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Abstract: In recent years, there has been a sharp and continuing increase in the volume of hazardous cargo transported by water. Acknowledging the risks, manufacturers and shippers, along with federal and state governments, have made commendable efforts to prevent casualties that involve dangerous cargoes. However, this focus on prevention may have diverted attention from an equally important aspect of hazardous cargo safety: the need for prompt, orchestrated, and highly effective response to the casualties that can and do occur despite the most stringent precautions, with emphasis on developing the technical and institutional capabilities for this response. In the meanwhile, the technical community who would be called upon to cope with a casualty has expressed concern about the capability to respond to and manage a significant marine incident involving hazardous cargoes. In reply to these concerns, the National Research Council's Marine Board undertook an assessment of current capability, both technical and institutional, for responding to casualties involving ships carrying hazardous cargoes. In February 1978, the Marine Board established a Panel on Response to Casualties Involving Ship-Borne Hazardous Cargoes to undertake the assessment. This report presents the results of that assessment. (Author)

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RESPONDING TO CASUALTIES OF SHIPS BEARING HAZARDOUS CARGOES

A Report Prepared by the
Panel on Response to Casualties Involving Ship-Borne
Hazardous Cargoes
of the
Marine Board
Assembly of Engineering
National Research Council

NATIONAL ACADEMY OF SCIENCES
Washington, D.C., 1979

NOTICE

The project that is the subject of this report was approved by the Governing Board of the National Research Council, whose members are drawn from the Councils of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine. The members of the panel responsible for the report were chosen for their special competences and with regard for appropriate balance.

This report has been reviewed by a group other than the authors, according to procedures approved by a Report Review Committee, consisting of members of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine.

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FOREWORD

The transport of hazardous cargoes by ship is increasing dramatically at sea, in congested port areas, and along the nation's inland waterways. Federal and state governments and industry have expended considerable effort to develop safe operating practices. This effort has taken the form of increased safety consciousness and measures on the part of industry, stringent regulations promulgated by government, and government and industry contingency planning. Legislative initiatives such as the Ports and Waterways Safety Act of 1972 (33USC1221-1227; 46USC391(a)), the Federal Water Pollution Control Act, as amended (86STAT816), the Hazardous Materials Transportation Act of 1974 (46USC170; 49USC1471, 1472, 1655, 1801-1812), and the Port and Tanker Safety Act of 1978 (P.L. 95-474) ensure the care and caution with which marine transportation of hazardous cargoes is undertaken.

Despite the prodigious effort expended to prevent marine casualties involving hazardous cargoes, insufficient attention has been paid to developing and maintaining the technical and institutional capability to respond to such casualties if and when they should occur. Even minor casualties of ships carrying hazardous cargo can result in major or catastrophic disasters affecting the ships and their crews, the marine environment, the shoreline, and the coastal settlements and their population.

The premise of the study is that the sequence of decisive and timely actions taken after the occurrence of a casualty is crucial in preventing major or catastrophic consequences. The basic casualty response functions include minimizing the consequences of the incident, including any accidental cargo release; maintaining local public safety; controlling and cleaning up pollution; and recovering (salving) the stricken vessel. The need to assess national response capability has been the subject of formal and informal discussions among the technical community and concerned federal agencies that would be involved in response. These discussions resulted in a request from the Society of Naval Architects and Marine Engineers that the Marine Board of the National Research Council establish a panel to assess response capabilities.

Accordingly, in February 1978 the Marine Board convened a Panel on Response to Casualties Involving Ship-Borne Hazardous Cargoes. The panel's work was supported by the U.S. Army Corps of Engineers, the U.S. Coast Guard, the Maritime Administration, and the U.S. Navy. The panel's charge was to assess current technical and institutional capability to respond to casualties involving ships carrying hazardous cargoes, including both incident minimization or damage-limiting capabilities and the capability to recover the hazardous cargo vessel.

In conducting the study, the panel was charged with the following responsibilities:

1. Outlining a number of plausible casualty scenarios;

2. Conducting seminar workshops to identify capabilities and deficiencies in equipment, personnel, and procedures for responding to the plausible casualties; and

3. Preparing a report, based on its deliberations, identifying deficiencies in equipment and personnel and recommending programs to alleviate deficiencies.

The study was conducted over a 12-month period. Drawing on expert advice from special contributors and available information, the panel prepared plausible scenarios for casualties involving hazardous cargoes. Although the scenarios describe events that have the potential to assume catastrophic proportions, the incidents are capable of being responded to and managed. The scenarios served as the basis for seminar sessions at which key actors--associated with industry, government agencies, and local public safety forces--played "what if" games and responded with decisions and actions as though the incidents described by the scenarios were actually occurring. In this report, these sessions are referred to as "game simulations." (The word "game" is used to differentiate them from mathematical or computer simulations.) The panel based its assessment of response capabilities on information that was revealed in the course of the study and on its collective experience and expertise in casualty response.

Although it marked a departure from typical National Research Council study approaches, the panel's study method is similar in many respects to the case studies often used in graduate education and occasionally used in conducting National Research Council studies.[1] The game simulation approach departs from usual case

[1] Notes are provided on pages 53-54.

study methodology in that the experts who would be relied upon to act in the event of a real emergency were called upon to formulate decisions and take actions as though an incident was actually occurring, rather than simply being asked to analyze a written description of probable actions.

It is important to recognize that the game-simulations were not designed or conducted as operational readiness exercises. They do not purport to test or compare agency, industry, or individual performance. Furthermore, the case study method does not produce statistically meaningful data which can be used to support definite conclusions. However, the method, which permits reiterations of several sequences of responses, does do what a formal examination may not do well: it tests human interactions and exposes decision processes. The case study method provides clues to technical and institutional weaknesses in response capability. By doing so, these game simulations provided a focus for the panel's collective expertise and experience. The panel's findings and recommendations, therefore, are based on these clues, as well as on their assessment of information developed during the course of the study.

