METEOROLOGICAL ASPECTS OF EMERGENCY ACTION LEVEL SCHEMES: NUREG-0654 VERSUS NUMARC-007

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by

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1.0 Introduction

Nuclear power reactor licensees are required to have NRC-approved emergency response plans for dealing with radiological emergencies pursuant to Section 50.47 of Title 10 of the Code of Federal Regulations (10 CFR 50.47). The intent of these emergency plans is to provide reasonable assurance that adequate protective measures can and will be taken in the event of a radiological emergency.

As a result of the Three Mile Island accident in March 1979, the U.S. Nuclear Regulatory Commission (NRC) amended its emergency plan requirements for nuclear power plants to include criteria for developing Emergency Action Levels (EALs). These EALs were intended to provide criteria for use in determining the need for notification and participation of offsite agencies and for determining when and what type of protective measures should be considered. Guidance on acceptable methods for developing EALs was published jointly in November 1980 by the NRC and the Federal Emergency Management Agency (FEMA) as Appendix 1 of Revision 1 to NUREG-0654[1]. The criteria and recommendations contained in NUREG-0654 were considered by the NRC to be the generally acceptable methods for complying with the emergency response plan standards listed in 10 CFR 50.47 as discussed in Revision 1 to Regulatory Guide 1.101[2].

In 1988, the National Environmental Studies Project (NESP) within the Atomic Industrial Forum (AIF) formed a task force for the purpose of re-evaluating the EAL guidelines

provided in NUREG-0654, based on years of industry experience in developing and using EALs. AIF was eventually dissolved into several components, including the Nuclear Management and Resources Council (NUMARC). The task force continued its work under the auspices of NUMARC (which has since been incorporated into the Nuclear Energy Institute) and subsequently published a generic set of EAL guidelines in January 1992 as Revision 2 to NUMARC-007[3]. Soon thereafter, NUMARC-007 was endorsed by the NRC as an acceptable alternative method for developing EALs by issuing Revision 2 to Regulatory Guide 1.101[4] in August 1992 .

The intent of this paper is to compare and analyze the differences in meteorological-related EAL guidelines presented in NUREG-0654 and NUMARC-007. Meteorology plays an important role in both the NUREG-0654 and NUMARC-007 EAL guidance documents in that: (1) certain weather phenomena (such as hurricanes and tornadoes) have the potential to adversely impact plant safety structures; and (2) meteorological conditions affect the location and magnitude of offsite doses resulting from any airborne radiological releases.

2.0 Development of the NUMARC-007 EALs

The majority of the EAL guidance criteria presented in Appendix 1 of Revision 1 to NUREG-0654 were initially issued for interim use and comment six months after the March 1979 accident at Three Mile Island as NUREG-0610[5]. The NUREG-0610 EAL guidelines were, with some changes, incorporated 14 months later into Revision 1 of NUREG-0654 as Appendix 1. Although these criteria were a good starting point, the nuclear industry felt nearly ten years later that it was able to identify a number of improvements based on experience in using the existing guidelines during annual emergency preparedness exercises and under actual emergency conditions.

A task force was subsequently formed by AIF (and continued by NUMARC after the breakup of AIF) to re-evaluate the NUREG-0654 EAL guidelines. The task force consisted of individuals from various U.S. utilities and liaisons were established with the NRC, FEMA, and the Institute of Nuclear Power Operations (INPO). The task force conducted a

review of the regulatory basis for the current NUREG-0654 EAL structure, analyzed EALs implemented at a number of plant sites, and determined the strengths and weakness of the current EAL approaches. As a result of these efforts, the task force was able to define a methodology for revising the EAL guidelines. A synopsis of their efforts follows.

1. NUREG-0654 EAL Guidelines

The task force reviewed the relevant NRC regulations, the NUREG-0654 EAL guidance criteria, and the implementation of EALs at several plant sites. They found that:

- There was ambiguous wording in the regulations and guidelines (including a lack of terminology definitions) which made interpretation difficult;
- There were inconsistencies among the various example initiating conditions which defined a particular emergency class; and
- Actual emergency situations had occurred which were not contemplated when the guidelines were written.

As a result, the task force discovered that existing EAL guidelines had been interpreted inconsistently, and broad variations existed in the way the guidelines had been applied by various plants. Consequently, the task force concluded that a revised set of EAL guidelines should be developed using a more systematic approach which included defining several technical terms, establishing characteristics for the EALs, enhancing the emergency class definitions, and developing emergency class thresholds.

2. Definitions

Based on a review of regulations, published guidance documents, and common usage, the task force offered the following descriptions for several commonly used EAL terms:

- Emergency Class: a grouping of off-normal nuclear power plant conditions according to: (1) their relative radiological seriousness; and (2) the time-sensitive onsite and

offsite radiological emergency preparedness actions necessary to respond to such conditions. Section C of 10 CFR 50 Appendix E defines four emergency classes: Notification of Unusual Event (Unusual Event), Alert, Site Area Emergency, and General Emergency.

