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Assessing the Reliability and Validity of the Evacuation Support Decision Tool

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Summary

This study examines the reliability and validity of the Evacuation Decision Support Tool (EDST). The EDST is designed to provide healthcare facilities, emergency managers, and other agencies with a systematic process with which to evaluate and guide "evacuation" versus "shelter in place" decision making for a variety of "all hazards" situations. The EDST is comprised of 7 items that assess "threat" and 9 items that measure "consequences" of a situation. The tool was designed to provide users with a decision on whether to remain, prepare, or evacuate from a healthcare facility. To date, there has not been a study that examined psychometric properties of *any* evacuation decision tool, including the EDST.

A total of 83 raters from 18 facilities (hospitals, nursing homes, and adult care centers) in New York State were recruited to participate in a controlled study. Three standardized scenarios (power failure, ice storm, and hurricane) were developed across five standardized situations (communications failure, critical supply shortage, electrical utility power failure, external flood, and internal flood). Preferred scores were determined for each situation by a panel of subject matter experts, essentially creating a "gold standard" against which the raters' scores could be judged and validated.

Main findings from this study are as follows:

- **The overall scale reliability was 0.93, indicating a high level of internal consistency across the items. Reliabilities for the threat and consequence items were 0.83 and 0.91, respectively.** This suggests that the scoring of items within each of the scales were highly consistent across different raters.

- **The EDST was found to measure two distinct constructs, threat and consequence of a situation.** As hypothesized, results supported the factorial validity (internal structure) of the tool to be composed of two factors. Measures of model fit used to provide evidence for factorial validity were consistent with standards used in the literature.
- **Rater reliability based on agreement between raters and expert judgment was 72% for raters and 76% for team-based scores, using combined measures of exact and adjacent agreement**. However, exact agreement was 28% for rater scores and 30% for team-based scores.
- **Discussion with team members led to about 50% of rater scores being changed, with 12% of the changed scores deviating by 2 or more points.**
- **Work experience was significantly associated with more accurate ratings.** Raters with more work experience at current facility, but fewer years at current position had greater odds of exact or adjacent agreement with expert judgments.
- **The accuracy of evacuation decisions generated by EDST compared to expert judgment was less than 40%.** This may indicate a mismatch between the evacuation decision reported by the tool and the perceived decision of the rater.

In summary, these findings suggest that the EDST provides consistent measures of threat and consequence across different raters. However, there remain questions regarding the accuracy of the scores and decisions generated by the tool. These preliminary results indicate a promising use of the EDST for planning and evaluation purposes, but may require continued refinements to increase accuracy of decisions.

Assessing the Reliability and Validity of the Evacuation Support Decision Tool

I. Introduction

Unlike observations that can be scored objectively (e.g., number of doctors or patients), rating processes often require raters to quantify subjective phenomena that may not have clear answers (McClellan, 2010; National Board for Professional Teaching Standards, 1993; Margolis & Ross, 1995). This can become a problem, because raters may vary in perception and prior knowledge of the material being evaluated. Yet, as with any rating procedure, the scores given by raters must be comparable, both over time and over different conditions; in other words, scores must be consistent and trustworthy, regardless of when or who scores the instrument.

The difficulty associated with rating tasks raises concerns about its possible benefits. However, according to Livingston (2009), there are complex competencies, direct performances, or explication of reasoning that cannot be fully measured when only objective measures are used. The judgment to evacuate, prepare, or remain in a healthcare facility (HCF) during a disaster is an example of a decision that may benefit from the use of raters. Although several models have been developed to assist HCF administrators with this decision, there has not been a comprehensive study that has examined various characteristics of these tools – in light of this need in the field, this study investigates the psychometric properties of the Evacuation Decision Support Tool (EDST; Incident Management Solutions, 2009), an instrument that bases decisions on the evacuation of a healthcare facility using measures of threat and consequence. The EDST is designed to provide HCF, emergency managers, and other agencies

with a systematic process to evaluate and guide "evacuation" versus "shelter in place" decision making for a variety of "all hazards" situations.

This study examines the reliability and validity of the EDST in light of the following:

- Reliability of the items (scale) to generate consistent scores,
- Factors underlying internal structure (factorial validity) of the EDST,
- Rater reliability and agreement,
- Characteristics of raters that affect accuracy, and
- Classification accuracy of evacuation decisions.

This report presents findings of a controlled study using standardized scenarios developed by content experts that describe the use of the EDST for evaluation and planning of evacuation decisions. Implications and future directions for research using an evacuation decision tool such as the EDST are also discussed.

II. Literature Review

Review of evacuation in healthcare facilities

There have not been many studies that have examined measurement characteristics of instruments used for evacuation in HCF. In fact, most studies focus on contextual aspects such as the cause, methods, and useful guidelines for evacuation. Despite lack of studies on this topic, this section provides an outline of previous studies that have examined evacuation – the review of these studies will indicate the significance of this current study to evaluate the reliability and validity of a tool that can guide and support evacuation planning decisions, as it fills a critical gap in the literature.

Although evacuation in HCF is often believed to be caused by natural disasters, they have mostly been identified as having been caused by hazards originating within the hospital or from "human intruders" (Sternberg, Lee, & Huard, 2004). With regards to methods used in evacuation, the study by Schultz, Koenig, and Lewis (2003) describe the results of two types of hospitals during an earthquake, where one evacuated their most critically ill patients first as they required the most resources and placed a greater burden on hospital staff; the other hospitals decided to move the healthiest patients first, a strategy that permitted the evacuation of large numbers of patients in the shortest amount of time. This study showed that the latter strategy was more efficient as concerns for speediness of evacuation of resources were less of a constraint.

Factors affecting hospital evacuation have also been examined through the use of simulation models (Taaffee, Kohl, & Kimbler, 2005; Taaffe, Johnson, & Steinamann, 2006). They have shown that effective use of simulation models can help assess plans for evacuation, determine plan sensitivities, develop risk probabilities, and prepare for physical exercise. It can also be used to create customization across hospital facilities based on hospital locations, patient mix, susceptibility to threats and other factors; it also allows local hospitals the ability to monitor an evacuation currently in progress. Simulation models have found that the number of patients and the mode of transportation were important factors contributing to the duration of evacuation.

In 2010, the Agency for Healthcare Research and Quality (AHRQ) in the U.S. Department of Health and Human Services released two guides for use in hospital evacuations. In the first report by Zane, Biddinger, Gerteis, and Hassol (2010), a framework was developed to assist in

the initial evaluation of a hospital upon return after an evacuation/closure due to an emergency event, which has sustained significant or widespread damage. Factors outlined for consideration were type of event, decisions supporting the implementation of the evacuation plan, non-structural reasons for the evacuation, environmental issues that may have affected the decision to evacuate, occupants of the hospital after shut down, and the length of time of closure. The second report by Zane, Biddinger, Hassol, Rich, Gerber, and DeAngelis (2010) provided guidance for hospital evacuation decision teams with organized and systematic methods on how to assess factors that affect the decision to order an evacuation and assist decision teams in identifying special situations. The framework outlined in this guide has the most relevance to this study. The guide included a pre-disaster self-assessment and discussion of both pre-and post-event evacuation decision making. It also presented decisions that affect the sequence of patient evacuation (e.g., evacuating medically fragile patients or mobile patients first).

Evacuation Decision Support Tool (EDST)

The EDST is designed to facilitate the emergency planner for possible evacuation of the HCF and is applicable in a variety of "all hazards" situations: communications failure, critical supply shortage, electrical utility power failure, fire (external), fire (internal), flood (external), flood (internal), fuel shortage (oil), generator failure, hazmat incident affecting facility, HVAC failure, loss of community infrastructure, loss of external support, medical gas failure, natural gas failure, physical plant damage, sewer failure, smoke or fumes (internal), staffing insufficiency, steam failure, and water supply failure. The EDST is designed to provide HCF,

emergency managers, and other agencies with a systematic process to evaluate and guide planning of “evacuation” versus “shelter in place” decision making.

The algorithm used to determine the evacuation decision is based on a combination of EDST items that measure threat and consequence factors of a particular situation. The threat factor consists of 7 items that question the types and severity of challenges: severity, duration, cascade potential, evacuation difficulty, shelter-in-place (SIP) capability, destination capability, and recovery time. In the original scoring guide, EDST threat items are scored in a scale of 0 (low) to 1 (high) in intervals of 0.2. The consequence factor inquires the consequences and their severity and comprises of 9 items: life safety, security, staffing, physical plant, utilities, communications, resources and assets, patient clinical and support activities, and external logistics. It is scored between 0 (low impact) to 9.5 (high impact). For this current study, both threat and consequence items were scored on a 1 to 6 scale to reduce possible bias that raters may perceive in the different scoring intervals used in the original scale.

The EDST decision to evacuate the healthcare facility is based on a two-step process. First, individual raters independently score the EDST. Following this process, raters in a HCF convene and review their individual results to develop a consensus score. When there is disagreement, the group discusses to resolve the issue and achieve consensus. The calculation of the evacuation decision score is based on the product of the sum scores within each factor; that is, a sum score for both threat and consequence factors are calculated and subsequently multiplied to produce a scale score on a range of 1 to 600. The EDST scoring guide provides the following interpretations for the scores:

- Scores less than 200: Remain at the facility (shelter in place)

- Scores between 200 and 399: Prepare for evacuation
- Scores above 400: Evacuate the facility

Studies on rater effects

There are two main difficulties associated with consistency in a rating process: (1) different raters assign different scores to a particular condition and (2) the same rater may assign different scores to the same response on different occasions (Coffman, 1971). In a classic study by Diederich, French, and Carlton (1961), where 300 essays were judged by 53 raters, it was found that 94% of the essays received at least 7 different scores from the raters. As exemplified in this study, there are a wide variety of errors, or *rater effects*, associated with rater scoring (Myford and Wolfe, 2003). Rudner (1992) classifies measurement errors associated with raters as follows:

(1) Halo effect: impressions that a rater forms about a condition,

(2) Stereotyping: impressions that a rater forms about a group of conditions,

(3) Perceptional differences: viewpoints and past experiences of a rater that can affect interpretation of behaviors or context,

(4) Leniency or stringency error: systematically scoring higher or lower because of insufficient knowledge to make an objective rating, and

(5) Scale shrinking: occurs when raters do not consistently or similarly use the ends of any scale.

To improve consistency and to reduce rating errors, the literature recommends that raters familiarize themselves with the measures they are using, understand the sequence of operation, and explain how they interpreted the data. There are many empirical studies that

have shown the effectiveness of these strategies. For example, in Latham, Wexley, and Purcell (1975), employment interviewers were trained to reduce rater effects and in Pulakos (1986), training focused on the type, interpretation, and usage of data led to greater inter-rater reliability. Furthermore, in Shohamy, Gordon, and Kraemer (1992), it was found that the overall reliability coefficients were higher for trained raters than untrained raters, whereas the background of the raters did not affect their reliability. As these studies show, rater training can be used to alleviate rater differences.

Studies have also documented the limitations of rater training, because they cannot completely reduce rater bias. For example, studies have shown that training was only effective among novice raters (Weigle, 1998) and that its sole use could not fully eliminate differences in raters' behaviors (Hoskens & Wilson, 2001; Engelhard, 1992; Lumley & McNamara, 1995). In fact, raters are reluctant to change their customary scoring habits – training them to ignore the appearance and the context has not been successful over time (Hughes et al., 1983; Powers et al., 1994; Rafoth & Rubin, 1984; Sweedler-Brown, 1992).

The findings from these studies reiterate that rater differences are difficult to overcome even with sufficient training. This may indicate that the level of reliability assumed in the instrument may not be attained even with training. As such, examining rater characteristics following effective training provides an indication of how reliable the instrument as whole function. In addition, items scored by raters and their interaction are of value as they together determine the soundness of the instrument used (DeCarlo, Kim, & Johnson, 2011).

III. Methods

This study examines the reliability and validity of the EDST, with respect to the following psychometric characteristics of the tool:

- Reliability of the items (scale) to generate consistent scores,
- Factors underlying internal structure (factorial validity) of the EDST,
- Rater reliability and agreement,
- Characteristics of raters that affect accuracy, and
- Classification accuracy of evacuation decisions.

This section describes the study design and analyses used to investigate these properties of the EDST.

Data and study design

Scenarios and situations. To study the EDST, standardized scenarios with pre-identified situations were developed. We define *scenario* as disasters such as flood, fire, hurricane that may require the use of the EDST instrument for evacuation; the magnitude of the situation is not accompanied in this definition. Three scenarios were developed: (1) power failure, (2) ice storm, and (3) hurricane. In addition, five situations were developed within scenarios. We define *situation* as the particular case within a scenario. The situations developed are as follows: (1) critical supply shortage, (2) communications failure, (3) electrical utility power failure, (4) external flood, and (5) internal flood. To apply the EDST for a situation within scenario standardized domain-specific facility models were developed. These standardized facilities were developed to provide raters with a model with which to apply the EDST, such that

all participants were using the same EDST framework; otherwise, raters could possibly apply the EDST to their own facility. All standardized scenario, situation, and domain-specific facilities were developed by a panel of subject matter experts through discussion and careful review of materials.

Table 1 shows the allocation of situations by scenarios. Actual description of the standardized scenarios and situations are attached to this document (see Appendix). For each scenario and situation, scores reflecting expert judgments for items in the EDST were predetermined. These are "preferred scores" (henceforth *true scores*), which essentially represent "gold standard" again which the raters' scores could be judged and validated. The process of developing true scores to compare rater scores is commonly practiced in evaluating scores for performance-based assessments.

Originally, the EDST scores threat items on a 0 to 1 scale with intervals of 0.2 (i.e., 0, 0.2, 0.4, 0.6, 0.8, and 1.0). Consequence items are scored on a 0 to 9.5 scale with intervals of 2.5 (i.e., 0, 1.5, 3.5, 5.5, 7.5, and 9.5). However, to standardize the scoring and to reduce possible rater bias, a 1 to 6 scale was used for this current study in both threat and consequence items. Table 1 shows the true scores using the original EDST scoring convention.

Table 1. Expert judgments of scores associated with scenarios and situations

Scenario		Situation	EDST Score	Threat Items							
				EDST Decision	Severity	Duration	Cascade Potential	Evacuation Difficulty	SIP Capability	Destination Capability	Recovery Time
1	Power Failure	Critical Supply Shortage	114	Shelter	0.6	0.4	0.4	0.4	0.4	0.6	0.4
	Power Failure	Communications Failure	83	Shelter	0.4	0.6	0.2	0.6	0.2	0.8	0.4
2	Power Failure	Critical Supply Shortage	225	Prepare	0.6	0.6	0.6	0.6	0.6	0.6	0.6
	Power Failure	Communications Failure	338	Prepare	0.6	1.0	0.6	0.8	0.8	0.8	0.4
3	Ice Storm	Electrical Utility Power Failure	205	Prepare	0.8	0.8	0.8	0.6	0.6	0.8	0.8
	Ice Storm	Critical Supply Shortage	166	Shelter	0.8	0.8	0.8	0.4	0.6	0.8	0.4
4	Ice Storm	Critical Supply Shortage	190	Shelter	0.8	0.8	0.8	0.4	0.6	0.8	0.6
	Ice Storm	Electrical Utility Power Failure	322	Prepare	0.8	0.8	0.8	0.8	0.8	0.8	0.8
5	Hurricane	Flood, External	311	Prepare	0.8	0.8	0.8	0.8	0.6	0.8	0.8
	Hurricane	Flood, Internal	267	Prepare	0.8	0.8	0.8	0.8	0.6	0.8	0.8
6	Hurricane	Flood, External	200	Prepare	0.6	0.8	0.6	0.6	0.6	0.6	0.6
	Hurricane	Flood, Internal	166	Shelter	0.6	0.6	0.6	0.6	0.6	0.6	0.6

Scenario		Situation	Consequence Items								
			Life Safety	Security	Staffing	Physical Plant	Utilities	Communications	Resources and Assets	Pt. Clinical & Support	External Logistics
1	Power Failure	Critical Supply Shortage	1.5	3.5	3.5	3.5	3.5	3.5	3.5	5.5	7.5
	Power Failure	Communications Failure	3.5	0.0	3.5	3.5	3.5	3.5	3.5	3.5	1.5
2	Power Failure	Critical Supply Shortage	1.5	5.5	5.5	7.5	7.5	3.5	5.5	9.5	7.5
	Power Failure	Communications Failure	5.5	3.5	7.5	5.5	9.5	9.5	7.5	9.5	9.5
3	Ice Storm	Electrical Utility Power Failure	5.5	1.5	1.5	5.5	5.5	5.5	3.5	5.5	5.5
	Ice Storm	Critical Supply Shortage	1.5	0.0	3.5	5.5	1.5	5.5	5.5	5.5	7.5
4	Ice Storm	Critical Supply Shortage	1.5	1.5	5.5	3.5	5.5	3.5	5.5	5.5	7.5
	Ice Storm	Electrical Utility Power Failure	7.5	5.5	5.5	5.5	7.5	5.5	5.5	7.5	7.5
5	Hurricane	Flood, External	7.5	5.5	7.5	7.5	7.5	3.5	5.5	7.5	5.5
	Hurricane	Flood, Internal	7.5	5.5	3.5	7.5	7.5	3.5	5.5	3.5	5.5
6	Hurricane	Flood, External	3.5	3.5	5.5	5.5	5.5	3.5	5.5	7.5	5.5
	Hurricane	Flood, Internal	3.5	3.5	3.5	5.5	5.5	3.5	5.5	3.5	5.5

Note: Values indicate expert judgments (true scores) for items in the EDST with respect to scenarios and situations. Originally, threat items are scored on a 0 to 1 scale with intervals of 0.2 (i.e., 0.0, 0.2, 0.4, 0.6, 0.8, and 1.0); consequence items are scored on a 0 to 9.5 scale with intervals of 2.5 (i.e., 0.0, 1.5, 3.5, 5.5, 7.5, and 9.5). This study recoded these categories into a 1 to 6 scale. The EDST score was calculated by taking the product of the sums for each factor.