SUMMARY

In recent years, there has been a sharp and continuing increase in the volume of hazardous cargo transported by water. Acknowledging the risks, manufacturers and shippers, along with federal and state governments, have made commendable efforts to prevent casualties that involve dangerous cargoes. However, this focus on prevention may have diverted attention from an equally important aspect of hazardous cargo safety: the need for prompt, orchestrated, and highly effective response to the casualties that can and do occur despite the most stringent precautions, with emphasis on developing the technical and institutional capabilities for this response. In the meanwhile, the technical community who would be called upon to cope with a casualty has expressed concern about the capability to respond to and manage a significant marine incident involving hazardous cargoes.

In reply to these concerns, the National Research Council's Marine Board undertook an assessment of current capability, both technical and institutional, for responding to casualties involving ships carrying hazardous cargoes. In February 1978, the Marine Board established a Panel on Response to Casualties Involving Ship-Borne Hazardous Cargoes to undertake the assessment. This report presents the results of that assessment.

The panel employed a case study methodology in the conduct of the study. This consisted of developing scenarios describing hypothetical but plausible marine casualties and then conducting game simulations in which those who would actually respond to the incidents simulated their actions in a seminar, or game, mode. The panel then based its assessment of response capabilities on information developed in the course of the case studies and its collective experience in casualty response.

Three case studies were developed and analyzed:

- A casualty on the Ohio River in which a towboat pushing barges of anhydrous ammonia struck a bridge abutment near Louisville, Kentucky;
- A collision between a liquefied natural gas tanker and a container ship in nearshore open ocean in the vicinity of Savannah, Georgia; and
- A collision between a Navy ammunition and explosives carrier and a bulk sugar carrier on the lower Sacramento River near San Francisco Bay.

The panel's analysis focused on government agency responsibilities and planning for marine casualty response; the need for technical information to support casualty response training and preparedness; salvage and marine fire fighting capabilities; and communications during casualty response.

In the area of government agency responsibilities and planning for marine casualty response, the need for clarifying institutional relationships among agencies and concerned interests was closely examined. The contribution that effective contingency planning can make to casualty response was explored in depth. The need to establish operating relationships among agencies involved in casualty response prior to the occurrence of a casualty was also established.

More immediate and effective delivery to response teams of high-level technical information on hazardous cargoes is critical to improving national response capabilities. Furthermore, a need was identified for some federal agency to have the ability and information to gain access to pollution control, salvage, and other equipment necessary for casualty response in a timely manner. Finally, the success of a marine casualty response can hinge on the availability of technical information on the characteristics and configuration of the vessel involved. This information is rarely, if ever, readily available.

A relatively high level of training and preparedness was apparent in the case studies, especially on the part of the Coast Guard, the State of California, and the liquid natural gas (LNG) industry.

A number of technical and legal constraints affecting the economic health and effective performance of the salvage industry are identified in the report. Recommendations to reduce these constraints include the requirement that hazardous cargo ships carry easily understandable and implementable technical information devoted to the details of salvage and casualty response. A more responsive salvage industry must also have access to all equipment necessary for casualty response. This may entail new institutional arrangements such as industrial cooperatives for salvage purposes.

The salvage industry also faces a number of legal barriers to responsible and effective performance. Most salvors now work on a no cure/no pay basis, meaning that the salvor can neither collect fees nor be reimbursed for his expenses unless he is able to complete the job as specified. In hazardous cargo incidents, the salvor may perform major salvage work and then fail to collect his fee because he can find no safe-haven port to which to tow the vessel for repair or scraping, as required. Further, the present outmoded system makes him liable for any pollution that may occur while the ship is under his care, even though it is the owner who carries insurance against pollution cleanup costs. Another important legal barrier to emergency salvage operations, from the point of view of shipowners and local authorities, is the Cabotage

Law, which forbids the use of foreign salvage equipment in U.S. waters unless no comparable domestic equipment is available. Government permission, a red-tape process that can delay marine disaster response, must be obtained before any foreign salvage vessel in the area can be called upon for help. These legal problems hampering salvage operations, most of which became manifest during the game simulations, are discussed in the report in greater detail and remedies are suggested.

In the area of marine fire fighting capability, there appeared to be a dearth of marine fire fighting resources in port areas. Further, the few resources that exist are apparently being sharply cut back as the result of strained municipal budgets and lack of federal financial support earmarked for marine fire fighting. Finally, contingency plans for regional fire fighting coordination often overlook the special case of marine fires, particularly coordination of marine with land fire fighting efforts.

In the area of communications, existing notification procedures for pollution incidents work well and serve a useful function for marine casualty response. After notification has been made, however, communications problems begin in earnest. For example, there are no commonly held, dedicated emergency communication frequencies in port areas, although the technology for this is readily available.

Numerous recommendations on these topics are made in the final section of the report. They are addressed to the various interests that should take the actions. In the private sector recommendations are directed to the hazardous cargo shipping industry, hazardous material manufacturers, and the salvage industry. In the public sector, recommendations are directed to the National Response Team, Customs Bureau, Environmental Protection Agency, Army Corps of Engineers, Maritime Administration, U.S. Coast Guard, and U.S. Navy. In addition, several recommendations are made that will require legislative action.

The report also contains an Afterword, which examines the utility of game simulations as a tool for policy and program development and evaluation. Finally, extensive discussion of the study methodology and exhaustive descriptions of the case studies are included as Appendixes A and B.

PANEL ON RESPONSE TO CASUALTIES INVOLVING SHIP-BORNE HAZARDOUS CARGOES

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BACKGROUND

The objective of this study is to assess national capability to respond to marine casualties involving vessels carrying hazardous cargoes. Response to an incident consists of minimizing the consequences of the incident, including any accidental cargo release; maintaining local public safety; controlling and cleaning up pollution; and salving the stricken vessel and its cargo. An evaluation of response capabilities was urgently needed because, despite tremendous growth in the marine transportation of hazardous cargoes and numerous studies undertaken to develop and promote safe operating practices, little attention has been paid to how government and industry would respond to a major maritime casualty involving hazardous cargoes. The technical community, including salvors and pollution control experts who would be called upon to respond to such an incident, are concerned about the capability to do so.

