



NIOSH EMERGENCY PREPAREDNESS AND RESPONSE PROGRAM

Expert Panel Review

January 2019

External Review Panel Members for the NIOSH Emergency Preparedness and Response Program

Mark Catlin (Chair), BS, BA

Occupational Health and Safety Director (retired). Service Employees International Union (SEIU),
Washington, DC

Deborah Gold, MPH, CIH

Deputy Chief for Health and Engineering Services (retired), Cal/OSHA, State of California

Erin N. Haynes, DRPH, MS

Professor, Division of Epidemiology, Department of Environmental Health, University of Cincinnati

Timothy M. Radtke, CIH, MS, (CAPT USPHS retired)

Acting Director, Office of Occupational Safety and Health and Chief, Occupational Health and Medical Programs,
Department of the Interior, Lakewood, Colorado

Scot Alan Rudolph, CSHO/ASP

Environmental, Health and Safety Manager-Enviva Biomass, Raleigh, North Carolina and former Safety Officer
during the Deepwater Horizon spill response in the Louisiana Incident Command Center

Table of Contents

External Review Panel Members for the NIOSH Emergency Preparedness and Response Program	1
Executive Summary	3
Background of the Review Process	5
Scoring Model and Process	5
Acknowledgements	6
Panel Findings.....	7
Relevance	7
Impact	8
Emergency Responder Health Monitoring and Surveillance Program (ERHMS)	10
Deepwater Horizon (DWH) Oil Spill Response.....	11
Hurricanes	12
Radiation	13
Anthrax Preparedness and Response Capabilities	13
Infectious Diseases	13
Recommendations for the Future	17
Appendix 1 – Abbreviations	19
Appendix 2 – Summary Panel Scoresheet.....	20
Appendix 3 – References.....	21

Executive Summary

The mission of Emergency Preparedness and Response (EPR) Program is to protect the health and safety of emergency response providers and recovery workers through the advancement of research and collaborations to prevent diseases, injuries, and fatalities during responses to natural and man-made disasters and novel emergent events. The EPR Program works to integrate occupational safety and health into emergency responses during planning and preparedness activities, as well as during active emergencies. It is a designated core and specialty program within the National Institute for Occupational Safety and Health (NIOSH), and functions as the coordination point for all NIOSH emergency preparedness and response activities, providing occupational safety and health assistance during emergencies.

All Panel members concluded that the EPR Program has done excellent work and made significant progress in improving worker health and safety, both in preparation for and during responses to a wide range of natural and man-made emergencies over the 10 years covered by this evaluation (2007–2017). Given the EPR Program's recent creation, small EPR Office (EPRO) staff, and limited budget, all Panel members were impressed with the EPR Program's impact, productivity, and ability to coordinate expertise from across NIOSH to accomplish this important work in response to a wide range of emergencies—some anticipated, but many of which unexpected.

The Panel found that the EPR Program Evidence Package (Evidence Package) provided significant documentation and information on the health and safety burden for these workers, as well as addressed the need for interventions to a wide range of hazards they face. The Panel also found that the Evidence Package included an impressive number of project outputs and interventions to address specific identified needs and build a solid base of knowledge and experience. These outputs included written publications and webpages, the development of training tools and materials, trainings, technical assistance, sampling methods and guidance, software and mobile apps, and many other tools.

The EPR Program strives to remain flexible and responsive to new focus areas and objectives that emerge, as its work is strongly shaped by current events. The EPR Program has shown a significant ability to adapt to the numerous calls for assistance and demands on its resources, often from external agencies and during unexpected emergencies, such as the 2010 Gulf oil spill and the 2014 Ebola outbreak. While the Panel was impressed with this flexibility, they had concerns with how this flexibility might diffuse its limited resources, affecting the Program's focus and impact in the future. Given that responding to current events can be a priority, the Panel also considered the ability of the Program to balance preparedness and response activities.

Below are three interconnected key elements believed to be critical to the successful impact of the Program work over the past decade, as identified by the Panel:

- Focusing activities and outputs from prior work to create a body of knowledge and tools useful for many types of future events. *The Panel saw this focus as crucial to strengthening and magnifying the EPR Program impact.*
- Building the capacity of the EPRO, specifically, and NIOSH, generally, to effectively engage and collaborate with the many other federal and state agencies and private organizations, especially those organizations in leadership roles during emergency preparedness and response. The Panel believes that while the Program has had much success gaining visibility and forging collaborations, many organizations still have limited experience with, and knowledge of, the EPR Program and NIOSH.
- Balancing preparedness and response activities led to the adoption of EPR Program outputs into federal, state, and other emergency plans and the integration of EPRO and other NIOSH staff to leadership

positions within emergency response systems. This adoption of outputs and integration of staff has greatly multiplied the impact of EPR work and led to greater and more widespread health and safety protections for emergency response workers.

An excellent example of the relevance and impact of this Program, in both preparedness and response, for a wide range of emergencies and disasters, the Panel members agree, is the Emergency Responder Health Monitoring and Surveillance (ERHMS) Program. The ERHMS Program aims to ensure that specific activities to protect the health and safety of emergency response and recovery workers are conducted during each of the three phases of a response—pre-deployment, deployment, and post-deployment. The ERHMS Program has shown its value, first in the Deepwater Horizon (DWH) oil spill response and later during the Ebola outbreak.

Other key examples of activities conducted by the EPR Program over the past decade, and described in this Review's findings, include: the DWH oil spill response, hurricane responses, radiation responses, anthrax preparedness, and infectious disease responses, including the H1N1 influenza pandemic and the Ebola outbreak.

Following their Review of the EPR Program, the Panel makes several recommendations for the future of the Program that they believe will assist in the continuation and expansion of the Program's successes and impact over the next decade.

