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June 13, 2003

PG&E Letter DIL-03-008

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

Docket No. 72-26
Diablo Canyon Independent Spent Fuel Storage Installation
Additional Questions Related to Supplemental Blasts and Explosions Responses to Additional NRC Questions for the Diablo Canyon Independent Spent Fuel Storage Installation Application (TAC No. L23399)

Dear Commissioners and Staff:

By letter dated December 21, 2001, the Pacific Gas and Electric Company (PG&E) submitted an application to the U. S. Nuclear Regulatory Commission (NRC) for a 10 CFR 72 site-specific license to build and operate an independent spent fuel storage installation (ISFSI) at the Diablo Canyon Power Plant site. The application included a Safety Analysis Report (SAR), Environmental Report (ER), and other required documents in accordance with 10 CFR 72.

PG&E Letter DIL-03-005, dated March 27, 2003, submitted additional information regarding blasts and explosions in response to additional NRC questions. The NRC has recently asked additional questions regarding blasts and explosions. Reponses to these questions are included in Enclosure 1 to this letter. Enclosure 2 is Calculation PRA 01-01, Revision 4, which was revised to clarify and support the responses to the additional NRC questions.

If you have any questions regarding this response, please contact Mr. Terence Grebel at (805) 545-4160.

Sincerely,

Lawrence F. Womack

NMSS01

psn/4998
Enclosures

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UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

In the Matter of PACIFIC GAS AND ELECTRIC COMPANY Diablo Canyon Independent Spent Fuel Storage Installation	Docket No. 72-26

AFFIDAVIT

Lawrence F. Womack, of lawful age, first being duly sworn upon oath states that he is Vice President, Nuclear Services of Pacific Gas and Electric Company; that he is familiar with the content thereof; that he has executed this supplemental response to additional NRC blasts and explosions questions regarding the Diablo Canyon Independent Spent Fuel Storage Installation license application on behalf of said company with full power and authority to do so; and that the facts stated therein are true and correct to the best of his knowledge, information, and belief.

Lawrence F. Womack
Vice President Nuclear Services

Subscribed and sworn to before me this 13th day of June 2003.

Karen T. Mason
Notary Public
State of California
County of San Luis Obispo

KAREN T. MASON
Commission # 1227704
Notary Public - California
San Luis Obispo County
My Comm. Expires Jul 31, 2003

PG&E Response to Additional NRC Questions Related to Blasts and Explosions for the Diablo Canyon ISFSI License Application

NRC Questions:

The following assumptions used in the Probabilistic Risk Assessment (PRA) (Pacific Gas and Electric Company, 2003) have not been properly justified.

(1) *The transporter will be in the vicinity of the hydrogen tanks a total of 10 hrs/yr. Neither the setback nor exposure distances, however, have been established to adequately estimate the exposure time. The setback and exposure distances have not been clearly established for other potential explosion hazards along the transfer cask transportation route. These hazards include the electrical transformers and cars parked in various locations [e.g., lots 7, 8, and 3 others (see Figure 2.2-1 of the SAR).*

(2) *The 189 l [50 gal.] gasoline powered vehicle travel (or exposure) distance while within the 73 m [238 ft] setback zone is 122 m [400 ft]. Following the procedure of NRC Regulatory Guide 1.91, however, the exposure distance for this particular hazard was calculated by the staff to be approximately 335 m [1,100 ft].*

(3) *The potential explosion energy release from the maximum number of gas bottles that may be transported by the ISFSI site is less than the potential energy release from the [2,000 gal] gasoline tanker truck. The maximum number of gas bottles that may be transported by the ISFSI site was not specified. As a result, it is not clear what the appropriate setback or exposure distances are. The yearly frequency of occurrence for the gas bottles explosion hazard needs to be quantified and summed with the 189 l [50 gal] and 7,571 l [2,000 gal] gasoline hazards for the ISFSI to establish the overall risk from explosions.*

In addition, the electrical transformer distance from the transfer cask transportation route needs to be clarified. The description provided on Sheet 11 of the PRA (Pacific Gas & Electric Company, 2003) suggests a separation distance of approximately 55m [180 ft], which is corroborated by Figure 2.2-1 of the SAR. Sheet 12 of the PRA, however, explicitly states a separation distance of 73 m [240 ft].

PG&E Response:

(1) The PRA Calculation PRA 01-01 has been revised to discuss the limitation on the exposure distance for the transporter from the hydrogen facility. The basis for this limitation is that the hydrogen tanks are in a vault that is only open on the side that the transporter passes on. As a result, the only exposure is the distance the transporter has to travel in front of that open vault side. There is no setback distance calculation required because of this configuration. The open side of the vault is less than 30 ft and at the normal transporter speed it will take less than two minutes,per trip and 16 minutes total, based on 8 trips per year. However, conservatively an exposure time of 10 hours per year was used in PRA 01-01.

For the other hazards along the transporter route, PRA Calculation 01-01 has also been revised to provide logic and justification for the assumptions made. For the transformers the exposure distance is affected by buildings that limit the line-of-sight of the transformers to the transporter to approximately 800 ft. As a result, no setback calculation is required. For the exposure distance in the parking lots, changes in elevation and limited line-of-sight results in the conservative 1000-ft exposure distance. This exposure distance considers a revised 175-ft setback distance (discussed below) calculated for the parked vehicles and includes all of the parking lots that may have exposure.

(2) PRA Calculation 01-01 was revised to include a figure that lays out the exposure distance for the ISFSI based on the 20-gallon average fuel tank setback of 175 ft. This revision provides a discussion of the limitations on this exposure distance because of the hillsides to the southwest of the ISFSI pad. As a result of this limitation the exposure distance is determined to be less than 300 ft. The 300 ft is used in the PRA calculation.

