RAM\J100-10 Standard CIPAC Workgroup Final Report to the Water Sector and Government Coordinating Councils

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1.0 Introduction

The Water Sector Coordination Council (SCC) and Government Coordination Council (GCC) convened the Critical Infrastructure Partnership Advisory Council Water Sector Risk Assessment Methodology Standard Examination Workgroup (RAM CIPAC) to examine whether further modifications to the recently upgraded water sector risk assessment methodologies – ARAM-W, SEMS, and VSAT – are necessary to align them with the J100 Standard (Attachment A provides the workgroup charter). The workgroup, as chartered by the Councils, had two objectives:

1. Examine the three water sector risk assessment methodology tools, ARAM-W, SEMS, and VSAT, with specific emphasis during this examination given to how these tools address the requirements defined in the J100 Standard; and
2. Determine what upgrades would be necessary for the three water sector risk assessment tools to ensure that they help utilities meet industry best practices as defined by the J100 Standard.

Under "Scope of Activities" the charter indicates the workgroup was expected to (among other items):

- Review and utilize the findings from the Water Research Foundation's J100 gap analysis report; and
- Provide prioritized recommendations, if necessary, to EPA and DHS on potential J100 Standard associated modifications to ARAM-W, SEMS, or VSAT.

The workgroup was comprised of nine direct members, with the SCC designating six members and the GCC designating three members (Attachment B provides workgroup membership). The direct members were supported in their deliberations by Subject Matter Experts (SMEs). These SMEs advised the workgroup, but did not have voting authority during workgroup decision making.

To meet its charge, the workgroup held three conference calls and one, three-day, in-person meeting. The workgroup used the three calls to clarify the scope and intent of the charter (call 1), review and agree upon topics for its in-person meeting (call 2), and review and agree upon its final agenda, including discussion questions (call 3). Consistent with the workgroup's designation as a CIPAC, all calls and meetings were closed to the public.

As prescribed by the workgroup charter, the Water Research Foundation's (WRF) analysis of ARAM-W, SEMS, and VSAT relative to the J100 Standard formed the basis for understanding and determining the areas of potential upgrades for the tools. The WRF analysis of ARAM-W, SEMS, and VSAT identified a number of gaps in relation to the J100 Standard for each tool. In order to have the most useful discussions during the in-person meeting, the multiple gaps associated with each tool were consolidated into gap "topics." Each "tool representative" (i.e., DHS/Sandia, EPA, and NRWA) prepared detailed WRF gap analysis review matrices. These matrices were used to produce the gap topics. DHS/Sandia, EPA, NRWA, and the J100 SME representatives on the workgroup indicated their support for using these topics for discussion purposes, and workgroup members approved the use of these topics for discussion purposes prior to their in-person meeting.

The workgroup held its in-person meeting on July 26 – 28 in Washington, DC. The agenda for the meeting was constructed around the gap topics and associated discussion questions. The agenda (provided in Attachment C) covered six gap topics (items 1 – 5, and 7 as listed below), while a seventh topic (item 6 below) was added during in-person meeting deliberations. The final gap topics addressed by the workgroup during its meeting were the following:

- Topic 1: Proximity and Dependency Hazards in Threat Characterization;
- Topic 2: Natural Hazards in Threat Characterization;
- Topic 3: Worst Case Consequence Analysis for Potentially Critical Assets;
- Topic 4: Quantitative Calculation of Risk for Threat-Asset Pairs;
- Topic 5: Quantitative Calculation of Resilience for Threat-Asset Pairs;
- Topic 6: Total Value and Risk Reduction Efficiency Estimates for Countermeasure Options; and
- Topic 7: Proxy Method for Threat Likelihood Calculation (Non-Mandatory Element).

During the meeting, gap topic discussions proceeded according to an agreed format: background presentation on the relevant J100 Standard requirement; presentation on current tool functionality and possible upgrade options; clarifying questions and SME observations; and direct workgroup member deliberations to formulate recommendations. During the course of deliberations, workgroup members established a series of clarifications related to the J100 Standard and the WRF analysis. These clarifications are essential to understanding the workgroup's recommended course of action and are therefore explicitly identified throughout this report's text with the designation "discussions ***clarified***…"

The remainder of the report text covers the workgroup recommendations (Section 2.0) and additional considerations and observations (Section 3.0). The recommendations are organized by each gap topic as discussed at the in-person meeting. For each gap topic, the text provides background information on the relevant J100 Standard text and the findings of the WRF gap analysis. The text then provides highlights of the workgroup's deliberations to frame the context for its recommendations. Each gap topic area ends with the final workgroup's recommendations. Section 3.0 provides additional considerations and observations derived from workgroup discussions; Workgroup members consider these items essential to understanding their gap topic recommendations, as well as the appropriate use and implementation of the recommendations going forward.

2.0 Recommendations

2.1 Proximity & Dependency Hazards

Section 4.5.3 (Dependency and Proximity Hazards) of the J100 Standard (page 12) states: *"Initial estimates of the likelihood of dependency hazards are based upon local historical records for the frequency, severity, and duration of service denials. These estimates may serve as a baseline estimate of 'business as usual,' or incrementally increased if the analyst believes they may be higher due to malevolent activity on the required supply chain elements. Likelihood of incurring collateral damage from an attack on a nearby asset is estimated based on the local situation, and using the same logic in estimating malevolent risks (Section 4.5.1 of the J100 Standard)."* Furthermore, Mandatory Appendix E (RAMCAP Reference Threats) of the J100 Standard (page 55) identifies six dependency and proximity hazard reference threat scenarios*: 1) utilities; 2) key suppliers; 3) key employees; 4) key customers; 5) transportation; and 6) proximity* that are required for inclusion in a J100-10 compliant risk analysis.

The WRF gap analysis indicated that, *"[T]o meet the [J100] Standard, the [ARAM-W, SEMS, and VSAT] tools must include dependency and proximity hazards threat likelihood calculations. [The tools] must also include historical data on dependency and proximity hazards to determine the likelihood that the threats will occur to the asset. The [WRF] investigators were unable to locate a field to identify dependency and proximity hazards threat likelihoods."*

2.1.1 Workgroup Deliberations

2.1.1.1 Workgroup members and workgroup subject matter experts (SMEs) agreed that ARAM-W, SEMS, and VSAT do not currently comply with Section 4.5.3 of the J100 Standard and areas related to this specific section as the tools currently lack inclusion of the required dependency and proximity hazards.