- Initiating Condition (IC): a nuclear power plant condition where a radiological emergency has the potential to exist or has already occurred. Examples of an IC include a continuous measurable parameter outside of Technical Specifications (such as an elevated RCS temperature or decreasing reactor coolant level), an event (such as a fire), or a fission product barrier breach.

- Emergency Action Level (EAL): an event or phenomenon which indicates an Initiating Condition and entry into a particular Emergency Class. An EAL can be a specific instrument reading, an equipment status indication, a measured parameter value, or an observable event.

According to the task force, the following paragraph from NUREG-0818[6] reflects the proper use of these three terms:

"The Nuclear Regulatory Commission (NRC) has established four classes of emergencies. They are, in order of increasing seriousness: notification of unusual event, alert, site area emergency, and general emergency. Appendix 1 of an NRC document, NUREG-0654 Rev. 1, provides example initiating conditions for each of the four emergency classes. These initiating conditions form the basis for the establishment by each licensee of specific plant instrument readings which, if exceeded, would indicate that a given initiating condition had been met and that the appropriate class of emergency must be declared. The plant-specific instrument readings are called emergency action levels (EALs). Their purpose is to provide a clear basis for the rapid identification of a possible problem and for the notification of offsite authorities that an emergency exists."

3. EAL Characteristics

As a result of their findings, the task force concluded that model EALs should reflect certain characteristics, including consistency, human engineering/user friendliness, completeness, accuracy, and objectivity. The most pervasive and complex characteristic was consistency, which meant similar circumstances at different plants should lead to similar decisions. Consistency also meant assuring that all the EALs which trigger an emergency class were in the same range of relative risk. This required a clear description of each emergency class so that risk assessments could be used to set emergency class boundaries (or thresholds).

4. Emergency Class Descriptions

The four classes of emergencies specified by the NRC are intended to group off-normal plant conditions according to their relative radiological seriousness and the time-sensitive onsite and offsite radiological emergency preparedness actions necessary to respond to such conditions. The task force concluded that in order to properly implement the four emergency classifications, off-normal plant conditions should be evaluated against the following three criteria: (1) the plant status with respect to its predefined design, safety, and operating envelopes; (2) the potential impact on radiological safety; and (3) the health threat beyond the site boundary. These criteria were then used by the task force to clarify the original NUREG-0654 emergency class descriptions as follows:

- Notification of Unusual Event (Unusual Event): Unusual events are in process or have occurred which indicate a potential degradation of the level of safety of the plant. Minor releases of radioactive materials are included but do not require monitoring or offsite response (i.e., dose consequences are less than 10 mrem).

  The purpose of the Unusual Event classification is to: (1) assure that the first step in any response later found to be necessary has been carried out; (2) bring the operating staff to a state of readiness; and (3) provide systematic handling of unusual event information and decision making.

- Alert: Events are in progress or have occurred which involve an actual or potential substantial degradation of the level of safety of the plant. Dose consequences are expected to be small fractions of the EPA Protective Action Guideline (PAG) plume exposure levels (i.e., about 10 to 100 mrem).

  The purpose of the Alert classification is to: (1) assure that emergency personnel are readily available to respond if the situation becomes more serious or to perform confirmatory radiation monitoring if required;[1] and (2) provide offsite authorities current status information.

- Site Area Emergency: Events are in process or have occurred which involve actual or likely major failures of plant functions needed for protection of the public. Any releases are not expected to result in exposure levels which exceed EPA PAG plume exposure levels except near the site boundary.

  The purpose of the Site Area Emergency classification is to: (1) assure that response centers are staffed; (2) assure that monitoring teams are dispatched; (3) assure that personnel required for evacuation of near-site areas are at duty stations if the situation becomes more serious; (4) provide consultation with offsite authorities; and (5) provide updates for the public through offsite authorities.

- General Emergency: Events are in progress or have occurred which involve actual or imminent substantial core degradation or melting with potential for loss of containment integrity. Releases can be reasonably expected to exceed EPA PAG plume exposure levels offsite for more than the immediate site area.

  The purpose of the General Emergency classification is to: (1) initiate predetermined protective actions for the public; (2) provide continuous assessment of information

[1]Note that an Alert is typically the lowest emergency classification for which the Technical Support Center (TSC) and Operations Support Center (OSC) are activated.

from licensee and offsite organization measurements; (3) initiate additional measures as indicated by actual or potential releases; (4) provide consultation with offsite authorities; and (5) provide updates for the public through offsite authorities.

The task force considered these emergency class descriptions important in setting emergency class thresholds and avoiding ambiguities in forming appropriate IC and EAL guidelines.

5. Emergency Class Thresholds

Once the descriptions of each emergency class were established, risk assessments were used to set the emergency class thresholds to assure that all the EALs triggering an emergency class would be in the same range of relative risk. The task force was also concerned about defining a clear threshold between the lowest emergency classification (i.e., Unusual Event) and the 10 CFR 50.72 "non-emergency" notifications (i.e., the one-hour and four-hour reports) since even occurrences of the lowest emergency classifications are often reported as "nuclear accidents" by industry watchdogs.