For the purposes of this report, the term "hazardous cargo" is defined to mean any hazardous polluting substance as defined by the Environmental Protection Agency, and also hazardous materials or dangerous cargo whose marine transportation is regulated by the U.S. Coast Guard.[2,3]

Today, more and larger vessels are carrying a wider variety of hazardous cargoes over more routes than ever before. A description of the growth in the carriage of one such cargo, liquefied natural gas (LNG), can substantiate the magnitude and growth of this traffic.[4] Ocean transportation of LNG began in 1959. Worldwide, as of January 1978 there were 81 LNG carriers in existence, under construction, or on order. As of that date, 3,278 voyages involving the carriage of about 136 million cubic meters of the product had been completed. The trade has grown from 5 voyages in 1959 to 594 in 1977.

The Department of Transportation maintains a reporting system for hazardous materials incidents that occur during the course of transportation.[5] Incidents must be reported whenever a person is killed or is injured and requires hospitalization; property damage exceeds $50,000; fire, breakage, spillage, or suspected contamination occurs involving shipment of radioactive material or etiologic agents; or a situation exists that presents danger to life at the scene of an incident. Between 1975 and 1977, 97 marine hazardous material incidents were reported to the Department of Transportation.

In the course of developing safe operating practices, hazardous cargo transportation has been studied extensively by government and industry on a national and international basis, including scientific research on the characteristics of hazardous cargoes and the consequences of their accidental release into the environment. Four kinds of studies have been undertaken: technology assessment, risk analysis, environmental assessment, and contingency planning for operations and safety.[6,7,8,9]

These prior studies have all been directed either towards preventing accidents or predicting consequences if and when a mishap should occur. The present study takes up where the others left off. Answers are sought to the question:

If a marine casualty should occur, how would it be responded to? Specifically,

1. How would public risk from and exposure to hazardous cargoes be kept to the minimum?

2. How would local, state, and federal government agencies work together with the owner of the stricken vessel to maintain public safety?

3. How would technical teams attempt to perform pollution control and cleanup and vessel salvage in the presence of hazardous cargoes? Would the necessary equipment be available? Would the personnel on the scene be knowledgeable? Would coordination mechanisms and operating systems be adequate to the challenge?

In developing answers to these questions through the case study method and other, concurrent investigations, the panel has assessed the adequacy of response capabilities for the types of incidents postulated and made recommendations for upgrading them.

The Scope of the Panel's Inquiry

The technical elements of a response to a marine casualty involving a ship carrying a hazardous cargo include:

- Reducing to an absolute minimum public hazard from accidental release of a hazardous cargo;

- Maintaining public safety (through police, fire, and medical services, etc.) in the face of an extreme emergency;

- Controlling and cleaning up pollution; and

- Salvaging the stricken vessel and cargo.

The success of a response effort hinges on six factors:

1. Adequacy of contingency planning for safe operations and for emergency response to any incidents which may occur;

2. Adequacy and availability of equipment needed to respond to an emergency;

3. Level of knowledge and training of personnel who must respond to an incident;

4. Coordination of all public and private efforts and management of assets to effect and maintain control of the situation;

5. The nature of legal and regulatory constraints on, and degree of public and political support for, technical response measures; and

6. Weather and other local conditions at the time of the incident.

In undertaking its assessment of response capabilities, the panel explored a variety of evaluation techniques. It soon became apparent that conventional techniques would be of limited utility in producing scientifically conclusive and statistically valid findings to support an assessment of response capabilities for incidents that rarely occur. Therefore, an alternate mode of assessment was adopted. A study method was chosen that simulated a small number of plausible casualty responses and that explored the technical and social (agency) interrelationships which influence response to marine casualties involving hazardous cargoes. The panel's analysis of these responses, in concert with their own expertise and past experiences and other available information, provided indications of probable areas of concern. These areas include possible deficiencies in contingency planning, communications, technical information, and organizational arrangements. They also include policy conflicts.

As a result of the limited scope of the inquiry, the findings of this report should be treated as indications of aspects of response capabilities that may need improvement, not as statistically significant conclusions about the adequacy of these capabilities.

A Methodology for Assessing Response Capabilities

This section describes the approach used by the panel to assess national capability to respond to casualities involving ships

carrying hazardous cargoes. It explains the choice of the study method; describes the study method, including development of the scenarios and organization and execution of the game simulations; points out certain artificialities in the study method that became evident during the course of the study; and provides the rationale behind the panel's choice of three specific incidents for case study scenario development and game simulation.

Choice of the Study Method

In choosing an approach to assessing response capabilities, the panel had the option of either surveying and analyzing all aspects of response to hazardous cargo incidents or focusing on those aspects of response that may need improvement. Cost limitations and the lack of functional focus made the survey approach unattractive. On the other hand, an essential requirement in identifying areas needing improvement was to proceed so that "real issues" were addressed, such as salvage and fire fighting capabilities, manpower training, technical information needs, and the operational interactions of response forces and agencies which are critical to any coordinated response. It was suggested in discussions with the agencies concerned that one means of identifying problem areas would be to develop scenarios describing hypothetical but plausible marine casualties, and then have those who would actually respond to the incidents simulate their actions in a seminar, or game. In adopting this approach, the panel recognized the novelty of its use as a tool for evaluation and policy development.

Description of the Study Method

The study was conducted in four stages:

- Information gathering and review
- Case study scenario development
- Case study game simulation
- Analysis and report preparation

This section will briefly discuss these four stages. More detailed information on the mechanics of scenario development and gaming is presented in Appendix A.

Information Gathering and Review Early meetings of the panel brought together the collective expertise and experience of the panel and the liaison representatives of the four sponsoring agencies. These meetings provided opportunities for discussion of

gaming techniques, information requirements, and information sources. They also permitted the panel to receive, discuss, and review a great deal of both general and specific information on actual occurrences of, and responses to, past casualties, as well as the participants' current perceptions of the status of casualty response planning and response capability.