(3) The PRA calculation has been revised to provide a specific evaluation of the potential for gas bottles explosions in the vicinity of the ISFSI based on additional plant information. In the PRA calculation the risk from gas bottles has been summed with all the evaluated risks for the ISFSI and all the risks for the transporter have been summed. Each of these sums is less than the RG 1.91 acceptance criterion of 1.0 E-6.

As a part of the revision to the PRA, more up to date information on the size and frequency of the 2000-gallon fuel truck and gas bottles that will pass the ISFSI was incorporated. Per this new information the 2000-gallon truck has been replaced with an 800-gallon truck that passes the ISFSI six times a week and the gas bottles data have been revised to show that there is a single 7-gallon propane bottle used by a forklift that passes the ISFSI four times a week.

In response to the last part of the NRC request concerning distance from the transformers to the transporter route, the PRA calculation has been revised. Additional discussion was added to clarify that the line-of-sight separation distance is approximately 240 ft and is the result of the change in elevation between the transformers and the transporter route.

Enclosure 2

PACIFIC GAS & ELECTRIC COMPANY

PROBABILISTIC RISK ASSESSMENT

CALCULATION FILE NO. **PRA01-01 Revision 4**

SUBJECT: Risk Assessment of Dry Cask/Spent Fuel Transportation within the DCPP Owner Controlled Area

PREPARED BY: ______________________ DATE: 6-10-03
D. F. Spaulding

VERIFIED BY: ______________________ DATE: 6/11/03
E. G. Davis

VERIFIED IN ACCORDANCE WITH: CF3.ID15

APPROVED BY: ______________________ DATE: 6/11/03
A. Afzali

NOTE: This Document contains assumptions and results that are the basis for parts of SAR Sections 2.2.2.3 and 8.2.6, Modification of this document will require evaluation under 10CFR72.48.

This file contains: 19 pages including Attachment 1 & 2

RECORD OF REVISIONS

REV. 0 Original Calculation.

REV. 1 In this revision, the risk of damage to dry casks due to explosion of an acetylene carrying truck is added to the analysis of risk of damage due to other hazards. This is done to support response to RAI 15-12.

REV. 2 In this revision, the date of the final HI-TRAC evaluation was changed to reflect the actual issuance date (March 6, 2001). The February 2001 date was a preliminary draft, which was the version available at the time this PRA calculation was initially issued (Revision 0 dated February 28, 2001).

REV. 3 In this revision, the evaluations have been revised to address the RG 1.91 1 PSI criteria where possible, to use more up to date vehicle crash data, and to clarify the previous evaluations.

REV. 4 In this revision, the evaluations have been revised to clarify various exposure distances, to reduce the average onsite gasoline powered vehicle fuel tank size to 20 gallons, replace the 2000-gallon fuel truck with a new 800-gallon fuel truck which is now being used, and clarify the evaluation of gas bottles passing by the ISFSI. Reference 9 provides updated information on hazardous materials being transported by the ISFSI.

INTRODUCTION

Per the requirements of RG 1.91, Revision 1, explosive hazards in transit are to be evaluated to ensure that there is no significant potential for damage to any safety related components. This RG also provides guidance that allows determination of risk based on location and amount of the hazard. When using a potential design limit of 1 psi for a component, if the risk is found to be less than 10^{-6} using conservative data or less than 10^{-7} using more site-specific data, then the risk is considered non-significant and acceptable. The methodology in the RG allows a hazard to be dismissed as non-significant if the 1 psi criteria is met based on a setback distance and volume of hazard. However, if the setback distances or volume of a hazard will potential exceed the 1 psi criteria the RG requires further evaluation based on probability and risk. Based on this the RG guidance risk evaluations were performed to assess the risks of an explosion causing damage to the dry casks while being transported, or while the casks are stored at the Independent Spent Fuel Storage Installation (ISFSI). As a result, several explosion sources were identified that potentially don't meet the setback and volume limitations and required further evaluation. Specifically, six bounding explosion sources were identified requiring this risk evaluation:

1. An explosion of a parked vehicle's fuel tank while the HI-TRAC transporter is passing on the road near or through the parking lots on its route to the ISFSI.

2. A hydrogen explosion in the protected area from the hydrogen tanks while the HI-TRAC transporter is in the vicinity.

3. An explosion of a 800-gallon fuel truck while it passes within 600 feet of the ISFSI facility.

4. An explosion of a Unit 2 transformer while the HI-TRAC transporter is passing on the elevated road inside the Radiologically Controlled Area (RCA).

5. Explosion of one of the 140 vehicles per day (with an average of 20 gallons of gasoline) that pass within 175 feet of the ISFSI facility.

6. An explosion at various compressed gas cylinder storage facilities and the movement of propane or acetylene bottles past the ISFSI area.

In addition, similar hazards that are potentially transported by different means are summed in this calculation to show the total exposure potential for that hazard per RG 1.91.

DISCUSSION

One of the requirements in the Diablo Canyon Spent Fuel Storage Installation (ISFSI) Safety Analysis Report (SAR) is the evaluation of explosions. During the evaluation process, six bounding potential explosion hazards were identified as needing a risk evaluation to ensure that they meet the RG 1.91 1 psi limit, or that they are acceptable risks per the methodologies provided in RG 1.91. These six explosion hazards are:

1. Explosion of a parked vehicle, while the HI-TRAC transfer cask transporter is passing in the vicinity of the parking lots.

