CCPS Pamphlet Series
Recovery from Natural Disasters

This pamphlet analyzes and presents, in a "how to use" format, the past experiences and successes of various CCPS member companies, their "Lessons Learned," and advice on how to prepare for and recover from a natural disaster.

The Center for Chemical Process Safety was established by the American Institute of Chemical Engineers in 1985 to focus on the engineering and management practices to prevent and mitigate major incidents involving the release of hazardous chemicals and hydrocarbons. CCPS is active worldwide through its comprehensive publishing program, annual technical conference, research, and instructional material for undergraduate engineering education. For more information about CCPS, please call 646-495-1371, e-mail ccps@aiche.org, or visit www.aiche.org/ccps.

This second edition was compiled by Adrian L. Sepeda, CCPS Staff Consultant with input from Charles Cowley, CCPS Staff Consultant, and oversight by Ms. Louisa Nara, CCPS Technical Director. It is made available for use with no legal obligations or assumptions (i.e. Use at your own risk). Corrections, updates, additions, and recommendations should be sent to Ms. Nara at louna@aiche.org .

Contents

I. Preamble and Introduction

II. Preplan
- A. Risk Assessment
- B. Natural Disaster Plan
- C. Communications
- D. Logistics
- E. Security, Identification , and Access Permissions
- F. Drills and Cumulative Learnings
- G. Information Sources

III. Shortly Before
- A. Securing the Facility
- B. Supplies and Shelter
- C. Backup Systems

IV. During
- A. Safety
- B. Security
- C. Communications

V. After
- A. Damage Assessment & Short Term/Emergency Repairs
- B. Security
- C. Communications with Outside World
- D. Recovery
- E. Staffing
- F. Restart
- G. Critique

VI. Recovery

VII. References

VIII. Appendices
- A. Example List of Major Decisions to Be Made
- B. Example List of Suggested Supplies
- C. Example Checklist of Communication Equipment
- D. Example List of Interdependencies
- E. Example Risk Analysis for Potential Onsite Consequences of Concern
- F. Example Risk Analysis for Potential Offsite Consequences of Concern

I. Preamble

Past Natural disasters have tested preparedness and response plans of the chemical and petrochemical industries not only on or near the U. S. Gulf coast, but along the Atlantic coast, interior sections of the US, and overseas operations. These natural disasters have occurred in the form of tornados, hurricanes, tropical storms, tsunamis, storm surges, earthquakes and uncontrolled wildfires.[1] The results have been everything from local flooding to widespread flooding of significant portions of coast lines due to storm surge,[2] tremendous destruction from high winds and/or rising water, tidal waves, and fire damage to valuable wooded interior sections of countries. Although responses were generally well managed and as efficient as conditions allowed, there is always room for improvement. Experience is often said to be the best teacher, but everyone should not have to experience the same adverse thing to learn from it. AIChE's Center for Chemical Process Safety (CCPS) member companies believe that sharing experiences and learnings from the past and others are effective and efficient ways of improving performance and reducing risk without suffering harm.

With that goal in mind, this pamphlet, originally funded by the generous support of the United Engineering Foundation, pulls together, analyzes, and presents in a "how to use" format the past experiences and successes of various CCPS member companies, the "Lessons Learned," and advice on how to prepare for and recover from a natural disaster. The natural disaster scenario that is the focus of this paper are storms—hurricanes and tropical storms specifically. The other common natural disasters, tornados, tsunamis, earthquakes and uncontrolled wildfires usually have little or no lead/preparation time, so the suggestions offered in the body of this paper may not be applicable. These natural disasters are addressed summarily in Appendix G.

Most of this information in this paper comes from workshops in 2006, with the April workshop and the June teleconference as the focal events. Members of the CCPS Technical Steering Committee who participated in the June teleconference, Scott Berger—CCPS Director, Karen Person—CCPS Project Engineer, Karen Tancredi—Dupont, and Adrian Sepeda—CCPS Staff Consultant, are recognized for the role they played in bringing this project to fruition. The reader is reminded that this pamphlet merely "suggests" but in no way sets a standard or expectation for performance or actions. Ultimately it is the responsibility of each company and its employees to act on their beliefs and available information to secure their site and protect their employees, the community, and the environment from harm.[3]

A risk based approach in addressing the phases of dealing with a natural disaster—preplanning, just before the disaster strikes, during the disaster, and after the disaster recovery is used for

---

[1] Much more information and Lessons Learned now exist on Earthquakes and Tsunamis. Search for it.

[2] Storm surge refers to the abnormal rise of seawater during a hurricane that can flood coastal areas. Storm surge was the culprit behind much of the damage sustained during Superstorm Sandy along the New Jersey Shore and in New York City, where a 13-foot wave submerged much of Lower Manhattan.

[3] Your suggestions, "Lessons Learned," and comments are welcome. This is the second edition of what we plan to make as a living document. The more information that is gathered, codified, and generally presented to users of this pamphlet, the better it becomes. Send your feedback to ccps@aiche.org and mention this pamphlet by name.

chronological clarity. The appendices provide checklists and examples that can be customized to suit the user's specific situation, resources, and company culture.

Introduction

The CCPS chemical and petrochemical company members are well grounded in using risk evaluations as a tool to operate their businesses safely. This paper uses that same risk evaluative approach in preparing for, enduring, and recovering from a natural disaster. Each phase of the preparation and recovery should be evaluated for risks considering probabilities, consequences and available resources to abate risks. This facilitates the preplanning, prioritization, scheduling, and evaluation of actions for effectiveness and impact.

Risk assessments (generally worst case scenarios, low probability events, and expected events) should be made covering two broad categories for each of the potential Natural Disasters to which your facility may be exposed:

- the risk that a natural disaster imposes on the safety and security of your facility, its contents, equipment, chemicals, market share, and personnel
- the risk that your facility (while being impacted by a natural disaster) imposes on the surrounding community and its inhabitants, ecosystem, and site personnel.

These risk evaluations facilitate understanding of appropriate actions to take, when to take them, and the required communications for them to be effective.

II. Preplan

A. Risk Assessment

To adequately prepare for any disaster, the risks must be identified, analyzed, and prioritized. This assessment for a manufacturing facility includes two separate considerations. The first analysis is to determine the risks that the natural disaster imposes on the facility itself. The second analysis is to determine what risks the facility imposes on the employees, the ecosystem, and the community as a consequence of the disaster. These risks may be similar or completely different from the risks the facility naturally imposes on the community during normal operations.

The risk assessment process highlights decisions that should be made regarding what can be sacrificed and what is to be secured, perhaps at all costs. It may also be dynamic, addressing changing risks with changing circumstances. Depending on your risk assessment methodology, you may estimate actual risk or prioritize identified risks. Either way it gives you a framework for managing them.

1. Risks the Natural Disaster Imposes on Facility:

Consider the hazards the natural disaster will bring to your facility. These might be rising water/flooding, high winds, heavy rain, storm surge[4], electrical disturbances, ground tremors, etc., or a combination of all of these. Convert those hazards to risks by estimating the probability of occurrence and then the consequences if they occur. Probabilities are easier to estimate because they are often disaster specific—for instance, if the natural disaster is a hurricane you can expect heavy rain and strong winds. Hurricanes often spawn tornadoes so that probability should be relatively high also. Expect past problems to be problems again. For instance, if flooding has been a problem in the past, expect it again.

Estimating consequences is more difficult—essentially because it involves imagining the unimaginable. Your plans should be for the expected scenarios and the worst case scenarios; do not spend much time evaluating scenarios with relatively low level consequences. If you are prepared for the worst case, the lesser consequences will usually be covered also. (Note: if this is not the case, evaluate low, high, and expected probability scenarios.) See Appendix E—Example List of Risk Analysis for Potential Onsite Consequences of Concern.

2. Risks the Facility Imposes on the Employees, Ecosystem and the Community:

Knowing the risks and potential consequences at your facility during a natural disaster helps you estimate the risks your facility will impose on the on-site employees, other facilities and their employees on-site, the ecosystem, and surrounding community. Determine these risks by estimating the probability of occurrence and then estimating the consequences if they do occur. Use the same logic that you used for estimating risks to your facility, but recognize that your facility could, should it lose containment of chemicals, energy, or site materials, impose significant risks to employees remaining onsite, other manufacturing sites, the surrounding community (people structures, and infrastructure), and the ecosystem. Your plans should be for the worst case scenarios; do not spend a lot of time evaluating relatively low level consequences. If you are prepared for major consequences, the lesser consequences will usually be covered also. To estimate offsite consequences, consider those that might occur within your facility and convert them to an outside-of-the-facility impact. See Appendix F—Example List of Risk Analysis for Potential Offsite Consequences of Concern.