Background of the Review Process

The National Institute for Occupational Health and Safety (NIOSH) is a public health agency within the federal government responsible for conducting research to reduce worker illness and injury and advance worker well-being; to promote safe and healthy workers through interventions, recommendations, and capacity building; and to enhance international worker safety and health through global collaborations. NIOSH is part of the Centers for Disease Control and Prevention (CDC), and serves as the lead for occupational safety and health during CDC responses. To accomplish this, NIOSH's Emergency Preparedness and Response (EPR) Program focuses on two areas: preparedness and response.

The EPR Program was created in 2002, following 9/11, which included attacks on the World Trade Center and Pentagon, and the anthrax letter terrorist attacks, to coordinate emergency preparedness and response within NIOSH and improve NIOSH's ability to respond to future emergencies and disasters. While initially focused on terrorism, NIOSH soon expanded the Program to include emergency response planning and research aimed at protecting workers across a wide range of events, including but not limited to, major natural disasters, infectious disease outbreaks, chemical and nuclear accidents, and terrorist attacks or threats.

The EPR Program, a critical element of the overall NIOSH portfolio, is a designated core and specialty program, contributing to the research and service goals set in the current NIOSH Strategic Plan. This is the first formal external review of the EPR Program.

An external Review Panel was convened to review the relevance and impact of NIOSH's EPR Program from fiscal years 2007-2017. The Panel Chair was charged, in November 2018, with recruiting Panel members, conducting a Review Process, and producing a Report based on the scoring methodology provided by NIOSH. Selected to represent a balance of individuals from academia, labor, industry, and government, the Panel composition included a translation science expert, three subject matter experts, and an evaluation expert, each with experience in one or more preparedness and response areas covered in this Review; all Panel members reported no conflict of interest.

During the Review period, the Program responded to several large-scale emergencies, including the 2009 H1N1 influenza pandemic, the 2010 Deepwater Horizon (DWH) oil spill, Hurricane Sandy in 2012, and the 2014 Ebola epidemic.

Scoring Model and Process

For this review, NIOSH adopted a slightly modified version of a program evaluation approach known as contribution analysis (1). This approach seeks to identify a reasonable association between Program activities and outputs and observed intermediate outcomes to establish a theory that explains the contribution of the Program to a given outcome. All Panel members received an orientation and overview of the contribution analysis model prior to conducting the evaluation.

In May 2018, Panel members participated in a webinar to receive an overview of the Review, evaluation model, and project timeline. The Panel then received a comprehensive EPR Program Evidence Package (Evidence Package) for 2007-2017, prepared by the EPR Program, providing detailed information about Program work and results. Included in the Evidence Package was a reminder that the Review excluded the World Trade Center

Health Program, routine emergency responses by public safety agencies (such as fire departments), the recently established (2014) Disaster Science Responder Research Program, and hurricane and other emergency responses during the fall of 2017.

Next, Panel members participated in a day-long, in-person meeting with EPR Program and other NIOSH staff in Atlanta, Georgia; one NIOSH grantee participated remotely via teleconference as well. The Panel members were presented with summary overviews of the work and results from large and small response and preparedness activities, with the opportunity to ask questions and engage in discussions following the presentation.

The following day, Panel member discussions included preliminary observations based on the provided materials, the presentations and discussions from the previous day, and their own personal experiences. Panel members then independently appraised all materials and provided, to the Panel chair, individual scores for relevance and impact, including supportive rationale for their scores. This Report is a synthesis of the Panel members' written reviews and discussion of the Evidence Package and the EPR Program presentation and discussions. All Panel members have reviewed and edited the Report, and each has provided individual Program scores for relevance and impact.

The Panel members' scores were averaged to issue a single relevance score and a single impact score (means), as well as a total Program score, the average (mean) of the sum of the scores for both relevance and impact (see Appendix 1).

The mean relevance score was 5 on a 5-point scale, with "1" indicating the rationale for the activities completed by the Program were not justified and "5" indicating the rationale for the activities completed by the Program were highly justified.

The mean impact score was 5 on a 5-point scale, with "1" indicating research activities and outputs do not result in, or are not likely to have, any application and "5" indicating the Research Program has made major contribution(s) to worker health and safety based on end outcomes or well-accepted intermediate outcomes.

All scores were rounded to the nearest 0.5 increment.

The overall Program score was 10.0.

Acknowledgements

The Panel was honored to review the EPR Program, with all Panel members expressing appreciation for the depth and breadth of NIOSH's work. Additionally, the Panel was grateful for NIOSH staff's expertise and deep commitment to this work.

The Panel would like to thank Sherry Baron, MD, MPH, from the Barry Commoner Center for Health and the Environment, Queens College, who provided valuable insight about the work done after Hurricane Sandy. The Panel also very much appreciated the logistical support from David Frye and Mary Dawson from AECOM.

Panel Findings

The mission of the National Institute of Occupational and Safety Health's (NIOSH) Emergency Preparedness and Response (EPR) Program is to protect the health and safety of emergency response personnel and recovery workers through the advancement and translation of research and collaborations and to prevent diseases, injuries, and fatalities during responses to natural and man-made disasters and novel emergent events.

The EPR Program seeks to integrate occupational safety and health into emergency response activities conducted by federal and state agencies and private organizations, during both planning and preparedness activities and during and after active emergencies. It is a designated core and specialty Program within NIOSH, and functions as the coordination point for all NIOSH emergency preparedness and response activities, providing occupational safety and health assistance during emergencies. The EPR Office (EPRO) manages this work, coordinating with the many other NIOSH programs conducting research and providing technical assistance that intersect with emergency response, including the National Personal Protective Technology Laboratory Health Hazard Evaluation (HHE) programs. The EPR Program also partners with other federal agencies, state agencies, academia, industry, trade and professional associations, and organized labor.