The development of the standardized cases considered comparability of situations assigned to facilities. Discussion and consensus with field experts were used to increase the fidelity of the cases.

Recruitment of raters. A total of 18 facilities were recruited for this study across 3 domains of facilities: (1) hospital, (2) nursing home, and (3) adult care. There was a balance in the number of facility domains (6 from each facility domains). 83 raters participated from the facilities. From adult care, there were 26 raters; from hospitals, there were 27 raters; and from nursing homes, there were 30 raters. Table 2 presents the distribution of facility domain and number of raters by facility name.

Table 2. Facility domain and number of raters by facility name

Facility Name (18 total)	Facility Domain (6 from each)	Raters per site (83 total raters)
Babylon Beach House	Adult Care	2
Beach Terrace Care Center	Nursing Home	5
Coney Island Hospital	Hospital	7
Elizabeth Church Manor Nursing Home	Nursing Home	4
Good Samaritan Hospital Medical Center	Hospital	4
Good Shepherd Fairview Home	Nursing Home	5
Horace Nye Home	Nursing Home	5
Keene Valley Neighborhood House	Adult Care	4
Kingsway Manor, LLC	Adult Care	6
New Haven Manor	Adult Care	4
NYU Hospitals Center	Hospital	6
Our Lady of Consolation	Nursing Home	5
Our Lady of Lourdes Memorial Hospital	Hospital	5
Rockaway Manor HFA	Adult Care	4
San Simeon By the Sound Center	Nursing Home	6
St. Mary's Healthcare	Hospital	3
The Hearth at Castle Gardens	Adult Care	6
United Health Services Hospitals	Hospital	2

Note: A total of 83 raters were recruited across 18 sites. There was a balance in the number of adult care, hospitals, and nursing homes (6 from each facility domain). Between facility domains, 26, 27, and 30 raters participated from adult care, hospital, and nursing homes, respectively.

Specifications for the study design. To allow for maximum balance of scenarios and situations, the following specification was designed (see Table 3). Each column represents situations (top header) and scenario (bottom header) combination. Details of each scenario and situation with respect to expert judgment scores are indicated in Table 1. For each facility, 2 different scenarios were assigned, with a total of 4 situations per facility. All raters within the same facility were assigned to score the same scenario and situation. The combination of scenario and situation assignment specified in Table 3 presents a balance of different conditions used in this study that also considered feasibility in distributing the case materials to the facilities. For example, for Babylon Beach House, communications failure and critical supply shortage situations were assigned from the power failure scenario; in addition, electrical utility power and critical supply shortage were assigned from the ice storm scenario.

Study procedure. Participants in the study were given access to the EDST scoring spreadsheet prior to the study session with instructions on the scoring guide. Scores in the EDST tool were generalized to be on a 1 to 6 scale for both threat and consequence factors. This was conducted to minimize any bias that raters may exhibit toward a particular item. During training, raters spent a day reviewing the overview of the study and were given detailed definitions of each score category and the differences in definition between each score category (e.g., “3” versus “4”). Each situation, scenario, and standardized facility was reviewed by a moderated conference call. Participating raters were emphasized to discriminate differences in each category by fully understanding details associated with the scoring guide of the EDST.

On the day of study, each facility received the scenario and situation description. Raters scored the EDST spreadsheet individually. Following individual scoring, the facility convened to generate team-based scores through discussion and consensus.

Table 3. Allocation of facility to scenarios and situations

Facility	Communications Failure:	Critical Supply Shortage:		Electrical Utility Power:	Flood, External:	Flood, Internal:
	Power Failure	Power Failure	Ice Storm	Ice Storm	Hurricane	Hurricane
Babylon Beach House	X	X	X	X		
Beach Terrace Care Center	X	X			X	X
Coney Island Hospital	X	X	X	X		
Elizabeth Church Manor	X	X	X	X		
Good Samaritan Hospital	X	X	X	X		
Good Shepherd Fairview Home	X	X	X	X		
Horace Nye Home	X	X			X	X
Keene Valley Neighborhood House	X	X	X	X		
Kingsway Manor	X	X			X	X
NYU Hospitals Center	X	X	X	X		
New Haven Manor	X	X			X	X
Our Lady of Lourdes Memorial	X	X			X	X
Our Lady of Consolation	X	X			X	X
Rockaway Manor HFA	X	X			X	X
San Simeon By the Sound Center	X	X	X	X		
St. Mary's Healthcare	X	X			X	X
The Hearth at Castle Gardens	X	X	X	X		
United Health Services Hospitals	X	X	X	X		

Note: Each column represents situations (top header) and scenario (bottom header). For each facility, 2 different scenarios are assigned, with a total of 4 situations per facility. For example, for Babylon Beach House, communications failure and critical supply shortage situations were assigned from the power failure scenario; in addition, electrical utility power and critical supply shortage were assigned from the ice storm scenario.

Raters were not permitted to change their individual scores. This process was repeated for each scenario. For both individual and team-based scores, perceived evacuation decisions (remain, prepare, or evacuate) were collected through a post-study survey. Characteristics of the participants that included their demographic information and work-related information were also collected in the post-study survey.

Analysis

Cronbach's alpha (Lord & Novick, 1968) was used to assess the *scale reliability* (i.e., internal consistency of scores in the EDST items). However, this does not provide evidence for *factorial validity*, which examines the underlying internal structure of the EDST (i.e., domains measured by the tool). The EDST is hypothesized to have two underlying factors – threat and consequence. To examine the factorial validity of EDST, fit statistics (e.g., Root Mean Squared Error of Approximation, χ^2 statistic, Information-Criteria measures, Tucker-Lewis index, Comparative Fit Index) from confirmatory factor analysis (CFA) was used. A model comparison between a unidimensional structure (single factor across all EDST items) and the two-factor structure (threat and consequence) was tested.

Rater reliability was assessed using measures of agreement between rater or team-based scores and expert judgments (true scores). Among the most commonly used measures for calculating inter-rater agreement are the exact, exact plus adjacent, and discrepant agreement statistics (Ricker-Pedley, 2011). These measures have gained popularity in assessing the accuracy of rating tasks that are ordinal in nature due to their simplicity in interpretation; agreement statistics are commonly used for operational purposes to examine rater agreement in high-stakes decisions. *Exact agreement* refers to exact match in scores between raters; *exact*

plus adjacent agreement is the proportion of scores that are one point above or below the score of another rater; *discrepant agreement* is the ratio of scores that differ by two or more points. These measures can be calculated based on scores given by multiple raters or between raters and an expert judgment (true score) given by a master or content expert. However, a limitation to this approach is the lack of consideration for agreement that can occur by chance. For example, in a rating task scored on a 1 to 6 scale, the probability of exact agreement by chance between two raters is 16.7%. Given that agreement can result from chance, researchers have also used *Cohen's kappa* as another measure for inter-rater agreement (Cohen, 1960); this statistic penalizes agreement that can occur by chance. A modified version of the kappa statistic that takes into account tendency for raters to score in the "middle" categories is the weighted kappa, where linear or quadratic weights are applied depending on the context and spacing between categories (Cohen, 1968; Shaeffer, Briel, & Fowles, 2001); the weighted kappa is equivalent to the *intraclass correlation* commonly used to assess rater agreement (Fleiss & Cohen, 1973). Differences between rater scores and team-based scores were also examined using measures of rater agreement.

To assess how rater characteristics (i.e., job level, years at current position, years at current facility, employment status, and facility type) may be related to the accuracy of scores, *logistic regression* was used. Finally, perceived evacuation decisions indicated by raters and the facilities were compared with expert judgments on evacuation decision to examine *classification accuracy* – how well perceived evacuation decisions matched with decisions provided by the EDST. Scores from the EDST based on original scoring algorithm (product of sum scores across threat and consequence factors) were also compared to perceived

evacuation decisions. Cross tabulations were created to present the proportion of accurate classification matches between the evacuation decisions.

IV. Results

Demographic characteristics of participants

Table 4 shows the demographic characteristics of the raters that participated in this study. More than 50% of the raters were over 50 years of age; they were mostly White. Slightly more females (54%) participated than males (46%). Nearly 60% of participants had at least a four-year college degree.

Table 4. Demographic characteristics of raters

Characteristic		*n*	%
Age	Less than 40 years	15	23.44%
	40 to 50 years	15	23.44%
	Over 50 years	34	53.13%
Race/Ethnicity	White	70	89.74%
	Other	8	10.26%
Gender	Female	42	53.85%
	Male	36	46.15%
Education	Less than 4 year college	25	40.32%
	4 year college	23	37.10%
	Advanced degree	14	22.57%

Note: Demographic characteristics were collected in a post-study survey. Some raters did not report their demographic background.

In addition to these background characteristics, Table 5 shows the distribution of work-related factors. More than half of the raters were senior-level. Work experience was measured using two questions: years at current position and years at current facility. In both measures of experience, more than 50% of the participants had less than 10 years of work experience.

Scale reliability and factorial validity

Reliability of the items to generate consistent scores: Scale reliability. Consistency in scores across different raters is an important characteristic of a psychometrically reliable tool. Scale reliability refers to the consistency in the same score (or decision) that can result from multiple uses of a tool. Reliability is traditionally measured using Cronbach's alpha (Cronbach, 1951). Accordingly to Nunnally (1978), a reliability coefficient above 0.70 can be viewed as an acceptable reliability estimate for an instrument.

The overall scale reliability of the EDST was assessed using Cronbach's alpha; the overall scale reliability was 0.93. Reliabilities for treat and consequence items were 0.83 and 0.91, respectively. These results indicate that the scoring of items within each of the scales were highly consistent across different raters.

Table 5. Work-related characteristics of raters

Characteristic		*n*	%
Job level	Entry-level	6	7.59%
	Mid-level	31	39.24%
	Senior-level	42	53.17%
Years at current position	≤ 5 years	31	39.24%
	6 to 10 years	14	17.73%
	11 to 20 years	16	20.26%
	20+ years	18	22.79%
Years at current facility	≤ 5 years	26	32.92%
	6-10 years	15	18.99%
	11-20 year	21	26.59%
	20+ years	17	21.52%
Employment Status	Full-time	76	96.20%
	Part-time	3	3.80%
Facility type	Hospital	25	31.65%
	Nursing Home	27	34.18%
	Adult care facility	27	34.18%

Note: Work-related information was collected in a post-study survey. Some raters did not report this information.

Factors underlying the internal structure of EDST: Factorial validity. This section examines whether the EDST measures two distinct factors as hypothesized. Without examining the underlying internal structure, it will be unclear whether there are multiple distinct factors and whether these factors share sufficient common variance (i.e., "hanging well together"). The underlying structure of the EDST was examined using confirmatory factor analysis (CFA). The use of CFA allows a test of whether the two hypothesized factors – threat and consequence – are distinct and have sufficient information to be measured as unique factors.

Table 6 presents the model comparison results between a single-factor model, assuming one underlying factor measured by the EDST, and a two-factor model, using the two hypothesized factors of threat and consequence. The one-factor model results indicates the fit indices when only a single construct is assumed in the EDST; the two-factor model assumes threat and consequence factors to be the underlying structure of the EDST. When model fit indices are better for a specific model, it implies that the data support the better fitting model, which provides a test for factorial validity.

Table 6. Model comparison results

Statistic	One-factor model	Two-factor model
χ^2 (*df*)	512.83 (104)	366.02 (103)
RMSEA (95% CI)	0.10 (0.09, 0.11)	0.08 (0.07, 0.09)
Akaike information criteria (AIC)	15258.62	15113.80
Bayesian information criteria (BIC)	15450.45	15309.63
Comparative fit index (CFI)	0.88	0.92
Tucker-Lewis index (TLI)	0.86	0.91

Note: One-factor model assumes unidimensional structure; two-factor model assumes two underlying factors, threat and consequence, as hypothesized by EDST design. RMSEA: Root mean squared error of approximation.

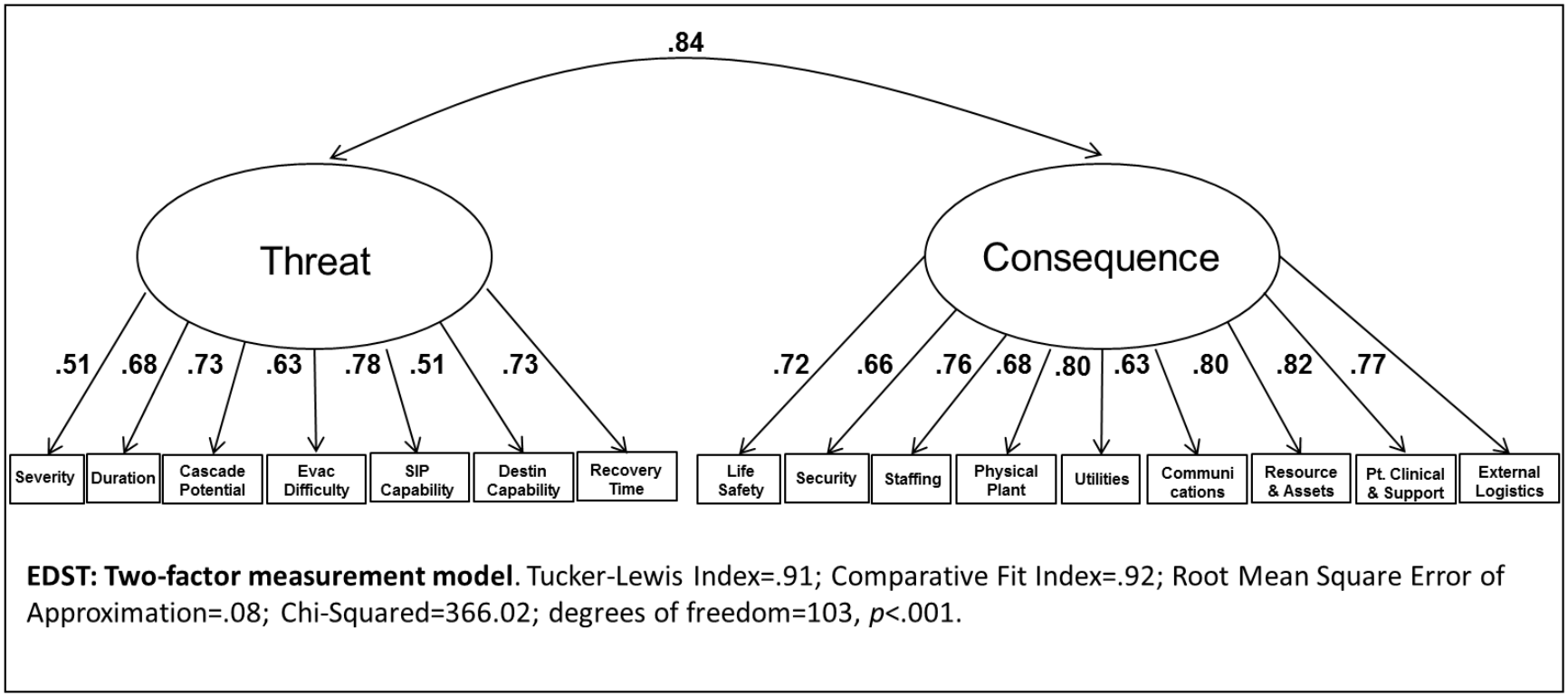
Results indicated that the two-factor model fit significantly better than the one-factor model. Using criteria recommended in Hu and Bentler (1999), the two-factor model was consistent with standards used in the literature, with RMSEA less than 0.08 and CFI/TLI above 0.90. The AIC and BIC indices were also lower for the two-factor model, which indicated that the model fit better. The χ^2 test was significant for both models, with $p<0.05$; however, given adequate fit indices from all other measures, these results can be used to support a two-factor structure in the EDST. As such, these results indicate that the underlying internal structure of the EDST supports the hypothesized factors of threat and consequences.

