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UPS/Next Day Air

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
11555 Rockville Pike
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Docket No.: 40-3392
License No.: SUB-526

SUBJECT: ADDITIONAL INFORMATION - HONEYWELL METROPOLIS WORKS SAFETY BASIS AND CORRECTIVE ACTION PLAN

Honeywell Metropolis Works hereby submits the additional information in response to the Request for Additional Information dated February 6, 2013. This request was issued upon completion of NRC's initial technical reviews of Honeywell Metropolis Works' Safety Basis and Corrective Action Plan submitted on November 30, 2012, in response to the Confirmatory Order EA-12-157 dated October 15, 2012.

Pursuant to the procedures set forth in NRC Regulatory Issue Summary 2005-31 pertaining to submitting security-related sensitive information, the enclosed submitted herewith contains security-related sensitive information. As such, certain appropriately marked parts of these documents are requested to be withheld from public disclosure under 10 CFR 2.390. In addition, we also request that all Attachments, except Attachment 5, be removed entirely as also containing security-related sensitive information. To better meet NRC's expectations, Honeywell is providing the non-public and public versions of the documents.

If you have any questions, or require additional information please contact Mark Wolf, Nuclear Compliance Director, at (618) 309-5013.

Sincerely,

Mark E A Wolf for
Larry Smith

Larry A. Smith
Plant Manager

Enclosures

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NMSS01

REQUEST FOR ADDITIONAL INFORMATION

HONEYWELL METROPOLIS WORKS
SAFETY BASIS AND CORRECTIVE ACTION PLAN DATED NOVEMBER 30, 2012
DOCKET: 40-3392 (TAC NO. L32788)

Consequences

The estimation of consequences of the release of radiological or toxic materials following seismic-induced releases is a complex problem that involves identifying a sequence of events, including initial release, in-building entrainment/mixing which is relevant for estimating the immediate extent of reactions and dilution followed by release conditions from the building for atmospheric dispersion. There is uncertainty about the details of the release and dispersion events and the parameters used in quantifying the consequences.

The following Requests for Additional Information (RAIs) from the staff seek to understand the range of potential offsite consequences of seismic-induced releases and Honeywell's estimate of the more likely consequences. These RAIs are intended to consider the sequence of events that would occur during a seismic-induced release and based on the information provided in Honeywell's Safety Basis and Corrective Action Plan (SBCAP) dated November 30, 2012.

Honeywell is requested to provide and/or justify the following information:

RAI JH-1

Provide information on the major structural features of the building that would influence the flow of any released material (gaseous and non-gaseous) within the building and the flow of air through the building. Provide the approximate dimensions of rooms that could be pressurized as a result of a liquid uranium hexafluoride (UF_6) release, flashing and hydrolysis reaction. Describe the ventilation systems and their expected performance following a seismic event.

MTW RESPONSE:
MTW Equipment Maps are provided (Attachment 1) showing major pieces of equipment by floor and where each is located. MTW-CALC-DIS-0003 (Attachment 2) is also provided showing air volume per floor which takes into account displacement volume of each major piece of equipment.

The ventilation systems (3) are:

1. A Hastings air heating system is located on the 6th floor which is used only for winter heating; its blower circulates warm air throughout the six floors of the distillation area.
2. A new ventilation blower will be installed at ground level to provide summertime climate control for the distillation confinement area (floors 1, 2, and 3). Fresh air make-up will be provided on each floor via weighted air dampers. The discharge of this new blower will be at the roof line of the FMB (90 ft elevation).
3. The basement area has an existing blower for climate control.

All blower systems will be configured for manual shut-down during an EQ event per MTW Emergency Procedure EPIP-0009.

RAI JH-2

Provide more detailed information on the physical distribution of the material throughout the Feed Material Building than is provided in Table 1 of the SBCAP. Provide information at a level of detail comparable to what was provided in the July 20, 2012, Recovery Plan. Discuss the differences between the current inventory estimate and past practice. It is noted that Table 1 of the SBCAP provides a 4th floor equipment inventory estimate of 36,000 lbs while the July 20, 2012, recovery plan reported an actual 4th floor inventory estimate of about 85,000 lbs.

MTW RESPONSE

All major vessels and piping containing liquid UF6 are listed in the revised SBCAP Table 1 (Attachment 3) as well as their contained mass. Note that procedural constraints that limit liquid UF6 inventory in the primary cold trap system to only two traps ([redacted]) at any given time.

The information shown in the July 20, 2012 Recovery Plan for Solid UF6 Stored on Site lists the weight of UF6 contained in the primary cold traps located on the 4th floor at the time of the process shut-down (May 2012). This material was held in its solid state prior to being loaded into cylinders per NRC approved procedures in advance of initiation of corrective actions related to the Confirmatory Order. These inventory values are not germane to the Confirmatory Order analysis which deals specifically with liquid UF6 hazards.

RAI JH-3

Identify which UF_6 vessels or process lines are more susceptible to failure given an earthquake and what is the expected nature of the failure (crack vs. clean break). A discussion of what is meant by weak, medium and strong piping identified in Figure 2 and Table 8 of the SBCAP would help provide this understanding.

MTW RESPONSE:

[redacted] The FMB structural design safety margin limit and degree of deformation for beyond design basis EQ events will be determined as part of the FMB push-over analysis which is in-progress.

[redacted]

Pipe fragility designation (weak, medium, strong) is based on the number of floors each pipe transverses in order to account for the floor-to-floor drift hazard. Strong piping connects vessels on the same floor, medium piping traverses one floor, and weak piping traverses two or more floors. All piping in liquid and vapor UF6 service is [redacted], all of which provide significantly greater strength than typical Schedule 20 Stainless or Carbon Steel piping.

SBCAP Table 1 (Attachment 3) is modified to designate weak, medium, or strong fragility classification for each piping system listed as follows:

[redacted].

RAI JH-4

Identify the estimated range of release rates and release duration from these vessels and process lines. Describe how such information was used to develop the two overall estimates presented in the SBCAP: the 199 lbs/sec presented on page 6 and the 136 lbs/minute (1,361 lbs over 10 minutes) presented on page 16. The November 28, 2012, email from K. Vilas to J. Price indicates that the smaller release rate and duration is comprised from smaller releases on the 4th, 5th and 6th floors. In the case of the lower release rate case (assumed to apply after completion of the seismic upgrades), are there other internal releases estimated that are not expected to exit the Feed Material Building? What features are projected to function to limit the releases below the 206,000 lbs as was estimated for the case of the existing (unmodified) facility?

