



HURRICANE KATRINA: ONE YEAR LATER

What Must We Do Next?

A Statement by the American Society of Civil Engineers Hurricane Katrina External Review Panel

Christine F. Andersen, P.E., M.ASCE
Jurjen Battjes, Ph.D.
David E. Daniel, Ph.D., P.E., M.ASCE (Chair)
Billy Edge, Ph.D., P.E., F.ASCE
William Espey, Jr., Ph.D., P.E., M.ASCE
Robert B. Gilbert, Ph.D., P.E., M.ASCE
Thomas L. Jackson, P.E., D.WRE, F.ASCE
David Kennedy, P.E., F.ASCE
Dennis S. Mileti, Ph.D. M.ASCE
James K. Mitchell, Ph.D., P.E., Hon.M.ASCE
Peter Nicholson, Ph.D., P.E., M.ASCE
Clifford A. Pugh, P.E., M.ASCE
George Tamaro, Jr., P.E., Hon.M.ASCE
Robert Traver, Ph.D., P.E., M.ASCE, D.WRE



HURRICANE KATRINA: ONE YEAR LATER

What Must We Do Next?

A Statement by the American Society of Civil Engineers Hurricane Katrina External Review Panel

Hurricane Katrina created a human tragedy of immense proportions. The members of the American Society of Civil Engineers (ASCE) extend their sincere condolences to the families and friends of those who lost their lives during and after Hurricane Katrina. Our heartfelt sympathy goes out to the people of the New Orleans area who are left without homes, communities, and jobs, and to those who face an uncertain future.

The members of the ASCE Hurricane Katrina External Review Panel have conducted an in-depth review of the comprehensive work of the United States Army Corps of Engineers (USACE) Interagency Performance Evaluation Taskforce (IPET). We are indebted to the dedicated efforts of more than 150 engineers and scientists who have, over the past year, evaluated the causes of the New Orleans area hurricane protection system failures.

As a result of this excellent work, we now have a better understanding of what went wrong and why. The ASCE Hurricane Katrina External Review Panel has an obligation to share our findings and insights, which go beyond the scope of the IPET review, so that others may learn from this tragedy and to prevent it from happening again. The question now becomes, “What must we do next?”

There are serious deficiencies in the Southeast Louisiana hurricane protection system that must be corrected if the New Orleans area is to avoid a similar catastrophe when the next major hurricane strikes. There are flaws in the way the hurricane protection system was conceived, budgeted, funded, designed, constructed, managed, and operated.

There is no quick fix for the complexity of problems. Overcoming the deficiencies in the New Orleans hurricane protection system – and instituting real change in its governance, management, and engineering – will require leadership, courage, conviction, and funding.

The lessons learned from Hurricane Katrina also have profound implications for other American communities and a sobering message to people nationwide: ***we must place the protection of public safety, health, and welfare at the forefront of our nation’s priorities.*** To do anything less could lead to a far greater tragedy than the one we have witnessed in New Orleans.

What follows are ten critical actions the ASCE Hurricane Katrina External Review Panel believes necessary. Each action falls under one of four required shifts in thought and approach: understand risk and embrace safety; re-evaluate and fix the hurricane protection system; revamp the management of the hurricane protection system; and demand engineering quality. We consider each action essential and we strongly recommend that each be implemented.

Understand Risk and Embrace Safety

When Hurricane Katrina came ashore, the hurricane protection system failed with tragic consequences. The catastrophe that befell New Orleans was born, in part, out of failure to recognize the fragility of the levee system in the face of storms of Hurricane Katrina's magnitude. Few appreciated how devastating the consequences of failure could be. There was far too little priority or urgency given to the hurricane protection system by its political leaders at all levels of government, designers and operators, and the people who lived under its shadow – evidenced by the fact that the system took decades to build and remains incomplete yet today.

The people of New Orleans – and all those who live in hurricane- and flood-prone communities around the country – must understand and acknowledge the risks under which they live. From this knowledge comes insight into what risks are acceptable for their communities and for the nation.

CALL-TO-ACTION NUMBER 1:

Keep safety at the forefront of
public priorities.

No single authority has ever been charged with responsibility for defining in clear, specific, and unambiguous terms what was to be expected from the hurricane protection system in the New Orleans region in terms of protection from flooding and loss of life. As the hurricane protection system for New Orleans was being designed and debated amongst the USACE and state and local stakeholders, compromises were made based on cost, land use, environmental issues, and other conflicting priorities. Protection of the public's safety was not always the outcome of these compromises.