2. Explosion of the bulk hydrogen storage facility while the cask transporter is in the area.

3. Explosion of one of the 800-gallon fuel trucks while the truck is passing within 600 feet of the ISFSI facility.

4. Explosion of a Unit 2 transformer while the cask transporter is moving through the RCA.

5. Explosion of one of the 140 vehicles per day (with an average of 20 gallons of gasoline) that pass within 175 feet of the ISFSI facility.

6. Explosion of various compressed gas cylinder storage facilities and the explosion of propane or acetylene bottles moving past the ISFSI facility.

ACCEPTANCE CRITERIA

Regulatory Guide 1.91 (Reference 1) contains guidance on acceptable risk from explosions for nuclear plants. Regulatory Guide 1.91 states, "If estimates of explosion rate, frequency of shipment, and exposure distance are made on a realistic or best estimate basis, an exposure rate less than 10^{-7} per year is sufficiently low. If conservative estimates are used, an exposure rate less than 10^{-6} is sufficiently low."

ASSUMPTIONS

1. It is estimated that there will be eight shipments per year of the HI-TRAC transfer casks from the spent fuel building to the ISFSI.

2. The hydrogen tanks will not be filled, tested or vented while the HI-TRAC transfer cask transporter is in the vicinity of the hydrogen tanks. (Ref: AR A0524878)

3. Additional physical barriers will be erected to prevent the transporter from getting too close to the hydrogen tanks. (Ref: AR A0524878)

4. The 800-gallon trucks will be maintained at least 600 feet from the transporter path during spent fuel transport. See Assumption 6 below for specific setback required to meet RG 1.91 criteria of 1 psi. (Ref: AR A0524878) Note: The 2000-gallon truck is no longer being used and has been replaced by an 800-gallon truck. (Reference 9)

5. A 800 gallon truck will pass by the ISFSI facility six time per week. This is based on three round trips per week. (Reference 9)

6. The 800-gallon truck does not stop within 600 feet of the ISFSI. Administrative controls will designate parking areas for this vehicle. However, if there is a mechanical breakdown within the 600 feet of the ISFSI, administrative controls will require immediate removal to its designated parking area or to a distance of greater than 600 feet from the ISFSI. (Ref: AR A0524878).

   The setback distance is based on the maximum amount of gasoline in the truck being 800 gallons. Using the RG 1.91 methodology, reference (1) the required setback or separation distance (at which the pressure wave is equal to or less than 1 psi) can be calculated.

   $R \geq kW^{1/3}$

   Where R is the setback in feet
   W_{tnt} is the explosion hazards in equivalent pounds on TNT
   k is 45 when R is in feet and W is in pounds

   Using the formula in reference (2) section 1) for 4000 gallons to determine the equivalent lb-TNT and using a 800 gallons capacity,

W_{tnt} = 11770.6 * 800/4000 = 2,354.12 lb-TNT

And

$R \geq (45)(2{,}354.12)^{1/3}$
$R \geq$ 598.63 feet in setback or separation distance
(Note: 600 feet will be used in this evaluation)

Note: the W_{tnt} calculated in reference (2) is conservative as it assumes "that 100% of the liquid has been vaporized and mixed with air between the upper and lower flammability limits" and that "No credit for partial shielding between the casks and the location of the explosion is considered."

7. The speed of all vehicles in the area of the ISFSI will be administratively controlled to less than 25 miles per hour. (Ref: AR A A0524878)

8. No vehicles will be allowed to pass the 800-gallon truck in either direction while it is in the 600 foot exclusion area around the ISFSI facility. (Ref. AR A0524878)

9. All gasoline powered vehicles, which must pass within 175 feet from the closest point of an ISFSI pad will be under administrative controls. The administrative controls will control speed, movement and provide designated parking areas outside the 175 foot setback distance for these vehicles. If there is a mechanical breakdown within the 175 foot setback distance, administrative controls will also require immediate removal to its designated parking area or to a distance of more than 175 feet from the ISFSI. (Ref: AR A0524878)

   The setback distance is based on the average amount of gasoline in any onsite vehicle fuel tank which is conservatively assumed to be 20 gallons. Using the RG 1.91 methodology the required setback or separation distance (at which the pressure wave is equal to or less than 1 psi) can be calculated.

   $R \geq kW^{1/3}$

   Where R is the setback in feet
   W_{tnt} is the explosion hazards in equivalent pounds on TNT
   k is 45 when R is in feet and W is in pounds

   Using the formula in reference (2) section 1) for 4000 gallons to determine the equivalent lb-TNT and using 20 gallons as the average tank capacity,

   W_{tnt} = 11770.6 * 20/4000 = 58.85 lb-TNT

   And

$R \geq (45)(58.85)^{1/3}$
$R \geq 175$ feet in setback or separation distance

Note: the W_{tnt} calculated in reference (2) is conservative as it assumes "that 100% of the liquid has been vaporized and mixed with air between the upper and lower flammability limits" and that "No credit for partial shielding between the casks and the location of the explosion is considered."

10. It is assumed that no more than 140 gasoline-powered vehicles per day will pass by the ISFSI facility. The actual number of vehicles that pass the ISFSI facility per day is approximately 50 vehicles and they pass it in two directions. However, 140 vehicles was used to be conservative.

11. The 4000-gallon fuel truck will be not allowed in the owner-controlled area during spent fuel transport. (Reference 2) (Ref: AR A0524878)

12. ~~Administrative controls will prevent the 4000-gallon truck from moving up the~~ hill and passing by the ISFSI facility. (Ref: AR A0524878)

13. Physical and administrative controls will be in place to prevent vehicle movement within 175 feet of the moving cask transporter. (Ref: AR A0524878)

14. The cask transporter, while loaded with a HI-TRAC transfer cask, will be in the vicinity of the bulk hydrogen storage facility less than 1 hour during each shipment from the spent fuel building to the ISFSI facility.

