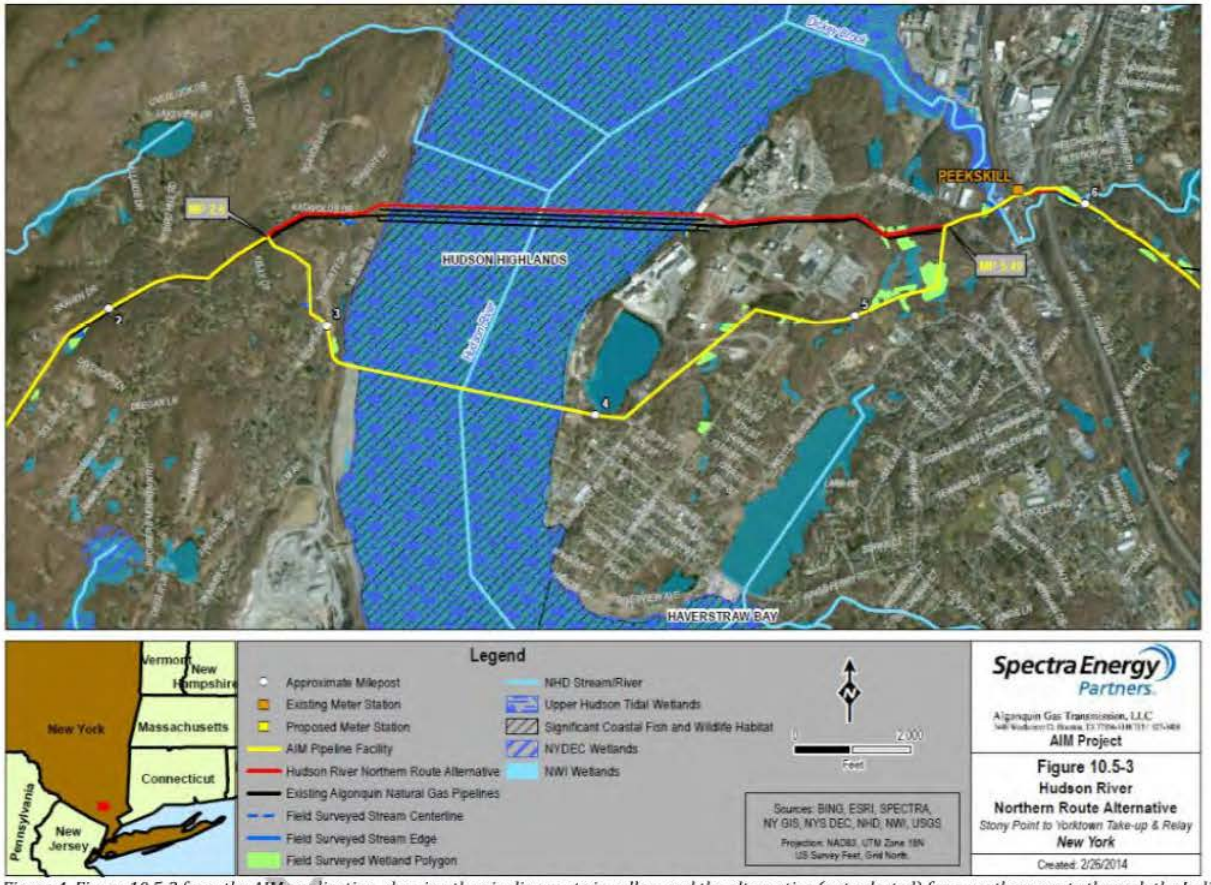


Figure 4. Figure 10.5-3 from the AIM application, showing the pipeline route in yellow and the alternative (not selected) for a northern route through the Indian Point site in red.

Figure 5. View of the 42-inch AIM pipeline from near Indian Point. At left is a view of the right of way from a cemetery southeast of Indian Point. The pipeline area can be identified by the lighter grass beyond the trucks on the opposite side of the road (Broadway); the Indian Point SOCA is well outside the frame to the right; the red and white tower is the meteorology tower that Entergy assessed for pipeline rupture impacts. At center is a view of the right of way from within the Indian Point property. The pipeline area can be identified by the lighter grass beyond the fence (behind the white items); the Indian Point SOCA is well behind the viewer and to the left of the frame. The photos show the hilly terrain near the site, with the pipeline in a low area. The image at right shows the Indian Point site near the top, blue dot with the location where the center photo was taken, and cemetery in the clear area near the bottom right. The pipeline area can be identified by the clear-cut through the trees; the Buchanan switchyard is just to the right of the frame where the road (Broadway) intersects the edge of the image. The photos were taken by the team on March 12, 2020. (Right image: Imagery ©2020 Maxar Technologies, New York GIS, USDA Farm Service Agency, Map data ©2020 Google.)

Figure 6. Images of above-ground connections where the 26-inch, 30-inch, and 42-inch pipelines connect, east of Indian Point. These photos were taken by the team on March 12, 2020.

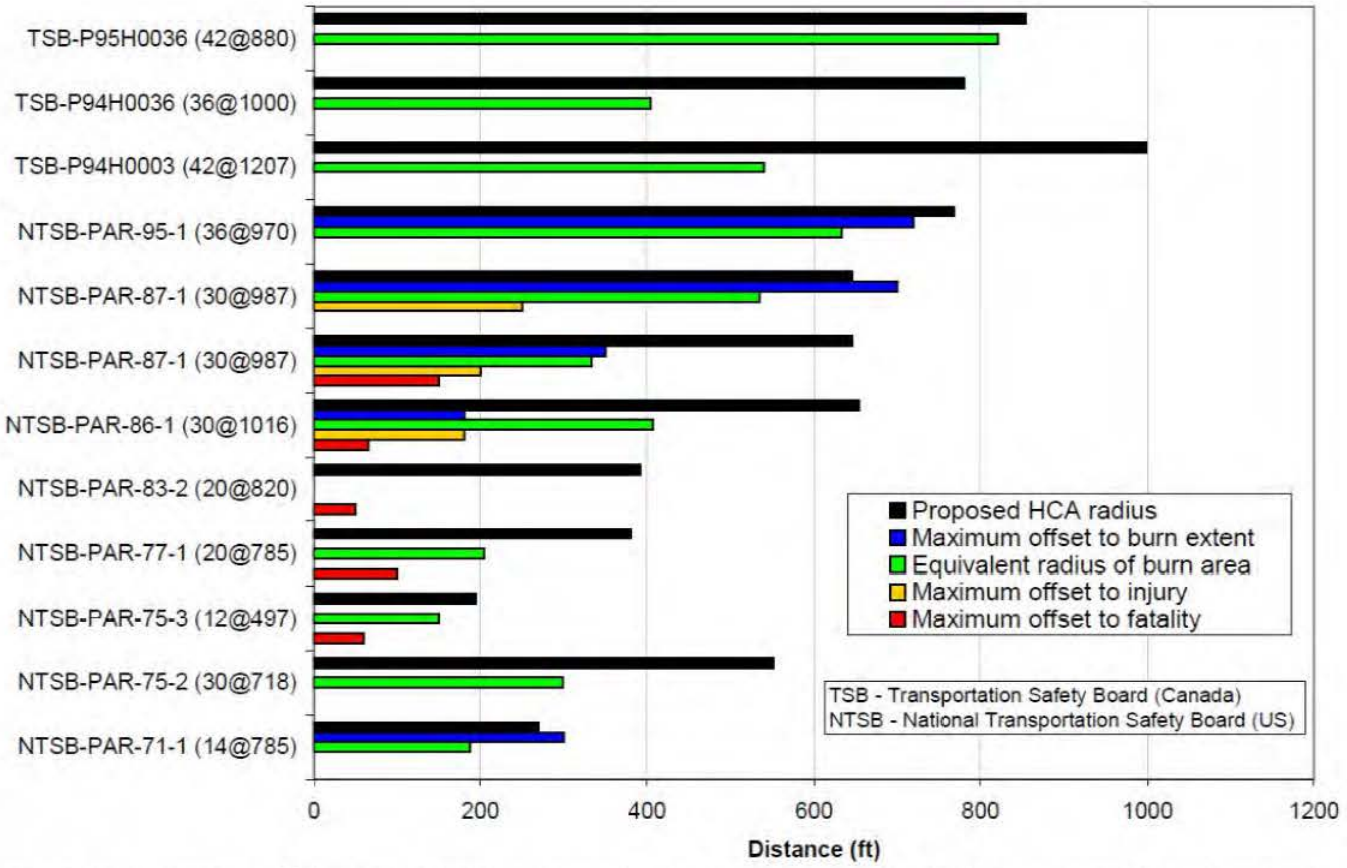
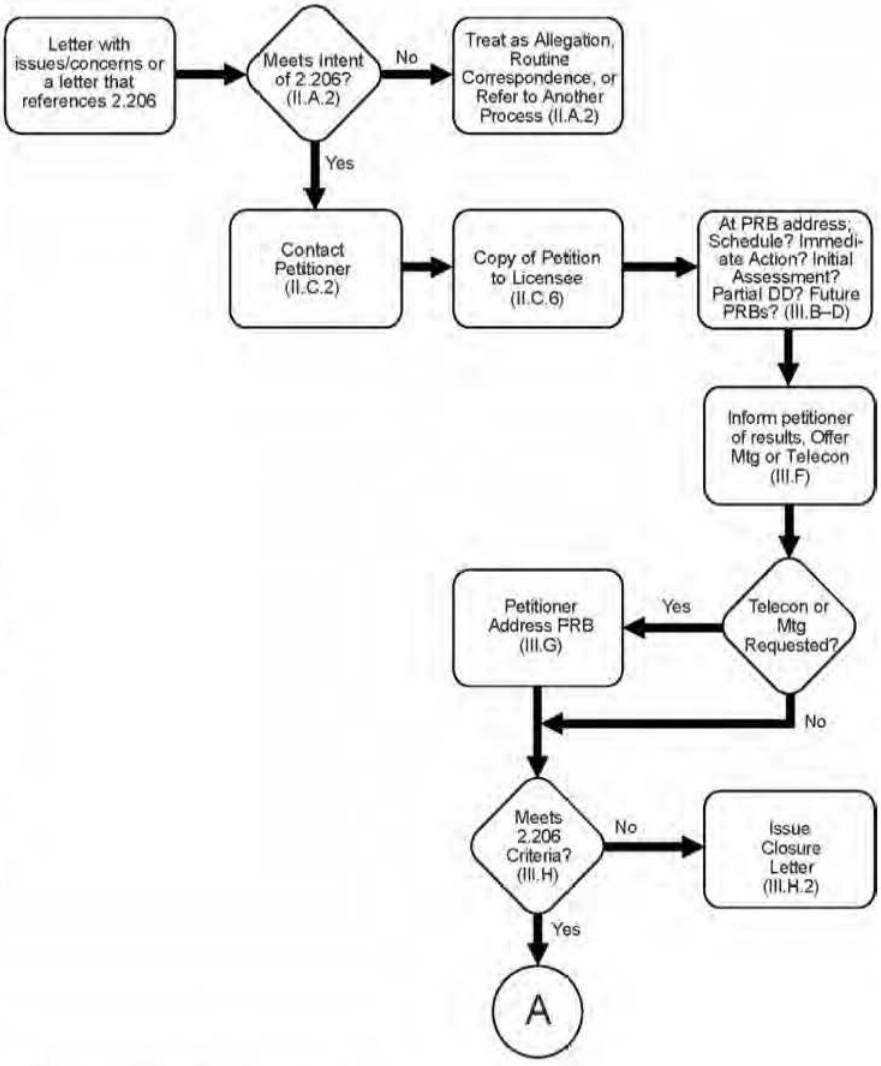


Figure 7. Figure 3.1 from Gas Research Institute / C-FER report comparing pipeline rupture damage areas to a proposed high consequence area (HCA) hazard area radius, which became the potential impact radius in Department of Transportation regulations.

Figure 8. Pipeline rupture accident images obtained from PHMSA. Accident sites are: (1) Appomattox, VA in 2008, (2) Artesia, NM in 2019, (3) Danville, KY in 2019, and (4) Moundville, OH in 2018.



1. Parenthetical Information is associated Guide paragraph number

Figure 9. Simplified process flowchart (1 of 2) from NRC desktop guide on 10 CFR 2.206 petition reviews (Exhibit 1).

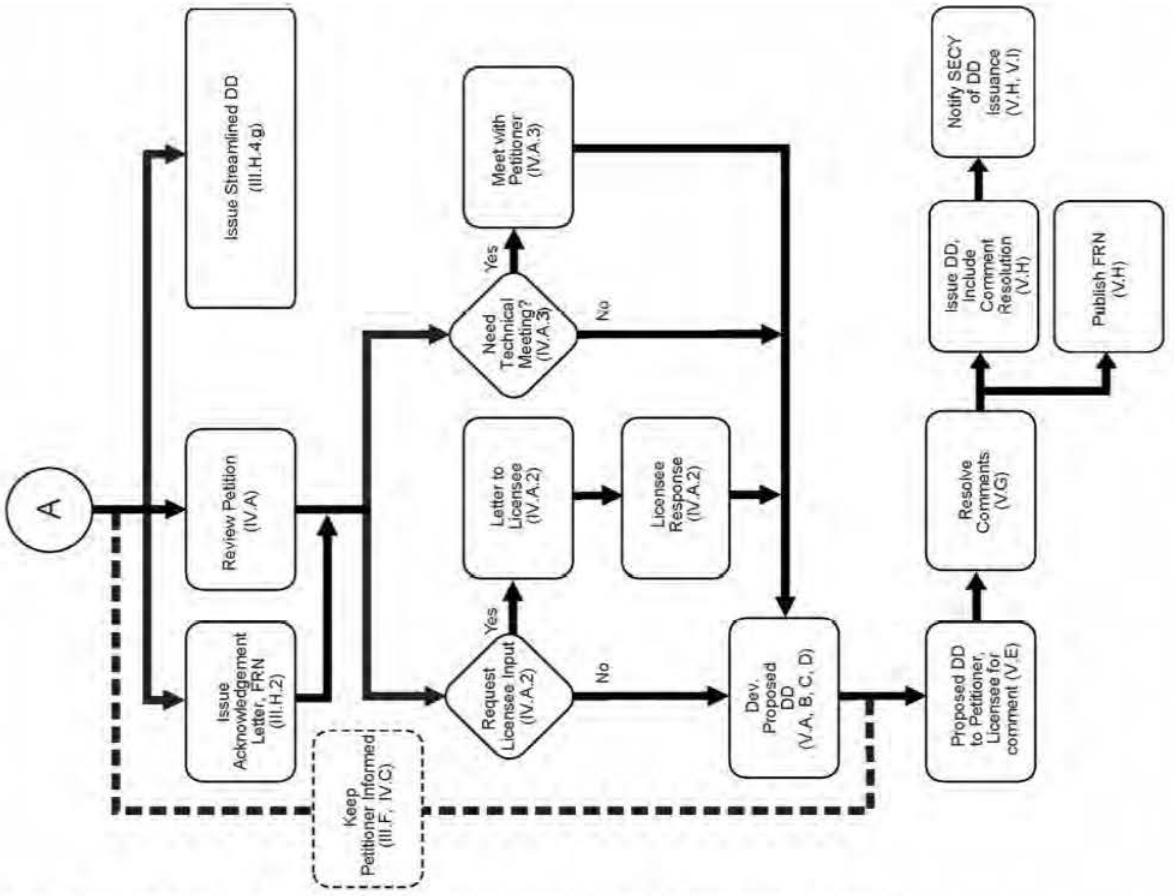
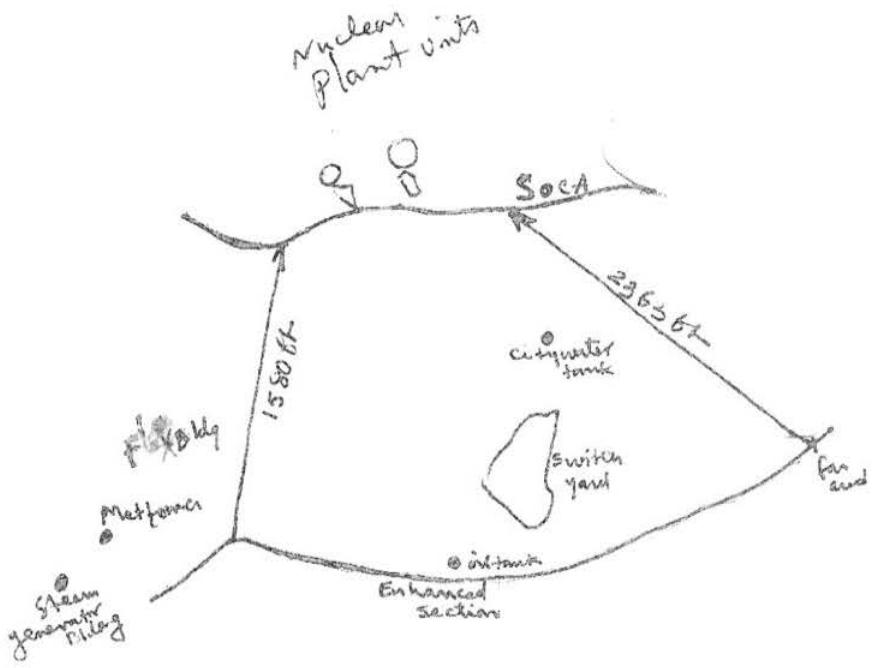


Figure 10. Simplified process flowchart (2 of 2) from NRC desktop guide on 10 CFR 2.206 petition reviews (Exhibit 1).



SOCA: Security owner controlled Area

distance to SOCA from enhanced Section of pipeline = 1580ft

distance to SSC from enhanced Section of pipeline = 1830 ft

distance to SOCA from far end (surface) Section of pipeline = 2363 ft

distance to SSC from far end (surface) Section of pipeline = 2988 ft

Figure 11. Sketch prepared by NRC analyst in conducting sensitivity study for PRB on 3-minute isolation valve closure time for AIM pipeline.

Note: Blacked out content appears in the original; it is not a FOIA redaction.

SUMMARY OF RESULTS

SOCA = Security owner controlled area
SSC = Structure, system and components

Scenario	Minimum safe distance to 1 psi (Distance to SOCA) ((Distance to SSC))	Heat flux kw/m² at SOCA Distance of 1380 ft
pipe burst with unbroken end closed (valve closed) RG 1.91 (Direct Explosion)	2351 ft (2363 ft) (([redacted] ft))	—
pipe burst with unbroken end connected to infinite source (valve open)	2509 ft (2363 ft) (([redacted] ft))	—
vapor plume explosion with no congestion	No explosion	—
pipe burst with unbroken end closed	—	4.05 kw/m²
pipe burst with unbroken end of pipe connected to infinite source	—	4.03

Figure 12. Image showing handwritten results of sensitivity study conducted by NRC analyst at the request of the PRB. The team redacted the "distance to SSC" as potentially security-related information, though similar information may exist in other documents.

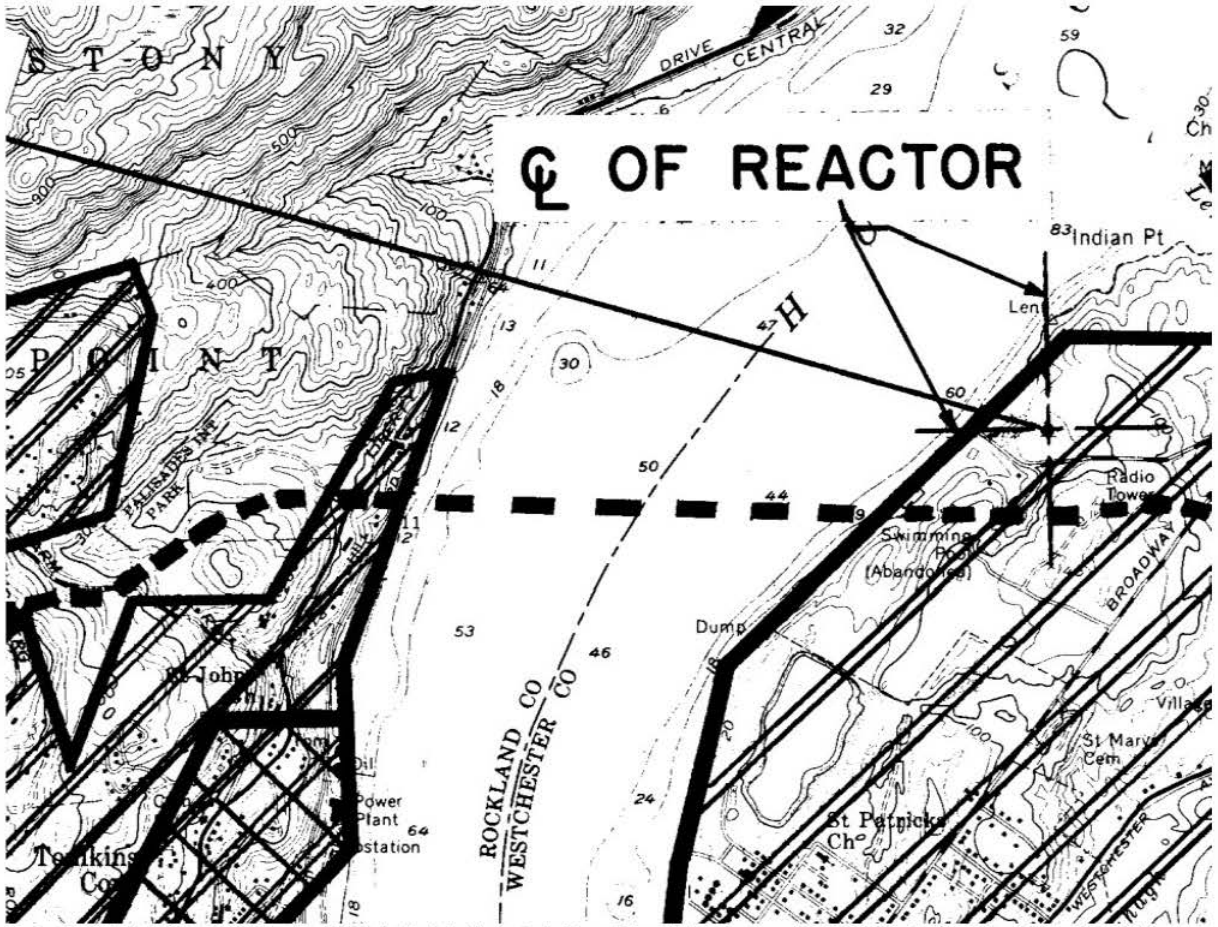


Figure 13. Selection from 1960 map of Indian Point Unit 1 vicinity, including public utilities. The preexisting 26-inch pipeline is shown as a dashed line.