The Panel members concluded that the EPR Program, over the 10 years covered by this evaluation (2007-2017), has done excellent work and made significant progress in improving worker health and safety, both in the preparation for and during responses to a wide range of natural and man-made emergencies. Given the Program's small EPRO staff, limited budget, and recent creation in 2002, all Panel members were impressed with the EPR Program's impact, productivity, and ability to coordinate expertise from across NIOSH to accomplish this important work in response to a wide range of events, some anticipated, but many of which were unexpected.

Relevance

Panel members found the priorities set by the EPR Program to be based on burden and need, and the rationale for the Program's activities highly justified. The mean relevance score from the Panel was 5.0.

Based on the EPR Program Evidence Package (Evidence Package), the presentations and discussions from the in-person meeting, and their own personal experiences, Panel members found significant documentation and information related to the health and safety burden of emergency response work, of which there is a limited but growing body of published research, as well as the need for interventions to address the wide range of hazards faced by emergency response workers.

Several Panel members discussed their experiences with NIOSH during emergency events that occurred before and after the creation of the EPR Program. Before the Program was established, NIOSH's role was valuable but limited, usually occurring through their HHE program. In contrast, Panel members noted that since the establishment of the EPR Program, NIOSH has played a larger, more valuable role.

A clear example of the need for, and value of, the EPR Program is NIOSH's contrasting response to the 1989 Exxon Valdez oil spill in Alaska and the Deepwater Horizon (DWH) oil spill in 2010, both large-scale events of national significance involving more than 10,000 workers. The Exxon Valdez response consisted primarily of two HHEs conducted by a small number of personnel, which although limited, were very useful in documenting worker health and safety issues observed and lessons learned (2).

NIOSH attempted, unsuccessfully, to conduct a systematic, record-based field evaluation of worker injuries and cleanup operations, and considered, but decided against, long-term medical surveillance of the workers involved in the cleanup. Had the field evaluation and long-term medical surveillance been carried out, the results may have helped inform the many worker safety and health questions that arose during the DWH response.

In contrast, the NIOSH response to the 2010 DWH oil spill was the largest activation of personnel to an event in its history (exceeded only by NIOSH's 2014 Ebola response). Among many activities, NIOSH provided extensive, independent support to the Unified Command (structure that brings together major organizations to coordinate an effective response) by working with OSHA (Occupational Safety and Health Administration) to anticipate and address the occupational safety and health needs of response workers. NIOSH also established a roster of more than 30,000 response workers and volunteers using their newly developed Emergency Responder Health Monitoring and Surveillance (ERHMS) Program. The data collected are now being used in follow-up studies to assess the health impacts to DWH response workers, which in turn, can inform planning for future oil spill responses. Details of the DWH response activities are described in the Evidence Package; the EPR Program, the Panel felt, contributed to this robust response.

EPR Program work is strongly shaped by current events. Emergencies, such as natural disasters, an emerging infectious disease, or a terroristic threat, dictate and influence the direction of its work. Some events are predictable and can be planned for (i.e., hurricanes and other weather-related emergencies); other events, however, may be anticipated, but occur unexpectedly, including actual or suspected terrorist attacks and infectious disease outbreaks, such as H1N1 and Ebola. The Panel agreed that the EPR Program strive to remain flexible and responsive to new focus areas and needs emerging from newly issued federal policy, plans, and initiatives; emergency responses; national-level exercises; and emergency supplemental funding.

Impact

All Panel members recognized that the EPR Program's activities and outputs have directly or indirectly led to improvements in, and major contributions to, workplace safety and health. The mean impact score from the Panel was 5.0. The mean total Program score was 10.0.

The Panel found that the Evidence Package included a considerable number of varied intervention outputs, allowing the transfer of experience and research knowledge to many diverse stakeholders. These outputs (written publications and webpages, classes and training tools, technical assistance, sampling methods and guidance, software and mobile apps, and other tools) and interventions have resulted in many and varied intermediate outcomes that address specified needs.

Below are three interconnected key elements believed to be critical to the successful impact of the Program work over the past decade, as identified by the Panel:

- Focusing activities and outputs from prior work to create a body of knowledge and tools across many types of future events. *The Panel saw this focus as crucial to strengthening and magnifying the EPR Program impact;*
- Building the capacity of the EPRO, specifically, and NIOSH, generally, to effectively engage and collaborate with the many other federal and state agencies and private organizations, especially those organizations in leadership roles during emergency preparedness and response. The Panel believes that while the Program has had much success gaining visibility and forging collaborations, many organizations still have limited experience with, and knowledge of, the EPR Program and NIOSH; and

- Balancing preparedness and response activities led to the adoption of EPR Program outputs into federal, state, and other emergency plans and the integration of EPRO and other NIOSH staff to leadership positions within emergency response systems. This adoption of outputs and integration of staff has greatly multiplied the impact of EPR work and led to greater, more widespread health and safety protections for emergency response workers.

The EPR Program has shown a significant ability to respond fluidly to the numerous calls for assistance and demands on its resources (e.g., the 2010 DWH oil spill and the 2014 Ebola outbreak). The Panel learned that Program involvement can be activated in many ways: requests can come directly from local response agencies, including employers and employees, state and local governments, or from other federal agencies; for smaller responses, CDC often notifies NIOSH of requests for assistance. The CDC Emergency Operations Center (EOC) manages larger responses requiring extensive interagency coordination, those with high complexity, or those with media interest. The EPRO then coordinates NIOSH involvement under the CDC EOC. While the Panel understand the need for this flexibility, members raised concerns about how that flexibility affected the Program's focus and impact.