The CFA also generates factor loadings, which indicates the strength of each item to the specified factor. Table 7 shows the factor loading results. Factor loadings range between 0 to 1 and can be interpreted as correlations between the items and the factor; higher values in factor loadings indicates greater strength in the item. In the threat factor, cascade potential and shelter-in-place (SIP) capability have the highest factor loadings. In the consequence factor, utilities, resources and assets, and patient clinical and suport have the highest factor loadings. Figure 1 illustrates the factor structure of the EDST to provide a visualization of the tool's internal structure. Arrows pointing to items (in rectangle boxes) indicate factor loadings. The figure also shows the correlation between the two factors of 0.84. Factor loadings can be used as weights that can be assigned for caculating the score for the factor to create weigthed threat or weighted consequence scores.

Table 7. Factor loadings from confirmatory factor analysis

	One-factor model	Two-factor model	
		Threat factor	Consequence factor
Severity	0.49 (0.04)	0.51 (0.04)	
Duration	0.60 (0.03)	0.68 (0.03)	
Cascade Potential	0.68 (0.03)	0.73 (0.03)	
Evacuation Difficulty	0.57 (0.04)	0.63 (0.03)	
SIP Capability	0.69 (0.03)	0.78 (0.02)	
Destination Capability	0.45 (0.04)	0.51 (0.04)	
Recovery Time	0.68 (0.03)	0.73 (0.03)	
Life Safety	0.73 (0.03)		0.72 (0.03)
Security	0.66 (0.03)		0.66 (0.03)
Staffing	0.75 (0.02)		0.76 (0.02)
Physical Plant	0.67 (0.03)		0.68 (0.03)
Utilities	0.79 (0.02)		0.80 (0.02)
Communications	0.62 (0.03)		0.63 (0.03)
Resources and Assets	0.79 (0.02)		0.80 (0.02)
Pt. Clinical & Support	0.79 (0.02)		0.82 (0.02)
External Logistics	0.75 (0.02)		0.77 (0.02)

Note: Values in parenthesis represent standard errors.



Note: Values pointing to EDST items indicate factor loadings, correlation between item to the respective factor. The correlation between the two factors was estimated to be 0.84.

***Figure 1*. Illustration of factor loadings for the two-factor model EDST**

Rater reliability and agreement

Rater reliability and agreement. To assess rater reliability, rater scores and team-based scores were compared with expert judgment (true scores) as indicated in Table 1; scores in Table 1 were converted to 1 to 6 scale. Table 8 shows the rater agreement measures across the 16 EDST items by rater and team. Exact agreement refers to the proportion of one-to-one match between rater and team-based scores to expert judgment scores; adjacent agreement indicates agreement for one point above or below expert judgment. Discrepant indicates proportion of two or more point difference in scores. Combined indicates sum of exact and adjacent agreement. Kappa is a measure of agreement that takes into account agreement that can occur by chance; weighted kappa takes into account the ordinal nature of the six score categories in EDST.

Overall, exact agreement across the EDST items for the raters was 28%; for the team-based scores, it was 30%. Combined exact and adjacent agreement was 72% and 76% for raters and team-based scores, respectively. Furthermore, threat factor had higher agreement than the consequence factor by about 10%. For the threat factor, the exact and adjacent agreement was 78% and 82% for raters and team-based scores, respectively; for the consequence factor, the exact and adjacent agreement was 68% and 72%, respectively.

Characteristics of raters that affect accuracy. Table 9 shows a cross tabulation of work-related factors that relate to greater agreement. Results indicate that more years at current position had lower agreement with expert judgment. Table 10 confirms this result in a logistic regression where all work-related factors were simultaneously analyzed. In addition to years at current position (less years) indicating greater odds of agreement, raters with more years at

current facility had a significantly greater odds of agreeing with expert judgments. An interaction term was added between years at current position and facility, which had a significant estimate. To aid interpretation of the interaction term, Table 11 was added, which presents the predicted odds ratio for each combination of work experience.

Table 8. Rater reliability: Rater and team scores with expert judgment

Item	Status	Exact	Adjacent	Combined	Discrepant	Kappa		Wgt. Kappa	
Severity	Rater	0.32	0.47	0.79	0.21	0.05	(0.03)	0.22	(0.05)
	Team	0.42	0.32	0.74	0.26	0.15	(0.07)	0.16	(0.10)
Duration	Rater	0.39	0.43	0.82	0.18	0.12	(0.04)	0.22	(0.06)
	Team	0.47	0.36	0.83	0.17	0.24	(0.09)	0.22	(0.13)
Cascade Potential	Rater	0.29	0.45	0.74	0.26	0.02	(0.03)	0.24	(0.05)
	Team	0.29	0.45	0.75	0.25	0.01	(0.07)	0.26	(0.11)
Evacuation Difficulty	Rater	0.29	0.48	0.77	0.23	0.02	(0.03)	0.15	(0.05)
	Team	0.38	0.50	0.88	0.12	0.09	(0.08)	0.19	(0.11)
SIP Capability	Rater	0.31	0.48	0.79	0.21	0.02	(0.03)	0.22	(0.05)
	Team	0.28	0.54	0.82	0.18	–0.02	(0.06)	0.24	(0.11)
Destination Capability	Rater	0.37	0.46	0.83	0.17	–0.01	(0.03)	-0.02	(0.04)
	Team	0.43	0.45	0.88	0.12	0.02	(0.08)	0.04	(0.10)
Recovery Time	Rater	0.30	0.46	0.76	0.24	0.05	(0.03)	0.19	(0.04)
	Team	0.25	0.61	0.86	0.14	–0.04	(0.07)	0.29	(0.10)
Life Safety	Rater	0.17	0.36	0.53	0.47	0.00	(0.02)	0.07	(0.03)
	Team	0.22	0.38	0.61	0.39	0.03	(0.05)	0.08	(0.07)
Security	Rater	0.18	0.34	0.52	0.48	–0.02	(0.02)	0.06	(0.03)
	Team	0.13	0.43	0.57	0.43	–0.10	(0.05)	0.16	(0.08)
Staffing	Rater	0.24	0.48	0.72	0.28	0.02	(0.03)	0.17	(0.04)
	Team	0.21	0.55	0.76	0.24	–0.02	(0.06)	0.11	(0.09)
Physical Plant	Rater	0.28	0.46	0.75	0.25	0.04	(0.03)	0.13	(0.04)
	Team	0.37	0.47	0.84	0.16	0.14	(0.07)	0.26	(0.10)
Utilities	Rater	0.25	0.43	0.68	0.32	0.04	(0.03)	0.18	(0.05)
	Team	0.29	0.41	0.70	0.30	0.08	(0.06)	0.12	(0.11)
Communications	Rater	0.23	0.42	0.65	0.35	0.08	(0.02)	0.15	(0.04)
	Team	0.20	0.46	0.66	0.34	0.02	(0.04)	0.15	(0.10)
Resources and Assets	Rater	0.25	0.53	0.79	0.21	0.01	(0.03)	0.23	(0.04)
	Team	0.26	0.61	0.87	0.13	0.00	(0.06)	0.24	(0.09)
Pt. Clinical & Support	Rater	0.26	0.46	0.73	0.27	0.04	(0.03)	0.19	(0.05)
	Team	0.29	0.43	0.72	0.28	0.05	(0.06)	0.16	(0.12)
External Logistics	Rater	0.28	0.45	0.73	0.27	–0.04	(0.03)	0.15	(0.05)
	Team	0.28	0.45	0.73	0.27	–0.03	(0.07)	0.18	(0.12)
Overall	Rater	0.28	0.45	0.72	0.28	0.03	(0.03)	0.16	(0.04)
	Team	0.30	0.46	0.76	0.24	0.04	(0.07)	0.18	(0.10)

Note: Exact agreement is the proportion of one-to-one match between rater and team scores with expert judgment; adjacent agreement indicates agreement for one point above or below the expert judgment. Discrepant indicates proportion of two or more point difference in scores. Combined indicates sum of exact and adjacent agreement. Kappa is a measure of agreement that takes into account agreement that can occur by chance; weighted kappa takes into account the ordinal nature of the score categories (1 to 6 scale) in EDST.

Table 9. Factors affecting agreement with expert judgment: Cross tabulation

Characteristic		Exact and adjacent agreement	Discrepant
Job Level	Entry	71.77%	28.23%
	Mid	71.65%	28.35%
	Senior	73.58%	26.42%
Years at current position**	≤ 5 years	72.62%	27.38%
	6-10 years	76.80%	23.20%
	11-20 year	71.99%	28.01%
	20+ years	70.13%	29.87%
Years at current facility	≤ 5 years	71.55%	28.45%
	6-10 years	74.63%	25.37%
	11-20 year	70.84%	29.16%
	20+ years	74.88%	25.12%
Employment Status***	Full Time	73.19%	26.81%
	Part-time	59.79%	40.21%
Facility Type	Hospital	70.76%	29.24%
	Nursing	74.35%	25.65%
	Adult	72.80%	27.20%

Note: Exact agreement is the proportion of one-to-one match between rater and team scores with expert judgment; adjacent agreement indicates agreement for one point above or below the expert judgment. Discrepant indicates proportion of two or more point difference in scores. ** p<0.01; *** p<0.001. Values represent row percents.

Table 10. Factors affecting agreement with expert judgment: Logistic regression

Variable	Odds Ratio	95% CI
Mid-level	0.99 (0.13)	(0.76, 1.28)
Senior-level	1.03 (0.15)	(0.78, 1.36)
Entry-level (reference)		
Years at current position***	0.72 (0.05)	(0.62, 0.82)
Years at current facility	0.92 (0.07)	(0.80, 1.07)
Years at current position x facility**	1.09 (0.03)	(1.03, 1.14)
Full time***	1.96 (0.32)	(1.41, 2.71)
Part-time (reference)		
Nursing	1.03 (0.10)	(0.86, 1.24)
Adult	1.02 (0.09)	(0.86, 1.21)
Hospital (reference)		

Note: Values in parenthesis represent standard errors. Odds ratio represent likelihood in greater exact or adjacent agreement with expert judgment. An intreraction term was added for year at current position with years at current facility. ** p<0.01; *** p<0.001.

Table 11 shows that as years at current facility increased, the odds of greater accuracy varied for different years at current position. In fact, when years at current position was less than 5 years or greater than 20 years, more work experience at current facility increased the odds of accurate ratings; however, when years at current position was between 6 to 20 years, the odds ratios varied. This indicates that work experience should be examined at both levels of current position and current facility.

Table 11. Predicted odds ratios (adjusted) between years at current position and facility

Years at current position	Years at current facility			
	≤ 5 years	6-10 years	11-20 year	20+ years
≤ 5 years	2.83	3.04	3.07	NA
6-10 years	NA	2.54	2.83	2.39
11-20 year	1.75	2.16	2.56	2.99
20+ years	1.44	1.85	2.36	3.07

Note: Values marked "NA" do not have raters for the particular combination. The table of predicted odds ratios presents the postestimation results based on Table 10.

Full-time status was also associated with greater agreement; however, there were only a small number of part-time workers (less than 4%).

Comparison between rater scores and team-based scores

Characteristics of raters that affect team-based scores. During the study, each rater individually scored the assigned situation described for the particular scenario. Following the individual scoring phase, raters gathered to generate team-based scores through discussion. Each facility subsequently generated a single team-based score for each situation assigned. Table 12 shows the agreement between rater scores and team-based scores (interpretation of the agreement statitics is the same as Table 8). Results indicate that on average, 50% of rater scores were unchanged; among the remaining 50% that were changed, 38% of rater scores had

adjacent agreement with team-based scores (1 point change), while only 12% of the scores had discrepancies of two or more points in the 1 to 6 scale. Between the threat and consequence factors, the combined agreement was 87% and 89%, respectively.

Table 12. Comparison of rater and team-based scores

Item	Exact	Adjacent	Combined	Discrepant	Kappa		Wgt. Kappa	
Severity	0.49	0.32	0.81	0.19	0.31	(0.03)	0.27	(0.06)
Duration	0.57	0.34	0.91	0.09	0.32	(0.04)	0.36	(0.06)
Cascade Potential	0.45	0.40	0.84	0.16	0.22	(0.03)	0.34	(0.06)
Evacuation Difficulty	0.43	0.44	0.88	0.13	0.19	(0.03)	0.42	(0.05)
SIP Capability	0.43	0.48	0.91	0.09	0.19	(0.03)	0.45	(0.06)
Destination Capability	0.50	0.35	0.85	0.15	0.22	(0.03)	0.35	(0.05)
Recovery Time	0.53	0.36	0.89	0.11	0.34	(0.03)	0.55	(0.05)
Life Safety	0.49	0.35	0.85	0.15	0.28	(0.03)	0.45	(0.05)
Security	0.45	0.41	0.86	0.14	0.26	(0.03)	0.52	(0.05)
Staffing	0.49	0.41	0.90	0.10	0.26	(0.03)	0.55	(0.05)
Physical Plant	0.53	0.35	0.88	0.12	0.35	(0.03)	0.51	(0.05)
Utilities	0.56	0.35	0.91	0.09	0.34	(0.03)	0.50	(0.05)
Communications	0.45	0.39	0.85	0.15	0.21	(0.03)	0.32	(0.05)
Resources and Assets	0.55	0.38	0.93	0.07	0.30	(0.03)	0.57	(0.05)
Pt. Clinical & Support	0.52	0.39	0.91	0.09	0.31	(0.03)	0.53	(0.05)
External Logistics	0.57	0.35	0.92	0.08	0.37	(0.03)	0.58	(0.06)
Total	0.50	0.38	0.88	0.12	0.28	(0.03)	0.45	(0.06)

Note: Exact agreement is the proportion of one-to-one match between rater and team scores with expert judgment; adjacent agreement indicates agreement for one point above or below the expert judgment. Discrepant indicates proportion of two or more point difference in scores. Combined indicates sum of exact and adjacent agreement. Kappa is a measure of agreement that takes into account agreement that can occur by chance; weighted kappa takes into account the ordinal nature of the score categories (1 to 6 scale) in EDST.

Table 13 indicates factors that are associated with team-based scores. This information can provide insight into individuals that lead the discussion process in generating team-based scores. Results indicate that entry- and senior-level raters have greater agreement than mid-level raters. This is also reflected in years at current position, where raters with 6 to 10 years of experience have the lowest exact and adjacent agreement. In Table 14, a logistic regression was

used to examine the influence of these factors together. Results reiterate findings in Table 13. Mid- and senior-level raters had a significantly lower odds of exact and adjancent agreement than entry-level rater. Similar to findings in Table 10, full-time status was also linked with lower agreement; however, given low sample sizes in part-time status raters, this result will not be given full meaning. Finally, although insignificant, more experience at current position was marginally associated with greater agreement with tream-based scores. The inclusion of an interaction term for work experience was not significant; as such, this is not represented in the final results shown in Table 14.