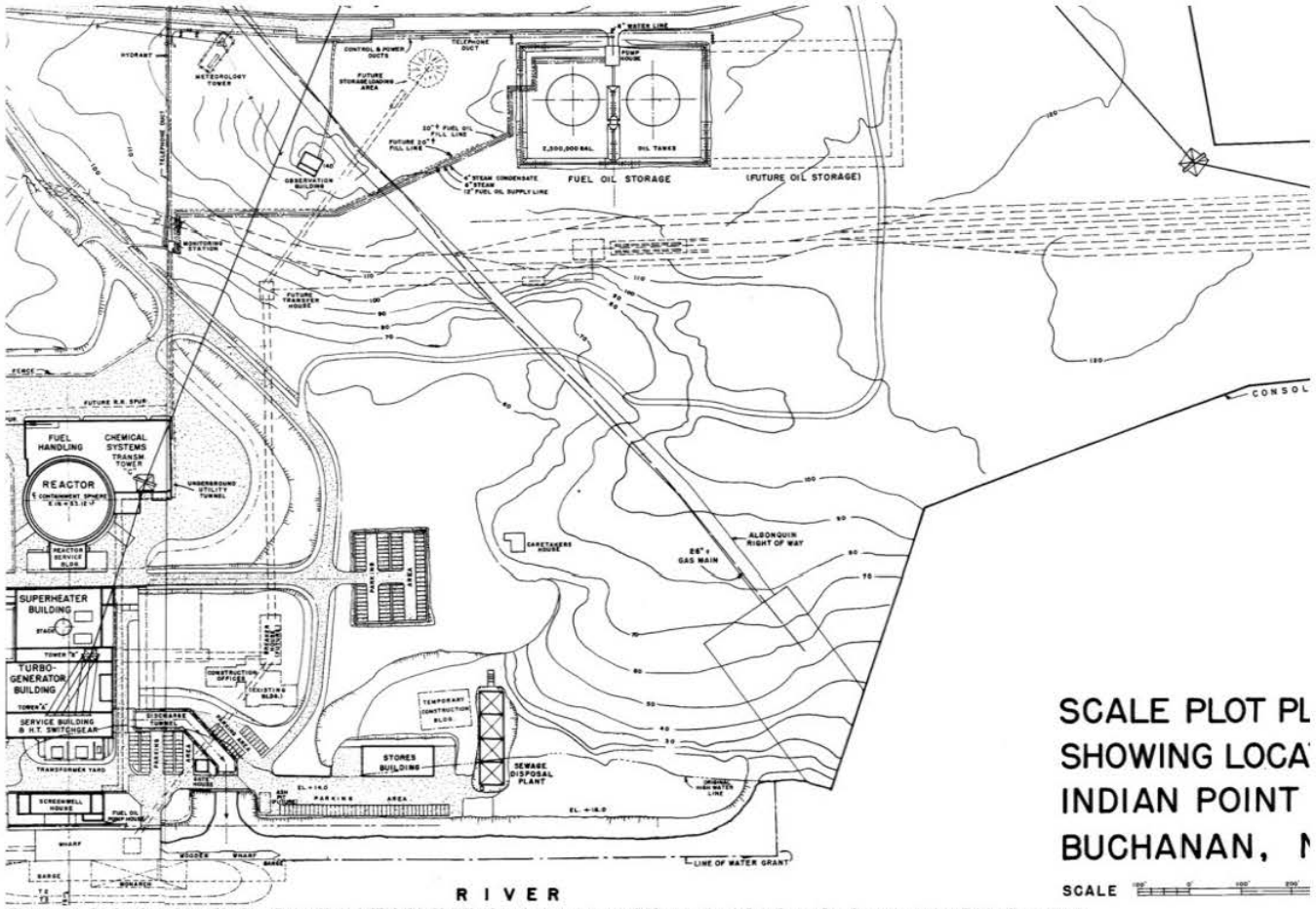


Figure 14. Scale plot plan of Indian Point Unit 1 (Exhibit H-14), showing reactor and Algonquin right of way for the preexisting 26-inch gas main.

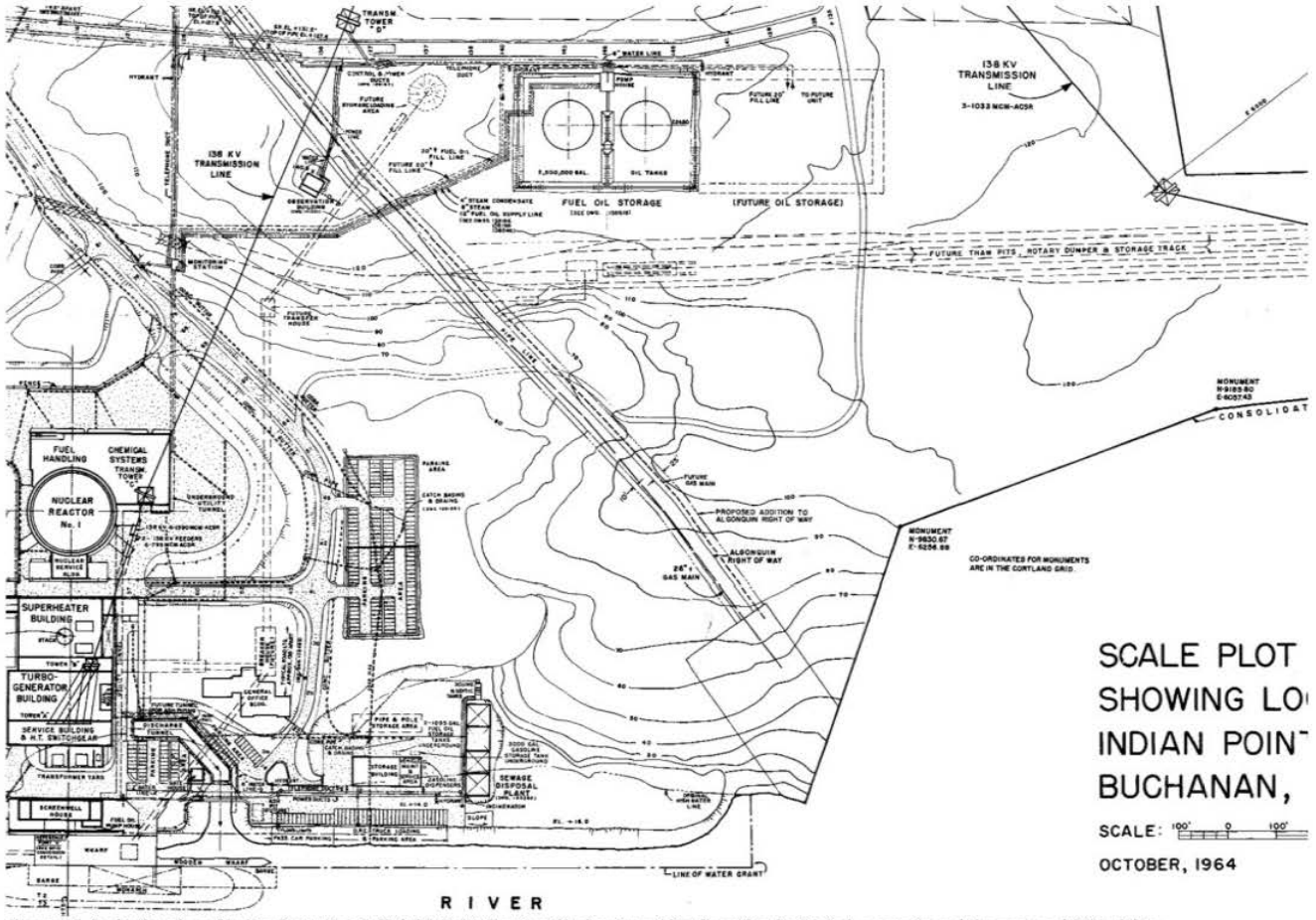


Figure 15. Scale plot plan of Indian Point Unit 1 (Exhibit H-14, Revision 2), showing right of way for the 26-inch gas main and the proposed 30-inch line.

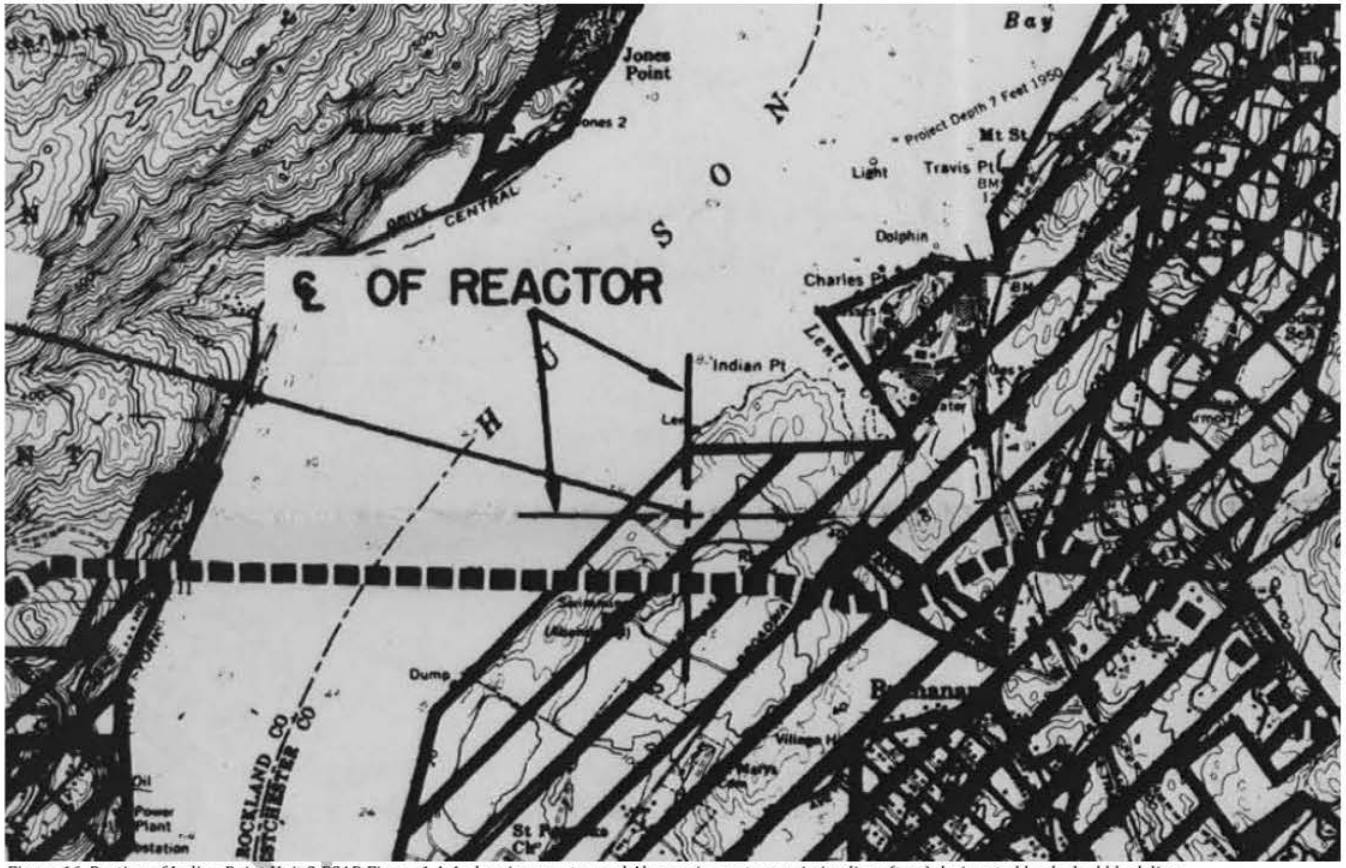


Figure 16. Portion of Indian Point Unit 2 PSAR Figure 1.4-4, showing reactor and Algonquin gas transmission lines (two) designated by dashed black line.

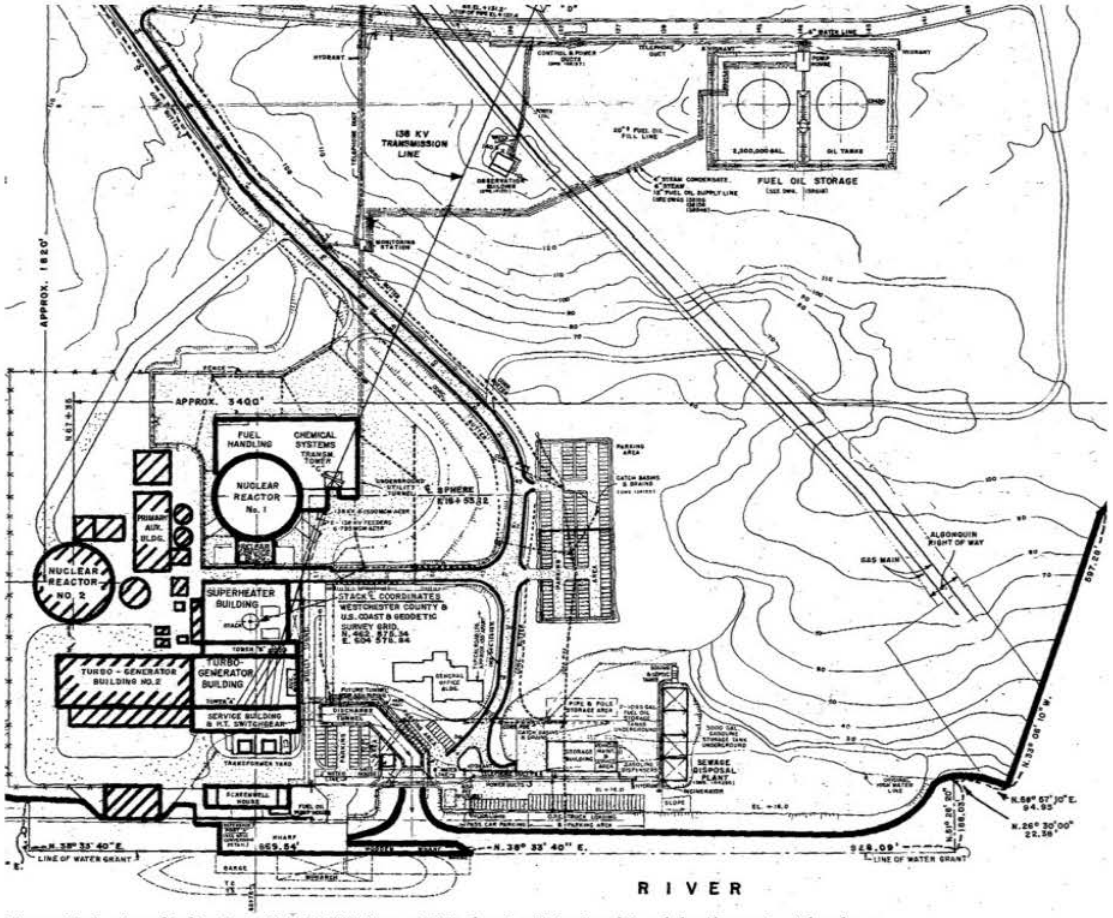


Figure 17. Section of Indian Point Unit 2 PSAR Figure 1.2-2, showing Units 1 and 2 and the Algonquin right of way.

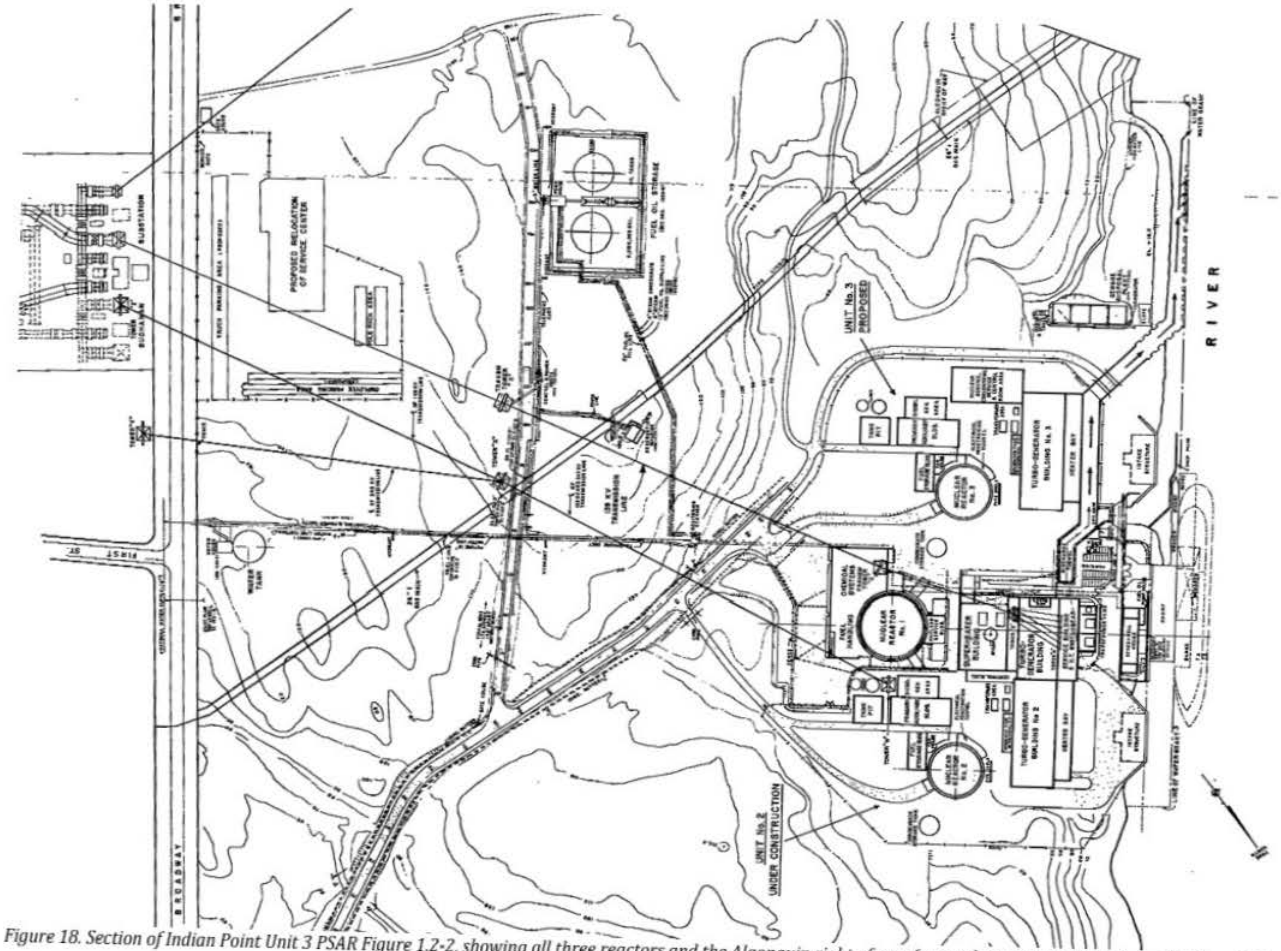


Figure 18. Section of Indian Point Unit 3 PSAR Figure 1.2-2, showing all three reactors and the Algonquin right of way (rotated counterclockwise from Unit 1 and 2 images).

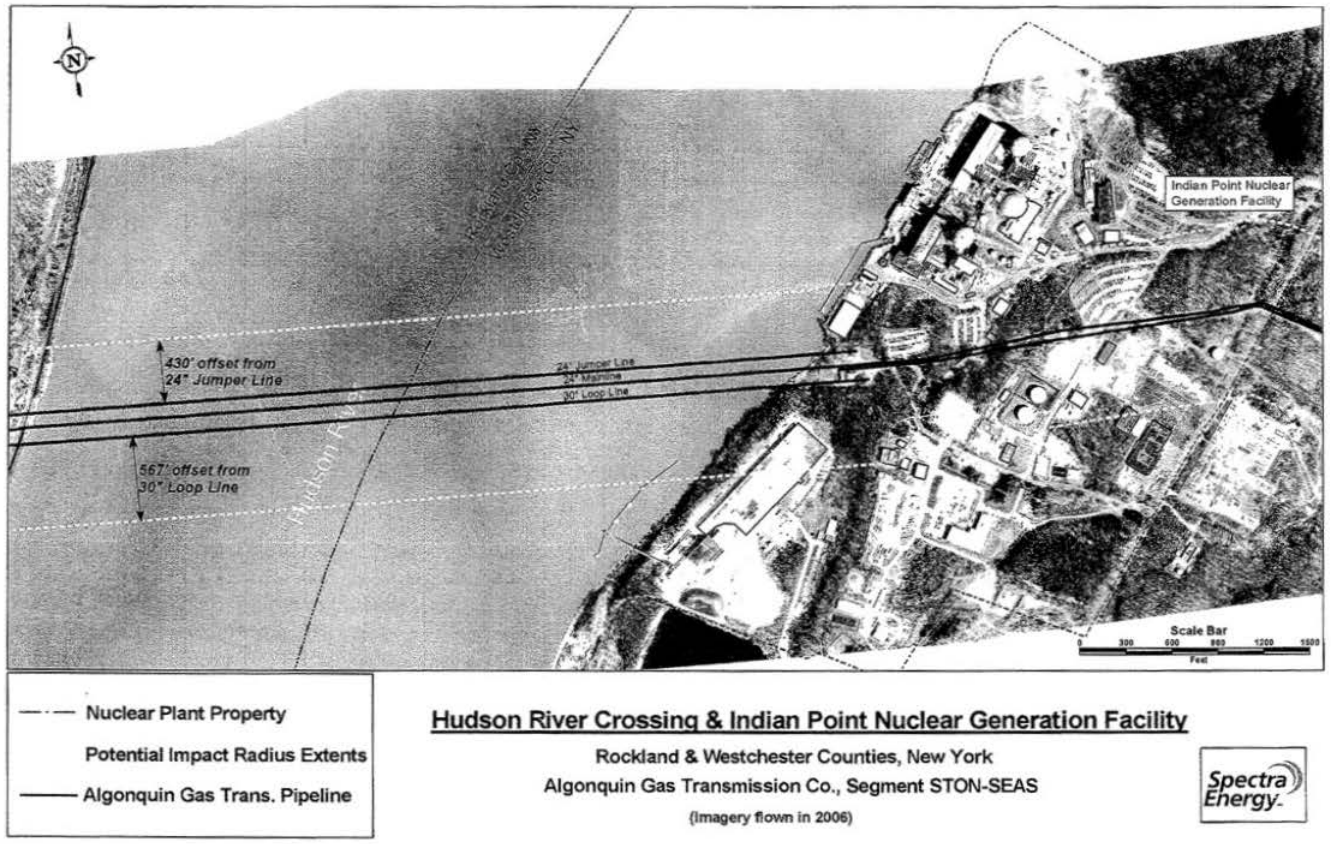


Figure 19. Section of Indian Point Unit 2 Updated FSAR Figure 2.2-3, showing the Hudson River crossing of the preexisting pipelines, the "potential impact radius"[199] extent in white dotted lines, and the Indian Point facility north of the pipelines.