For Unusual Events, the potential degradation of the level of plant safety is indicated primarily by exceeding plant Technical Specification Limiting Conditions of Operation (LCOs) and Action Statement Times. In the case of Alerts, the potential substantial degradation of the level of plant safety means that increased monitoring of plant functions is warranted. The primary intent of an Alert is to address the operations staff's need for additional help so the increased monitoring can be used to better determine the actual plant safety state (e.g., establishing whether escalation to a higher emergency class or de-escalation to a lower emergency class is warranted).

The threshold between Site Area Emergency and General Emergency is whether or not EPA PAG plume exposure levels are expected to be exceeded outside the site boundary. Subsequently, the General Emergency thresholds are primarily expressed in terms of plant function status (as opposed to dose projections) to better assure timely notification for the purposes of either sheltering or evacuating the general public.

6. NUMARC-007 EAL Guidance

The task force concluded its effort by publishing a set of generic IC and corresponding EAL guidance criteria in NUMARC-007. The resulting EAL guidelines are not intended to be applied as-is; rather, the EAL guidelines are intended to provide the logic for developing site-specific EALs based on plant-specific design and instrument readouts.

The NUMARC ICs and example EALs are presented as a function of the following four Recognition Categories:

A - Abnormal Rad Levels/Radiological Effluent
F - Fission Product Barrier Degradation
H - Hazards and other Conditions Affecting Plant Safety
S - System Malfunction

NUMARC-007 also provides a list of ICs for each of the four emergency classes and example EALs for each of the ICs. The basis for each IC and example EAL is also furnished in order to aid plant personnel in preparing site-specific EALs and provide information for training purposes and for explanation to state and local officials.

The NUMARC EAL guidelines have the primary threshold for Unusual Events as operation outside the safety envelope for the plant as defined by plant Technical Specifications, including Limiting Conditions of Operation (LCOs) and Action Statement Times. In addition, certain precursors of more serious events such as the loss of offsite AC power and earthquakes are included in Unusual Event EALs. A number of Alert EALs are chosen for situations requiring increased monitoring of the plant, such as the occurrence of events which could damage plant safety systems (such as tornadoes or fires in plant vital areas) or require additional help (such as Control Room evacuation). Damage resulting from such hazards would be the basis for escalation to a higher emergency class.

Site Area Emergency and General Emergency EALs are based primarily on the extent and severity of fission product barrier challenges, based on plant conditions as presently known or as can be reasonably projected. Radiological EALs are also provided to address those events for which fission product barrier challenges are not relevant (e.g., spent fuel pool accidents and ruptured waste gas tanks) and to address event sequences where an escalation path based on plant conditions could not be identified. These events, while not constituting core melt sequences, could still result in site boundary doses approaching EPA PAG plume exposure levels.

3.0 Meteorological-Related ICs and Example EALs

If the IC Recognition Category classification scheme developed by the NUMARC task force is used to group both the NUREG-0654 and NUMARC-007 meteorological-related ICs, then meteorological-related ICs and example EALs are found in three of the four NUMARC-007 Recognition Categories: A (Abnormal Rad Levels/Radiological Effluent), H (Hazards and Other Conditions Affecting Plant Safety), and S (System Malfunction). These meteorological-related ICs and EALs are listed as a function of Recognition Category in Exhibits 1 through 3. The intent of this section is to compare the differences in the meteorological-related ICs and EALs presented in NUREG-0654 and NUMARC-007 based on the NUMARC task force criteria for generating EALs.

1. **Abnormal Rad Levels/Radiological Effluent ICs and Example EALs**

   The meteorological-related NUREG-0654 and NUMARC-007 ICs and example EALs belonging to the Abnormal Rad Levels/Radiological Effluent Recognition Category are listed in Exhibit 1.

   The NUREG-0654 Unusual Event and Alert meteorological-related ICs for this recognition category involve releases which: (1) exceed plant Radiological Effluent Technical Specifications (RETS) limits for Unusual Events; or (2) exceed 10 times RETS limits for Alerts. The corresponding NUMARC-007 ICs appear to be less restrictive; an unplanned radioactive gaseous release exceeding two times RETS for 60 minutes or

longer is an IC for an Unusual Event and an unplanned radioactive gaseous release exceeding 200 times RETS for 15 minutes or longer is an IC for an Alert. The basis for the corresponding NUMARC-007 EALs implies that the RETS 500 mrem/yr whole body site boundary dose limit from noble gas releases is the benchmark used to implement these ICs.[2]

The intent of the NUMARC-007 Unusual Event and Alert ICs is to identify circumstances representing an uncontrolled situation and, therefore, a potential degradation in the level of safety of the plant. The final integrated doses (which should be at least two orders of magnitude below the EPA PAG plume exposure levels) are not important for these emergency classifications; what is important is the fact that releases are continuing unchecked for a specific period of time.

