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Safety Review and Confirmatory Analysis

Entergy's 10 CFR 50.59 Safety Evaluation

Algonquin Incremental Market (AIM) Project

Indian Point Energy Center (IPEC)

Introduction

Algonquin Gas Transmission, LLC (Algonquin) proposes an installation of new 42-inch diameter pipeline near the southern boundary of IPEC for the transport of natural gas as part of the AIM Project, to replace the existing 26-inch pipeline in vicinity of IPEC, which will remain in place but idled. Entergy prepared a 10 CFR 50.59 Safety Evaluation (Reference 1) related to the proposed AIM Project with an enclosure "Hazards Analysis" (Reference 2). The 10 CFR 50.59 safety evaluation and enclosure covered the consequences of a postulated fire and explosion following release of natural gas from the proposed new (southern route) AIM Project 42-inch pipeline south of IPEC and determined exposure rates associated with failure of that proposed 42-inch natural gas pipeline. Based on the hazards analysis and also accounting for the pipeline design and installation enhancements, Entergy has concluded that the proposed AIM Project poses no increased risks to IPEC and there is no significant reduction in the margin of safety. Therefore, Entergy further concluded that the change in the design basis external hazards analysis associated with the proposed AIM Project does not require prior NRC approval.

The NRO/DSEA/RPAC Staff at NRC Headquarters has reviewed Entergy's hazards analysis that supports the 10 CFR 50.59 Safety Evaluation related to the AIM Project, by performing independent confirmatory calculations to determine whether or not the licensee's conclusion is reasonable and acceptable, and also to ascertain that there is adequate reasonable assurance of safe operation of the plant or safe shutdown of the plant.

Summary of Evaluation

The staff has reviewed Entergy's "Hazard Analysis" supporting the 10 CFR 50.59 Safety Evaluation related to the AIM Project. Entergy evaluated potential hazards to safety-related structures, systems and components (SSCs) and also SSCs important to safety (SSC ITS) using reasonable assumptions and rationale. Entergy's methodology is appropriate and acceptable. The staff has performed independent confirmatory calculations with conservative assumptions and rationale using RG 1.91 methodology and also using the ALOHA model for vapor plume explosion. The staff also calculated the frequency of potential pipe line failure and determined that there is no additional potential risk to the safe operation of the IPEC units.

Based on the review of the hazards analysis provided as part of Entergy's 10 CFR 50.59 Safety Evaluation, and the staff's independent confirmatory calculation results using conservative

b-1

assumptions and rationale, the staff concludes that (1) no 1 psi overpressure is extended to any safety-related SSC inside the Security Owner Control Area (SOCA), (b)(7)(F)
(b)(7)(F)
However, nearby SSC ITS would be affected, because the calculated minimum safe distances to the impacts are exceeded. The staff finds that the impacts to the SSC ITS from the proposed new 42-inch pipeline are bounded by the impacts from low probability events of extreme natural phenomena (including seismic activity, tornado winds, and hurricanes) which have been assessed and already addressed in the Indian Point Units 2 and 3 UFSARs. The cloud flash fire may occur aloft and burn very rapidly in a few seconds, without affecting any safety-related SSCs or equipment; and the existing margin of safety is not expected to be reduced due to a potential rupture of the proposed AIM Project pipeline near IPEC. The staff also finds that the applicant's conclusions, that the potential rupture of the proposed AIM Project pipeline near IPEC poses no threat to safe operation of the plant or safe shutdown of the plant, are reasonable and acceptable, and also comparable to the staff's conclusions.

Technical Evaluation

The staff's independent confirmatory analysis was performed based on the rupture of the proposed new
42-inch natural gas pipeline consisting of about 3 miles between isolation valves, of which the enhanced section of pipeline length is identified to be 3935 ft., located along the southern route near IPEC. The analysis assumed that rupture of the natural gas pipeline may result in an unconfined explosion or jet flame at the source, delayed vapor cloud fire, or vapor cloud explosion. Missile generation may also accompany the rupture/explosion. For the assessment of an unconfined explosion, RG 1.91 (Reference 3) methodology was used to calculate the minimum safe distance. For the jet flame, cloud fire, and vapor cloud explosion, the ALOHA chemical release modeling computer code (Reference 4) is used to determine the hazard impact distances which are compared with the actual distances at IPEC to structures, systems and components (SSCs) related to safety or SSCs important to safety (SSC ITS), as listed in Reference 2, Table 1, in order to assess the impact potential. ALOHA is run using the appropriate source term (amount of methane released) for the scenario considered, using conservative meteorological conditions (b)(7)(F)
(b)(7)(F)
Open country ground roughness conditions modeling assumptions were chosen.