2.1.1.2 Discussions explored the best means for the tools to support users in establishing likelihood and risk values for the required dependency and proximity hazards. The options explored reflected a range from

substantial definitional work for each hazard (e.g., establishing workgroups to generate and vet definitions and metrics for each hazard) to supporting a "user defined" approach (e.g., relying on the user to input likelihood values). The workgroup considered the general lack of national data for many of these hazards in its deliberations. From these discussions, a hybrid approach emerged. In concept, this approach blends a structured question framework (to help users systematically consider each hazard) coupled with user defined values. This approach emerged in response to the recognition that proximity and dependency hazard values will be closely tied to local conditions limiting the ability of any tool to efficiently provide relevant data sets to tool users. (See Attachment D for an example of the type of approach envisioned by the workgroup.)

2.1.2 Workgroup Recommendation(s)

2.1.2.1 To meet compliance with the J100 Standard, each tool must include the six dependency and proximity hazard reference threat scenarios identified in Section 4.5.3 of the J100 Standard and Mandatory Appendix E.

2.1.2.2 To aid users with these threat scenarios, develop a structured question framework reflective of Attachment D that could be included as guidance for the software users or incorporated in the software itself. Note that Attachment D is for information purposes only, and workgroup members did not attempt to refine or endorse the specific questions contained therein. All water sector tools would adopt this framework, and tool developers/representatives would work with sector partners to refine this framework.

2.2 Natural Hazards

Section 4.2.2 of the J100 Standard (pages 8-9) states: "*Utilities shall describe, for natural hazards, all hurricanes, earthquakes, floods, wildfires, ice storms, and tornadoes that have occurred or could occur in the location of the facility.*" Mandatory Appendix E of the J100 Standard (page 55) identifies the following mandatory natural disaster threats: *1) hurricanes; 2) earthquake; 3) floods; and 4) tornadoes* for inclusion in an analysis.

According to the WRF analysis, to comply with Section 4.2.2 of the J100 Standard, SEMS must include natural hazard threat likelihood calculations. The tool must also allow the practitioner to assign the likelihood or frequency of a natural hazard to an asset, based on historical data that may be provided by the tool via maps, data, or links to reference materials. The tool must also calculate the risk of each natural hazard and sum them to determine the overall risk due to natural hazards. The SEMS software has fields for historic information and magnitudes, however, the [WRF] investigators found that these values do not impact the calculated results in the analysis. The WRF analysis also indicated that ARAM-W and VSAT meet the J100 Standard requirements for Natural Hazards (Section 4.5.2 of the J100 Standard), while identifying some areas of potential, though not required for Standard compliance purposes, improvement.

2.2.1 Workgroup Deliberations

2.2.1.1 Workgroup discussions ***clarified*** that Section 4.2.2 contains the operative natural hazards requirement for the Standard, indicating that the tools must support the inclusion of hurricanes, earthquakes, floods, wildfires, ice storms, and tornadoes to meet compliance with the Standard.

2.2.1.2 ARAM-W, SEMS, and VSAT do not currently have wildfires or ice storms identified in their standard threat set, and therefore do not comply with the requirement in Section 4.2.2 of the Standard (hurricanes, earthquakes, floods, and tornadoes are, however, included in all three tools). On this basis, Workgroup discussions ***clarified*** that ARAM-W and VSAT do not currently meet the Standard.

2.2.1.3 Furthermore, SEMS does not appear to include natural hazard threat likelihood calculations (in the overall risk calculation) for the natural hazards currently covered by the tool (hurricanes, earthquakes, floods, and tornadoes).

2.2.1.4 Discussions indicated that a range of national data sets exist (e.g., United States Forest Service Drought Index) that might support the derivation of wildfire likelihood values. No national data sets for ice storms were identified during discussions. Due to the lack of standardized national severity and frequency data/scales for wildfires and ice storms, tools are anticipated to provide only external "pointers" to information on wildfires and

ice storms rather than "normalized" frequency and severity scales and therefore these data would be user defined inputs.

2.2.2 Workgroup Recommendation(s)

2.2.2.1 To meet compliance with the J100 Standard, wildfires and ice storms must be included in the reference threats of all three tools.

2.2.2.2 Provide fields in each tool for user defined likelihood and severity estimates for wildfires and ice storm threats.

2.2.2.3 Guidance on data sources and methods for preparing likelihood and severity estimates for wildfires and ice storms will aid users; its preparation is therefore desirable but not required.

2.2.2.4 To meet compliance with the J100 Standard, SEMS requires risk calculations for all six natural hazards.

2.3 Worst Case Consequence Analysis for Potentially Critical Assets

Section 4.1 (Asset Characterization) of the J100 Standard (page 7) states *"Ultimately, asset characterization produces a list of critical assets that must be considered in subsequent steps…The utility may make this a two–phased process, in which the first phase, or "facility screening," is the analysis of whole facilities to select a subset of all facilities of a specific sort to be analyzed more thoroughly, and the second phase is the analysis of the component assets of the facility to be assessed in detail. Alternatively, the utility may prefer universal application of risk analysis and start with the consideration of the components. In either case, the same procedure shall be followed."* Further on in Section 4.1, the J100 Standard states: *"…the utility shall conduct an asset characterization using the following six-step process…"* referring to steps identified in Sections 4.1.1 through 4.1.6.

The WRF Gap analysis indicated that SEMS and VSAT do not estimate the worst reasonable consequences resulting from the destruction or loss of each asset, without regard to the threat as required by Section 4.1.5 of the J100 Standard. Also, Section 4.1.6 of the J100 Standard indicates that critical assets should be prioritized using the estimated consequences. The WRF analysis indicated that SEMS and VSAT do not support such a prioritization. The WRF analysis did not identify a gap for ARAM-W in these areas.

2.3.1 Workgroup Deliberations

2.3.1.1 Discussions confirmed that SEMS and VSAT do not currently estimate worst reasonable consequences resulting from the destruction or loss of each asset, without regard to threat. Also, the tools do not support a prioritization of assets based on the estimated consequences without regard to threat.

2.3.1.2 Discussions ***clarified*** that supporting "facility screening" is a non-mandatory component of the J100 Standard and is not necessary for the tools to meet compliance with the J100 Standard.

2.3.1.3 Discussions ***clarified*** that the intent of Standard text at 4.1.5 ("*[T]he consequence metrics include: the potential for fatalities, serious injuries, major economic losses to facility or the community it serves, impacts to the environment, loss of public confidence, and/or inhibiting the effective function of national defense or civilian government at any level.*") is to assist the utility in identifying its most critical assets for purposes of high-level prioritization prior to any analysis and not to require a rigorously quantitative basis for prioritization. The objective of this high-level prioritization is to allow a utility user to focus risk analysis resources, if needed, to the assets associated with the highest consequences (i.e., to improve the efficiency of the analysis).

2.3.1.4 Discussions ***clarified*** that ARAM-W does currently support the assignment of consequences to assets without regard to threat, but the tool does not support creating a prioritized list of assets based on the consequence analysis and therefore is not in compliance with Section 4.1.6 of the Standard.

2.3.1.5 Compliance with Sections 4.1.5 and 4.1.6 of the J100 Standard supports the creation of a list of assets based on prioritization of the most critical assets at the utility.