The implementation of the 500 mrem/yr dose limit EALs is simplified by another RETS criteria which requires radiological effluent monitors with alarm/trip setpoints set to identify whenever dose rates at any time at and beyond the Site Boundary from noble gas effluents exceed the 500 mrem/yr dose limit. These setpoints are typically established within each plant's Offsite Dose Calculation Manual (ODCM) by determining the release rate (in terms of μCi/sec) which, if persisted throughout the year, would result in a dose of 500 mrem at the offsite location (i.e., critical receptor) with the highest historical annual average atmospheric dispersion (X/Q) factor.

The example EALs for both the NUMARC-007 Unusual Event and Alert ICs include the requirement to "assess" a release if a valid effluent monitor reading exceeds a specified threshold representing a release rate exceeding either 2 times RETS limits (for an Unusual Event) or 200 times RETS limits (for an Alert). The required assessment

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[2]This 500 mrem/yr whole body dose limit is derived from Section 20.106 of the "old" 10 CFR 20. It has subsequently been replaced by a 100 mrem/yr Total Effective Dose Equivalent (TEDE) limit pursuant to Section 20.1301 of the "new" 10 CFR 20 promulgated in May 1991. However, the NRC has allowed licensees to maintain the 500 mrem/yr limit (which is expressed as an instantaneous release rate) as part of their RETS on the basis that several other RETS limits are already more restrictive than the 100 mrem/yr TEDE limit.

includes performing a dose projection using a X/Q based on actual meteorology occurring during the release. The intent is to ensure that "the X/Q based on actual meteorology is not significantly more adverse than the annual average X/Q used to establish the monitor EALs"[7].[3] Two additional NUMARC-007 EALs for the Unusual Event and Alert ICs include a valid reading on a perimeter radiation monitoring system (if available) or a valid indication on an automatic dose assessment system (if available) exceeding specified levels for a specified time period (i.e., for an Unusual Event, 0.10 mrem/hr above normal background for longer than 60 minutes, and for an Alert, 10 mrem/hr for longer than 15 minutes).[4]

In contrast to the Unusual Event and Alert ICs which are a function of RETS release rate limits, the NUREG-0654 and NUMARC-007 Site Area Emergency and General Emergency ICs are a function of actual or imminent offsite doses. In particular, the NUMARC IC for a Site Area Emergency is based on actual or imminent offsite doses exceeding 100 mrem whole body or 500 mrem child thyroid for the actual or projected duration of the release; the NUMARC IC for a General Emergency is based on actual or

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[3]Note that, by definition, actual (i.e., hourly) X/Qs will generally be higher than the annual average X/Qs used to establish the monitor EALs because the monitor EAL annual average X/Qs are normalized by the percent of time the wind blows towards the ODCM's critical receptor.

[4]This author believes the 0.10 mrem/hr Unusual Event EAL dose rate threshold is too low and could result in an Unusual Event classification while still within RETS release rate limits. The 0.1 mrem/hr EAL threshold was derived by dividing the 500 mrem/yr RETS dose limit by 8760 hours/yr and then multiplying by two:

$$2\left(\frac{500\ mrem}{yr}\right)\left(\frac{yr}{8760\ hr}\right) \approx 0.1\ mrem/hr$$

This computation assumes that the 500 mrem/yr RETS criteria occurs continuously at the critical (maximum offsite) receptor identified in the ODCM at an average rate of approximately 0.05 mrem/hr (i.e., at half the Unusual Event dose rate threshold of 0.1 mrem/yr). In reality, wind direction constantly changes throughout the year and is typically assigned hourly to one of sixteen direction sectors. Assuming the critical offsite receptor is in the prevalent downwind sector and the wind blows towards this prevalent downwind sector approximately 20% of the time (e.g., ~2000 hr/yr), the actual site boundary dose rate could average around 0.25 mrem/hr throughout the year without exceeding the calculated 500 mrem/yr RETS limit at the critical receptor; yet, the 0.10 mrem/hr Unusual Event dose rate threshold would be exceeded if one were to take a measurement.

imminent offsite dose rates exceeding 1000 mrem whole body or 5000 mrem child thyroid for the actual or projected duration of the release. Note that these IC threshold dose limits are 0.1 and 1.0 times the lower range of the EPA-520[8] PAG plume exposure levels, respectively.[5] As with the Unusual Event and Alert example EALs, the Site Area Emergency and General Emergency example EALs consists of: (1) valid effluent monitor readings exceeding predetermined thresholds followed by assessments using actual meteorology; and (2) valid perimeter radiation monitor system readings or field survey results exceeding specified levels for a specified duration.

2. Hazards and Other Conditions Affecting Plant Safety ICs and Example EALs

The meteorological-related NUREG-0654 and NUMARC-007 ICs and example EALs belonging to the Hazards and Other Conditions Affecting Plant Safety Recognition Category are listed in Exhibit 2.