B. Natural Disaster Plan

The Natural Disaster Plan should document all of the things that you want to happen (your plans) for all of the considered events (disasters). It describes "who" is to do "what," "when," and "how." Using the risk based approach identifies and documents the ways that you will address 1) the risks your facility will incur due to the disaster and 2) the risks your facility will impose on others, all within the "who," "what," "when" and "how" descriptions. The plan should also document the communication protocols to be used and any interdependency

[4] Storm surge, which refers to the abnormal rise of seawater during a hurricane that can flood coastal areas, was the culprit behind much of the damage sustained during Superstorm Sandy along the New Jersey Shore and in New York City, where a 13-foot wave submerged much of Lower Manhattan.

opportunities. Finally, your plan should create two emergency command centers, one onsite and one offsite, to coordinate all activities and serve as communication hubs.

Your Natural Disaster plan should include at least the following:

- Emergency Command and Communication Centers—these centers (either real or virtual) will serve as activity coordination and communication hubs.
    - The offsite Emergency Command Center should be remote from the disaster's effects. Its function is to coordinate all emergency response, recovery and restart type activities, arrange for assistance and repairs, and respond to needs of the manufacturing facility or employees therein.
    - The onsite Emergency Command center, if there is one, should be staffed by a small count crew with specialized expertise and specific assignments. Their function is to monitor the affects of the disaster on the facility and resultant affects on the surroundings so that appropriate and timely actions can be taken to minimize risks, on and offsite impacts, keep the facility in a safe state, and return the facility to service as soon as is practical and safe to do so. For the onsite staffers to determine the affects of the disaster on the facility they will need to monitor and observe the facility throughout the disaster. This may entail the installation of special instrumentation specific to the disaster expected (wind speed and direction monitoring for hurricane winds, for instance) and the ability to see out of the Emergency Command center. Since doors will be closed and windows barricaded, normal visual positions may be inaccessible. Consider having a protected window(s) or periscope type device(s) for observing the outside conditions during the disaster.
        - SAFETY NOTE: Because of its purpose, the command center may be relatively air tight if not properly ventilated. Special safety precautions should be taken to ensure that the atmosphere is not contaminated by equipment and/or depleted. Consider installing several battery operated oxygen sensors with low oxygen alarms.
- Activation prompts and system—includes the activation criteria (prompts) and the communication systems for notification of activation
- Staffing assignments—to get the right people in the right places doing the right things at the right time
- Evacuation plans—for removing unnecessary personnel before the disaster and for emergency evacuation (should the need arise) of those remaining in the facility during or shortly after the disaster
- Emergency onsite power supplies—in case the utility electrical power supply is interrupted (which is usually a high probability).
- Communication systems and protocols—for sending and receiving information before, during and after the disaster (Note: recent experience has proven that cell phones,, tablets, etc. <u>may</u> be an unreliable mode of communication. The communication infrastructure may be compromised by the event. Consider backup systems such as satellite phones, etc.

- Protection plans for business-critical equipment, information, and data—a description and action plan for how these will be protected or sheltered from the hazards (i.e. risk management)
- Security plans—to ensure that onsite and offsite personnel (employees and non-employees), facilities, chemicals, equipment, etc. are properly protected from intruders
- Antiterrorism plans—recognize that terrorists may view a natural disaster as an opportunity to cause intentional damage.
- Safety plans—for last minute housekeeping activities and for the implementation of any special safety protocols to be used only during the emergency
- During disaster configuration—how the facility should be physically configured (and staffed) to weather the disaster considering the risk analysis results and recognition of salient interdependencies
- Supplies—what supplies will be on hand, where they will be stored and how they will be accessed, including cash? Depending on the scope of the disaster, cash may be the only way to buy things after the disaster for some time.
- Quality assessment/Quality control—a description of how the plan is to be kept up to date, accurate, and appropriate for the types of disasters predicted. Usually this includes periodic review, drills and critiques plus "Lessons Learned" from others.

Your Natural Disaster plan should also consider the following elements:

1. Interdependency:

Interdependency is the relationship of how your facility depends on and influences other things around it and how those things depend on and influence your facility. Interdependencies should be communicated to any and all agencies and/or organizations that might benefit from that knowledge. A plan for the effective use of interdependencies to facilitate disaster recovery should be developed, shared with, and agreed upon by all affected parties.

Electrical power is an interdependency example. Your manufacturing facility may have a cogeneration facility onsite capable of supplying the power needed to operate the facility. The local commercial power generating company serves as your backup. You are dependent on them for power when your cogeneration system goes down. You also need power from them to start up your cogeneration system; and, you need them to take any excess power you generate. They in turn operate a certain number of generators because they are expecting your facility to normally consume a minimal amount of power or even supply some power back into the grid. They are impacted by what happens at your manufacturing facility and your facility is impacted by what happens at their generating plant. In other words you are interdependent.

Your natural disaster plan should include all interdependencies your facility has. Particular attention should be given to those interdependencies that would play a major role during or after an emergency. For instance, if we follow through with the example above and your onsite cogeneration system is down due to the disaster, you will need power from the commercial generator to get your system up and running. Why would they spend time just to get your system up? Because when your system is running you can supply power to the grid for others to use, thereby effecting a faster and safer recover for all users on the grid. Effective use of interdependency is a key, but often hidden asset. Make sure that those who will be making

disaster recovery decisions, particularly the state and federal agencies, know about and understand the interdependencies in your area. See Appendix D—Example List of usual Interdependencies.

2. Inventory Philosophy:

A key risk decision that must be made is how to handle inventories. The decision process must consider the risks associated with leaving the inventories (feed stocks/raw materials, in-process materials, and finished goods) at normal levels verses decreasing them. To make this analysis, estimate the risk (consequences and probability) of loss of containment and compare that to the estimated consequences and probability of unwanted scenarios due to lack of inventory. For instance, if a tank contains a flammable toxic liquid, you should evaluate the probability and consequence of loss of containment. If it is reasonable that some loss of containment may occur during the disaster and the liquid, if spilled, would pollute waterways, groundwater and could possibly ignite, compare that risk to risks associated with removal prior to the disaster. This analysis should consider risks associated with the deinventorying process, what would happen to the empty tank—float off, wind damage etc., and risks associated with reinventorying the tank and preparing it for reuse. Your analysis might indicate that refilling the tank with water to prevent float off damage is a viable action. If that is the case, don't forget to analyze the risks associated with preparing the tank for process chemicals after the disaster and possible startup issues because of latent water.

An inventory philosophy and plan should be made for each vessel of concern. Potentially, the situations would be different and the risk analyses might yield different results. The inventory philosophy should be converted to action plans that are to be enacted during the early stages of preparing for the disaster. Coordinate your Inventory Philosophy (Section II. B.) with your Logistics plan (Sections II. D.).

3. Utility Services:

The same risk analysis process should be made to determine the actions to take regarding utility services. This would apply to inbound utility services (water, electricity, fuel, purchased compressed air from a neighbor plant, etc.) and outbound services (cogeneration excess electricity, fuel sold, compressed air sent offsite, etc.). Consider interdependencies when making this risk assessment. Do not assume that it is less risky to discontinue all services. Conduct a risk assessment to decide which services to continue and which ones to discontinue during the disaster.

4. Emergency Onsite Power Supplies:

The risk analysis for electrical power interruption is generally straight forward. Determine what items in your facility must have electrical power to meet the functions described in your Natural Disaster Plan. If the facility is shut down, (and it probably is at this point), there will be a significant reduction in electrical power needs—potentially to the point that emergency onsite generators can meet the needs described in your Natural Disaster Plan. Even though it is probable, it is not positive, so the availability should be confirmed.

Your risk analysis should delineate what will need emergency power back up and why, and should also give you guidance as to how the onsite emergency electrical supply system should be configured. It may indicate that only a few large generators are appropriate or that several smaller generators provide the best option. Either way, consider holding in reserve a few small generators that use little fuel for servicing critical systems—such as your communication systems, ventilations systems, battery chargers, and alarms, in case a primary generator fails. They may be needed if fuel supplies are almost exhausted and/or if large generators cause unexpected risks. Be sure that these smaller generators can easily "plug in" to the critical electrical circuits.

5. Staffing Plan:

A key decision here is whether or not the facility will be staffed during the natural disaster. The second decision is if it is to be staffed, by whom should it be staffed and what are they to do? Key considerations in this decision process should be:

- Why staff the plant?—there must be a valid reason, such as significant risk reduction, for you to decide to keep people in harms way.
- What will you want them to do?—clearly define their roles after the plant has been evacuated and prior to the natural disaster, during the natural disaster, and after the disaster. Develop a Job Hazard Analysis (JHA) for each of the tasks you expect of them and establish appropriate safety and health procedures and protocols they should follow.
- Who should they be?—identify people based on the skills needed to fulfill your expectations. Request volunteers with the needed skills; don't assign an unwilling person. Recognize that this team of volunteers may have a different order of command and authority than during normal times. Choose volunteers who understand that potential change and can live with it as well as people who can work together in isolation for several days.
- How will they be rescued if necessary?—talk this over with the federal, state, and local emergency response agencies.