NIOSH preparedness activities highlight the ability of the EPRO, specifically, and NIOSH, generally, to effectively work with other federal and state agencies and private organizations. This preparedness work has led to the addition of improved worker health and safety into national policy and incident-specific response plans, NIOSH participation in exercises to test these plans, and NIOSH research to inform policy and guidance that improves the ability to protect workers in future responses. The Panel strongly supports this engagement and collaboration with partners during the relative calm of preparedness, but raised concerns about whether the Program is able to maintain a balance between preparedness and response activities, given that responding to immediate current events would, understandably, be a priority.

NIOSH is equipped to provide a broad range of field responses and consultative expertise across a wide range of emergency types. The EPR Program supports these NIOSH response capabilities through professional development of staff, including specialized response training, and numerous internal CDC/NIOSH work groups and committees and external groups to ensure occupational safety and health is considered during the development of guidance documents, communication materials, and response plans. These efforts result in increased coordination among key responder groups working with NIOSH during responses.

The Panel strongly supports the need for, and value of, having a core EPRO staff with on-the-ground experience in disaster response operations. The Panel also strongly supports the need for, and value of, relationships with other agencies and groups established during preparedness activities and past responses.

Recent federal responses (e.g., Hurricanes Harvey, Irma, and Maria) have provided NIOSH personnel with important roles within the federal incident response structure. One Panel member recalled the difficulties they observed while assigned to a U.S. Department of Health and Human Services/Assistant Secretary for Preparedness Response (HHS/ASPR) mission during the Hurricane Harvey response, in which a NIOSH employee likely did not understand the complexities and sensitivities at the local level, and was attempting to collect health data while providing recommendations to local residents and government officials. This interaction, while well-meaning, led to difficulties with other federal partners who were similarly attempting to provide support.

It is recommended that all NIOSH personnel who are assigned to missions within a joint state and federal management plan (as part of a joint HHS response) be well-versed on the scope and limitations of the mission and the sensitivities that may be encountered at the local level. Staff who have experience working in

emergency responses, either within NIOSH or with other federal partners (e.g., National Institute of Environmental Health Sciences [NIEHS]), should be engaged to provide guidance/training in this space.

During its Review, the Panel sometimes found it difficult to differentiate the impact of the EPR Program activities from that of other parts of NIOSH. Although understandable, given the coordinator role often played by the EPRO, the Panel expressed concern that this lack of distinct visibility can obscure the EPR Program's good work, at least to outside organizations. At the same time, the Panel recognizes that NIOSH is usually not the lead organization during response and preparedness activities, and appreciates the complexities EPRO staff must navigate to accomplish their mission.

In the following sections, the Panel's findings in key activities, detailed in the Evidence Package and discussed at the Atlanta meeting, are described and information supporting the Panel's scores are provided. The Panel felt that these activities provide a good sampling of the range of outputs and impacts of the EPR Program work and highlight the three cross-cutting elements described previously (focusing activities, building capacity, and balancing preparedness).

Emergency Responder Health Monitoring and Surveillance (ERHMS) Program

The ERHMS Program, Panel members acknowledged, was an excellent example of the relevance and impact of the EPR Program, in both preparedness and response, for a wide range of emergencies and disasters. They also acknowledged that it was the best example of a focused and sustained effort of building on experience from earlier responses and developing valuable tools for use in many different types of emergencies. The wide range of outputs, including written and digital materials and trainings, have led to many good intermediate outcomes. ERHMS Program development and support, led by the EPRO, is a good model of collaboration and engagement with many federal, state, and international partners. The Evidence Package also describes some success in integrating ERHMS into several emergency response systems, expanding the impact.

The ERHMS Program, as described in detail in the Evidence Package, was developed in response to the demonstrated need, after the 9/11 attacks, to better protect, equip, and promote the health and safety of emergency responders. The ERHMS Program's framework, created by NIOSH, in collaboration with federal agencies, state health departments, and unions, allows organizations, large and small, public or private, to monitor the health and safety of emergency responders throughout the critical phases of a response.

ERHMS Program goals are to prevent short-term and long-term illness and injury in emergency responders and to ensure workers can respond safely and effectively to future emergencies. To do so, specific ERHMS Program activities are conducted during each of the three response phases: pre-deployment, deployment, and post-deployment. This Program has shown its value, initially during the DWH oil spill response and later during the Ebola outbreak and other responses.

Beginning in 2009, NIOSH led an ERHMS workgroup comprised of subject matter experts representing federal, state, and local governments and private stakeholders. This workgroup assisted in the development of the ERHMS Program, and supported its expanded use. The ERHMS Program was still in early development during the EPR Program's early response to the DWH oil spill in 2010; however, EPRO staff saw an opportunity to begin implementing elements of the ERHMS Program into the response by rostering and conducting health surveillance of workers during the pre-deployment and deployment phases of the response.

Elements of the ERHMS Program were also implemented during CDC's 2014 Ebola response, and received positive feedback. Based on that experience, CDC established an ERHMS unit in their EOC and a permanent

Office of Risk Management and Operational Integrity, staffed full-time to focus on improving the deployment process.

During the 2017 hurricane season, NIOSH EPRO staff led the Occupational Health Task Force for CDC's EOC hurricane response—the first time that occupational health operated at the task force level. During the hurricane response and recovery, NIOSH staff advocated, and provided technical assistance, for the use of the ERHMS Program.

The Panel is especially supportive of NIOSH's work with HHS' ASPR National Disaster Medical System to discuss utilization of the ERHMS Program to manage the nearly 5,000 volunteer medical professionals from across the United States – volunteers they can activate in response to a disaster to provide medical care and services. ASPR also utilized the ERHRM Program's tools when deploying volunteers for Zika responses and following Hurricane Maria in Puerto Rico. The Panel strongly supports NIOSH's plan to reach out to the ASPR Hospital Preparedness Program (HPP) in 2018 to identify ways the ERHMS Program can be implemented by HPP grant recipients throughout the United States.