Appendix H. Chronology of Events and Documents Related to Indian Point Pipeline Review

Date	Category	Activity	Reference
1968-08-30	Licensee Review / Analysis	Consolidated Edison concludes in Indian Point Unit 3 preliminary safety analysis report Supplement 1 that pipeline fire will not endanger Unit 3, references 4-minute automatic isolation	ML093480204
1973-09-21	U.S. Nuclear Regulatory Commission (NRC) Review / Analysis	U.S. Atomic Energy Commission concludes in Indian Point Unit 3 operating license safety evaluation report that pipeline failure will not impair safe operation	ML072260465
1975-01-31	NRC Guidance	NRC issues Revision 0 to Regulatory Guide 1.91	ML12298A133
1978-02-28	NRC Guidance	NRC issues Revision 1 to Regulatory Guide 1.91	ML003740286
1982-03-05	Licensee Review / Analysis	Power Authority of the State of New York and Consolidated Edison submit Indian Point Probabilistic Safety Study to NRC	ML093430890
1982-12-31	NRC Review / Analysis	NRC completes review of Indian Point Probability Safety Study (NUREG/CR-2934), including heat flux and missiles from pipeline explosions/leaks	ML091540534
1983-01-21	Licensee Review / Analysis	Power Authority of the State of New York and Consolidated Edison submit Amendment 1 to Indian Point Probabilistic Safety Study to NRC, updating several analyses (but not pipeline)	ML093431170
1984-04-02	Licensee Review / Analysis	Consolidated Edison and Power Authority of the State of New York submit Amendment 2 to Indian Point Probabilistic Safety Study to NRC, updating several analyses (but not pipeline)	ML100321844
1995-12-06	Licensee Review / Analysis	Consolidated Edison screens pipeline failure out of Indian Point Unit 2 Individual Plant Examination for External Events (IPEEE) based on low frequency, notes that automatic shutoff valves had been removed	ML11227A100
1997-09-26	Licensee Review / Analysis	New York Power Authority screens pipeline vapor cloud explosion out of Indian Point Unit 3 IPEEE based on low frequency	ML11227A102
1999-05-14	NRC Review / Analysis	NRC issues safety evaluation of IP2 IPEEE, noting that natural gas pipeline accidents were screened based on frequency	ML090130608
2000-10-25	10 CFR 2.206	NRC updates Management Directive 8.11 on Title 10 of the *Code of Federal Regulations* (10 CFR) 2.206 petition reviews (most recent update before pipeline-related petitions)	ML041770328

Date	Category	Activity	Reference
2001-02-15	NRC Review / Analysis	NRC transmits Indian Point Unit 3 IPEEE safety evaluation to Entergy, noting evaluation and walkdowns of pipeline	ML11227A103
2003-04-25	NRC Review / Analysis	NRC documents review regarding safety hazard of exposed natural gas pipelines near the Hudson River shoreline	memo: ML11223A040 (public) enclosure: ML031210213 (non-public)
2007-02-28	NRC Guidance	U.S. Environmental Protection Agency and National Oceanic and Atmospheric Administration issue ALOHA User's Manual	https://nepis.epa.gov/
2008-03-12	NRC Review / Analysis	NRC issues Request for Information RI-2008-A-021 on gas pipelines	non-public (not in ADAMS)
2008-03-28	Licensee Review / Analysis	Entergy completes safeguards analysis for pipeline explosion near Indian Point Unit 3	NS107994 (non-public, safeguards)
2008-04-12	Licensee Miscellaneous	Entergy changes licensee-controlled documents to remove gas turbine references and add station blackout and Appendix R diesel for Indian Point Unit 2	ML090410062
2008-04-23	Licensee Review / Analysis	Entergy provides initial response to RI-2008-A-021 on gas pipelines	non-public (not in ADAMS)
2008-05-12	NRC Guidance	NRC/Office of Nuclear Reactor Regulation (NRR) issues office instruction ADM-405, "NRR Technical Work Product Quality and Consistency," Revision 1	ML072750452 (non-public)
2008-09-30	Licensee Review / Analysis	Entergy provides supplemental analysis to RI-2008-A-0021 on gas pipelines, enclosing 08/14/2008 Risk Research Group analysis	letter: (non-public, not in ADAMS) enclosure: ML103140627 (non-public)
2008-10-20	Licensee Misc	Entergy updates Indian Point Unit 2 final safety analysis report to correct references to gas pipelines	Chapter 2: ML083390226 (non-public)
2009-10-13	Licensee Misc	Entergy updates Indian Point Unit 3 final safety analysis report to include 2008 pipeline analysis information	Chapter 2: ML093430729 (non-public)
2010-04-12	Correspondence / Meetings	NRC responds to 03/04/2010 email from Paul Blanch re: Indian Point pipeline "unanalyzed condition," referencing 2008 and earlier analyses	ML101020487
2010-05-27	Licensee Misc	Entergy corrects description of pipelines in Indian Point license renewal application	ML101590515
2010-07-06	Correspondence / Meetings	NRC responds to 06/08/2010 email from Paul Blanch re: Texas pipeline incidents and applicability to Indian Point	ML101890929
2010-10-25	10 CFR 2.206	Paul Blanch submits 10 CFR 2.206 petition regarding pre-existing gas pipelines	ML103020293 (public) ML102990527 (non-public)

Date	Category	Activity	Reference
2010-11-02	10 CFR 2.206	NRC holds Petition Review Board meeting regarding 10/25/2010 10 CFR 2.206 petition from Paul Blanch	ML103081077
2010-11-05	10 CFR 2.206	Paul Blanch supplements 10 CFR 2.206 petition re: hazard frequency and 10 CFR 50.59 review on change to non-automatic valves	ML103260134 (public) ML103160377 (non-public)
2010-11-09	10 CFR 2.206	NRC holds Petition Review Board meeting regarding 10/25/2010 10 CFR 2.206 petition from Paul Blanch	ML103190125
2011-03-03	10 CFR 2.206	NRC holds Petition Review Board meeting regarding 10/25/2010 10 CFR 2.206 petition from Paul Blanch	ML110680090
2011-03-03	10 CFR 2.206	Paul Blanch supplements 10 CFR 2.206 petition re: 10 CFR 50.59 review on change to non-automatic valves and Part 100 siting requirements	ML110630131
2011-03-04	NRC Review / Analysis	NRC/Office of Nuclear Security and Incident Response completes safeguards review of Indian Point gas pipelines (referenced in staff memos)	NS108076 (non-public, safeguards) 3/7 memo: ML110700162 (non-public) 3/23 memo: ML11223A041 (public), ML110750113 (non-public)
2011-03-31	10 CFR 2.206	NRC rejects 10/25/2010 Paul Blanch petition, finding that issues had been previously resolved	ML110890309
2011-07-20	NRC Guidance	NRC issues draft Revision 2 to Regulatory Guide 1.91 (DG-1270) for public comment	ML110390554 76 FR 43356
2012-06-15	10 CFR 2.206	NRC staff responds to Atomic Safety and Licensing Board order re: 10 CFR 2.206 petitions	ML12167A524
2013-04-17	NRC Guidance	NRC issues Revision 2 to Regulatory Guide 1.91	ML12170A980
2013-12-23	NRC Guidance	NRC/NRR issues office instruction ADM-405, "NRR Technical Work Product Quality and Consistency," Revision 2	ML13337A212 (non-public)
2013-12-30	NRC Guidance	NRC/NRR issues office instruction COM-106, "Control of Task Interface Agreements," Revision 4	ML13300A002
2014-02-28	AIM / FERC	Algonquin Gas Transmission, LLC submits application to the Federal Energy Regulatory Commission (FERC) for Algonquin Incremental Market (AIM) project under CP14-96	https://elibrary.ferc.gov/idmws/file_list.asp?document_id=14190856 https://elibrary.ferc.gov/idmws/file_list.asp?document_id=14244199
2014-04-02	AIM / FERC	NRC and FERC meet to discuss whether to cooperate on FERC environmental impact statement for AIM pipeline	https://elibrary.ferc.gov/idmws/file_list.asp?document_id=14209634

Date	Category	Activity	Reference
2014-04-30	AIM / FERC	Algonquin Gas Transmission, LLC submits info on Hudson River crossing, Indian Point location, and aerial view with measurements near Indian Point to FERC	https://elibrary.ferc.gov/idmws/common/OpenNat.asp?fileID=13532866 (see pp. 85 and 315)
2014-05-30	NRC Guidance	NRC/NRR issues office instruction LIC-504, "Integrated Risk-Informed Decision-Making Process for Emergent Issues," Revision 4	ML14035A143
2014-07-29	Licensee 50.59	Spectra sends information on AIM pipeline enhancements to Entergy (via Morgan Lewis) [Ref. 7 in 08/21/2014 10 CFR 50.59 evaluation]	obtained from Entergy through IP senior resident inspector
2014-08-06	AIM / FERC	FERC issues draft environmental impact statement for AIM pipeline	https://www.ferc.gov/industries/gas/enviro/eis/2014/08-06-14-eis.asp
2014-08-21	Licensee 50.59	Entergy submits 10 CFR 50.59 evaluation #1 for AIM pipeline	ML14245A110 (letter and Encl. 1) ML14245A111 (Encl. 2 non-public) ML15061A219 (Encl. 2 public)
2014-09-07	AIM / FERC	Paul Blanch submits comments on FERC draft environmental impact statement	ML18177A401 (Enclosure 3)
2014-09-30	AIM / FERC	NRC submits comments on FERC draft environmental impact statement, referencing planned 10 CFR 50.59 inspection	https://elibrary.ferc.gov/idmws/file_list.asp?document_id=14255780
2014-10-15	10 CFR 2.206	Paul Blanch submits 10 CFR 2.206 petition re: Entergy 10 CFR 50.59 evaluation	ML14294A751
2014-10-16	Licensee 50.59	NRC/Office of New Reactors (NRO) documents "safety review and confirmatory analysis" re: Entergy's 08/21/2014 10 CFR 50.59 evaluation	ML14329A189 (non-public) ML15070A086 (public, redacted)
2014-10-17	AIM / FERC	NRC and FERC meet to discuss NRC 10 CFR 50.59 inspection	https://elibrary.ferc.gov/idmws/file_list.asp?document_id=14276308
2014-10-30	Licensee 50.59	NRC Region 1 Division of Reactor Safety completes 10 CFR 50.59 inspection feeder to quarterly inspection report for Indian Point	ML14307B748
2014-11-03	AIM / FERC	Rick Kuprewicz provides report on AIM pipeline to Town of Cortlandt, questioning 3-minute assumption and asking for safety/risk assessment (submitted as supplement to 10/15/2014 petition)	ML14352A397
2014-11-07	Licensee 50.59	NRC issues integrated inspection report including 10 CFR 50.59 inspection results	ML14314A052
2014-11-11	Correspondence / Meetings	Paul Blanch responds to 11/06/2014 email from Dori Willis re: corrosion of gas lines	ML15008A117
2014-12-12	10 CFR 2.206	Entergy (Prussman) provides information to NRC (McCarver) re: basis for 3-minute valve closure time	ML15168A042

Date	Category	Activity	Reference
2014-12-30	AIM / FERC	Rick Kuprewicz writes to FERC re: need for transient analysis, risk assessment	enclosure in ML15027A419
2014-12-30	Correspondence / Meetings	NRC Chairman Macfarlane writes to Rep. Nita Lowey re: Entergy and NRC analyses	ML14343A934
2015-01-06	Correspondence / Meetings	Paul Blanch writes to Bill Dean (Region I Regional Administrator) re: 3-minute closure time and whether valves should be safety related	ML15008A119
2015-01-15	Correspondence / Meetings	Assemblywoman Sandy Galef writes to NRC Chairman Macfarlane re: independent risk analysis, Kuprewicz concerns	ML15027A419
2015-01-16	Licensee 50.59	Spectra sends Entergy updated (final) drawings for the tie-in between new and pre-existing pipelines	obtained from Entergy through IP senior resident inspector
2015-01-23	AIM / FERC	FERC issues final environmental impact statement for AIM pipeline	https://www.ferc.gov/industries/gas/enviro/eis/2015/01-23-15-eis.asp
2015-01-28	10 CFR 2.206	NRC holds public Petition Review Board meeting regarding 10/15/2014 10 CFR 2.206 petition from Paul Blanch	ML15044A459
2015-02-24	10 CFR 2.206	NRC holds internal Petition Review Board meeting to discuss initial decision to reject 10/15/2014 10 CFR 2.206 petition	(no reference)
2015-02-26	10 CFR 2.206	Paul Blanch writes to Doug Pickett (project manager) re: source for 3m closure time	ML15057A530
2015-03-03	AIM / FERC	FERC issues approval order for AIM pipeline	https://www.ferc.gov/CalendarFiles/20150303170720-CP14-96-000.pdf
2015-03-13	Correspondence / Meetings	NRC (Evans) responds to Assemblywoman Sandy Galef re: 60-minute analysis, Petition Review Board process	ML15050A131
2015-03-17	Correspondence / Meetings	Paul Blanch writes to Commissioners re: delay in 10 CFR 2.206 acknowledgement letter, deficiencies in NRC analysis	ML15082A419
2015-03-27	Correspondence / Meetings	Paul Blanch writes to NRC Chairman Burns re: testimony before Rep. Lowey	https://elibrary.ferc.gov/idmws/common/OpenNat.asp?fileID=13829121
2015-03-19	10 CFR 2.206	NRC/NRO documents sensitivity study regarding 3-minute isolation valve closure time on AIM pipeline	ML15078A067 Undated document; date estimated based on ADAMS addition.
2015-03-30	Licensee 50.59	NRC/NRR documents peer review of Entergy and NRC analyses re: 10 CFR 50.59	ML15331A342
2015-04-08	Licensee 50.59	Entergy submits 50.59 evaluation #2 for as-built AIM pipeline	ML15104A660 (letter and Encl. 1) ML15104A661 (Encl. 2 non-public)
2015-04-27	10 CFR 2.206	Dave Beaulieu emails Petition Review Board with background information on valve closure times (greater than 3m)	ML15274A108

Date	Category	Activity	Reference
2015-04-28	10 CFR 2.206	Doug Pickett (project manager) emails Paul Blanch re: Petition Review Board's initial recommendation to reject petition, offers opportunity for second presentation	ML15124A027
2015-04-30	Correspondence / Meetings	NRC, FERC, and U.S. Department of Transportation hold government-to-government meeting with Assemblywoman Sandy Galef re: pipeline	mentioned in ML15251A372 slides received from Region I
2015-05-20	Correspondence / Meetings	Entergy writes to NRC responding to questions raised at 04/30/2020 government-to-government meeting, including Spectra procedures, inline inspections, and idle status of 26-inch pipeline	ML15182A235
2015-05-20	Correspondence / Meetings	NRC holds annual assessment meeting for Indian Point	https://www.nrc.gov/pmns/mtg?do=details&Code=20150737 summary: ML15152A076 Paul Blanch statement: ML15159A609
2015-06-13	Licensee Review / Analysis	Allegation submitted re: pre-existing pipelines	ML15167A444
2015-06-24	Correspondence / Meetings	NRC Chairman Burns writes to Rep. Nita Lowey re: confidence in findings, "worst case" scenarios	ML15159A865 ML15176A589
2015-07-09	10 CFR 2.206	Paul Blanch supplements 10 CFR 2.206 petition re: failure probability of pre-existing gas lines	ML15195A081
2015-07-15	10 CFR 2.206	NRC holds second Petition Review Board meeting regarding 10/15/2014 10 CFR 2.206 petition from Paul Blanch	ML15216A047
2015-07-27	10 CFR 2.206	Paul Blanch writes to Doug Pickett (project manager) with 39 questions to be addressed by PRB	ML15251A050
2015-08-04	Correspondence / Meetings	Assemblywoman Sandy Galef writes to NRC Chairman Burns requesting independent risk assessment including transient risk analysis	ML15232A212
2015-08-27	Licensee Review / Analysis	NRC (Scott) issues Request for Information (RI-2015-A-0074) on gas pipelines	non-public (not in ADAMS)
2015-09-09	10 CFR 2.206	NRC (Miller) rejects 10/15/2014 Paul Blanch petition, finding that issues had been previously resolved	ML15251A023
2015-09-10	Correspondence / Meetings	Paul Blanch meets with NRC Chairman Burns and Commissioners Baran and Ostendorff (September 10-11)	ML15259A047

Date	Category	Activity	Reference
2015-09-25	Correspondence / Meetings	NRC (Satorius) writes to Assemblywoman Sandy Galef re: conservative assumptions, 04/30/2015 meeting	ML15251A372
2015-10-07	Correspondence / Meetings	NRC (McCree) responds to Timothy Judson of Nuclear Information and Resource Service re: Entergy and NRC analyses	ML15253A007
2015-10-12	Correspondence / Meetings	Rick Kuprewicz writes to Sandy Galef re: 09/25/2015 letter to her, need for transient analysis	https://elibrary.ferc.gov/idmws/common/OpenNat.asp?fileID=14016631
2015-10-15	Licensee Review / Analysis	Entergy responds to RI-2015-A-0074, enclosing 10/07/2015 analysis by Risk Research Group, as well as 2008 analysis listed above	non-public (not in ADAMS) - files on CD were not retained [additional safeguards material may exist]
2015-10-27	Correspondence / Meetings	Assemblywoman Sandy Galef writes to NRC (Satorius), attaching 10/12/2015 Rick Kuprewicz letter	https://elibrary.ferc.gov/idmws/common/OpenNat.asp?fileID=14039741
2015-11-06	10 CFR 2.206	NRC (Miller) responds to Paul Blanch's 39 questions re: 10/15/2014 10 CFR 2.206 petition	ML15287A257
2015-11-20	NRC Guidance	NRC/NRR issues OI COM-106, "Control of Task Interface Agreements," Revision 5	ML15219A174
2015-11-30	Correspondence / Meetings	NRC Chairman Burns writes to David Lochbaum re: Regulatory Guide 1.91 and Advisory Committee on Reactor Safeguards man-made hazards working group	ML15258A242
2015-12-07	Correspondence / Meetings	NRC Chairman Burns meets with elected officials near Indian Point	referenced in ML15348A324
2015-12-07	NRC Review / Analysis	NRC/NRO completes confirmatory analyses related to 30-inch pipeline at Indian Point as allegation follow-up	ML16235A166 (pp. 12-15, 47-50,53-56, 59-62 of PDF for various copies of analysis documentation) ML16215A115
2015-12-14	10 CFR 2.206	Paul Blanch responds to Chris Miller re: 11/6/2015 "39 questions" letter	ML15348A324
2015-12-17	AIM / FERC	Paul Blanch contacts Pipeline and Hazardous Materials Safety Administration (PHMSA) administrator re: 49 CFR 192	https://elibrary.ferc.gov/idmws/common/OpenNat.asp?fileID=14126329
2015-12-17	AIM / FERC	Paul Blanch contacts FERC Chairman re: 49 CFR 192	https://elibrary.ferc.gov/idmws/common/OpenNat.asp?fileID=14081851
2016-01-07	Correspondence / Meetings	NRC Chairman Burns writes to Rep. Nita Lowey re: differences of opinion, lack of need for additional risk assessment	ML15355A409
2016-01-21	AIM / FERC	FERC responds to Paul Blanch FOIA re: PHMSA risk analysis (no records)	enclosure in ML16064A007 (non-public)

Date	Category	Activity	Reference
2016-01-21	Correspondence / Meetings	NRC Chairman Burns responds to Assemblywoman Sandy Galef re: planned meeting with Rick Kuprewicz	ML16013A181
2016-01-26	AIM / FERC	Paul Blanch emails PHMSA administrator re: pipeline risk assessment (49 CFR 192)	https://elibrary.ferc.gov/idmws/common/OpenNat.asp?fileID=14126330
2016-02-02	Correspondence / Meetings	NRC and PHMSA meet with Rick Kuprewicz re: pipeline; NRC provides follow-ups with plant information, 2014 10 CFR 50.59 evaluation	meeting summary: ML16036A347 (non-public) 02/17/2016 follow-up email: ML16048A097
2016-02-18	AIM / FERC	PHMSA replies to Paul Blanch re: NY DPS inspections of pipeline, risk analysis	(no reference)
2016-02-18	Correspondence / Meetings	NRC (Krohn) responds to Assemblywoman Sandy Galef re: 12/28/2015 letter requesting NRC staff meeting with Rick Kuprewicz (held 02/02/2016)	ML16042A488
2016-02-25	OIG Inquiry	Paul Blanch writes to NRC Office of the Inspector General (OIG) to request investigation of NRC staff not fulfilling its regulatory responsibilities	provided by Paul Blanch to Dave Skeen 3/8/2020
2016-02-29	AIM / FERC	NY State informs FERC that the Governor directed an independent safety risk analysis of AIM pipeline near Indian Point	https://elibrary.ferc.gov/idmws/common/OpenNat.asp?fileID=14166823
2016-03-11	AIM / FERC	Paul Blanch writes to PHMSA administrator requesting risk analysis	(no reference)
2016-03-22	Correspondence / Meetings	NRC holds government-to-government meeting near Indian Point re: pipeline	slides received from Region I (date estimated)
2016-04-12	Correspondence / Meetings	Paul Blanch holds teleconference with PHMSA staff	https://elibrary.ferc.gov/idmws/common/OpenNat.asp?fileID=14209383
2016-06-08	Correspondence / Meetings	NRC holds annual assessment meeting for Indian Point	ML16176A116
2016-09-12	AIM / FERC	Rick Kuprewicz completes filing (filed 09/21/2016) re: AIM pipeline in FERC court case (DC Circuit Docket No. 16-1081)	https://www.delawareriverkeeper.org/sites/default/files/Safety%20Threats%20Ignored%20Attachment%203%2C%20Declaration%20of%20Richard%20Kuprewicz%2C%20T....pdf
2016-09-16	AIM / FERC	Paul Blanch completes filing (filed 09/21/2016) re: AIM pipeline in FERC court case (DC Circuit Docket No. 16-1081)	http://documents.dps.ny.gov/public/Common/ViewDoc.aspx?DocRefId=%7B226348E4-8AA4-4E5F-B420-141915EE8C1F%7D
2016-10-18	AIM / FERC	Spectra requests FERC to authorize AIM to be placed in service using the pre-existing Hudson River crossings	https://elibrary.ferc.gov/idmws/common/OpenNat.asp?fileID=14379082

Date	Category	Activity	Reference
2016-11-30	Correspondence / Meetings	Paul Blanch emails Rao Tammara to request a meeting re: calculations	ML16336A729
2016-12-23	Correspondence / Meetings	NRC (Boland) responds to Paul Blanch request for meeting	ML16351A187
2018-02-08	NRC Guidance	NRC Commission holds public meeting on potential changes to the 10 CFR 2.206 petition review process	https://www.nrc.gov/reading-rm/doc-collections/commission/tr/2018/
2018-02-20	NRC Guidance	NRC issues Staff Requirements Memorandum re: Management Directive 8.11 updates (SRM-M180208)	ML18051A998
2018-06-22	AIM / FERC	NY State submits executive summary of risk analysis to FERC	ML18176A367 http://documents.dps.ny.gov/public/Common/ViewDoc.aspx?DocRefId=%7B72A21EDA-B822-46D0-8C1E-E873D7F570E8%7D
2018-06-25	AIM / FERC	Paul Blanch writes to FERC Chairman asking for risk assessment required by 49 CFR 192.917	ML18177A401
2018-07-27	AIM / FERC	DC Circuit Court of Appeals issues ruling in City of Boston v. FERC re: AIM pipeline	https://www.ferc.gov/legal/court-cases/opinions/2018/16-1081CITYOFBOSTON.pdf
2018-08-02	AIM / FERC	Enbridge writes to FERC re: New York State letter of 06/22/2018, pipeline safety	https://elibrary.ferc.gov/idmws/common/OpenNat.asp?fileID=14992932
2018-08-16	AIM / FERC	Paul Blanch writes to New York Governor re: Enbridge's statements	https://elibrary.ferc.gov/idmws/common/OpenNat.asp?fileID=15000090
2019-03-01	NRC Guidance	NRC updates Management Directive 8.11 on 10 CFR 2.206 petition reviews	ML18296A043
2020-02-13	OIG Inquiry	NRC OIG issues Event Inquiry 16-024 on gas transmission lines near Indian Point	ML20056F095
2020-02-24	OIG Inquiry	NRC Chairman Svinicki tasks Executive Director for Operations (EDO) in response to OIG Event Inquiry 16-024	ML20057E265
2020-02-26	OIG Inquiry	EDO writes memo to Commission re: no need for immediate regulatory action	ML20058D088
2020-02-27	OIG Inquiry	EDO tasks David Skeen with leading expert evaluation team in response to OIG Event Inquiry 16-024	ML20058E354
2020-03-09	OIG Inquiry	NRC publicly releases evaluation team plan	ML20069A759
2020-03-09	OIG Inquiry	New York Department of Public Service writes to NRC and FERC re: NRC OIG report and 06/22/2018 letter	ML20071F306

Date	Category	Activity	Reference
2020-03-17	OIG Inquiry	Enbridge writes to FERC re: 03/09/2020 New York Senator Harkham letter, OIG report	https://elibrary.ferc.gov/idmws/common/OpenNat.asp?fileID=15486325
2020-03-19	OIG Inquiry	New York Attorney General's office writes to NRC, FERC, and PHMSA re: NRC OIG report	ML20090B533
2020-03-23	OIG Inquiry	Paul Blanch writes to NRC evaluation team leads	ML20086L164
2020-03-26	OIG Inquiry	New York State Public Service Commission writes to NRC evaluation team leads	ML20086L280

Appendix I. Notes

[1] Historical documents conflict on whether the pipeline under the Hudson is 24 inches or 26 inches in diameter. (It is 26 inches in diameter for the portion that crosses the site.) This report uses the 24-inch diameter based on the AIM application, Resource Report 10, Section 10.5.3 (https://elibrary.ferc.gov/idmws/common/OpenNat.asp?fileID=13473930).

