SeabrookNPEm Resource

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Sent: Wednesday, November 03, 2010 1:00 PM
To: Cliche, Richard; Carley, Edward
Cc: OKeefe, Michael; Susco, Jeremy
Subject: Draft SAMA RAIs for Monday's Telecon
Attachments: Seabrook LRA SAMA Draft RAIs.docx

Rick,

Attached are the draft SAMA RAIs that we would like to discuss during the phone call scheduled for Monday, November 8.

Thanks,
Mike

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Request for Additional Information
Regarding the Analysis of Severe Accident Mitigation Alternatives
For the Seabrook Station License Renewal Review

1) Provide the following information regarding the Level 1 Probabilistic Safety Assessment (PSA) used for the Severe Accident Mitigation Alternatives (SAMA) analysis:

   a. Environmental Report (ER) Section F.3 states that Probabilistic Risk Assessment (PRA) model SSPSS-2006 is the model-of-record used to support the SAMA evaluation. Identify any changes to the plant (physical and procedural modifications) since 2006 that could have a significant impact on the results of the SAMA analyses, and provide a qualitative assessment of their impact on the PRA and on the results of the SAMA evaluation.

   b. ER Section F.3 explains that the SAMA evaluation is determined from severe accident risk based on Level 1 and 2 PRA models for internal and external events, including internal floods, internal fires, external floods, and seismic events. A table in Section F.3.1.1.2 shows the PRA model history from 1983 to 2006 for internal and external full power events and indicates that it was a single PRA model. It is not clear from the table when internal flooding, external flooding, fire, and seismic modeling components were incorporated into the model or what were their individual contributions to the total core damage frequency (CDF) and large early release frequency (LERF). Also, it is not clear from the description of model changes provided on pages F-20 through F-28 what the most significant updates between models were. Relative to these issues, provide the following:

      a. The CDF and LERF contributions from internal and external events, including flooding, fire, and seismic hazard categories, for each PRA model update.

      b. Indicate when internal flooding, external flooding, fire, and seismic modeling components were incorporated into the model.

      c. Of the changes identified for each model update, identify those changes that had the most impact on changing CDF and LERF.

   c. The table in Section F.3.1.1.2 that shows the PRA model history from 1983 to 2006 provides the CDF and LERF. The ratio of LERF to CDF (<1%) is atypically small. Explain why LERF is so low compared to CDF.

   d. ER Section F.3.3 identifies two peer reviews that have been performed on the PRA: a 1999 Westinghouse Owner's Group certification peer review and a 2005 focused peer review against the American Society of Mechanical Engineers (ASME) standard and presents all the Category A and B facts and observations along with their associated resolutions. However the scope of those peer reviews was not described and other reviews (e.g., internal reviews) were not identified. Provide the following:

a. A summary of the scope of the 2005 focused peer review against the ASME standard and the 1999 peer review including whether Level 1, Level 2, internal flooding, external flooding, fire, or seismic event modeling was reviewed.

b. A summary of the scope of any other PRA model reviews, a discussion of how each finding was resolved, and an assessment of the impact of all unresolved findings on the SAMA evaluation.

e. Describe the quality control process for the PRA, including the process of monitoring potential plant changes, tracking items that may lead to model changes, making model changes (including frequency for model updates), documenting changes, software quality control, independent reviews, and qualification of PRA staff.

f. ER Table F.3.1.1.1-2 presents the top basic events by Risk Reduction Worth (RRW) for the Level 1 PRA. While the contributions of initiating events to CDF are provided in Table F.3.1.1.1-1, no initiating events appear in the list for RRW in Table F.3.1.1.1-2. Clarify if initiating events were included in the determination of the RRW listing and, if initiating event were not included, determine their RRW values and identify and evaluate SAMAs to address these events.

g. ER Section F.3.1.1.1 states that “The event tree quantification was calculated using a truncation cut-off frequency of 1.0E-14.” It is not clear whether this value indicates the truncation level for the Level 1 PRA model. Clarify what truncation level was used for the Level 1 PRA model results used for the SAMA evaluation.

h. Section F.3.1.1.1 explains that “The fault tree method of quantification is binary decision diagram quantification which provides an exact solution for split fractions.” We understand binary decision diagram quantification to be used to evaluate Event Trees to pass along dependencies in associated fault trees. Is this what is meant?

i. Table F.3.1.1.1-1 listed two switchgear (SWGR) room fire frequencies as 1.0E-3/yr, which would seem low unless these were specifically for localized fires involving only the buses cited. Are only the cited buses involved with these events?