MTW RESPONSE:

Following retrofit installations, material releases due to a [redacted] design basis EQ are highly unlikely since equipment and piping are designed to withstand the design ground motion.

[redacted] This worst case scenario assumes all liquid UF6 is released ([redacted]) at grade due to severe building deformation from a [redacted] earthquake. [redacted]

The case described in SBCAP Section III.C.3.b pertains to the worst-case credible UF6 release sequence from a beyond design basis event up to the design safety margin limit of the FMB structure. Up to the safety margin limit, installation of seismically activated isolation valves, robust equipment restraints, and upgraded piping supports will limit potential UF6 releases to cracks or small breaks in UF6 process piping. [redacted]

Similar to the above, releases from weak pipe [redacted] are assumed possible due to beyond design basis EQs up to the design safety margin limit of the FMB structure. However, no hazardous materials are released to the environment outside the FMB due to material containment within the FMB Distillation confinement area. As above, potential releases are expected to result from cracked or broken piping [redacted], no loss of liquid UF6 from vessels is expected due to seismically activated isolation valves, robust equipment restraints, and upgraded piping supports. [redacted]

RAI JH-5

Describe any other detailed release scenarios (e.g., initial UF_6 release/flash/reaction followed by later, slower hydrolysis of solid UF_6) that were considered and evaluated before selecting the overall release rate and location discussed on page 16 of the SBCAP. Were various plant siding conditions considered? The staff noted that Table 8 of the SBCAP suggests the potential for different siding conditions (i.e., minor and severe damage). Describe these conditions.

MTW RESPONSE:

The release scenario described on page 16 of SBCAP Section III.C.3.b bounds all credible, yet highly unlikely, release scenarios up to the design safety margin limit of the FMB. The modeled scenario assumes all liquid UF6 in piping above the confinement zone is released [redacted] and results in no impact to the public. This bounding scenario encompasses all other more likely credible pipe release scenarios (i.e., damage to only weak pipe or damage to weak and medium pipes) and is appropriately conservative for the following reasons:

1. The building structure, eqpt restraints and siding are robustly designed and assessed to be capable of withstanding EQs up to the structure's design safety margin limit.
2. The most vulnerable systems/components in the FMB are "weak" piping systems.
3. The quantity of liquid UF6 most at risk for release to the environment due to a beyond design basis EQ is that contained in weak piping [redacted]

The FMB building metal siding [redacted] was assessed by both a seismic capability engineer and structural experts to be adequately attached to the braced frame structure for ground motions up to the

design safety margin limit. Likewise, the unreinforced masonry walls surrounding [redacted] the confinement area are also being reinforced to withstand comparable seismic forces. Thus, the confinement area [redacted] will remain an effective barrier against any meaningful UF6/HF leakage to the environment [redacted], and thus is not a factor in the release scenario dispersion modeling described above.

Both siding and piping fragility values shown in SBCAP Table 8 represent "typical" values; i.e., they are not validated via engineering calculations. Consequently, the Event Tree (SBCAP Figure 2) is provided solely to demonstrate the approximate relative contribution of each successive protection layer to the overall frequency for each accident event scenario shown. It is not intended to quantitatively define the FMB's overall hazardous material release frequency following installation of all retrofit projects. Due to the complexity and interdependency of the multiple layers of protection being installed, a single, composite Failure Probability Value of [redacted] is assumed for the FMB PFAPs as discussed in SBCAP Section III.C.3.b.(1). This assigned value is very conservative for an exceptionally robust passive engineered PEC.

RAI JH-6

Describe any consideration that was given to releases of other materials (e.g., water, natural gas) that might increase or reduce the severity of the consequences.

MTW RESPONSE:
Natural gas was considered and a seismically activated isolation valve will be installed on the natural gas supply to the plant as part of this seismic effort. Consideration was given to releases of instrument air and nitrogen; however, the safety concern is unavailability of these services and not release of the chemical itself. Safeguards have been designed as needed to ensure loss of instrument air or nitrogen will not impact safety of the process (e.g., fail-safe valves, emergency air reservoirs, etc). Water was considered and found to be of no consequence.

RAI JH-7

What is the basis for assuming that the hydrolysis of exposed, solid UF_6 would be negligible when estimating the release rate from the Feed Material Building?

MTW RESPONSE:
The statement regarding solid UF6 in SBCAP Section III.B.2 will be restated as follows:
Solid UF6 occurs only in cold traps and final product cylinders. In both cases, the solid UF6 material is maintained under vacuum until heated in preparation for draining [redacted] *or discharging from the product cylinder. Since MTW UF6 cylinders are robust, DOT-approved containers stored outdoors in wooden cradles, EQ damage resulting in cracking or puncture is considered non-credible.*

[redacted] *Additionally, vessel*

restraints are designed to withstand EQ forces up to the structure's design safety margin limit thus rendering displacement damage highly unlikely. For this reason it is reasonably assumed solid UF6 inventories "do not appreciably contribute to hazardous material plumes" during an EQ event up to the FMB design safety margin limit.

NUREG/CR-6410, A-28 discusses the release of liquid UF6 and the subsequent coating of liquid UF6 with a UO2F2 crust. This precipitated coating, combined with UF6 freeze-out due to evaporative cooling from HF vapor evolution, prevents further reaction of liquid UF6 with air moisture to form HF. For all calculations unless otherwise specifically stated, sufficient moisture is assumed to be present in the atmosphere to allow the HF reaction to occur. Likewise, the reaction of solid UF6 to HF is controlled by the amount of air moisture in contact with the solid. Since MTW maintains all solid UF6 under vacuum, air infiltration into damaged cold traps or cylinders will only generate HF up to the point where HF vapor generation is sufficient to equilibrate cylinder pressure with atmospheric pressure. At this point, further HF generation occurs slowly via air moisture diffusion into the cylinder. Thus, rate of HF formation [redacted] is negligible in comparison to liquid UF6 containing vessels.