[2] In 2018, Spectra Energy was acquired by Enbridge Inc. Uses in this report of Algonquin, Spectra, and Enbridge are interchangeable. https://www.enbridge.com/media-center/news/details?id=123526&lang=en&year=2018

[3] Submitted February 28, 2014; publicly available initial submittal files accessible at https://elibrary.ferc.gov/idmws/file_list.asp?document_id=14190856, with other documents retrievable via FERC's Docket Search for CP14-96.

[4] Submittal dated October 14, 2013, responding to a September 13, 2013, FERC request for scoping comments on a planned environmental impact statement for the AIM pipeline; https://elibrary.ferc.gov/idmws/common/OpenNat.asp?fileID=13369875. This submittal is part of the pre-filing review docket PF13-16. Entergy's submittal notes that the potential for increased safety risks need to be evaluated before the pipeline begins operating. Entergy posed multiple questions regarding the construction and operations of the new pipeline.

[5] https://elibrary.ferc.gov/idmws/common/OpenNat.asp?fileID=13473930

[6] Issued August 6, 2014; https://www.ferc.gov/industries/gas/enviro/eis/2014/08-06-14-eis.asp.

[7] Dated September 29, 2014; https://elibrary.ferc.gov/idmws/file_list.asp?document_id=14255369.

[8] Dated September 30, 2014; https://elibrary.ferc.gov/idmws/file_list.asp?document_id=14255780.

[9] Issued January 23, 2015; https://www.ferc.gov/industries/gas/enviro/eis/2015/01-23-15-eis.asp

[10] https://www.law.cornell.edu/cfr/text/49/part-192/subpart-O

[11] See pp. 4-276 to 4-279 of the final environmental impact statement.

[12] Issued March 3, 2015; https://www.ferc.gov/CalendarFiles/20150303170720-CP14-96-000.pdf.

[13] https://www.eia.gov/todayinenergy/detail.php?id=29032

[14] https://www.nrc.gov/reading-rm/doc-collections/cfr/part050/part050-0059.html

[15] Submitted August 21, 2014. The letter and 10 CFR 50.59 evaluation are publicly available at ADAMS Accession No. ML14245A110. Enclosure 2 to the letter (the Risk Research Group hazards analyses) is available to the NRC staff at ADAMS Accession No. ML12245A111. A redacted version of Enclosure 2 is publicly available at ADAMS Accession No. ML15061A219.

[16] This discussion of rupture isolation (sheets 7 to 8 of the 10 CFR 50.59 evaluation) is the first identification of the "three-minute assumption" discussed multiple times in this document. Specifically, the evaluation states (emphasis added) that: "[t]he existing pipeline automation and control system, which will be used for the proposed new 42 inch pipeline near [Indian Point], does not provide for an automatic isolation of the closest upstream and downstream mainline valves upon the detection of a pipeline rupture. The two closest actuated valves are located at mile post 2.61 on the west side of the Hudson River and at mile post 5.47 just east of [Indian

Point]. They would require an operator to take action to close these valves. The system, however, is monitored 24 hours a day and an alarm would immediately alert the control point operator, located in Houston, Texas, of an event and isolation would be initiated. This would result in all the gas between these valves at the time of closure being able to vent or burn. **The estimated time to respond to the alarm (less than one minute) and the closure time of the valves (about one minute) was used as the basis for an assumed closure time of three minutes for the analysis performed in the attached report** [Enclosure 2]" (emphasis added).

[17] This guidance did not exist at the time the applications were submitted for Indian Point; see note 181.

[18] In the 2015 Entergy submittal (note 19), these frequencies were updated to 1.25×10^{-5} per year per mile and 1.87×10^{-6} 1818per year per mile for generic pipeline and enhanced pipeline, respectively.

[19] Submitted April 8, 2015. The letter and 10 CFR 50.59 evaluation are publicly available at ADAMS Accession No. ML15104A660. Enclosure 2 to the letter (the Risk Research Group hazards analyses) is available to the NRC staff at ADAMS Accession No. ML15104A661.

[20] Submitted September 19, 2016, for Unit 2; ADAMS Accession No. ML16280A161. (Chapter 2 is publicly available at ADAMS Accession No. ML16280A162, and the Chapter 2 figures are publicly available at ADAMS Accession No. ML16280A163.) Submitted October 2, 2017, for Unit 3; ADAMS Accession No. ML17299A163. (Chapter 2 is publicly available at ADAMS Accession No. ML17299A180, and the Chapter 2 figures are publicly available at ADAMS Accession No. ML17299A183.)

[21] Current version issued November 26, 2019; ADAMS Accession No. ML19197A103. The version that was in effect at the time of the Indian Point inspection (issued December 21, 2010) is publicly available at ADAMS Accession No. ML101320542.

[22] Issued November 7, 2014; ADAMS Accession No. ML14314A052

[23] The documentation of the NRC confirmatory analysis dated October 15, 2014, is available to the NRC staff at ADAMS Accession No. ML14329A189. A redacted version is publicly available at ADAMS Accession No. ML15070A086. The regional inspection report "feeder" dated October 30, 2014, is publicly available at ADAMS Accession No. ML14307B748.

[24] Held April 2 and April 23, 2014; https://elibrary.ferc.gov/idmws/file_list.asp?document_id=14209634.

[25] Submitted September 30, 2014; https://elibrary.ferc.gov/idmws/file_list.asp?document_id=14255780.

[26] https://elibrary.ferc.gov/idmws/file_list.asp?document_id=14276308

[27] Issued February 13, 2020; ADAMS Accession No. ML20056F095

[28] ADAMS Accession No. ML20057E265

[29] ADAMS Accession No. ML20058D088

[30] ADAMS Accession No. ML20058E354

[31] ADAMS Accession No. ML20069A759

[32] ADAMS Accession No. ML20078L380

[33] Transcripts available at ADAMS Accession Nos. ML20087M164 and ML20087M178.

[34] Revision 2 issued April 2013; ADAMS Accession No. ML12170A980.

[35] Spectra (now Enbridge) informed Entergy that the pipe would have 0.72-inch wall thickness and be X-70 piping with 70,000 psi yield strength and 82,000 psig minimum tensile strength. The pipe would be procured from vendors who have passed a stringent quality audit, and full-time mill inspection would be performed by Algonquin Gas Transmission during pipe production. Specifications would require additional quality testing and integrity requirements beyond normal standards. These enhancements were discussed in a Spectra Energy (Algonquin Gas Transmission) memorandum to Energy regarding Response to Entergy Document entitled "Pipeline Enhancements Being Evaluated to Mitigate a Pipeline Failure," dated July 29, 2014.

[36] Defined in 49 CFR 192.103; https://www.law.cornell.edu/cfr/text/49/192.903.

[37] Spectra Energy, "Integrity Management Program (IMP) Manual," 09-0000, Revision 11, dated October 10, 2019. This manual is not publicly available, but Enbridge made it available to the team.

[38] "Managing System Integrity of Gas Pipelines," published in 2018. Publicly available from https://www.asme.org/codes-standards/find-codes-standards/b31-8s-managing-system-integrity-gas-pipelines. The team had access to this standard through the NRC's subscription service.

[39] Specified minimum yield strength is defined in 49 CFR 192.3, "Definitions," https://www.law.cornell.edu/cfr/text/49/192.3. For the AIM pipeline near Indian Point, Enbridge specified that the piping would have a 70,000 psi yield strength.

[40] https://www.law.cornell.edu/cfr/text/49/part-192/subpart-J

[41] "Algonquin Incremental Market Pipeline Risk Analysis Report," transmitted from several New York State agencies to the FERC Chairman on June 22, 2018 (see note 129 for a related letter). The report is marked privileged and confidential and may contain Critical Energy Infrastructure Information, as designated by the FERC. It is not available to the public.

[42] See notes 15 and 19.

[43] See note 22.

[44] "Studies for the Requirements of Automatic and Remotely Controlled Shutoff Valves on Hazardous Liquids and Natural Gas Pipelines with Respect to Public and Environmental Safety," ORNL/TM-2012/411, dated October 31, 2012; https://www.phmsa.dot.gov/sites/phmsa.dot.gov/files/docs/technical-resources/pipeline/16701/finalvalvestudy.pdf

[45] Regulatory Guide 1.91 does not include any guidance on calculating heat fluxes associated with blasts. The guide assumes that overpressurization is the limiting scenario.

[46] 68 FR 69778, issued December 15, 2003; https://www.govinfo.gov/link/fr/68/69817. Additional information on this rule can be found in the docket folder at https://www.regulations.gov/docket?D=PHMSA-RSPA-2000-7666.

[47] Dated October 2000; https://www.regulations.gov/document?D=PHMSA-RSPA-2000-7666-0049.

[48] See note 44

[51] Published September 1983; ADAMS Accession No. ML062260290.

[52] Response to a Request for Additional Information regarding Order EA-12-049 and Order EA-12-051, dated December 2, 2016; ADAMS Accession No. ML16350A103.

[53] Indian Point Unit 3 Individual Plant Examination, dated June 1994; ADAMS Accession No. ML110320477

[54] Letter from J. Knubel, NY Power Authority to NRC on Indian Point, Unit 3, Transmittal of Individual Plant Examination of External Events (IPEEE); ADAMS Accession No. ML11227A102

[55] See note

[56] IMC-0609 issued January 2019; ADAMS Accession No. ML18187A187

[57] Revision 3 issued January 2018; ADAMS Accession No. ML17317A256

[58] UFSAR Section 16.2; ADAMS Accession No. ML17299A229

[59] From PHMSA Gas Distribution Incident Data - January 2010 to present (ZIP); https://www.phmsa.dot.gov/data-and-statistics/pipeline/distribution-transmission-gathering-lng-and-liquid-accident-and-incident-data

[60] 77 FR 41454, issued July 13, 2012; https://www.govinfo.gov/content/pkg/FR-2012-07-13/pdf/2012-17110.pdf

[61] FSAR for HI-STORM 100; ADAMS Accession No. ML081350153

[62] https://www.nrc.gov/reading-rm/doc-collections/cfr/part050/part050-0009.html

[63] https://www.nrc.gov/reading-rm/doc-collections/cfr/part050/part050-0005.html

[64] 10 CFR 2.206 Petition Review Board, RE: Indian Point Nuclear Generating Unit, Docket No. 50-247, Transcript, (July 15, 205), p. 14, 16.

[65] The petitioner raised this issue during his interview with the team, as well in multiple instances of correspondence with the NRC.

[66] *See* Enforcement Manual, Part II-1: General Topics, Section 1.5.

[67] Submitted October 15, 2014; ADAMS Accession No. ML14294A751.

[68] Concerns with issues related to the petition that were handled in other NRC processes are addressed in Section 5. This section focuses on the 10 CFR 2.206 petition process.

[69] A transcript of the January 28, 2015, meeting is available ADAMS Accession No. ML15044A459.

[70] A transcript of the July 15, 2015, meeting is available at ADAMS Accession No. ML15216A047.

[71] Submitted July 27, 2015; ADAMS Accession No. ML15251A050.

[72] Petition rejection issued September 9, 2015; ADAMS Accession No. ML15251A023. Response to 39 questions issued November 6, 2015; ADAMS Accession No. ML15287A257.

[73] Enforcement Petition Process brochure dated March 2019; ADAMS Accession No. ML19070A037.

[49] See note 41

[50] See Note 19

[74] Based on the team's review, the newly modified process would have been unlikely to result in material change in the outcomes. As a result, the team focused on how the current process could be improved to address the concerns identified by OIG Event Inquiry (see note 27).

[75] Management Directive 8.11, "Review Process for 10 CFR 2.206 Petitions," issued March 1, 2019; ADAMS Accession No. ML18296A043.

[76] "Desktop Guide: Review Process for 10 CFR 2.206 Petitions," effective March 1, 2019; ADAMS Accession No. ML18176A147

[77] Unsupported assertions, general opposition to nuclear power, the identification of safety issues without seeking enforcement action fall outside the 10 CFR 2.206 petition process. Other processes that could be triggered include allegation reviews or investigations by the NRC Office of Investigations or OIG.

[78] The office coordinator is selected from the NRC office responsible for regulating the licensee (e.g., NRR for an operating reactor).

[79] The PRB may include a representative from the Office of Investigations and a cognizant office enforcement coordinator.

[80] Desktop Guide, Appendix B, Section III.C.

[81] Desktop Guide, Appendix B, Section III.C – III.D.

[82] Desktop Guide, Appendix B, Section III.D.1.a.

[83] "Significant" information means that the information is sufficiently great or important to be worthy of attention and that the information is real and not speculative. The information must also be "new" in that the NRC staff has not previously received and/or evaluated the information in response to the issue raised in the petition (which includes any prior resolutions of the issue). The term "significant new information" means that the information is both significant and new. Desktop Guide, Appendix B, Section III.D.1.b. n. 1.

[84] The PRB chairperson informs the office director or designee of its initial assessment.

[85] Some limited exceptions to the public meeting requirement may apply. See Management Directive 3.5, "Attendance at NRC Staff-Sponsored Meetings," issued December 4, 2019; ADAMS Accession No. ML19350A643.

[86] Desktop Guide, Appendix B, Section III.H.3.

[87] A Director's Decision is the official agency response to a 2.206 petition that is accepted for review. The Director's Decision may grant, partially grant, or deny the action requested by the petitioner. In most cases, the staff prepares a proposed Director's Decision, which is transmitted to the petitioner and licensee for comment. After receiving any comments, the staff dispositions the comments and revises the Director's Decision as appropriate. The director's decision is then issued and a notice of issuance is subsequently published in the Federal Register. Desktop Guide, Appendix B, Section V.

[88] Desktop Guide, App. B, p.2. The Commission will not entertain a request for review of the office director's decision. *Id.*

[89] See note 67. 10 CFR 2.206 Petition Review Board, RE: Indian Point Nuclear Generating Unit, Docket No. 50-247, Transcript, (July 15, 205), p. 14, 16.

[91] See note .

[92] A security-related summary of this analysis is available to the NRC staff at ADAMS Accession No. ML15078A067. Images of portions of the analysis are included in this report as Figure 11 and Figure 12.

[93] Information provided by the petitioner on these meetings is available to the NRC staff at ADAMS Accession No. ML15259A047.

[94] Volume 8, Licensee Oversight Programs Review Process for 10 CFR 2.206 Petitions Handbook 8.11 Part II, p. 9. Similar criteria for rejecting a petition continue to appear in the current guidance for evaluating 10 CFR 2.206 petitions.

[95] Issued March 18, 2020; available to the NRC staff at ADAMS Accession No. ML20066J085.

[96] Training slides are available to the NRC staff at ADAMS Accession No. ML20070M965.

[97] NRR-COM-106, issued November 20, 2015; ADAMS Accession No. ML15219A174.

[98] In the case of the 10 CFR 50.59 inspection for Indian Point, the inspector recalled the analyst taking a couple of months to respond. This level of effort probably warranted a Task Interface Agreement.

[99] Desktop Guide on 2.206, Appendix B, p. 8.

[100] The petition manager "[b]riefs the petition review board on the petitioner's request(s), any background information, the need for an independent technical review, and a proposed plan for resolution, including target completion dates." Volume 8, Licensee Oversight Programs Review Process for 10 CFR 2.206 Petitions Handbook 8.11 Part I, p. 4.

[101] Filing dated June 15, 2012; ADAMS Accession No. ML12167A524.

[102] Copies of the ALOHA runs and hand calculations were returned to the technical reviewer during the team's review.

[103] Staff Responses to Public Comments on Regulatory Guide 1.91, Revision 2, issued April 26, 2013; ADAMS Accession No. ML12170A987.

[104] See note .

[105] Given the short timeframe for the team's activities, the team decided not to review any NRC staff who were involved with these issues but had subsequently retired. OIG interviewed some of these individuals, including the licensing project manager referenced as "NRC's primary communicator with FERC."

[106] The team observes that the AIM pipeline does *not* cross Indian Point property. See Figure 4 for an overview of the AIM pipeline in yellow.

[107] Management Directive 5.1, issued April 5, 1993; ADAMS Accession No. ML041770442.

[108] 10 CFR 51.29(a)(7); https://www.nrc.gov/reading-rm/doc-collections/cfr/part051/part051-0029.html.

[90] 10 CFR 2.206 Petition Review Board, RE: Indian Point Nuclear Generating Unit, Docket No. 50-247, Transcript, (July 15, 205), p. 23. For a comparison of the ALOHA calculations with the analysis performed by Sandia as part of this team's activities, refer to Section 2 and **Error! Reference source not found.**.

[109] 73 FR 55546, published September 25, 2008; https://www.federalregister.gov/documents/2008/09/25/E8-22528/notice-of-availability-of-memorandum-of-understanding-between-us-army-corps-of-engineers-and-us

[110] Effective in April 2018; https://www.whitehouse.gov/wp-content/uploads/2018/04/MOU-One-Federal-Decision-m-18-13-Part-2-1.pdf. The NRC is not a party to this memorandum of understanding but is addressing certain aspects of the referenced Executive Order in its environmental review practices, as appropriate.

[111] See note 19.

[112] See note 23.

[113] See note 15.

[114] See note 92.

[115] Zalosh, R.G., SFPE Handbook of Fire Protection Engineering, 2nd Edition, "Explosion Protection," Society of Fire Protection Engineers (SFPE), Boston, MA, June 1995.

[116] See note 12.

[117] See note 26.

[118] The meeting summary conclusion is: "Based on its review, the NRC came to the same conclusion that Entergy did in its 50.59 submission. Therefore, NRC finds Entergy's 50.59 submission acceptable and has determined that no prior approval from the NRC is needed."

[119] The November 2014 NRC inspection report concludes that "**Entergy's conclusions** involving the potential rupture of the proposed pipeline near [Indian Point] poses **no threat to safe operation of the plant or safe shutdown of the plant**, are reasonable and acceptable, and are also comparable with the staff's conclusions" (emphasis added). Other NRC documents, including the response to the petitioner's 39 questions in November 2015 (see note 72), did include looser uses of "safe operation."

[120] 10 CFR 50.2: "*Safety-related structures, systems and components* means those structures, systems and components that are relied upon to remain functional during and following design basis events to assure: (1) The integrity of the reactor coolant pressure boundary[;] (2) The capability to shut down the reactor and maintain it in a safe shutdown condition; or (3) The capability to prevent or mitigate the consequences of accidents which could result in potential offsite exposures comparable to the applicable guideline exposures set forth in § 50.34(a)(1) or § 100.11 of this chapter, as applicable." https://www.nrc.gov/reading-rm/doc-collections/cfr/part050/part050-0002.html

[121] The reference to "important to safety" SSCs in Regulatory Guide 1.91 complicates matters somewhat. The guide's intent is not clear for this reference. The NRC does not define important to safety in its requirements, other than in the general statement in the introduction to 10 CFR Part 50, Appendix A, "General Design Criteria": "structures, systems, and components that provide reasonable assurance that the facility can be operated without undue risk to the health and safety of the public."[121] There has been significant discussion of this definition and how it differs from (is broader than) the definition of "safety-related" over the decades since this regulation was issued (after the construction permits were issued for Indian Point Units 2 and 3). Licensees have taken individual approaches to defining important-to-safety SSCs for their facilities. In its 2015 final 10 CFR 50.59 evaluation, Entergy listed "important to safety" equipment or structures that could

be affected by pipeline ruptures: the switchyard, diesel fuel tank, meteorological tower, and emergency operations facility. The team did not question Entergy's classification of these as "important to safety," but the team did not follow up on whether Entergy treats all of these as such (e.g., analyzing them against dynamic effects under General Design Criterion 4) or is required to depending on the Indian Point licensing basis. The team agrees, however, with Entergy's conclusion that loss of these, while not ideal, is either analyzed (in the case of the switchyard, which would cause a loss of offsite power) or could be mitigated by backups (the diesel fuel tank has a tanker truck backup, and the meteorological tower and emergency operations facility that both have backup facilities). These SSCs could be analyzed for missile impacts, but since they were already considered lost because of overpressure or heat flux, that does not seem necessary.

[122] For example, tornadoes at Indian Point Unit 2 were not evaluated in detail at initial licensing, but were considered in the hearings discussed in Section A.4 of Appendix A to this report. The Commission determined that only a wind evaluation of certain equipment and structures was needed.

[123] ADAMS Accession No. ML20086L280.

[124] ADAMS Accession No. ML20086L164

[125] Not yet publicly available at the time this report was finished; available to the NRC staff at ADAMS Accession No. ML20090B533.

[126] Not yet publicly available at the time this report was finished; available to the NRC staff at ADAMS Accession No. ML20084M363.

[127] Not yet publicly available at the time this report was finished; available to the NRC staff at ADAMS Accession No. ML20087M278.

[128] Not yet publicly available at the time this report was finished; available to the NRC staff at ADAMS Accession No. ML20071F306.

[129] Dated June 22, 2018; ADAMS Accession No. ML18176A367.

[130] Dated November 30, 2015; ADAMS Accession No. ML15258A242.

[131] The "amended and substituted application" submitted on December 5, 1960, is the likely source of this map. It is available to the NRC staff at ADAMS Accession No. ML110690359. Exhibit H-13 is separately available at ADAMS Accession No. ML093220861.

[132] Available to the NRC staff at ADAMS Accession No. ML110590360.

[133] Issued February 21, 1962; available to the NRC staff at ADAMS Accession No. ML111510462.

[134] DPR-5 issued on March 26, 1962; available to the NRC staff at ADAMS Accession No. ML100330629.

[135] By 1965, this paragraph had been revised to include "as amended" at the end. (ADAMS Accession No. ML110480269 shows the updated paragraph.) Later, the proposed technical specifications for the full-term operating license were even more explicit: "The transmission and distribution of natural gas shall be through the use of facilities located as described in U.S. Atomic Energy Commission Docket No. 50-3, Exhibit H-14." (ADAMS Accession No. ML100601013)

[136] Additional context for this paragraph can be found in the transcript of the Commission hearing (hearing held January 3, 1962; available to the NRC staff at ADAMS Accession No. ML100082152).

Dr. Bryan of the AEC Division of Licensing and Regulation was asked about changes the applicant made regarding activities on the site. He stated that "[i]n the application, the only description of activities connected with the use of handling of natural gas had to do with the transmission of natural gas through a line which traverses the site. We have not had any, we have not had presented to us any evaluation of the hazards that might be involved in utilization, in any further utilization of such facilities than that described in the application." The focus of the discussion appears to be on the potential hazards of "distribution and utilization" of natural gas onsite (e.g., if the licensee wanted to use the natural gas to supply a power plant onsite), not the transmission pipeline itself that the AEC staff was aware of and on which it was making its findings.

Also, the AEC staff sent a brief on, that provided input for the licensing order (dated February 5, 1962; available to the NRC staff at ADAMS Accession No. ML111510466). In this brief, the staff noted that it had proposed an amendment to technical specifications Section A.3 "in order to assure that any expansion of such activities [related to natural gas], not presently in the application will be subject to Commission review under the change procedure set forth" in the license. This change procedure was similar to 10 CFR 50.59, "Changes, tests, and experiments," which did not become effective until July 1962 (27 FR 5491). It enabled the licensee to make certain changes to the Hazards Summary Report (analogous to the FSAR) if they did not involve an unreviewed safety question—i.e., if the probability of occurrence of an analyzed accident did not increase, if the consequences of an analyzed accident did not increase, and if the change did not create a credible probability of a different type of nuclear accident than those analyzed. If the change would affect the technical specifications (Appendix A of the license) then AEC approval would be needed.