2.3.1.6 Discussion established that the prioritization criteria must consist of those identified in Section 4.1.5 (fatalities, serious injuries, major economic losses to the facility, major economic losses to the community, impacts to the environment, loss of public confidence, inhibition to the effective function of national defense or civilian government).

2.3.1.7 Although not explicitly called out in the J100 Standard, workgroup discussion ***clarified*** that it is acceptable to group these criteria into categories such as "public-health impacts," "economic impacts," and "other," provided a clear connection is maintained to the criteria from 4.1.5.

2.3.2 Workgroup Recommendation(s)

2.3.2.1 To establish compliance with Section 4.1.5 of the J100 Standard, SEMS and VSAT need to support the ability of a user to conduct a high-level assignment of consequences to assets regardless of threat. Moreover, to establish compliance with Section 4.1.6 of the J100 Standard, SEMS, VSAT, and ARAM-W must allow the user to prioritize assets on the basis of the high-level consequence assignment process.

2.3.2.2 This prioritization would consist of using basic qualitative measures (e.g., high, medium, low) for each consequence category (e.g., public health impacts and economic impacts).

2.3.2.3 The group expressed an interest in all three tools providing the flexibility for additional consequence categories, as identified by the user, to support user flexibility (workgroup members recognized that this additional functionality is not a mandatory requirement of the J100 Standard).

2.3.2.4 The development of optional guidance to assist users in more efficiently and consistently assigning high-level consequence values (regardless of threat) to support prioritization of assets was viewed as helpful but not a requirement of the J100 Standard. For example, this guidance could provide suggestions of how to define the low, medium, and high ranges for the consequence metrics identified in Section 4.1.5 of the J100 Standard. (Discussions indicated that Appendix A of the J100 Standard describes a qualitative, user defined scale that a utility could use for this step of the analysis.)

2.3.2.5 The ability to group assets, for example into five "priority" categories based on consequence assessment results, was viewed as helpful, but not required by the J100 Standard. For example, the tools might support the user in defining and then assigning assets to very high, high, medium, low, and very low "bins" based on the findings of the consequence review.

2.4 Quantitative Calculation of Risk for Threat-Asset Pairs

Section 4.6.1 of the J100 Standard states the utility shall *"Calculate risk for each threat-asset pair as the product of the results from Consequence Analysis (see 4.3), Vulnerability Analysis (see 4.4), and Threat Analysis (see 4.5), using the following equation: Risk = Consequences x Vulnerability x Threat Likelihood = C x V x T."*

Referring to Section 4.6.1 of the Standard, the WRF analysis indicates that, to meet the Standard, a tool must allow the practitioner to calculate the risk associated with each threat-asset pair based on the consequence, vulnerability, and threat likelihood values. For SEMS, the WRF analysis indicates that the tool does not provide a place to input a specific value for vulnerability or threat likelihood. For VSAT, the WRF analysis indicates that the tool does not calculate overall risk to the utility or the risk to each threat-asset pair using the J100 Standard formula. VSAT instead displays the risk to each threat-asset pair explicitly as a function of consequences, vulnerability, and threat likelihood. Regarding ARAM-W, the WRF analysis indicates the tool meets the requirements of 4.6.1.

2.4.1 Workgroup Deliberations

2.4.1.1 Workgroup deliberations reinforced the WRF analysis that SEMS and VSAT must produce a quantitative risk calculation for each threat-asset pair.

2.4.1.2 Workgroup discussion ***clarified*** that ARAM-W does not fully meet the J100 Standard in this area as it currently produces a qualitative risk value as a final tool output for threat-asset pairs.

2.4.1.3 Discussion ***clarified*** that there are two "paths" within Section 4.6.1 of the Standard:

2.4.1.3.1 One path results in a single quantitative risk value for each threat-asset pair, expressed in dollar terms, inclusive of the four RAMCAP consequence categories (i.e., fatalities; injuries; utility economic; and community economic), along with a display of numeric numbers (#s) of fatalities and serious injuries NOT included with the dollar values;

2.4.1.3.2 A second path results in a risk number for each threat-asset pair expressed in dollar terms exclusive of the RAMCAP consequence fatality and serious injury categories (i.e., only include utility economic and community economic dollar values) along with a display of numeric numbers (#s) of fatalities and serious injuries included with the dollar values.

2.4.1.4 The workgroup accepted that deriving a single risk estimate for each threat-asset pair expressed in dollar terms inclusive of the four consequence categories requires using the statistical dollar value of a human life and the statistical dollar value of serious injuries. Discussion indicated that there are several recognized sources of data for these values (including EPA recommendations for the statistical value of human life contained in its 2000 *Guidelines for Preparing Economic Analysis*) as referenced in the J100 Standard.

2.4.2 Workgroup Recommendation(s)

2.4.2.1 To meet compliance with the J100 Standard Section 4.6.1, all three tools should enable the two paths identified in 2.4.1 to provide for the quantitative determination of consequence values for each threat-asset pair and the subsequent quantitative estimation of risk expressed in dollar terms for each threat-asset pair:

2.4.2.1.1 A single quantitative monetary risk value for each threat-asset pair that includes the four RAMCAP consequence categories (i.e., fatalities; injuries; utility economic; and community economic) will be displayed. Additionally, the numeric numbers (#s) of fatalities and serious injuries will be presented separately; and

2.4.2.1.2 A quantitative monetary risk value for each threat-asset pair that includes the RAMCAP consequence fatality and serious injury categories will be displayed. Additionally, the numeric numbers (#s) of fatalities and serious injuries will be displayed separately.

2.4.2.2 The workgroup recognized that follow-up work is needed to review and select sources of data for deriving value of human life and, in particular, serious injury estimates.

2.5 Quantitative Calculation of Resilience for Threat-Asset Pairs

Section 4.6.2 of the J100 Standard (pages 13-14) states: *"At the threat-asset pair level, the utility shall estimate asset and economic metrics of resilience using elements of the previously estimated consequences (step 4.3), which are used in slightly different ways and shall be displayed along with risk."* Specific subsections of 4.6.2 provide further detail on the required resilience metrics.