<u>RAI JH-8</u>

Provide assumptions made regarding hydrolysis and dilution of the UF_6 within the process building before its release from the building. Include the range of reasonable in-building dilution assumptions based on the nature of the tank/line failure or the performance of building walls/window and ventilation systems following an earthquake with an assumed 475-year return frequency.

MTW RESPONSE:
We assume that all UF6 entering the atmosphere is completely hydrolyzed. All formed HF is perfectly dispersed throughout the building on the floor where the release occurred. [redacted] we assume complete mixing throughout the entire confinement area due to the common vent system and multiple floor penetrations.

No forced ventilation is assumed. Natural ventilation [redacted] is assumed for floors [redacted] above the confinement area. This air change rate is based on a conservative approximation for natural ventilation of a "leaky" work space as discussed in the following paper: W.R. Chan, P.N. Price, A.J. Gadgil, "Ventilation Information Paper - Sheltering in Buildings from Large-Scale Outdoor Releases", Air Infiltration and Ventilation Centre, Lawrence Berkeley National Laboratory (Attachment 5).

<u>RAI JH-9</u>

Provide the estimated UF_6/HF release rates and gas density and any momentum conditions for the material released from the building. Are there multiple release locations, rates and concentrations? Are there alternate release locations/rates/concentrations for material initially released within the building depending on the response of the building and ventilation equipment to the 475-year earthquake?

MTW RESPONSE:

Details pertaining to all updated UF6 dispersion analyses are fully described in BakerRisk Report, MTW Dispersion Modeling Results, Feb 2013 (Attachment 6) and SBCAP Reference 8. The following UF6 release scenarios were evaluated as bounding cases which encompass all credible releases from EQs up to the design safety margin event:

[redacted]

[redacted]

[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

* [redacted]

[redacted]

- [redacted]
- [redacted]

[redacted]

- [redacted]
- [redacted]
- [redacted]

[redacted]

- [redacted]
- [redacted]
- [redacted]

[redacted]

- [redacted]
- [redacted]

[redacted]

[redacted]

[redacted]

Other specific SafeSite® (BakerRisk dispersion modeling tool) input details and conservative assumptions utilized in these release scenario calculations (e.g., assumptions, gas densities, temp/pressures, etc) are provided in the BakerRisk modeling report (Attachment 6).

RAI JH-10

Describe the fundamental features of the dispersion analysis conducted by Baker Risk and discussed in the November 28, 2012, email from K. Vilas to J. Price. Describe the severely damaged panels and the basis for the 15 ACH (assumed to be air changes per hour).

MTW RESPONSE:
The referenced dispersion analysis (BakerRisk Report, dated 28 November 2012) has been superseded by an updated analysis which is fully described in Attachment 6.

[redacted] This study was performed to demonstrate the relative value of various layers of protection being built into MTW's seismic upgrade project for protection against beyond design basis earthquakes ([redacted]). Since the fragility values used in this study are reasonable approximations provided by seismic and structural experts, and not supported by detailed engineering calculations, this information and conclusions drawn are provided in the SBCAP document for general "guidance" regarding the salutary contributions from the various layers of protection being installed by this project.

[redacted]

RAI JH-11

Clarify whether other release-reaction-dispersion estimates have been prepared that consider other reasonable conditions (e.g., leakage from both lower level floors as a result of ventilation systems or pressurized rooms created by the flashing of released UF_6). If so, provide the relevant details.

MTW RESPONSE:
No confinement area leakage rate estimates were developed for beyond design basis UF6 releases. However, it was determined there is insufficient differential pressure driving force across exterior walls to cause a meaningful loss of hazardous materials to the environment due to siding leakage. [redacted] This differential pressure driving force is assessed to be insufficient to generate appreciable HF loss through siding lap joints.

Based on BakerRisk modeling results (Attachment 6), it is reasonable to conclude no public impact results from the resulting toxic HF plume [redacted].

RAI JH-12

For the release and consequence scenarios that have been identified and analyzed, provide a listing of conservative and non-conservative factors inherent in the assumptions that are part of the analysis.

MTW RESPONSE:
All release models were developed using conservative factors appropriate for the scenario considered. These are described in SBCAP Reference 8 and BakerRisk Report, MTW Dispersion Modeling Results, Feb 2013 (Attachment 6).

Methodology

In the SBCAP, Honeywell has chosen to demonstrate Metropolis Works' (MTW's) acceptable performance within its current safety basis due to a seismic event by using a risk-informed methodology similar to those used by other fuel cycle facilities regulated by Title 10 of the *Code of Federal Regulations* Part 70. For the methodology that Honeywell has chosen to use, it is necessary to demonstrate the acceptable likelihoods and consequences associated with an accident and the safety controls which would prevent or mitigate consequences to workers and the public due to hazardous radiological or chemical releases.

The following RAIs from the staff seek to understand the potentially high consequence events due to the initiation of a seismic event, and how they are adequately prevented or mitigated due to the controls designated by Honeywell in its accident sequence risk demonstration.

Honeywell is requested to provide and/or justify the following information:

RAI KM-1

Provide clarification of the term "connected" when stating that (SBCAP, Section 2, pg 5 of 29) in the worst case release scenario all liquid UF_6 piping is assumed ruptured and "connected"

vessel inventories are released. Provide a list or summary of all vessels, or vessel types, that are connected and an estimate of their inventories.

MTW RESPONSE:
In the referenced worst case release scenario, the "connected" vessels are those in the Distillation process which are connected via process piping. SBCAP Table 1 (Attachment 3) shows the liquid UF6 volume contained in process piping by floor as well as total UF6 contained in connected vessels. A UF6 process schematic diagram is attached (Attachment 9) that depicts the Distillation area equipment, how these vessels are arranged and their UF6 capacities.

RAI KM-2

In the demonstration of meeting highly unlikely as provided in the SBCAP, Figure 2, the likelihood for a general passive control was given. Provide an explanation of the likelihood assumed addressing whether the likelihood of failure is conditional based on the seismic event or independent of the likelihood of the initiating event. Also, provide a listing or summary (by type) of the controls included in this composite passive control and the estimated individual likelihoods of each control type. In describing the Plant Features and Procedures (PFAPs) (page 2 of 29), Honeywell made the statement that "the following list of PFAPs must operate in the event of an earthquake... to ensure risk performance." The staff has noted that not all PFAPs in the list appear to be credited. Honeywell is requested to provide clarification for the statement made in describing these PFAPs.