[137] Later changed to a minimum of 1400 feet "from the reactor facility to the nearest land boundary of the exclusion area." ADAMS Accession No. ML0112500379.

[138] Dated October 23, 1964; available to the NRC staff at ADAMS Accession No. ML110590225.

[139] Available to the NRC staff at ADAMS Accession No. ML110490188.

[140] Dated November 10, 1969; available to the NRC staff at ADAMS Accession No. ML100080840.

[141] The General Design Criteria now appear as Appendix A to 10 CFR Part 50 and are part of the application requirements for reactor licenses. At the time, they existed as a proposed rule (32 FR 10213).

[142] Available to the NRC staff at ADAMS Accession No. ML111370488.

[143] A 1979 petition from the Union of Concerned Scientists resulted in NRC action that effectively (if not formally) revoked the Unit 1 operating license. Section A.3 has more information on this petition.

[144] Submitted December 16, 1965; ADAMS Accession No. ML093520917 (transmittal letter; PSAR chapters are in separate documents).

[145] ADAMS Accession No. ML102460284

[146] ADAMS Accession No. ML073240146. The second page of this document notes that it reflects the October 1968 submittal through Supplement 15 in November 1970, with certain sensitive information redacted.

[147] ADAMS Accession No. ML072260449

[148] Submitted April 26, 1967; ADAMS Accession No. ML100250264 (transmittal letter; PSAR chapters are in separate documents)

[149] ADAMS Accession No. ML093480188

[150] Submitted August 30, 1968; ADAMS Accession No. ML093480204. The evaluation begins on p.253 of the file: Item 7 of Supplement 1 to the Indian Point Unit 3 PSAR. The PSAR is part of the application to the AEC for a construction permit.

[151] ADAMS Accession No. ML100261033

[152] This quotation is from Amendment 13 to the FSAR, submitted December 4, 1970, available to the NRC staff at ADAMS Accession No. ML093480359.

[153] ADAMS Accession No. ML072260465

[154] ADAMS Accession No. ML031080517

[155] The FSAR was submitted on July 22, 1982. It is not publicly available but is available electronically to NRC staff; Chapter 2 is ADAMS Accession No. ML100350907.

[156] The FSAR was submitted in July 20, 1984. It is not publicly available but is available electronically to NRC staff; Chapter 2 is ADAMS Accession No. ADAMS Accession No. ML100431991

[157] The October 20, 2008, transmittal letter is publicly available at ADAMS Accession No. ML083390108. The FSAR is not publicly available but is available electronically to NRC staff. (Chapter 2 is ADAMS Accession No. ML083390226 and the Chapter 2 figures are ADAMS Accession No. ML083390227.)

[158] The October 6, 2010, transmittal letter is publicly available at ADAMS Accession No. ML11280A140. The FSAR is not publicly available but is available electronically to NRC staff. (Chapter 2 is ADAMS Accession No. ML11280A135 and the Chapter 2 figures are ADAMS Accession No. ML11280A136.)

[159] The July 14, 1982, transmittal letter is publicly available at ADAMS Accession No. ML093380878. The FSAR is not publicly available but is available electronically to NRC staff. (Chapter 2 is ADAMS Accession No. ML20055A765.)

[160] The October 13, 2009, transmittal letter is publicly available at ADAMS Accession No. ML093430690. The FSAR is not publicly available but is available electronically to NRC staff. (Chapter 2 is ADAMS Accession No. ML093430729 and the Chapter 2 figures are ADAMS Accession No. ML093430731.)

[161] FSAR Reference 1: IP-[RPT]-08-00032, "Consequences of Fire and Explosion Following the Release of Natural Gas from Pipelines Adjacent to Indian Point", by David Allen, Risk Research Group, August 2008.

[162] The FSAR was submitted on October 1, 2015. It is not publicly available but is available electronically to NRC staff. (Chapter 2 is ADAMS Accession No. ML15293A108 and the Chapter 2 figures are ADAMS Accession No. ML15293A109.)

[163] Issued February 11, 1980; available to the NRC staff (without enclosures) at ADAMS Accession No. ML100290756.

[164] Issued May 30, 1980; available to the NRC staff at ADAMS Accession No. ML100150748.

[165] The task force issued its results as NUREG-0715, "Task Force Report on Interim Operation of Indian Point," in August 1980 (available to the NRC staff at ADAMS Accession No. ML19344F216), concluding that was the overall risk of the Indian Point reactors was about the same as the typical reactor on a typical site. The task force report does not mention the natural gas pipelines. This report supported a Commission decision that the units could continue to operate during the adjudicatory proceeding, but the Commission noted that it would not "turn a decision on interim operation into a final decision on the long-term acceptability [of] the Indian Point site."

[166] Dated January 8, 1981, and September 18, 1981; available to the NRC staff at ADAMS Accession Nos. ML19340E920 and ML20039A702, respectively.

[167] Available to the NRC staff at ADAMS Accession No. ML20081A330.

[168] CLI-85-06, issued May 7, 1985; legacy ADAMS Accession No. 8505090592 (not available electronically to the NRC staff)

[169] ADAMS Accession No. ML003778131

[170] Submitted March 5, 1982; ADAMS package Accession No. ML093430890

[171] ADAMS Accession No. ML102520202 (part of package referenced in Note 170)

[172] United Engineers and Constructors was the principal subcontractor to Westinghouse as the architect-engineer of Indian Point.

[173] Submitted August 25, 1982; available to the NRC staff at ADAMS Accession No. ML100200464. (This version is marked as a draft.)

[174] NUREG/CR-2934, "Review and Evaluation of the Indian Point Probabilistic Safety Study," dated December 1982. ADAMS Accession No. ML091540534.

[175] Dr. Budnitz was an expert in the area of probabilistic risk assessment. He had served for two years as the director of the NRC Office of Nuclear Regulatory Research. Among other activities as an independent consultant, he was part of an independent advisory body to the NRC that reviewed the pioneering WASH-1400 Reactor Safety Study to describe how risk assessment methodology could be used in the NRC review process.

[176] Written testimony submitted January 24, 1983; available to the NRC staff at ADAMS Accession Nos. ML20070N197. Hearing held February 10, 1983; transcript available to the NRC staff at ADAMS Accession No. ML20064N013.

[177] During the hearing, Dr. Budnitz was asked if he was aware that there was a 13.8 kilovolt underground cable from the Buchanan substation to the plant that was extrinsic to those power sources; he said he was not. Presumably this line was perceived by the Board as a backup to the overhead transmission lines.

[178] ADAMS Accession No. ML051400209

[179] ADAMS Accession No. ML093430606

[180] Only an internal input to the safety evaluation was readily available to the team (ADAMS Accession No. ML093450337). The transmittal file for the final safety evaluation (available to the NRC staff at ADAMS Accession No. ML093430874) did not include an enclosure.

[181] For example, the following guidance documents issued after the initial licensing of the Indian Point units address natural gas pipelines in various ways. Regulatory Guide 1.70 on format and

Review Plan, issued for the first time in 1975 (ADAMS Accession No. ML081510817). Sections 2.2.1 and 2.2.2 of the Standard Review Plan noted that "[t]he problems of pipeline rupture and other flammable gas releases are reviewed on an individual case basis by evaluating analyses provided by the applicant, and may also involve independently checking the gas cloud size and TNT equivalency derived by the applicant." The AEC provided related guidance to applicants and licensees in Regulatory Guide 1.91, "Evaluation of Explosions Postulated To Occur on Transportation Routes Near Nuclear Power Plant Sites," issued in January 1975 (ADAMS Accession No. ML12298A133). The introduction of the 1975 edition was clear that it was focused on materials carried over transportation routes "not including gases." The NRC revised the guidance in February 1978 (ADAMS Accession No. ML003840286) to be even more clear about its scope: "This guide is limited to solid explosives and hydrocarbons liquified under pressure and is not applicable to cryogenically liquified hydrocarbons, e.g., LNG. It considers the effects of airblasts on highway, rail, and water routes but excludes pipelines and fixed facilities." This Revision 1 does not reference gases at all. Not until 2011 did the NRC issue draft guidance (DG-1270) that addressed pipeline explosions specifically (ADAMS Accession No. ML110390554). This guidance was finalized in 2013 as Revision 2 to Regulatory Guide 1.91 (ADAMS Accession No. ML12170A980).

[182] Generic Letter 88-20, Supplement 4, "Individual Plant Examination of External Events (IPEEE) for Severe Accident Vulnerabilities - 10CFR 50.54(f)," dated June 28, 1991. https://www.nrc.gov/reading-rm/doc-collections/gen-comm/gen-letters/1988/gl88020s4.html

[183] SECY-90-343, "Status of the Staff Program to Determine How the Lessons Learned from the Systematic Evaluation Program Have Been Factored into the Licensing Bases of Operating Plants," dated October 4, 1990. Available to the NRC staff at ADAMS Accession No. ML19324H923.

[184] Submitted December 6, 1995; ADAMS Accession No. ML11227A100.

[185] The team reviewed 10 CFR 50.59 annual reports from 1980 through 1997 for Indian Point Units 2 and 3 and could not find a disposition of this change with respect to docketed correspondence for Units 1 and 3 (see notes and).

[186] Memo dated May 14, 1999; ADAMS Accession No. ML090130608.

[187] Submitted September 26, 1997; ADAMS Accession No. ML11227A102.

[188] Memo dated December 15, 2000; available to the NRC staff at ADAMS package Accession No. ML003780825.

[189] Letters dated April 23, 2008, and September 30, 2008, are not in ADAMS but were made available to the team. The September letter included a security-related enclosure dated August 14, 2008, that is available to the NRC staff at ADAMS Accession No. ML103140627. This is the same analysis that was referenced in the 2009 revision to the Indian Point Unit 3 FSAR (see Section 0 of this report).

[190] Letter dated October 15, 2015, is not in ADAMS but was made available to the team. The referenced "2015 Report" was not available to the team but was discussed in detail in the attachment to the letter.

content for safety analysis reports (reactor license applications) was not issued until 1972 (ADAMS Accession No. ML13350A353). This document standardized the format of applications submitted after that time. Section 2.2.3 of Regulatory Guide 1.70, Revision 0, states "[i]f large natural gas pipelines cross, or pass close to the nuclear plant, explosions from this source should be evaluated." The NRC staff's review of later applications was conducted under the Standard

[191] For example, Entergy states that the metal siding on the Unit 3 fuel storage building could be damaged by the heat flux, but the building has been evaluated for the effects of siding damage and fires, and the reinforced concrete spent fuel pool would not be affected.

[192] Memo dated April 25, 2003; ADAMS Accession No. ML11223A040. The non-public enclosure is available to the NRC staff at ADAMS Accession No. ML031210213.

[193] See Note 51.

[194] Submitted October 25, 2010; ADAMS Accession No. ML103020293. The non-public version is available to the NRC staff at ADAMS Accession No. ML102990527.

[195] An internal memo dated March 23, 2011, referencing these reviews is publicly available at ADAMS Accession No. ML11223A041. Detailed information is available to the NRC staff at ADAMS Accession Nos. ML110750113 (March 23, 2011, memo) and ML110700162 (March 7, 2011, input memo), as well as in a safeguards report that the team reviewed.

[196] Letter dated March 31, 2011; ADAMS Accession No. ML110890309

[197] UFSAR Section 16.2; ADAMS Accession No. ML17299A229

[198] From PHMSA Gas Distribution Incident Data - January 2010 to present (ZIP); https://www.phmsa.dot.gov/data-and-statistics/pipeline/distribution-transmission-gathering-lng-and-liquid-accident-and-incident-data

[199] "Potential impact radius" is defined in DOT regulations at 49 CFR 192.903 as the radius of a circle within which the potential failure of a pipeline could have significant impact on people or property. PIR is determined by the formula r = 0.69* (square root of (p*d 2)), where "r" is the radius of a circular area in feet surrounding the point of failure, "p" is the maximum allowable operating pressure (MAOP) in the pipeline segment in pounds per square inch and "d" is the nominal diameter of the pipeline in inches. The 0.69 constant is the applicable value for natural gas.

From: Dennis, Suzanne
To: Mohmand, Jamal Ahmed
Subject: RE: RE: RE: [EXTERNAL] Comments/Clarifications on Draft Report
Date: Tuesday, March 31, 2020 11:24:00 AM
Attachments: image001.png

Great; thank you!

From: Mohmand, Jamal Ahmed <jamohma@sandia.gov>
Sent: Tuesday, March 31, 2020 11:23 AM
To: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Subject: [External_Sender] RE: RE: [EXTERNAL] Comments/Clarifications on Draft Report

Yup I understand now and I do agree with those values for the NRC report.

Jamal

From: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Sent: Tuesday, March 31, 2020 9:20 AM
To: Mohmand, Jamal Ahmed <jamohma@sandia.gov>
Subject: RE: RE: [EXTERNAL] Comments/Clarifications on Draft Report

Hey Jamal,

I added it to the main body of the report, which you haven't seen yet. I just wanted to get your verification on those numbers.

Those values in the table should remain for sure.

Is that more clear?
Suzanne

From: Mohmand, Jamal Ahmed <jamohma@sandia.gov>
Sent: Tuesday, March 31, 2020 11:11 AM
To: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Subject: [External_Sender] RE: [EXTERNAL] Comments/Clarifications on Draft Report

Hi Suzanne,

I'm not seeing where I discuss a heat flux at roughly 2320 feet. There is a short discussion about a heat flux of 44 kW/m^2 at 1580 feet (SOCA fence) at the bounding mass flow rate.

The table does reflect that at 2320 feet (roughly 700 meters) that the heat flux would be 11 kW/m^2 at the Nominal flow rate and 21 kW/m^2 at the bounding flow rate. This is a slight correction to what was sent to the team previously, only at this distance. Should these value remain or be removed from the Appendix altogether?

Table A-1: Incident Radiation at Various Distances and Mass Flow Rates

Case	Distance (m)	Mass Flow Rate (kg/s)	Radiated Power (kW)	Fire Diameter (m)	Transmissivity	Incident Radiation (kW/m^2)
Sample	482	N/A	N/A	N/A	N/A	N/A
	700	N/A	N/A	N/A	N/A	N/A
	500	1700	4.09E+07	295	0.7	19.6
	1000				0.63	4.6
	1500				0.57	2.0
Nominal	482	1940	4.57E+07	312	0.7	23.6
	500				0.7	22.1
	700				0.65	~~9.6~~10.9
	1000				0.63	5.3
	1500				0.57	2.2
Bounding	482	4000	9.61E+07	452	0.7	44.1
	500				0.7	41.5
	700				0.65	~~19.9~~21.4
	1000				0.63	10.7
	1500				0.57	4.4

Thanks,
Jamal

From: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Sent: Monday, March 30, 2020 7:07 PM
To: Luketa, Anay <aluketa@sandia.gov>; Mohmand, Jamal Ahmed <jamohma@sandia.gov>; LaFleur, Chris <aclafle@sandia.gov>
Cc: Sanborn, Scott Edward <sesanbo@sandia.gov>
Subject: [EXTERNAL] Comments/Clarifications on Draft Report

Hi SNL team,

Thanks again for all of your help on this! We are so glad to have your expertise!

On report

- Page 3: "ALOHA is not capable of modeling...congestion" I thought this was an option? Is it not? Please clarify.
- Page 3 states that ALOHA is not appropriate for this kind of application. Can you add a quick description on when ALOHA is appropriate, if at all (like for very bounding applications)?
- Page 4 states "yields as high as 50% have been recorded," can you add a reference there?
- Under "duration of release on page 5," First sentence needs edit: "The amount of mass used in equation 1 **will determine by** the duration...:"
- Last sentence, second para, page 6 needs edit: "if it behaves as a dense gas which will greatly **extent** the time"
- Figure 9: please split into separate figures and note minute represented
- Add foot measurements to Appendix A
- A question I forgot to ask today (or can't remember the question if I did): Do you have an idea of

overpressure if ignition occurred within 1-minute after rupture?

- If pipe rupture is occurring in a crater, does that change the results? When we talked to accident experts at PHMSA today, they said that typically the super-critical, high mass flow would be expected before the pipe exploded to the surface, but once it pushed through the dirt, it would become buoyant.
- Also, our discussion with the PHMSA experts reminded me that we should probably state somewhere that your boundary condition calculation assumed the equivalent of an above-ground break, correct?
- Explosions away from the rupture site or blast impacts at a longer distance than the heat-affected area have not been seen by the PHMSA accident experts, either in accidents or from controlled blowoff valves (which would not have the turbulent effects of two pipe segments facing each other) - anything that could explain why this phenomenon has not been seen in real life? *Steve is going to try and set-up a phone call with the investigator that looked at the Florida rupture to talk about the cloud.*
- Jamal – the report currently states: "closest safety-related structure [2320 ft] would be 11 kW/m^2 for a mass flow rate of 1940 kg/s. For a bounding flow rate of 4000 kg/s, the heat flux would be 21 kW/m^2." Can you verify but not add to report.

Let me know if you have any questions about any of these.

We got Steve a copy of the report tonight (he was having trouble accessing BOX), so we might need to meet-up tomorrow if he has any questions. We're hoping to have the draft copy of the whole report to you all by tomorrow. I know it will be a tight turnaround to review (for me too!).

Thanks again,
Suzanne

Suzanne Dennis
Office of Research
U.S. NRC
301-415-0760

From: Dennis, Suzanne
To: Mohmand, Jamal Ahmed
Subject: RE: RE: RE: [EXTERNAL] Bio
Date: Monday, March 30, 2020 10:09:00 AM

Thank you!

From: Mohmand, Jamal Ahmed <jamohma@sandia.gov>
Sent: Monday, March 30, 2020 10:06 AM
To: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Subject: [External_Sender] RE: RE: [EXTERNAL] Bio

Member of the Technical Staff

From: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Sent: Monday, March 30, 2020 7:49 AM
To: Mohmand, Jamal Ahmed <jamohma@sandia.gov>
Subject: RE: RE: [EXTERNAL] Bio

What's your official title?

From: Mohmand, Jamal Ahmed <jamohma@sandia.gov>
Sent: Friday, March 27, 2020 3:57 PM
To: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Subject: [External_Sender] RE: [EXTERNAL] Bio

Mr. Mohmand graduated from Texas A&M University with a Bachelor of Science in Radiological Health Engineering in 2017. Mr. Mohmand has several years of experience of building Fire PRA models. In particular Plant Partitioning, Ignition Frequency, Fire Scenario Selection, Quantification, Uncertainty Analysis, and model integration. Mr. Mohmand has helped build and maintain several FPRA models at plants across the country. Mr. Mohmand has participated in peer reviews, plant walkdowns, significance determination process responses, and requests for additional information in regards nuclear probabilistic risk models.

Thanks,
Jamal

From: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Sent: Friday, March 27, 2020 1:37 PM
To: Mohmand, Jamal Ahmed <jamohma@sandia.gov>
Subject: [EXTERNAL] Bio

Hey Jamal,

Can you send me a quick (one paragraph-ish) bio that we can include in the report?

Thanks!
Suzanne

Suzanne Dennis
Office of Research
U.S. NRC
301-415-0760

From: Dennis, Suzanne
To: "Luketa, Anay"; "Sanborn, Scott Edward"; Mohmand, Jamal Ahmed; "LaFleur, Chris"
Subject: FYI: Coming Soon - Draft Report
Date: Monday, March 30, 2020 9:20:00 AM

FYI, we are working on our report draft. We hope to have it up on the BOX site for you and PHMSA to review within the next day. We'll be asking for your edits/comments within a day or two of that time, so we can get our report to our Executive Director for Operations this week.

Thanks again for all of your help!

Talk to you soon,
Suzanne

From: Sanborn, Scott Edward
To: Dennis, Suzanne; IP Expert Eval Team; Nanney, Steve (PHMSA); Luketa, Anay; Mohmand, Jamal Ahmed; LaFleur, Chris; Glover, Austin Michael; Skeen, David; Clark, Theresa
Subject: [External_Sender] RE: [EXTERNAL] IP Expert Full Team Meeting
Date: Thursday, March 26, 2020 3:08:02 PM

All,

SNL's draft memo documenting the independent evaluation has been uploaded to the BOX site.

Thanks,
Scott

-----Original Appointment-----
From: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Sent: Thursday, March 26, 2020 12:17 PM
To: IP Expert Eval Team; Nanney, Steve (PHMSA); Sanborn, Scott Edward; Luketa, Anay; Mohmand, Jamal Ahmed; LaFleur, Chris; Glover, Austin Michael; Skeen, David; Clark, Theresa
Subject: [EXTERNAL] IP Expert Full Team Meeting
When: Monday, March 30, 2020 2:00 PM-3:00 PM (UTC-05:00) Eastern Time (US & Canada).
Where: Skype Meeting

Hi all,

We wanted to get the whole team together (including SNL and PHMSA) to go over Sandia's independent evaluation, so we can make sure we have a common understanding before we finish writing up our draft report.

Let me know if this time doesn't work for you.

Thanks so much!
Suzanne

Join Skype Meeting

Trouble Joining? Try Skype Web App

Join by phone

301-415-0333, (b)(6) # (HQ) English (United States)

Find a local number

Conference ID: (b)(6)

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1. Use the first link if you are an NRC user
2. Use the second link if you are not an NRC user
3. Users who dial-in only via phone will not be able to join the meeting until another attendee has joined by completing step 1 above.
4. If using Skype over Citrix (which is not as optimal a service as VPN), choose the 3rd option “Don’t join audio” and dial into the meeting from a phone. You will be able to see the video presentation over the Skype and audio via the phone.

From: Dennis, Suzanne
To: "Sanborn, Scott Edward"
Cc: Luketa, Anay; Mohmand, Jamal Ahmed
Subject: RE: RE: [EXTERNAL] Phone Call Monday
Date: Thursday, March 26, 2020 1:57:00 PM

Scott,

That should be good! If you just want to throw it up on the BOX site, that's secure and then Steve can access it too.

Thanks!
Suzanne

From: Sanborn, Scott Edward <sesanbo@sandia.gov>
Sent: Thursday, March 26, 2020 1:02 PM
To: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Cc: Luketa, Anay <aluketa@sandia.gov>; Mohmand, Jamal Ahmed <jamohma@sandia.gov>
Subject: [External_Sender] RE: [EXTERNAL] Phone Call Monday

Hi Suzanne,

We will be ready to send a draft over this afternoon. Can we send the draft (it is OUO) and then have the discussion with PHMSA on Monday?

Thanks,
Scott

From: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Sent: Thursday, March 26, 2020 10:51 AM
To: Sanborn, Scott Edward <sesanbo@sandia.gov>
Cc: Luketa, Anay <aluketa@sandia.gov>; Mohmand, Jamal Ahmed <jamohma@sandia.gov>
Subject: [EXTERNAL] Phone Call Monday

Hi Scott,

Are you all available for a phone call on Monday with our PHMSA team member? We were thinking that before you all sent over the report, we could all meet together as team to make sure that everyone has the opportunity for questions, etc. I understand that this would push back when you all send the report, but I am ok with that.

Thanks!
Suzanne

Suzanne Dennis
Office of Research

U.S. NRC
301-415-0760

From: Dennis, Suzanne
To: Luketa, Anay
Subject: RE: RE: [EXTERNAL] Quick Call?
Date: Tuesday, March 24, 2020 12:59:00 PM

Wounderful – thanks!

From: Luketa, Anay <aluketa@sandia.gov>
Sent: Tuesday, March 24, 2020 12:01 PM
To: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Subject: [External_Sender] RE: [EXTERNAL] Quick Call?