Both NUREG-0654 and NUMARC-007 list the occurrence of a tornado as an Unusual Event EAL, with the relevant strike zones being the plant site versus the plant protected area, respectively. The NUMARC-007 Unusual Event is based on the assumption that a tornado touching down within the protected area has the potential to damage plant structures containing functions or systems required for safe shutdown of the plant. Both NUREG-0654 and NUMARC-007 also consider the occurrence of such phenomena as hurricanes, floods, and sieches as an Unusual Event. The basis for this NUMARC-007 EAL states that sites subject to severe weather-induced station blackouts may need to include additional EALs based on the activation of severe weather mitigation procedures (such as precautionary shutdowns, diesel testing, and staff callouts).

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[5]The EPA Protective Action Guidelines (PAGs) referenced by NUMARC-007 are the 1 to 5 rem projected whole body gamma dose and 5 to 25 rem projected thyroid dose values presented in Chapter 2 of EPA-520[8]. The EPA has subsequently revised these values per EPA-400[9] with a 1 to 5 rem projected sum of the Effective Dose Equivalent (EDE) resulting from exposure to external sources and the Committed Effective Dose Equivalent (CEDE) incurred from all significant inhalation pathways. Note that the NRC has "pre-approved" the substitution of Total Effective Dose Equivalent (TEDE) and Committed Dose Equivalent (CDE) values for the NUMARC whole body and child thyroid EAL criteria, respectively.

NUMARC-007 lists the occurrence of a tornado or high winds greater than FSAR design basis striking plant vital areas as an Alert EAL, while NUREG-0654 listed the occurrence of a tornado or high winds near design basis and exceeding design basis as Alert and Site Area Emergency EALs, respectively. The NUMARC-007 Alert EAL addresses an event that may have resulted in a plant vital area being subjected to forces beyond design limits. However, unlike the NUREG-0654 EAL classification scheme which results in a Site Area Emergency whenever winds exceed design levels, the NUMARC-007 EAL classification scheme will not escalate beyond an Alert unless actual damage has occurred to plant safety systems resulting in a system malfunction, fission product barrier degradation, or abnormal rad releases/radiological effluent EAL being met.[6]

3. **System Malfunction ICs and Example EALs**

The meteorological-related NUREG-0654 and NUMARC-007 ICs and example EALs belonging to the System Malfunction Recognition Category are listed in Exhibit 3.

NUREG-0654 contains only one meteorological-related System Malfunction IC; it is listed under the Unusual Event emergency classification as the loss of indications or alarms on process or effluent parameters in the Control Room to the extent requiring plant shutdown or other significant loss of assessment or communication capability. The loss of all meteorological instrumentation is then listed as an example EAL. In contrast, NUMARC-007 contains no meteorological-related System Malfunction ICs.

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[6]Both the NUREG-0654 and NUMARC-007 EAL schemes could be interpreted to imply that the onsite meteorological monitoring systems should be used to determine if onsite wind speeds have exceeded the plant design basis wind speed. However, in some situations, this may not be practical, especially if the plant design basis wind speed is higher than the upper limit of the wind speed channels or exceeds the design basis of the meteorological tower or the wind speed instrumentation. As such, the NUMARC-007 Q&A document[7] states that onsite meteorological monitoring systems should not be used to assess hurricane and tornado strength for emergency classification purposes. According to the NUMARC-007 Q&A document, the hurricane wind speed data used for emergency classification purposes should be the estimated sustained winds provided by the National Weather Service or hurricane warning indication. For tornadoes or other high wind conditions, visible structural damage to plant safety structures would be prima facie evidence of winds exceeding design basis.

The loss of all meteorological instrumentation was probably included in NUREG-0654 as an example Unusual Event EAL because site meteorological information is needed to generate atmospheric effluent transport and diffusion estimates during radiological releases,[7] and these estimates are considered necessary to provide reasonable assurance that adequate protective measures could and would be taken in the event of a radiological emergency[8]. Subsequently, Appendix 2 to NUREG-0654 provided guidelines for meteorological monitoring systems supporting emergency preparedness activities, and the NRC revised Regulatory Guide 1.97[10,11] to include wind speed, wind direction, and atmospheric stability as variables to be monitored in the Control Room during accident situations.

Nonetheless, the loss of all meteorological instrumentation was not included as an example EAL by the NUMARC task force because the loss of all meteorological instrumentation does not meet the task force's threshold for Unusual Events: operation outside the safety envelope for the plant as defined by plant Technical Specifications. The first set of Standard Technical Specifications published by the NRC (i.e., NUREG-0103, NUREG-0123, NUREG-0212, and NUREG-0452) did contain a Limiting Condition for Operation (LCO) requiring wind speed, wind direction, and temperature difference (delta-T) channels be operable at all times. However, a more recent set of draft Standard Technical Specifications (i.e., NUREG-1430 through NUREG-1434) have deleted the meteorological monitoring LCO requirements based on the Technical Specification Improvement Program criteria issued by the NRC in February 1987 (52 FR 3788). According to the NRC Technical Specification Improvement Program criteria, plant Technical Specifications should include only those regulatory requirements and operating restrictions involving maintaining the integrity of the physical barriers

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[7]10 CFR 50.47 requires that emergency plans provide "(A)dequate methods, systems, and equipment for assessing and monitoring actual or potential offsite consequences of a radiological emergency condition ...".