Table 13. Factors affecting agreement with team-based scores: Cross tabulation

Characteristic		Exact and adjacent agreement	Discrepant
Job Level***	Entry	93.92%	6.08%
	Mid	84.12%	15.88%
	Senior	90.00%	10.00%
Years at current position**	≤ 5 years	88.88%	11.12%
	6-10 years	84.44%	15.56%
	11-20 year	87.27%	12.73%
	20+ years	89.67%	10.33%
Years at current facility	≤ 5 years	88.41%	11.59%
	6-10 years	87.16%	12.84%
	11-20 year	87.81%	12.19%
	20+ years	88.07%	11.93%
Employment Status*	Full Time	87.72%	12.28%
	Part-time	93.65%	6.35%
Facility Type	Hospital	87.35%	12.65%
	Nursing	88.76%	11.24%
	Adult	87.69%	12.31%

Note: * $p<0.05$; ** $p<0.01$; *** $p<0.001$. Values represent row percents.

Table 14. Factors affecting agreement with team-based scores: Logistic regression

Exact and adjacent agreement	Odds Ratio	95% CI
Mid-level***	0.35 (0.08)	(0.22, 0.55)
Senior-level*	0.60 (0.15)	(0.38, 0.97)
Entry-level (reference)		
Years at current position	1.10 (0.06)	(0.99, 1.22)
Years at current facility	0.93 (0.05)	(0.83, 1.03)
Full time**	0.40 (0.13)	(0.22, 0.74)
Part-time (reference)		
Nursing	1.09 (0.14)	(0.85, 1.41)
Adult	0.99 (0.12)	(0.79, 1.25)
Hospital (reference)		

Note: Values in parenthesis represent standard errors. Odds ratio represent likelihood in greater exact or adjacent agreement with expert judgment. Interaction term between years at current position and current facility not added to the table, as it was insigificant. * $p<0.05$; ** $p<0.01$; *** $p<0.001$.

Classification accuracy of evacuation decision

The final result examines the comparison between a global decision (remain, prepare, evacuate) and the decision EDST scores suggest. This evaculation of classification accuracy is critical as decisions from the tool is expected to predict an external critera. To assess the classification accuracy of evacuation decisions, three measures were used: (1) self-reported perceived evacuation decision by raters and teams, (2) predetermined evacuation decision by content experts, and (3) EDST score decisions based on rater and team-based scores (using cutoff criteria of EDST scores < 200 for remain, 200 to 400 for prepare, and above 400 for evacuate). Table 15 shows the cross tabulation of these results for both raters and teams. A greater classification accuracy represents a closer match between an external criteria and the decision inferred by the tool.

The first cross tabulation in Table 15 shows the classification between rater perceived decision with EDST score decision. Classification accuracy (agreement in the decision) was 38% for raters and 31% for teams. In the the second cross tabulation, the classification between expert predetermined decision (true score) and EDST score decision are presented. The classificaiton acuracy was 54% for both raters and teams. Finally, in the third cross tabulation, expert predetermined decision was compared with raters' perceived decision. Classification accuracy was 37% for raters and 38% for teams. Values with correct classification are highlighted.

These results indicate that correct classification with raters' perceived decision was less than 40%. The classification accuracy of experts' predetermined decisions mapped with EDST score decisions (based on raters' scores) was less than 55%, indicating possible misclassification between decisions. Overall, depending on the external criteria used, classification accuracy ranged between 37% to 54%.

Figure 2 illustrates the range of EDST scores by raters' perceived decisions (X-axis) and EDST scores (Y-axis). This figure was generated to indicate ranges of EDST scores for which raters perceived to yield decisions to remain, prepare, and evacuate. Since there are two expert judgments pertaining to remain and prepare, two figures were restricted to situtions that indicate these decisions. Although the figure does not provide definitive ranges of EDST scores that indicate evacuation decisions, the 95% confidence interval ranges do illustrate some association between perceived decisions with EDST scores.

V. Discussion

The use of an evacuation decision instrument to guide decisions during an emergency or disaster should provide greater assistance for preparing facilities and individuals. It should also provide support in providing policymakers with additional evidence when such an instrument is known to be reliable and valid. However, to date, there has not been a study that has examined such psychometric characteristics of a tool. With respect to such demand, this study fills the gap in the literature as well as provide the necessary foundation for administrators and policymakers in the field.

This study examined the reliability and validity of the EDST, an instrument that provides a systematic process for evaluating and planning whether a facility can remain, prepare, or evacaute from a disaster. In particular, this study investigated the scale reliability (consistency in scores), factorial validity (factors underlying the internal structure of the tool), rater reliability (agreement), characteristics of raters that affect accuracy, and classification accuracy of decisions reported by the tool. Results indicate that scale reliability of the instrument was excellent with high internal consistency. This means that scoinrg of items witin each of the scales were highly consistent across different raters – a critical foundation required in a reliable tool.

Table 15. Classification of perceived evacuation decision with predetermined and EDST score decision

Rater perceived decision \ EDST score decision	Rater (%)				Team (%)			
	Remain	Prepare	Evacuate	Total	Remain	Prepare	Evacuate	Total
Remain	**12.00**	22.67	4.00	38.67	**3.64**	9.09	0.00	12.73
Prepare	9.00	**22.33**	2.00	33.33	23.64	**20.00**	0.00	43.64
Evacuate	5.67	18.33	**4.00**	28.00	9.09	27.27	**7.27**	43.64
Total	26.67	63.33	10.00	100.00	36.37	56.36	7.27	100.00

Note Classification accuracy for raters and teams is 38% and 31%, respectively. Values represent cell percent. Correct classification is highlighted.

Expert predetermined decision \ EDST score decision	Rater (%)				Team (%)			
	Remain	Prepare	Evacuate	Total	Remain	Prepare	Evacuate	Total
Remain	**16.47**	25.88	3.82	46.18	**21.05**	23.68	1.32	46.05
Prepare	10.29	**37.06**	6.47	53.82	14.47	**32.89**	6.58	53.95
Total	26.76	62.94	10.29	100.00	35.53	56.58	7.89	100.00

Note Classification accuracy for raters and teams is 54% and 54%, respectively. Values represent cell percent. Correct classification is highlighted.

Expert predetermined decision \ Rater perceived decision	Rater (%)				Team (%)			
	Remain	Prepare	Evacuate	Total	Remain	Prepare	Evacuate	Total
Remain	**18.33**	14.33	14.33	47.00	**7.27**	12.73	25.45	45.45
Prepare	20.33	**19.00**	13.67	53.00	5.45	**30.91**	18.18	54.55
Total	38.67	33.33	28.00	100.00	12.73	43.64	43.64	100.00

Note: Classification accuracy for raters and teams is 37% and 38%, respectively. Values represent cell percent. Correct classification is highlighted.

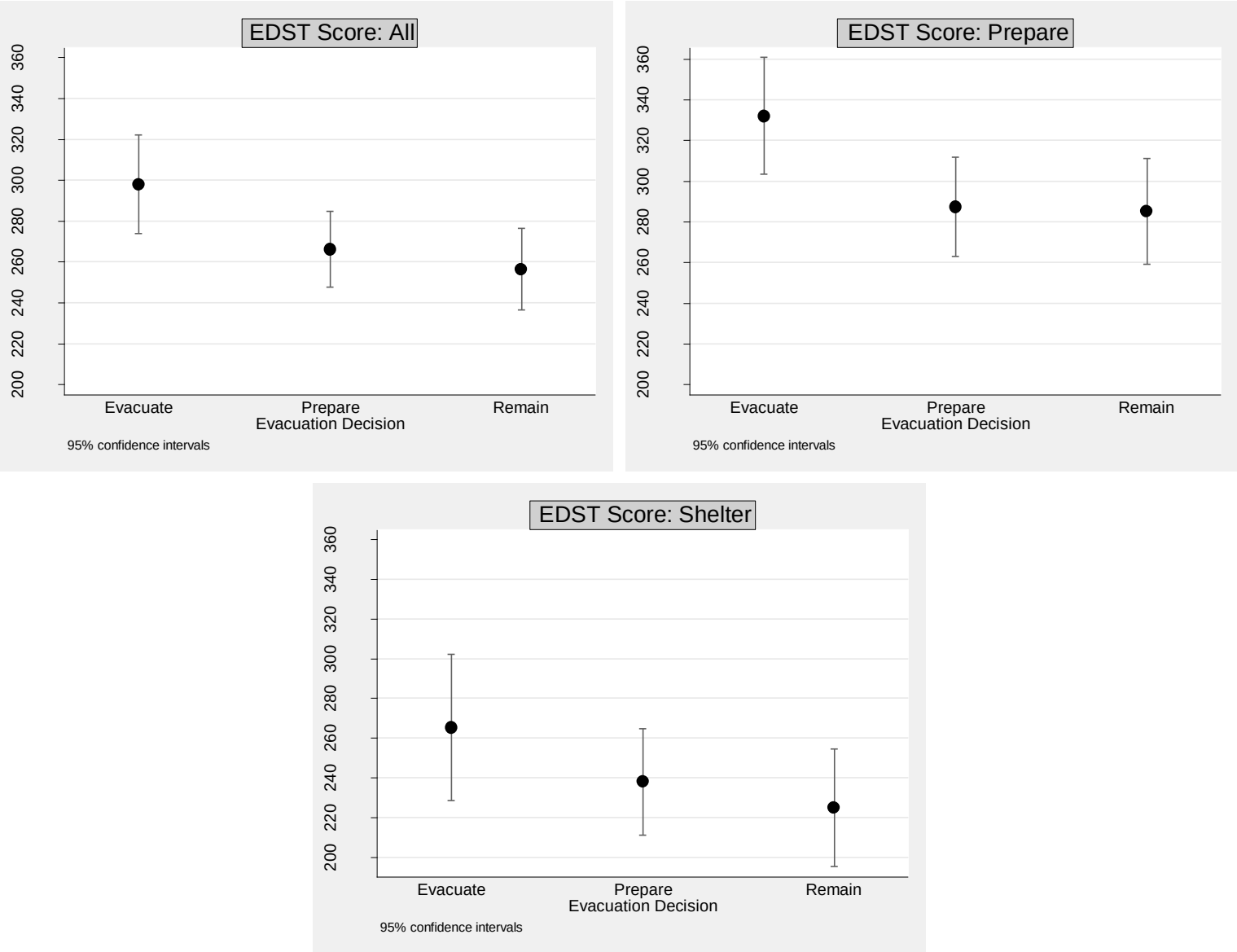


***Figure 2*. Measure of raters' perceived decisions with EDST scores**

In addition, as hypothesized, two factors were found to describe the underlying structure of the EDST – threat and consequence factors. These results should be promising evidence that the fundamental aspects of the tool are sound. Results from the confirmatory factor analysis also indicated different factor loadings between items of EDST to their respective factors, which suggests possible differential weighting algorithm of the items for calculating the EDST score.

Measures of rater reliability indicated further research may be required to increase agreement and scoring accuracy. Currently, exact agreement was less than 30% and combined exact and adjacent agreement was about 75%. In addition, it appeared that team-based scores did not significantly improve the accuracy of scores; they only improve agreement marginally (by about 4%). Further emphasis or research can be conducted to refine agreement by increasing methods for training or developing scenarios that may better assess these findings. Finally, classificaion accuracy of evacuation decision requires continued attention. Results from this study indicates classification accuracy with perceived decision to be less than 40%. Prediction of accuracte evacuation decision is the ultimate outcome of this tool and may require additional attention for refinement in score calculation and derivation of meaningful cutpoints. These results suggest that the EDST should be used as a planning tool to assist in guiding evacuation process as well as providing a sysmtatic framework for collecting relevant information in situations where evacuation or shelter in place is a possible course of action.

The overall findings of this study indicate that the current framework used in EDST lead to consistent scores. However, the accuracy of scores and the associated decisions require further investigation in a continued study. There are several possibilities to consider in future

work, which could not be investigated in this current study. Four relevant considerations for future studies are suggested. First, assigning different weights to items in EDST seems to be a reasonable action based on variability of factor loadings from the CFA. In fact, the factor loadings can be used as a weight in deriving the EDST score. Currently, the tool assumes equal weight across the items. Second, the tool currently uses 6 disctinct ordinal categories for each item. However, it is unclear whether raters perceive 6 distinct categories, based on exact and adjacent agreement statistics. Training should reinforce raters to master the understanding of each category associated with the item. Raters should be able to discriminate differences between each category; for example, training can focus on differences between adjacent categories such as “3” and “4” which should allow raters to increase their awareness of the scores they assign. At the same time, when certain categories seem overlapping, collapsing them can be an alternative; when raters cannot discriminate certain categories, they could be collapsed. The specific methodology used for collapsing may need to be developed in future work. Third, the scoring algorithm used to calculate the overall EDST score requires refinement. Taking the sum of items within each factor and subsequently taking their product to derive the overall EDST score has not been validated in previous research; this report also finds that the current EDST score may not reflect the full information gathered in the 16 items of EDST. A careful study design that considers a composite score combining the two factors is required. Finally, setting appropriate cut points to the instrument is necessary; this process is known as standard settig in the educational and psychological literature. This is an extensive process that requires results from both empirical data and expert judgment from a representative panel.

Without setting meaningful cutpoints based on both data collection and expert judgment, it becomes difficult to validate the classification accuracy of evacuation decisions.

There are several limitations to this study. This includes the participants and facilities recruited, which cannot be generalized to raters that may face an actual disaster in a healthcare facility. In addition, standardized scenarios, situations, and facilities developed in this study may be specific to the particular content assessed. These limitations can be addressed in future studies that recruit a larger sample of participants and a greater variety of scenarios. Likewise, demographic information of participants should be collected to continue investigating characteristics of raters that would give the most accurate ratings in planning evacuation decisions.

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Appendix

Scenario I. Power Failure – Overview of Incident

It is 5:30 am, Thursday August 16, 2012. At about 4:00 am EST, a transformer handling power for a major trunk line exploded due to heat accumulation and high use associated with an on-going heat wave striking the Northeast. The explosion caused the transformer to go off line resulting in a spotty regional power failure affecting some homes, health care facilities and businesses in Empire County (EC) and in the area of Empire County Nursing Home (ECNH). Due to the regional power failure, cell phone service is disrupted and land line circuits are over loaded. ECNH is on emergency power, has activated its Emergency Operations Plan (EOP), contacted its office of emergency management, its NYSDOH RO and begun to contact its mutual aid partners. Per its EOP it is activating and staffing its primary EOC, contacting staff and developing an incident action plan to manage its response to the power outage.

- ECNH has established baseline Evacuation Decision Support Tool (EDST) scores as part of pre incident planning in conjunction with its yearly hazard vulnerability assessment (HVA). The emergency management committee (EMC) has concerns about facility ability to maintain a safe environment of care for its residents with limited electric power as this is a type of incident that is not high on its HVA. It is considering two possible situations that may develop, shortage of critical supplies and communications failure.
- To assist in its planning and response to the incident, the EMC has developed an overview of the impact of the incident on ECNH. The evaluation is based on the detailed inventories of key facility systems, utilities and resources, as well as its plans and procedures for resident care, staff support and anticipated community support during the incident. What follows is a summary of the evaluation as discussed by the EMC, including consideration of OEM and DOH situations reports and baseline bed availability data as of August 16, 2012.

Critical Supply Shortage – Situation Warranting a SIP/Evacuation Decision

ECNH has food, fluids, medication and linens for about 72 hours, including about 3.5 days (84 hrs) of diesel fuel on site to power its emergency generator. It has instituted system wide conservation measures, to include fuel, food and other supplies. It expects to continue conservation measures throughout the outage, operating on a projected time frame of 8 - 24 hours. The EMC is concerned that ECNH will experience shortages of such resources as fuel and medical gases if the power outage lasts for more than three days. Due to the wide distribution of the incident, disruption of community based supply chain and large distribution of evacuation zone if needed, full restoration of services and depleted resources will take between 8 - 24 hrs beyond the restoration of the usual power supply. ECNH has a plan and resources to

transport staff to the facility when usual transportation systems are not effective and anticipates that less than 10% of its staff will not be able to come to work during the next operational period. Some non-essential services will be combined across shifts to minimize impact on resident services. Per its EOP, staff support services (rest and sleeping, food, family support) will be provided as applicable.