Hi Suzanne,
I had connectivity issues yesterday, so sorry for the delayed response. The only information that I didn't get was the delay time used in ALOHA. I did work backwards to about match Rao's number using an 8 minute delay time. So, if he doesn't remember I'm just going to note this in the memo. -Anay

From: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Sent: Monday, March 23, 2020 1:42 PM
To: Luketa, Anay <aluketa@sandia.gov>
Subject: [EXTERNAL] Quick Call?

Hey Anay,

Are you available for a quick call? I just wanted to check-in after our call with Rao.

Thanks!
Suzanne
(b)(6)

Suzanne Dennis
Office of Research
U.S. NRC
301-415-0760

From: Dennis, Suzanne
To: Mohmand, Jamal Ahmed
Subject: RE: RE: [EXTERNAL] FW: SNL
Date: Tuesday, March 24, 2020 11:15:00 AM

Great; thank you!

From: Mohmand, Jamal Ahmed <jamohma@sandia.gov>
Sent: Tuesday, March 24, 2020 11:14 AM
To: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Subject: [External_Sender] RE: [EXTERNAL] FW: SNL

I've added the table and write-up as an appendix to Anay's memo.

Jamal

From: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Sent: Tuesday, March 24, 2020 7:10 AM
To: Mohmand, Jamal Ahmed <jamohma@sandia.gov>
Subject: Re: [EXTERNAL] FW: SNL

Hi Jamal,

Yes, I think the EDGs at the 4000 kg/s is fine.

I agree that I think the RG should include a reference to this report. It's very valuable!

Suzanne

From: Mohmand, Jamal Ahmed <jamohma@sandia.gov>
Sent: Monday, March 23, 2020 11:04 PM
To: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Subject: [External_Sender] [EXTERNAL] FW: SNL

Do you want the EDGs also at the 4000 kg/s mass flow rate?

Something you might want keep in mind is that Entergy and the NRC both analyzed a 12.5 kW/m^2 fire but, that's not a requirement in 1.91 from what I see.
The 12.5 is roughly half what the nominal case is based on this NUREG. It may be beneficial to reference Nureg 3330 in 1.91 it seems relevant to this process and is not mentioned once.

It provides important siting guidance in the process of analyzing gas pipelines.
Maybe if the safe distance to XYZ is within X feet, do an analysis similar to one done in Nureg 3330.

Which might quell the question of are plants safe if an explosion calculation is wrong, or any unforeseen explosion occurs. I think if an analysis like this was provided or discussed in this process it would have stymied some of the issues.

Jamal

From: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Sent: Monday, March 23, 2020 6:34 PM
To: Mohmand, Jamal Ahmed <jamohma@sandia.gov>
Subject: RE: RE: RE: RE: RE: RE: RE: [EXTERNAL] FW: SNL

I think that the bounding flow rate is ok. Given that according to the NUREG, reinforced concrete buildings can survive for 5 hours at 50 kW/m2, I think it's good to show that even a MUCH higher flow rate is still ok for safety systems. Could you add a row at 700 meters? That's close to how far away the closest EDGs are.

Suzanne

From: Mohmand, Jamal Ahmed <jamohma@sandia.gov>
Sent: Monday, March 23, 2020 7:12 PM
To: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Subject: [External_Sender] RE: RE: RE: RE: RE: RE: [EXTERNAL] FW: SNL

Suzanne,

I've prepared a write-up based on what we discussed today. In doing so I realized that the SOCA fence is only 482 meters from the pipeline according to Entergy (we were looking at 1500 m) earlier this morning.
I've put together this table, using the 4000 kg/s mass flow rate as a bounding value. Which is more than what is described in the nureg 2000-3200 kg/s. At 44 (50 kW/m^2) the exposure time is 5 hours.

Let me know if you would rather use a different bounding mass flow rate, or use more accurate distances to buildings.

Case	Distance (m)	Mass Flow Rate (kg/s)	Radiated Power (kW)	Fire Diameter (m)	Transmissivity	Incident Radiation (kW/m^2)
Sample	482	N/A	N/A	N/A	N/A	N/A
	500	1700	4.09E+07	295	0.7	19.6
	1000				0.63	4.6
	1500				0.57	2
NRC	482	1900	4.57E+07	312	0.7	23.1
	500				0.7	21.6
	1000				0.63	5.2
	1500				0.57	2.2
Bounding	482	4000	9.61E+07	452	0.7	44.1
	500				0.7	41.5
	1000				0.63	10.6
	1500				0.57	4.7

Thanks,
Jamal

From: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Sent: Monday, March 23, 2020 1:30 PM
To: Mohmand, Jamal Ahmed <jamohma@sandia.gov>
Subject: RE: RE: RE: RE: RE: RE: [EXTERNAL] FW: SNL

(b)(6)

From: Mohmand, Jamal Ahmed <jamohma@sandia.gov>
Sent: Monday, March 23, 2020 3:28 PM
To: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Subject: [External_Sender] RE: RE: RE: RE: RE: [EXTERNAL] FW: SNL

What's your number, I've got 30 minutes.

From: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Sent: Monday, March 23, 2020 1:19 PM
To: Mohmand, Jamal Ahmed <jamohma@sandia.gov>
Subject: RE: RE: RE: RE: RE: [EXTERNAL] FW: SNL

Hey Jamal,

I'm free anytime this afternoon. The same skype link should work, or you can give me a call.

Suzanne

From: Mohmand, Jamal Ahmed <jamohma@sandia.gov>
Sent: Monday, March 23, 2020 3:10 PM
To: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Subject: [External_Sender] RE: RE: RE: RE: [EXTERNAL] FW: SNL

Suzanne,

I've completed the calc, let me know when you have time to go over it.
This was a quick/rough reproduction of the paper, I included the calculation from the example.

Thanks,
Jamal

From: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Sent: Monday, March 23, 2020 12:07 PM
To: Mohmand, Jamal Ahmed <jamohma@sandia.gov>
Subject: RE: RE: RE: RE: [EXTERNAL] FW: SNL

Great! Thank you!

From: Mohmand, Jamal Ahmed <jamohma@sandia.gov>
Sent: Monday, March 23, 2020 2:05 PM

To: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Subject: [External_Sender] RE: RE: RE: [EXTERNAL] FW: SNL

I am working on re-producing the example calculation, once I do that I'll start applying the numbers related to the AIM pipeline.

From: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Sent: Monday, March 23, 2020 11:57 AM
To: Mohmand, Jamal Ahmed <jamohma@sandia.gov>
Subject: RE: RE: RE: [EXTERNAL] FW: SNL

Interesting! I'm looking at it and thinking about it too...it seems like something we should be able to use.

From: Mohmand, Jamal Ahmed <jamohma@sandia.gov>
Sent: Monday, March 23, 2020 1:09 PM
To: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Subject: [External_Sender] RE: RE: [EXTERNAL] FW: SNL

I forgot to mention that the Nureg specifically discusses pipeline explosions.
Stating that a 36 inch pipeline does not pose a significant hazard at 500 feet or greater. (5/60 PDF)

Starting on page 41 there are example calculations for a high-pressure natural gas pipeline.
Provides a flow rate of 2000-3200 (kg/s) for a 40 inch diameter pipeline. (table 3-1)

I'm trying to think or see if there is a way to adapt the method/equations used in this NUREG and apply them to our situation.
Let me know what you think about that.

Thanks,
Jamal

From: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Sent: Monday, March 23, 2020 9:07 AM
To: Mohmand, Jamal Ahmed <jamohma@sandia.gov>
Subject: RE: RE: [EXTERNAL] FW: SNL

Sure! 10:30 MDT works for me. You can give me a call (or vice versa) or I can set-up a quick Skype.

Whatever works best for you!

Suzanne
301-415-0760
(b)(6)

From: Mohmand, Jamal Ahmed <jamohma@sandia.gov>
Sent: Monday, March 23, 2020 11:04 AM
To: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Subject: [External_Sender] RE: [EXTERNAL] FW: SNL

Hi Suzanne,

I have found some related information in NUREG 3330, and shared that with Scott and Anay.
Do you have some time to go over what your concerns and we can discuss if what I found suffices?

Thanks,
Jamal

From: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Sent: Monday, March 23, 2020 7:12 AM
To: Sanborn, Scott Edward <sesanbo@sandia.gov>
Cc: Luketa, Anay <aluketa@sandia.gov>; Mohmand, Jamal Ahmed <jamohma@sandia.gov>; Glover, Austin Michael <amglove@sandia.gov>; LaFleur, Chris <aclafle@sandia.gov>
Subject: [EXTERNAL] FW: SNL

Hi Scott,

Is this something you all could help with? We're looking for big-picture numbers at this point.

Thanks!
Suzanne

From: Clark, Theresa <Theresa.Clark@nrc.gov>
Sent: Monday, March 23, 2020 8:15 AM
To: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Subject: SNL

Can you ask SNL to look at heat transfer through reinforced concrete walls of the thickness we are looking at? 12.5 KW on the outside based on some of the materials we are seeing... what's the inside?

We may have expertise in the NRC on this, but if SNL can do it, that may be even easier.

Thanks,
Theresa

From: Dennis, Suzanne
To: Sanborn, Scott Edward
Subject: RE: RE: Re: [EXTERNAL] Chris" Status?
Date: Monday, March 23, 2020 7:36:00 PM

Thank you!

From: Sanborn, Scott Edward <sesanbo@sandia.gov>
Sent: Monday, March 23, 2020 5:54 PM
To: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Cc: LaFleur, Chris <aclafle@sandia.gov>
Subject: [External_Sender] RE: Re: [EXTERNAL] Chris' Status?

Hi Suzanne,

I just checked with Chris. She is available to talk anytime tomorrow if you want. Her cell phone is (b)(6)

Thanks,
Scott

From: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Sent: Monday, March 23, 2020 8:21 AM
To: Sanborn, Scott Edward <sesanbo@sandia.gov>
Subject: RE: Re: [EXTERNAL] Chris' Status?

Scott,

Thanks! I had a couple specific questions that I was hoping she could help with.

Suzanne

From: Sanborn, Scott Edward <sesanbo@sandia.gov>
Sent: Friday, March 20, 2020 8:29 PM
To: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Subject: [External_Sender] Re: [EXTERNAL] Chris' Status?

Hi Suzanne,

She is not back at work but I did text her yesterday and everything is still progressing on track. I'll see if we can get her support on the phone next week.

Thanks,
Scott

Sent from Workspace ONE Boxer

On March 20, 2020 at 6:11:33 PM MDT, Dennis, Suzanne <Suzanne.Dennis@nrc.gov> wrote:

> Hi Scott,
>
> I should have asked today while we were on the phone. Is Chris back from (b)(6) yet?
>
> Thanks!
>
> Suzanne Dennis
> Office of Research
> U.S. NRC
> 301-415-0760

From: Dennis, Suzanne
To: Mohmand, Jamal Ahmed
Subject: Heat Flux through Reinforced Concrete
Start: Monday, March 23, 2020 12:30:00 PM
End: Monday, March 23, 2020 1:00:00 PM
Location: Skype Meeting

Per your email – talk to you soon!

.....

Join Skype Meeting <https://skype.nrc.gov/meet/suzanne.schroer/LZLTMDC8>

Trouble Joining? Try Skype Web App <https://skype.nrc.gov/meet/suzanne.schroer/LZLTMDC8?sl=1>

Join by phone

301-415-0333, (b) (6) # (HQ) English (United States)

Find a local number <https://skype.nrc.gov/dialin?id= (b) (6) >

Conference ID: (b) (6)

Forgot your dial-in PIN? <https://skype.nrc.gov/dialin> |Help <https://o15.officeredir.microsoft.com/r/rlidLync15?clid=1033&p1=5&p2=2009>

_____

1. Use the first link if you are an NRC user

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3. Users who dial-in only via phone will not be able to join the meeting until another attendee has joined by completing step 1 above.

4. If using Skype over Citrix (which is not as optimal a service as VPN), choose the 3rd option "Don't join audio" and dial into the meeting from a phone. You will be able to see the video presentation over the Skype and audio via the phone.

[!OC([1033])!]

.....

From: Dennis, Suzanne
To: Luketa, Anay
Subject: Additional NRC Analysis
Date: Monday, March 23, 2020 10:24:00 AM

Hi Anay,

Just an FYI, I added a supplemental analysis that Rao did to the BOX site. We just found the documentation this morning. It might be helpful to take a look before our call today.

Suzanne

Suzanne Dennis
Office of Research
U.S. NRC
301-415-0760

From: Dennis, Suzanne
To: Luketa, Anay
Cc: Mohmand, Jamal Ahmed
Subject: FW: Blast radius calculations
Date: Friday, March 20, 2020 9:10:00 AM
Attachments: 20170417 Indian Point Blast Calc.pdf
Joe carson Blast Radius Calculation.pdf
Lochbaum Pipeline blast radius Calculation Check copy.pdf
Blast Radius Chart Chart with anotations.pdf

Hi Anay,

I know you're focused on the simulation right now, so I don't want to overwhelm you, but here are how other people have used RG 1.91. We're trying to see if there is a difference in assumptions or a problem with the RG. So, if you get a chance, take a look.

Jamal – if you can look these over too – that would be helpful!

Thanks!
Suzanne

From: Skeen, David <David.Skeen@nrc.gov>
Sent: Friday, March 20, 2020 9:03 AM
To: Clark, Theresa <Theresa.Clark@nrc.gov>; Harris, Brian <Brian.Harris@nrc.gov>; Dennis, Suzanne <Suzanne.Dennis@nrc.gov>; Li, Yueh-Li <Yueh-Li.Li@nrc.gov>
Subject: FW: Blast radius calculations

All,

FYI – Paul sent these calculations that several folks did using RG1.91. He will likely raise this issue during our call today.

This one of Paul's contentions - that the calculation performed by the NRC was not done properly.

I know Suanne and Renee have already been looking at the NRC's calculations. Hopefully, by reviewing these calculations by others we may be able clarify whether there is a problem with the actual guidance in RG1.91, or identify where there may be an error in assumptions used by either the NRC or these external stakeholders.

Thx!

From: Paul <pmblanch@comcast.net>
Sent: Friday, March 20, 2020 8:54 AM
To: Skeen, David <David.Skeen@nrc.gov>
Cc: Paul M. Blanch <pmblanch@comcast.net>
Subject: [External_Sender] Blast radius calculations

David:

Here are four independent non-QA calculations done by 3 PEs and David Lochbaum using the NRC's RG 1.91 equation.

Paul Blanch
135 Hyde Rd.
West Hartford, CT 06117
pmblanch@comcast.net
860-236-0326
Cell 860-922-3119

Indian Point blast radius calculation
from NRC supplied data and equations

$$W_{Feet} = 45_{Feet\ (30\ Minutes)} * (w_{lbm})^{1/3} = 45 * \sqrt[3]{\frac{Mf_{lbm} * DHC_{BTU/lbm} * Y_{Yield\%}}{4500}} = \sqrt[3]{\frac{Mf_{lbm} * 50030 * 0.95_{Kj/BTU} * 5\%}{4500}} = Feet$$

Time in minutes	Blast Radius Feet	Blast Radius Meters	Constant (45)	$M_{f(Kg)}$	Mf Lbm	DHC (BTU/lbm)	Yield	**Kilotons TNT Equivlent for 100% yield. (Total energy released)**	TNT Equivlent in tons for a 5% yield
1	#REF!	1064	18	376000	827200	50030	5%	**8**	414
2	#REF!	1226	18	576000	1267200	50030	5%	**13**	634
3	#REF!	1293	18	676000	1487200	50030	5%	**15**	744
4	#REF!	1354	18	776000	1707200	50030	5%	**17**	854
5	#REF!	1410	18	876000	1927200	50030	5%	**19**	964
6	#REF!	1462	18	976000	2147200	50030	5%	**21**	1074
7	#REF!	1510	18	1076000	2367200	50030	5%	**24**	1184
8	#REF!	1555	18	1176000	2587200	50030	5%	**26**	1294
9	#REF!	1598	18	1276000	2807200	50030	5%	**28**	1404
10	#REF!	1639	18	1376000	3027200	50030	5%	**30**	1514
11	#REF!	1677	18	1476000	3247200	50030	5%	**32**	1624
12	#REF!	1715	18	1576000	3467200	50030	5%	**35**	1734
13	#REF!	1750	18	1676000	3687200	50030	5%	**37**	1844
14	#REF!	1784	18	1776000	3907200	50030	5%	**39**	1954
15	#REF!	1817	18	1876000	4127200	50030	5%	**41**	2064
16	#REF!	1849	18	1976000	4347200	50030	5%	**43**	2174

Calculation performed by Paul M Blanch PE
April 10, 2017

Indian Point blast radius calculation
from NRC supplied data and equations

17	#REF!	1879	18	2076000	4567200	50030	5%	**46**	2284
18	#REF!	1909	18	2176000	4787200	50030	5%	**48**	2394
19	#REF!	1938	18	2276000	5007200	50030	5%	**50**	2504
20	#REF!	1966	18	2376000	5227200	50030	5%	**52**	2614
21	#REF!	1993	18	2476000	5447200	50030	5%	**54**	2724
22	#REF!	2019	18	2576000	5667200	50030	5%	**57**	2834
23	#REF!	2045	18	2676000	5887200	50030	5%	**59**	2944
24	#REF!	2070	18	2776000	6107200	50030	5%	**61**	3054
25	#REF!	2095	18	2876000	6327200	50030	5%	**63**	3164
26	#REF!	2119	18	2976000	6547200	50030	5%	**65**	3274
27	#REF!	2142	18	3076000	6767200	50030	5%	**68**	3384
28	#REF!	2165	18	3176000	6987200	50030	5%	**70**	3494
29	#REF!	2188	18	3276000	7207200	50030	5%	**72**	3604
30	#REF!	2210	18	3376000	7427200	50030	5%	**74**	3714

Calculation performed by Paul M Blanch PE
April 10, 2017

Paul

Per your request, I have reviewed your calculation assuming the average flow rate from a ruptured line is 1877 Kg per second and lasting for 360 seconds. This information was provided from a response to FOIA 2015-0246.
DHC is a constant of 50030

Applying equation from FOIA

$$\text{WTNT} = \text{M}_f * DHC * Y / 4500 = 675{,}720_{Kg(TNT)}$$

This is equivalent to 1,486,584 pounds or 743 tons of TNT after 6 Minutes.

The NRC provides the equation $d = 45 * \sqrt[3]{(w)}$ where d is the minimum safe distance in feet .

Applying this NRC equation[1] $45 * \sqrt[3]{1{,}486{,}584 * 50030 * .05 / 4500}$ equals 4,185 feet as the Minimum blast radius from a 6 minute release using the following:

$$d_{ft\ (3\ \text{Minutes})} = 45_{Ft} * (w_{Pounds})^{1/3} = 45 * \sqrt[3]{\frac{Mf_{(Kg)*} * DHC_{(Kj/Kg)} * Y_{(5\%Yield)}}{4500}} = 45 * \sqrt[3]{\frac{(\text{Total flow after 3 Minutes})_{Kg} * 50030 * .05}{4500}} = ?\ feet$$

Conclusion

Assuming a Yield of 5%, the lowest value from NRC Regulatory Guide 1.91, and a DHC of 50030 from FOIA 2015-0076, **my calculated blast radius is 4,185 feet**, consistent with Dave Lochbaum's calculated radius of 4269 feet and in total conflict with Entergy's and the NRC's results of about 1100 feet from Entergy's 10 CFR 50.59 analysis.

1

$$d_{ft\ (3\ \text{Minutes})} = 45_{Ft} * (w_{Pounds})^{1/3} = 45 * \sqrt[3]{\frac{Mf_{(Kg)*} * DHC_{(Kj/Kg)} * Y_{(5\%Yield)}}{4500}} = 45 * \sqrt[3]{\frac{(\text{Total flow after 3 Minutes})_{Kg} * 50030 * .05}{4500}} = ?\ feet$$

Joseph Carson PE

Date

Pipeline calculation check by Dave Lochbaum, Union of Concerned Scientists

From NRC Regulatory Guide 1.91, Rev. 2, April 2013

Equation (1):

Rmin = Z * W^.333

where

Rmin = distance from explosion to point where overpressure will drop to 1.0 psi
Z = scaled distance = 45 ft/lb^.333 when R is in feet and W is in pounds
Z = scaled distance = 18 m/kg^.333 when R is in meters and W is in kilograms
Check: NUREG-1805 (December 2004) Figure 15-3 supports 45 ft/lb^.333 for 1 psi overpressure

Equation (2):

Weff = (Hexp/Htnt) * Wexp

where

Weff = effective charge equivalent
Wexp = weight of the explosive charge
Hexp = heat of detonation of the explosive
Htnt = heat of detonation of TNT

Equation (3):

E = α * △Hc * mf

where

E = blast wave energy, BTU or kilojoules
α = yield (fraction of available combustion energy participating in blast wave = 5% from Table 1
△Hc = theoretical net heat of combustion (BTU/lb or kilojoules/kilogram)
mf = mass of flammable vapor released (pounds mass or kilograms)

Equation (4):

Wtnt = E / (1900 BTU/pound mass) or E / (4420 kilojoules/kilogram)

From FOIA-2015-0076:

△Hc = 50,030 kiljoules/kilogram
Check: NUREG-1805 (December 2004) Table 3-2 gives 50,000 kJ/kg for LNG and 46.000 kJ/kg for LPG
Check: NUREG-1805 (December 2004) Table 15-2 gives 50,030 kJ/kg for Methane gas
Check: NUREG-1805 (December 2004) Table 15-2 gives 46,360 kJ/kg for Propane gas
Check: NUREG-1805 (December 2004) Table 15-2 gives 47,490 kJ/kg for Ethane gas
mf = 376,000 kilograms + 200,000 kilograms + 100,000 kilograms = 676,000 kilograms

Solving Equation (3):

E = α * △Hc * mf
E = 0.05 * 50,030 kilojoules/kilogram * 676,000 kilograms
E = 1,691,014,000 kilojoules for 676,000 kilograms
E = 940,564,000 kilojoules for 376,000 kilograms

Solving Equation (4):

Wtnt = E / (1900 BTU/pound mass) or **E / (4420 kilojoules/kilogram)**
Wtnt = 382,582 kilograms for 676,000 kilograms
Wtnt = 212,797 kilograms for 376,000 kilograms

Solving Equation (1):