[8]Appendix E to 10 CFR 50 states that emergency facilities and equipment shall include "(E)quipment for determining the magnitude of and for continuously assessing the impact of the release of radioactive materials to the environment."

designed to contain radioactivity. Although site meteorological data may be important in assessing the offsite dose consequences of a radiological release, meteorological monitoring systems do not detect abnormal plant conditions and, therefore, are not directly related to maintaining fission product barriers.

Note that Revision 3 to NRC Regulatory Guide 1.01[4] specifically states that licensees cannot combine portions of NUREG-0654 and NUMARC-007 in developing EAL schemes. However, the NRC has recently issued a Branch Position on acceptable deviations from Appendix 1 to NUREG-0654[13] which now allows licensees to utilize the technical bases for the example NUMARC-007 EALs to enhance and clarify site-specific EALs developed using NUREG-0654 guidelines. One example permissible change listed in the Branch Position is the removal of the loss of all meteorological instrumentation as an example EAL. The basis given for this change is a shift in emphasis from classification based on dose assessment to classification based on plant conditions. As such, licensees can remove this EAL without having to upgrade their entire EAL classification scheme using all of the NUMARC-007 criteria. However, it should be emphasized that all EAL changes must first be discussed with and agreed upon by State and local officials in accordance with Appendix E to 10 CFR 50.

4.0 Conclusion

The Emergency Action Level (EAL) development methodology presented in NUMARC-007 represents a significant improvement over the previously published NUREG-0654 EAL guidance criteria. NUMARC-007 provides a generic set of EAL guidelines developed from industry experiences with implementing EALs in conjunction with regulatory considerations. The resulting EAL guidelines, together with their basis, define conditions which represent increasing risk to the public. Their use should result in consistent emergency classifications when applied at different sites.

Meteorology continues to play an important role in the EAL guidelines in that: (1) certain weather phenomena have the potential to adversely impact plant safety structures; and (2)

meteorological conditions affect the location and magnitude of offsite doses resulting from any airborne radiological releases. However, NUMARC-007 no longer includes the loss of all meteorological instrumentation as an example EAL for an Unusual Event because meteorological monitoring systems do not detect abnormal plant conditions and, therefore, are not directly involved in maintaining fission product barriers.

A suggested area for improvement in the NUMARC-007 EAL guidelines pertains to the ICs concerning gaseous radioactive releases and their corresponding example EALs. These EALs utilize both effluent monitor readings and measured offsite dose rates to determine if an emergency classification threshold has been exceeded. The NUMARC-007 basis for these EALs clearly states that the threshold indications for the effluent monitors should be based on ODCM dose projection methodologies which typically utilize annual average X/Qs. However, an actual short-term (i.e., hourly) X/Q during a release will generally be higher than an ODCM annual average X/Q since ODCM annual average X/Qs are (by definition) normalized by the percent of time the wind blows towards the ODCM's critical (maximum offsite) receptor. Consequently, consideration should be given to utilizing an "average hourly X/Q" instead of an "annual average X/Q" to correlate EAL effluent monitor indications with corresponding short-term offsite dose rates. For example, average hourly X/Qs could be used to revise the dose assessment, perimeter monitor, and site survey dose rate EAL thresholds corresponding to the Unusual Event and Alert ICs concerning unplanned releases exceeding 2 and 200 times RETS limits; likewise, average hourly X/Qs could be used to revise the effluent monitor EAL thresholds corresponding to the Site Area Emergency and General Emergency ICs concerning releases exceeding 0.1 and 1.0 times the lower range of the EPA PAG plume exposure levels.

5.0 References

1. U.S. Nuclear Regulatory Commission and the Federal Emergency Management Agency, Criteria for Preparation and Evaluation of Radiological Emergency Response Plans and Preparedness in Support of Nuclear Power Plants, NUREG-0654, FEMA-REP-1, Revision 1, November 1980.

2. U.S. Nuclear Regulatory Commission, Emergency Planning and Preparedness for Nuclear Power Reactors, Regulatory Guide 1.101, Revision 2, October 1981.

3. Nuclear Management and Resources Council, Inc., Methodology for Development of Emergency Action Levels, NUMARC/NESP-007, Revision 2, January 1992.

4. U.S. Nuclear Regulatory Commission, Emergency Planning and Preparedness for Nuclear Power Reactors, Regulatory Guide 1.101, Revision 3, August 1992.