2) Provide the following information relative to the Level 2 analysis:

a. ER Section F.3.2.1 explains that “inputs to the Level 2 analysis are the core damage sequences,” and that these sequences are “considered in groups of accident sequences that exhibit similar thermal-hydraulic behavior.” The ER does not identify or discuss the use of Plant Damage States (PDSs). Describe the grouping of Level 1 accident sequences that provide the input to Level 2. Include in that discussion identification of those groups (e.g. PDSs), the attributes that define that group, and the CDF associated with each group.

b. ER Section F.3.2.1 explains that “mapping of sequences between the Level 1 model and the release categories is governed by the CET [containment event tree]” and that “containment analysis covers all conceivable failure modes of the containment, including pre-existing leaks, containment bypass sequences, external events impacting the structure, and internal loads that have the potential to fail the containment early (shortly after core melt) or late (many hours after the melt)." No example or actual CET is presented. Present or describe the CETs. Discuss the selection of the top events, how the branch point probabilities are determined, and the number of CETs developed for each of the four PRA model aspects (i.e., internal events, internal fire, seismic, external flooding).

c. ER Section F.3.2.1 explains that the "CET is linked directly with the Level 1 event trees to generate the frequencies of each release category bin." Explain how release category bin frequencies are determined, beginning with Level 1 accident sequence grouping and CET sequence results.

d. ER Section F.3.1 explains that Section E.6.5 and Table E.6-5 indicate the correlation between Modular Accident Analysis Program (MAAP) runs and release categories but does not provide the basis for the MAAP run selection. Provide information on the selection of the MAAP case for each release category, in particular how scenarios of less than dominant frequency but larger potential consequences were considered.

e. ER Table F.3.2.1-2 presents the top basic events by RRW for the Level 2 PRA basic events that contribute to a large early release frequency (LERF). While the contributions of initiating events to CDF are provided in Table F.3.1.1.1-1, no initiating events appear in the list for RRW in Table F.3.2.1-2. Relative to Table F.3.2.1-2, address why there are no initiating events in this list. Clarify if initiating events were included in the determination of the RRW listing and, if initiating events were not included, determine their RRW values and identify and evaluate SAMAs to address these events.

f. Relative to Table F.3.2.1-2, provide a listing of the risk important basic events contributing to the other release categories (e.g., LL3, SE3) that contribute 90% of the population dose-risk. Identify and evaluate SAMAs to address these events.

g. Provide a release fraction/source term summary table that relates run duration, time after SCRAM or when a general emergency (GE) is declared, and plume release fractions (if multiple plume releases are applicable) for each release category.

h. With respect to F&O 3, discuss how this resolution addresses the Peer Review Finding aspect regarding the training, qualification, and familiarity of plant staff with the long-term operation of the turbine-driven (TD) emergency feedwater (EFW) pump.

3) Provide the following information with regard to the treatment and inclusion of external events in the SAMA analysis:

a. The ER does not address the status of one plant improvement identified in the IPEEE SER: modification of several exterior doors so that they will be able to withstand the design pressure differential resulting from high winds. Discuss the status of this improvement and, if not already implemented, provide a cost-benefit evaluation of a SAMA that addresses this improvement recommendation.

b. The ER does not provide the status of potential plant improvements identified as part of the IPE processes. Provide a list of all suggested plant improvements identified in the IPE, provide an implementation status of each, and provide an evaluation of a SAMA that addresses those improvements that have not been implemented or have not already been evaluated in the ER.

c. ER Section F.3 explains that internally initiated fire events are included in the current PRA and that the fire risk analysis has been updated since the IPEEE. There is no discussion of the fire PRA method in the ER and no presentation of the important fire areas and their contribution to Level 1 or fire CDF. In light of this, provide:

   a. A description of the fire risk analysis method including to what extent the method was based on NUREG-6850. In the response, specifically discuss how fire-induced ISLOCAs are addressed, how fire-induced containment impact is addressed, and model conservatisms. In the response, specifically address whether the RRWs listed in Table F.3.2.1-2 include fire-induced sequences where a component required to maintain containment integrity could be failed by the fire itself rather than randomly and independently from failures that induce core damage.