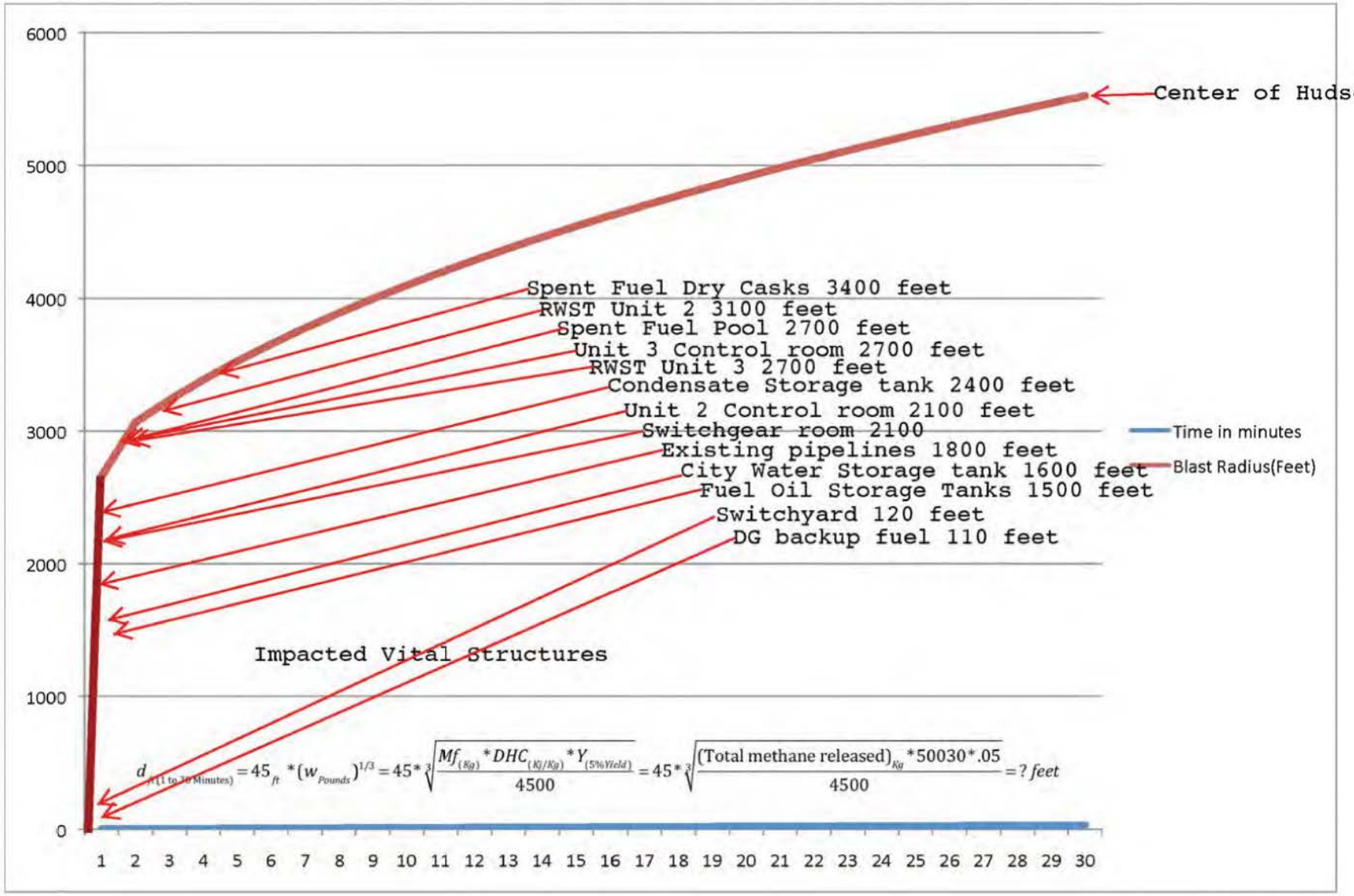
Rmin = Z * W^.333
Rmin = 1,301 meters for 676,000 kilograms
Rmin = 4,269 feet for 676,000 kilograms
Rmin = 0.81 miles for 676,000 kilograms
Rmin = 1,070 meters for 376,000 kilograms
Rmin = 3,511 feet for 376,000 kilograms
Rmin = 0.67 miles for 376,000 kilograms

Paul M. Blanch

Parametric Study:

Amount of Gas, kilograms	Heat of Combustion, kilojoules/kilogram		
	50,030	47,490	46,360
676,000	4,269	4,195	4,162
376,000	3,511	3,451	3,423
	minimum standoff distance, feet		

Indian Point Damaging Blast Radius (1 PSI) vs time from NRC RG 1.19 Equations



From:	Dennis, Suzanne
To:	Tammara, Rao; Li, Yueh-Li; Luketa, Anay
Subject:	Follow-Up Meeting
Start:	Monday, March 23, 2020 1:00:00 PM
End:	Monday, March 23, 2020 2:00:00 PM
Location:	Skype
Sensitivity:	Private

Hi Rao,

We have a couple more follow-up questions and one of our team members from Sandia also has a couple question on the Indian Point analysis.* Are you available Monday to meet?

Thank you so much for your patience with us! As non-pipeline experts, we have a lot to learn!
Suzanne

*If it helps you to prepare, most of our questions are centering around the case described on the last paragraph of page 3 of your write-up. (It starts "Assuming a 5% yield factor...")

Join Skype Meeting <https://skype.nrc.gov/meet/suzanne.schroer/LZLTMDC8>

Trouble Joining? Try Skype Web App <https://skype.nrc.gov/meet/suzanne.schroer/LZLTMDC8?sl=1>

Join by phone

301-415-0333,,(b)(6)# (HQ) English (United States)

Find a local number <https://skype.nrc.gov/dialin?id=(b)(6)>

Conference ID: (b)(6)

Forgot your dial-in PIN? <https://skype.nrc.gov/dialin> |Help <https://o15.officeredir.microsoft.com/r/rlidLync15?clid=1033&p1=5&p2=2009>

Tips:

1. Use the first link if you are an NRC user

2. Use the second link if you are not an NRC user

3. Users who dial-in only via phone will not be able to join the meeting until another attendee has joined by completing step 1 or 2 above.

4. If using Skype over Citrix (which is not as optimal a service as VPN), choose the 3rd option "Don't join audio" and dial into the meeting from a phone.

You will be able to see the video presentation over the Skype and audio via the phone.

[!OC([1033])!]

.....

From: Dennis, Suzanne
To: Sanborn, Scott Edward
Subject: RE: IP deliverable
Date: Thursday, March 19, 2020 4:09:00 PM

Hi Scott,

Just to follow-up, a memo should be fine. It should definitely be OUO – we'll decide what we can release for the public report. (We're currently working through what needs to be security-related.) Let's chat on Wednesday to discuss.

Thanks!
Suzanne

From: Sanborn, Scott Edward <sesanbo@sandia.gov>
Sent: Thursday, March 19, 2020 3:57 PM
To: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Subject: [External_Sender] IP deliverable

Hi Suzanne,

I wanted to check with you on SNL producing a deliverable for the IP pipeline issue. I know you said in the past that nothing more than email is required. However, in thinking about some potential pit-falls with some information being taking out of context, we will plan to document our work in a memo to you by the 27th. Let me know if you see any concerns with us writing a memo and if you feel it should be marked OUO for pre-decisional purposes.

As a side note, most of SNL is working from home, so if you need to reach me either email or call my cell (b)(6) .

Thanks,
Scott

From: Dennis, Suzanne
To: Mohmand, Jamal Ahmed; Luketa, Anay
Subject: RE: Notes from call with Rick Kuprewicz
Date: Thursday, March 19, 2020 3:08:00 PM

I think I already let you guys know, but this conversation was transcribed, so we'll have the full transcript available in not too long.

From: Mohmand, Jamal Ahmed <jamohma@sandia.gov>
Sent: Thursday, March 19, 2020 2:26 PM
To: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>; Luketa, Anay <aluketa@sandia.gov>
Subject: [External_Sender] Notes from call with Rick Kuprewicz

wondered if the plant could reach cold shut-down

not comfortable with any of the resolutions during his interactions with NRC several years ago

suggests not overwork the issue of leak versus rupture

has it been properly evaluated for a rupture at any location

rupture is not going to immediately lead to a pressure drop for a while
the correct timing for length of release (at least several minutes, most likely 15-30 minutes)

potential impact radius, large diameter pipeline impact zones can be really large. PIR equations may not be as relevant
turbulence of gas, not one immediate explosion

aloha is not the correct tool, will release a lot of tonnage
if things within roughly 2 feet of concrete you're fine

if you use either 1.5 or 2 times the PIR and the items are still safe then that's defensible

embridge states they'll they most likely close the valves 15 miles apart
first 5 minutes are most dangerous, super high radiation levels...depends on the system on how it'll drop-off
concrete structures at roughly 1800 feet are fine

pipe rupture is always a guillotine break
hard to model the turbulence, agreed on PIR and then add a 1.5-2 safety factor...no need to do complex model

Aloha not appropriate for gas transmission pipeline rupture, have not across many models that can properly model...its difficult and site specific
no such thing as an invincible steel pipeline

not going to be a jet fire, become huge clouds
focus on detonation (multiple), mixing and turbulence very difficult to model

defendable action of using 2.0 times of PIR with safety structures being 1800 feet away
using the 3 minutes aggravated the issue of closing the valve

topography is extremely important for natural gas analysis
heat radiation is the real threat to the plant

advice is not be rushed, don't expose yourself try to do the right thing
doesn't think a travelling cloud and then igniting is not a big concern...PIR does not model turbulence
different pockets of ignition that then mix and may re-ignite

force of blast will make buried pipeline exposed

feels that the team is moving in the right direction and asking the right questions

metal buildings, diesel generator fuel storage tank could fail...
4 hours immediate and several days within plant...moved fuel truck tanker to opposite side of plant (NRC)

don't want to over-compensate the mitigative features used
leak would not be a rupture

Jamal Mohmand
Fire, Risk, and Tranportation Systems (8854)
Sandia National Laboratories
~~+1-505-844-3282 (O)~~ | (b)(6) (C)
jamohma@sandia.gov

From: Dennis, Suzanne
To: Mohmand, Jamal Ahmed
Subject: RE: RE: RE: [EXTERNAL] Let me know if you have any questions. Thanks! (EOM)
Date: Thursday, March 19, 2020 2:13:00 PM

Also, just FYI, we're looking at a risk analysis to see what the impact would be if we lose the switchyard. So, it's definitely something that we're looking at. (So far, it looks like you would need to lose the diesels for both units, the Appendix R diesels, and FLEX equipment for it to be a real problem.)

From: Mohmand, Jamal Ahmed <jamohma@sandia.gov>
Sent: Thursday, March 19, 2020 2:09 PM
To: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Subject: [External_Sender] RE: RE: [EXTERNAL] Let me know if you have any questions. Thanks! (EOM)

Haha agreed

From: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Sent: Thursday, March 19, 2020 12:04 PM
To: Mohmand, Jamal Ahmed <jamohma@sandia.gov>
Subject: RE: RE: [EXTERNAL] Let me know if you have any questions. Thanks! (EOM)

I don't think he has any knowledge of plant operations (that us).

From: Mohmand, Jamal Ahmed <jamohma@sandia.gov>
Sent: Thursday, March 19, 2020 1:59 PM
To: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Subject: [External_Sender] RE: [EXTERNAL] Let me know if you have any questions. Thanks! (EOM)

I was going to bring up the switchyard, and the ability to shutdown the plant (something we need to think about).

Is a vapor cloud travelling and then ignition a concern? Potentially entering buildings.

From: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Sent: Thursday, March 19, 2020 11:57 AM
To: Mohmand, Jamal Ahmed <jamohma@sandia.gov>
Subject: [EXTERNAL] Let me know if you have any questions. Thanks! (EOM)

Suzanne Dennis
Office of Research
U.S. NRC

301-415-0760

From: Dennis, Suzanne
To: Luketa, Anay
Subject: RE: RE: RE: [EXTERNAL] FW: Gas Loss in a Pipeline - based upon pressure and mileage
Date: Thursday, March 19, 2020 2:07:00 PM
Attachments: image001.png

Ok – I'll see if he still has the input files. Since it's been so long, I'm not sure what he still has electronically. I'll give him a call and let you know.

Thanks!
Suzanne

From: Luketa, Anay <aluketa@sandia.gov>
Sent: Thursday, March 19, 2020 12:28 PM
To: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Subject: [External_Sender] RE: RE: [EXTERNAL] FW: Gas Loss in a Pipeline - based upon pressure and mileage

Hi Suzanne,

I find sometimes in discussion there can be misinterpretation, etc. I would actually prefer an e-mail with inputs in a table which is more straightforward for me. This hopefully should be pretty easy for Rao to do. Let me know it's a problem.

Thanks,
Anay

From: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Sent: Thursday, March 19, 2020 9:39 AM
To: Luketa, Anay <aluketa@sandia.gov>
Cc: Mohmand, Jamal Ahmed <jamohma@sandia.gov>
Subject: RE: RE: [EXTERNAL] FW: Gas Loss in a Pipeline - based upon pressure and mileage

Hey Anay,

I know we just got off the phone, but after thinking about it further, would you just like me to set-up a telecon with Rao? That way you can ask any questions you need, and nothing will get lost in translation.

Suzanne

From: Luketa, Anay <aluketa@sandia.gov>
Sent: Thursday, March 19, 2020 10:56 AM
To: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>; Mohmand, Jamal Ahmed <jamohma@sandia.gov>
Subject: [External_Sender] RE: [EXTERNAL] FW: Gas Loss in a Pipeline - based upon pressure and mileage

Hi Suzanne,

I have a few questions about the NRC analysis. On page 3, last paragraph, it states that ALOHA was used for an explosion calculation. It also states that a 5% yield factor was assumed. Using ALOHA I don't see an entry for that. Based upon what I read, I'm getting 1.8 miles, no 3054 ft. So, either I'm misunderstanding what was done, incorrect value was stated, or we're using different versions of ALOHA.

Can I be provided what inputs were used for this calculation? Also, can you find out what version of ALOHA was used?

Thanks!
Anay

From: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Sent: Thursday, March 19, 2020 7:55 AM
To: Luketa, Anay <aluketa@sandia.gov>; Mohmand, Jamal Ahmed <jamohma@sandia.gov>

Subject: [EXTERNAL] FW: Gas Loss in a Pipeline - based upon pressure and mileage

Good mornir g,

Steve shared the below equation from PHMSA. Not sure if it is helpful to you all, but I thought I would pass it along.

Suzanne

From: Nanney, Steve (PHMSA) <Steve.Nanney@dot.gov>
Sent: Wednesday, March 18, 2020 8:14 PM
To: Clark, Theresa <Theresa.Clark@nrc.gov>; Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Cc: Nanney, Steve (PHMSA) <Steve.Nanney@dot.gov>
Subject: [External_Sender] Gas Loss in a Pipeline - based upon pressure and mileage

Below is an equation for determining volume of gas loss in a gas pipeline.

Additionally, upgrading pipelines generally requires operators to empty the natural gas from the pipeline via a procedure called "blowdown" which entails releasing natural gas into the atmosphere. PHMSA calculated the amount of gas that would be released through this procedure per mile using **Equation 1**.

Equation 1: $$\boldsymbol{Vb = (28.798 * (Tb/Pb) * (Pavg/(Zavg * Tavg)) * D^2)/1000}$$

Where:

Vb = Volume of gas released per mile (thousand cubic feet; MCF)

Tb = Temperature at standard conditions (70 degrees F)

Pb = Pressure at standard conditions (14.7 pounds per square inch; PSI)

Pavg = Pressure at blowdown conditions (100 PSI for intrastate; 150 PSI for interstate)

Zavg = Compressibility factor at packed conditions (0.88)

Tavg = Temperature at packed conditions (70 degrees F)

D = inside diameter of pipeline in inches (29.25 for 30-inch pipes, 15.25 for 16-inch pipes, and 7.5 for 8-inch pipes)

Steve Nanney
PHMSA - Houston
(b)(6) **– mobile**

From: Dennis, Suzanne
To: Luketa, Anay
Subject: RE: RE: [EXTERNAL] FW: Gas Loss in a Pipeline - based upon pressure and mileage
Date: Thursday, March 19, 2020 11:06:00 AM
Attachments: image001.png

Hey Anay,

Give me a call when you can.

Thanks!
Suzanne

From: Luketa, Anay <aluketa@sandia.gov>
Sent: Thursday, March 19, 2020 10:56 AM
To: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>; Mohmand, Jamal Ahmed <jamohma@sandia.gov>
Subject: [External_Sender] RE: [EXTERNAL] FW: Gas Loss in a Pipeline - based upon pressure and mileage

Hi Suzanne,

I have a few questions about the NRC analysis. On page 3, last paragraph, it states that ALOHA was used for an explosion calculation. It also states that a 5% yield factor was assumed. Using ALOHA I don't see an entry for that. Based upon what I read, I'm getting 1.8 miles, no 3054 ft. So, either I'm misunderstanding what was done, incorrect value was stated, or we're using different versions of ALOHA.

Can I be provided what inputs were used for this calculation? Also, can you find out what version of ALOHA was used?

Thanks!
Anay

From: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Sent: Thursday, March 19, 2020 7:55 AM
To: Luketa, Anay <aluketa@sandia.gov>; Mohmand, Jamal Ahmed <jamohma@sandia.gov>
Subject: [EXTERNAL] FW: Gas Loss in a Pipeline - based upon pressure and mileage

Good morning,

Steve shared the below equation from PHMSA. Not sure if it is helpful to you all, but I thought I would pass it along.

Suzanne

From: Nanney, Steve (PHMSA) <Steve.Nanney@dot.gov>
Sent: Wednesday, March 18, 2020 8:14 PM
To: Clark, Theresa <Theresa.Clark@nrc.gov>; Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Cc: Nanney, Steve (PHMSA) <Steve.Nanney@dot.gov>
Subject: [External_Sender] Gas Loss in a Pipeline - based upon pressure and mileage

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Additionally, upgrading pipelines generally requires operators to empty the natural gas from the pipeline via a procedure called "blowdown" which entails releasing natural gas into the atmosphere. PHMSA calculated the amount of gas that would be released through this procedure per mile using **Equation 1**.

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Where:

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Pavg = Pressure at blowdown conditions (100 PSI for intrastate; 150 PSI for interstate)

Zavg = Compressibility factor at packed conditions (0.88)

Tavg = Temperature at packed conditions (70 degrees F)

D = inside diameter of pipeline in inches (29.25 for 30-inch pipes, 15.25 for 16-inch pipes, and 7.5 for 8-inch pipes)

Steve Nanney
PHMSA - Houston
(b)(6) **– mobile**

From: Dennis, Suzanne
To: Mohmand, Jamal Ahmed
Subject: RE: Pipeline External Fire at NPP
Date: Wednesday, March 18, 2020 2:36:00 PM

Hi Jamal,

I've added Chapter 9 of the Unit 3 UFSAR to the BOX site.

We won't have access any EPRI documents that aren't publicly available, unfortunately. We have to go through their paywall too.

Suzanne

From: Mohmand, Jamal Ahmed <jamohma@sandia.gov>
Sent: Wednesday, March 18, 2020 2:23 PM
To: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Subject: [External_Sender] Pipeline External Fire at NPP

Hi Suzanne,

Not sure if we talking about the potential impact for an external fire or if it was someone else on the phone, but something the might be helpful to me would be the Fire Protection Program portion of the Indian Point USAR. I believe that's typically chapter 9, it might have some information on that but I have not specifically looked for.
I will also look for any EPRI documents regarding the topic, if I do find something from EPRI I won't have access to due to their paywall. I am not sure if the NRC would have access to that information.

Thanks,
Jamal

Jamal Mohmand
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jamohma@sandia.gov

From: Dennis, Suzanne
To: Luketa, Anay; Mohmand, Jamal Ahmed; Glover, Austin Michael; Sanborn, Scott Edward; LaFleur, Chris
Subject: REQUEST: Interview questions (by Wed.)
Date: Tuesday, March 17, 2020 11:27:38 AM

Hi all,

Thursday and Friday we have two interviews with folks outside the NRC:

- Rick Kuprewicz at 1pm EDT Thursday 3/19
- Paul Blanch at 1pm EDT Friday 3/20

You are welcome to participate in both by phone (Bridgeline: 866-663-7988 Passcode: 8129958). **Dave will have the lead on asking questions** (rather than everyone jumping in). **Please let me know of any specific questions that you all want asked of either individual so we can add them to that list by tomorrow.** If you think of something during the call, you can email me, and I'll make sure it gets asked.

The best sources of information for you to consider for questions are what we've already sent you and put in BOX (including the two court filings from those individuals). Many of the issues Paul has raised can be found in the following two files. I can't attach them because our VPN is down, but the links to our public site should work.

- NRC responses to Paul Blanch's 39 questions during the 10 CFR 2.206 petition review process - https://www.nrc.gov/docs/ML1528/ML15287A257.pdf
- Paul Blanch's responses to those responses (with additional questions embedded) - https://www.nrc.gov/docs/ML1534/ML15348A324.pdf

Thanks!
Suzanne

From: Dennis, Suzanne
To: Mohmand, Jamal Ahmed
Cc: Luketa, Anay
Subject: RE: RE: RE: [EXTERNAL] RE: Indian Point Nuclear Facility - AIM Pipeline Questions
Date: Monday, March 16, 2020 4:34:00 PM

FYI – I also added the calculation done by the Calvert Cliffs to the BOX site.

Suzanne

From: Mohmand, Jamal Ahmed <jamohma@sandia.gov>
Sent: Monday, March 16, 2020 3:41 PM
To: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Cc: Luketa, Anay <aluketa@sandia.gov>
Subject: [External_Sender] RE: RE: [EXTERNAL] RE: Indian Point Nuclear Facility - AIM Pipeline Questions

Suzanne,

Calvert Cliffs does have a pipeline located near the site, an analysis was done by the utility and the NRC did confirm the analysis. I have uploaded the reference to the box site, the pdf that was provided was only a response to a specific RAI that was issued to the utility.

Regarding Turkey Point, the reference provided was the analysis was for units 6&7 which have not been built yet. The USAR applications have been accepted by the NRC so they will be helpful. I am currently looking for the Reg Guide 1.91 analysis done for the operational units at Turkey Point 3&4.

Thanks,
Jamal

From: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Sent: Monday, March 16, 2020 9:24 AM
To: Mohmand, Jamal Ahmed <jamohma@sandia.gov>
Subject: RE: RE: [EXTERNAL] RE: Indian Point Nuclear Facility - AIM Pipeline Questions

Glad to hear it!

From: Mohmand, Jamal Ahmed <jamohma@sandia.gov>
Sent: Monday, March 16, 2020 11:22 AM
To: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Subject: [External_Sender] RE: [EXTERNAL] RE: Indian Point Nuclear Facility - AIM Pipeline Questions

Thanks Suzanne, this is great!

From: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>

Sent: Friday, March 13, 2020 2:25 PM
To: Luketa, Anay <aluketa@sandia.gov>; Sanborn, Scott Edward <sesanbo@sandia.gov>; LaFleur, Chris <aclafle@sandia.gov>; Mohmand, Jamal Ahmed <jamohma@sandia.gov>; Glover, Austin Michael <amglove@sandia.gov>
Cc: Clark, Theresa <Theresa.Clark@nrc.gov>
Subject: [EXTERNAL] RE: Indian Point Nuclear Facility - AIM Pipeline Questions

Opposite – blue is ISFSI and red is the truck.

Have a good weekend!

From: Dennis, Suzanne
Sent: Friday, March 13, 2020 4:16 PM
To: 'Luketa, Anay' <aluketa@sandia.gov>; 'Sanborn, Scott Edward' <sesanbo@sandia.gov>; 'LaFleur, Chris' <aclafle@sandia.gov>; 'Mohmand, Jamal Ahmed' <jamohma@sandia.gov>; 'Glover, Austin Michael' <amglove@sandia.gov>
Cc: Clark, Theresa <Theresa.Clark@nrc.gov>
Subject: RE: Indian Point Nuclear Facility - AIM Pipeline Questions

I found a semi-updated plant layout. That coupled with the google maps picture (the red is the ISFSI and the blue is the tanker truck that they moved away from the pipeline) that I added should be helpful.

Is this what you all need or something more?

Thanks!
Suzanne

From: Dennis, Suzanne
Sent: Friday, March 13, 2020 3:45 PM
To: Luketa, Anay <aluketa@sandia.gov>; Sanborn, Scott Edward <sesanbo@sandia.gov>; LaFleur, Chris <aclafle@sandia.gov>; Mohmand, Jamal Ahmed <jamohma@sandia.gov>; Glover, Austin Michael <amglove@sandia.gov>
Subject: FW: Indian Point Nuclear Facility - AIM Pipeline Questions

Hi all,

We've uploaded some more information to the BOX site in the "Files from Spectra" and "Site images" folders. Let me know if you can't get into the BOX site, either through https://usnrc.app.box.com/folder/106230269301 or the main https://usnrc.app.box.com.