5. U.S. Nuclear Regulatory Commission, Draft Emergency Action Level Guidelines for Nuclear Power Plants, NUREG-0610, September 1979.

6. U.S Nuclear Regulatory Commission, Emergency Action Levels for Light Water Reactors, NUREG-0818, Draft Report for Comment, October 1981.

7. Nuclear Management and Resources Council, Inc., Methodology for Development of Emergency Action Levels, NUMARC/NESP-007 Revision 2, Questions and Answers, June 1993.

8. U.S. Environmental Protection Agency, Manual of Protective Action Guides and Protective Actions for Nuclear Incidents, EPA-520/1-75-001, September 1975 (Revised June 1980).

9. U.S. Environmental Protection Agency, Manual of Protective Action Guides and Protective Actions for Nuclear Incidents, EPA-400-R-92-001, October 1991.

10. U.S. Nuclear Regulatory Commission, Instrumentation for Light-Water-Cooled Nuclear Power Plants to Assess Plant and Environs Conditions During and Following an Accident, Regulatory Guide 1.97, Revision 2, December 1980.

11. U.S. Nuclear Regulatory Commission, Instrumentation for Light-Water-Cooled Nuclear Power Plants to Assess Plant and Environs Conditions During and Following an Accident, Regulatory Guide 1.97, Revision 3, May 1983.

12. U.S. Nuclear Regulatory Commission, "Branch Position on Acceptable Deviations to Appendix 1 to NUREG-0654/FEMA-REP-1," Richard L. Emch, Jr. memorandum to James H. Joyner/William E. Cline/John A. Grobe/Blaine Murray, July 11, 1994.

EXHIBIT 1
(Sheet 1 of 2)

Meteorological-Related ICs and Example EALs Involving Abnormal Rad Levels/Radiological Effluent

	Unusual Event	Alert
A. NUREG-0654	**IC #2:** Radiological effluent technical specification limits exceeded.	**IC #15:** Radiological effluents greater than 10 times technical specification instantaneous limits (an instantaneous rate which, if continued over 2 hours, would result in about 1 mr at the site boundary under average meteorological conditions).
B. NUMARC-007	**IC #AU1:** Any unplanned release of gaseous radioactivity to the environment that exceeds two times the Radiological Technical Specifications for 60 minutes or longer. 1. A valid reading on one or more of the following monitors that exceeds the "value shown" (site specific monitors) indicates that the release may have exceeded the above criterion and indicates the need to assess the release with (site-specific procedures). Note: if the monitor reading(s) is sustained for longer than 60 minutes and the required assessments cannot be completed within this period, then the declaration must be made based on the valid reading. 2. Confirmed sample analyses for gaseous releases indicates concentrations or release rates with a release duration of 60 minutes or longer in excess of two times (site-specific technical specifications). 3. Valid reading on perimeter radiation monitoring system greater than 0.10 mR/hr above normal background for 60 minutes or longer (for sites having telemetered perimeter monitors). 4. Valid indication on automatic real-time dose assessment capability greater than (site-specific value) for 60 minutes or longer (for sites having such capability).	**IC #AA1:** Any unplanned release of gaseous radioactivity to the environment that exceeds 200 times the Radiological Technical Specifications for 15 minutes or longer. 1. A valid reading on one or more of the following monitors that exceeds the value shown indicates that the release may have exceeded the above criterion and indicates the need to assess the release with (site-specific procedures). Note: if the monitor reading(s) is sustained for longer than 15 minutes and the required assessments cannot be completed within this period, then the declaration must be made based on the valid reading. 2. Confirmed sample analyses for gaseous releases indicates concentrations or release rates in excess of (200 times site-specific technical specifications) for 15 minutes or longer. 3. A valid reading on perimeter radiation monitoring system greater than 10.0 mR/hr sustained for 15 minutes or longer (for sites having telemetered perimeter monitors). 4. Valid indication on automatic real-time dose assessment capability greater than (200 times site-specific Technical Specifications value) for 15 minutes or longer (for sites having such capability).

EXHIBIT 1
(Sheet 2 of 2)

Meteorological/Related ICs and Example EALs Involving Abnormal Rad Levels/Radiological Effluent