It is human nature – both at a personal and institutional level – to lose focus of long-term needs in light of short-term demands. The infrequency of major hurricanes tends to lull society into neglect and inaction. Long-term safety must take precedence. Without a significant elevation of safety as a priority, the hurricane and flood protection systems in New Orleans and the nation have the potential to return to a low priority. *All responsible agencies in New Orleans and elsewhere should reevaluate their policies and practices to ensure that protection of public safety, health, and welfare is the top priority for the infrequent but potentially devastating impacts from hurricanes and flooding.*

Consistent inspection, maintenance, and repair of the hurricane protection system are essential. We cannot afford to permit our hurricane and flood protection systems to deteriorate. *The U.S. Congress should establish and fund a program for nationwide levee safety and rehabilitation, much as we do for major dams.* The levee safety program will help ensure that levee structures and components – in New Orleans and throughout the country – receive the level of attention needed for critical life safety systems.

CALL-TO-ACTION NUMBER 2:

Quantify the risks.

Assessment of risk is a key engineering function. Engineers must assess and communicate clearly to decision makers and the public how risk-cost-benefit tradeoffs will impact performance and safety. They must take an active role in formulating public policy and in decision-making at all levels of government.

The USACE IPET has undertaken the critically important effort of quantifying the risks associated with the New Orleans hurricane protection system. Using sophisticated risk models, the IPET is analyzing the potential consequences from a range of storm scenarios. Among the variables considered are hurricane intensity, hurricane location and direction of approach, height and strength of levees, ability of pump stations to remove water, whether levee penetrations are closed, and land elevation and its propensity for flooding.

The ASCE Hurricane Katrina External Review Panel encourages the IPET's work toward quantifying risk for each geographic region of the New Orleans area. Completing this work must remain a very high priority. Only then can fully informed decisions be made regarding the future of the region.

The level of risk also changes with time, depending on changes in the natural and man-made environment. Therefore, the risk analyses need to be updated as new information becomes available.

The USACE IPET should complete the work necessary to quantify risk as soon as possible, and because risk assessment is not static, should periodically update the assessment of risk. This risk assessment approach should be extended to all areas of the nation that are vulnerable to major losses from hurricanes and flooding.

CALL-TO-ACTION NUMBER 3:

Communicate the risks to the public and decide how much risk is acceptable.

The future of New Orleans and the State of Louisiana depends on people's confidence in the hurricane protection system. Local, state, and federal leaders – in concert with the engineering community – need to embrace a common risk-based decision support tool for planning and decision-making. These leaders need to initiate and maintain an honest and open dialogue with all major stakeholders about the risks of living in a hurricane-prone region.

The people of New Orleans – and those who live in flood- and hurricane-prone communities around the country – must have a voice in decisions about the conditions under which they live. Decisions which have the potential for profound impact are best based on knowledge, insight, and timely, structured debate.

Local, state, and federal agencies should create and maintain quality programs of public risk communication in New Orleans and other areas threatened by hurricanes and flooding. The public risk communication program should be based on state-of-the-art best practices for process and content, and address a full range of pertinent topics. The public needs to know, for instance, the probability that a major hurricane will hit a particular region and the level of protection provided by their region's hurricane protection system. People also need to know the full range of citizen-based emergency preparedness and response options and evacuation plans.

The ultimate goal of the risk communication program should be to produce an adequately informed and engaged public. There are a number of examples which could be used as a model for the New Orleans risk communication initiative, including the work of the State of California's Office of Emergency Services as part of the Parkfield Earthquake Prediction Experiment in the 1980s, and the work done by the U.S. Geological Survey in the San Francisco Bay area after the Loma Prieta earthquake in 1989.

Major hurricanes of the scale of Katrina are infrequent. Without an effective risk communication program, people will gradually forget about the risks. In doing so, they will unknowingly contribute to the severity of the consequences from the next hurricane that strikes.

Re-evaluate and Fix the Hurricane Protection System

The first line of defense in the hurricane protection system for New Orleans includes levees and floodwalls to hold back the high water from a storm surge, yet it failed catastrophically at over 50 different locations during Hurricane Katrina. There was no second line of defense other than, perhaps to some extent, the pump stations.

Not only did the hurricane protection system have many weak links – in the form of penetrations, low points, and gaps – but it lacked “redundancy.” If one component failed, there was no back-up component or strategy to take its place to reduce the damage. Internal levees were not used as much as they could have been to isolate various sub-sections of the city and prevent floodwaters from spreading. The pump stations, which might have removed water from the city more quickly, were not designed to function in a major hurricane or mitigate flooding if the levees were overtopped or breached. The “system” was not a system.

CALL-TO-ACTION NUMBER 4:

Rethink the whole system, including land use in New Orleans.

The nation learns lessons after every major disaster: lessons in decision making, structural integrity, disaster response, and communications. The nation is now at a unique juncture where past mistakes in the hurricane protection system for New Orleans can be learned from and rectified.