Deepwater Horizon (DWH) Oil Spill Response

The Panel found NIOSH's work during the DWH oil spill to be an excellent example of the EPR Program's impact during and after an emergency. As described in the Evidence Package, NIOSH created outputs that resulted in many useful intermediate outcomes, providing much-requested assistance, including conducting HHEs, providing technical guidance, analyzing injury and illness data, and conducting toxicity studies. While providing these activities, and to build upon their prior work with the ERHMS Program, NIOSH developed a focused body of knowledge and experience to strengthen their engagement and collaboration with other agencies and organizations, including OSHA and NIEHS.

Based on the experiences of several Panel members and the information contained within the Evidence Package, the Panel identified several key elements to highlight:

- NIOSH was integrated early into the response incident management structure, allowing for greater impact, as well as the development of strong collaborations.
- NIOSH established a roster of response workers and volunteers - the first time that a prospective, centralized roster of workers had ever been developed for an event of this magnitude. The EPR Program took advantage of this opportunity to implement elements of their ERHMS framework, even while it was still under development. The purpose of the roster was to create a written record of those who participated in the DWH response activities, to collect information on the training they received and the nature of their projected work assignments, and to have a way to contact responders about possible work-related illness or injury symptoms during and after the event. This rostering database is available to researchers, with one important use already: the NIEHS-initiated GuLF STUDY, which investigated the health effects to persons involved in the DWH oil spill response and cleanup and has resulted in numerous publications, with more publications expected in future years.
- The release of the NIOSH/OSHA *Interim Guidance for Protecting Deepwater Horizon Response Workers and Volunteers*, the first time NIOSH and OSHA released a co-branded guidance document during an emergency response. Due to the success of this effort, NIOSH continues to work with OSHA and other federal agencies to issue co-branded guidance during emergencies. In addition, NIOSH has published many other guidance documents and peer-reviewed papers to capture lessons learned (listed in the Evidence Package).

- A Panel member highlighted a valuable HHE, requested by British Petroleum (BP), in which seven fishermen working on five different response vessels became ill and required hospitalization. The initial assumption was that the cases were related to chemical exposures during response activities (i.e., crude oil and dispersants, as well as potential exposures to oiled, decaying organic material, smoke and soot from in-situ burning, or other unrecognized and potentially harmful health and safety risks). NIOSH brought their expertise and neutrality into this emotionally charged situation and provided an objective evaluation, which determined that chemicals used on these boats to clean oil decks and equipment, along with heat-related illnesses, were the likely causes of illness. Based on this HHE study, medical protocols were put into place to help mitigate the risks associated with strenuous work in extreme heat and humidity. BP has since implemented a heat stress management system that focuses on the appropriate work/rest cycle, allowing workers time to rest, re-hydrate, and cool down prior to resuming work.

Hurricanes

The Panel found NIOSH's activities after Hurricane Sandy to be a good example of engagement, collaboration, and support of public and private partners, including community-based organizations and universities at the state and local level, as detailed in the Evidence Package and by a Panel member's experience.

NIOSH has traditionally had a limited role in providing support to hurricane disaster responses, although this appears to have changed following their work during Hurricanes Katrina and Sandy. They've developed a Storm, Flood, and Hurricane Response website (<https://www.cdc.gov/niosh/topics/emres/flood.html>), as well as publications to address common occupational safety and health concerns before, during, and after a response. NIOSH staff also answered technical questions on health and safety concerns and helped educate response organizations through ERHMS and other programs.

After Hurricane Sandy, NIOSH funded five projects investigating possible hazards and adverse health effects among response and recovery workers, including Latino day laborers, EMS personnel, tree care services, Red Cross shelter personnel, and volunteer laborers. Some of the findings from these research studies have directly benefited more recent hurricane responses in 2017.

The Panel found the intervention project conducted by Queens College, a Hurricane Sandy grantee, for Latino construction day laborers especially interesting. As part of this project, researchers developed a novel approach, using a mobile phone app, to facilitate workplace assessments, allowing trained participants to report hazards via a user-friendly checklist and document working conditions with photographs. This app was used in 175 workplace assessments by 16 trained workers. It was later shared with investigators and several worker centers in Houston following the 2017 hurricane. The Panel believe this app is a perfect example of integrating new technology into emergency preparedness and response, with great potential as a tool for use in future research and future emergency responses.

The Panel also found other noteworthy outputs from the supported projects, including resources designed for healthcare providers, material assessing personal protective equipment (PPE) needs, and the *Guidance for Clinicians on the Recognition and Management of Health Effects Related to Mold Exposure and Moisture Indoors*.

Radiation

Even though radiological and nuclear emergencies are rare, the planning and preparation for a successful response to radiological and nuclear threats is a major component of the EPR Program portfolio, as described in the Evidence Package. Important to the planning and preparation for such an event is having a health physicist on staff. Although the EPRO does not have one on staff, they are able to utilize health physicists from different NIOSH Divisions for response work. This provided relevant worker safety and health expertise, outside of NIOSH, that the Panel agreed was a good example of EPRO's positive impact. In addition, the Panel agreed that the EPR Program's work on radiation event preparedness was an example of EPRO's successful engagement and collaboration with other response organizations.