MTW RESPONSE:
Due to the complexity and interdependency of the multiple layers of protection being installed, a single, composite Failure Probability Value [redacted] is assigned to the multiple PFAPs being implemented as discussed in SBCAP Section III.C.3.b.(1). This assigned value is very conservative for an exceptionally robust passive engineered PEC (refer to Nureg 1520, Appendix A-3, Table A-10).

The composite FPIN is independent of the initiating event [redacted] (a non-linear static push-over analysis of the FMB is in-progress to define this limit). [redacted]

Attachment 10 (shown below) provides a summary listing of the seismic accident scenarios considered, applied PFAPS and types, and the resulting mitigated risk likelihood for a [redacted] design EQ event. In all cases, the mitigated likelihood is highly unlikely.

[redacted]

RAI KM-3

Supplement the data in the SBCAP, Figure 2, by providing an estimate of the assumed material released or resulting consequences for the intermediate conditions assumed for various pipe failure scenarios. For the intermediate scenarios, is it assumed that only the contents of the pipes would be released or would the contents of the vessels associated with the pipes be expected to be released as well? What are the assumptions associated with damage and release for each of the pipe damage scenarios?

MTW RESPONSE:

Note that SBCAP Figure 2 - Event Tree is provided solely to demonstrate the approximate relative contribution of each successive protection layer to the overall frequency for the accident event scenarios shown. It is not intended to provide defensible quantification of the FMB's overall hazardous material release frequencies post-retrofits since the fragility values described in SBCAP Table 8 are "best estimates" based on expert input and have not been determined from actual MTW engineering data.

As reported in RAI JH-3, SBCAP Table 1 (Attachment 3) is modified to include the fragility classifications (weak, medium, strong) for each piping segment as shown below:

Piping Segment	Fragility
PCTs to STFs	Medium
STF to Vaporizer	Weak
LBC to LBC Reboiler	Strong
LBC Reflux Line	Medium
HBC to HBC Reboiler	Strong
Product Condenser to Cylinder Fill	Weak

Post-installation of PFAPs described in SBCAP Section II – Summary of Plant Features and Procedures (PFAP), release of UF6 due to damage from a [redacted] design basis EQ is highly unlikely. Structure

upgrades, equipment restraint improvements and piping support upgrades are specifically designed to withstand this seismic event. [redacted] To be conservative, this worst case event was modeled [redacted]

[redacted]

Following equipment restraint installations, vessels are assessed by a seismic capability engineer and structural/piping engineering experts to be capable of withstanding EQs [redacted] Seismically activated shut-off valves will effectively "lock-in" UF6 material in vessels thereby preventing release of UF6 to the environment should connecting piping damage occur. Thus, no loss of liquid UF6 from vessels on any floor is expected [redacted] due to seismically activated isolation valves, robust equipment restraints, and upgraded piping supports.

[redacted].

<u>RAI KM-4</u>

Honeywell has made the argument that the seismic safety system provides defense in depth, and that the system is not required for demonstration of meeting risk-based performance requirements. In order to understand the benefit of this system and the possible value for defense in depth it provides for preventing or mitigating possible consequences, provide either an impact on the unmitigated consequences or an estimation of the possible material at risk that would be prevented from release by these features.

MTW RESPONSE:
At the design basis [redacted], there is no need for the added protection afforded by the seismically activated shut-off valves since all structures and components are robustly designed and capable of withstanding a [redacted] and any accident scenario occurring up to the design basis EQ level are highly unlikely. For above design basis earthquakes, these valves protect against the most credible worst case scenario [redacted]

RAI KM-5

In the SBCAP, Summary of PFAPs, (Page 2 of 29), the descriptions of the controls appear to be based on administrative processes that control the design and change processes associated with the controls leading one to assume that these could be administrative controls. In the Integrated Safety Analysis (ISA) demonstration, the controls are described and credited as passive engineered controls. Provide an explanation or modification of the description associated with each PFAP.

MTW RESPONSE:
SBCAP Section II - Summary of Plant Features and Procedures (PFAP) was modified to list only the specific PFAP structure, system or component and PFAP type. Refer to Attachment 11 for the revised Summary of Plant Features and Procedures (PFAP) listing.

RAI KM-6

In the SBCAP, Section 3 (pg 13 of 29), for the modified design assessment, Honeywell has made a statement that the evaluation is based on the release of hazardous chemicals (e.g., UF_6, uranyl fluoride, hydrogen fluoride [HF], ammonia [NH_3]), yet the consequence analysis seems only to address liquid UF_6. Describe the assumptions made in the modified assessment in terms of evaluation of possible material at risk and possible quantities of hazardous chemicals assumed to result in the estimated consequences.

MTW RESPONSE:
Hazardous materials with potential to impact safe operation of MTW's uranium processing facilities were identified during hazard reviews completed in support of the MTW Integrated Safety Analysis Report, dated 25 Oct 2006. [redacted] All of the above are addressed in the SBCAP document except [redacted] which was eliminated via calculation (Attachment 12) that determined insufficient [redacted] is present in the [redacted] to result in an intermediate or high consequence event impacting workers, the public or safe operations of uranium-bearing materials in the FMB.

[redacted] Following retrofits, release of liquid UF6 is highly unlikely from design basis EQ or tornado events as described in the SBCAP document. For FMB related accident scenarios, only liquid UF6 is considered to define the source material quantity for dispersion modeling since vapor mass in equipment and piping contributes minimally to the total at-risk mass.

[redacted] anhydrous HF storage will be eliminated by this project. Following retrofits, at design basis EQ and tornado events, an NH3 release is highly unlikely, as is a release of HF from the new HF rail car unloading station. [redacted] these systems ([redacted] were designed to ASCE 41 code using a 1.5 Importance Factor. Based on a walk-down assessment by a seismic capability engineer and structural engineers, these systems and supporting

piping/valves will be capable of withstanding seismic events approaching a [redacted]. Seismically actuated inlet/outlet shut-off valves on these systems also contribute to beyond design basis EQ capability. Natural Gas releases are highly unlikely due to a seismically activated shut-off supply valve located at the plant's entrance metering station. Consequence modeling was not done for both [redacted] accident scenarios since any appreciable [redacted] release from these systems is assumed to be [redacted] event. However, the likelihood of a significant release from these systems capable of harming the public is highly unlikely for design basis events as described in the SBCAP document.