The USACE’s IPET has made excellent progress on the task of identifying deficiencies in the hurricane protection system. There is still much to be done to build on IPET’s work, and we strongly urge that this work be funded and pursued to its completion. Information from the IPET analyses, coupled with a clear definition of the public’s expectations (as framed in Call-to-Action Number 3), will form the basis for rethinking the entire hurricane protection system.

At the outset, the design hurricane and storm surge levels need to be reassessed and updated using a risk-based approach. The design hurricane conditions cannot be static design criteria. Risk and levels of acceptable risk evolve with time – as does our knowledge on which the storm criteria are based.

The future system will incorporate existing infrastructure (such as levees and pump stations) but must include other appropriate tools and strategies as well. Prudent land use decisions (for example, limiting development in the most flood-prone areas or establishing minimum first floor elevations) can put fewer people and less property at risk. More rigorous building requirements can reduce the impact of flooding to structures. A more effective hurricane warning, response, and evacuation protocol can be instituted and practiced in regular training exercises. Pre-planning can expedite recovery and reconstruction after a major hurricane.

The ASCE Hurricane Katrina External Review Panel calls on New Orleans and all hurricane- and flood-prone communities around the nation to use the lessons learned from Hurricane Katrina to develop roadmaps for safety and protection. *Local, state, and federal leaders should review the overall strategy and systems approach, integrating hurricane protection tactics, land use considerations, and emergency response strategies into a coherent and well thought out system.*

CALL-TO-ACTION NUMBER 5:

Correct the deficiencies.

Hurricane Katrina obliterated many critical hurricane protection structures and wreaked great damage on others. The disaster also brought to light many weaknesses and deficiencies in the existing system that, if not fixed, remain vulnerable to future hurricanes. The work to be done includes making up for past design deficiencies and strengthening components of the system to make them more resilient to damage.

Hurricane Katrina offers a cautionary tale and subsequent mandate to other hurricane-prone communities as well. Now is the time to fix deficient or damaged parts of existing flood and hurricane protection systems throughout the country to provide the intended levels of protection. *Local, state, and federal leaders should continue the work necessary to correct the deficiencies in the hurricane protection system, and bring this work to completion with urgency.* In the New Orleans region, must-do items include:

- **Establish mechanisms to incorporate changing information.**

The dynamics of the hurricane protection system – such as levee heights and meteorological and oceanographic conditions – need to be monitored routinely, especially when processes like subsidence

are known to occur. Advances in surveying technology need to be fully utilized to establish and regularly update geodetic vertical datum and water surface elevations. Levee design, construction and maintenance must be tied to elevations that provide the true level of flood and hurricane protection intended for New Orleans.

- **Make the levees survivable if overtopped.** During Hurricane Katrina, waves and water rushing over the levees severely damaged and compromised their integrity. Overtopping of the levees because of hurricanes is inevitable. To prevent damage, the levees need to be armored by resurfacing them with protective non-erodable materials.
- **Strengthen or upgrade the floodwalls and levees.** Full investigation and analyses need to be performed to ensure that the floodwalls and levees have adequate margins of safety against failure, consistent with critical life support structures. Such was not the case pre-Katrina, and may not always be the case now.
- **Upgrade the pumping stations.** Not only was the pumping system not fully integrated into the hurricane protection system, but many of the pump stations were not strong enough to withstand the forces of a hurricane. The pump stations need to be made survivable from flooding caused by hurricanes and unanticipated levee breaches. If this is not done, New Orleans will remain unnecessarily vulnerable.

Revamp the Management of the Hurricane Protection System

The management of New Orleans's hurricane protection system was dysfunctional because there were too many organizations involved in managing separate pieces of the system. No one entity or person was in charge. Many agencies had partially overlapping roles, yet there was no effective coordination between agencies.

The members of the ASCE Hurricane Katrina External Review Panel believe that correcting the deficiencies in the management of the hurricane protection system is just as important as correcting the physical deficiencies. With effective management comes a more unified approach to hurricane protection – which is greatly needed in New Orleans.

CALL-TO-ACTION NUMBER 6:

Put someone in charge.

No complex program or system can be successful without good leadership, management, and someone in charge. The New Orleans hurricane protection system evolved over decades under the initiative and management of numerous agencies, none of which had definitive authority to adjudicate conflicting priorities. Until someone is put in charge of overall management and made accountable, organizational dysfunction will continue.

Local, state, and federal leaders should agree to assign to a single individual the responsibility for managing critical hurricane and flood protection systems such as the one in the New Orleans area.