If the decision is to staff the facility during the natural disaster, primary staffers and alternates should be named, trained, and educated as to their assignments, performance expectations, and reporting scheme. Particular attention may be required for the families of those who will staff the facility during this time. For these staffers to perform as needed, it is important that they know that their families are safe. Plans must be in place to assure that their families are protected and/or evacuated.

6. Data Protection:

Data protection falls in to two broad categories—onsite or offsite. Onsite data protection requires the recognition of the difference between volatile data and fixed data. Volatile data requires continuous power if it is to be retained whereas fixed data does not. For instance, your computer systems contain both types of data. When you save a file to the hard drive, that data is fixed and no electrical power is required for it to remain there. On the other hand, if you fail to save it and shut your computer down, the data is lost because it was in the part of the

memory (often called "flash" memory) that requires power to function. For those using a distributive computer control system (DCS) some of the data may be volatile and must be protected via emergency power supply—even when the system is not functionally controlling your facility. Each facility should analyze where their critical data resides, what type of memory contains it and then establish secure systems to protect that data during all type of service interruptions. Consider making copies of and securing Distributive Control Systems (DCS) and other critical computer systems configuration data just in case some of it is in the "flash" memory and all power, including emergency and battery power, fails.

Some data may already reside offsite having been transferred via internet routes, "T" line transfers, or other physical or electronic transfer modes. This data may inherently be protected from local natural disasters simply because of its remoteness and redundancy. Other onsite data can be collected and sent offsite to secure locations via those same routes or simply by making electronic copies and sending via a variety of modes. Regardless, it is important to identify data that should be protected, develop a protection scheme, and then put that scheme into action prior to the onset of the natural disaster.

7. Safety Procedures:

It may be appropriate to modify safety procedures and protocol during and immediately after the natural disaster. This is not a lessening of safety, but rather an adaptation to the special circumstances. Some changes may involve not having the usual personnel available for checking and authorizing certain safety procedures, such as MOCs or lock outs, etc. To manage this risk, ensure that those who will be involved in authorizing safety permits have the proper training and experience to do so and that they fully understand their role and responsibilities. Conduct a risk analysis using your management of change procedure to uncover any unrecognized unwanted consequences of modified safety procedures.

While all safety procedures are important, take special care with management of change (MOC) requests and pre-startup safety reviews (PSSRs). There will be pressure to quickly approve requested changes necessitated by plant damage, unusual equipment configuration, and/or the rush to return to normalcy. No shortcuts allowed! The facility may be in an unusual configuration and contamination may also be present. Changes must be reviewed thoroughly and with special attention to hidden consequences. PSSRs must be done with critical diligence since there may be many potential anomalies and hidden hazards.

C. Communications

Communications during and after an emergency or disaster are more than just a convenience; they are essential for personnel safety, ecosystem protection, and facility well-being. Therefore, preplanning your communication strategy is a key ingredient in ensuring its reliability and effectiveness. To ensure that this vital link exists, two things are needed—the right equipment and a plan for how it will be used.

1. Communications Equipment:

Conventional communication equipment may or may not work during a disaster. Hope that it does, but have a plan should it fail. It is common and almost expected that land line telephone

systems and wireless systems may fail. Your cell phone may be no more useful than a rock to throw at someone to get their attention. With these out of service your facility will be isolated unless your disaster plan includes alternate communication systems.

- Get **GETS**: Register for GETS, the Government Emergency Telecommunications Service that supports federal, state, local, and tribal government, industry, and non-governmental organization personnel in performing their National Security and Emergency Preparedness missions. GETS provides emergency access and priority processing in the local and long distance segments of the Public Switched Telephone Network when regular telephone service is congested. To learn more about GETS and/or register, go to: http://gets.ncs.gov/.

- Radio: Consider purchasing a NOAA Weather radio with a warning tone and battery back up for your emergency command centers.
- Cell Phones: Increase the chance of connecting with a cell telephone service that is operable by subscribing to several different providers.
- Satellite Phones: Consider purchasing or renting satellite telephones and a base station. Satellite phones are more complicated to operate than cell phones so train several people in their use. They also require a relatively unobstructed path to the satellite. Plan on using them outdoors or connected to a remote antenna.
- Internet Communication Systems: Computer and PDA internet-based devices may work in bad weather if the sending, relay, and receiving systems are still intact. Consider having key personnel or the emergency command post stocked with a computer and a PDA device (Blackberry, I-Phone, etc.). Each will need a contracted internet provider. Consider allowing this "emergency use computer" to be directly connected to the "outside" world and not routed through your company's firewall, spam filters, etc. These systems could hinder or completely block its use during an emergency.
- Citizen Band Radios: CB's have long been recognized and used as emergency use communication devices. Consider having a CB base station and an appropriate number of portable units in your emergency command post. CB operators must be licensed and may need training on the equipment you buy. There may be licensed CB operators already working at your facility who would volunteer to staff the equipment in an emergency.
- Walkie-Talkies: These may or may not help you communicate with the "outside" world, but will generally allow you to communicate with those left to staff the plant during the emergency. If you already have a system, make sure that your emergency command post has the ability to use it (perhaps add a second base station in the command post) and that extra radios are available. If you do not use this type communication system, consider purchasing a small one for your emergency command post use only. Keep a stock of charged batteries available and put the battery chargers on your emergency power supply.

2. Communications Plan:

All the equipment in the world will not help if you don't have anyone to communicate with. So, you need a communication plan—in fact, you need several communication plans.

- State and Federal Emergency Services**:** It is important that State and Federal Emergency Service Providers be able to communicate with your Company's Emergency Response & Coordination Center and the facility being impacted by the natural disaster (if it is staffed). To facilitate this, establish and agree on communication protocols with each agency and exchange lists of telephone numbers and people to call. Agree on who calls whom and when. Call prompts might be agreed upon periodic (every hour, for instance) updates or when there are significant changes in risks or circumstances. As part of the preplan, all communications modes should be tested.
    - To improve the probability that Communication Plans actually work properly when needed, strongly consider including the state and Federal emergency response agencies in your table top exercises and mock drills. By so doing, communication issues can be identified and corrected before they are a "life and death" communication. Further, it gives the Federal and state authorities the opportunity to understand your plan and offer improvement suggestions just as you have the same opportunity to critique their plans.
- Company Emergency Response & Coordination Center**:** This is your communication center for managing emergencies and disaster response. Obviously, to function effectively, it must have the ability to gather and disseminate information. This facility or system should be located so that it is not directly impacted by the disaster itself. It should be able to communicate in all available modes—land line telephone, GETS, cell telephones, satellite telephones, internet devices/PDAs/computer e-mails, CB radios, etc. Since it will function as the hub of most communications, it should have an up to date list of contacts, telephone numbers and e-mails. A plan or protocol as to who handles the calls should be established and tested. As part of the preplan, all communications modes should be tested.
- Employees**:** Your employees may or may not be displaced by the disaster. Regardless, they need a way to contact you, and you probably want to talk with them. To communicate with employees not in the plant, consider one or both of the following mechanisms.
    - Establish a 1-800 telephone number/"hot-line" that they can call to:
        1. talk with someone about their status and the plant's status,
        2. leave a message, or
        3. hear a message.

    The base or operator/receptionist of the 1-800 line should be remote from the natural disaster area. The line can be staffed full time or it can serve only as a recorded message center. Make sure that all of your employees know the 1-800 number and how it is to be used. Explain that if they are displaced, they can use this system to let the company know where they are and what their status is as well as hearing your status.

You may want to coordinate the use and staffing of this 1-800 line with the Company Emergency Response & Coordination Center mentioned above.

- Establish a computer internet site or Web page that can receive and send e-mails. Use and staff it much like you would the 1-800 number call in system. Publicize the internet site along with the 1-800 emergency telephone number. Remember that everyone is not internet fluent, so if you can have only one emergency communication system for your employees, use the 1-800 telephone system.

As part of the preplan, all communications modes should be tested periodically to assure availability when needed.

- Communications and Education**:** Each company should establish when the preplan actions are to be initiated. That decision should trigger a refresher training and education effort. Employees and their families need to be given last- minute/up to date information so that they can take care of themselves and help you take care of the facility. It is important that the families of employees who will remain onsite to help are safe and that the employee knows it.