   b. Fire PRA results including revised fire zone contribution to the CDF. Additionally, explain the reason for significant differences between the IPEEE and updated Fire PRA results.

d. In the description of PRA model changes made since 1993, on pages F-20 through F-28 of the ER, at least one instance of a major update to the seismic PRA was indicated (i.e., on page F-27). However, there is no discussion of the updated seismic PRA methodology in the ER. In light of this, provide:

   a. A description of the seismic risk analysis method including the seismic hazard curves being modeled. Additionally, provide a discussion of model conservatisms.

   b. Seismic PRA results including revised seismic initiator contribution to the CDF. Additionally, explain the reason for significant differences between the IPEEE and updated Seismic PRA results.

e. ER section F.3.1.2.2 explains that the NUREG-1407 procedure for screening high wind, flooding, and other external (HFO) events was used to conclude that contribution to the Seabrook Station total CDF from HFO is less than 1.0E-06 per year. However, the IPEEE discusses two external events that have a CDF contribution greater than 1.0E-06 per year. While the ER addresses one of these events, flooding caused by a storm surge, it does not address the second: a truck crash into the SF6 transmission lines having an IPEEE CDF contribution of 1.4E-06 per year. Discuss whether this event is addressed by a loss of off-site power initiator in the current PRA model and, if not, assess the impact of this event on the results of the SAMA evaluation.

While the ER and IPEEE address flooding resulting from a storm surge caused by a hurricane, neither appears to specifically address the impact of hurricane-force winds. In light of the potential for hurricanes and "Nor'easters" hitting the Seabrook Station, assess the risk of hurricane-force and the impact of that risk on the results of SAMA evaluation.

d. ER Section E.5.5.3 does not identify any reviews of the fire or seismic PRAs. Identify any internal and external reviews of the fire and seismic PRAs, discuss how each finding was resolved, and provide an assessment of the impact of any unresolved findings on the SAMA evaluation.

e. NRC Information Notice 2010-18, Generic Issue 199, "Implications of Updated Probabilistic Seismic Hazard Estimates in Central and Eastern United States on Existing Plants," informs licensees that updated seismic data and models show increased seismic hazard estimates for some plants. The NRC report cited in the information notice estimates the seismic CDF for Seabrook Station to be between 5.9E-06 and 2.2E-05 per year using 2008 U.S. Geologic Survey (USGS) seismic hazard curves. Provide an assessment of the impact of the updated seismic CDF on the SAMA evaluation.

4) Provide the following information concerning the Level 3 analysis:

a. Provide the breakdown of the baseline population dose-risk (person-rem/yr) and offsite economic cost-risk (OECR in $/yr) by release category and the total.

b. ER Section F.3.4.3 explains that the Cobalt inventory was based on the MACCS2 sample problem A, multiplied by the ratio of the Seabrook projected future power to the reference power (3659 MW / 3412 MW). The ER also states that the core inventory was estimated using ORIGEN2.1. Clarify why the cobalt inventory required correction. The statement is confusing in that: 1) if a Seabrook specific calculation was performed, why was correcting the cobalt required and 2) if sample problem A was scaled for cobalt, why not for iodine? If a Seabrook specific core inventory was not calculated, quantitatively discuss the impact of long-lived isotopes that are cycle specific (such as Sr-90, Cs-134 and Cs-137) and not just power-related.

c. Sensitivity analyses are presented in ER Section F.8.4. Provide a quantitative discussion of the results of each of the sensitivity analyses (i.e., provide the percent change in population dose-risk and OECR). Also, discuss the sensitivity of the SAMA results to the population projection assumptions.

d. Three SECPOP2000 code errors have been publicized, specifically: 1) incorrect column formatting of the output file, 2) incorrect 1997 economic database file end character resulting in the selection of data from wrong counties, and 3) gaps in the 1997 economic database numbering scheme resulting in the selection of data from wrong counties. Address whether these errors were corrected in the Seabrook Station analysis. If they were not corrected, then provide a revised cost-benefit evaluation of each SAMA with the errors corrected.