Section 4.6.2.1 states: *"The asset resilience metric is service denial due to a threat-asset pair, weighted by vulnerability and threat likelihood. Asset Resilience Metric = Duration X Severity X Vulnerability X Threat Likelihood, where:*

- *Duration = the time period of service denial, in days.*
- *Severity = the amount of daily service denied, in gallons per day.*
- *Vulnerability and Threat Likelihood as defined in Sections 4.4 and 4.5 respectively."*

Section 4.6.2.2 of the J100 Standard (page 14) states: *"The owner's economic resilience metric is lost revenue to the utility owner due to the threat-asset pair (also estimated in step 4.3). Lost revenue is simply asset resilience times the unit price of the service, where price is the pre-disruption price. This metric puts operational resilience on a dollar basis that can be compared with the costs of reducing the metric, i.e., enhancing resilience. Owner's economic resilience is often a required input for estimating community economic resilience metric."*

Section 4.6.2.3 states: *"The community economic resilience metric is the lost economic activity to the community served by the utility. For the community, the metric is the same as the economic loss to the community, estimated in step 4.3."*

Section 4.6.3 states: *"Record the risk and resilience estimates for each threat-asset pair for use in step 4.7."*

Regarding resilience estimates, the WRF analysis indicates that ARAM-W, SEMS, and VSAT must determine overall resilience of the utility, including the duration of service denial and the severity of service denial (in millions of gallons per day) in order to determine the resilience of each threat-asset pair.

2.5.1 Workgroup Deliberations

2.5.1.1 Workgroup discussions confirmed that ARAM-W, SEMS, and VSAT do not currently comply with Section 4.6.2 of the J100 Standard.

2.5.1.2 Discussion ***clarified*** the nature and role of the threat-asset pair *resilience* calculations as they relate to the threat-asset pair *risk* calculations prepared in compliance with Section 4.6.1.

2.5.1.2.1 The threat-asset pair risk calculation incorporates the full range of consequences a utility can anticipate (including duration and severity of service outages) if conducted consistent with Section 4.3 of the J100 Standard.

2.5.1.2.2 The threat-asset pair resilience calculations include the same service denial duration, severity, and vulnerability that are contained in the current risk calculation, where:

- Duration = the time period of service denial, in days.
- Severity = the amount of daily service denied, in gallons per day.
- Vulnerability and Threat Likelihood as defined in Sections 4.4 and 4.5 respectively.

2.5.1.2.3 Resilience as outlined in Section 4.6 of the J100 Standard is a component of overall risk as defined in Section 4.3 of the Standard. Discussion also indicated that resilience as defined consistent with Section 4.6 could be viewed as a calculation of the expected monetary value of restoring operations and that this definition may undergo further refinement as the use, validation, and maturity of the concept of resilience evolves within the critical infrastructure sectors.

2.5.1.2.4 The threat-asset pair resilience calculations isolate the effects of countermeasures on service denial severity and duration. As such, the resilience metrics are complementary to the overall risk calculation. For example, two different packages of countermeasure options could produce an identical reduction in threat-asset pair risk. At the same time, they may have a different impact on the threat-asset pair resilience metric (service denial severity or duration). This information allows for selecting between these two countermeasure option packages based on the degree of interest a utility manager has in affecting the service denial severity and duration aspects of overall risk reduction.

2.5.1.3 Workgroup discussion also ***clarified*** that the service denial metric for wastewater facilities will be "gallons not treated" per day.

2.5.2 Workgroup Recommendation(s)

2.5.2.1 To meet compliance with Section 4.6.2, all three tools must support the resilience calculations defined in the J100 standard. This will result in the tools meeting this portion of the J100 Standard, as well as providing a complementary measure to the quantitative threat-asset pair risk calculation.

2.5.2.2 Establish clarity in the tools or guidance that the threat-asset pair resilience calculations isolate the impacts of countermeasures on changes in service denial severity and duration. Consistent with the intent of the J100 Standard, a user will not be balancing or trading off between risk and resilience, but will be informed that, as risk is reduced through countermeasures, some packages of countermeasures (even those with identical risk reduction) will produce more or less service denial severity or duration reduction.

2.6 Total Value and Risk-Reduction Efficiency Estimates for Counter Measure Options

Section 4.7 articulates a required nine-step process for supporting risk and resilience management. The steps take a utility manager through the definition and costing of countermeasures and mitigation options, and evaluation of the risk reduction efficiency of such measures expressed in dollar terms, and the monitoring, evaluating, and updating of implementation over time. Section 4.7.6 specifically states that a utility shall *"calculate the net benefits and benefit-cost ratio (and/or other criteria that are relevant in the utility's decision making) to estimate the total value and risk reduction efficiency of each option."*

The WRF analysis indicates that the SEMS software does not support risk or resilience management actions or metrics as required in Section 4.7. WRF indicates that while VSAT uses "risk reduction units" to guide countermeasure selection, it does not calculate the net benefits in dollars and benefit-cost ratios. The WRF analysis draws the same conclusion for ARAM-W stating that the tool does not calculate net benefits in dollars and benefit-cost ratios.

2.6.1 Workgroup Discussion

2.6.1.1 Workgroup discussion explored what flexibility tool developers have in meeting the requirements of the J100 Standard under Section 4.7.6.

2.6.1.2 Discussions focused on articulating the objective of this section (to ensure utility managers understand the risk reduction efficiency of their countermeasure options in dollar terms to aid in financial decision making) and the extent to which this can be accomplished through an alternative other than a cost-benefit ratio.

2.6.1.3 Discussions ***clarified*** that alternative means, such as VSAT's risk reduction units, can be acceptable provided the objective is met through, for example, a countermeasure effectiveness measure expressed in dollar terms (essentially providing a measure of cost effectiveness for countermeasures).

2.6.1.4 Discussions ***clarified*** that if a tool had been upgraded to meet requirements such as those in 4.6.1 (quantitative calculation of risk for threat-asset pairs), then that tool would have the data necessary to support all requirements of Section 4.7.6 of the J100 Standard.

2.6.2 Workgroup Recommendation(s)

2.6.2.1 To comply with the J100 Standard, tools must ensure they provide a quantitative means for utility managers to understand the risk reduction efficiency of their countermeasures in dollars.

2.6.2.2 Any tool upgraded to meet the requirements of J100 Standard Section 4.6.1 will have the data necessary for calculating a threat-asset pair benefit-cost ratio. Workgroup members understood presentation of a benefit-cost ratio is a requirement for compliance with the J100 Standard, although the standard allows for substitute metrics, such as risk reduction units in VSAT, that achieve the same purpose by estimating the total dollar value and risk reduction efficiency of each option.

2.7 Proxy Method for Threat Likelihood Calculation (Non-Mandatory Element)

Section 4.5 (Threat Analysis) of the J100 Standard (page 11) states: *"This step estimates likelihood of malevolent event, dependency/proximity hazard, or natural hazard. The utility shall estimate the likelihood or frequency of all hazards and threats."* Section 4.5.1 Malevolent Threats (pages 11- 12) states the following: "*Estimate the likelihood of a malevolent event based on the adversary's objectives and capabilities and the attractiveness of the region, facility, and threat-asset pair relative to alternative targets. Information on adversary's capabilities, intentions, and the attractiveness of the general location (e.g., city, metropolitan area, general type of facility or asset) may be informed by security, intelligence, and/or law enforcement agencies. The relative attractiveness of the specific target is based on an evaluation of alternative target options of the same type, the level of vulnerability, the likelihood of success, and the cost/effectiveness of the incident to the adversary. Any among the following three approaches to estimating malevolent threat likelihood may be used:*

4.5.1.1 Proxy Measure – Proxy measures may be based on attractiveness of utility, size of metropolitan area, amount of governmental facilities in the area, or other attributes and be provided by industry or other organizations to provide a common basis for evaluation of risk from malevolent threats. Appendix F contains an optional approach for estimating a proxy indicator of terrorism threat likelihood.