The ASCE Hurricane Katrina External Review Panel recommends that the “person-in-charge” or “commissioner” be a high-level, licensed engineer (or, alternatively, a panel comprising licensed engineers). We suggest that the commissioner might be a direct gubernatorial appointment, with input from affected entities, so that he or she has the authority to act on behalf of the governor. The currently proposed changes to the New Orleans area levee board structure will help streamline communications and establish a stronger technical basis for managing the levees. The ASCE Hurricane Katrina External Review Panel endorses this effort.

This commissioner cannot control every piece of this complex system. Rather, he or she must be empowered and authorized by mutual consent to become deeply engaged with all responsible agencies. The commissioner's overarching responsibility will be to keep hurricane-related safety at the forefront of public priorities. The commissioner will provide leadership,

strategic vision, definition of roles and responsibilities, formalized avenues of communication, prioritization of funding, and coordination of critical construction, maintenance, and operations.

CALL-TO-ACTION NUMBER 7:

Improve inter-agency coordination.

There has been a historic lack of coordination between agencies at all levels: local, state, and federal. The only practical way to overcome this organizational confusion is to implement strong, sustainable mechanisms for communication, cooperation, and coordination. We envision that the commissioner (as identified in Call-to-Action Number 6) will be able to provide overall direction and make sure that all parties are working together.

All agencies involved in the hurricane protection system should implement far better and more effective mechanisms for coordination and cooperation. The agencies responsible for funding must coordinate with and advocate for those responsible for implementation. Those responsible for the hurricane protection system must establish iron-clad protocols with those who are responsible for emergency response. Those responsible for maintenance of the hurricane protection system must collaborate with system designers and constructors to upgrade their inspection, repair, and operations to ensure that the system is hurricane-ready and flood-ready. Those responsible for operating the floodgates must take direction from those responsible for emergency preparedness and close the levee penetrations when a hurricane threatens.

Demand Engineering Quality

The ASCE Hurricane Katrina External Review Panel believes that the failures in New Orleans' hurricane protection system constitute one of the worst catastrophes ever to befall this country. The flaws uncovered as a result of Hurricane Katrina must serve as a sobering reminder to engineers everywhere that their work has life or death implications. Whatever the constraints – whether related to cost, schedule, political resistance, or inertia – engineers must continue to uphold the highest standards of their profession, knowing that people's lives are at stake.

CALL-TO-ACTION NUMBER 8:

Upgrade engineering design procedures.

The USACE and its consultants – as well as ASCE and its members – must upgrade engineering design procedures, placing greater emphasis on safety, taking into account lessons learned from Hurricane Katrina, and incorporating the latest research findings and best engineering practices. *The engineering community should review and update engineering design procedures for hurricane and flood protection systems to ensure that these updated procedures take all reasonable steps to protect the public safety, health, and welfare.*

The USACE – and engineering research organizations around the country – should increase research into the design and construction of better hurricane protection systems. The latest technological advances should be used to improve the models, designs, retrofits, and maintenance of hurricane protection systems in New Orleans and other parts of the country.

CALL-TO-ACTION NUMBER 9

Bring in independent experts.

ASCE has a long-standing policy that recommends independent expert review for all public works projects where performance is critical to the public health, safety, and welfare; where reliability of performance under emergency conditions is critical; that use innovative materials or techniques; that lack redundancy in the design; or that have unique construction sequencing or a short/overlapping design-construction schedule.

The ASCE Hurricane Katrina External Review Panel believes that many of the major deficiencies in New Orleans’s hurricane protection system could have been avoided if the engineering plans and designs had undergone high-level, independent engineering review by external experts.

Agencies responsible for design of hurricane and flood protection system and other critical life safety structures should engage independent experts in high-level review of every project.

CALL-TO-ACTION NUMBER 10:

Place safety first.

Although the conditions leading up to the New Orleans catastrophe are unique, the fundamental constraints placed on engineers for any project are not. Every project has funding and/or schedule limitations. Every project must integrate into the natural and man-made environment. Every major project has political ramifications.

In the face of pressure to save money or to make up time, engineers must remain strong and hold true to the requirements of the profession’s canon of ethics, never compromising the safety of the public. Organizations must be structured to enable, not to inhibit, the focus on safety. Engineers must continually evaluate the appropriateness of design criteria. They must always consider how the performance of individual components affects the overall performance of a system.

The first Fundamental Canon of ASCE’s Code of Ethics states that “Engineers shall hold paramount the safety, health, and welfare of the public....” This canon *must* be the guiding principle for rebuilding the hurricane protection system in New Orleans. And it must be applied with equal rigor to every aspect of an engineer’s work – in New Orleans, in America, and throughout the world. *ASCE, working in partnership with the USACE and other engineering organizations should reinforce the need to place the safety, health, and welfare of the public first, and should communicate that public safety must always take precedence.*