Key Facility Systems, Utilities and Resources

ECNH has run checks on all critical life safety, e.g., fire alarm and suppression systems, resident wandering systems, ventilator, oxygen and dialysis and associated back-up systems. All are connected to the emergency power system (EPS) and are operable. Little impact from future critical supply shortages is expected. All safety and security systems and most but not all of the 40 electronic locks in the facility are tied to emergency power. Those that are not will fail to the open position and require monitoring. The ECNH building is drafty, and some areas do receive excessive sun exposure. The AC and ventilation systems are on emergency generator and will continue per the availability of fuel with at worst only partial brown outs to non-essential zones. Two of the five elevators are on emergency power. This will slow down but not preclude vertical transit of residents and services. The facility is able to provide boiler generated steam, prepare hot and cold foods, pump water as needed and maintain refrigeration. Due to restrictions on number of utilities tied to emergency power, and procedures to conserve existing fuel, these functions will be slower than usual. The facility's internal phone and intercom communications system are operational. External land line and cell phone services are very unreliable. It has tested its two way radios and is cycling all through recharge to ensure continued use.

Plans and Procedures for Patient Care, Staff Support, External Supplies

The EMC is weighing out the pros and cons of evacuation, availability of receiving facilities and shelter in place. ECNH has some evacuation equipment, about 50% of the staff have been trained on its use. Limited evacuation equipment combined with possible restricted use of elevators may make evacuation more difficult, requiring about twice the time of its established planning assumptions, and physically demanding. The EMC has learned that many of its mutual aid partners in contiguous counties have been impacted by the power failure and have expressed reluctance to even consider accepting evacuees should that become necessary. They have indicated that even though they have available beds, they too are concerned about staffing and resources shortages should the outage continue for several days. The EMC considers that that if evacuation becomes necessary, residents will need to be placed outside the community and face travel times of more than one hour each way, well in excess of its evacuation planning assumptions. The EMC has reviewed ECNHs evacuation and shelter in place plans with facilities management, dietary, nursing and human resources. The facility is

secure and has the resources and a stay team available and is operating on a minimum SIP time frame of three days. In spite of conservation measures, as supply of resources decreases during the incident, staff will have to spend more time and effort to distribute its on-site supplies to its residents as supplies will have to be moved from deeper in reserves for actual use. Some reduction of resident related services (hot food, social activities) and environmental services (AC) will be reduced to decrease fuel consumption. Further decreases in the type and timing of resident services cannot be ruled out at this time. ECNH is a member of a local mutual aid plan. However, many of these facilities, local vendors and emergency management partners will be equally challenged by the power outage and may not be able to provide assistance in the form of medical and non-medical supplies. If the outage becomes protracted, and/or its distribution widens over the next operational period, resource replenishment from external partners will be more much difficult and time consuming.

0.6	0.4	0.4	0.4	0.4	0.6	0.4	1.5	3.5	3.5	3.5	3.5	3.5	3.5	5.5	7.5	114	Shelter in Place

Communications Failure – Situation Requiring a SIP/Evacuation Decision

ECNH has various different interoperable communications methods including two way radios for internal and short range communications. These have been tested and found operational. The local public utility company and Office of Emergency Management have reported that it could be 2-3 days before power is restored and have suggested that health care facilities plan on system wide problems for at least this period of time. The power outage is making it difficult to communicate with staff via cell phone as cell phone service is disrupted and land line circuits are over loaded. Once the EOC team is in place, ECNH begins to examine its in house staff and ability to contact off duty staff. It anticipates that up to 10% of its staff will not be able to come to work during the next operational period. This may worsen over successive operational periods as staff content with the power outage in their homes and with their families. It has instituted communications as possible with staff or volunteers to maintain safe operations. ECNH anticipates that all services can be maintained by existing staff and resources for at least 2-3 days and that communication limitations should be resolved between 8 - 24 hours after the resumption of regular electrical power services.

Key Facility Systems, Utilities and Resources

ECNH has reviewed all life safety and security systems. They are operational and connected to the emergency power system. It has adequate internal communications capabilities should any life safety or security issues arise and to communicate within the physical plant in the absence of external electric power. The power outage is making it difficult to communicate with external constituents via cell phone and may delay or impede ECNH's ability to contact utility and other

repair staff during the event. ECNH has various different IOC systems which have been tested and found operational, but communications is still slow. ECNH's internal phone and intercom communications system is operational. However, external land line and cell phone services are very unreliable, no signal or dropped signal is already common, making communications more challenging and slow. ECNH does not have any priority (GETS, WPS, TSP) service agreements in place. ECNH does not have an 800 mhz or amateur radio in place. It has tested its two way radios and found they are operable. Facility management has placed them on chargers to ensure they remain operable.

Plans and Procedures for Patient Care, Staff Support, External Supplies

ECNH has begun to contact its local mutual aid partners and is learning that many other healthcare facilities both in and contiguous to EC are also experiencing either limited or total power and communication outages. This communications issue might delay placement of residents if there is a need to evacuate, and evacuation time frames would run much longer than those used for plan assumptions. ECNH is confident that the facility infrastructure is resilient and that if sufficient resources are available it can successfully and safely shelter in place. ECNH is currently successfully communicating with local emergency management and giving them situational awareness of their resource needs. HERDS surveys normally used to assess the bed availability and appropriate care capabilities for ECNH residents do not have complete information on all facilities due to difficulty in communications. With the information currently available it is suggested that only about 50% of ECNH residents can be placed locally and the remainder would need to travel at least 90 minutes to be placed. ECNH has multiple IOC systems, including two way radios for internal and short range external communication; however, service is slow and unreliable and is causing delays and some failed communications. Due to the general power failure, access to electronic medical records is unavailable and the facility would need to rely on paper patient files; though communications are slow and difficult, the resources on hand and should last through to the expected restoration time. ECNH has multiple IOC systems, including two way radios for internal and short range external communications to whom it may reach out for external supplies should the power outage continue for more than three days.

Communications Failure	0.4	0.6	0.2	0.6	0.2	0.8	0.4	3.5	0	3.5	3.5	3.5	3.5	3.5	3.5	1.5	83	Shelter in Place

Scenario II: Power Outage – Overview of Incident

Real time, 5:30 am, Saturday August 18, 2012. At about 4:00 am EST, a transformer handling power for a major trunk line exploded due to heat accumulation and high use associated with the recent and on-going heat wave striking the Northeast. The explosion caused the transformer to go off line resulting in a widespread regional power failure affecting many homes, health care facilities and businesses in Empire and surrounding counties, and in the area of EC Nursing Home. Due to the power failure, cell phone service is limited and land line circuits are in-operable. ECNH is on emergency power, has activated its Emergency Operations Plan (EOP), contacted its office of emergency management, its NYSDOH RO and begun to contact its mutual aide partners. Per its EOP it is activating and staffing its primary EOC, contacting staff and developing an incident action plan to manage its response to the power outage.

- ECNH has established baseline Evacuation Decision Support Tool (EDST) scores as part of pre incident planning in conjunction with its yearly hazard vulnerability assessment (HVA). The emergency management committee (EMC) has concerns about facility ability to maintain a safe environment of care for its residents with limited electric power as this is a type of incident that is not high on its HVA. It is considering two possible situations that may develop, shortage of critical supplies and communications failure.
- To assist in its planning and response to the incident, the EMC has developed an overview of the impact of the incident on ECNH. The evaluation is based on the detailed inventories of key facility systems, utilities and resources, as well as its plans and procedures for resident care, staff support and anticipated community support during the incident. What follows is a summary of the evaluation as discussed by the EMC, including consideration of OEM and DOH situations reports and baseline bed availability data as of August 18, 2012

Critical Supply Shortage – Situation Requiring a SIP/Evacuation Decision

ECNH has food, fluids, medication, linens and personal supplies for about 3 days, and about 3.5 days (84 hrs) of diesel fuel on site to power its emergency generator. Due to the regional distribution of the power outage, it is concerned about local resource depletion especially if the outage continues for several days. It is Saturday. The local public utility company and Office of Emergency Management have reported that the extent of the outage will not be fully appreciated before Monday and are unable to provide a good estimate of the duration at this time. Some EMC members recall that a power outage that struck the region 2 years ago lasted 9 days. The facility will initiate conservation methods today and expects to continue in that mode at least through Monday. The EMC anticipates that supply shortages resulting from the power outage may limit its ability to obtain delivery of fuel and medical gas supplies as well as

service to its generator should that be needed. ECNH anticipates that the impact the supply shortage should be resolved between 24 – 96 hours after the resumption of regular electrical power services. As the power failure is a community wide incident, ECNH estimates that about 30% of its staff will be unable or unwilling to show for work as they deal with the power outage personally. ECNH's staff transport plan is limited and is not expected to have a significant impact in this circumstance. Schools are closed and some families have relocated out of town to stay with friends and family. However, due to wide distribution of the incident, disruption of community based supply chain and large distribution of evacuation zone if needed, full restoration of services, staff and depleted resources will take more than 24 hrs.

Key Facility Systems, Utilities and Resources

ECNH has run checks on all critical life safety systems and security systems. All are operating. All life safety and most door locking systems are on the EPS. Those that are not will default to the open position. These areas will now require 24 hrs/day monitoring which will be further impacted by staffing shortages. The facility is drafty, and some areas do receive excessive sun exposure which will negatively impact maintenance of internal temperature. The HVAC is on emergency generator and should be able to continue per the availability of fuel. However, strain on the emergency generator due to prolonged operations at high output and high temperatures and strain on AC units is expected to lead to more significant restriction of power to at least some essential zones. Two of the five elevators are on emergency power. This will greatly slow down but not preclude vertical transit of residents and services. In order to conserve fuel, the power to some essential zones (AC, ventilation) would be reduced. Of concern is that though the generator has been tested monthly, careful review of recent logs indicates that load was less than the recommended 30% of the kW rating and that test times had included warm up and cool down. Facility management will monitor the generator and has advised that further power reductions in power may be needed if the duration of the power outage increases. ECNH's internal phone and intercom communications system is operational. External land line and cell phone services are very unreliable. It does not have a cache of cell phones, so is reliant on staff phones already on site. It does not own a Sat phone and does not have any priority (GETS, WPS, TSP) service agreements in place. It has tested its two way radios and found that not all are operable. Facility management has placed them on chargers to replenish the power source. It does not have 800 mhz or amateur radio in place. It anticipated difficulty contacting external partners for support will worsen over the next few operational periods but otherwise impact due to supply shortage is limited.

Plans and Procedures for Patient Care, Staff Support, External Supplies

The EMC is weighing out the pros and cons of evacuation, availability of receiving facilities and shelter in place. ECNH does not have adequate evacuation equipment, and only about 25% of

staff have been trained on its use. Combined with a significant staff shortage and limited use of elevators, evacuation will be much more difficult, time consuming and physically demanding, with total times estimates of at least twice that of planning assumptions. The EMC has reviewed ECNHs evacuation and shelter in place plans with facilities management, dietary, nursing and human resources. The facility is secure. It has the resources and a stay team available. It can SIP but is not confident of the time frame as there is concern that it will be completely reliant on its EPS. In spite of conservation measures, as supply of resources decreases during the incident, staff will have to spend more time and effort to distribute its on-site supplies to its residents as supplies will have to be moved from deeper in reserves for actual use. ECNH has learned that many of its mutual aid partners in contiguous counties have been impacted by the power failure and share the same concerns about staffing and resources should the outage continue for several days. Many have indicated that though suitable beds are available, they do not expect to be able to receive resident evacuees should that become necessary. ECNH incident management considers that that if evacuation becomes necessary, many residents may need to be placed outside the community, more than one hour travel time each way and may face extensive delays due to shortage of transportation resources and staff to accompanying them during transport. Some reduction of resident related services (hot food, social activities) and environmental services (AC) have already been made to decrease fuel consumption. Further decreases in AC due to fuel or system failure due to internal heat may lead to completed disruption of this utility. Dialysis treatments may have to be relocated due to staffing and supply issues. Further decreases in the type and timing of resident services could become intolerable for some residents and few if any reasonable mitigation strategies are available. Many of ECNH's mutual aid partners, facilities, local vendors and emergency management partners will be equally challenged by the power outage and may not be able to provide assistance in the form of medical and non-medical supplies. If the outage becomes protracted, and/or its distribution widens over the next operational period, resource replenishment from external sources will be more much difficult and time consuming.

Critical Supply Shortage	0.6	0.6	0.6	0.6	0.6	0.6	0.6	1.5	5.5	5.5	7.5	7.5	3.5	5.5	9.5	7.5	225	Prepare for Evacuation

Communications Failure – Situation Requiring a SIP/Evacuation Decision

The power outage is making it difficult and slow to communicate with external contacts. Cell phone service is poor; land lines are unavailable. ECNH has resources and supplies on site for approximately 72 hours, including diesel fuel on hand for 3.5 days at 100% emergency power. There is concern that the drain on existing communications systems in the region will only

strain and worsen the ability to communicate as the incident continues. The EMC expects this to worsen over the next few operational periods further complicating the impact of communication. Since it is a Saturday, residential power demand is relatively high while business and industry power usage is relatively low. The local public utility company and Office of Emergency Management have reported that a full deployment of emergency crews and complete assessment of full damage and effects of the outage will not occur before Monday. They are unable to provide a good estimate of the duration of the outage at this time. Some EMC members recall that a power outage that struck the region 2 years ago lasted 9 days. ECNH anticipates that the impact that communications capabilities should be resolved between 8 - 24 hours after the resumption of regular electrical power services. Once the EOC team is in place, ECNH begins to examine its in house staff and ability to contact off duty staff. It anticipates that up to 30% of its staff will not be able to come to work during the next operational period and it urgently needs to communicate with staff or volunteers to be able to maintain safe operations.

Key Facility Systems, Utilities and Resources

ECNH has reviewed all life safety systems. They are operational and connected to the emergency power system (EPS). It has adequate internal communications to manage life safety systems. However, given the uncertain duration of the event, continued strain on regional communications could lead to failure and inability to reach out for any needed supplies or services. ECNH security systems are also operational and connected to the EPS and has adequate internal communications capabilities should any security issues arise during the power outage. However, even these devices will become drained over time and less available. Reduced internal communications could be a threat to security. Strain on the emergency generator due to prolonged operations at high output and high temperatures will lead to need to restrict use of this power to only critical care systems and leave communications support to dwindle. Therefore there will be reduced internal and external essential communications. ECNH has multiple IOC systems, however, given the uncertain duration of the event, continued strain on regional communications could lead to failure and inability to reach out for any needed resources or services to support continued operation of these critical utilities. Our vendors and contract agencies may not even have communications operating to be reached by. Essentially isolating the facility from help and endangering safe operations.

Plans and Procedures for Patient Care, Staff Support, External Supplies

The power outage is making it difficult to communicate with staff and local situation reports indicate that travel is very difficult. ECNH expects that given its own staffing limitations, limited access and experience using evacuation equipment, all response related activities would require much more time and effort, is concerned about the physical demand of manual tasks

during the heat wave, and that internal and external evacuation time frames will run several times longer than those used for its planning assumptions. Though there is no danger to the structure of ECNH, and it can sustain all usual operations to SIP for about 3 days without external replenishment of supplies. There is however concern that prolonged duration and limited ability to communicate with the vendor and support communications will negatively impact this ability if the time frame becomes protracted. ECNH has begun to contact its local mutual aid partners. From those with whom it can communicate, it is learning that many other health care facilities both in and contiguous to Empire County are also experiencing power and in some cases communications outages, compounded by large staff shortages. NYSDOH - Health Emergency Response Data System (HERDS) surveys normally used to assess the bed availability and appropriate care capabilities for ECNH residents, do not have complete information on all facilities due to difficulty in communications. With the information currently available it is suggested that only about 50% of ECNH residents can be placed locally and the remainder would need to travel at least 90 minutes to be placed. Internal supplies will dwindle during the incident, despite conservation methods. Its internal communications capability is intact and should have only limited impact on its on duty staff's ability to distribute resources and supplies per established plans and procedures. The local power company is not able to provide an estimated duration, and therefore worsening communications will greatly increase the difficulty to communicate needs for assets and supplies, even if they were available within the region. This is expected to worsen on Monday when business and industry demands and strains on power are added to residential. Due to the general power failure, access to electronic medical records is unavailable and the facility would need to rely on paper patient files; the ability to communicate for needed resources, including staff to perform these services, especially as duration of event continues, is at risk, and could endanger the facility's ability to provide these key services. ECNH has multiple IOC systems, however, but given the uncertain duration of the event, continued strain on regional communications could lead to failure and inability to reach out for any needed resources or services to support continued critical operations. Our vendors and contract agencies may not even have communications operating to be reached by. Essentially isolating the facility from help and endangering safe operations.