Scenario Development The written scenarios describe the occurrence of an incident, plausible events that may result, and actions that may be taken in the response to the incident. The scenarios provided the "plot" for the game simulations, as developed by working groups consisting of panel members, sponsoring agency liaison, and outside experts with knowledge about salvage and the postulated hazardous cargoes and casualty locations (see Appendix B).

Game Simulations Game simulation sessions were convened to "play out" the scenarios. At these sessions, role players simulated actions they would take in a real casualty and discussed the ramifications of those actions.

In the games, different branches of the scenario were played out sequentially. This permitted multiple iterations of sequences of actions in a variety of circumstances.

The games necessitated three primary centers of activity: a "game room," an "information/assessor room," and the "panel room." In the game room, a group of players acted out the decision-making processes and other activities involved in casualty response and then discussed the ramifications of events and actions. Experts in the information/assessor room supported the role players in information gathering and assessment. They also independently assessed the consequences of players' actions and occasionally provided information that required redirection of action. In the panel room, the panel members and sponsoring agency representatives monitored the game via closed-circuit television and controlled its progress through contact with the game director (in the game room) and the team in the information/assessor area. Notes on the progress of the games were made by recorders in the game room and panel room. In addition, a review and critique session for all participants was convened at the conclusion of each game. These information sources provided the basis for the game records presented in Appendix B.

Analysis and Report Preparation The game simulations triggered insights that were corroborated or rejected by the panel after analysis based on each panel member's experience and expertise in casualty response, as well as on direct observation of the game simulations and review of information gathered in the course of the study. As a result, the findings and recommendations of this report often transcend the events that occurred in the games themselves.

Limitations and Artificialities of the Case Study Approach

A description of the study method would be incomplete without an explanation of its limitations and artificialities.

The panel's case study method was not devised as an operational-readiness exercise and should not be used to test or compare agency, industry, or individual performance. The panel turned to the study method simply as a tool to assist it in its evaluation of response systems. The games were not designed to produce any "winners" or "losers."

Names of companies and ships in the study are fictional; however, the majority of role players represented their real-life positions or responsibilities. They adhered closely to their actual responsibilities and interrelationships, and they exercised their expert judgement to make what to them appeared to be the most probable and logical decisions based on their experience. The realism of the simulations was also enhanced by the numerous contacts maintained during the course of the game with outside government and industry information sources.

Although the simulations were designed to reflect real-life situations, certain artificialities of the gaming method were very evident. Participants in the the game had access to more technical information than is likely to be available in real situations. Further, there are physical limitations on the number of roles that can be accommodated in a seminar game. Certain roles, such as local, state, and federal political officials, were necessarily simulated. Other roles, such as the numerous Navy offices that would have been concerned about the damaged ammunition carrier in the San Francisco simulation, were combined to facilitate the conduct of the game.

There was a tendency among role players in the simulations to shorten event and response times. For instance, fires that have the potential to burn for days were extinguished in the simulation in a matter of hours. Moreover, the seminar situation, in which role players are able to directly observe and converse with one another, makes communications unrealistically easy, as compared to those in the real world where offices are located across town, telephone circuits jam, and key decision makers may spend hours out of touch while traveling by air to the scene of the incident. This ease of communication proved productive because it increased the speed and quality of players' interactions and also facilitated reiterations of similar sequences of actions. Other aspects of the artificial ease of communications were the absence of language problems associated with foreign crews and the speed with which contact was established with often-elusive shipowners.

Finally, there was a tendency to downplay the significance of gaps in the availability of technical information because of the desire to proceed with the game.

The existence of these artificialities need not undermine the utility of the study method, although a lack of awareness of them probably would.

Rationale for Choosing Three Specific Incidents for Case Study

The task of choosing specific types of marine casualties for case study was assigned to a planning group of the panel. Several criteria shaped the choice of specific casualties:

- The case studies were to provide opportunity for a reasonable and realistic test of an essentially complete range of required responses to plausible incidents.

- Casualties were to have the potential for disastrous consequences; however, they had to still be capable of being responded to and managed.

Although casualties were to be plausible, the degree of probability was not considered to be a factor in selecting the types of incidents for the scenarios.

Using these criteria, the planning group developed a matrix of plausible casualties and locations. Then the panel, after considering various combinations of these matrix elements, selected the three casualty situations that best met the above criteria for the case study.

One case study involved a casualty on the Ohio River in which a towboat pushing barges of anhydrous ammonia would strike a bridge abutment near Louisville, Kentucky. This choice was influenced by a chlorine barge casualty near Louisville that occurred in 1972. Because it paralleled a real-life incident, the Louisville game simulation was convened first in order to test, refine, and improve the panel's game simulation techniques. It also was designed to provide insight into response to casualties involving hazardous cargoes that occur on the nation's inland waterways.

A second case study centered on a collision between a liquefied natural gas carrier and a container ship in the open sea just off Savannah, Georgia. This case emphasized an assessment of the capability to salve an LNG carrier, a relatively new type of vessel and cargo, unfamiliar to many response personnel. The Savannah case study was also designed to provide insight into response to casualties involving hazardous cargoes that occur offshore. The Savannah area was chosen over other East Coast LNG ports because panel members were most familiar with its operation. Further, in the opinion of the panel, the difficult approach to Savannah and the

incident's proximity to a population center offered the possibility of a realistic test of response systems.

In the third case study, a Navy ammunition ship and a bulk sugar carrier hypothetically collided on the lower Sacramento River near San Francisco Bay. This simulation was set in an especially complex jurisdictional setting. A Navy ship would be involved in a collision with a private vessel. Emergency forces that would respond would be under local, state, and federal control. Some fires would be fought from land by local fire departments; others would be fought from the water by the Coast Guard and the Navy. The purpose of this case study was to examine the interplay among government agencies in order to identify means of strengthening emergency response, and also to pinpoint breakdowns in coordination and other institutional factors that hampered the response effort. The case was also designed to provide insight into response to casualties involving hazardous cargo that occur in major urban port areas.

In combination, the three case studies served their purpose well, illuminating both the deficiencies and strengths of the response capabilities of American communities to a marine hazardous cargo disaster.