4.5.1.2 Best Estimate –With this method, likelihood is determined based upon organization experience, input from federal, state and local law enforcement, and others. The likelihood will be either a qualitative measure, e.g., low, medium, high, very high or can be a probability with a value between 0.0 and 1.0.

4.5.1.3 Conditional Assignment – With this method, the likelihood of the threat is considered to be a probability of 1.0. This is a useful approach for examining the worst case potential for a variety of malevolent threats."

The Standard further notes that, "*when comparing the results between analyses, the same method and assumptions must be used for the evaluations if the comparison is to be valid. Only the proxy indicator may be used when the results are to be compared with other RAMCAP analyses.*"

The WRF analysis, referring to Section 4.5.1, indicates tools, if they are to meet the Standard, must include malevolent threat likelihood calculations using proxy measures, best estimates, and conditional assessments. For SEMS, the analysis identifies best estimate as the only method used in the tool and concludes SEMS has a gap relative to the Standard. For VSAT, the WRF analysis states, "*the VSAT software allows the practitioner the choice to use Best Estimate or Conditional Assessment at the start of the assessment. If Best Estimate is chosen, then the software only allows the practitioner to determine the threat likelihood of each threat and record them as very high, high, moderate, or low likelihoods (basically a best estimate). It does not allow the practitioner to use proxy measures or conditional assessments. As this feature was met* by *only two out of three requirements in the J100 -10 Standard, the researchers have identified this as a gap."* For ARAM-W, the WRF analysis concludes the tool meets the Standard because it supports using a conditional, expert judgment, or questionnaire method.

2.7.1 Workgroup Deliberations

2.7.1.1 Workgroup discussions ***clarified*** that the use of the proxy method is one of three acceptable approaches under Section 4.5.1 of the J100 Standard, and inclusion of any one of the three threat likelihood calculations would result in compliance with the Standard.

2.7.1.2 Workgroup discussions also articulated an important objective of Section 4.5.1 as enabling the user to establish threat likelihoods on a reasonably consistent basis across different threat classes such as malevolent, natural disaster, and others. For example, VSAT derives threat likelihood for tornadoes from a NOAA dataset, whereas in the absence of a comparable dataset the threat likelihood from terrorism is calculated using conditional (100% probability) or best estimates (e.g., 0, 0.3, 0.5, etc.).

2.7.1.3 Discussion also indicated an interest on the part of workgroup members to have a threat likelihood method for malevolent threats this is structured, transparent, repeatable, and defensible, while there was a difference of opinion regarding the extent to which currently available proxy methods support this ideal.

2.7.1.3.1 Certain observations indicated discomfort with the proxy method as an approach that lacks validation and acceptance within the intelligence community and a concern that its use will lead users to attribute more accuracy to the estimates than is appropriate. Concerns were also raised that the proxy method could remain static in its application while local conditions related to malevolent threats may evolve. The proxy method was viewed by some as a worthwhile, aspirational objective of the Standard, but the absence of a validated proxy method made its inclusion in a tool an infeasible objective for the near-term.

2.7.1.3.2 Other observations indicated support for inclusion of at least a proxy value in the tools. This support followed from the perspective that, the proxy approach, though recognized as not perfect, provides a systematic and replicable means for users to establish threat likelihood values for malevolent threats. Discussions indentified *Terrorism Risk Modeling for Intelligence Analysis and Infrastructure*

Protection, prepared for the Department of Homeland Security by the RAND Center for Terrorism Risk Management Policy, as providing a basis for use of a proxy method. The proxy approach moreover was viewed as allowing a more realistic assessment of the likelihood of terrorism relative to the likelihood of natural disasters and other threats, and thus generating a more balanced risk assessment. Discussion indicated that a best estimate approach, if informed by locally available and relevant intelligence data, can be preferable to a proxy approach, but recognized the sector has experienced difficulty obtaining such information from intelligence agencies.

2.7.2 Workgroup Recommendation(s)

2.7.2.1 To help enable the objective of Section 4.5.1 (balanced consideration of malevolent, natural disaster, and other threats), include in the tools a field to capture a user supplied threat likelihood value derived from application of a proxy method.

2.7.2.2 The workgroup considered a recommendation to build into the tools a method for calculating threat likelihood based on a proxy method but failed to reach consensus on this point of discussion. Therefore it is at the discretion of the tool developer as to how to integrate the input for proxy method (i.e., internal calculation or external source).

3.0 Other Considerations and Observations

3.1 Priorities for Tool Upgrades

3.1.1 Workgroup members explicitly acknowledged that the upgrades recommended for ARAM-W, SEMS, and VSAT to meet compliance with the J100 Standard could be time consuming and resource intensive. Moreover, workgroup members consistently expressed the need for any upgraded tools to be accessible to the non-risk professional, as most utilities lack specialized risk management staff and will conduct assessments in a resource and time constrained context. Overall, there was an interest in ensuring that potential upgrades result in a tool or tools that can support the entire industry, regardless of utility type, size, and risk expertise. Workgroup members believed that these resource and usability issues are important considerations in future discussions regarding the water sector's need for risk assessment tools.

3.1.2 After exploring several different bases for providing a sense of priority for tool upgrade options, workgroup members concluded that meeting compliance with the Standard is an "all or nothing proposition." This conclusion stemmed from the belief that tool users will view a partially upgraded tool as little or no different than a currently non-compliant tool. Thus, partial investments or upgrades are anticipated to be problematic for the user with compliance with the Standard in mind.

3.1.3 The discussion of setting priorities for the upgrades did yield some insights into possible paths forward if, in fact, only partial upgrades are possible. The workgroup viewed the possible upgrades as falling into three general categories: improving the integrity of the risk assessment process by building in additional threats (e.g., dependency threats); improving the decision making capacity of the tool user through introducing additional metrics (e.g., a quantitative risk calculation expressed in dollar terms, a new resilience metric); and improving the efficiency of the risk analysis process (e.g., use of worst reasonable consequences without regard to threat as a means to identify critical assets). To the extent any one of these three categories has strong appeal to users, they could be used as a basis for sequencing improvements.

3.1.4 Finally, discussion also explored the technical considerations associated with implementation of the upgrades and how that might constrain how the sequence or priority of upgrades can be considered. Certain dependencies did in fact emerge from these discussions (e.g., the dependence of the resilience metric on the quantitative risk calculation elements). Workgroup members understood that such dependencies could dictate upgrade sequence.