0.6	1	0.6	0.8	0.8	0.8	0.4	5.5	3.5	7.5	5.5	9.5	9.5	7.5	9.5	9.5	338	Prepare for Evacuation

Scenario III: Ice Storm – Overview of Incident

It is Thursday January 13, 2012. The emergency management committee (EMC) of Empire County Adult Care Facility (ECACF) has been following the National Weather Service (NWS) and local OEM/DOH updates about a large low pressure system currently in the Ohio valley. This system is predicted to move eastward into the Big Valley area, including Empire County (EC) by Sunday January 15, 2012, bringing with it heavy precipitation which will convert to freezing rain and sleet. EC and each of its contiguous county neighbors is predicted to experience about ¼ "of ice accumulation. By late Monday January 16, sustained winds are expected to increase to between 20 – 25 mph. By Tuesday January 17, the area of EC and its contiguous neighbors is expected to experience several days of cold weather, ranging from 12 – 27^0 F. OEM and DOH are warning facilities that total storm impact on health care organizations will likely be at least 3 – 4 days after the end of the storm.

- ECACF has established baseline Evacuation Decision Support Tool (EDST) scores as part of pre incident planning in conjunction with its yearly hazard vulnerability assessment (HVA). The emergency management committee (EMC) has concerns about facility ability to maintain a safe environment of care for its residents with limited electric power, a type of incident that is high on its HVA. It is considering two possible situations that may develop, failure of the electrical utility and shortage of critical supplies.
- To assist in its planning and response to the incident, the EMC has developed an overview of the impact of the incident on ECNH. The evaluation is based on the detailed inventories of key facility systems, utilities and resources, as well as its plans and procedures for resident care, staff support and anticipated community support during the incident. What follows is a summary of the evaluation as discussed by the EMC, including consideration of OEM and DOH situations reports and baseline bed availability data as of January 13, 2012.

Loss of electrical power utility – Situation Requiring a SIP/Evacuation Decision

Loss of electrical utility due to the downing of wind-blown ice laden power lines at the service entry to the facility has occurred in the past. ECACF's EM committee considers the storm as predicted is likely to cause power disruptions. Based on its experience, this manageable but does represent a significant challenge as the facility must rely solely on emergency power for an indeterminate period of time. The facility has adequate supplies of food, fluids, linens and personal supplies on- site for resident and staff needs for at least 72 hours, including about 3.5 days of fuel for its emergency generator which has a burn rate of about 400 gallons per day at 100%. It will need to initiate and maintain fuel conservation measures which it expects to continue throughout the outage, operating on an initial projected time frame of 8 - 24 hours. Based on National Weather Service (NWS) and local reports, the active storm period is

predicted to last for 12- 18 hours, followed by an additional three to four days of sub-freezing temperatures. The EMC considers it unlikely that the facility will receive any external supplies, including fuel, for at least four (4) days. Prolonged use of the emergency generator for four (4) or more days will lead to shortage of fuel, attempts at power shedding may result in HVAC disruption. Considering past experience of line repair times of 2-3 days, ECACF anticipates that full restoration and recovery will take four (4) to five (5) days, including repatriation of residents should evacuation become necessary. Staff shortages are expected due to the storm, local road conditions and as staff deal with their own disruptions/loss of electrical power that will be common in the region. This will make it more difficult to augment staff to manage on site utility and resident needs.

Key Facility Systems, Utilities and Resources

Life safety systems are connected to the emergency power system (EPS), are currently intact and functioning. Fluctuations in power associated with fuel conservation methods will necessitate facility staff to monitor the LS systems well beyond that required for routine maintenance. Reductions or complete shut off of power in some areas of the facility will result in decreased internal and external lighting which may limit the use of security surveillance systems. This will force security to be more reliant on human monitoring.

The emergency power system is not configured into emergency and critical equipment zones, so power shedding for fuel conservation will not be possible without totally cutting off power to other areas and utilities of the facility. ECACF will shut down power to any areas of the facility not essential to resident or staff safety. This will result in closure of the exercise rooms, some of the elevators, some dining areas, and decrease in the usual internal temperature to the main lobby and recreational areas. Not all elevators or pumps or cooking functions are connected to emergency power. To the degree possible, those that are will have power reduced and/or shut down to conserve fuel and maintain internal temperature during the cold snap. The generator will need constant monitoring. All communications systems are operable. Loss of power and weather conditions will likely affect at least cell service. ECACF has limited IOC capabilities and lacks any radio equipment. The primary EOC is in the lobby which is now closed so incident command will need to relocate to the secondary EOC, which does not have internet connection.

Plans and Procedures for Resident Care, Staff Support, External Supplies

The EMC is weighing out the pros and cons of evacuation, availability of receiving facilities and shelter in place. Given the loss of use of 50% of the elevators using the EPS, as well as some restrictions in lighting and closure of some areas of the facility, the EMC anticipates that the time required for resident packaging and transport to internal staging will require about twice the time based on its established planning assumptions. The EMC has reviewed ECACFs

evacuation and shelter in place plans with facilities management, dietary, nursing and human resources. The facility is secure, has the resources and a stay team available and is operating on a minimum SIP time frame of 2-3 days if that becomes necessary. It anticipates that it will need to rely on EPS for at least some of this period. Restriction of power to various facility systems which will result in decreased lighting to some areas such are basement and ground floor storage, loss of half the elevators, various pumps and some cooking functions. This will increase the difficulty, time and effort needed to obtain, manage and distribute on site supplies and resources throughout the facility. It will also lead to the shut-down of power to any areas of the facility not essential to resident or staff safety, such as the lobby, closure of group common meeting areas, exercise rooms, dining and some recreational areas. Non-essential resident activities, such as admissions, transfers, scheduling, assessments and exercise services will be discontinued or limited as much as possible. Changes in routines for behavioral health residents and or residents with other special needs or unique vulnerabilities will be very disruptive to this population. ECACF participates in a local mutual aid plan with other HCFs (including ACFs) in EC and contiguous counties. Based on the forecasts, most of these facilities will be within the storm's impact zone and are likely to experience similar interruption of municipal power, reliance on emergency power systems and shortage of resources. ECACF plans to discharge to home about 10% of its residents. Local baseline bed availability data has identified suitable beds, but most are outside the community and would require resident transport more than one county away, well beyond anticipated planning assumptions, and estimated to require more than 90 minutes travel one way. The storm and sub-freezing cold weather are predicted to continue for four (4) days. Local OEM reports that road travel is expected to be very hazardous for the next several days. Thus, ability to acquire supplies, including fuel, from external sources will be limited both during and just following the storm.

0.8	0.8	0.8	0.6	0.6	0.8	0.8	5.5	1.5	1.5	5.5	5.5	5.5	3.5	5.5	5.5	205	Prepare for Evacuation

Critical Supply Shortage – Situation Requiring a SIP/Evacuation Decision

ECACF has had some past experience with severe winter ice storms which resulted in interruption access to critical medical and non-medical supplies and other key resources. ECACF's emergency generator has a burn rate of about 400 gallons per day at 100%. There is about 1500 gallons of # 2 diesel fuel on hand (about 3.5 days). The facility has adequate supplies on site for resident and staff needs for 72 hours. Based on the forecasted weather, OEM reports on possible road conditions, and past experiences, the EMC anticipates that it will not receive any deliveries for at least four (4) days. This will place the facility in a vulnerable

position which would force adoption of system wide conservation measures and curtailment of facility services to residents. Conservation measures and interruption of the flow of medical and non-medical supplies is expected to trigger other problems, such as shortage of fuel for the generator, loss of external support (e.g., repairs to generator and damage to physical plant) and shortage of tanked oxygen. Critical resource supply should have only limited direct impact on staffing at ECACF. Staff who do not live nearby and do present to work and need housing will increase use of some supplies and further stress conservation methods. If supply shortage occurs as anticipated, based on its past experiences it expects that it will take about 24 – 36 hours to recover, including repatriation of residents if evacuation becomes necessary.

Key Facility Systems, Utilities and Resources

The ECACF's emergency management committee does not expect critical supply shortage to have any direct impact on the facility's life safety systems (fire, emergency lighting systems and alarms) or safety and security systems. The facility has a history of leaks and/or water intrusion due to wind driven rain or snow. The windows are double-paned. The exterior doors and large glass walls of the dining areas and lobby are subject to moderate drafting and loss of heat. Loss or interruption in resources may increase the duration and or cost of repairs to any aspects of the physical plant that are damaged during the storm.

The emergency power system is not divided into emergency and critical equipment zones, so power shedding to lessen consumption of fuels will not be possible. The facility is drafty which will negatively impact maintenance of internal temperature. The HVAC systems are on emergency generator and should be able to continue per the availability of fuel. Strain on the emergency generator due to prolonged operations at high output and resultant high temperatures is expected to lead to force further restriction of power to at least some essential zones. Boilers are gas fired, other utilities, plumbing, water and sanitation should not be affected. Loss of critical supplies should not directly impact ECACFs internal or external communications capabilities. It will need to ensure that all battery back-ups are brought up to full charge.

Plans and Procedures for Resident Care, Staff Support, External Supplies

The EMC is weighing out the pros and cons of evacuation, availability of receiving facilities and shelter in place. Most of ECACF's residents are ambulatory. The facility has a small selection evacuation support supplies. Loss of critical supplies and system wide conservation methods will have only limited impact on the ability to evacuate. EMC has reviewed ECACFs evacuation and shelter in place plans with facilities management, dietary, nursing and human resources. The facility is secure though drafty. It has the resources and a stay team available and is operating on a minimum SIP time frame of 2-3 days if that becomes necessary. Most of ECACF's mutual aid partners will be within the storm's impact zone and would be expected to

experience similar interruption of access and delivery of medical and non-medical supplies. Local bed availability data has identified suitable beds, but facilities within 30 – 60 minute travel time have already indicated that they will be reluctant to accept evacuees due to similar concerns of resource shortages. The EMC anticipates that most potential receiving facilities will be well outside the community and would require resident transport of up to 90 minutes one way, well beyond its planning assumptions. Predicted storm and cold weather duration will necessitate that conservation methods will have to be in place for at least four (4) days. As supply of resources decreases during the incident, ECACF staff will have to spend more time and effort to distribute its on-site supplies to its residents and to maintain other facility services as supplies will have to be moved from deeper in reserves for actual use. To conserve non-medical supplies, some non-essential resident activities, such as admissions, transfers, scheduling, assessment, exercise services, social gatherings, field and shopping trips will be curtailed. Changes in routines for behavioral health residents and or residents with other special needs or unique vulnerabilities will also be affected. ECACF participates in a local mutual aid plan with other HCF in EC and contiguous counties. However, based on the forecasted weather, most of these facilities will be within the storm's impact zone, will experience their own supplies shortages and be unable to assist ECACF. Road and travel conditions will also further complicate and lengthen trip time to and from more distant sites that may have supplies.

0.8	0.8	0.8	0.4	0.6	0.8	0.4	1.5	0	3.5	5.5	1.5	5.5	5.5	5.5	7.5	166	Shelter in Place

Scenario IV: Ice Storm – Overview of Incident

Friday, January 13, 2012: The emergency management committee of ECACF has been following the National Weather Service (NWS) and local OEM/DOH updates of a large low pressure system currently in the Ohio valley. This system is predicted to move eastward into the Big Valley area, including Empire County (EC) by Sunday January 15, 2012, bringing with it heavy precipitation which will convert to freezing rain and sleet. EC, and each of its contiguous county neighbors is predicted to receive .3 – 1.00 "of ice accumulation. By late Monday January 16, sustained winds are expected to increase to between 20 – 25 mph, with gusts reaching 35 – 40 mph. By Tuesday January 17, the area of EC and its contiguous neighbors is expected to experience several days of very cold temperatures, ranging from 0 – 14 ^{0} F, and continued moderate cloud cover. OEM and the local power authorities are warning the region that storm

related damage to trees will likely block roads and interrupt power supplies. DOH is advising health care facilities to plan for a total storm impact that may last 4 - 5 days beyond the storm.

- ECNH has established baseline Evacuation Decision Support Tool (EDST) scores as part of pre incident planning in conjunction with its yearly hazard vulnerability assessment (HVA). The emergency management committee (EMC) has concerns about facility ability to maintain a safe environment of care for its residents during the approaching ice storm, which is high on its hazard vulnerability assessment. It is considering two possible situations that may develop, failure of the electrical utility and shortage of critical supplies.
- To assist in its planning and response to the incident, the EMC has developed an overview of the impact of the incident on ECNH. The evaluation is based on the detailed inventories of key facility systems, utilities and resources, as well as its plans and procedures for resident care, staff support and anticipated community support during the incident. What follows is a summary of the evaluation as discussed by the EMC, including consideration of OEM and DOH situations reports and baseline bed availability data as of January 13, 2012

Loss of electrical power utility – Situation Requiring a SIP/Evacuation Decision

Loss of electrical utility due to the downing of wind-blown ice laden power lines at the service entry to the facility has occurred in the past. ECACF's EM committee considers the storm as predicted is likely to cause power disruptions. Based on its experience, this is manageable but does represent a significant challenge as the facility must rely solely on emergency power for an indeterminate period of time. The facility has adequate supplies of food, fluids, linens and personal supplies on- site for resident and staff needs for at least 72 hours, including about 3.5 days of fuel for its emergency generator which has a burn rate of about 400 gallons per day at 100%. It will need to initiate and maintain fuel conservation measures which it expects to continue throughout the outage, operating on a projected time frame of 4-5 days beyond the storm, as recommended by OEM and DOH reports. Fortunately its boilers are gas fired. Based on National Weather Service (NWS) and local reports, the active storm period is predicted to last for 12- 18 hours, followed by an additional three to four days of sub-freezing temperatures. The EMC considers it unlikely that the facility will receive any external supplies, including fuel, for at least four (4) days. Prolonged use of the emergency generator for four (4) or more days will lead to shortage of fuel, attempts at power shedding may result in HVAC disruption. Considering past experience of line repair times of 2-3 days, ECACF anticipates that full restoration and recovery will take four (4) to five (5) days, including repatriation of residents should evacuation become necessary. Facility loss of electrical utility will have limited impact on staff. Staff shortages are expected due to the storm, local road conditions and as staff deal with their own disruptions/loss of electrical power that will be common in the region. This will make it more difficult to augment staff to manage on site utility and resident needs.

Key Facility Systems, Utilities and Resources

Life safety systems are connected to the emergency power system (EPS), are currently intact and functioning. Fluctuations in power associated with fuel conservation methods which will be in place for the duration of the incident will necessitate facility staff to monitor the LS systems well beyond that required for routine maintenance. Reductions and complete shut off of power in some areas of the facility for fuel conservation will result in decreased internal and external lighting. This may limit the use of security and surveillance systems, also on EPS, forcing security to be more reliant on human monitoring, which may be exacerbated by staffing issues.

ECACF boilers are gas fired and it can produce steam. The boilers will be strained to maintain reasonable internal temperature due to the very low temperatures and leaky and drafty windows and large rooms. Auxiliary electric heater that would usually be used to supplement heat in some areas will not be used to shed load and decrease fuel consumption. In order to conserve fuel, some areas of the facility will need to be shut completely, with restrictions of staff and resident access.

The emergency power system is not configured into emergency and critical equipment zones. Power shedding for fuel conservation will not be possible without totally cutting off power to other areas and utilities of the facility. ECACF will shut down power to any areas of the facility not essential to resident or staff safety. This will result in closure of the exercise rooms, some of the elevators, some dining areas, and decrease in the usual internal temperature to the main lobby and recreational areas. To stretch resources further, residents may be moved staff and residents will be confined in restricted and smaller areas of the facility. The generator will need constant monitoring. All communications systems are operable. Loss of power and weather conditions will likely affect at least cell service. ECACF has limited IOC capabilities and lacks any radio equipment. The primary EOC is in the lobby which is now closed so incident command will need to relocate to the secondary EOC, which does not have internet connection.