15. The cask transporter, while loaded with a HI-TRAC transfer cask, will be in the vicinity of the parking lots less than 1 hour during each shipment from the spent fuel building to the ISFSI facility. This estimated time is very conservative considering that the total exposure distance as a result of the travel route of the transporter in the parking lots (which are located within 175 feet of the transport route and which could impact the transporter from an explosion, i.e., no intervening buildings or elevation differences) is approximately 1000 feet, the transporter moves at about 0.4 mph, and the transporter will pass straight through these areas with minimal maneuvering required. At the 0.4 mph speed the transporter would be in the area less than 30 minutes. This time has been doubled to be conservative in this evaluation.

16. Administrative Procedure AD4.ID1 requires that all bottles within the RCA and outside the protected area will be appropriately secured and chained so they are not hazards. A walkdown will occur prior to the transporter beginning its trip, from the Spent Fuel Pool Building to the ISFSI, to confirm the bottles are appropriately chained. (Ref: AR A0524878)

17. Walkdowns will occur in the parking lots, which have the potential to affect the transportation route, to assure that no potential explosive hazards (such as leaking

gasoline tanks) exist prior to any movement of the loaded cask transporter in the vicinity of these parking lots. (Ref: AR A0524878)

18. Additionally, a walkdown will occur outside the protected area prior to movement of the cask transporter, while loaded with a HI-TRAC transfer cask, to evaluate any transient hazardous material located along the pathway. (Ref: AR A0524878)

19. It is assumed that all gas bottles transported past the ISFSI facility will be appropriately secured in the upright position within the transporting vehicle.

CALCULATIONS

Hydrogen Tank Explosion

The bulk hydrogen facility contains 6 hydrogen tanks. The hydrogen tanks and hydrogen piping contain relief valves, which are vented to atmosphere. Because of the design, a hydrogen explosion is not considered credible. However, hydrogen fires are credible, and appear in the EPRI Fire Events Database (Reference 5), including fires caused by a stuck open or leaking relief valve.

The EPRI Fire Events Database gives an annual frequency of Hydrogen fires of 3.2e-3/year (Reference 5). It is conservatively assumed the entire frequency of fires can be assigned to the bulk tank facility. Thus, the hourly frequency of hydrogen fires at the bulk tank facility is:

Hydrogen Fire Frequency = 3.2e-3/yr * yr/8760 hrs = 3.7e-7/hr

Because of the design of the hydrogen system, which does not allow hydrogen to accumulate in confined spaces, there is an extremely low probability of a hydrogen explosion, even if a hydrogen fire occurs. If we conservatively assume a conditional probability of 0.1 that a hydrogen explosion occurs, given a hydrogen fire has occurred, then the Hydrogen Explosion Frequency is:

Hydrogen Explosion Frequency = 3.7e-7/hr * 0.1 = 3.7e-8/hr

The hydrogen explosion is a concern when the HI-TRAC transfer cask transporter is in the vicinity of the hydrogen tanks. As noted in the assumptions section, the transporter should be in the vicinity of the hydrogen tanks less than 1 hour for each shipment, with eight shipments per year. It will be assumed that the transporter will be in the vicinity of the hydrogen tanks a total of 10 hours per year. This assumption is very conservative because the hydrogen facility is a vault that is open on one side only. The open side is where the transporter passes. Because of the configuration of the area around the vault the transporter is only exposed to the potential of an explosion as it passes directly in front of the open end of the vault. The vault open end is less than 30 ft

across and at the normal speed of the transporter it will be exposed for less than two minutes per trip. However, conservatively the calculation has used 10 hours per year.

On a yearly basis, the probability (exposure rate) of a hydrogen explosion potentially damaging the HI-TRAC cask is:

3.7e-8/hr * 10 hr/yr = 3.7e-7/yr

According to Regulatory Guide 1.91, "if conservative estimates are used, an exposure rate less than 10-6 per year is sufficiently low."

800 Gallon Truck Explosion

There is data available from the Department of Transportation on truck crashes and truck fires. Table 38 of the 2001 NHTSA statistics (Reference 6) show that in 2001 large trucks were involved in 429,000 crashes. Table 1 of the 2001 FMCSA data (Reference 7) shows that in 2001 large trucks traveled approximately 207,686 million miles. This results in a "Large trucks involvement rate" of 207 per 100 million miles. This data includes crashes from all hazards including weather and natural causes.

Per the assumption that no other vehicle will be traveling near the ISFSI when the 800-gallon truck is in motion it is assumed that only a single vehicle accident can occur. Based on Table 46 of the 2001 NHTSA statistics (Reference 6), single vehicle crash data, shows a total of 96,000 crashes occurred in 2001, which is approximately 22 percent of all large truck crashes.

Per the listed assumptions the speeds in the area of the ISFSI are to be controlled below 25 miles per hour at all times. Based on this, Table 29 of 2001 NHTSA statistics (Reference 6) shows that for all single vehicle crashes approximately 31 percent are less than 30 miles per hour. Although there is no specific data provided for large trucks as compared with all vehicles, for our calculations we are conservatively assuming that for trucks it is similar to the single vehicle crash percentage which is 31 percent of all accidents are at less than 30 miles per hour,

Although the Table 29 data does not provide a direct correlation between the large truck data and the all vehicle data, the use of 31 percent is believe d to be reasonable. In support of this assumption, Table 26 of the 2001 FMCSA data (Reference 7) provides data that shows that the percentage of fatal crashes involving a single large truck at 25 miles or less is about 6.8 percent of all fatal large truck crashes. Table 29 of 2001 NHTSA statistics (Reference 6) shows that for all fatal single vehicle crashes approximately 13 percent are at less than 30 miles per hour. For speeds above this level the percentage of fatal accidents involving large trucks continues to remain below the percentage for all vehicles. Based on this trend it is reasonable to consider that the percentage of single large truck accidents under 30 mph will remain below the percentage for all vehicles crashes. However, to ensure this is conservative this evaluation used a 31 percent figure as discussed above.