RAI KM-7

The statement is made in the SBCAP, Section 2, Consequences (pg 17 of 29), that the likelihood of the accident scenario is highly unlikely and that the consequence is effectively mitigated by a "see and flee" protocol. Explain the above statement and provide a discussion of whether the control is being credited in the demonstration and needs to be included in the credited PFAPs. If credited, provide justification for the mitigative value as assumed by the analysis. Similar credit for worker action also seems to be taken in Honeywell's evaluation of the NH_3 storage tank and pipe rack analysis. Provide additional discussion and justification for taking this credit.

MTW RESPONSE:
The discussion in SBCAP regarding worker "see and flee" describes an added safeguard to be implemented by MTW to protect workers from hazardous material releases. This safeguard is not credited as a PFAP since it is unnecessary to meet the defined risk performance requirement for "highly unlikely" [redacted] at the design basis EQ event. Also refer to the MTW Response to RAI KM-8 for discussion associated with the NH3 storage tanks.

RAI KM-8

For the NH3 storage tank and pipe rack analysis, were the unmitigated consequences evaluated? Are there likelihoods of failure assumed for the structures associated in this analysis? What is the basis for the statement that the structures far exceed the capability needed to survive a design basis seismic event?

MTW RESPONSE:
Unmitigated consequences were conservatively analyzed for the worst case release of the total contents [redacted]) of anhydrous ammonia from the 2 NH3 storage tanks as part of MTW's EPA Risk Management Plan (40 Code of Federal Regulations (CFR) 68, – "Chemical Accident Prevention Provisions," Subpart B – Hazard Assessment). SAFER TRACE modeling results show the NH3 ERPG-2 [redacted]) toxic end point extends [redacted]. [redacted] the likelihood of release is equivalent to the initiating event frequency [redacted]

Following retrofit of tank restraints and piping supports per the SBCAP Project, the NH3 tanks will be capable of withstanding ground motion forces from a design basis [redacted] EQ. Likewise, retrofits will also

protect sensitive targets ([redacted]) from damage due to design tornado missile strikes. These retrofits have been assessed by a seismic capability engineer and structural/piping experts to have sufficient seismic safety margin to protect against NH3 releases from beyond design basis EQ ground motions up to approximately [redacted] The "see and flee" protocol provides additional protection for beyond design basis events.

The new HF rail car unloading project is being designed to withstand a [redacted] design basis EQ. Thus, a release from a design basis EQ event is highly unlikely. The design also assumes an Importance Factor of 1.5 for structural design per ASCE 41 code. Therefore, it is reasonably estimated the structure's design safety margin is equivalent to a [redacted] The "see and flee" protocol provides additional protection for beyond design basis events.

[redacted] The pipe rack is being designed to withstand a [redacted] design basis EQ with a 1.5 Importance Factor per ASCE 41 code. Thus, a release from a design basis EQ event is highly unlikely. The design also assumes an Importance Factor of 1.5 for structural design. Therefore, it is reasonably estimated the structure's design safety margin is equivalent to a ~[redacted] The "see and flee" protocol provides additional protection for beyond design basis events.

<u>RAI KM-9</u>

Provide the associated quantities of materials for the new rail car versus the previous use of HF storage tanks. Is the rail car material a consideration in any of analyses performed? What safety impact is there, and what if anything is being credited by Honeywell in either a preventative or mitigative manner?

MTW RESPONSE:

The current MTW NRC license limits HF inventory to [redacted] in a combination of storage tanks and rail cars. With elimination of existing HF storage tanks as part of the SBCAP Project, the aforementioned HF inventory will be held only in rail cars.

There are no credible material release accident scenarios for rail cars not connected at the unloading rack. HF rail cars are designed per DOT 112S500W specifications (refer to Attachment 13) and are fully capable of slow roll-over without damage to external valves. Also, HF rail car shell wall thickness is sufficient to prevent penetration from a design basis tornado missile strike based on missile penetration calculations (SBCAP Reference 20).

For HF rail cars connected to the UF6 process at the rail car unloading station, appropriate PFAPs are being identified as part of the HF Rail Car Unloading Project. A hazard review process is utilized to ensure all credible process and external hazard accident scenarios (seismic, tornado, fire, etc.) are addressed and NRC risk performance requirements are satisfied. The hazard review will be available to NRC reviewers when finalized as part of the process engineering design package.

Existing anhydrous HF storage tank inventory is [redacted] lbs and risk of material release from these tanks will be eliminated by this project.

RAI KM-10

Provide what the determining factor is for a release assumed to occur from vessels. What is the structural failure mechanism assumed? Are assumed releases based on failures of equipment restraints or piping failures of pipes connected to a vessel and/or both? How is failure of vessel restraints determined and what impact would there be on consequences, if any?

MTW RESPONSE:
Material release from vessels is assumed to occur via 3 mechanisms:

- [redacted]
- [redacted]
- [redacted].

Vessel damage from all three mechanisms due to a [redacted] design basis EQ is highly unlikely since the structure, piping and equipment restraints are all designed for this level EQ ground motion. Per ASCE 41 code an Importance Factor of 1.5 was applied which provides additional design safety margin above design basis (a non-linear static push-over analysis of the FMB is in-progress to define this limit).

As ground motion increases beyond design basis up to the structure's design safety margin limit [redacted] no loss of UF6 from vessel dislodgement occurs since all vessels remain secured to their attachments per assessment by a seismic capability engineer. As seismic activity approaches the FMB structure's design margin safety limit, some loss from piping may occur from broken pipe. However, material losses are mitigated via closure of seismically activated isolation valves on vessel inlets/outlets. Loss of containment from falling or dislodged objects striking a vessel is highly unlikely since the structure and equipment are designed to withstand ground motions up to the design safety margin limit.