Plans and Procedures for Resident Care, Staff Support, External Supplies

The EMC is weighing out the pros and cons of evacuation, availability of receiving facilities and shelter in place. Reduction of power to elevators and lighting in some areas in order to conserve fuel will decrease the safety, and increase the time needed to evacuate. The EMC anticipates that the time required for resident packaging and transport to internal staging will be about twice that of its established planning assumptions. EMC has reviewed ECACFs evacuation and shelter in place plans with facilities management, dietary, nursing and human resources. The facility is secure, but would be reliant on emergency power and would be exercising system wide resource conservation methods. Based on NWS and local reports, and consistent with DOH and OEM recommendations, ECACF is projecting a 4 – 5 day time frame for SIP, without external replenishment of supplies. SIP for this length of time will be more difficult

due staffing limitations which are expected to increase over future operational periods. ECACF participates in a local mutual aid plan with other HCFs (including ACFs) in EC and contiguous counties. However, based on the forecasts, most of these facilities will be within the storm's impact zone and are likely to experience similar interruption of municipal power, reliance on emergency power systems and shortage of resources. ECACF plans to discharge to home about 10% of its residents. Local bed availability data has identified suitable beds, but most are outside the community and would require resident transport more than one county away, well beyond anticipated planning assumptions, and estimated to require more than 90 minutes travel one way. To reduce load and conserve fuel, all non-essential resident activities, such as admissions, transfers, scheduling, assessments and exercise services will be discontinued until full recovery is achieved. Changes in routines for behavioral health residents and or residents with other special needs or unique vulnerabilities will be necessary to manage these residents with fewer staff and or in unusual locations and groups within the facility. This too will be maintained until full recovery has been achieved. The storm and following cold weather snap are predicted to continue for about five days. Local OEM reports that road travel is expected to be very hazardous for the next several days. Combined, ECACFs ability to acquire supplies, including fuel, from external sources will be severely limited for at least 5 days.

0.8	0.8	0.8	0.8	0.8	0.8	0.8	7.5	5.5	5.5	5.5	7.5	5.5	5.5	7.5	7.5	322	Prepare for Evacuation

Critical Supply Shortage - Situation Requiring a SIP/Evacuation Decision

ECACF has had only limited experience with severe winter ice storms and resultant loss of community support in the past. It has adequate on site supply of resources for 72 hrs, including about 3.5 days of fuel (at 100% load) for its emergency generator. The ice storm and follow on cold weather is predicted to impact the entire region for least four days, ensuring that ECACF will be without external support beyond the limit of it's on-site cache without resource conservation measures. Based on NWS and local reports, the active storm period is predicted to last for 12- 18 hours. Forecasts for ice accumulation and continued sub-freezing temperatures will make it likely that ECACF will not receive any external supplies for at least four (4) days and will force adoption of conservation measures to deal with dwindling supplies. The EMC anticipates that storm related interruption to the flow of medical and non-medical supplies will likely trigger several other situations, (vulnerabilities) including shortage of fuel for the generator, loss of external support (e.g., repairs to generator and damage to physical plant) and shortage of tanked oxygen. If ECACF has to evacuate due to resource shortages compounded by loss of external support, it anticipates the ability to recover from these

situations, including repatriation of residents within 24 - 36 hours following full restoration of all services. Full recovery and repatriation cannot be estimated based on the current information. ECACF has electronic and hard copy staff contact lists. On site staff will be retained and provided key support services, including limited family lodging, as applicable. ECACF has a plan to transport staff to and from the facility when traditional staff transportation means are unavailable and to provide staff lodging, supplies and food during a SIP event. Though it expects to encounter transport related difficulties, it is expected that less than 10% of staff may not be able to reach the facility due to local road conditions and/or will be unavailable as they are managing their own family and home safety and security.

Key Facility Systems, Utilities and Resources

Critical supply shortage is not expected to have any significant impact any life safety, such as fire, emergency lighting systems and alarms or security systems. These systems are connected to the emergency power and are operable. Safety and security includes internal and external rounds by trained staff. ECACF houses behavioral and dementia residents who require regular monitoring. The facility has a history of leaks and/or water intrusion due to wind driven rain or snow. The windows are double paned. The exterior doors and large glass walls of the dining areas and lobby are subject to moderate drafting and loss of heat. Loss or interruption in resources may increase the duration and or cost of repairs to any aspects of the physical plant that are damaged during the storm. With the exception of risk of losing systems that rely on battery back-up, loss of critical supplies should not impact ECACFs internal or external communications capabilities. It will need to ensure that all battery back-ups are brought up to full charge. The emergency power system is not divided into emergency and critical equipment zones, so power shedding to lessen consumption of oil fuels will not be possible. Loss of municipal power locally is possible but duration cannot be predicted. Not all elevators or pumps or cooking functions are connected to emergency power. Depending on severity and duration, most or all of these systems will have power reduced and the emergency generator will need constant monitoring.

Plans and Procedures for Resident Care, Staff Support, External Supplies

The EMC is weighing out the pros and cons of evacuation, availability of receiving facilities and shelter in place. Most of ECACF's residents are ambulatory. The facility has 3 days of medical and non-medical supplies on site, including some evacuation support supplies. Loss of critical supplies will have only limited impact on the ability to evacuate. Based on NWS and local reports, and consistent with DOH and OEM recommendations, ECACF is projecting a 4 – 5 day time frame for SIP, without external replenishment of supplies. It plans to initiate system wide resource conservation immediately and maintain them throughout this period. SIP for this length of time will be further restricted by staffing limitations. ECACF participates in the local

mutual aid plan. There are other ACFs in EC and contiguous counties, most of which are within the storms impact zone and report that they are experiencing similar problems with critical supply shortages. ECACF plans to discharge to home about 10% of its residents. Local bed availability data has identified suitable beds but most are outside the community and will require resident transport more than one county away, beyond anticipated planning assumptions, and estimated to require more than 90 minutes travel one way. ECACF has requested pre storm assets from its vendors, including fuel, without success. As supply of resources decreases during the incident, ECACF staff will have to spend more time and effort to distribute its on-site supplies to its residents and to maintain other facility services as supplies will have to be moved from deeper in reserves for actual use. To conserve non-medical supplies, some non-essential resident activities, such as admissions, transfers, scheduling, assessment, exercise services, social gatherings, field and shopping trips will be curtailed. Changes in routines for behavioral health residents and or residents with other special needs or unique vulnerabilities will also be affected. ECACF participates in a local mutual aid plan with other HCF in EC and contiguous counties. However, based on the forecasted weather, most of these facilities will be within the storm's impact zone, will experience their own supplies shortages and be unable to assist ECACF. Road and travel conditions will also further complicate and lengthen trip time to and from more distant sites that may are potential external suppliers of resources.

0.8	0.8	0.8	0.4	0.6	0.8	0.6	1.5	1.5	5.5	3.5	5.5	3.5	5.5	5.5	7.5	190	Shelter in Place

Scenario V: Hurricane – Overview of Incident

Thursday, June 21: 1000 am. The emergency management committee (EMC) of Empire County Hospital (ECH) has been following the National Weather Service (NWS) updates on tropical storm (**TS) X** beginning with its naming as the first hurricane of the season on Monday June 18, with maximum sustained winds of 85 mph (140 km/hr). The storm track included landfall near Panama City, Florida with winds of 75 mph (120 km/h), and subsequent weakening to a tropical storm then a tropical depression by Wednesday June 20. Present time weather briefing reports indicate that the tropical depression unexpectedly re-strengthened into a TS and has once again emerged into the Atlantic Ocean near Nags Head, North Carolina. **TS "X"** is now predicted to make landfall near NYC with sustained winds **of 65 mph/100km/h on June 22**. Coastal storm surge of less than 4 feet (SLOSH 1) is predicted. In the Big Valley region (75 miles north-west of NYC**), 6 – 10 inches of** rain is predicted. A weak low just on the coast is expected to block the

storms easterly flow, slowing the storm and contributing to rainfall totals with **may reach 18 inches** in some areas. **Zero hour (time when winds reach >39 mph)** for the Big Valley area is predicted to be between 3 – 7 pm, Friday June 22. Local emergency management and health department briefing have emphasized that travel after zero hour may not be safe and will be restricted. There are no mandatory evacuation orders at this time. **The A river, and its tributaries B and C rivers** converge in the southern area of Big Valley. They are predicted to flood well **above previous 100 year** (base elevation) flood levels, due in part to new rainfall and the 2-3 inches of rain that has fallen in the valley over the past two weeks.

- ECNH has established baseline Evacuation Decision Support Tool (EDST) scores as part of pre incident planning in conjunction with its yearly hazard vulnerability assessment (HVA). The emergency management committee (EMC) has concerns about ECH's ability to maintain a safe environment of care for its patients during the storm. This situation is high on its hazard vulnerability assessment. It is considering two possible situations that may develop, external flooding and internal flooding.
- To assist in its planning and response to the incident, the EMC has developed an overview of the storms possible impact on ECH. The evaluation is based on the detailed inventories of key systems, utilities and resources, and plans and procedures for patient care, staff support and anticipated community support during the incident. What follows is a summary of the evaluation as discussed by the EMC, including consideration of OEM and DOH situations reports and baseline bed availability data as of June 21, 2012

External Flood – Situation Requiring a SIP/Evacuation Decision

ECH is located at the far edge of the 100 year inundation zone of A river. Predicted rainfall will be greater than any in recent memory and rivers in the Big Valley are expected to crest above flood levels. ECH is 650 feet from and 15-20 feet above the usual water level. EC Office of Emergency Management has informed ECH Emergency Management that based on flood mapping, ECH should expect River A flood waters will extend as least 500- 600 feet beyond the river banks. The EMC is very concerned about this expectation. Heavy rains over already water soaked grounds will increase the impact of external flooding and the likelihood of water intrusion at any vulnerable access points and problem drainage areas. The emergency generator system is located outside at grade, is protected from wind but not from water intrusion. ECH has some sand bags to use for a barrier around the generator and other vulnerable access points, will have to fill and construct as barriers, but does not have any experience as to the viability of this as a barrier against water intrusion. The expected storm period is 18 – 24 hours, beginning at 3 pm Friday. Rivers are predicted to crest on Sunday and recede to below flood levels by Tuesday. External flooding from the river may directly cause failure of the outdoor – at grade emergency generator, and result in internal flooding and damage to the physical plant and utilities. Predicted flooding and damage to roads will lead to extensive and prolonged disruption of community infrastructure. ECH anticipates the ability to

recover from the external flooding to be within 4-5 days after the storm's end. ECH has electronic and hard copy staff contact lists. On site staff will be retained and provided key support services, including family lodging, as applicable. ECH has a plan to transport staff during an emergency, but does not expect this to be effective if predictions are on target. It is expected that up to 30% of staff may not be able to reach the facility due to local road conditions and/or will be unavailable as they are managing their own family and home safety and security. This includes some who staff the ICU, CCU, NICU and psychiatric units.

Key Facility Systems, Utilities and Resources

Fire and emergency lighting systems are currently un-affected and are connected to the emergency power system. External flooding may interrupt or result in loss of emergency power. Internal flooding to key utilities and the electrical rooms located below and at grade will impact the LS systems which can operate on battery backup for only limited periods of time. Security consists of internal and external rounds and closed circuit camera surveillance. Security and surveillance equipment are on emergency power and will function as long as the EPS is intact. Internal flooding may disable security systems. Increased security may be needed if areas in the building are off limits due to flooding. ECH has a history of water intrusion during heavy wind driven rain and intrusion at several vulnerable access points, problem drainage areas, and door frame gaps is expected. The atrium window is a weak point. Key utilities are located at and or below grade but not protected by concrete walls, waterproof doors or pumps. Most windows are rated for 60 mph winds, gusts may be higher, glass doors windows are otherwise unprotected from flying debris. ECH has adequate resources and supplies of food, fluids, linens, medications and personal supplies for 72 hours. The generator runs off a 4,000 gallon diesel fuel tank which is currently full. The emergency power system is not divided into separate critical and non-essential zones. Only 3 of its 6 elevators, some pumps and cooking functions are connected to emergency power. If regular power fails, most or all non-essential circuits will have power reduced and the emergency generator will need constant monitoring and protection from external flooding. The facility does not have external docking or a suitable above grade level location to accept another external generator. ECH has tested all its communications systems and found them operable. Possible loss of power and weather conditions will likely effect at least cell service. ECH does not have a Telecommunications Service Priority contract on key lines.

Plans and Procedures for Patient Care, Staff Support and External Supplies

The EMC is weighing out the pros and cons of evacuation, availability of receiving facilities and shelter in place. Only half of the facility's 6 elevators are tied to the emergency power system. If elevators are used while on emergency power, transport time from the floors to staging areas will also be greatly increased. If the EPS fails, evacuation of all patients would have to be

conducted manually. ECH has sufficient evacuation equipment but not all staff has been trained in its use. Bed availability surveys have identified suitable beds for most of ECH's patients, most are more than one hour of travel away. EMC estimates that total evacuation times may exceed twice its planning assumptions. The EMC members have consulted with facilities management, nursing and dietary. They have concluded that despite the extreme conditions of the forecasted storm, the facility is secure, a stay team can be available and on hand supplies are sufficient to SIP. However, patients may need to be moved from rooms to alternate safe refuge zones, and it will need to initiate resource conservation and protection measures to basement and ground floor supplies immediately. It has no live experience with such procedures. Flooding to first floor electrical rooms may further impact loss of power. Water damage to linens on this level will make them unusable. ECH does not have an adequate supply of sand bags or inflatable bladders to adequately protect all these areas from water intrusion. It would need to obtain increased supplies before zero hour to accomplish this task.

ECH participates in a local mutual aid plan with other hospitals and nursing homes in EC and contiguous counties. Several are also in known hazard zones, some are not. External flooding, electrical utility power failure, road closures and staffing limitations may impact them similarly to ECH. Bed availability surveys have identified suitable beds for most of ECH's patients. Most are located outside the community, beyond planning assumption time frames and will require more than one hour of travel time one way, longer if road conditions vary. ECH has established facility policies and procedures to distribute supplies to all departments as needed. There is concern that flooding and water intrusion may damage some resources and/or increase the amount of handling and effort needed to distribute supplies, which will cause moderate disturbance in services to patients and staff. ECH anticipates that at some essential patient clinical services will be discontinued due to staffing gaps related to 30% of staff shortage. This includes some staff who man ICU, CCU, NICU and psychiatric units.

Flooding external to the facility will block access to the ED and main floor lobby, which will interfere with triage, admission and transfers. Non-essential tests, procedures, ambulatory testing and various therapy centers will be closed before zero hour and not resume service until travel conditions are safe. Visitor hours will follow the same schedule for all but critical cases. Many of ECH’s mutual aid partners in close proximity expect to be equally impacted by storm related flooding and limited supply of critical medical and non-medical supplies. Most all will be hampered by storm related damage to roads and travel conditions and will not able to assist with supplies or resources. Local OEM has advised ECH not to expect external support for at least two after the storm's end.

0.8	0.8	0.8	0.8	0.6	0.8	0.8	7.5	5.5	7.5	7.5	7.5	3.5	5.5	7.5	5.5	311	Prepare for Evacuation

Internal Flood – Situation Requiring a SIP/Evacuation Decision

ECH is located at the far edge of the 100 year inundation zone of A river. Rainfall and flooding from TS X is predicted to be greater than any in recent memory with rivers cresting above flood levels. ECH is 650 feet from and 15-20 feet above the usual water level. EC Office of Emergency Management has informed ECH that flood mapping suggests that River A flood waters will extend at least 500 – 600 feet beyond the river banks. Heavy rains over already water soaked grounds (swollen water table) will increase the likelihood of water intrusion (internal flooding) at any vulnerable access points and problem drainage areas, and may damage critical utilities and stores located on below and at grade including the main lobby and ED. ECH pre storm planning includes sand bagging and placing fillable bladders around these key areas to mitigate water intrusion ECH does not have an adequate supply of sand bags or inflatable bladders to adequately protect all these areas from water intrusion, will have to fill and construct these barriers, but does not have any experience as to the viability of this as a barrier against water intrusion. It would need to obtain increased supplies before zero hour to accomplish this task. The expected storm period is 18 – 24 hours, beginning at 3 pm Friday. Rivers are expected to crest on Sunday and recede to below flood levels by Tuesday. Water table levels should return to lower levels following the recession of flood waters. Internal facility flooding from the storm may result in damage to the physical plant, and damage or failure of HVAC and boilers. ECH has electronic and hard copy staff contact lists. On site staff will be retained and provided key support services, including family lodging, as applicable. Staffing may be limited due to external flooding and associated road closures. Internal flooding itself may cause burdens and or limit exist staff's abilities to manage patient care services but will not reduce staff census at work. ECH anticipates the ability to recover from the immediate effects of internal flooding within 1 – 2 days of the storms end. Some areas of the facility may not be available for full use, but the overall mission of the facility can be accomplished.