THE CASE STUDIES: DESCRIPTION OF THE SCENARIOS AND GAME SIMULATIONS

Introduction

This section describes the scenarios and the course of the game simulations to support and facilitate an understanding of the panel's analysis and recommendations. Detailed supporting information for each of the cases is presented in Appendix B, including the scenarios developed by the panel that served as the basis of the game simulations, as well as records of discussions, interactions, decisions, and actions as they actually occurred in the game simulations.

Anhydrous Ammonia Barge Casualty
Louisville, Kentucky

It is a Saturday afternoon of a Memorial Day weekend, and thousands of people are attending an outdoor bluegrass concert and other public events occurring along Louisville's redeveloped riverfront. Suddenly, just offshore on the Ohio River, a towboat pushing four barges of anhydrous ammonia strikes a bridge abutment. The incident occurs in full view of the throng of holiday makers.

Anhydrous ammonia is a corrosive gas. Its vapors are extremely irritating to skin and mucous membranes. Substantial exposure can cause corrosive burns or even death. The gas is shipped under compression and refrigeration. When exposed to fire or radiant heat, a pressurized ammonia container can rupture violently, releasing the toxic chemical. In light (6 mph) winds, a small spill covering an area of 30 feet square would require evacuation of an area 1,500-feet wide for 2,000 feet downwind to protect life. In the event of an explosion of a pressurized container, the minimum safe distance from flying fragments would be 2,000 feet in all directions. Although a water spray can dissipate corrosive vapors in the event of a spill, anhydrous ammonia is water soluble and can kill marine life. If the wind were to direct a large ammonia vapor cloud from the stricken barge into the waterfront crowds in Louisville, there would be many severe injuries.

Steering gear failure causes the casualty. Although the towboat soon regains control, the forward two barges break free. One of these barges floats towards the tainter gate* at the dam structure located less than a mile downstream and goes aground just above the structure. The other barge partially sinks in mid-river directly offshore from downtown Louisville. Failure of refrigeration systems on the sunken barge allows the cold ammonia tank to warm up. The relief valve permits a slow, but highly visible, release of a poisonous cloud of anhydrous ammonia. This arouses immediate public alarm in the crowded riverfront area.

In accordance with the National Oil and Hazardous Substances Pollution Contingency Plan (National Contingency Plan), the Coast Guard serves as the acting on-scene coordinator of all federal agency response actions until the arrival of the EPA representative. Immediately upon receiving a radio message from the towboat Captain, the Coast Guard initiates a series of notifications which includes the vessel owner and concerned federal, state, and local agencies. The news media are also notified of the incident, in addition to having observed it.

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*A tainter gate is a structure resembling a very large bulldozer blade. It is used to control and direct the flow of water over a spillway.

Early action focuses on notifying all concerned parties, mobilizing for timely response, and securing all information necessary for evaluating technical and public risk and developing a response plan. One decision that must be made immediately by local public safety forces in the game is whether to close the highway bridge across the Ohio River until all danger is past. A logistical problem that occurs as a result of the numerous notifications that must be made is the jamming of switchboards at Coast Guard and Corps of Engineers (COE) offices. Another communications problem that soon develops is the inability of federal agencies to satisfy the public demand (as represented by the media and politicians) to know what has occurred. The reason for this, as revealed in the course of the game, is that tremendous operational demands are placed on a staff that is not large enough to handle all demands simultaneously. Any emergency staff called in at the regional or headquarters level could not be on the scene for many hours.

At one point the scenario calls for a tornado to touch down elsewhere in Louisville. It knocks out communications and power systems and forces Coast Guard and Corps of Engineers headquarters to switch to emergency power. The tornado also diverts the attention of local public safety forces and political leaders. The Louisville Department of Public Safety orders a voluntary evacuation of the riverfront area. The governor calls out the National Guard to respond to the tornado casualties and damage.

During this time, the towboat retrieves the barge that had floated toward the tainter gate at the dam (and grounded). However, at this point the scenario calls for an ammonia tank on the sunken barge to break free and float downriver. If it ruptures, a massive release of poisonous anhydrous ammonia will occur. Notified of the free-floating tank, the COE game player closes the tainter gate in order to slow the river current and raise the level of the pool in which the tank is floating. The COE also notifies the barge owner that if the tank should lodge at the tainter gate, the COE will direct its removal in order to safeguard the lock structure. Technical discussions occur between the salvor, the Corps, and the Coast Guard as to means available to secure the tank.

Three hours have elapsed since the incident occurred, and an EPA representative arrives in Louisville. Acting according to the instructions in the regional response plan, this representative assumes the role of the on-scene coordinator of federal support and response actions for pollution control. This produces confusion among officials of those federal agencies already at the scene, who, although not as well prepared in the mechanics of the regional response plan, are still responding to the emergency.

The free-floating tank does ground and rupture, causing a massive release of anhydrous ammonia. Winds dissipate the poisonous plume in 30 minutes, blowing it away from downtown Louisville. EPA makes available technical information to help the public cope with the gas cloud. This includes instructions for constructing a primitive gas mask by breathing through a can that has been perforated and filled with moist coffee grounds.

Considerable discussion in the game is devoted to developing a salvage plan for the sunken barge. Some of this discussion leaks out from the technical teams into the public arena. Public exposure of dissension among the technical team undermines public confidence in the solutions that are recommended. On the other hand, the better the access that the media and political leaders have to information, the more supportive they are of the response measures that must be undertaken.

An interesting interplay occurs in the game between the Corps of Engineers, the Coast Guard, and the barge owner over legal responsibility for various actions. The Corps of Engineers can take remedial action to protect navigation structures and to remove hazards to navigation and the Coast Guard can contain and clean up pollution and act to promote safety. However, neither agency is inclined to take direct response action as long as the owner is known and acting properly, regardless of the fact that the agencies may have much more technical response capability than the owner and may be able to respond more readily to the emergency.