EXPLOSION

The ALOHA model for explosion scenario 1 conservatively assumed that the pipe rupture occurred at the far end of the pipe line above the surface, considering the length of pipeline to be 3 miles, (b)(7)(F) at a maximum operating pressure of 850 psig. The ALOHA calculation for this scenario resulted in a maximum sustained methane release rate of (b)(7)(F) and estimated total release amount of (b)(7)(F) considering manual closure of the isolation valves within 3 minutes. Conservatively assuming the maximum release (b)(7)(F)

(b)(7)(F) and determining the TNT equivalent amount with a (b)(7)(F) (b)(7)(F) with equation given below, the minimum safe distance (d) to 1 psi overpressure is calculated to be (b)(7)(F) by using RG 1.91 methodology as follows:

WTNT= (Mf * DHC * Y)/4500 where
WTNT= TNT equivalent Mass, kg
Mf = Mass of vapor, kg
DHC = Heat of combustion, kj/kg (50030)
Y = (b)(7)(F)
$d = 45 * (w)^{1/3}$ where
d= minimum safe distance (ft) to 1 psi overpressure
w= TNT equivalent mass in pounds

This calculated minimum safe distance of (b)(7)(F) is smaller than the actual distance of (b)(7)(F) to the SOCA (Security Owner Control Area) from the pipeline at the far end above surface on (b)(7)(F) (b)(7)(F) to the nearest safety-related SSC (nearest safety-related SSC inside SOCA from is about (b)(7) in from the edge of the SOCA) and therefore 1 psi overpressure is not expected at any safety-related SSC inside the SOCA from a potential rupture and explosion at the far end of the pipeline located above the surface. However, as the calculated minimum safe distance of (b)(7) (b)(7)(F) is larger than the actual distances to all SSC ITS, they may experience greater than 1 psi overpressure. Therefore, the SSC ITS would be impacted. Nevertheless, their impacts are bounded by the severe/beyond design basis accidents considered as part of low probability events such as natural phenomena that include seismic, hurricane and tornado events including Loss of Offsite Power and Station Black Out (SBO) considerations with design of redundant systems, engineering safeguards and mitigation measures in the plant UFSARs. The frequency of exposure due to failure of these SSC ITS from potential rupture of AIM Project is also briefly presented later in this report to address whether the margin of safety is reduced or compromised due to rupture of AIM Project.

Assuming a (b)(7)(F) for an unconfined methane explosion (as given in RG 1.91), the methane amount determined from the maximum (b)(7)(F) of methane released (b)(7)(F) (b)(7)(F) determined from the ALOHA run) is used as an instantaneous methane release to simulate the vapor cloud dispersion, transport, and delayed explosion (b)(7)(F)

(b)(7)(F)

Moreover, the SSCs are generally designed to withstand an overpressure of 3 psi. (b)(7)(F) (b)(7)(F) as methane is buoyant and quickly rises aloft, disperses rather rapidly, (b)(7) (b)(7)(F) Therefore, the ALOHA model was rerun with the same input except with an assumption of no congestion in the area. The ALOHA model resulted in no vapor cloud explosion of 1 psi

overpressure at any distance due to potential ignition. The potential pipe rupture underground at the enhanced section of the pipeline would be expected to result in a slower methane release rate, and thereby have potentially much lower impacts than those determined as above.

JET FIRE

The ALOHA model was run conservatively assuming that the pipe rupture occurred at the far end of the pipe line above the surface, considering the length of pipeline to be 3 miles, (b)(7)(F) at a maximum operating pressure of 850 psig. Methane is assumed to be released from the ruptured pipe as a flammable gas and burning. The ALOHA model run resulted in a maximum burn rate of (b)(7)(F) and an estimated total amount burned of (b)(7)(F) and considering manual closure of the isolation valves within 3 minutes. The distances (Table 2) to thermal radiation levels of (b)(7)(F) 5.0 kW/m^2, and 2.0 kW/m^2 calculated by ALOHA are (b)(7)(F) respectively.

The ALOHA model was also run conservatively assuming that the rupture of pipe occurred in the middle of the pipe located underground at the enhanced section identified close to the SOCA, considering half the length of the pipeline between isolation valves (1.5 miles) on each side of the rupture location, (b)(7)(F) at a maximum operating pressure of 850 psig. Methane is assumed to be released from the ruptured pipe segment as a burning flammable gas. The ALOHA model run resulted in a maximum burn rate of (b)(7)(F) and considering closure of the isolation valves within 3 minutes. The calculated distances(Table 2) to the thermal radiation levels of (b)(7)(F) 5.0 kW/m^2, 2.0 kW/m^2 are (b)(7)(F) respectively.

The distances determined to the thermal radiation level of (b)(7)(F) (which has a potential to damage structures and equipment) due to potential pipe rupture at far end of the pipeline or in middle of the pipeline are (b)(7)(F) respectively. Both of these determined distances are smaller than the actual distances of (b)(7)(F) and 1580 ft, respectively, to the SOCA, and therefore, jet fire would not pose any adverse effect on SSCs related to safety. However, it may impact some of the SSC ITS as the radiation level of (b)(7)(F) may be exceeded for some SSC ITS outside of the SOCA. Nevertheless, the impacts to SSC ITS are bounded by the severe/beyond design basis accidents considered as part of seismic and tornado events covering Station Black Out (SBO) and Loss of Offsite Power considerations with design of redundant systems, engineering safeguards and mitigation measures already addressed in the plant UFSARs.

