



## Executive Summary

On the evening of September 21, 1998, Hurricane Georges made landfall on Puerto Rico's east coast as a strong Category 2 hurricane. It traveled directly over the interior of the island, mainly in an east-west direction, and passed off Puerto Rico's west coast on September 22. Puerto Rico had not experienced a hurricane of this magnitude since Hurricane Hugo, a devastating Category 3 hurricane that passed over the northeast corner of Puerto Rico in a southeast to northwest direction in September 1989.

On September 30, the Federal Emergency Management Agency's (FEMA) Mitigation Directorate deployed a Building Performance Assessment Team (BPAT) to Puerto Rico to assess damages caused by Hurricane Georges. The team included architects, engineers, planners, insurance specialists, and floodplain management specialists. The BPAT's mission was to assess the performance of buildings and other structures throughout Puerto Rico and make recommendations for improving building performance in future events.

After an aerial assessment of the island, the BPAT conducted field investigations in selected areas affected by the storm. The field investigations of significantly damaged areas centered on the performance of single-family residential home construction. Isolated examples of success and failure in commercial buildings (primarily building envelope issues in high-rise buildings) and several essential facilities observed during field investigations were also documented. Commercial buildings were not investigated for compliance with current structural seismic guidelines. One- and two-family residential buildings, however, were investigated for their ability to sustain a seismic event. Seismic resistance of nonstructural elements was also observed.

It is important to note that wind speeds experienced on the island were not of the strength to test the design of Puerto Rico's buildings. A more significant wind event striking Puerto Rico would likely have resulted in even more failures than were observed.

A large number of residential buildings in Puerto Rico experienced structural damage from the high winds of Hurricane Georges. This can be attributed to a lack of a continuous load path from the roof structure to the foundation that the BPAT observed in most of the damaged buildings. In addition, a large number of residential buildings in identified Special Flood Hazard Areas (SFHAs) were damaged from floodwaters.

A limited number of mid- and high-rise buildings were inspected by the BPAT. Damage observed at these buildings was to nonstructural elements, including damage to glazing, curtain walls, interior walls, and damages to finishes from windborne rain. Building envelope damage resulted from loads on the components and windborne debris that broke glazing.

The BPAT concluded that while not all of the damage caused by Hurricane Georges could have been prevented, a significant amount could have been avoided if more buildings had been constructed to Puerto Rico's existing Planning Regulation 7 (building code).

Furthermore, a lack of compliance with and enforcement of Planning Regulation 13 (floodplain management) contributed to the damages. Additional damage could have been avoided if more buildings had been designed and constructed to current codes and regulations that address flood, wind, and seismic loads. Although the BPAT observed several examples of successful mitigation implementation, many buildings unfortunately received too little attention to mitigation. If effective mitigation efforts had been implemented more extensively in the design and construction of buildings, the widespread devastation of the hurricane would have been substantially reduced.

Puerto Rico's Regulations and Permitting Administration (Administración de Regalmentos y Permisos [ARPE]) has taken several important steps following Hurricane Georges to increase public safety and reduce property damage from natural hazards. These steps include:

- At ARPE's request, the International Conference of Building Officials (ICBO) conducted and completed a peer review of ARPE in January 1999. This peer review evaluated the new needs created by Hurricane Georges as well as the re-engineering effort currently underway.
- The Government of Puerto Rico, including ARPE, passed emergency regulation in December 1998 that repealed Planning Regulation 7 and adopted the 1997 Uniform Building Code (UBC) as the building code for Puerto Rico.
- ARPE is positioned to make recommendations concerning building regulations to the new Certification and Building Board of Puerto Rico that is expected to be created in March 1999 under proposed legislation submitted by the Governor to the Puerto Rico Legislature.
- ARPE and FEMA are implementing a strategic plan to provide the necessary training to make the transition to these new building regulations.

The ICBO's peer review of ARPE assessed how ARPE administers and enforces planning regulations related to building design and construction. The review evaluated ARPE's current needs—and identified unmet needs—to respond effectively to the massive amount of reconstruction necessary following Hurricane Georges as well as future construction. The peer review resulted in recommendations in the areas of policies, procedures, practices, training and education, facilities, salaries, benefits, promotion, and office automation. Since the completion of the peer review, FEMA, ICBO, and ARPE have been working closely together to develop a plan that meets the identified unmet needs.

In addition to the recommendations outlined above, the BPAT recommends the following:

- The Government of Puerto Rico should continue supporting positive mitigation education efforts undertaken by the Puerto Rico Civil Defense, Colegio de Ingenieros y Agrimensores (CIAPR), Colegio de Arquitectos, and the University of Puerto Rico College of Engineering in Mayagüez.
- ARPE and the Puerto Rico Planning Board should use information gathered by the Community Assistance Visit (CAV) in May 1998 and from the damage of Hurricane Georges to continue to educate homeowners on the risks involved in building in floodprone areas. A renewed effort in enforcement of Planning Regulation 13 during the rebuilding stages, specifically in the permitting process, should result in a significant reduction in property loss from future hurricane events.
- The BPAT agrees with the Government of Puerto Rico's decision to adopt the 1997 UBC as an interim step toward adopting the International Building Code

(IBC) when it becomes available. Furthermore, the BPAT recommends several local amendments be adopted.

- Essential facilities should be evaluated for their vulnerability to natural hazard events.
- The Government of Puerto Rico should perform a study on its electrical power distribution system.