3.2 Clarifications

3.2.1 Throughout workgroup discussions, clarifications to both the WRF Gap Analysis and the J100 Standard emerged. For example, clarification was given that, for natural hazard requirements, users should use the statements from Section 4.2.2, and not other areas of the text (where inconsistencies exist). Similarly with the Gap Analysis, more in-depth exploration or clarification of Standard requirements or a closer look at current tool functionality resulted in a reassessment of the nature or extent of identified gaps. These clarifications are identified throughout the text capturing the workgroup deliberations by the inclusion of the term "***clarified***" in the text.

3.2.2 Regarding the WRF analysis, workgroup members believe it is important to acknowledge that clarifications regarding the type and existence of tool gaps made in this workgroup document should supersede the findings contained in the WRF analysis. This will avoid confusion in the future as tools move forward with upgrades and potential users assess them from the perspective of compliance with the Standard.

3.2.3 Regarding clarifications to the Standard made in this report, workgroup members believe it is critical that these clarifications receive verification or endorsement from an official body associated with the J100 Standard (the J100 Standard Committee). The clarifications from this report will then form the foundation on which recommendations for tool modifications will be assessed by the J100 Standard Committee. Therefore, before tool representatives move to invest significant resources in upgrades/modifications with the intent to achieve compliance with the J100 Standard, they must receive assurance that the clarifications in this document---and any subsequent upgrades/modifications to the tools based directly on these clarifications---will be judged consistent with the J100 Standard by individuals who may not have participated in this CIPAC workgroup's discussion.

ATTACHMENT A: RAM Charter

CRITICAL INFRASTRUCTURE PARTNERSHIP ADVISORY COUNCIL

WATER SECTOR RISK ASSESSMENT METHODOLOGY / STANDARD EXAMINATION WORKGROUP

APRIL 11, 2011

CHARTER

I. Background, Establishment, and Designation

Background: Three water sector (drinking water and wastewater) risk assessment methodologies -- ARAM-W, SEMS, and VSAT -- were recently upgraded as part of an overall effort to bring them consistent with the 2007 Risk Analysis and Management for Critical Asset Protection (RAMCAP®) Sector-Specific Guidance for Drinking Water and Wastewater Systems. While upgrades to water sector risk assessment methodologies were in progress, the American Water Works Association (AWWA) and ASME-Innovative Technologies Institute (ITI) developed a standard for water sector risk assessment methodologies. This AWWA and ASME-ITI process resulted in the July 2010 American National Standards Institute/ASME-ITI/AWWA J100 Risk Analysis and Management for Critical Assets Protection (RAMCAP®) Standard for Risk and Resilience Management of Water and Wastewater Systems hereinafter (J100 Standard).

Establishment: The Critical Infrastructure Partnership Advisory Council (CIPAC) Water Sector Risk Assessment Methodology / Standard Examination Workgroup (hereinafter Workgroup) is convened by the Water Sector Coordinating Council (SCC) and Government Coordinating Council (GCC).

Designation: The Workgroup intends to examine whether further modifications to the recently upgraded water sector risk assessment methodologies -- ARAM-W, SEMS and VSAT -- are necessary in order to align them with the J100 Standard.

The Secretary of the Department of Homeland Security exempted CIPAC and its workgroups from the requirements of the Federal Advisory Committee Act.[1]

II. Objectives

The Workgroup has two objectives.
1) Examine the three water sector risk assessment methodologies. Specific emphasis during this examination will be given to how these tools address the requirements defined in the J100 Standard.

2) Determine what upgrades would be necessary for the three water sector risk assessment tools to ensure that they help utilities meet industry best practices as defined by the J100 Standard.

III. Scope of Activities

The Workgroup is expected to:
1) Identify questions to be addressed and analyses to be conducted in order to meet the objectives of the Workgroup, as stated above. Where possible, EPA will provide technical assistance to the Workgroup through Agency and contractor resources by obtaining data and conducting analyses requested by the Workgroup;

2) Consider data and information from other sources that serve to inform Workgroup questions, including that obtained from utilities that used RAM-W (ARAM-W), SEMS, and VSAT;

3) Review and utilize the findings from the Water Research Foundation's J100 gap analysis report;

4) Provide prioritized recommendations, if necessary, to EPA and DHS on potential J100 Standard associated modifications to ARAM-W, SEMS, or VSAT; and

5) Recommend training and outreach approach for the tools. The approaches may be different for small systems versus large systems.

IV. Membership

In total the Workgroup will be comprised of up to nine (9) members with representation focused on public and private drinking water and wastewater utilities, associations, state drinking water and primacy agencies, EPA, DHS, and other federal, state, and local agencies as appropriate. It is anticipated that the Workgroup will also have subject matter experts. **The Water Sector Coordinating Council will have six (6) representatives with the remaining representation coming from the Government Coordinating Council.** Workgroup representatives may be selected from sitting members of the Council, association staff and/or their membership, and other experts.

V. Operating Procedures and Ground Rules

The Workgroup is expected to follow the Workgroup Operating Procedures and Ground Rules (see attached).

VI. Schedule and Duration

The Workgroup is expected to complete its activities by **June 2011**. The following is a suggested timeframe for the Workgroup activities. The Workgroup will develop a more detailed project plan and the timeline below may be modified.

1) Review and approve charter:
- **a. Complete**

2) Identify CIPAC members for the Workgroup
- **a. Complete**

3) Conduct a facilitated Workgroup "kick-off" conference call
- **a. Weeks 2-3, April 2011**

4) Hold a 2 to 3 day in-person, facilitated Workgroup meeting
- **a. Weeks 1-2, May 2011**

5) Follow-up / final Workgroup conference call
a. Weeks 3-4, May 2011

6) CIPAC Workgroup provides its recommendations to EPA and DHS
a. Week 1, June 2011.