e. ER Section F.3.4.3 states that release fractions for accident categories LE-2, LE-3, SE-2, SE-3 and, LL-5 were taken from Seabrook original analyses and all others were from Seabrook MAAP simulations. Clarify what this means, and specifically address how release fractions were developed for the original analyses.

f. Section 2.6.1 of the ER indicates a year 2000 50-mile total population of 4,157,215 (Tetra Tech 2009a) while Table F.3.4.1-1 indicates a total population of 4,232,394. Clarify the discrepancy.

g. The ER provides no discussion of the effects of sea-breeze circulation on radionuclide deposition and whether this sea-breeze effect was factored into the MACCS2 calculations. Clarify whether sea-breeze effects were considered in the SAMA evaluation and, if not, provide an assessment of the sea-breeze effect on the results of the SAMA evaluation.

h. Table F.3.4.1-1 indicates that several sector populations extrapolate to zero population in year 2050. For example radius 3 mi to 4 mi, ENE population decreases from 788 to zero). This occurs in several other locations. Clarify why this occurs, and address the potential impact to the SAMA analysis if a more conservative approach were used for extrapolating negative population growths to earlier years.

5) Provide the following with regard to the SAMA identification and screening process:

a. ER section F.5.1 explains that "the current plant procedures and training meet current industry standards" and that there "were no additional specific procedures improvements identified that would affect the result of the HEP calculations" and that therefore "no SAMA items were added to the plant-specific list of SAMAs as a result of human actions with risk reduction worth greater than 1.005." Describe other mitigation options (besides procedure and training improvement) for addressing each of the human error events that appear in importance Tables F.3.1.1.1-2 and F.3.2.1-1 (e.g., installing or improving automatic control, additional alarms) and provide justification for not considering a non-procedure/training SAMA to address these basic events.

b. Importance Tables F.3.1.1.1-2 and F.3.2.1-1are not linked to SAMA options except by associated SAMA category (e.g., AC Power SAMAs, Containment SAMAs). It is not always clear, however, how the identified SAMAs address the specific basic events listed (for example, basic events CCE17A.GL and CCE17B.GL. For each basic event identified in the importance lists, identify the specific SAMA(s) that address each event and describe how the SAMA(s) address the basic event. For any basic event for which no SAMA is identified, provide justification for not identifying a SAMA(s).

c. Importance Tables F.3.1.1.1-2 and F.3.2.1-1 combine the importance of internal, fire, and seismic events, so that it is not possible to determine the relative importance of each basic event for each hazard category. As a result, the SAMA identified to address each event may not address the more important initiator (e.g., fire). Provide a Level 1 and 2 importance list for each hazard category (internal, fire, and seismic) and identify which SAMA(s) address each event. For any basic event for which no SAMA is identified, identify and evaluate a new SAMA.

d. Importance Tables F.3.1.1.1-2 and F.3.2.1-1 identify only one event (i.e., COTK25.RT – Condensate Storage Tank CO-TK-25 ruptures/excessive leakage) to be related to seismic fragility (based on the basic event descriptions presented). SAMA 162, "Increase the capacity margin of the condensate storage tank (CST)," appears to have been identified to address this event. However, it is not clear that this SAMA addresses the seismic fragility of the CST since the SAMA is described as increasing the capacity margin of the CST. Provide an assessment of a SAMA to reduce the seismic fragility of the CST.

e. SAMA 92, "Use the fire water system as a backup source for the containment spray system," was screened in Table F.6-1 because the containment spray function is not important early. Yet, RCPCV456A.FC and RCPCV456A.FC (Spray Valves fail to open on demand) appear on the LERF importance Table F.3.2.1-1 and may also provide benefit in late releases. In light of this, provide an assessment of this SAMA.

f. SAMA 143 (Upgrade fire compartment barriers) was screened in Table F.6-1 because the Seabrook Station plant design includes 3-hour rated fire barriers. Clarify how additional barriers for fire areas were considered and assess the impact that adding additional barriers would have on the SAMA results.

g. SAMA 79, "Install bigger pilot operated relief valve so only one is required," was screened in Table F.6-1 because the intent of the SAMA has already been implemented. However, the Phase I Disposition column explains that 2-of-2 PORVs is needed for intermediate head Safety Injection. In light of this success criteria, provide an assessment of this SAMA.