Table 38 of the 2001 NHTSA statistics (Reference 6) shows that 0.5 percent of all large truck crashes result in fires. Thus, the frequency of truck fires is:

(207 * 0.22 * 0.31 / 100e6) *0.005 = 7.061e-10/mile

For the purposes of this analysis, it is conservatively assumed that all truck fires result in an explosion. Thus, the explosion rate for truck fires is 7.06e-10/mile.

Regulatory Guide 1.91 provides the following equation for use in the evaluation of explosions:

r = nfs, where

n= explosion rate for the substance and transportation mode in question in explosions per mile
f = frequency of shipment for the substance in question in shipments per year, and
s = exposure distance in miles

It is assumed that the ISFSI exposure distance, s is conservatively 2300 feet based on a 600 foot exclusion area from the nearest cask. This exposure distance is limited on the west and south sides of the ISFSI by an elevated hillside, which limits line-of-sight to the roadway. As noted above in the assumptions section, the frequency of shipments is 6 times per week, or 312 per year.

Thus, r = (7.06e-10/mile) * 312 * 2300/5280 = 9.59e-8/year

Note: This is conservative because we are assuming that all vehicle fires lead to an explosion

<u>20 Gallon Gasoline Powered Vehicle Explosion near ISFSI</u>

There is data available from the Department of Transportation on all vehicle crashes and all vehicle fires. The 2001 National Statistics summary of the NHTSA statistics (Reference 6) show that in 2001 all motor vehicles were involved in 6,323,000 total crashes. It also shows that motor vehicles traveled approximately 2,781,462 million miles. This results in a "vehicle involvement rate" of 227 per 100 million miles." This data conservatively include all motor vehicles including large trucks and from all hazards including weather and natural causes.

Per the assumption that vehicle travel will be limited within the 175 feet setback distance from the closest part of the ISFSI facility and will result in no vehicle being allowed to pass another vehicle within that setback distance As a result, only a single vehicle accident can occur. Based on this Table 29 of the 2001 NHTSA statistics (Reference 6) provides single vehicle crash data, which shows a total of 1,907,000 crashes in 2001, which is approximately 30 percent of all vehicle crashes.

Per the listed assumptions the speeds in the area of the ISFSI are to be controlled below 25 miles per hour at all times. Based on this, Table 29 of 2001 NHTSA statistics (Reference 6) shows that for all single vehicle crashes approximately 30 percent are less than 30 miles per hour.

Table 38 of the 2001 NHTSA statistics (Reference 6) shows that 0.1 percent of all vehicle crashes result in fires. Thus, the frequency of vehicle fires is:

227 * 0.30 * 0.30 / 100e6 * 0.001 = 2.04e-10/mile.

For the purposes of this analysis, it is conservatively assumed that all vehicle fires result in an explosion. Thus, the explosion rate for vehicle fires is 2.04e-10/mile.

Regulatory Guide 1.91 provides the following equation for use in the evaluation of explosions:

r = nfs, where

n= explosion rate for the substance and transportation mode in question in explosions per mile
f = frequency of shipment for the substance in question in shipments per year, and
s = exposure distance in miles

It is assumed that the ISFSI exposure distance, s is approximately 300 feet as shown in attachment 2. The exposure distance on the southwest side of the ISFSI is limited by an elevated hillside which limits line-of-sight to the roadway. The exposure distance reflects the exposure of any cask at the ISFSI facility from this hazard on while this hazard in on the roadway and within the setback of 175 feet distance.

As noted above in the assumptions section, the frequency of 140 per day, or 51,100 per year.

Thus, r = 2.04e-10/mile * 51,100 * 300/5280 = 5.92e-7/year

Summing the potential exposure rates from a gasoline hazard for the ISFSI facility per RG 1.91:

Total potential exposure = 9.59e-8/year + 5.92e-7/year = 6.88e-7/year

According to Regulatory Guide 1.91 Revision 0, if conservative calculations are used, an exposure rate, of less than 1e-6/year is acceptable.

For explosions from gasoline hazards at the ISFSI, all of the above date and results are very conservative as they are based on national highway statistics and do not take into consideration the very controlled nature of the activities at the ISFSI, the limited

maneuvers performed by any vehicle in the area of the ISFSI, the normal speeds which are below 25 miles per hour, the over stated potential for fires resulting in explosions, and the number of vehicles in the area.

Parked Vehicle Explosion Risk

Vehicle (defined as non-large truck) explosions almost always are the result of a crash or collision, and rarely, if ever, occur in parked vehicles. Based on the known history of DCPP there has been only one fire in a vehicle in the parking lots. That fire ignited at the time the car was being started and occurred in the ignition system. That fire would not be considered a credible scenario during fuel transport because of administrative controls that will be in place as follows:

Prior to a loaded transporter being moved in the vicinity of a parking lot, administratively controlled walk downs of the parking lots will be performed looking for any possible fire or explosion hazards such as leaking gasoline.

During the transportation of the HI-TRAC transfer cask, administrative and physical controls will be in place to prevent vehicles from moving within 175 feet of the transporter, while it is in the vicinity of the parked vehicles.