  - For Employees**:** Make sure that all employees know how to take care of their families as a first priority and offer assistance if needed. Tell the employees who will remain onsite the contact numbers and methods that are expected to be available for contacting their families and for their families to contact them. Remind each employee of the part they are to play in securing the plant site for the natural disaster and conduct overview/refresher training sessions, if needed. If special equipment, such as satellite phones, etc. is to be used, conduct refresher training on where it is, how to access it, and how it is to be used. Go over the assignment list and reporting protocol and compensate for any absences or vacancies.

  - For Families**:** Send disaster preparedness pamphlets to each employee's home so that they can properly prepare their home for the disaster, gather supplies and plan their evacuation mode and route should they choose to leave the area. Communicate with families that have special needs to ensure their safety. Include contact information in the packet you send to the families so that employees offsite can let the company know where they are and find out what you want them to do. Also include information for families who will have a family member remaining at the site to contact the company for information about the site and their family member.

D. Logistics

Having people and materials located where they are safe but can be accessed quickly is a key component of preplanning that minimizes ongoing damage and facilitates recover after a disaster. The two broad groups to be considered are 1) emergency recovery: assistance, materials and supplies, and 2) manufacturing materials: raw materials and products. Make arrangements with the local, state, and federal agencies that will control access to the disaster

area so that your people and materials will be allowed into the impacted area when needed. (See Section II E below for a more detailed discussion on access credentials.)

I. Emergency Recovery:

Some people have specialized skills and expertise that may be needed during or immediately after an emergency to minimize safety hazards, onsite or offsite damage, and/or environmental contamination. Choose these people carefully based on their expertise, ability to function under pressure and adverse circumstances, and their safety ethic. Your preplan should position these people out of harm's way during the disaster but make them available quickly should the need arise. Make sure that your emergency command center communication team knows who these people are, what they can do, and how to activate them.

Emergency recovery materials and supplies (such as food, water, clothing, shelter, first aid, repair materials, extra communication equipment, etc.) should be staged and stored in a secure area not expected to be impacted by the disaster, but readily available to replenish exhausted or damaged onsite supplies. Have a delivery system predesigned and ready to respond as the need arises and flexible enough to gather additional items if not already stocked.

II. Manufacturing Materials**:**

In your risk assessment, you developed an inventory philosophy (Section II. B.) regarding storage of feed stocks and finished goods onsite or offsite. Based on those decisions, develop a staging plan if one is needed for feed stocks/raw materials and finished goods. Conduct a risk assessment of the staging plan and available options. Just because the materials are not on your site during the disaster does not mean that there are no risks of concern. Be careful not to trade one risk for an equal or higher risk. Check with your suppliers to confirm that they can delay/hold/store materials for you at their unimpacted sites. If so, they can probably do so with less risk than you having to make temporary arrangements with others not accustomed to storing the materials. Regardless of the system chosen, determine the risks and make informed risk-based decisions regarding offsite storage/staging of materials. Make arrangements well in advance of any need (perhaps at the beginning of the hurricane season) with your suppliers, your customers, and owner/operators of potential storage locations for use prior, during and after a natural disaster. Plans made just before a natural disaster strikes are more likely to be flawed and/or incomplete.

E. Security, Identification, and Access Permission

Your site must be secure from unwanted visitors and observers (including the media), but it must be accessible to key employees and other specialists before and after the disaster. To facilitate access for those needed at the site, contact the local, state, and federal authorities to understand:

- who will be controlling access to the impacted areas,
- what roads will be used for emergency travel, and
- what credentials will be needed by your employees to travel those roads.

After you understand what is needed, have the proper credentials made and checked by the governing agencies. Request a confirmation stamp, or sticker on the credentials to show that access has been pre-approved. Employees remaining in the plant should know who will be coming into the site after the disaster. They may be called by one of the emergency response agencies seeking permission to let someone or team in.

Area access may be restricted well before the disaster hits. Develop a plan for emergency access credentials for employees who will be coming in to staff the plant during the emergency. Do not count on employees being able to get in just because the disaster had not yet occurred. Local emergency officials may have already closed roads to all travelers without appropriate credentials.

After the disaster, area access is almost always restricted for safety and security reasons. The emergency access credentials that you get should be for personnel who can help resolve the issues and lessen the risk. Visitors and bystanders are not needed. Determine if different credentials are required for access before and after the event. Make sure that the right people have the right credentials by having the governing agencies and authorities validate them. Include the use of emergency access and needed credentials in each drill to train your employees to bring them and to "condition" authorities to expect requests for entry using these documents.

F. Drills and Cumulative Learnings

Design your drills for the types of natural disasters you can reasonably expect depending on your facility's location, natural disaster history, and emergency response agencies preparedness plans. Make your drills as realistic and comprehensive as possible. Of particular importance to validate/test during the drill are:

- Communications—do they work as planned?
- Participants knowledge—does each participant know what to do, when to do it, how to do it, and can they actually do it?
- Safety and Security—do actions taken to ensure the safety and security of personnel, the facility, the ecosystem, and the community, work as planned? If not, revise and retest until they do.
- Access—can those needing access to the site get through the maze of local, state and federal barriers?

If a natural disaster has occurred in the past and/or if one has occurred at another facility similar to yours, use that as a model for your drill. If it is impossible or impractical to conduct a full involvement drill, start to finish, consider conducting staged or topic drills. For instance, conduct a staged drill starting on the "Preplan" activities and critique it. Then at a later date, conduct a drill on the "Shortly Before" activities, then later on the "During" activities, and finally on the "After" activities and critique each stage. Another approach is to drill on functions or actions—such as "Communications" then later on "Security, Identification and Access" and so on. Critique each function and make upgrades as needed.

Drills are good training and usually generate suggested improvements. To evaluate the worthiness of the suggested change, use your MOC process to validate the expected and desired impact of the change and to discover the potential unexpected/undesired consequences. Update your emergency response plan as needed. Redistribute the updated plan and conduct training if needed. Ensure that everyone has the opportunity to ask questions relative to their roles and expected actions. Ensure everyone knows what to do, when to do it and how to do it.

III. Shortly Before

Now is the time to secure the facility and ensure it is as ready as possible for the type of disaster and hazards expected. Check supplies and confirm that they are accessible and conduct last minute tests of backup systems. There may be extra employees available to help with these tasks. When the job is done, they will leave and only those employees designated to remain onsite during the disaster will be left.

A. Securing the Facility

Securing the facility involves reducing the risks that the facility will impose on itself and others during the natural disaster. One risk reduction item to address is housekeeping. Any and all items that might become missiles in high winds must be removed, stored away, and/or tied down. Look for any chemicals stored in drums or buckets and store them in a secure location to prevent spillage. Remove unnecessary vehicles from roads, clean out truck beds of items that may fly off, pick up loose insulation and uninstalled piping materials and tools, signs, etc. Look for anything that will impose a hazard in high winds or rising water. Bottom line—clean house like your mother-in-law will be visiting!

Another risk reduction opportunity is to configure the facility to withstand the disaster. Based on your preplan, you have already decided what to do about inbound raw materials and outbound products. Enact those plans now. Your preplan risk assessments also helped you decide what to do about tank inventories and securing tanks that are emptied. Enact those plans now.

Test and confirm adequacy of all modes of communication. Don't wait until they are needed to find out they don't work as expected.

And, finally, evacuate all unnecessary personnel (no visitors and/or "just to observe" people) and activate your Natural Disaster Safety and Security System as a line of protection against unwanted intruders—human or animal.

B. Supplies and Shelter

Conduct an inventory of the onsite supplies matching actual quantities to listed required quantities. If there are shortfalls, arrange for them to be addressed quickly. Pay particular attention to batteries. Electrical power failure is relatively common so battery chargers may not work. Ensure that there are plenty of charged walkie-talkie, cell phone and satellite phone batteries. Make sure that supplies are accessible from the onsite Emergency Command post. See Appendix B for suggested supply lists. Be sure that those that will staff the onsite command

post have at least a week's worth (two week's may be better) of their personal prescription medications.

The onsite Emergency Command post should be inspected thoroughly and all equipment tested. Pay particularly attention to the safety features and the communications systems. If emergency generators, any other fuel consuming equipment, or wet cell batteries are inside the command center, ensure that there is proper ventilation! Check oxygen sensors (in the command center and/or the personal ones) to make sure that they are working. Test all equipment, including communications, ventilation fans, alarms, etc.

C. Back-Up Systems

The person responsible for each back-up system should test it and make sure that the system they are responsible for is ready to go. They should also confirm the "as hooked up" configuration, extra fuel availability, and ventilation.