CLOUD FIRE

The ALOHA model was run conservatively assuming that the rupture of pipe occurred at the far end of the pipe line above the surface, considering the length of pipeline to be 3 miles, (b)(7)(F) at a maximum operating pressure

of 850 psig. The ALOHA model run resulted in a maximum sustained release rate of (b)(7)(F) (b)(7)(F) and an estimated total release amount of (b)(7)(F) (b)(7)(F) considering manual closure of the isolation valves within 3 minutes. Conservatively assuming the maximum release rate (b)(7)(F) of methane (determined from the ALOHA run) is used as an instantaneous release (b)(7)(F) to simulate the vapor cloud dispersion, transport to determine the distance to reach the methane lower explosive limit (LEL) of 44,000 ppm. The ALOHA model determined a distance of (b)(7)(F) to reach the LEL. This estimated distance would bound the potential distance to the LEL from the rupture in the middle of pipe in the enhanced area buried underground. Even though the methane plume travels for a long distance, it is buoyant and rises aloft quickly and, therefore, also burns rather rapidly in seconds far above the ground without sustaining and without challenging the structures and components, if enough oxygen is available. Therefore, the impact from cloud fire on SSCs and equipment is not considered challenged.

DETERMINATION OF EXPOSURE RATE FOR FAILURE OF THE AIM PROJECT PIPELINE NEAR IPEC

Based on Pipeline Hazardous Materials Safety Administration (PHMSA) data (www.phmsa.dot.gov), and also published information from "Handbook of Chemical Hazards Analysis Procedures" (Reference 5), the accident rate of pipes greater than 20 inches diameter is about 5×10^{-4}/mile-yr. Assuming 3 miles of AIM Project pipeline near IPEC, the accident rate is determined to be 1.5×10^{-3}/yr. Based on the information in these references, estimating 1 percent of accidents result in a complete pipe break or 100 percent instantaneous release, and assuming also only 5 percent of the time that the released gas becomes ignited leading to potential explosion, the explosion frequency for the AIM project pipeline near IPEC is calculated to be about
7.5×10^{-7}/yr. If this release is due to the underground pipe, the frequency of explosion will be further reduced by at least an order of magnitude. In addition, the frequency of a large radioactivity release from the reactor due to the frequency of the above pipe rupture event, considering operating reactor conditional core damage frequency (CCDF), would be at least a few orders of magnitude lower, and therefore would not be identified as a design basis event. Therefore, it is concluded that the pipe failure resulting in a methane release from the proposed AIM Project near IPEC, would not reduce any further the existing safety margins, and would not pose a threat to the safe operation of the plant or safe shutdown.

CONCLUSION

Based on the review of the hazards analysis provided as part of Entergy's 10 CFR 50.59 Safety Evaluation related to the AIM Project near IPEC, and staff's independent confirmatory calculation results using conservative assumptions and rationale, the staff concludes that no 1 psi overpressure is extended to any safety-related SSC inside the SOCA (b)(7)(F) (b)(7)(F)
However, nearby SSC ITS would be affected, as the calculated minimum safe distances to the

impacts are exceeded, but these impacts are bounded by the impacts from low probability events of extreme natural phenomena that include seismic, tornado winds, hurricanes which have been assessed and already addressed in UFSAR. Cloud flash fire may occur aloft and burn very rapidly in few seconds, without affecting any safety related SSCs or equipment, and the existing margin of safety is not expected to be reduced due to potential rupture of the proposed AIM Project pipeline near IPEC. The staff also finds that the applicant's conclusions that the potential rupture of the proposed AIM Project pipeline near IPEC poses no threat to safe operation of the plant or safe shutdown of the plant are reasonable and acceptable. The staff's review finds that the hazards analysis supporting the licensee's 10 CFR 50.59 safety evaluation is appropriate and shows that there is not more than a minimal increase to the likelihood of occurrence or consequences of damage to a safety-related SSC or SSC ITS, when compared to the current hazards analysis in the plant UFSARs.

REFERENCES

1. Entergy, "10 CFR 50.59 Safety Evaluation and Supporting Analyses Prepared in Response to the Algonquin Incremental Market Natural Gas Project Indian Point Nuclear Generating Units Nos. 2 & 3," NL-14-106, August 21, 2014. ML14245A110.

2. Entergy, "Hazards Analysis," Enclosure to NL-14-106, August 21, 2014. ML14245A111 (Non-public).

3. US Nuclear Regulatory Commission, Regulatory Guide 1.91, "Evaluations of Explosions Postulated to Occur at nearby Facilities and on Transportation Routes Near Nuclear Power Plants," Revision 2, April 2013.

4. US EPA, NOAA,"ALOHA User's Manual," February 2007.

5. FEMA, US DOT, US EPA, "Handbook of Chemical Hazard Analysis Procedures."

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