With these controls in place the only possible explosion scenario is spontaneous combustion of a parked car. This event is not considered credible.

In support of this conclusion, a search was conducted for industry data concerning the frequency of explosions of parked vehicles. However, no industry information of this type was found. However, to be conservative the following analysis was performed.

Per the previous analysis of a 20-gallon vehicle, it was determined that the frequency of fires/explosions in a single moving vehicle crash is 2.04e-10/mile. Since none of the parked cars are moving or allowed to move within 175 feet of the transporter and the event is not considered credible, reducing this frequency by a factor of ten is considered reasonable and very conservative.

Regulatory Guide 1.91 provides the following equation for use in the evaluation of explosions:

$$r = nfs, \text{ where}$$

n= explosion rate for the substance and transportation mode in question in explosions per mile
f = frequency of shipment for the substance in question in shipments per year, and
s = exposure distance in miles

The frequency (s) of shipment in the assumption section is 8 trips will be made per year. It is assumed that the ISFSI exposure distance, s is conservatively 1000 feet. In

addition, it is estimated that a maximum of 200 vehicles will be within that 175 feet setback distance at any moment while the transporter is moving through the exposure distance.

> Thus, conservatively r = exposure rate * frequency * exposure distance *number of exposure vehicles = 2.04e-11 * 8 * 1000/5280 * 200 = 6.18e-9

Note: This is conservative because we are assuming that all vehicle fires lead to an explosion and we are using moving vehicle explosion rates for stationary vehicles.

According to Regulatory Guide 1.91 Revision 1, if conservative calculations are used, an exposure rate, of less than 1e-6/year is acceptable.

Transformer Explosion

There are 6 active, normally energized transformers located on the Unit 2 side (south side) of containment. Three are single-phase 500kV transformers, two are three phase 25kV transformers and the last is a three-phase 12kV transformer. There are also two spare transformers stored adjacent to the active transformers. The transformers are located at elevation 85'. The road for the transporter is at elevation 115' and runs perpendicular to the potential explosion zone for under 800 feet. Based on the existence of several large buildings (parts of the power block and the administration building) that shield the transporter beyond the 800 feet, the total exposure distance to this hazard is taken as 800 feet. At the normal speed of the transporter, it will be exposed for approximately 23 minutes each trip. This evaluation conservatively uses 10 hour per year.

There is a sloped, rock-covered embankment located approximately 120 feet from the transformers. That embankment is 30 feet tall and would take the majority of the explosive force heading in that direction. On the top of the embankment at elevation 115' is a paved lot that is used as a storage area – this has already been evaluated in Reference 4. Approximately 60 feet away from the ledge of the embankment is the road that the HI-TRAC transporter will traverse. Because of change in elevation from the transformers to the transporter route the straight-line distance is approximately 240 feet.

The layout of the transformers is such that the three single-phase 500kV transformers are located closer to the pathway, while the two three phase 25kV transformers are mostly shielded from the pathway by the 500kV transformers. The 12kV transformer is located further yet, and is also shielded by the other transformers. All of the active transformers have a fire suppression system surrounding them, which will activate in the event of a fire.

Failure rate for transformers was obtained from a standard nuclear industry source (Reference 10) using catastrophic failures, which are composed of open and short circuits, plus not crediting mitigation by protective features; i.e. potential explosive

failures. The recommended values from the reference were utilized, which is conservative for the new 500kV transformers installed on Unit 2.

Transformer type	Failure Rate	Reference
500 kV Single Phase Transmission	2.6E-7 failures per hour	Page 369, Section 6.3.1.6
12kV – 25kV Three Phase Transmission	6.6E-7 failures per hour	Page 371, Section 6.3.2.1

Consistent with the assumptions throughout this calculation, the conservative time of 10 hours of transport will be used. There are three transformers of each type. Additionally, there is a geometric factor to consider, for an explosion would have to impact the transporter traveling approximately 240 feet away at an elevated height of 30 feet above the transformer. The geometric factors utilized assumed that there would be no bounce, or reflection off structures or the rock embankment that could impact the transporter and that the blast was evenly distributed over the potential 180 degrees of blast direction. As noted earlier, the transporter will be approximately 240 feet away from the transformers and elevated approximately 30 feet. As a result, the ratio of the transformer target area to the total blast area is quite small, and is judged to result in geometry factors of 5e-3 for the 500 kV transformers and 1e-3 for the 12-25kV transformers, assuming a 20% throughput of energy past the 500kV transformer acting as a directional shield.

Thus: 500kV: (2.6e-7 failures per hour per transformer) x (3 transformers) x (10 hours per year) x (5e-3 geometric) = 3.9e-8 per year

And

12-25kV: (6.6e-7 failures per hour per transformer) x (3 transformers) x (10 hours per year) x (1e-3 geometric) = 1.98e-8

The total risk is the sum of the risks from the two calculations for the 6 transformers, which is 5.88e-8 per year.

The risk from a transformer explosion, based on exposure time and distance, is estimated to be less than the 1e–6 acceptance criteria stated by R G 1.91.

Gas Bottle Explosion

There are no storage facilities for explosive gases within 1000 feet of the ISFSI facility and the uses for these gases are very limited within that distance. Based on recent discussions with the DCPP personnel there is some cutting requiring a touch is done at the maintenance facility east of the ISFSI and they do use propane powered forklifts occasionally at that facility. These forklifts use a 7-gallon propane bottle. Per these discussions, it was also determined that less than one acetylene bottle is bought by the ISFSI per year and that less then one single propane bottle per week passes the ISFSI. The estimate of the propane movement is based on both the actual movement of a

spare propane bottle in a truck or the movement of the forklift itself. The movement of the forklift is controlled under the same administrative controls for large trucks in the area of the ISFSI.