In the "Files from Spectra" folder:

- Attachment A/B PDFs – aerial layout photo and cross-section sketch of how pipeline is buried
- three Word files – details on how the pipeline is operated – particularly useful is the

third Word file (BB6040) which has a table of questions from Entergy with answers, like how the pipeline is monitored and where the isolation valves are
- S7-G-9032 – a couple versions of drawings of the above-ground valve station where the existing and new pipelines connect (you will see where in the aerial layout Attachment A PDF

In the "Site images" folder:
- 2899 – from across Broadway (southeast of site) – you can see the pipeline right-of-way across the street in a cleared lighter colored area beyond where the trucks are parked; the facility in front is a gypsum plant; near the center is the meteorological tower, and the safety areas of the plant are way off to the right outside the frame (the building on the right is a training building)
- 2902/2905/2901 – above-ground area offsite, east of Broadway, where the existing and new pipelines connect – this is valve site 143 which is the one in the "Spectra Latest drawing" email at MP 5.41 (measured, I think, from 0.0 at the Stony Point compressor station across the river, based on the BB6040 file mentioned above) – you can see in 2901 that it is up a hill
- Satellite 2 – this a screenshot of my phone while we were at the valve site so you can see where it is (blue dot)

I'm still working on getting updated plant layout info (other than a google maps overlay), but hopefully this helps!
Suzanne

From: Dennis, Suzanne
To: Mohmand, Jamal Ahmed
Cc: Luketa, Anay
Subject: RE: RE: RE: [EXTERNAL] RE: Indian Point Nuclear Facility - AIM Pipeline Questions
Date: Monday, March 16, 2020 3:49:00 PM

Hi Jamal,

I'm not sure there was an analysis done for the operational units. It's not in their FSAR, and I'm not sure when the pipelines were installed. I wouldn't spend too much time on it, since the analysis done for Units 6/7 should be the most up-to-date.

Thanks for the Calvert references!
Suzanne

From: Mohmand, Jamal Ahmed <jamohma@sandia.gov>
Sent: Monday, March 16, 2020 3:41 PM
To: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Cc: Luketa, Anay <aluketa@sandia.gov>
Subject: [External_Sender] RE: RE: [EXTERNAL] RE: Indian Point Nuclear Facility - AIM Pipeline Questions

Suzanne,

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Sent: Monday, March 16, 2020 11:22 AM
To: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>

Subject: [External_Sender] RE: [EXTERNAL] RE: Indian Point Nuclear Facility - AIM Pipeline Questions

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Sent: Friday, March 13, 2020 3:45 PM
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Subject: FW: Indian Point Nuclear Facility - AIM Pipeline Questions

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- Satellite 2 – this a screenshot of my phone while we were at the valve site so you can see where it is (blue dot)

I'm still working on getting updated plant layout info (other than a google maps overlay), but hopefully this helps!

Suzanne

From: Dennis, Suzanne
To: Sanborn, Scott Edward
Cc: Luketa, Anay; Mohmand, Jamal Ahmed
Subject: RE: Declined: [EXTERNAL] IP Status Update
Date: Monday, March 16, 2020 9:52:00 AM

Hi Scott,

I understand. Of course, if Anay has something sooner, we are all available to meet whenever.

Suzanne

-----Original Appointment-----
From: Sanborn, Scott Edward <sesanbo@sandia.gov>
Sent: Sunday, March 15, 2020 8:01 PM
To: Dennis, Suzanne
Cc: Luketa, Anay; Mohmand, Jamal Ahmed
Subject: [External_Sender] Declined: [EXTERNAL] IP Status Update
When: Wednesday, March 18, 2020 1:00 PM-2:00 PM (UTC-05:00) Eastern Time (US & Canada).
Where: Skype Meeting

Hi Suzanne,

This new time does not work for me. However, don't reschedule if it works for Anay and Jamal as they more critical to this work than I am.

Thanks,
Scott

From:	Dennis, Suzanne
To:	Luketa, Anay; LaFleur, Chris; Mohmand, Jamal Ahmed; Sanborn, Scott Edward; IP Expert Eval Team; Glover, Austin Michael; Skeen, David; Clark, Theresa; Harris, Brian; Li, Yueh-Li; Nanney, Steve (PHMSA)
Subject:	IP Status Update
Start:	Wednesday, March 18, 2020 1:00:00 PM
End:	Wednesday, March 18, 2020 2:00:00 PM
Location:	Skype Meeting

Hi all,

Let's meet to see where everyone is at.

Let me know if this time doesn't work for you.

Have a great weekend!

Suzanne

.....

Join Skype Meeting <https://skype.nrc.gov/meet/suzanne.schroer/LZLTMDC8>

Trouble Joining? Try Skype Web App <https://skype.nrc.gov/meet/suzanne.schroer/LZLTMDC8?sl=1>

Join by phone

301-415-0333,(b)(6)# (HQ) English (United States)

Find a local number <https://skype.nrc.gov/dialin?id=(b)(6)>

Conference ID: (b)(6)

Forgot your dial-in PIN? <https://skype.nrc.gov/dialin> |Help <https://o15.officeredir.microsoft.com/r/rlidLync15?clid=1033&p1=5&p2=2009>

Tips:

1. Use the first link if you are an NRC user

2. Use the second link if you are not an NRC user

3. Users who dial-in only via phone will not be able to join the meeting until another attendee has joined by completing step 1 or 2 above.

4. If using Skype over Citrix (which is not as optimal a service as VPN), choose the 3rd option "Don't join audio" and dial into the meeting from a phone.

You will be able to see the video presentation over the Skype and audio via the phone.

[!OC([1033])!]

.....

From:	Dennis, Suzanne
To:	Luketa, Anay; LaFleur, Chris; Mohmand, Jamal Ahmed; Sanborn, Scott Edward; IP Expert Eval Team; Glover, Austin Michael; Skeen, David; Clark, Theresa; Harris, Brian; Li, Yueh-Li; Nanney, Steve (PHMSA)
Subject:	IP Pipeline Status Meeting
Start:	Friday, March 13, 2020 1:00:00 PM
End:	Friday, March 13, 2020 3:00:00 PM
Location:	Skype Meeting

Hi team,

Let's meet and see where we are at with the whole team (PHMSA and Sandia included).

Suzanne

.....

Join Skype Meeting <https://skype.nrc.gov/meet/suzanne.schroer/LZLTMDC8>

Trouble Joining? Try Skype Web App <https://skype.nrc.gov/meet/suzanne.schroer/LZLTMDC8?sl=1>

Join by phone

301-415-0333, (b) (6) # (HQ) English (United States)

Find a local number <https://skype.nrc.gov/dialin?id= (b) (6) >

Conference ID: (b) (6) 8

Forgot your dial-in PIN? <https://skype.nrc.gov/dialin> |Help <https://o15.officeredir.microsoft.com/r/rlidLync15?clid=1033&p1=5&p2=2009>

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2. Use the second link if you are not an NRC user

3. Users who dial-in only via phone will not be able to join the meeting until another attendee has joined by completing step 1 or 2 above.

[!OC([1033])!]

.....

From:	Dennis, Suzanne
To:	LaFleur, Chris; Luketa, Anay; Sanborn, Scott Edward; Mohmand, Jamal Ahmed; Glover, Austin Michael
Subject:	RE: [External_Sender] RE: RE: RE: [EXTERNAL] ACTION: Questions for First Interview
Date:	Monday, March 09, 2020 12:42:00 PM
Attachments:	FMDS0742 Vapor Cloud Explosions.pdf

The attached Prevention Data Sheet, published by FM Global, may be downloaded at https://www.fmglobal.mobi/research-and-resources/fm-global-data-sheets.

Yep!

From: LaFleur, Chris <aclafle@sandia.gov>
Sent: Monday, March 09, 2020 12:20 PM
To: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>; Luketa, Anay <aluketa@sandia.gov>; Sanborn, Scott Edward <sesanbo@sandia.gov>; Mohmand, Jamal Ahmed <jamohma@sandia.gov>; Glover, Austin Michael <amglove@sandia.gov>
Subject: [External_Sender] RE: RE: RE: [EXTERNAL] ACTION: Questions for First Interview

HI Suzanne,

Do you have FM Data Sheet 7-42 and *Estimating the Flammable Mass of a Vapor Cloud* by J.L.Woodward, 1998 (Ref. 9) from the Reg Guide?

Thanks!

From: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Sent: Monday, March 9, 2020 9:26 AM
To: LaFleur, Chris <aclafle@sandia.gov>; Luketa, Anay <aluketa@sandia.gov>; Sanborn, Scott Edward <sesanbo@sandia.gov>; Mohmand, Jamal Ahmed <jamohma@sandia.gov>; Glover, Austin Michael <amglove@sandia.gov>
Subject: RE: RE: RE: [EXTERNAL] ACTION: Questions for First Interview

Great! Just FYI – we have the references used in several of the documents already "found," so if you need something, please reach out!
Suzanne

From: LaFleur, Chris <aclafle@sandia.gov>
Sent: Monday, March 09, 2020 11:22 AM
To: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>; Luketa, Anay <aluketa@sandia.gov>; Sanborn, Scott Edward <sesanbo@sandia.gov>; Mohmand, Jamal Ahmed <jamohma@sandia.gov>; Glover, Austin Michael <amglove@sandia.gov>
Subject: [External_Sender] RE: RE: [EXTERNAL] ACTION: Questions for First Interview

Box site works for me!
Chris

From: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Sent: Monday, March 9, 2020 9:21 AM
To: LaFleur, Chris <aclafle@sandia.gov>; Luketa, Anay <aluketa@sandia.gov>; Sanborn, Scott Edward

<sesanbo@sandia.gov>; Mohmand, Jamal Ahmed <jamohma@sandia.gov>; Glover, Austin Michael <amglove@sandia.gov>
Subject: RE: RE: [EXTERNAL] ACTION: Questions for First Interview

We'll be taking notes and we will absolutely share that. Is the BOX site working for you all? We'll probably put the notes there, so you and Steve (PHSMA) can access them.

Suzanne

From: LaFleur, Chris <aclafle@sandia.gov>
Sent: Monday, March 09, 2020 11:15 AM
To: Luketa, Anay <aluketa@sandia.gov>; Dennis, Suzanne <Suzanne.Dennis@nrc.gov>; Sanborn, Scott Edward <sesanbo@sandia.gov>; Mohmand, Jamal Ahmed <jamohma@sandia.gov>; Glover, Austin Michael <amglove@sandia.gov>
Subject: [External_Sender] RE: [EXTERNAL] ACTION: Questions for First Interview

Hi Suzanne,

Yes, those questions seem pretty thorough for now. I am sure we would have some follow-on questions once we review his answers. Will there be a transcript of his answers? Or will notes be taken that we can read?

Thanks
Chris

From: Luketa, Anay
Sent: Monday, March 9, 2020 9:06 AM
To: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>; LaFleur, Chris <aclafle@sandia.gov>; Sanborn, Scott Edward <sesanbo@sandia.gov>; Mohmand, Jamal Ahmed <jamohma@sandia.gov>; Glover, Austin Michael <amglove@sandia.gov>
Subject: RE: [EXTERNAL] ACTION: Questions for First Interview

Hi Suzanne,

These are definitely a good list of questions. I don't have anything to add as of now. It will be interesting to see what he has to say.

-Anay

From: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Sent: Monday, March 9, 2020 8:49 AM
To: Luketa, Anay <aluketa@sandia.gov>; LaFleur, Chris <aclafle@sandia.gov>; Sanborn, Scott Edward <sesanbo@sandia.gov>; Mohmand, Jamal Ahmed <jamohma@sandia.gov>; Glover, Austin Michael <amglove@sandia.gov>
Subject: [EXTERNAL] ACTION: Questions for First Interview

Good morning Sandians,

We are interviewing our first person this afternoon (1pm EST). If you have any questions you'd like to ask Rao (the Physical Scientist identified in the IG report), other than those listed below, please let me know asap.

Thanks!
Suzanne

****

- Can you tell us how you were involved in the review of the Indian Point 50.59 analysis or the 2.206 petition?
- We will have some specific questions as we go through this. Initially, could you walk us through your role in analysis or petition briefly?
- Have you had a chance to read the OIG event inquiry?
- Do you have any thoughts about the OIG inquiry? Any concerns? Parts that you agree with and parts where you think they made an error or misunderstood something about the IP analysis?

Specific questions:

- How did you select methodology?
- How did you chose meteorological conditions?
- How did you obtain pipeline data? (Licensee analysis? FERC?)
- Are you familiar with Kuprewicz's comments/concerns?
- There are several references to reanalysis/sensitivities - is this documented somewhere? Is it different than what was done for the inspection?
- 39Qs said maximum release rate was sustained and did not decline - how related to this? Basis for doubling the break?
- How were buried vs. above-ground pipelines considered?
- How were missiles considered (for both units)?
- Why was risk piece included given that this was a postulated break scenario? If yes, where was risk information obtained (PRA group)?
- Why assume that underground pipe explosion frequency would be an order of magnitude less?
- Why assume that above ground was conservative
- Similar to other reviews / analyses you conducted for NRC? Which?
- Input to selecting peer reviewer?
- Who was peer reviewer?
- Who is lead preparer of RG 1.91?
- RG 1.91 equation change mentioned in IG report - aware? Of concern to you?
- Any other documentation than the 6-page report?
- Also conducted reanalysis and sensitivities at PRB timeframe (60 minute) - how/where documented?
- Can you explain why the PRB responses to Mr. Blanch seem to reflect more conservatism than reflected in the inspection report? Was additional analysis conducted? Is there a record of that analysis? Did that additional analysis receive any peer review?
- Participated in meeting with FERC? What remember? Who was there?
- Reviewed/concurred on documents that referenced your analyses? Which? (For example, did not concur on 39Qs letter; may have reviewed. Congressional responses?)
- Management involvement in analysis, decisions, later use?

Suzanne Dennis
Office of Research
U.S. NRC
301-415-0760

From: Dennis, Suzanne
To: IP Expert Eval Team; Sanborn, Scott Edward; LaFleur, Chris; Glover, Austin Michael; Mohmand, Jamal Ahmed; Luketa, Anay
Subject: Status Check-In on IP Pipeline
Start: Tuesday, March 10, 2020 3:00:00 PM
End: Tuesday, March 10, 2020 5:00:00 PM
Location: Skype Meeting

Hi all,

We thought it would be good to have the whole gang together.

Please let me know if this time is prohibitive for you.

Suzanne

301-415-0760

.....

Join Skype Meeting <https://skype.nrc.gov/meet/suzanne.schroer/LZLTMDC8>

Trouble Joining? Try Skype Web App <https://skype.nrc.gov/meet/suzanne.schroer/LZLTMDC8?sl=1>

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[!OC([1033])!]

.....

From: Dennis, Suzanne
To: "Luketa, Anay"
Subject: RE: RE: [EXTERNAL] RE: FOR YOUR REVIEW: Indian Point documents
Date: Friday, March 06, 2020 3:21:00 PM

I just remembered that we tested this file – are you only putting the password without the "<>"?

From: Luketa, Anay <aluketa@sandia.gov>
Sent: Friday, March 06, 2020 2:47 PM
To: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>; Sanborn, Scott Edward <sesanbo@sandia.gov>; LaFleur, Chris <aclafle@sandia.gov>; Glover, Austin Michael <amglove@sandia.gov>; Mohmand, Jamal Ahmed <jamohma@sandia.gov>
Subject: [External_Sender] RE: [EXTERNAL] RE: FOR YOUR REVIEW: Indian Point documents

Mmm...still isn't opening. If you don't want to set a password, I can send you a link to a secure Sandia site that handles large files.

From: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Sent: Friday, March 6, 2020 12:19 PM
To: Sanborn, Scott Edward <sesanbo@sandia.gov>; LaFleur, Chris <aclafle@sandia.gov>; Glover, Austin Michael <amglove@sandia.gov>; Mohmand, Jamal Ahmed <jamohma@sandia.gov>; Luketa, Anay <aluketa@sandia.gov>
Subject: [EXTERNAL] RE: FOR YOUR REVIEW: Indian Point documents

Try 2.

From: Dennis, Suzanne
Sent: Friday, March 06, 2020 1:33 PM
To: Sanborn, Scott Edward <sesanbo@sandia.gov>; LaFleur, Chris <aclafle@sandia.gov>; Glover, Austin Michael <amglove@sandia.gov>; Mohmand, Jamal Ahmed <jamohma@sandia.gov>; Luketa, Anay <aluketa@sandia.gov>
Subject: RE: FOR YOUR REVIEW: Indian Point documents

Hi all,

Rather than waiting for the BOX site, here are some non-public files. I will send the password shortly.

Suzanne

From: Dennis, Suzanne
Sent: Thursday, March 05, 2020 5:54 PM
To: Sanborn, Scott Edward <sesanbo@sandia.gov>
Cc: LaFleur, Chris <aclafle@sandia.gov>; Luketa, Anay <aluketa@sandia.gov>; Clark, Theresa <Theresa.Clark@nrc.gov>
Subject: FOR YOUR REVIEW: Indian Point documents

Hi Scott! Thanks again for your support to our team. SNL's expertise will be a big asset to our team.

The documents you can start looking at now are listed below. The public ones are hyperlinked and all of them will be available in our BOX file-sharing site as soon as we get that set up. Hopefully, Chris and Anay (and anyone else you'd like) will get an automatic message tomorrow. A BOX "quick" reference guide (35 pages!) is attached, as well as login instructions.

1. Licensee (Entergy) analysis under 10 CFR 50.59 (Indian Point, Units 2 & 3 - Revised 10 C.F.R. 50.59 Safety Evaluation and Supporting Analyses Prepared in Response to the Algonquin Incremental Market Natural Gas Project [OUO – Security-Related Information to come; only on BOX]
2. NRC analysis summary [OUO – Security-Related Information to come; only on BOX]
3. Regulatory Guide 1.91, "Evaluations of Explosions Postulated To Occur on Transportation Routes Near Nuclear Power Plants"
    a. Current Revision 2 (issued 4/2013)
    b. Draft Revision 2, DG-1270 (issued 7/2011 and mentioned in the OIG report)
4. OIG Event Inquiry OIG-16-24
5. Court filings (DC Circuit Court of Appeals Case #16-1081) from individuals who have raised concerns with the pipeline near Indian Point:
    a. Richard Kuprewicz declaration
    b. Paul Blanch declaration

As for schedule... in general, we would like your initial feedback by the end of next week (3/13) if possible. More specifically—

- We may be visiting the Indian Point site late next week. If there are specific things you would like us to look for, please let us know.
- We are planning interviews with various involved persons. If you have any specific questions, please let us know asap. The first interview is on Monday.

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Suzanne
301-415-0760

From: Dennis, Suzanne
To: Sanborn, Scott Edward; LaFleur, Chris; Glover, Austin Michael; Mohmand, Jamal Ahmed; Luketa, Anay
Subject: RE: FOR YOUR REVIEW: Indian Point documents
Date: Friday, March 06, 2020 2:17:00 PM
Attachments: Indian Point pipeline analysis.zip

Note: The four attached records, the subject of prior FOIA requests, have been excluded from the scope of this request.

Try 2.

From: Dennis, Suzanne
Sent: Friday, March 06, 2020 1:33 PM
To: Sanborn, Scott Edward <sesanbo@sandia.gov>; LaFleur, Chris <aclafle@sandia.gov>; Glover, Austin Michael <amglove@sandia.gov>; Mohmand, Jamal Ahmed <jamohma@sandia.gov>; Luketa, Anay <aluketa@sandia.gov>
Subject: RE: FOR YOUR REVIEW: Indian Point documents

Hi all,

Rather than waiting for the BOX site, here are some non-public files. I will send the password shortly.

Suzanne

From: Dennis, Suzanne
Sent: Thursday, March 05, 2020 5:54 PM
To: Sanborn, Scott Edward <sesanbo@sandia.gov>
Cc: LaFleur, Chris <aclafle@sandia.gov>; Luketa, Anay <aluketa@sandia.gov>; Clark, Theresa <Theresa.Clark@nrc.gov>
Subject: FOR YOUR REVIEW: Indian Point documents

Hi Scott! Thanks again for your support to our team. SNL's expertise will be a big asset to our team.

The documents you can start looking at now are listed below. The public ones are hyperlinked and all of them will be available in our BOX file-sharing site as soon as we get that set up. Hopefully, Chris and Anay (and anyone else you'd like) will get an automatic message tomorrow. A BOX "quick" reference guide (35 pages!) is attached, as well as login instructions.

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2. NRC analysis summary [OUO – Security-Related Information to come; only on BOX]
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    a. Current Revision 2 (issued 4/2013)
    b. Draft Revision 2, DG-1270 (issued 7/2011 and mentioned in the OIG report)
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5. Court filings (DC Circuit Court of Appeals Case #16-1081) from individuals who have raised

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a. Richard Kuprewicz declaration
b. Paul Blanch declaration

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Suzanne
301-415-0760

From:	Dennis, Suzanne
To:	"Sanborn, Scott Edward"; "LaFleur, Chris"; "Glover, Austin Michael"; "Mohmand, Jamal Ahmed"; "Luketa, Anay"
Cc:	Harris, Brian; Clark, Theresa; Li, Yueh-Li; "Nanney, Steve (PHMSA)"
Subject:	RE: FOR YOUR REVIEW: Indian Point documents
Date:	Friday, March 06, 2020 1:49:00 PM

As discussed, here's a link to the video from Save the Pipeline: https://sape2016.org/resources/indian-point/videos/ It may help you visualize topography.

Steve, I included you on this email, in case it would be helpful.

Suzanne

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To: Sanborn, Scott Edward <sesanbo@sandia.gov>; LaFleur, Chris <aclafle@sandia.gov>; Glover, Austin Michael <amglove@sandia.gov>; Mohmand, Jamal Ahmed <jamohma@sandia.gov>; Luketa, Anay <aluketa@sandia.gov>
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Suzanne
301-415-0760

From: Dennis, Suzanne
To: Sanborn, Scott Edward
Subject: Re: RE: [EXTERNAL] Quick Phone Call
Date: Wednesday, March 04, 2020 9:43:36 PM

Hi Scott,

That's great news! I'll be going ahead on our end to execute the contract then. We can discuss more tomorrow, if you'd like. (I'm available anytime after noon EST.) Our experts are currently limited to myself and another NRC staffer. Since the team needed people that were independent, we're a small group. Meeting tomorrow or Friday would be great for us.

Thanks so much for your quick response!
Suzanne
301-415-0760

From: Sanborn, Scott Edward <sesanbo@sandia.gov>
Sent: Wednesday, March 4, 2020 8:16 PM
To: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Subject: [External_Sender] RE: [EXTERNAL] Quick Phone Call

Hey Suzanne,

Just to update you on progress after our call. If Anay Luketa is available we can provide NRC support by combining Anay's natural gas modeling expertise and our fire PRA expertise even with Chris's upcoming absence (Chris did say she would be able to help our team out by phone). I spoke with Anay's manager but haven't gotten a hold of Anay yet. I sent both of them the OIG report to review as well.

If Anay does have availability then I'd like to organize a short call before the end of this week to dig into the details with your experts. Separately we are still chasing down how to exercise that clause in the EWA.

Thanks,
Scott

Scott E. Sanborn, Ph.D.
Manager - Fire, Risk, & Transportation Systems, 08854
Nuclear Energy Safety Technologies
Sandia National Laboratories
(505)845-3635 – office
(b)(6) – mobile
sesanbo@sandia.gov

From: Dennis, Suzanne <Suzanne.Dennis@nrc.gov>
Sent: Wednesday, March 4, 2020 3:01 PM
To: Sanborn, Scott Edward <sesanbo@sandia.gov>
Subject: [EXTERNAL] Quick Phone Call

Hi Scott,

Are you available for a quick phone call this afternoon?

Thanks,
Suzanne
301-415-0760