[redacted]

PFAPs

The following RAIs from the staff seek to understand the design of PFAPs identified in the SBCAP (page 2 of 29).

Honeywell is requested to provide and/or justify the following information:

RAI JC-1

To understand its availability and reliability in performing its function when needed, regarding PFAP-TOR-1, provide the design and supporting information for the weather monitoring system associated with this PFAP.

MTW RESPONSE:
MTW has installed First Alert Weather Radios™ in selected personnel buildings, the FMB control room and the Central Alarm Station (security center). These radios are powered by common 120V utility service as well as internal battery back-up which provides several hours of continued use. A battery maintenance PM task will be established in MTW Emergency Procedure EPIP-0008 to trigger battery replacement on a routine basis (replacement cycle to be determined).

RAI JC-2

Regarding PFAP-TOR-03, Honeywell proposes to configure high-high pressure basic process control system alarm for the Fuel Manufacturing Building control room and local indication at Tank Farm operator station. Describe the functionality of the basic process control system for this PFAP which would ensure that the alarm is available and reliable to perform its function when needed.

MTW RESPONSE:
NH_3 tank pressure indication and high pressure alarm signal for both anhydrous ammonia storage tanks will be hard-wired to the local tank farm operator station located in immediate proximity to the NH_3 storage and rail car unloading area. The high pressure alarm indication will also be configured to alert the FMB main control room operator as a back-up.

Since the FMB control room alarm is a secondary alert and not necessary for proper functioning of this PFAP, DCS functionality is irrelevant to this PFAP's reliability and availability.

Attachment 5

Air Infiltration and Ventilation Centre
Ventilation Information Paper
Sheltering in Buildings from Large-Scale Outdoor Releases
W.R. Chan, P.N. Price, A.J. Gadgil

1. Introduction

Intentional or accidental large-scale airborne toxic release (e.g. terrorist attacks or industrial accidents) can cause severe harm to nearby communities. Under these circumstances, taking shelter in buildings can be an effective emergency response strategy. Some examples where shelter-in-place was successful at preventing injuries and casualties have been documented [1, 2]. As public education and preparedness are vital to ensure the success of an emergency response, many agencies have prepared documents advising the public on what to do during and after sheltering [3, 4, 5]. In this document, we will focus on the role buildings play in providing protection to occupants.

2. How effective is sheltering?

The sudden nature of a terrorist or accidental release means that there is often not enough time to safely evacuate the nearby communities. The remaining option is to take shelter until the toxic plume has dispersed. The obvious advantage of staying indoors is that there is a reservoir of clean air contained in buildings. Even though buildings are not airtight, building envelopes restrict the transport of the toxic pollutant to the indoors. The result is that the indoor concentration will increase much slower and remain low relative to the outdoor concentration.

2.1 Outdoor-indoor air exchange

When sheltering in buildings, doors and windows should be closed, and ventilation and exhaust fans should be off to minimize air exchange with the outdoors. In such cases, the air change per hour (ACH) is determined by uncontrolled air leakage across the building envelope (*Figure 1*). Air infiltration is a function of the leakiness of the building, and the differential pressures across the envelope, which are caused by indoor-outdoor temperature difference and the forces exerted by wind.

Air infiltration rates can vary from less than 0.1 ACH for a tight house under mild weather conditions to over 1.5 ACH for a leaky house under severe weather conditions (*Table 1*). These values are derived from air leakage measurements of residential houses in the US [7]. Houses in countries where the climate is more severe, such as Sweden, Norway, and Canada, tend to be more airtight than the values presented here [8].

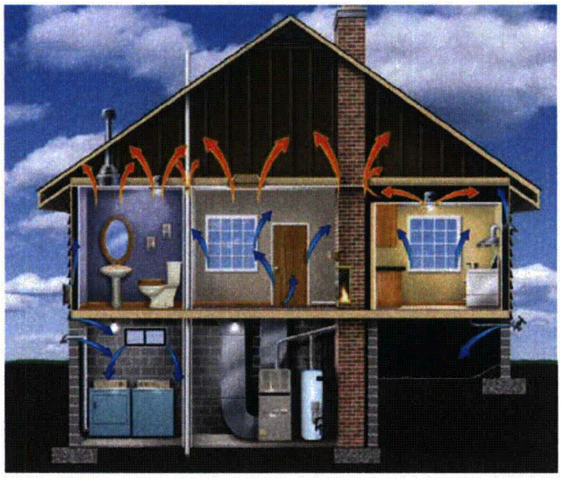

Figure 1: Uncontrolled air leakage, known as air infiltration, across the building envelope of a house.[1]

Weather condition	Wind speed [m/s]	Indoor-outdoor Δ temperature [K]	Δ Pressure across building envelope [Pa]	Air infiltration [ACH]		
				Tight house	Typical house	Leaky house
Mild	2	5	0.2	0.07	0.1	0.4
Moderate	5	15	1	0.2	0.3	1.0
Severe	7	25	2	0.3	0.5	1.6

Table 1: Typical normalized leakage and air infiltration rate of US residential houses estimated using LBL Infiltration Model [6] under different weather conditions.

For a conserved contaminant, indoor concentration during sheltering can be predicted using the air infiltration rate and the outdoor concentrations (*Figure 2*). Houses with high air infiltration rates (e.g. 1 ACH) will permit larger amounts of the toxic material to enter indoors as the outdoor plume arrives. However, due to the rapid exchange with the outdoors, the indoor concentration will also decay much faster compared to tighter houses after the outdoor plume departs. If shelter-in-place were maintained in all houses for sufficiently long time, the indoor exposure (time integrated concentration) would eventually approach the outdoor level assuming no toxic material is lost while entering and within the building. Therefore, termination of shelter-in-place is an important part of the overall sheltering strategy in order to minimize exposure.

[1] Used with permission of US EPA ENERGY STAR®.