IV. During

During the height of the natural disaster, the primary role of those chosen to remain in the facility is to:

- stay safe—above and beyond all else,
- monitor and record the disaster's affect on the manufacturing facility, including releases and exposures if possible,
- abate damages, spills, releases and unsafe and/or environmentally damaging conditions if able to do so without endangering themselves, and
- periodically report conditions to the offsite communications center along with requests for assistance, if needed, heads-up on repairs and repair personnel needed after the disaster, and potential offsite damages due to debris and/or loss of containment of chemicals.

A. Safety

Safety of the onsite personnel is vital. How to take care of themselves and others during this stressful time must be part of their training program and emphasized strongly. There will be tremendous pressure to shortcut safety procedures to respond to emergencies. These actions, although superficially heroic, can be misplaced and lead to unnecessary risks and injuries. (Coordinate with Preplan, Natural Disaster Plan, Safety Procedures, Section II. B.) Require all onsite personnel to have first aid training. (Advanced first aid training would be even better.)

B. Security

During the disaster, the facility may incur damages that adversely affect its security or security systems. Usually little, if anything, can be done during the disaster. Notification should be made to the offsite Emergency Command Center, and plans for immediate repairs should be scheduled as soon as circumstances allow it to be done safely. If complete repairs are not possible in the short term, consider temporary repairs and/or alternate systems.

C. Communications

Communicating is often the primary role onsite staffers provide during the disaster. It is their responsibility to observe, deduce, and understand just what damage is being done, the effect of that damage on the facility's well-being, security, safety, and the potential offsite impacts. Their role is to communicate observations and deductions to the offsite Emergency Command Center so that coordinated repair plans and notifications to other response agencies can be made. Being able to make sufficient observations during the disaster may be challenging, but safety should not be compromised in an effort to make them. (Reference Preplan, Natural Disaster Plan, Section II. B.) Several communication tools should be available to the onsite staffers. (Reference Preplan, Communications, Sections II. C.)

V. After

Immediately after the disaster there will be a strong desire to get outside to see the damages. Resist that urge until you are sure that the danger has passed and it is safe to venture outside of the command post. Consider the possibility of chemical releases. Use the appropriate personal protective equipment (PPE) when venturing outside until monitoring proves it is safe. Communicate your status to the offsite command post and let them know that you are going outside. Consider sending a small team out first to validate your assumption that it is safe. Then follow up with more people in small groups. Keep the small groups separate from each other so that each can function as a rescue team for any other team that needs help. Until you are absolutely sure that the hazards are recognized and the risk is tolerable, keep at least one person in the command post. All teams should carry portable communication equipment and stay in touch with the other teams and the command post.

All hazards may not be easily observable. Take special precautions, such as using dielectric boots and rubber gloves when first venturing outside. Be careful of what you touch and where you walk since electrical and/or electronic equipment may have shorted out. If the electrical power is off, electrical hazards may not be apparent until the power is turned back on. Resurvey for electrical hazards after the power has been restored. Chemical hazards may be hidden also. Some caustic chemicals and some acids look like water. Some float on top of the water and some are heavier than water so the water floats on them.

If there is physical damage to your facility, this presents (new) physical hazards. These are often observable, but some can be hidden. Take special care when walking under equipment or structures. They may be damaged or have debris on them that could fall off at any time. Be aware of sharp and jagged edges, broken glass, tripping and slipping hazards, and "visitors/critters." Depending on where your facility is located, you may find cows, dogs, cats, snakes, alligators, and a variety of wild life, wandering around your facility. Most will be distressed, tired, frightened, hungry, and not in a good mood at all. This is not the time to pick a pet. Get the help needed (sometimes experts are needed) to rescue "critters" safely.

A. Damage Assessment and Short Term/Emergency Repairs

As soon as it is safe, survey the facility to assess damages. Look first for things that are severe safety and/or environmental risks requiring immediate attention. Then look for damages that

impact the operability of the facility. Categorize damages into two groups—those that can be addressed with resources currently onsite and those that will require additional resources. Communicate this to the offsite Emergency Command Center so that they can send people to the site with appropriate expertise. Take pictures to document the damages as they are before remediation—for insurance purposes and for improvement hints for designing a safer facility. Do not make repairs and/or modifications without analyzing the consequences of your actions and inactions. Use the management of change process specifically designed for these circumstances. Consider monitoring the air and water and collect samples for environmental reference. Reference Section II. B. Safety Procedures.

B. Security

As soon as the critical safety and environmental issues are identified and are being addressed, turn your attention to site security. Site security involves problems that might be caused by news people, scavengers, looters, curious citizens, terrorists, opportunists, people who are lost or injured and animals of all sorts. On a more somber note, it might also include human bodies and bodies of a variety of animals and reptiles, so be prepared.

As soon as services are available, activate as many of the security systems as possible—including lighting, video monitoring, motion detectors, gate locks, access authorization cards, and guards as soon as it is safe for them to be there. Train guards for the type of situations they may encounter at this time. Since a fence around your facility is a basic form of security, have it repaired as soon as possible.

Make and enact plans to remove the dead (human and animal) as soon as possible and remember to be particularly cautious as corpses may be laden with pollutants, insects, disease, and animals, snakes and rats. Any and all may carry disease and will be a threat to your safety.

1. News People:

News people have the right to document and report on the news. They do not have the right to come onto private or company property without permission. They do not have the right to endanger others and/or the safety and security of your facility or the chemicals onsite. They may bring new risks to the location in the form of lack of knowledge of how to conduct themselves in a chemical manufacturing environment, lack of knowledge of the hazards imposed by the chemicals being handled, and risks imposed on the facility simply from the equipment they may bring.

If possible, keep them out of your facility until it is completely safe and secure and you receive authorization from senior management to grant them access. Try to intercept them before they actually get on the property and explain that safety checks are not yet complete and, therefore, no visitors are allowed in yet. Also tell them that access to the site can be granted only by senior management located in the offsite command center, law enforcement, or certain state or federal agencies, and then only for cause. If already on the property, escort them off. Be polite but firm. Do not say the situation is unsafe unless you want to make the 5:00 o'clock news. Say only that a safety evaluation is being made and is not yet complete. Everything you say or do may be videotaped or recorded and played on the news, so act accordingly.

2. Looters, Scavengers, Terrorists, etc.

These people will probably leave as soon as they see you. If not, ask them to leave. Have the person staffing your onsite command center notify law enforcement. If safe to do so, take their picture for law enforcement follow-up, but do not try to apprehend them yourself.

C. Communications with Outside World

The primary focus of communications with the outside world at this time is to relay messages regarding injury reports, condition of the facility, damages, needed supplies, unusual situations or activities, risks involving release of chemicals, and resources needed. Ongoing risks onsite with possible offsite consequences should be evaluated and described in detail so that appropriate responses can be made. Needed resources may be anything from people with specialized expertise or knowledge to specific types of equipment.

This is the time also for those in the facility to make contact with their families to assure them that they are well and safe and to get caught up on how their families weathered the natural disaster. The offsite command center should recognize this need and facilitate contacts. This is not the time to call television or radio stations and make statements or give narrations of what happened. Do not receive these calls either. If some get through to you, politely tell them that you are busy and cannot talk with them now.

D. Recovery

The disaster has passed and now it is time to deal with the aftermath and get back to normal. Not only will there be damaged equipment to repair, there will be contamination to deal with, hidden or silent failures, new hazards associated with old equipment, and the usual startup risks and problems. Your recovery and recommissioning plan must be as comprehensive as the initial start-up of a new facility, perhaps even more rigorous. The risks will be very similar except with one extra twist—things that may have worked properly before the disaster may not work after it—but you might not know that until something goes drastically wrong. Don't assume that past performance will be repeated. Confirm it.

1. Repairs:

After the critical emergency repairs are made, begin to compile and categorize the other damages that must be repaired before restart. Some damages will be obvious, but some will not. Consider dividing the repairs into categories—such as obvious physical/mechanical damage, potential hidden damages, contamination, support services impairments, electrical outages, electronic/signal failures, and computer issues. Assign appropriate teams to ferret out the extent of the damages and make repair decisions. Remember that some repairs may require Code stamps (API, ASME, ASTM, U or R code stamp, etc.) and/or worker certification of some type. Other repairs may have to conform to national codes (national electrical code, for instance) or standards (ISA is one example) and others may require conformance to your company standards. Be sure those making repairs are qualified to do so and don't forget to do the paperwork—which might include getting a certified inspector to approve the repair.

This may be the time to make some of the upgrades previously planned. If you do, (this decision should not be made without serious consideration), be sure that they are properly reviewed using your management of change procedure and process, including training where needed and a risk assessment is made to validate that it is appropriate to do so at this time.