	Site Area Emergency	General Emergency
A. NUREG-0654	**IC #13:** a. Effluent monitors detect levels corresponding to greater than 50 mr/hr for 1/2 hour or greater than 500 mr/hr whole body for two minutes (or five times these levels to the thyroid) at the site boundary for adverse meteorology. b. These dose rates are projected based on other plant parameters (e.g., radiation level in containment with leak rate appropriate for existing containment pressure) or are measured in the environment. c. EPA Protective Action Guidelines are projected to be exceeded outside the site boundary.	**IC #1:** a. Effluent monitors detect levels corresponding to 1 rem/hr whole body or 5 rem/hr thyroid at the site boundary under actual meteorological conditions b. These dose rates are projected based on other plant parameters (e.g., radiation levels in containment with leak rate appropriate for existing containment pressure with some confirmation from effluent monitors) or are measured in the environment.
B. NUMARC-007	**IC #AS1:** Boundary dose resulting from an actual or imminent release of gaseous radioactivity exceeds 100 mR whole body or 500 mR child thyroid for the actual or projected duration of the release. 1. A valid reading on one or more of the following monitors that exceeds or is expected to exceed the value shown indicates that the release may have exceeded the above criterion and indicates the need to assess the release with (site-specific procedures). Note: if the monitor reading(s) is sustained for longer than 15 minutes and the required assessments cannot be completed within this period, then the declaration must be made based on the valid reading. 2. A valid reading sustained for 15 minutes or longer on perimeter radiation monitoring system greater than 100 mR/hr (for sites having telemetered perimeter monitors). 3. Valid dose assessment capability indicates dose consequences greater than 100 mR whole body or 500 mr child thyroid. 4. Field survey results indicate site boundary dose rates exceeding 100 mR/hr expected to continue for more than one hour; or analysis of field survey samples indicates child thyroid dose commitment of 500 mR for one hour of inhalation.	**IC #AG1:** Boundary dose resulting from an actual or imminent release of gaseous radioactivity that exceeds 1000 mR whole body or 5000 mR child thyroid for the actual or projected duration of the release using actual meteorology. 1. A valid reading on one or more of the following monitors that exceeds or is expected to exceed the value shown indicates that the release may have exceeded the above criterion and indicates the need to assess the release with (site-specific procedures). Note: if the monitor reading(s) is sustained for longer than 15 minutes and the required assessments cannot be completed within this period, then the declaration must be made based on the valid reading. 2. A valid reading sustained for 15 minutes or longer on perimeter radiation monitoring system greater than 1000 mR/hr (for sites having telemetered perimeter monitors). 3. Valid dose assessment capability indicates dose consequences greater than 1000 mR whole body or 5000 mr child thyroid. 4. Field survey results indicate site boundary dose rates exceeding 1000 mR/hr expected to continue for more than one hour; or analysis of field survey samples indicates child thyroid dose commitment of 5000 mR for one hour of inhalation.

EXHIBIT 2
(Sheet 1 of 1)

Meteorological-Related ICs and EALs Involving Hazards and Other Conditions Affecting Plant Safety[9]

	Unusual Event	Alert	Site Area Emergency	General Emergency
A. NUREG-0654	**IC #13:** Natural phenomenon being experienced or projected beyond usual levels: b. 50 year flood or low water, tsunami, hurricane surge, sieche c. Any tornado on site d. Any hurricane	**IC #17:** Severe natural phenomena being experienced or projected: c. Any tornado striking facility d. Hurricane winds near design basis level	**IC #15:** Severe natural phenomenon being experienced or projected with plant not in cold shutdown: c. Sustained winds or tornadoes in excess of design levels.	None
B. NUMARC-007	**IC #HU1:** Natural and destructive phenomena affecting the Protected Area: 2. Report by plant personnel of tornado striking within protected area boundary 7. (Site-Specific) Occurrences (such as hurricane, flood, or seiche)	**IC #HA1:** Natural and destructive phenomena affecting the plant vital area: 2. Tornado or high winds striking plant vital areas: Tornado or high winds greater than (FSAR design basis) mph strike within the protected area and 3. Report of any visible structural damage on any of the following plant structures: • Reactor Building • Intake Building • Ultimate Heat Sink • Refueling Water Storage Tank • Diesel Generator Building • Turbine Building • Condensate Storage Tank • Control Room • Other (Site-Specific) Structures	None	None

[9]Although not indicated as such in the final document, discussions with the NUMARC-007 EAL task force project manager indicate that NUMARC-007 IC #HA1/EAL #2 was intended to be "ANDed" with IC #HA1/EAL #3.

EXHIBIT 3
(Sheet 1 of 1)

Meteorological-Related ICs and Example EALs Involving System Malfunction[10]

	Unusual Event	Alert	Site Area Emergency	General Emergency
A. NUREG-0654	**IC #11:** Indications or alarms on process or effluent parameters not functional in Control Room to an extent requiring plant shutdown or other significant loss of assessment or communication capability (e.g., plant computer, Safety Parameter Display System, all meteorological instrumentation).	{**IC #14:** Most or all alarms (annunciators) lost.}	{**IC #12:** Most or all alarms (annunciators) lost and plant transient initiated or in progress.}	None
B. NUMARC-007	{**IC #SU3:** Unplanned Loss of most or all safety system annunciation or indication in the Control Room for greater than 15 minutes.}	{**IC #SA4:** Unplanned loss of most or all safety system annunciation or indication in Control Room with either (1) a significant transient in progress, or (2) compensatory non-alarming indicators are unavailable.}	{**IC #SS6:** Inability to monitor a significant transient in progress.}	None

[10]Note that the ICs and EALs listed in brackets do not directly involve meteorology, but are provided to show the progression of related ICs and EALs through the various emergency classifications.