Key Facility Systems, Utilities and Resources

Fire and emergency lighting systems are currently unaffected and are connected to the emergency power system. Concern is related to possible water intrusion damage to these utilities. Security consists of internal and external rounds and closed circuit camera surveillance. Internal surveillance will be limited to the few cameras at key access points. Internal rounds will continue but may be limited by the # trained staff available. There are no locked wards. Increased security may be needed if areas of the facility remain off limits due to storm related damage and water intrusion. ECH has a history of water intrusion during heavy wind driven

rainfall, and intrusion at several vulnerable access points, including a large atrium window, problem drainage areas, and door frame gaps is expected. Most windows are rated for 60 mph winds, gusts may be higher and glass doors windows are otherwise unprotected from flying debris. All of this will cause or at least contribute to internal flooding. Key utilities and services, e.g., kitchen, refrigeration, cafeteria the ATS, mechanical rooms, boilers are at or below grade, are not protected by concrete block walls or sump pumps and are thus vulnerable to internal flooding. Pre storm planning includes relocating the cafeteria, and preparing some foods in advance. This has been practiced but not tested by a live event. ECH has tested all its communications systems and found them operable. Possible loss of power and weather conditions will likely effect at least cell service. ECH does not have a Telecommunications Service Priority contract on key lines.

Plans and Procedures for Patient Care, Staff Support, External Supplies

The EMC is weighing out the pros and cons of evacuation, availability of receiving facilities and shelter in place. Internal flooding may cause damage to the physical plant and immediate surroundings of the building that may force changes in internal evacuation routes and or access to and from staging areas. This would make the evacuation process more physically demanding and estimated to require about twice the time as in planning assumptions. The EMC members have consulted with facilities management, nursing and dietary. They have concluded that despite the extreme conditions of the forecasted storm, the facility is secure, a stay team can be available and on hand supplies are sufficient to SIP. However, patients may need to be moved from rooms to alternate safe refuge zones, and it will need to initiate resource conservation and protection measures to basement and ground floor supplies immediately. It has no live experience with such procedures. Facilities in neighboring counties impacted by the storm may face some of the same internal flooding problems as ECH. This will limit their ability to accept ECH patients even if they have suitable available beds and sufficient supply of other key resources. The EMC estimates that most patients will need to be placed in available beds over one hour travel time, outside its evacuation planning assumptions. ECH has established policies and procedures to conserve fuel, food and other resources, and to distribute on site supplies to all departments as needed. It has no experience with these procedures during a live event. There is concern that flooding and water intrusion may damage some resources and/or increase the amount of handling and effort needed to distribute supplies, which will cause moderate disturbance in services to patients and staff. ECH anticipates that will be able to maintain most all essential patient clinical services. Some basement and first floor services may need to be relocated, some areas of the facility may need to be closed due to wet or outright flooded floors. This will cause delays and re-routing in the emergency department, processing patient admissions and discharges, some radiology functions and some food services. Most of ECH's nearby mutual aid partners will be in the storm related hazard zone, a few will not. ECH

has communicated with many of these facilities, who express concern with their own ability to protect their critical infrastructure, supplies and resources during the storm, as they too may experience damage from internal flooding. They report that they may not be able to provide support if they sustain damages.

0.8	0.8	0.8	0.8	0.6	0.8	0.8	7.5	5.5	3.5	7.5	7.5	3.5	5.5	3.5	5.5	267	Prepare for Evacuation

Scenario VI: Hurricane – Overview of Incident

Thursday, June 21: 1000 am. The emergency management committee (EMC) of Empire County Hospital (ECH) has been following the National Weather Service (NWS) updates **on TS X** beginning with its naming as the first hurricane of the season on **Monday June 18**, with maximum sustained winds of 85 mph (140 km/hr). The storm track included landfall near Panama City, Florida with winds of 75 mph (120 km/h), and subsequent weakening to a tropical storm then a tropical depression by Wednesday June 20. Present time weather briefing reports indicate that the tropical depression unexpectedly re-strengthened into a tropical storm (TS) and has once again emerged into the Atlantic Ocean near Nags Head, North Carolina. **TS "X"** is now predicted to make landfall near NYC **with sustained winds of 65 mph/100km/h on June 22.** Coastal storm surge of less than 4 feet (SLOSH 1) is predicted. In the Big Valley region (75 miles north-west of NYC)**, 6 – 10 inches of rain** is predicted. A weak low sitting off the east coast may slow the storm's exit, increase rainfall totals and cause flooding well above previous 100 year base elevations. **Zero hour** (time when winds reach > 39mph) for the Big Valley area is predicted **to be between 3 – 7 pm, Friday June 22.** Local emergency management and health department briefing have emphasized that travel after zero hour may not be safe and will be restricted. There are no mandatory evacuation orders at this time. The A river, and its tributaries converge in the southern area of Big Valley.

- ECNH has established baseline Evacuation Decision Support Tool (EDST) scores as part of pre incident planning in conjunction with its yearly hazard vulnerability assessment (HVA). The emergency management committee (EMC) has concerns about ECH's ability to maintain a safe environment of care for its patients during the storm. This situation is high on its hazard vulnerability assessment. It is considering two possible situations that may develop, external flooding and internal flooding.
- To assist in its planning and response to the incident, the EMC has developed an overview of the storms possible impact on ECH. The evaluation is based on the detailed

inventories of key systems, utilities and resources, and plans and procedures for patient care, staff support and anticipated community support during the incident. What follows is a summary of the evaluation as discussed by the EMC, including consideration of OEM and DOH situations reports and baseline bed availability data as of June 21, 2012

External Flood – Situation Requiring a SIP/Evacuation Decision

ECH is located at the far edge of the 100 year inundation zone of A river. Rainfall and flooding from TS X is predicted to be greater than any in recent memory with rivers cresting above flood levels. ECH is 650 feet from and 15-20 feet above the usual water level. EC Office of Emergency Management has informed ECH that flood mapping suggests that River A flood waters will extend at least 400 – 500 feet beyond the river banks. Heavy rains over already water soaked grounds may increase the impact of external flooding and the likelihood of water intrusion at any vulnerable access points and problem drainage areas. The emergency generator system is located outside at grade, protected from wind but not water intrusion. ECH pre storm planning includes use of on-site sand bags and fillable bladders as a barrier around the generator should flood waters rise to this area. This has been practiced but not tested by a live event. The expected storm period is 18 – 24 hours, beginning at 3 pm Friday. Rivers are expected to crest on Sunday and recede to below flood levels by Tuesday. The EMC is operating on a projected time frame of at least four days. The storm may cause other problems to develop including loss of the emergency generator, internal flooding and loss of internal utilities. ECH has electronic and hard copy staff contact lists. On site staff will be retained and provided key support services, including limited family lodging, as applicable. Human resources department expects that up to 20% of staff may not be able to reach the facility due to local road conditions and/or will be unavailable as they are managing their own family and home safety and security. Storm related rainfall and winds will cause damage and disruption of community infrastructure and usual supply chains. ECH anticipates the ability to recover from the external flooding to be within 3-4 days after the storm's end.

Key Facility Systems, Utilities and Resources

ECH life safety systems are currently unaffected. All are connected to the emergency power system (EPS). Concern is related to possible water intrusion damage to these utilities. Staff monitoring of life safety systems will be increased during the storm. Security consists of internal and external rounds and closed circuit camera surveillance. External rounds will be discontinued as the storm nears and during the actual storm period and will resume when conditions permit. Increased security may be needed if areas around the building are off limits due to storm related damage or other hazardous conditions. ECH has a history of water intrusion during heavy wind driven rainfall and some intrusion at several vulnerable access points, problem drainage areas, and door frame gaps is expected. The atrium window is a weak

point. Key utilities are located at and or below grade and are not protected by concrete walls, waterproof doors or pumps. Most windows are rated for 60 mph winds, gusts may be higher and glass doors windows are otherwise unprotected from flying debris. . ECH has adequate resources and supplies of food, fluids, linens, medications and personal supplies for 72 hours. The generator runs off a 4,000 gallon diesel fuel tank which is currently full. The emergency power system is not divided into separate critical and non-essential zones. Only 3 of its 6 elevators, some pumps and cooking functions are connected to emergency power. If regular power fails, most or all non-essential circuits will have power reduced and the emergency generator will need constant monitoring and protection from external flooding. The facility does not have external docking or a suitable above grade level location to accept another external generator. ECH has tested all its communications systems and found them operable. Possible loss of power and weather conditions will likely effect at least cell service. ECH does not have a Telecommunications Service Priority contract on key lines.

Plans and Procedures for Patient Care, Staff Support, External Supplies

The EMC is weighing out the pros and cons of evacuation, availability of receiving facilities and shelter in place. Only 3 of its 6 elevators are tied to the emergency power system. It has some evacuation equipment but not all its staff have received training in its use. If evacuation is conducted while on emergency power, patient transport from the floors to staging areas will require more effort and as estimated by the EMC, about twice the time as in planning assumptions. ECH's nearby mutual aid partners are likely to be similarly impacted by TS X. Those more distant are predicted to experience a relatively mild storm with less severe external flooding, electrical utility power failure, road closures and resultant staffing limitations. Bed availability surveys have identified suitable beds for most of ECH's patients well within its planning assumption of 30 – 60 minutes travel time. The EMC members have consulted with facilities management, nursing and dietary. They have concluded that the facility is secure, a stay team can be available and on hand supplies are sufficient to SIP. However, patients may need to be moved from rooms to alternate safe refuge zones, and it will need to initiate resource conservation and protection measures to basement and ground floor supplies immediately. It has no live experience with such procedures. It has established facility policies and procedures to distribute supplies to all departments as needed. There is concern that flooding and water intrusion may damage some resources and/or increase the amount of handling and effort needed to distribute supplies, which will cause moderate disturbance in non-essential services to patients and staff. ECH anticipates that up to 20% of staff, including who man ICU, CCU, NICU and psychiatric units will not be present to work. This will disrupt and at least delay some patient services. Flooding external to the facility will block access to the ED and main floor lobby, which will interfere with triage, admission and transfers. Non-essential tests, procedures, ambulatory testing and various therapy centers will be closed before zero

hour and not resume service until travel conditions are safe. Visitor hours will follow the same schedule for all but critical cases. The EMC has concerns about limited external supply of resources due to storm conditions throughout the region. It has requested some pre storm assets, including fuel, from its vendors, and more distant mutual aid partners without success. They and local OEM have advised ECH that they cannot release supplies at this time and to expect this to continue for at least a 1-2 days after the storm's end.

0.6	0.8	0.6	0.6	0.6	0.6	0.6	3.5	3.5	5.5	5.5	5.5	3.5	5.5	7.5	5.5	200	Prepare for Evacuation

Internal Flood – Situation Requiring a SIP/Evacuation Decision

ECH is located at the far edge of the 100 year inundation zone of A river. Rainfall and flooding from TS X is predicted to be greater than any in recent memory with rivers cresting above flood levels. ECH is 650 feet from and 15-20 feet above the usual water level. EC Office of Emergency Management has informed ECH that flood mapping suggests that River A flood waters will extend at least 400 – 500 feet beyond the river banks. Heavy rains over already water soaked grounds may increase the impact of overall flooding and the likelihood of water intrusion (internal flooding) at any vulnerable access points and problem drainage areas, and may damage critical utilities and stores which are at or below grade but are not protected by concrete block walls or sump pumps. This includes the main lobby and ED. ECH pre storm planning includes sand bagging and placing fillable bladders around these key areas to mitigate water intrusion. This has been practiced but not tested by a live event. The expected storm period is 18 – 24 hours, beginning at 3 pm Friday. Rivers are expected to crest on Sunday and recede to below flood levels by Tuesday. Water table levels should return to lower levels following the recession of flood waters. Internal facility flooding from the storm may result in damage to the physical plant, and damage or failure of HVAC and boilers. ECH has electronic and hard copy staff contact lists. On site staff will be retained and provided key support services, including family lodging, as applicable. Staffing may be limited due to external flooding and associated road closures. Internal flooding itself may cause burdens and or limit exist staff's abilities to manage patient care services but will not reduce staff census at work. ECH anticipates the ability to recover from the immediate effects of internal flooding within 1 – 2 days of the storms end. Some areas of the facility may not be available for full use, but the overall mission of the facility can be accomplished.

Key Facility Systems, Utilities and Resources

Fire and emergency lighting systems are currently un affected and are connected to the emergency power system. Concern is related to possible water intrusion damage to these

utilities. Security consists of internal and external rounds and closed circuit camera surveillance. Internal surveillance will be limited to the few cameras at key access points. Internal rounds will continue but may be limited by the # trained staff available. There are no locked wards. Increased security may be needed if areas of the facility remain off limits due to storm related damage and water intrusion. ECH has a history of water intrusion during heavy wind driven rainfall, and intrusion at several vulnerable access points, including a large atrium window, problem drainage areas, and door frame gaps is expected. Most windows are rated for 60 mph winds, gusts may be higher and glass doors windows are otherwise unprotected from flying debris. All of this will cause or at least contribute to internal flooding. Key utilities and services, e.g., kitchen, refrigeration, cafeteria the ATS, mechanical rooms, boilers are at or below grade, are not protected by concrete block walls or sump pumps and are thus vulnerable to internal flooding. Pre storm planning includes relocating the cafeteria, and preparing some foods in advance. This has been practiced but not tested by a live event. ECH has tested all its communications systems and found them operable. Possible loss of power and weather conditions will likely effect at least cell service. ECH does not have a Telecommunications Service Priority contract on key lines.

Plans and Procedures for Patient Care, Staff Support, External Supplies

The EMC is weighing out the pros and cons of evacuation, availability of receiving facilities and shelter in place. Internal flooding may cause damage to the physical plant and immediate surroundings of the building that may force changes in internal evacuation routes and or access to and from staging areas. This would make the evacuation process more physically demanding and it is estimated requiring about twice the time as in planning assumptions. Key utilities and services are at or below grade and unprotected. If impacted by internal flooding, ECH's ability to SIP will be compromised, even with sufficient supply of other key resources. Facilities in neighboring counties impacted by the storm may face some of the same internal flooding problems as ECH. This will limit their ability to accept ECH patients even if they have suitable available beds and sufficient supply of other key resources. The EMC estimates that most patients can be placed in available beds within its planning assumptions of about 30-60 minutes travel time. ECH has established policies and procedures to conserve fuel, food and other resources, and to distribute on site supplies to all departments as needed. It has no experience with these procedures during a live event. There is concern that flooding and water intrusion may damage some resources and/or increase the amount of handling and effort needed to distribute supplies, which will cause moderate disturbance in non-essential services to patients and staff. ECH anticipates that will be able to maintain most all essential patient clinical services. Some basement and first floor services may need to be relocated, some areas of the facility may need to be closed due to wet or outright flooded floors. This will cause delays and re-routing in the emergency department, processing patient admissions and discharges, some

radiology functions and some food services. Patients may need to be moved to other location/rooms in the facility that are not located on outside walls or have unprotected glass windows. ECH participates in a local mutual aid plan with other hospitals and nursing homes in EC and contiguous counties. Most of these facilities will be in the storm related hazard zone, a few will not. ECH has communicated with many of these facilities, who express concern with their own ability to protect their critical infrastructure, supplies and resources during the storm, as they too may experience damage from internal flooding. They report that they may not be able to provide support if they sustain damages.

0.6	0.6	0.6	0.6	0.6	0.6	0.6	3.5	3.5	3.5	5.5	5.5	3.5	5.5	3.5	5.5	166	Shelter in Place