[1] For more information, see: http://www.dhs.gov/cipac

ATTACHMENT B: List of Workgroup Members, SMEs, and Support Staff

Direct Workgroup Members			
Mark Anderson	ASDWA	**Jorge Monseratte**	San Antonio, TX Water System
David Baird	City of Milford, DE	**Debbie Newberry**	EPA
Charles Hilton	Breezy Hill Water and Sewer Company	**Nick Santillo**	American Water
Michael Hooker	Onodaga County Water Authority	**Brookie Tate**	Columbus Water Works
John Laws	DHS	**David Travers**	EPA
Subject Matter Experts			
Curt Baranowski	EPA	**Chuck Manly**	SEMS Technologies
Cade Clark	NAWC	**Kevin Morley**	AWWA
Ryan Costello	SEMS Technologies	**Bridget O'Grady**	ASDWA
Debra Decker	FBI	**Dan Rees**	Scientech
John DeGour	EPA	**Shannon Spence**	Malcolm Pirnie
Cynthia Finley	NACWA	**Patrick Starke**	FBI
Sarah Goes	DHS	**Jim Sullivan**	WEF
Cal Jaeger	Sandia National Laboratories	**Vance Taylor**	AMWA
Shalini Jayasundera	CSC	**Ed Thomas**	SEMS Technologies
William Komianos	American Water		
Supporting Staff			
Rob Greenwood	Ross & Associates	**Morgan Hoenig**	Ross & Associates
Kyle Harger	SRA		

ATTACHMENT C: July 26–28 In-Person Meeting Agenda

CIPAC Water Sector RAM/Standard Examination Workgroup
In-Person Meeting
July 26 – 28, 2011

Location: Hotel Rouge, Washington, DC

DAY 1 – July 26

8:30	Settle In	Rob Greenwood
8:35	Notice of CIPAC Compliance	John Laws
8:40	Co-Chair Welcome	Charles Hilton & David Travers
8:50	Introductions, Agenda Review, and Charter	Rob Greenwood
9:10	J100-10 Standard Highlights and Q&A	Kevin Morley

RAM Water Sector Tools Flow Process
with Identification of Gap Theme Areas

9:30	Overview of ARAM-W	Cal Jaeger
9:50	Overview of SEMS	Chuck Manly
10:10	Overview of VSAT	Dan Rees
10:30	**BREAK**	

First Gap Topic: Proximity & Dependency Hazards - Gap for All Tools

10:45	J100-10 Element Description of Proximity & Dependency Hazards	Kevin Morley
11:00	RAM Tool Current Approach – VSAT Focus	Dan Rees

Discussion Questions

11:15	1. What is the gap and range of gap responses and associated potential upgrade options (technical, methodological, cost, time) for VSAT? Are there additional responses or upgrade options unique to ARAM-W or SEMS?	Curt Baranowski Dan Rees John Laws Cal Jaeger Ed Thomas Chuck Manly
11:40	2. What are the challenges, if any, associated with the potential upgrades?	SME Perspectives Workgroup Discussion
12.00	**LUNCH**	On Your Own

Proximity & Dependency Hazard Discussion Questions (continued)

1:15	3. Preliminary Recommendation(s) a) Are upgrade options constrained by any identified challenges?	Workgroup Discussion

DAY 1 – July 26		
	b) How necessary are these upgrades (to ensure the tools assist utilities meet industry best practices as defined by the J100-10 Standard)? c) What priority (high, medium, low) should the potential upgrades be given?	
2:15	4. Are there any additional recommendations for ARAM-W or SEMS in light of these discussions?	Cal Jaeger Perspectives Chuck Manly Perspectives Workgroup Discussion
2:45	**BREAK**	
	Second Gap Topic: Natural Hazards - Gap for SEMS	
3:00	J100-10 Element Description of Natural Hazards	Kevin Morley
3:10	SEMS Current Approach	Chuck Manly
	Discussion Questions	
3:20	1. What is the gap and range of gap responses and potential upgrade options (technical, methodological, cost, time) for SEMS?	Ed Thomas Chuck Manly
3:30	2. What are the challenges, if any, associated with the potential upgrades?	SME Perspectives Workgroup Discussion
4:00	3. Preliminary Recommendation(s) a) Are upgrade options constrained by any of the identified challenges? b) How necessary are these upgrades (to ensure the tools assist utilities meet industry best practices as defined by the J100-10 Standard)? c) What priority (high, medium, low) should the potential upgrades be given?	Workgroup Discussion
4:30	4. Are there any additional recommendations for ARAM-W or VSAT in light of these discussions?	Cal Jaeger Perspectives Dan Rees Perspectives Workgroup Discussion
4:45	Plan for Day 2	Rob Greenwood
5:00	**ADJOURN**	
DAY 2 – July 27		
8:00	Settle In and Agenda Review	Rob Greenwood
	Third Gap Topic: Worst Case Consequence Analysis for Potentially Critical Assets – Gap for SEMS and VSAT	
8:15	J100-10 Element Description of Worst Case Consequence Analysis for Potentially Critical Assets	Kevin Morley
8:30	RAM Tool Current Approach – VSAT Focus	Dan Rees
	Discussion Questions	
8:45	1. What is the gap and range of gap responses and associated potential upgrade options (technical, methodological, cost, time) for VSAT? Are	Curt Baranowski Dan Rees

DAY 2 – July 27			
		there additional responses or upgrade options unique to SEMS?	Ed Thomas Chuck Manly
9:05	2.	What are the challenges, if any, associated with the potential upgrades?	SME Perspectives Workgroup Discussion
9:30		**BREAK**	
9:45	3.	Preliminary Recommendation(s) a) Are upgrade options constrained by any of the identified challenges? b) How necessary are these upgrades (to ensure the tools assist utilities meet industry best practices as defined by the J100-10 Standard)? c) What priority (high, medium, low) should the potential upgrades be given?	Workgroup Discussion
10:30	4.	Are there any additional recommendations for SEMS and ARAM-W in light of these discussions?	Chuck Manly Perspectives Cal Jaeger Perspectives Workgroup Discussion
		Fourth Gap Topic: Quantitative Calculation of Risk for Threat-Asset Pairs – Gap for SEMS and VSAT	
10:45		J100-10 Element Description of Quantitative Calculation of Risk for Threat-Asset Pairs for SEMS and VSAT	Kevin Morley
11:00		ARAM-W Approach to Quantitative Risk Calculation ➢ Explanation of how ARAM-W calculates risk ➢ Explanation of VSAT and SEMS approaches to risk representation	Cal Jaeger Dan Rees and Chuck Manly
11:15		RAM Tool Current Approach – VSAT Focus	Dan Rees
11:30		**LUNCH**	On Your Own
		Discussion Questions	
12:30	1.	What is the gap and range of gap responses and associated potential upgrade options (technical, methodological, cost, time) for VSAT? Are there additional responses or upgrade options unique to SEMS?	Curt Baranowski Dan Rees Ed Thomas Chuck Manly
12:50	2.	What are the challenges, if any, associated with the potential upgrades?	SME Perspectives Workgroup Discussion
1:15	3.	Preliminary Recommendation(s) a) Are upgrade options constrained by any of the identified challenges? b) How necessary are these upgrades (to ensure the tools assist utilities meet industry best practices as defined by the J100-10 Standard)? c) What priority (high, medium, low) should the potential upgrades be given?	Workgroup Discussion