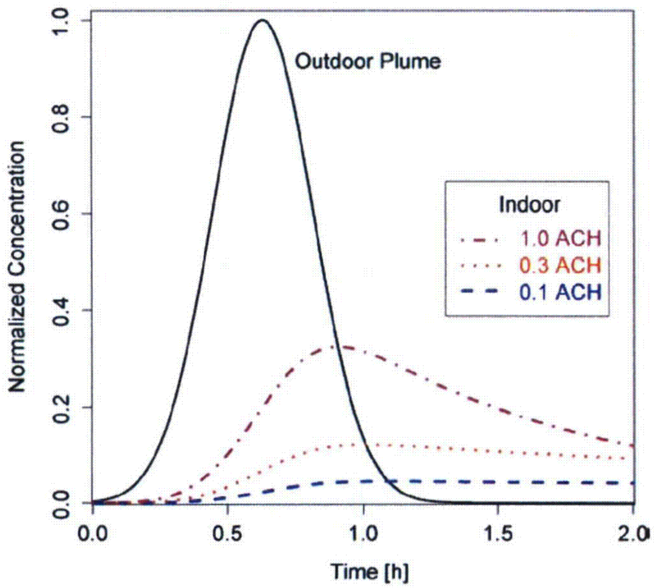

Figure 2: Indoor concentration profiles for a well-mixed dwelling at different air exchange rates. The concentrations shown are normalized to the peak outdoor concentration.

2.2 Removal mechanisms

Mechanisms by which toxic materials are removed by buildings further decrease the indoor concentration of the toxic material. Building envelopes can remove some bio-aerosols (typical size range 1 to 5 μm) as they infiltrate through cracks. The penetration factor, defined as the fraction of contaminant in the infiltrating air that passes through the building envelope, has been found to be close to 1 for particles that are 1 μm in diameter [9]. Experimental study also suggests that particles larger than 5 μm can have a significantly lower penetration factor in houses with tighter construction [10]. Building envelopes can therefore offer some, but not substantial, protection from outdoor bio-aerosol plumes.

Once inside buildings, bio-aerosols can deposit out of the air onto surfaces. For 1 to 5 μm particles, the loss rate by deposition is equivalent to having an additional fresh air supply of 0.1 to 1 ACH [11]. *Figure 3* shows the indoor concentrations at different loss rates. At a loss rate of 1 h^{-1}, the indoor concentration drops to less than 1% of the outdoor peak concentration several hours before the no-loss case does. On the other hand, a loss rate of 0.1 h^{-1} has little effect on the indoor concentration. Resuspension of particles, a process not considered here, can reintroduce deposited particles into the air and changes the airborne concentration.

The penetration factor of gases is highly dependent on the pollutant-surface reaction probability, which is defined as the ratio of removal rate to the collision rate of the gaseous species on the surface [12]. However, sorption to

indoor surfaces, which may include adsorption, absorption, and chemical binding, is likely to be the dominate removal mechanism for chemical agents. Similar to particle deposition, loss rate by sorption is also highly sensitive to the level of furnishing and other indoor conditions. Sorbed chemicals can also slowly desorb from surfaces. Room-scale experiments indicate that the sorption loss rate of NH_3, Cl_2, SO_2, sarin, and VX are equivalent to having an additional fresh air supply of 1 ACH [13, 14, 15], which is significantly more rapid compared to the typical air change rate of 0.3 h^{-1}.

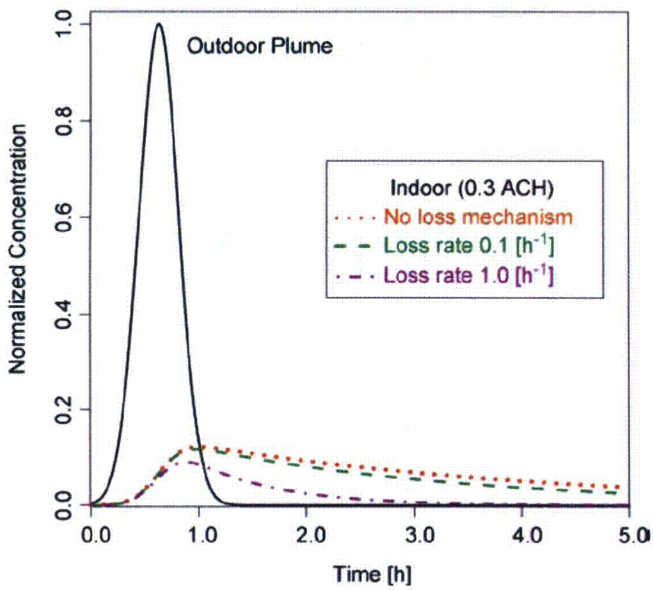

Figure 3: *Indoor concentration profiles for a typical dwelling with different loss rates. The concentrations shown are normalized to the peak outdoor concentration.*

2.3 Health effects

Health effects of many chemicals are best described by the "toxic load rate". Toxic load rate is the airborne concentration of the chemical raised to an appropriate exponent. For an agent with a high exponent (e.g. H_2S has an exponent of 4, some nerve agents have an exponent of 2), exposure to high concentration for a short time is worse than exposure to a lower concentration for a proportionally longer duration of time. This non-linear dose-response characteristic means that sheltering is very effective in preventing injuries and fatalities because the indoor concentration remains much lower than the outdoor during the release (*Figure 2*). After the plume has passed, the indoor concentration rises above the outdoor. Therefore, sheltering should be terminated by opening windows and doors to avoid prolonged exposure to the residues that remain indoors. The exact timing of termination will depend on the characteristics of the release as well as the protectiveness of buildings against the agent. In

general, termination time is most critical if sheltering in leaky buildings from a highly concentrated puff release of an agent that does not undergo deposition or sorption indoors.

3. Role of ventilation systems

Most commercial buildings have some form of heating, ventilating, and air-conditioning system (HVAC) that includes an air-filter to remove particles, and in some cases an air-cleaner to remove gases. For bio-aerosols in the size range of 1 to 5 μm, many air-filters might have limited collection efficiency depending on the particular design and loading on the filter [16]. Commonly used air-cleaning media is even less effective against most chemical warfare agents. Special chemically active sorbents might be needed to achieve significant removal. Filter or sorbent bypass is another problem that can limit the efficiency of such system. Furthermore, operation of the ventilation system can increase the overall air exchange with the outdoors which is undesirable during sheltering. The default advice is therefore to shut down the mechanical ventilation system and bathroom exhaust fans in response to an outdoor release [17]. Intake and exhaust dampers should also be fully closed.