h. SAMA 64, "Implement procedure and hardware modification for a component cooling water header cross-tie," was screened in Table F.6-1 because a cross-tie already exists to support a maintenance activity. Clarify whether exiting plant procedures provide for the cross-tie between divisions A and B of the PCCW system in the event of a loss of cooling water and, if not, provide an assessment of a SAMA to develop and implement a procedure to perform the cross-tie.

i. SAMA 127, "Revise emergency operating procedures to direct isolation of a faulted steam generator," is screened in Table F.6-1 using Criterion B. However, the explanation provided in the Phase I Disposition column, "Faulted SG refers to Steam line break and Ruptured SG refers to SG rupture," does not explain why this is not a viable SAMA candidate. Clarify whether the existing emergency operating procedures (EOPs) implement this SAMA and if the EOPs distinguish between a faulted steam generator and a ruptured steam generator.

j. SAMA 82, "Stage backup fans in switchgear rooms," and SAMA 84, "Switch for emergency feedwater room fan power supply to station batteries," are screened in Table F.6-1 as not applicable to the Seabrook Station. However, the explanation in the Phase I Disposition column does not appear to preclude the viability of these SAMAs. Provide further justification for screening out these SAMAs or provide an evaluation of each.

k. The SAMA identification process (ER Section F.5) did not appear to include a review of the cost-beneficial SAMAs identified for other Westinghouse 4-loop plants for which license renewal applications have been submitted. Provide an itemized review of the cost-beneficial SAMAs identified in the following recent license renewal applications for Westinghouse 4-loop plants: Salem, Diablo Canyon, Vogtle, Indian Point 2/3, and Wolf Creek. In the response, provide a Phase I screening of each and, if not screened, provide a Phase II evaluation.

l. SAMAs were identified for all basic events having a RRW greater than or equal to 1.005. Provide the maximum dollar benefit of a SAMA that eliminates 100% of the risk of a basic event having an RRW value of 1.005.

m. Table F.5.6-1 identifies the source of 38 SAMAs as being plant-specific SAMAs based on review of the IPE, IPEEE, plant personnel, and expert panel. Identify the specific source for each of these SAMAs.

n. SAMAs 105 and 191 were screened as not applicable to Seabrook because they would violate the current licensing basis. This is not a valid basis for screening the SAMAs as not applicable. Provide further justification for why these SAMAs should not be considered in the Phase II evaluation.

o. SAMA 54, "increase charging pump lube oil capacity," was screened in Table F.6-1 because the Seabrook Station has an alternate cooling capability for cooling the charging pump lube oil. Provide an assessment of a SAMA to increase the lube oil capacity in the event of a lube oil leak that reduces inventory.

p. SAMAs 173 and 185 both are described as "improve procedural guidance for directing depressurization of RCS" and both are dispositioned as already implemented. Clarify the difference between these two SAMAs.

q. ER Table F.5.6-1 Footnote A states that "Plant-specific SAMA candidates based on review of IPE, IPEEE, presentation and solicitation of plant personnel and expert panel " were the source for several non-industry or NEI SAMAs. Clarify that the RRW listing was used to identify SAMAs consistent with Tables F.3.1.1.1-2 and F.3.2.1-2.

r. ER Table F.5.6-1 presents SAMA 188 to modify "a containment ILRT 10-inch test flange to include a 5-inch adapter" that Table F.6-1 screen outs with an explanation in the Phase I Disposition column that "flange and procedure exists." The applicability of this disposition is unclear. Is there already a 5-inch adapter on the ILRT 10-inch flange to connect fire water?

s. Section F.6 presents screening criteria used in the Phase 1 analysis. Neither screening criterion D (Excessive Implementation Cost) nor E (Very Low Benefit) is used in Table F.6.1. Phase II Table F.7.1 seems to use screening criterion D via Footnote 1: "Risk reduction not specifically evaluated because estimated cost exceeds the possible maximum averted cost-risk." Clarify that criterion D was used in Phase II and not Phase I and why. Also clarify why criterion E was not used at all?