NIOSH has taken a leadership role on a standing worker safety and health task force for radiation events. Over the decade covered by this review, NIOSH participated in interagency coordination teams and subcommittees to develop planning guidance to support a federal government response. Participation in eight national-level radiation preparedness exercises involving numerous federal agencies allowed NIOSH to work through those federal plans, address challenges and gaps in preparedness and response, and train staff to support responses. As an outcome of this participation, NIOSH co-authored interagency guidance, *Health and Safety Planning Guide for Planners, Safety Officers, and Supervisors for Protecting Responders Following a Nuclear Detonation*, to assist in the preparation for health and safety management in the event of a successful improvised nuclear device event; the National Security Council's Domestic Readiness Group approved this health and safety planning guide for publication in 2016.

Since 2003, NIOSH has been a member of the Advisory Team for Environment, Food, and Health, an emergency response group tasked with providing protective action recommendations to state, local, and territorial governments following a radiological incident. Over the last decade, this Advisory Team has used NIOSH's recommendations in exercises concerning worker exposure limits, PPE recommendations, and health monitoring.

NIOSH's work also led to CDC's recognition of the value of a Worker Safety and Health Task Force, making it a permanent part of CDC's Incident Management System (IMS) structure for radiation events.

After the Fukushima nuclear power plant was damaged by a tsunami in 2011, NIOSH provided a clearinghouse of information regarding worker risks associated with coming into contact with people and materials from areas affected by radiation. NIOSH also worked with the Department of Homeland Security (DHS), CDC, and the Department of State to provide recommendations on protecting embassy staff and Urban Search and Rescue responders.

Anthrax Preparedness and Response Capabilities

As it applies to occupational safety and health, the EPR Program has contributed much to anthrax preparedness and response. The Evidence Package details NIOSH's activities during the 2001 anthrax response, and describes subsequent efforts to increase anthrax preparedness and response capabilities.

The Panel found the anthrax activities over the past decade to be a good example of focusing activities and outputs to create a body of knowledge and tools, built on prior work, that can be useful across many types of future events. During this work, NIOSH effectively engaged and collaborated with many other federal and state agencies and private organizations. The Panel believes NIOSH's anthrax work is a good example of the value of preparedness activities leading to the adoption of EPR Program outputs into federal, state, and other emergency plans and to the integration of EPRO and other NIOSH staff to leadership positions within emergency response

systems. Panel members expect that this work has increased NIOSH's capacity to respond to bioterrorism and infectious diseases events, in general, and not just to anthrax attacks.

Between 2007 and 2017, NIOSH participated in five anthrax exercises and responded to six non-terroristic anthrax events, each of which is described in the Evidence Package. NIOSH conducted a range of activities, including the development of sample collection procedures, creation of health and safety guidance for responders, training of response personnel, and participation in interagency exercises, helping NIOSH define its role as one of technical assistance and support, rather than sample collectors, for other agencies. Furthermore, NIOSH was able to build strong relationships with key response partners during this work.

Infectious Diseases

Infectious disease outbreaks differ from many other emergencies in that they may be widespread and prolonged, with a decentralized response, as seen with the 2009 H1N1 pandemic. The Panel found that the EPR Program, and NIOSH overall, made a significant impact in worker protection from infectious diseases during the 2007-2017 period.

NIOSH's work in this area provides a good example of building on prior activities and outputs to create a powerful body of knowledge and tools for use in future events. The Evidence Package, along with the experiences of several Panel members, provided the Panel with documentation of NIOSH's broad and deep work preparing for, and responding to, major infectious disease events, including:

- The 2005-2006 DHS and HHS pandemic Influenza planning period;
- The 2009-2010 H1N1 influenza pandemic;
- The 2014-2015 Ebola virus disease (EVD) response in West Africa; and
- The U.S. preparation for, and worker protection during, the treatment of possible EVD cases.

The Panel agreed that preparedness and response activities during these events constituted appropriate prioritization of resources, particularly given the potential widespread effects if healthcare workers, and other affected workers, were significantly impacted by disease.

Pandemic Influenza Planning Period

In 2005 and 2006, NIOSH contributed to developing and addressing several key national planning documents (*National Strategy for Pandemic Influenza*, *National Strategy for Pandemic Influenza Implementation Plan*, and *Pandemic Influenza Plan*) published by DHS and HHS. NIOSH also participated with OSHA and other federal agencies and state and local health departments to develop and test pandemic flu plans. During this planning period, NIOSH conducted important research on aerosols containing influenza virus to better characterize the behavior, persistence, and viability of these potentially infectious aerosols. NIOSH also commissioned a National Academies report, *Preparing for an Influenza Pandemic: Personal Protective Equipment for Healthcare Workers*, which included national, state, and local pandemic influenza planning information provided by NIOSH, including decisions regarding equipment to be stockpiled to support healthcare and other essential functions.

One Panel member recounted how this information was immediately utilized in California's 2006 *Pandemic Influenza Preparedness and Response Plan* to ensure that NIOSH-certified respirators would be available to, and used by, exposed employees in healthcare settings. NIOSH research on worker protection from infectious aerosols generated by humans, animals, or laboratory processes was also instrumental in the development and

adoption of California OSHA's Aerosol Transmissible Diseases Standard (<https://www.cdph.ca.gov/Programs/CCDC/DEODC/OHB/CDPH%20Document%20Library/ATD-Guidance.pdf#43>).

2009 H1N1 Pandemic Influenza

During the initial H1N1 response, CDC, in collaboration with NIOSH, recommended the use of respiratory protection for healthcare workers exposed to pandemic influenza patients, a recommendation that was supported by scientific research regarding the behavior and control of infectious aerosols, much of which came from prior NIOSH research (OSHA announced that it would enforce these recommendations during the pandemic). Throughout this pandemic, NIOSH's recognized expertise on worker protection provided invaluable support to healthcare organizations, labor unions, employees, healthcare professionals, state and local public health agencies, and OSHA and OSHA state plans, including in California.