In another branch of the simulation, one of two anhydrous ammonia tanks on the sunken barge is made to float loose and lodge against a tainter gate of the dam without rupturing. Discussion focuses on developing a salvage plan. EPA representatives, after some deliberation, explain that they are more concerned about air pollution, which poses a hazard to people, than water pollution. Furthermore, in the face of favorable weather predictions, EPA scales down the size of the area that they feel should be evacuated.

A salvage plan is finally agreed on. Under the direction of the Corps of Engineers, the tank will be rolled right-side-up and then towed off. A variety of equipment, including a crane of sufficient size, will be needed to accomplish this. Considerable time is spent locating equipment and other salvage assets. The salvage plan is publicly presented at a press conference convened by the regional response team.

Salvage of the sunken barge must also be accomplished. This is complicated by frequent shifting of the barge's position. The salvors recommend deliberately dumping the contents of the remaining cargo tank into the river prior to undertaking salvage. The owner's lawyer cautions the owner that deliberate dumping of hazardous substances is prohibited by law. He advises that the cargo not be released unless and until the government issues a written order to do so. At the conclusion of the game simulation, EPA is concerned that the effects of a massive release of anhydrous ammonia into the river are not known, nor is information readily available on means of buffering the release.

Liquefied Natural Gas Tanker/Container Ship Collision
Savannah, Georgia

Liquefied natural gas is a compressed gas which is transported at extremely cold temperatures (-260°F). If released on water it will float and boil and produce a visible and flammable vapor cloud. A vapor cloud from an uncontained release will drift downwind. If a source of ignition is encountered, a short, severe fire will consume the vapor. Flashback along the vapor trail may occur. Vapors that encounter a source of ignition in an enclosed space may explode. LNG is not a hazardous polluting substance. It is not harmful to aquatic life. The major hazard associated with the transport of LNG is its extreme flammability, especially when a casualty of some kind has created a large vapor cloud.

In the Savannah simulation, a fully loaded LNG vessel is inbound to discharge cargo at a receiving facility in the Savannah area. It is complying with Coast Guard arrival procedures for LNG ships, which include vessel traffic control between Savannah harbor and the Savannah light. Coast Guard regulations require the presence of an escort vessel, which is on station awaiting the ship's arrival. However, marine traffic delays and steering gear failure precipitate a collision between an outbound container ship and the inbound LNG ship about nine miles off Savannah Beach, a heavily populated seashore resort area. The LNG tanker master immediately proceeds to implement damage control procedures to protect crew and equipment from fire and other hazards. Coast Guard personnel on the escort boat witness the collision and initiate notifications and preliminary response actions, as stipulated in the regional response plan for pollution incidents. (Even though LNG is not a polluting substance, the National Contingency Plan and regional response plans established pursuant to it may be activated in response to the threat of pollution. In the Savannah game, both ships carry some fuel oil, which is a polluting substance.)

In the game, the collison does not cause the ships to lock together. However, fire breaks out on the LNG tanker. One entire tank of cargo is consumed in an intense fire that burns for approximately 15 minutes. The shipboard fire precludes the formation of any vapor cloud. The ship's sophisticated design and equipment are effective in confining the fire, although shipboard primary electrical and communications systems are knocked out. Until new antennas can be rigged, the LNG tanker will be able to communicate only via walkie-talkie messages sent to and relayed by the Coast Guard escort boat. Class A (combustible material capable of being extinguished with water) fires remain after the LNG fire

has burned itself out. The master organizes work parties to extinguish these fires. Meanwhile, the LNG tanker drifts aground. The master sets anchor to keep the ship from being forced harder aground by wind and waves.

The Coast Guard closes down all vessel traffic in the vicinity of the incident. It requests staff and material assistance from the district, and also requests the advice and involvement of the Supervisor of Salvage, U.S. Navy. The owner has access to necessary salvage and cargo transfer equipment stockpiled in Norfolk, Virginia and immediately orders that this be sent to Savannah. A cargo transfer vessel is also diverted to the scene. One reason for a strong and early response by the owner is that he has developed corporate contingency plans for an LNG casualty and has sponsored manpower training programs.

The scenario calls for a 22,000 hp foreign salvage tug returning to Europe from a town in the Gulf of Mexico to notify the Coast Guard that it is in the immediate area and is available to assist as necessary. However, cabotage law (46 USC 316) prevents the use of foreign salvage assets unless the Commissioner of Customs certifies that comparable domestic assets are not available. Valuable early response time is lost in securing the cabotage waiver.

The Coast Guard holds a public briefing in the game. Because the owner appears to be responding properly to the situation, Coast Guard operations are in a monitoring and support mode. Contingency funds for pollution cleanup cannot easily be made available because no pollution has occurred, although the threat of pollution probably exists.

After some time has elapsed, the foreign salvage tug prepares to tow the LNG ship out to deeper water. Technical questions that are raised in preparing for the tow, which are not adequately addressed in the master's damage control book or in other contingency planning documents, center on how best to de-water and ballast the ship and how much horsepower will be necessary to refloat the it. Another question that arises as a result of the towing attempt is, where will the ship be towed to? A safe haven must be--and is--found in which to effect cargo transfer and salvage. The safe haven problem proves politically volatile in the game. Congressional interest in the matter is even expressed.

The foreign tug successfully tows the tanker off-ground. The foreign tug is then dismissed. Attended by smaller domestic tugs, the ship will await the arrival of cargo transfer and salvage gear before being towed to the safe haven.

Another branch of the simulation explores more fully the technical question of ballasting for towing, using available domestic tugs. Since there is less horsepower in the vicinity for towing than when the foreign salvage tug was present, the ship must float free of its own accord, through proper ballasting and offloading of cargo, before she can be towed to a safe haven. The owner estimates that it will take 8 hours to rig for cargo transfer and towing, and 24-36 hours to lighter and de-water the vessel and fill the holds

with inert gas (equipment for this is enroute). The vessel can then be towed to a repair facility in Norfolk.

In the same branch of the simulation, the tanker owner's lawyer expresses concern about obtaining statements from those involved and preserving evidence for subsequent legal actions. He suggests that the Coast Guard convene a fact-finding hearing into the incident immediately, on board the stricken vessel if necessary. Since both the LNG master and the Coast Guard object to such disruption, a hearing will be held in port after the emergency has passed.