2. Recommissioning:

Recommissioning involves preparing equipment and personnel again for all of the tasks associated with manufacturing a product. A special recommissioning plan should be developed for recovery from natural disaster-related shutdowns where damages and contaminations are expected. Just because it worked as you wanted it to before the disaster doesn't mean that it will work now, even if there are no apparent damages. Damages may be hidden, calibration may be lost, or contamination might have occurred. Instrumentation is particularly vulnerable to hidden damages, lost calibration, and contamination.

For instrumentation, step through the process one stage at a time and check configuration and responses ensuring that each item is performing as designed. Check for responses to out-of-acceptable or operational-range conditions to ensure that the process controls and safety instrumented systems will bring the process back under control or to a safe configuration. Carefully check (functional check preferred) each safety device or system:

- Basic process controls
- Preventative safety systems
    - Active safety systems
    - Passive safety systems
- Mitigative safety systems
    - Active safety systems
    - Passive safety systems

Do not forget that your distributative control system(s) (DCS) may be the hub of most of these instrumented systems, so check functionality all the way through the DSC.

For processing equipment, check for damages and contamination and confirm that each is ready to receive materials. Pay particular attention to storage tanks that may have been emptied or filled with water during the disaster. Look for displacement and damage to foundations or to tankage due to floating. Also look for piping damage due to tankage displacement and/or impacts from flying debris. After you are sure of the integrity of the equipment, start reinventorying it based on your startup plan. Support systems, such as lubrication, compressed air, inerting, and fuel supply systems should be carefully checked for contamination and product quality. Bearings and seals may have been compromised so check them for contamination including grease/packing and local lubrication supply systems. If you are uncertain regarding contamination, assume it to have occurred and flush/replace lubrication systems and supplies.

3. Training:

Remember to train (or refresher train) employees who will be recommissioning the facility. Don't assume that just because they were good operators before the disaster that they will remember how to start up a facility recovering from a complete shutdown. Consider training recommissioning personnel together so that they develop a team concept and are accustomed to working with each other. If contractors are involved, make them part of the retraining and

recommissioning team. Customize the recommissioning training to the types of circumstances associated with the type shut down the facility went through and the type of natural disaster it experienced. The training should reemphasize the need for workplace safety, process safety, and process material containment control. Emphasize that they must function as a team and be a model of safety and environmental responsibility. Consider making a process safety expert(s) part of the recommissioning training and team with the specific purpose of helping the team identify and properly analyze risks.

Recommissioning may highlight several changes that may be needed to compensate for missing and/or damaged equipment or makeshift repairs. Use the specially developed MOC process and do not shortcut the system in an effort to get the facility ready for restart quickly. Changes made in this stage can be particularly risky and, if not properly analyzed, can cause catastrophic consequences. The same thought process should be applied to Prestart-up Safety Reviews. These must be thorough and comprehensive. See Section F for a more complete description of how to conduct PSSRs after a disaster.

4. Interdependencies:

Startup may be contingent on help from others, perhaps for electrical power or water supply. Consider the interdependencies developed and discussed in Section II, B and use them to your advantage. Recognize that this is a give-and-take proposition—you may be called on to give a service associated with interdependencies with another company before you can receive a service from them. Either way, play your part and do what you can to help everyone, including yourself, recover from the disaster.

When developing recovery and recommissioning plans, consider what interdependent services will be available and how they might be used to help you recover from the disaster and restart your facility. Make it known just what services you need and explain how those services will enable your facility to provide services to others. Follow through on your "promises" by providing services to others as outlined in the interdependencies section of your disaster preplan. (See Appendix D—Example List of Interdependencies)

5. Agencies Assistance and Interactions:

Make sure that the agencies understand the interdepencies and how proper utilization will facilitate recovery and restart not only for manufacturing facilities but for the community as well. In addition to interdepencies, don't be shy in asking the agencies for help in recovery. They may be able to provide expedited routes for repair materials, some security assistance, technical expertise, and establish communication mechanisms.

E. Staffing

Staffing the facility for emergency repairs, long term repairs, and eventual restart has several phases each with different needs. Staffing may be with company employees only, but will probably include contractors as well. To keep staffing levels manageable and working effectively, develop a time line or sequence chart of what needs to be done and in what order. Match required expertise to the different tasks and then develop a staffing chart to match. As projects are completed, adjust staffing accordingly.

1. Locating Employees:

Your preplans should have included a mechanism for employees to contact the company and a way for the company to contact and/or in some way get messages to employees. See Section II. C—Communications. Based on the staffing chart developed above in Section V, E—Staffing, schedule identified employees to come back into the plant. This should be voluntary if at all possible. Recognize that some employees may not be available because of significant damages to their homes and/or family issues associated with the evacuation requiring their attention.

2. Lodging:

After needed employees and contractors are back onsite, they may need local housing and services which they may not be able to secure on their own. If you expect them to continue helping secure, repair, and start up the plant, you may have to provide housing and services for them. Consider contracting with a local hotel or motel to provide them. If that is not possible or if local services are damaged beyond use, consider installing temporary housing, laundry, kitchen, etc. onsite. Also consider bringing in additional contractors to operate these temporary facilities and services.

It may be that your employees' homes were damaged and their families have no place to stay. Consider making arrangements for them to be housed in surrounding areas not severely impacted by the disaster. It is important that you take care of your employees and their families during this time. The cost to do so will probably be insignificant when compared to the total disaster cost. The favor will be returned.

F. Restart

Restarting your facility after a natural disaster could be a very hazardous event if not planned properly. Before starting manufacturing operations a number of risks must be identified and addressed. These risks range from making sure those responsible for the startup are properly trained to ensuring that the equipment is ready to receive the chemicals and that all operational and safety systems are functional.

1. Operational PSSRs:

After the disaster, inspect your facility even better than you would a new facility. Section the facility into blocks of equipment or processing mini-sections and perform a PSSR[5] on each section using the employees who will operate and service the area with help from specialists. Don't forget to function test equipment, especially instrumentation and safety systems. Look for blockages (for instance in relief valve discharge pipes) and debris that might impair the functionality of equipment (for instance a twig prohibiting a valve from stroking). Note areas where insulation has been damaged and restrict access if personnel safety is involved.

[5] Guidelines for Performing Effective Pre-Startup Safety Reviews, Center for Chemical Process Safety, New York, 2007.

If heavy rains and/or flooding were involved, inspect all tanks for evidence of cracking, foundation, or tie down damage. Also look for damage to piping connected to tanks that might have floated or been displaced. Conduct an internal inspection, if possible, to check for water contamination. Inspect all type lubrication systems. Grease may have washed out or oil reservoirs may be contaminated. Test all electrical and electronic equipment and systems. If needed, megger motors, conduct infrared scans to detect hot spots in equipment and panel boards, system-check instrumentation loops, and function- test everything that you can.

If strong winds were involved, look for debris-impact damage such as missing insulation, broken tubing and wiring, dented piping, and bent structural supports. Pay particular attention to sensitive or fragile instrumentation systems.

2. Safety PSSRs:

After the operational PSSRs, re-review the area and pay particular attention to tripping, falling, cutting, and "critter" hazards. Remember that snakes, spiders, dogs, cats, and even alligators may have been looking for a safe haven during the storm. By now, they are sure to be frightened, hungry, tired, uncomfortable, and dangerous. Cautiously open equipment, panels, and drainage trenches.

3. Training:

We tend to spend many more training hours on how to operate the facility than we do on shutting it down and starting it up—which are often the most dangerous periods. Startup after a disaster, where contamination, damage, unusual location of processing materials, and a taxed/tired support system might coexist with unhappy and frightened "critters", could be particularly hazardous.

To offset this hazard, retrain (or give refresher training to) all the employees who will be responsible for startup. This includes operational, maintenance, safety, engineering and supervision. Training should focus on recognizing anomalies in the startup sequence and how to correct them. Consider training people together in teams of operations, maintenance, engineers, and supervision so that they become familiar with each other's actions and "styles." For support personnel (mechanics, electricians, and instrument specialists), consider retraining them on recognizing early effects of contamination, electrical issues, and failed safety systems. Supervisors and engineers should be reminded of and retrained in the part they are to play in the startup, how they are to interact, and their specific responsibilities and authorities. Spend some training time on protocols for communicating requests for help, status reports, and concerns. Consider training a process safety person (or team) to function as an "unbiased" advisor to give the startup team advice on potential responses to risks encountered.

Give everyone refresher training on the basic safety procedures that may be used during startup. Pay particular attention to recognizing and responding to changes required. Retraining on your MOC procedure, or training on the MOC procedure developed just for this startup, would be very valuable. Remind startup personnel that the plant may be occupied by unwanted visitors, such as snakes, spiders, and even alligators. Educate/ reeducate them on safety procedures for opening panels, junction boxes and going into confined spaces as to how

they should respond if such intruders are encountered. Remind everyone to look before they reach.