Throughout the pandemic, NIOSH responded to issues surrounding respirator use in healthcare settings, including possible methods of disinfection for N95 filtering facepiece respirators, as well as extended use, redonning, and fit testing. At the request of the California OSHA, NIOSH conducted an HHE into poor-fitting 3M 8000 model N95 respirators from federal stockpiles. While NIOSH did not find a problem with the respirator construction or certification, this HHE provided important information to the California OSHA regarding NIOSH's Total Inward Leakage Project (addressing half-mask respirator requirements, fit, and testing).

2014-2015 Response to Ebola Virus Disease (EVD) in West Africa

During the Ebola response in 2014-2015, health and safety protections available to healthcare workers in Guinea, Liberia, and Sierra Leone were challenged by a lack of medical equipment resources, the heat and other field conditions, and the large number of patients who were severely ill. Alongside international efforts, NIOSH provided occupational safety and health support to the U.S. response, later applying lessons learned when establishing the recommendations for EVD patients in the United States.

The Evidence Package describes the role of EPR Program staff deploying to West Africa in providing occupational health and safety assistance to U.S. healthcare teams on the ground. One staff member was specifically deployed to help CDC develop and teach the course *Preparing Healthcare Workers to Work in Ebola Treatment Units (ETUs) in Africa, at Anniston, Alabama* to these U.S. healthcare workers. EPRO staff provided course content and extensive review of the training materials as the course was in development. This course was developed to better prepare U.S. healthcare workers volunteering to care for Ebola patients in Africa, lecturing on worker safety and health and proper PPE use, as well as directing hands-on scenarios in which participants donned PPE, practiced providing safe care in a mock Ebola treatment unit, mimicked moving through a treatment unit, and then simulated proper exiting and doffing of PPE. One Panel member who attended this class did not recall NIOSH or EPR Program involvement.

As the outbreak grew to the largest single recorded outbreak of EVD, healthcare facilities and public health agencies in the United States began to plan in case Ebola reached U.S. borders. NIOSH's expertise in PPE, donning and doffing procedures, and control of parenteral and other exposures to blood and bodily fluids was important in developing protocols in Africa and for transferring the knowledge gained to U.S. preparedness.

EVD Preparedness and Response in the United States

When two nurses contracted EVD after treating the first U.S. EVD patient in Dallas, Texas, CDC guidance on PPE was criticized for not being sufficiently specific. It was at that point that NIOSH's decades of research and research-to-practice projects provided important and credible leadership, not only on PPE, but on the organization needed to contain contamination, protect workers, and prevent disease spread. Expertise gained in addressing donning, doffing, decontamination, and hazardous waste handling in a variety of environments contributed to NIOSH's ability to provide technical support to healthcare facilities. CDC guidance, which NIOSH helped develop, was incorporated into an assessment tool created by CDC for Ebola treatment centers and assessment hospitals. One Panel member credited NIOSH, in part, for the successful treatment of the patient at Bellevue Hospital in New York City, in which no healthcare workers contracted EVD.

The EPR Program also provided preliminary findings from a NIOSH project evaluating isolation gowns that found many gown models did not meet the consensus standards.

NIOSH also received numerous inquiries during the EVD response from employers, employees, labor unions, volunteer organizations, and the public on how to protect against Ebola infection in non-healthcare settings. In response, NIOSH, in partnership with CDC, immediately developed guidance documents and communication materials that focused on worker health and safety, as well as provided significant occupational safety and health content to guidance documents and communications developed by CDC. Additionally, NIOSH communicated with representatives from OSHA, health and safety organizations, PPE manufacturers, professional organizations, and labor unions regularly on the development and status of these materials. Through a collaboration with the American Federation of Labor and Congress of Industrial Organizations and OSHA, NIOSH routinely solicited feedback on draft guidance under development. One Panel member recalled this process producing excellent factsheets for workers at airports and other sites.

The Panel agreed that measuring the impact of NIOSH's preparedness work for emergencies that have yet to occur proves challenging. However, the planning and preparedness process for one emergency type that brings together many different federal agencies and partners ensures a more successful response to any emergency. The Ebola work provides a recent example of this – NIOSH quickly leveraged existing response knowledge for other infectious diseases and existing knowledge from outbreaks in remote areas of Africa to successfully respond to the epidemic.

Recommendations for the Future

Although all Panel members found that the EPR Program's activities and outputs directly or indirectly led to improvements in workplace safety and health, as well as recognizing the EPR Program has made major contributions to worker health and safety during preparedness and emergencies, there are several recommendations outlined below that Panel members believe will strengthen the Program.

All Panel members expressed concern that NIOSH maintain and strengthen the three interconnected key elements believed to have been critical to the successful impact of the EPR Program work over the past decade. To accomplish this, the Panel encourages the EPR Program to consider the following recommendations:

1. Continue to sharpen the focus of activities and outputs to create deep and strong bodies of knowledge and tools built on prior work that can be useful across many types of events.

- a. The EHRMS Program is the current best example of this – an impressive body of tools proven useful across several different types of emergency responses. Continue to develop additional tools for the EHRMS Program based on input by users and potential users, including the integration of technologies, such as the cell phone app piloted by Queens College, and the exploration of newer technologies appearing in the next decade. With rapid advances in technology, such as deployed, wearable, sampling devices and rapid analysis and interactive communication with individual emergency responders during and after these events, NIOSH and the EPR Program should be a key contributor and developer in this space. If possible, add protections for human subjects and informed consent into the EHRMS Program to allow for follow-up studies by academia to evaluate the long-term health impacts to responders.
- b. As part of a systematic management strategy for Program improvement, periodically assess gaps in the bodies of knowledge and tools, seek opportunities to fill these gaps, if possible, and explore the adaption of knowledge and tools from one response type to another. For example, can the successful sampling tools and decontamination knowledge for anthrax be adapted for use with other biological agents?