The movement of the propane and acetylene bottles past the ISFSI facility will be controlled through administrative procedures. These procedures will not only control the amount of gas being transported, but how it is physically restrained during transport to ensure limited potential for failure.

Explosions or failures of any type involving compressed gas bottles usually are caused from valves being broken or the bottles being pierced by some external object. These types of failures require some motive force and are considered to be limited in the case of the area around the ISFSI to a vehicle crash. In addition, because of the limitations on vehicle motion the possibility of a crash is limited further to single vehicle crashes similar to the large truck evaluation, which was found to be 9.59e-8/year in this calculation. If we conservatively consider that every truck crash causing a bottle failure that will potentially affect the ISFSI, the risk is less than significant per RG 1.91.

When using RG 1.91 approach for evaluating the risk of damage due to explosion from gas bottles transported in a truck, the estimates of parameters used for calculating exposure rate (r) are considered to be bounded by the estimates used for the 800-gallon truck explosion on the basis that:

n (explosion rate) is taken as the same as the 800-gallon truck since the primary reason for a bottle explosion is judged to be due to large truck crashes.

f (frequency of gas bottle shipments) is estimated to be four times a week or 208 times per year.

s (exposure distance in miles) is conservatively taken as the same as the 800 gallon truck hazard, although the potential energy release from explosion of a few gas bottles is significantly lower than the potential energy release from explosion of 800 gallons of gasoline.

Thus, r = (7.06e-10/mile) * 208 * 2300/5280 = 6.39e-8/year

Note: This is very conservative because we are assuming that all vehicle crashes lead to a bottle explosion.

There is one other potential failure mode for these pressurized bottles and that is a welded seam failure. Although this is a possibility, the gas bottles provided on the site are required to meet current industry testing standards. These standards are provided to ensure that a weld failure is not a significant risk.

Therefore, based on RG 1.91 criteria, the risk of damage due to gas bottle explosion is less than 1.0E-6 and is therefore considered insignificant.

Note that the risk of damage is a conservative measure to use as a surrogate for the risk to the public on the basis that the damage to the casks does not constitute failure of the cask barrier integrity or the fuel cladding integrity.

In addition to the transportation of gas bottles past the ISFSI facility, there is one stationary gas bottle facility along the transporter route that could potentially affect the transporter. This facility is located on the east side of the cold machine shop and contains acetylene bottles. This facility is more than twenty-five feet from the transporter route and is a few feet below the transport roadbed. The facility only holds a maximum of 10 bottles and is protected on two sides by concrete block walls and on the third side by a building. The Diablo Canyon procedural requirements for the storage of gas bottles ensure that these bottles are restrained in a vertical position ensuring that no potential missiles are aimed at the transporter route. These restraint requirements are provided for seismic considerations. In addition, the exposure time for the transporter being in the area is less than 10 hours per year.

Explosions or failures of any type involving compressed gas bottles usually are caused from valves being broken or the bottles being pierced by some external object. These types of failures require some motive force. The location of this facility provides limited access by vehicles and administrative controls will not allow any vehicle motion within 175 feet of the transporter, therefore, there is no motive force and the possibility of an explosion is not considered credible. The risk provided by this facility is conservatively bounded by the hydrogen facility risk potential.

RESULTS

The risks associated with explosions, which could potentially damage the HI-TRAC transfer cask or the HI-STORM storage cask and their associated SSC's, were evaluated. All the hazards evaluated resulted in conservative estimates for exposure rates of less than 10^{-6}, which is risk insignificant. According to RG 1.91, this risk level is acceptable.

The total risk potential for the Transporter is the sum of the risks that it will be exposed to as it moves along its travel route. To determine this total, the risk from the hydrogen facility, the transformers and the parking lot vehicles are summed as follows:

Hydrogen facility (3.7e-7/year) + transformers (5.88e-8/year) + parked vehicles (6.18e-9/year) = 4.35e-7/year

The total risk potential for the ISFSI is the sum of the risks that it will be exposed to by hazards moving past it. To determine this total, the risk the gasoline powered vehicles and the gas bottles are summed as follows:

Gasoline powered vehicles (6.88e-7/year) + gas bottles (6.39e-8/year) = 7.52e-7/year

The total risk from all hazards result in risk rates of less than 10^{-6}, which is risk insignificant and according to RG 1.91, this risk level is acceptable.

RECOMMENDATIONS

Each of the assumptions listed in the assumptions section of this calculation should be implemented through administrative procedures. This is being tracked by AR A0524878.

REFERENCES

1. "Regulatory Guide 1.91, Revision 2, "Evaluation of Explosions Postulated to Occur On Transportation Routes Near Nuclear Power Plants," February 1978.

2. PG&E Calculation M-1046, Revision 0, "Minimum Separation Between Fuel Tanks and Storage Casks."

3. PG&E White Paper, "Bulk Hydrogen Facility Risk Evaluation," Doug Spaulding, dated February 2001.

4. "Evaluation of the HI-TRAC Transportation Route", Dave Hampshire, dated March 6, 2001.