The final "what if" branch of the game simulation starts at the collision. Instead of separating, the ships remain locked together for some time. An LNG fire occurs at the point of impact. Other fires burn on both vessels. Personnel injuries occur on the container vessel. Both ships are dead in the water and drift until running aground.

The LNG master wants to try to break the ships apart. He believes that while such action would result in a large fire of short duration, this is preferable to the threat of explosion from gas entrapment resulting from an LNG leak.

In the shadow of the fires, the Coast Guard initiates a search and rescue operation to find crewmen who may already have abandoned the container vessel.

The LNG fire soon burns itself out, but the container ship burns out of control. Coast Guard and other fire fighting equipment in the area is ineffective in controlling these major vessel fires. The most effective fire fighting measures appear to be those that are actually located on the ships--the LNG ship fire is brought under control quickly because the ship is equipped to fight it.

The container vessel fire is brought under control and extinguished after several hours. During this time, the owner, his salvor, the LNG master, the Coast Guard, and the Navy salvor discuss possible courses of action.

They decide to tow the ships--still locked together--to deeper water before attempts are made to pull them apart. Technical questions regarding ballasting for towing and freeing the ships are discussed in the game. The salvage engineer calculates that the ships are locked together because the LNG tanker, down by the stern, is impaled on the container vessel's bow. To separate the ships, either the container vessel must be ballasted or the LNG tanker must be lightened. In the midst of the discussions, the container vessel bow shears off as a result of being subjected to the intense cold in the LNG cargo tank, and the vessels separate of their own accord. At the end of the game simulation, cargo transfer is begun, as before.

Navy Ammunition Ship/Bulk Sugar Carrier Collision
San Francisco, California

The Carquinez Strait is located on that portion of the Sacramento River that connects San Francisco Bay, a major urban port area, with Suisun Bay, a relatively undisturbed body of water that provides an excellent water-fowl habitat. Separating two counties, the Sacramento River is bridged by an interstate highway at the town of Crockett. Industry in the vicinity of the Carquinez Strait includes the Union Oil refinery, the C&H sugar refinery, a marina in the town of Crockett, and somewhat farther upriver, Port Chicago, a Navy ammunition and explosives port facility.

The rugged topography in the Carquinez Strait area interferes with radio transmission. For this reason a bulk sugar carrier, which in the scenario is pulling away from the C&H sugar refinery pier, delays checking in with the Bay Area Vessel Traffic System. As a consequence, it is unaware that a loaded Navy ammunition and explosives ship (designated as an AE) is at that precise time being escorted upriver to Port Chicago and is transiting the Carquinez Strait. Coast Guard regulations call for traffic to avoid the AE. Obscured line of sight in the curved channel, poor radio communications in the strait, the sugar carrier's failure or inability to register with the Vessel Traffic System, and a sudden loss of power and maneuverability cause the bulk carrier and the AE to collide. The AE is holed, incurs some flooding, and sinks by the bow, while Class A (combustible materials) fires break out on board. The bulk carrier also is holed, burns out of control, and leaks large amounts of oil.

The bulk carrier is leaking bunker fuel, which has the potential to form an oil slick that can pollute shorelines and harm waterfowl. Bunker fuel is also combustible, and water may be ineffective in extinguishing a bunker fuel fire. The ammunition ship is carrying a "standard load" of conventional munitions, ranging from small arms ammunition to 500-pound bombs. Although the larger explosives are not transported in a fused, or armed, condition, radiant heat from an external source such as a ship fire can still ignite the explosive material. Such spontaneous ignition of explosives in the presence of radiant heat is called "cooking off." One means of controlling cooking off in the presence of fire is to flood the ammunition holds. A significant cook-off in a congested area would certainly cause considerable property damage and ignite secondary fires at various points of impact. A major detonation near a bridge abutment could even threaten the bridge structure.

In the game, the master of the bulk carrier radios the Coast Guard as soon as the casualty occurs. The AE captain radios Navy offices. The Coast Guard initiates a regional response to a pollution emergency, as detailed in the regional response plan. The Navy immediately sends assistance from elsewhere in the Bay Area, mainly for the Mare Island Naval Shipyard.

Fire fighters and police in the town of Crockett witness the incident, which occurs almost directly beneath the highway bridge. Police units are dispatched to control traffic on the bridge. The fire department calls the Coast Guard for more information. The Coast Guard reveals the fact that a Navy AE is involved.

In the game, the Coast Guard contacts the Navy and requests that an operations liaison and public information point of contact be established. Because of overlapping responsibilities between the Commandant 12th Naval District and the Commander Surface Forces Pacific Fleet, there is some delay in getting back to the Coast Guard. The Coast Guard decides to let the Navy speak for itself and to concentrate on its own immediate problems. However, local and state response forces are not made aware of the liaison arrangements. Questions about the Navy vessel are still directed to the Coast Guard.

Considerable communications difficulties are encountered in the game in the early hours of the response, when the Coast Guard is trying to obtain information from the two ships and local fire and police departments are attempting to communicate with the Coast Guard, because there are no commonly held, dedicated emergency radio frequencies. As a consequence, for some hours the various government agencies cannot communicate directly by radio, until sophisticated communications gear arrives from the State Office of Emergency Services and the Coast Guard Strike Team.

In the game, local emergency forces respond to the emergency by closing roads in the vicinity and preparing for any actions which may be necessary, such as evacuations and fire fighting. They look to the Coast Guard for technical information concerning the ships and the response needed and to the State Office of Emergency Services (OES) for coordination of the public safety response.

The AE is hard aground and must await the arrival of Navy salvage tugs from Pearl Harbor before she can be towed off. In the meantime, her condition and the condition of her cargo appear stable. The bulk carrier continues to burn out of control and leak oil.