6) Provide the following with regard to the Phase II cost-benefit evaluations:

   a. Provide the % reduction in OECR for each SAMA evaluated in Table F.7-1 and any other SAMAs evaluated in response to RAIs.

   b. ER Section E.7.2 and Table F.7-1 state that an expert panel developed the implementation cost estimates for each of the SAMAs. Describe the level of detail used to develop the cost estimates (i.e., the general cost categories considered). Also, clarify whether the cost estimates accounted for inflation, contingency costs associated with unforeseen implementation obstacles, replacement power during extended outages required to implement the modifications, and maintenance and surveillance costs during plant operation.

   c. For certain Phase II SAMAs listed in Table F.7-1, the information provided does not sufficiently describe the associated modifications and what is included in the cost estimate. Provide a more detailed description of both the modification and cost estimate for SAMAs 44, 59, 94, 112, 114, 163, 186, and 187.

   d. The benefit and cost evaluation of SAMA 80, “Provide a redundant train or means of ventilation,” assumes removal of HVAC dependency for cooling system (CS), safety injection (SI), residual heat removal (RH), and containment building (CB) spray pumps. It is possible that just one of these systems provides most of the benefit. Provide an assessment of a SAMA to remove HVAC dependency for just the highest risk system.

   e. The estimated cost of SAMA 65, “Install a digital feed water upgrade,” is $30M while the estimate cost of SAMA 147, “Install digital large break LOCA protection system,” is >$500K. Provide justification for the cost estimates for these two systems. In the response, address the reason for the large cost difference between what appear to be two similar modifications.

   f. The estimated benefits for SAMAs 96, 108, and 109, which assume elimination of all hydrogen ignition/burns, are negative for the reduction in dose-risk (i.e., the dose-risk increases). Describe the reason for this anomalous result.

   g. The estimate cost for SAMA 113, “Increase leak testing of valves in ISLOCA paths,” of $100K seems high for what does not appear to be a hardware modification. Provide justification for the cost estimate.

   h. It is unclear from the description of SAMAs 157 and 159 (SAMA Case INDEPAC) what changes were made to the PRA model to generate the estimated benefits. Provide a more detailed description of the PRA model changes made to evaluate these SAMAs.

   i. The estimated cost of SAMA 157, “Provide independent AC power source for battery chargers,” of $30K seems low for what is described as a hardware change. Provide justification for the cost estimate.

   j. The evaluation of SAMA 179, which assumed eliminating initiator FCRPL, resulted in a Table F.7-1 reduction in CDF of 0.69%, while Table F.3.1.1.1-1 reports the contribution to CDF from initiator FCRPL to be 1.00%. The evaluation of SAMAs 119, 121, 125, 126, and 129, which assume SGTR events do not occur, resulted in a Table F.7-1 reduction in CDF of 3.47%, while Table F.3.1.1.1-1 reports the contribution to CDF from initiator SGTR to be 4.00%. The evaluation of SAMAs 113, 115, and 187, which assume ISLOCA events are all eliminated, resulted in a Table F.7-1 reduction in CDF of 2.08%, while Table F.3.1.1.1-1 reports the contribution to CDF from initiator LOC1VS to be 2.30%. Clarify the reason for these, and any other, discrepancies and their impact on the SAMA analysis.

k. The ratio of the 95th percentile CDF to the mean value CDF was reported to be 1.9 in Section F.8.2 of the ER. While this is a "typical" result for internal event CDF, it seems quite low for the fire and seismic CDFs which generally have wider uncertainty bands than internal events. Describe how the uncertainty distribution was developed and discuss how and why the CDF distribution is different for internal, fire, and seismic CDF.

7) For certain SAMAs considered in the ER, there may be lower-cost alternatives that could achieve much of the risk reduction at a lower cost. In this regard, discuss whether any lower-cost alternatives to those Phase II SAMAs considered in the ER would be viable and potentially cost-beneficial. Evaluate the following SAMAs (previously found to be potentially cost-beneficial at other plants), or indicate if the particular SAMA has already been considered. If the latter, indicate whether the SAMA has been implemented or has been determined to not be cost-beneficial at Seabrook Station.

a. Use a portable generator to extend the coping time in loss of AC power events (to power selected instrumentation and DC power to the turbine-driven auxiliary feedwater pump). This is an expanded version of SAMA 74.

b. Provide alternate DC feeds (using a portable generator) to panels supplied only by DC bus.

c. Purchase or manufacture of a "gagging device" that could be used to close a stuck-open steam generator safety valve for a SGTR event prior to core damage.