5. EPRI, "Fire Events Database for U.S. Nuclear Power Plants."

6. US Department of Transportation, National Highway Traffic Safety Administration (NHTSA), "Traffic Safety Facts 2001," "2001 Motor Vehicle Crash Data from FARS and GES". http://www-nrd.nhtsa.dot.gov/pdf/nrd-30/NCSA/TSFAnn/TSF2001.pdf

7. US Department of Transportation, Federal Motor Carrier Safety Administration (FMCSA) "Large Truck Crash Facts 2001", January 2003 http://ai.volpe.dot.gov/CarrierResearchResults/PDFs/LargeTruckCrashFacts2001.pdf

8. PG&E Calculation M-1047, Revision 0, "Minimum Separation Between Acetylene Tanks and Transfer Casks."

9. "Telecon with Lou Ricks on Fuel Truck Size and Frequency, and Gas Bottle Size and Frequency" Philippe Soenen and Lou Ricks, 06/05/03. Attachment 1

10. IEEE Std. 500-1984, "IEEE Guide to the Collection and Presentation of Electrical, Electronic, Sensing Component, and Mechanical Equipment Reliability Data for Nuclear-Power Generating Stations."

11. Army TM 5-1300 – Structures to Resist the Effects of Accidental Explosions, November 1990, page 2-57.

"Telecon with Lou Ricks on Fuel Truck Size and Frequency, and Gas Bottle size and Frequency" Philippe Soenen and Lou Ricks, 6/5/03

In a discussion between Philippe Soenen, Licensing Engineer, and Lou Ricks, Garage Sub Forman, on the size and frequency of fuel trucks and gas bottles passing by the ISFSI site, the following was stated:

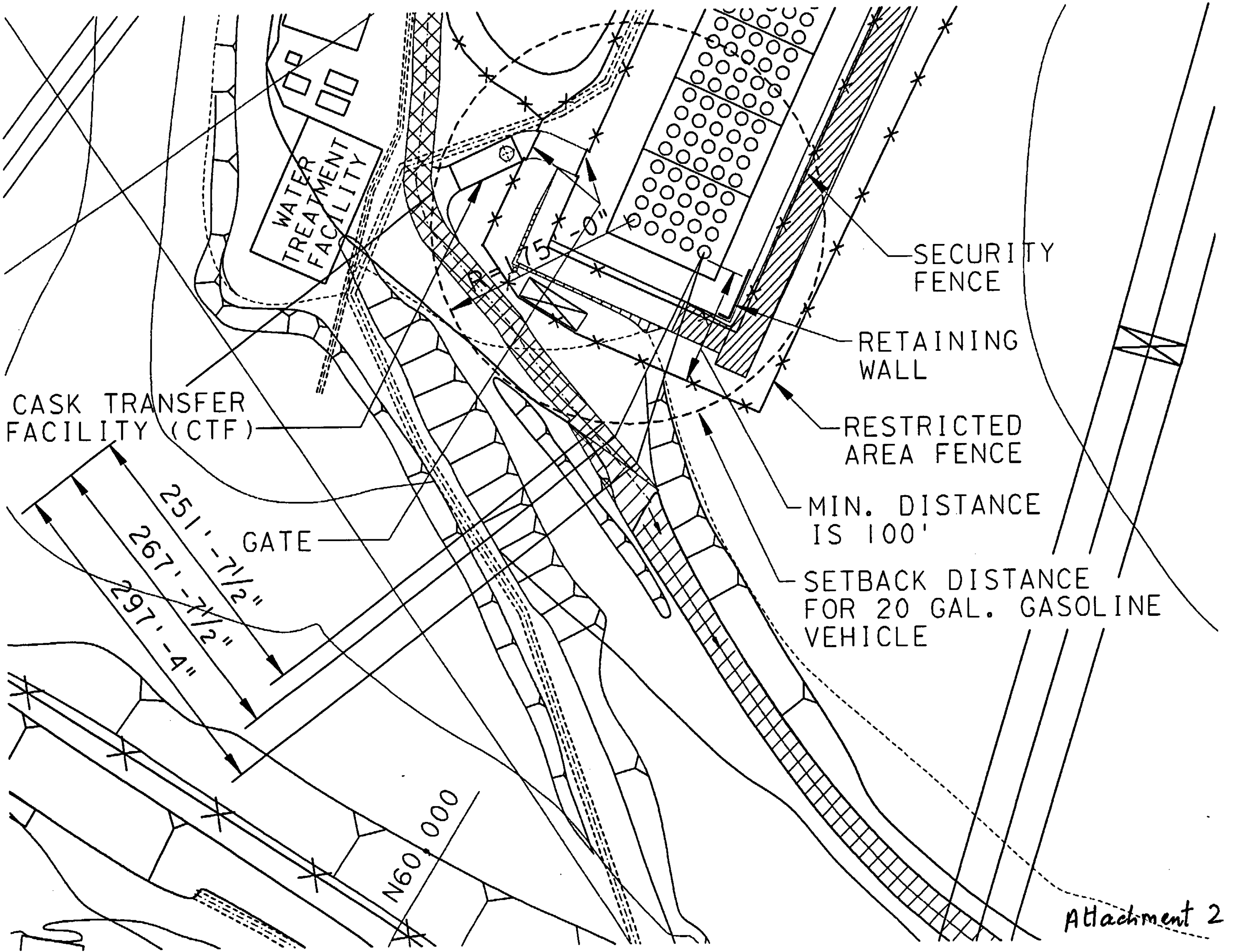
The 2,000-gallon gasoline fuel-tanker truck no longer goes past the ISFSI site. There is now an 800-gallon gasoline truck that passes by the site, on average, 6 times per week.

The only time propane bottles pass by the ISFSI site is when a forklift is traveling past the site or if a spare propane bottle for a forklift is brought to the Maintenance Shop.

On average, a forklift makes goes past the ISFSI site 4 times per week.

All of the propane bottles have a volume of 7 gallons.

The only other potential explosion hazard compressed gas bottle that is brought by the ISFSI site is an acetylene gas bottle for a cutting torch. A new bottle is taken up to the Maintenance Shop about once every four years.



Attachment 2