DAY 2 – July 27		
2:15	4. Are there any additional recommendations for SEMS or ARAM-W in light of these discussions?	Chuck Manly Perspectives Cal Jaeger Perspectives Workgroup Discussions
2:45	**BREAK**	
	Fifth Gap Topic: Quantitative Calculation of Resilience for Threat-Asset Pairs – Gap for All Tools	
3:00	J100-10 Element Description of Quantitative Calculation of Resilience for Threat-Asset Pairs	Kevin Morley
3:15	RAM Tool Current Approach – ARAM-W Focus ➢ With input from SEMS and VSAT	Cal Jaeger Chuck Manly and Dan Rees
	Discussion Questions	
3:30	1. What is the gap and range of gap responses and associated potential upgrade options (technical, methodological, cost, time) for VSAT? Are there additional responses or upgrade options unique to SEMS or VSAT?	John Laws Cal Jaeger Ed Thomas Chuck Manly Curt Baranowski Dan Rees
3:55	2. What are the challenges, if any, associated with the potential upgrades?	SME Perspectives Workgroup Discussion
4:30	3. Preliminary Recommendation(s) a) Are upgrade options constrained by any of the identified challenges? b) How necessary are these upgrades (to ensure the tools assist utilities meet industry best practices as defined by the J100-10 Standard)? c) What priority (high, medium, low) should the potential upgrades be given?	Workgroup Discussion
5:30	Wrap Up, Plan for Day 3	Rob Greenwood
5:35	**ADJOURN**	

DAY 3 – July 28		
8:00	Settle In and Agenda Review	Rob Greenwood
	Fifth Gap Topic: Quantitative Calculation of Resilience for Threat-Asset Pairs – Gap for All Tools (Continued Discussion from Day 2)	
8:15	4. Are there any additional recommendations for VSAT or SEMS in light of these discussions?	Chuck Manly Perspectives Dan Rees Perspectives Workgroup Discussion
	Sixth Gap Topic: Proxy Method for Threat Likelihood Calculation – Gap for All Tools	

DAY 3 – July 28

8:45	J100-10 Element Description of Proxy Method for Threat Likelihood Calculation	Kevin Morley
9:00	RAM Tool Current Approach – ARAM-W Focus	Cal Jaeger
	Discussion Questions	
9:15	1. What is the gap and range of gap responses and associated potential upgrade options (technical, methodological, cost, time) for each tool? Are there additional responses or upgrade options unique to SEMS or VSAT?	John Laws Cal Jaeger Ed Thomas Chuck Manly Dan Rees Curt Baranowski
9:40	2. What are the challenges, if any, associated with the potential upgrades?	SME Perspectives Workgroup Discussion
10:15	**BREAK**	
10:30	3. Preliminary Recommendation(s) a) Are upgrade options constrained by any of the identified challenges? b) How necessary are these upgrades (to ensure the tools assist utilities meet industry best practices as defined by the J100-10 Standard)? c) What priority (high, medium, low) should the potential upgrades be given?	Workgroup Discussion
11:30	4. Are there any additional recommendations for VSAT or SEMS in light of these discussions?	Chuck Manly Perspectives Dan Rees Perspectives Workgroup Discussions
12:00	**LUNCH**	On Your Own
1:15	Review Recommendations 1. What revisions are needed to individual gap recommendations? 2. Do the recommendations as a whole produce a cohesive approach for each tool? If not, what changes are needed?	Workgroup Discussion
2:15	Next Steps	Workgroup Discussion
2:45	Co-Chairs Wrap Up	Charles Hilton and David Travers
3:00	**ADJOURN**	

ATTACHMENT D: Example Approach to Proximity and Dependency Hazards

Reference Threat	Question/Selections	Types of Choices/Input
Utilities	Select the utilities that are critical to your operations	Electric, Gas, telephone, etc. [dropdown]
	How long can you operate without (electric, gas)?	___ hours, ___ days
	Have you suffered service interruptions in the past?	Y/N
	If so, on average how many times per year?	___ per year
	If so, on average how long was the duration of outage?	___ hours, ___ days
	Provide your best estimate for the probability of (power, gas, etc.) loss to this asset above your critical threshold per year.	percentage
Key Suppliers	What are your key suppliers?	Chemical Suppliers [Soda Ash, Hypochlorite, etc. dropdown]
	How long can you operate without (key chemicals)?	___ hours, ___ days
	Have you suffered service interruptions in the past?	Y/N
	If so, on average how many times per year?	___ per year
	If so, on average how long was the duration of outage?	___ days, ___ hours
	Provide your best estimate for the probability of (chemical) loss to this asset above your critical threshold per year.	percentage
Key Employees	Do you have any key employees? (see Definitions for further explanation)	Y/N
	If so, how many?	___ key employees
	Assuming all of your key employees were unavailable. (For example, due to illness). How long before your *normal operations* would be seriously impacted?	___ days, ___ weeks
	Assuming all of your key employees were unavailable. How long before your *emergency operations* would be seriously impacted?	___ hours, ___ days
	Have you experienced either of these situations in the past?	Y/N
	If so, on average how many times per year?	
	Normal operations	___ per year
	Emergency operations	___ per year
	If so, on average for how long?	___ days, ___ hours
	Normal operations	___ hours, ___ days
	Emergency operations	___ hours, ___ days
	Provide your best estimate for the probability of key employees being unavailable above your critical threshold year.	
	Normal operations	percentage
	Emergency operations	percentage
Key Customers	Do you have any critical customers? (i.e., customers, for whom, a loss of service would constitute a serious impact on	Y/N

Reference Threat	Question/Selections	Types of Choices/Input
	your mission?) Examples might include: hospitals, military bases, key industrial customers.)	
	If so, please list these critical customers.	[blank text field]
	Of all of your critical customers what is the *shortest* duration of service interruption (or degradation) that they can withstand without serious impacts to their operations?	___ hours, ___ days
	Have there been these types of service interruptions/degradation to your critical customers in the past?	Y/N
	If so, on average how many times per year?	___ per year
	Provide your best estimate for the probability of service interruptions/degradation to your critical customers above the critical threshold per year.	percentage
Transportation	Do you have key, non-redundant transportation routes to your key facilities?	Y/N
	If so, please list these.	[blank text field]
	If any one of these routes was out of service how long before there would be serious impact on your operations?	___ hours, ___ days
	Have you suffered service interruptions in the past?	Y/N
	If so, on average how many times per year?	___ per year
	If so, on average how long was the duration of outage?	___ days, ___ hours
	Provide your best estimate for the probability of the loss of your key transportation routes above your critical threshold per year.	percentage
	1. Add in emergency operations 2. Include or repeat for transportation means other than roads. (e.g., rail, barge, boat etc.)	
Proximity	Is your opinion is your (facility/asset) located in close proximity to dangerous neighboring sites that if damaged or destroyed could affect your operations?	Y/N
	If so, please list these.	[blank text field]
	Have you suffered major impacts on your interruptions due to your proximity to these sites in the past?	Y/N
	If so, on average how many times per year?	___ per year
	If so, on average how long did the major impact on your operations last?	___ days, ___ hours
	Provide your best estimate for the probability of experiencing such impact on your operations per year.	percentage