G. Critique

"Lessons Learned" come from having experiences and then documenting them in order to learn from and share them. As soon as possible after the natural disaster, have everyone involved compile their notes and experiences so that a critique of the events and responses can be made. Each person should list all of the things that:

- went well (as planned or better than planned),
- did not go well (did not go as planned or was significantly deficient, short sighted, or misdirected),
- were unanticipated/unplanned events, and
- had sections that should be improved.

If possible, ask neighboring facilities and the civic authorities who participated in managing the disaster and/or response to do the same.

Have a meeting where this information is shared, learned from, and factored into an updated overall disaster plan. Don't make this a "blame somebody" type meeting, but rather a meeting in which all learn what worked, what did not work, and how the approaches and actions can be changed so that everything works better the next time. Everyone should work within the alliances already established in preparing for the disaster and walk away from the meeting with assignments on improving various issues within their realm of responsibilities. If interdependencies were involved, try to get other company facilities, utilities, or services that were interdependent with your facility involved also. Set up a follow-up meeting in about six months to review status reports and needs for further assistance/ resources, etc. Have a full drill about a year after the disaster (or just before the next natural disaster season) to confirm that progress has been made. Try to include everyone and every function, agency/etc. that participated in the real thing a year earlier. Test all systems, communications, responses, and recovery actions. Make it as real as possible. Critique the drill and continue to learn and improve.

VI. References

A. U.S. Chemical Safety and Hazard Investigation Board Safety Bulletin No. 2005-01-S, September 2005, "After Katrina: Precautions Needed During Oil and Chemical Facility Startup"
B. Center for Chemical Process Safety, Publication # N-8, "Corporate Crisis Management"
C. National Petrochemical & Refiners Association, NPRA White Paper: Hurricane Security Operations," May 31, 2006
D. FEMA Web site: http://www.fema.gov/
E. American Red Cross, Business & Industry Guide—Preparing Your Business for the Unthinkable
F. U. S. Department of Labor, Occupational Safety and Health Administration, "Hurricane eMatrix—Hazard Exposure and Risk Assessment Matrix for Hurricane Response & Recovery Work" Web site: http://www.osha.gov/SLTC/etools/hurricane/index.html
G. "Lessons Learned from Natural Disasters" presentation at the OECD Workshop Natech Risk Management, May 23-25, 2012, Dresden, Germany by Mr. Charles Cowley, AIChE/Center for Chemical Process Safety, Staff Consultant

VII. Appendices

A. Example List of Major Decisions to be made
B. Example List of Suggested supplies
C. Example Checklist of Communication Equipment
D. Example List of Interdependencies
E. Example Risk Analysis for Potential Onsite Consequences of Concern
F. Example Risk Analysis for Potential Offsite Consequences of Concern
G. Natural Disasters that may occur without (much) Warning

APPENDIX A: EXAMPLE LIST OF MAJOR DECISIONS TO BE MADE*

* This is an example. You should develop your own checklist specific for your situation.

Topic	Made By	Made When	Decision	Required Actions
Operate manufacturing and storage facility or shut them down	Bill Smith, Plant Manager	1 week before expected disaster	Shut it down	Initiate total shutdown process including deferring inbound raw materials and notification of personnel
How to handle in plant inventories	Sue Hastings, Production Manager	Immediately after operate or not decision	Deinventory/empty all tankage with toxic, flammable, or oil based materials	Initiate Purge and Clean deinventory plan
Operate cogeneration unit or shut it down	Stan Charge	4 days before disaster expected	Shut it down	Notify commercial utility company; initiate cogeneration total shutdown procedure
Tankage—leave empty or fill with water	Sue Hastings, Production Manager	Immediately after operate or not decision	Leave empty	Survey all empty tankage and add tie-down security if needed
Activate and staff onsite command post during disaster or not	Bill Smith, Plant Manager	3 days before disaster expected	Yes	Initiate onsite disaster command post activation sequence and actions. Notify those who will staff the plant. Notify and train needed replacements. Order needed supplies
Where will the offsite command post be	Top Dog, Area Director	First warning of impending disaster		Secure accommodations and get a Tee time scheduled
Where will materials be staged offsite	Lou Jistics	First warning of impending disaster	First terminal outside of 300 miles from plant	Formal alert notification to suppliers and customers.
Will Interdepencies be called upon	Percy Swasor	First warning of impending disaster	You bet!	Notify all agencies and interdependent companies. Review interdepencies with each and protocol for activation.
Complete the list of major decisions that will have to be made for your facility				

APPENDIX B: EXAMPLE LIST OF SUGGESTED SUPPLIES*

* This is an example listing of supplies that should/could be on hand for those remaining onsite. It does not include quantities. Those who have experienced hurricanes say that you probably should increase your original quantity estimate by 50%. You should develop your own checklist and quantities specific for your situation and expected needs.

First Aid Supplies:

Item	Quantity
Antacids	
Anti-diarrhea medication	
Ipecac	
Emetrol	
Cold tablets/liquids	
Laxatives	
Cough drops/syrup	
Nasal spray/inhalers	
Aspirin products	
Non-aspirin pain relievers	
Eye wash/rinses	
Eye patches	
Gauze—strips, pads, rolls	
Cotton pads and balls	
Cotton Swabs	
Bandages—strip, butterfly	
Band aids	
Butter fly bandages	
Burn ointment	
Vaseline petroleum jelly	
Insect repellant	
Insect bite ointment	
Snake bite kit	
Hydrogen peroxide	
Rubbing alcohol	
Iodine	
Calamine lotion	
Suntan lotion	
Baking soda	
Tooth ach medication	
Lip balm	
Penicillin ointment	
Contact lens supplies	
Listerine	
Vicks Vapor Rub	
First aid instruction book	

Item	Quantity
First aid kit	
Blood pressure kit	
Scissors	
Tweezers	
Knife	
Thermometer	
Magnifying glass	
Disposable safety razors	
Nail clippers	
Nail file	
Safety pins	
Needle	
Small Mirror	
Small flashlight	
Tongue depressors	
Disinfectant soap	
Germicidal hand wipes or waterless alcohol-based hand sanitizer	
Antiseptic wipes	
Medical grade non-latex gloves	
Cold pack	
CPR breathing barrier	
Adhesive tape	
Salve for wounds	
Eye wash cup	
Murine/Visine/etc./	
Eye patches	
Sanitary napkins	
Burn blanket	
Add your own first aid items	

*Note: This is just a suggested list. Your list should consider the type injuries expected and/or possible.

APPENDIX B: EXAMPLE LIST OF SUGGESTED SUPPLIES*--Continued

Food Supplies:

Item	Quantity
Bottled water—estimate about 2 gallons/person/day for drinking	
Bottled sports drinks	
Canned juices—apple, orange, etc.	
Soft drinks	
Coffee—instant and perked	
Tea—instant and seeped	
Milk	
Buttermilk	
Powered milk	
Cans of evaporated milk	
Peanut butter	
Jelly	
High-energy foods (granola bars, energy bars)	
Power Bars	
Cookies	
Honey	
Cereal	
Saltine crackers	
Wheat Thins	
Cheeses	
Chips—potato, corn, etc.	
Packages of party snacks	
Ice	
Marshmallows	
Nuts—peanuts, pecans, almonds, etc.	
Hard candy	
Pancake mix	
Pancake syrup	
Eggs	
Bread	
Tortillas	
Rice	
Mashed potato mix	
Seasonings	
Sugar	

Item	Quantity
Salt	
Pepper	
Cooking oil	
Flour	
Ramen Noodles	
Canned soups	
Canned vegetables	
Pork and beans	
Canned Chili	
Spaghetti sauce	
Spaghetti/pasta	
Hot dogs	
Hamburger meat	
Ready-to-eat canned meals, meats, fruits, and vegetables	
Packaged sliced meats	
Mac & Cheese Packets	
Fresh fruit—Apples, oranges, grapes, bananas, pears, etc.	
Dried fruit—raisins, plums, prunes, etc.	
Canned fruit and sauces—applesauce, etc.	
Microwave popcorn	
Your favorite Cajun seasonings	
Your favorite hot sauce	
Multivitamins	
Paper plates and plastic utensils	
Aluminum foil	
Zip lock type bags in varying sizes	
Can opener—non-electric	

*Note: This is just a suggested list of food for those who will remain onsite during the disaster. You should develop your own list considering the culture of the area and the people (possibly with food restrictions) who will be there.