2. Maintain and strengthen engagement and collaboration with organizations outside of NIOSH.

- a. Build partnerships with NIOSH-funded Education and Research Centers by creating opportunities for collaboration with their faculty and students in local or regional emergencies or preparedness activities, including developing novel technology and tools (the Queens College work with Latino day laborers is one example). Explore extramural opportunities and other mechanisms to permit their rapid involvement in research and interventions. Similar collaborations might also be possible with other federally funded centers, such as the Centers of Excellence for Infection Prevention and Control.
- b. More clearly define/identify the role of the EPRO and EPR Program for organizations outside of NIOSH. Raise the visibility of the EPR Program, if possible, to ensure its good work is recognized broadly by federal, state, and private emergency response organizations, including the Federal Emergency Management Agency (FEMA) and state and local agencies. Continue branding and publication of research in peer-reviewed literature. Explore ways to formally integrate with FEMA and OSHA during a response to fill the scientific advisement role for worker safety and health.

3. **Strengthen efforts to have EPR Program outputs and tools adopted into federal, state, and other emergency plans. Increase, as possible, the integration of EPRO and other NIOSH staff to leadership positions within emergency response systems.**
 - a. Panel members strongly support efforts to promote the adoption/integration of the EHRMS Program into the emergency management system for national, state, and local emergency responses. Consider a demonstration project with FEMA to show the value of incorporating EHRMS.
4. **NIOSH should continue work on developing “next-generation” PPEs that are more appropriate for use in emergency responses, including use in difficult field conditions.** This is especially needed for healthcare workers, since higher-level PPE ensembles present challenges in terms of mobility, heat stress, and the ability to drink and use sanitary facilities without contamination; field conditions exacerbate these challenges. This research must include input from frontline healthcare and other workers. The Training for Development of Innovative Control Technologies Project in San Francisco provides a model for this work (3).
5. **The NIOSH EPR Program should explore effective strategies for integrating organized labor and other stakeholders often left out of national-, state-, and local-level emergency planning and response and recovery planning and implementation.** When possible, this role should be formalized in the national planning for response and recovery. Workers often have both the greatest personal stake in operational safety, as well as a unique knowledge of the conditions. The NIOSH EPR Program, in collaboration with the NIEHS Worker Training Program and organized labor, could make specific recommendations for institutionalizing a participatory role for workers, workers’ union representatives, and other affected communities in emergency response and recovery.

Appendix 1 – Abbreviations

ASPR	Assistant Secretary for Preparedness and Response
CDC	Centers for Disease Control and Prevention
DHS	Department of Homeland Security
DWH	Deepwater Horizon (oil spill)
EOC	Emergency Operations Center
EPR	Emergency Preparedness and Response (Program)
EPRO	Emergency Preparedness and Response (Program) Office
ERHMS	Emergency Responder Health Monitoring and Surveillance (Program)
EVD	Ebola Virus Disease
FEMA	Federal Emergency Management Agency
HHE	Health Hazard Evaluation
HHS	(Department) of Health and Human Services
HPP	Hospital Preparedness Program (ASPR)
NIEHS	National Institute of Environmental Health Sciences
NIOSH	National Institute for Occupational Safety and Health
OSHA	Occupational Safety and Health Administration
PPE	Personal Protective Equipment

Appendix 2 – Summary Panel Scoresheet

NIOSH Emergency Preparedness and Response (EPR) Program Panel Scoresheet

Relevance

Did the EPR Program appropriately set priorities based on burden and need?

- 5** = The rationale for the activities completed by the program are highly justified.
- 4** = The rationale for the activities completed by the program are justified.
- 3** = The rationale for the activities completed by the program are moderately justified.
- 2** = The rationale for the activities completed by the program are minimally justified.
- 1** = The rationale for the activities completed by the program are not justified.

5.0 = Average Panel Relevance Score

Impact

How engaged was the EPR Program in transferring research into the workplace? Has (or is it likely in the future) the EPR Program's activities and outputs directly or indirectly led to improvements in workplace safety and health?

- 5** = Research program has made major contribution(s) to worker health and safety on the basis of end outcomes or well-accepted intermediate outcomes.
- 4** = Research program has made some contributions and/or demonstrates great potential to contribute to end outcomes or well-accepted intermediate outcomes.
- 3** = Research program activities are ongoing, and outputs produced are likely to result in improvements in worker safety and health. Well-accepted outcomes have not been recorded, but potential for well-accepted outcomes has been demonstrated.
- 2** = Research program activities are ongoing, and outputs produced may result in new knowledge or technology, but only limited application is expected. Well-accepted outcomes have not been recorded, and the potential for well-accepted outcomes is limited.
- 1** = Research activities and outputs do not result in, or are not likely to have, any application.

5.0 = Average Panel Impact Score

Total Score

Average Panel Relevance Score + Average Panel Impact Score = Total EPR Program Score

10.0 = Total EPR Program Score

Appendix 3 - References

1. Mayne, J. (2011). Contribution Analysis: Addressing cause and effect. In K. Forss, M. Marra, & R. Schwartz (Eds.), *Evaluating the complex: Attribution, contribution, and beyond* (Vol. 18, pp. 53-96). New Brunswick, NJ: Transaction Publishers.
2. NIOSH (1991). Exxon/Valdez Alaska Oil Spill. By Gorman R, Berardinelli S, Bender T. Cincinnati, OH: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, Health Hazard Evaluation Report HETA 89-200 & 89-273-2111, <https://www.cdc.gov/niosh/hhe/reports/pdfs/1989-0200-2111.pdf>.
3. Training for Development of Innovative Control Technologies Project, San Francisco General Hospital. <http://www.tdict.org/index.htm>