Commercial buildings further differ from small residential buildings because the air within the former cannot be considered well-mixed throughout the building. Consequently, the indoor concentrations in various parts of the building will depend also on the interzonal airflows [18] and will not be uniform throughout the building (*Figure 4*). When the HVAC is operating, transport of the contaminant within the building is determined by the airflow directed by the air handling units and duct systems. Typically, air is rapidly mixed within a zone, but airzones are designed to be isolated from one another. When the HVAC is turned off, the overall airflow and within-zone mixing is much reduced. However, the contaminant can now spread throughout the entire building with time. Under such circumstances, indoor concentrations can vary greatly depending on the weather conditions and the air leakage pathways of the building.

4. Proactive measures

Apart from closing all doors and windows, and turning off ventilation systems, a range of measures can be taken to make buildings more protective from an outdoor release (*Figure 5*). Simple taping of doors and vents, and plastic sheet over windows can reduce air infiltration to some extent [19], particularly when an interior room is chosen for the sheltering. More permanent modifications can include weatherization techniques such as caulking to improve the airtightness of residential dwellings [20]. Larger and more vulnerable buildings might install a filtration system to supply clean air at a positive pressure that can prevent contaminated air from leaking in. Active filtration can also take the form of a stand-alone air purifying unit containing HEPA and activated carbon filters [21, 22].

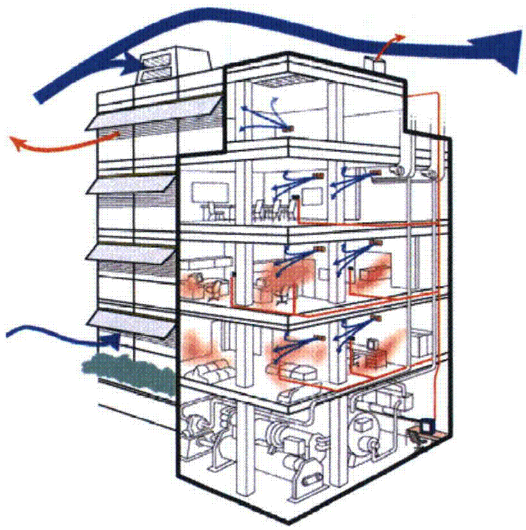

Figure 4: Complex airflow pathways in a commercial building leading to multizone condition.

Figure 5: Examples of some proactive measures: duct tape/plastic sheet, weatherization, and air purifier.[2]

5. Discussion

While the idea of shelter-in-place is straightforward, challenges remain in characterizing the benefits of sheltering under realistic scenarios. Large variability in building characteristics means that there is a range of shelter-in-place effectiveness. There are also considerable uncertainties owing to the limited

[2] Used with permission of Sedgwick County Emergency Management (left), Big Five's Weatherization Program (center), and Morrow County Oregon Emergency Management Office (right).

understanding of some of the indoor transport mechanisms and fate of airborne toxic materials. Even so, past experiences and preliminary investigations have pointed to shelter-in-place as a promising emergency response strategy.

Illustrated in *Figure 6* is a simulation of the expected harm reduction from sheltering for a community in Albuquerque from a hypothetical large-scale chlorine gas release [23]. Air infiltration rates of the houses are estimated based on the air leakage characteristics and the weather conditions during the release. Estimation of sorption to indoor surfaces is also included. At the end of the 4-hour release, the area at risk of life-threatening effects is an order of magnitude smaller if people were sheltering indoors for the duration of the release than if everyone were outdoors. Sheltering can be even more effective than shown here for releases of a shorter duration, and if suitable proactive measure and strategy is deployed.

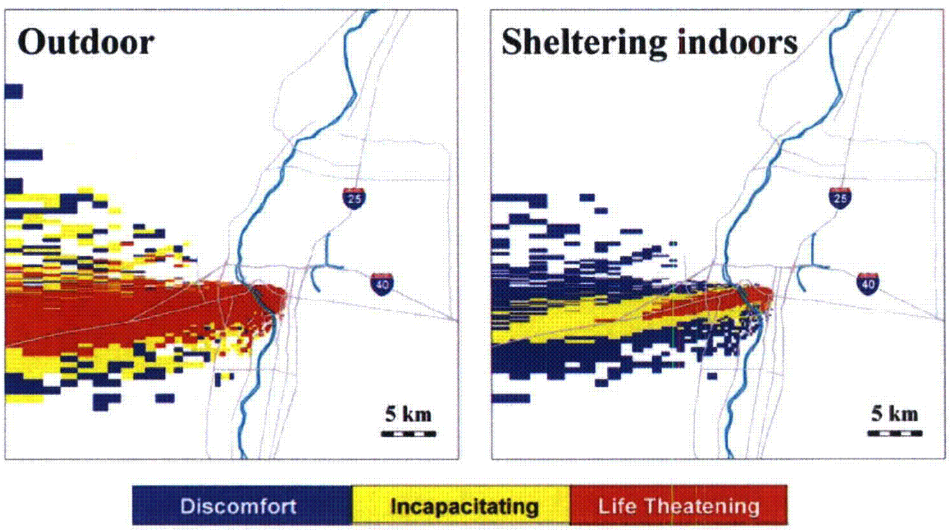

Figure 6: Predicted health effects based on US EPA's Acute Exposure Guidelines [24] of a hypothetical 4-hour chlorine gas release in Albuquerque if shelter-in-place is implemented (right) compared to if everyone is outdoors (left).

6. Conclusion

- Under most circumstances, shelter-in-place is an effective response against large-scale outdoor releases. This is particularly true for release of short duration (a few hours or less) and chemicals that exhibit non-linear dose-response characteristics.
- The building envelope not only restricts the outdoor-indoor air exchange, but can also filter some biological or even chemical agents. Once indoors, the toxic materials can deposit or sorb onto indoor surfaces. All these processes contribute to the effectiveness of shelter-in-place.
- Tightening of building envelope and improved filtration can enhance the protection offered by buildings. Common mechanical ventilation system

present in most commercial buildings, however, should be turned off and dampers closed when sheltering from an outdoor release.

- After the passing of the outdoor plume, some residuals will remain indoors. It is therefore important to terminate shelter-in-place to minimize exposure to the toxic materials.

7. Acknowledgement

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