APPENDIX B: EXAMPLE LIST OF SUGGESTED SUPPLIES*--Continued

Clothing and Personal Effects:

Item	Quantity
Mens shirts—long sleeve, cotton in various sizes	
Mens Bluejeans/slacks in various sizes	
Mens briefs—cotton in various sizes and styles	
Womens blouses—long sleeve, cotton in various sizes	
Womens bluejeans/slacks in various sizes	
Womens briefs—cotton in various sizes	
Bras—sports bras—cotton in various sizes	
"T" shirts in various sizes	
Socks—tube cotton in various sizes	
Raincoats in various sizes	
Trench coats in various sizes	
Gloves—cotton in various sizes	
Gloves—rubber/dielectric in various sizes	
Boots—Rubber, dielectric in various sizes	
Sleeping Bags	
Pillows	

Item	Quantity
Blankets	
Sheets	
Sleeping arrangements—cots, beds, etc.	
Female personal items	
Combs	
Toothbrushes	
Toothpaste	
Mouthwash	
Deodorant	
Disposable razors	
Shaving soap	
Tissues/Kleenex, etc.	
Shampoo	
Soap	
Towels	
Washcloths	
Lotion	
Sanitizing soap	
Generic reading classes of varying strengths	
Flashlights	
Plastic bags	
Pre-moistened towelettes	
Waterless hand cleaner	
Toilet paper--lots	

*Note: This is just a suggested list of clothing for those who will remain onsite during the disaster. You should develop your own list considering the culture of the area, the time of the year, weather expected, and the people who will be there.

APPENDIX B: EXAMPLE LIST OF SUGGESTED SUPPLIES*--Continued

Tools & Supplies:

Item	Quantity
Batteries—Various sizes including AAA, AA, C, D, 9 volt, 6 volt, etc.	
Portable walkie-talkie radio batteries	
Battery-operated black& white TV	
Battery-operated AM-FM radio (with Weather Alert)	
Battery chargers for a variety of batteries	
Cellular phones with extra batteries and battery chargers	
Fire extinguishers of different types and sizes	
Brooms	
Mops	
Squeegee	
Rags for clean up	
Candles	
Flashlights	
6 volt lanterns	
Propane lanterns	
Matches	
Lighters	
Sterno	
Rope of varying sizes and lengths—some manila and some nylon	
Tarpaulin Fire Resistant	
Duct tape	
Masking tape	
Adhesive tape	
Oil absorbents	
Oil boom with absorbents	
Sheet plastic both black and clear of varying thicknesses	
Plywood ¼" and ½" for boarding up broken windows	
Tire and tube repair materials and plugs/patches	
Spare vehicle tires and jacks	

Item	Quantity
Electrical contact cleaner spray	
Tree saw	
Insect killer—bees, wasps, etc.	
Charcoal	
Charcoal lighter fluid	
Lighter	
Water (for flushing toilet, washing hands, etc)	
Paper plates, cups, etc.	
Thermos for keeping beverages hot	
Plastic garbage bags	
Zip-lock type bags of varying sizes	
Large leaf bags	
Garbage can liner 30 gallon type bags	
Burlap Bags	
Toilet paper	
Paper towels	
Hammers and nails	
Heavy duty Staplers	
Battery operated fans	
Coleman type coolers of varying sizes (keep ice in coolers until needed)	
Ice (keep ice in Coleman type coolers until needed)	
Small propane tanks--full	
Gasoline tanks in vehicles topped off	
Mops & buckets	
Mechanics box of tools	
Cash—coins and currency	

*Note: This is just a suggested list of tools and supplies for those who will remain onsite during the disaster. You should develop your own list considering the type facility you have, the equipment involved, your emergency command center and the people who will staff it.

APPENDIX C: EXAMPLE CHECKLIST OF COMMUNICATION EQUIPMENT*

* This is an example. You should develop your own checklist specific for your situation and the equipment you will use.

Communication Equipment	Purpose/Service	Assigned to:	Located:	Tested by:	Ready?
GETS—Government Emergency Telecommunications Service	Gives priority if land line telephone services are overloaded or congested	ER team members	Wallet cards	ER team members	Yes
NOAA Band Radio	Weather reports	ER Communications coordinator	Onsite emergency control center on desk	ER Communications coordinator	Yes
Cell Phones	Multiple communication points and sources	ER team members + management team	Individual in possession	Individual in possession	
Satellite Phones	More secure and less susceptible to outages	Onsite emergency team commander, second in command and offsite management team	Onsite emergency control center—main desk	Onsite emergency team commander	
Internet	Non voice communications; separate telecommunication route	ER Communications coordinator	Onsite emergency control center, second office	ER Communications coordinator	
Citizen Band Radios	Separate communications route				
Walkie-talkies	Short range communications for onsite employees				
Two Cans and Ball of String	Last chance—albeit a slim one				
Complete the list with any other communications equipment you have					

APPENDIX D: EXAMPLE LIST OF INTERDEPENDECIES

* This is an example. You should develop your own checklist specific to interdependencies for your situation.

Interdependency	With Whom	Contact/Tel #	Notes
Electricity	Cajun Electrical Power Supply	Buba Poche/555-555-5555	We need electrical power from CEPS to get our cogeneration unit running. After startup, we can supply electrical power back in to public grid.
Steam and Fuel	ABC Gas Processors	Terry (Mr. T) Boudreaux/555-123-456	If our steam boilers and our cogeneration plant are running, we can supply steam to ABC who in turn will be able to supplement our fuel supply by sending us the off gas from their steam heaters.
Communications and Electrical power	Tell-Tell Communications Co.	Mary LeBlanc/555-345-6789	We supply TTC electrical power and they operate our communications systems and tower for us.
Fire fighting emergency response	Bayou Area Fire Emergency Response Team	Dwaine (Dupe) Dupree	BAFERT supplies mobile firefighting equipment and personnel. We supply the fire truck and personnel.
Add your own list of interdependencies and contacts			

APPENDIX E: EXAMPLE RISK ANALYSIS FOR POTENTIAL *ONSITE* CONSEQUENCES OF CONCERN*

Example Risk analysis of consequence sequences that may be of concern onsite include:
* This is an example. You should develop your own consequences of concern, risk and abating actions specific for your situation.

Hazard	Initial onsite Consequence	Secondary onsite Consequence	Risk Rating	Abating Action
Heavy rain	shorting out control instruments, safety instrumentation or systems, and/or communication equipment	• Loss of process containment for hazardous chemicals • Loss of communication capabilities	Medium	Waterproof, cover, and protect all junction boxes, switchgear, electrical cabinets, and enclosures.
Heavy rain	causing a high weight load on structures and buildings roofs	• Structural failure, roof collapse, possible injuries	High	Clear all roof gutters and downspouts, check all drainage routes, and do not allow people in building or upper floors.
Flooding	causing tanks to break loose from their tie-downs and float off			
Flooding	causing surge pits/waste water ponds/etc. to overflow releasing their contents to the surrounding area			
Lightning strike	destroys your process computer and/or SIS systems			
Lightning strike	damages your communication equipment			
Lightning strike	Ignites flammable storage tanks	Damage / collapse of nearby tanks	High	Empty and rinse tanks
High Winds	damages structures; wind blown shrapnel			

Hazard	Initial onsite Consequence	Secondary onsite Consequence	Risk Rating	Abating Action
Develop your own unimaginable list of consequences that potentially will occur				

APPENDIX F: EXAMPLE RISK ANALYSIS FOR POTENTIAL *OFFSITE* CONSEQUENCES OF CONCERN*

Example Risk analysis of consequence sequences that may be of concern offsite include:
* This is an example. You should develop your own consequences of concern, risk and abating actions specific for your situation.

Hazard	Initial onsite Consequence	Secondary onsite Consequence	Risk Rating	Abating Action
Loss of process chemical containment	• Air borne toxics • Water borne toxics/pollutants	• Respiratory injury to people • Animal injury or death	Medium	Reduce all toxic chemical inventory to minimal levels and secure remaining supplies in strongest tanks
Storage or process tanks break loose from their restraints and float off	• Impact damage to structures, homes and utility services • Carries possible contaminants	• Displaced inhabitants • Pollution and toxic contamination/injuries	Low	• Reduce all toxic chemical inventory to minimal levels and secure remaining supplies in strongest tanks • Secure tankage from floating
Storage or process tanks overflow due to rain water intrusion	• Contamination • Pollution/toxic effects • Possible increase in fire hazard			
Explosion causing shrapnel to be thrown	• Impact damage to structures, homes and utility services • People and livestock injuries/deaths			
Debris blown from plant	Same as explosion	Same as explosion	High	Housekeeping + tying everything down and/or storing all loose items in buildings
Develop your own unimaginable list of consequences that potentially will occur				