In the game, the State Office of Emergency Services asks the Coast Guard what the primary blast radius would be if the AE were to explode. Advice is also sought on whether or not the town of Crockett should be evacuated, since it would presumably be in the blast radius. The Coast Guard cannot answer these questions, and there is some difficulty in obtaining this information from the Navy. Although aspects of this problem can be attributed to the logistical inability of having all concerned Navy offices represented in the game simulation, the need to have technical information on the hazardous cargo available in a contingency mode is still very apparent.

The Coast Guard attempts to locate equipment to fight the fire on the bulk carrier. The two fireboats owned by the cities of San Francisco and Oakland decline to participate unless and until they are requested under OES emergency mutual assistance procedures. Even then, the decision to send a fireboat outside its jurisdiction would be at the mayor's level on an ad hoc basis. All other external fire fighting equipment is of negligible size and effect. It becomes evident in the game that the most effective means of fighting the ship fires is with shipboard equipment and systems. Of course, this is impossible once a ship has been abandoned. And in fact, the master of the bulk carrier soon gives the order to abandon ship.

The Coast Guard tries to determine the bulk carrier owner's intentions as to pollution control. After some discussion, and against the advice of his lawyer, the owner informs the Coast Guard of his intention not to take direct response action. This clears the way for the Coast Guard to act unilaterally to control and clean up the pollution. The lawyer's advice on this issue stems from the fact that the lawyer feels that the owner's action could possibly be construed as acceptance of legal and financial responsibility for the pollution. In actuality, the Coast Guard will bill whoever is found at fault for the cost of cleanup.

During this time, the AE ship has been debarking unnecessary crew. A Navy harbor tug is due shortly to stabilize the ship's position, which is very close to a bridge abutment. Navy divers are enroute to conduct a preliminary damage survey.

In the game, federal, state, and local response forces establish command posts in the vicinity of the incident. The Coast Guard obtains public information assistance from the district level and technical assistance from the strike team. Arrangements have been made with a commercial oil spill organization to assist in the cleanup, especially to place booms across the Sacramento River to keep oil from entering Suisun Bay. A commercial salvor is also placed on contract. The Coast Guard's response strategy is to extinguish the fire, then offload the remaining fuel oil to stem the pollution.

After six hours of response, the situation in the game is as follows: The AE is aground close to a bridge abutment. Although the cargo is stable at the moment, the Navy considers the situation to be fraught with hazard and has advised the Coast Guard and local and state governments accordingly. Abandoned and burning out of control, the bulk sugar carrier has drifted several miles downstream and is now directly opposite the Union Oil pier. The owner has released his pollution control responsibility to the Coast Guard. The Coast Guard has contracted for assistance from salvors and pollution control experts. Local fire and police forces, under the coordination of and with the support of the OES, have responded effectively. Traffic and crowd control operations are in effect. Fire equipment has been readied and is on standby in the area. Contingency plans for evacuation are being reviewed and developed. However, as long as the condition of the AE remains stable, the public safety emergency appears to be be winding down, with the exception of oil spill operations.

The scenario calls for the bulk carrier fire to burn itself out after some time. The abandoned hulk becomes an obstruction to navigation. The Coast Guard asks the Corps of Engineers to so designate and mark the hulk (and thereby acknowledge removal responsibility). The Coast Guard also asks the Corps to predict the movement of the oil spill on its San Francisco Bay hydraulic model.

With the bulk carrier fire extinguished, operations to offload the remaining fuel oil are undertaken. This may take several days. The master of the bulk carrier and some crew return to the ship to assist as necessary.

The bulk carrier owner's lawyer advises that the ship may be a constructive total loss (CTL), a condition in which costs of salvage and repair exceed the worth of the vessel. Discussion in the game on this point brings out the various interests of the owner, the hull insurer, and the P&I (Protection and Indemnity) insurer. The hull insurer would still be liable for the cost of salvage and repair up to the insured value of the vessel. The P&I insurer would, of course, then not be liable for wreck removal. The owner will base his decision on market conditions and the cost to him. In the end, the bulk carrier is declared a CTL. Wreck removal becomes the responsibility of the Corps of Engineers, which contracts for commercial assistance. At some later date, the Corps will bill whoever is found liable for the cost of wreck removal.

The many legal wranglings that emerged in the course of the game have the potential of causing operational delays for the salvor and for government agencies. The salvor has other problems as well. The strict liability provisions of the Federal Water Pollution Control Act, as amended, make the salvor liable for pollution that occurs during salvage, even when pollution occurs in the course of preventing additional pollution. Furthermore, the "no cure/no pay" standard salvage contract shifts any responsibility of the owner to the salvor. Additionally, if the salvor performs his job but is unable to deliver the vessel because of pollution or other problems (the safe-haven problem, for instance), he is not entitled to payment and will not be reimbursed for his expenses.

At a Regional Response Team (RRT) meeting convened during the game, the Navy presents a salvage plan which would require offloading much of the AE's cargo prior to undertaking salvage to refloat the ship. Offloading of cargo is considered necessary to save valuable ammunition, to refloat the ship, and to lessen the risk of catastrophic explosion during salvage. Cargo handling operations could take as long as 10 days and will require some evacuation of the town of Crockett. It may take up to a month to refloat the ship.

Pollution cleanup is also discussed at the RRT meeting. A series of booms is being deployed across the river. Information obtained from the Corps' hydraulic model indicates that there is ample time to deploy the booms. State fish and game personnel are setting up bird assistance stations. A NOAA scientific support team is on its way to monitor environmental effects.

The governor tours the area. He is pleased by state and local response, concerned about federal interface with state and local agencies, and very concerned about the economic and social disruption that evacuation, according to the Navy's plans, would cause. The governor questions the technical justification for offloading cargo prior to refloating the ship.

In another branch of the simulation, the bulk carrier burns out of control as before. However, the fire on the Navy ship is more significant. Some explosive material cooks off and causes fires on shore, including one at the nearby sugar refinery. The highway patrol closes the bridge. Based on discussions with the Coast Guard and the Navy, the State Office of Emergency Services recommends that the local government order a two-mile evacuation, which is promptly acted upon.

The AE has suffered significant personnel injuries. Two-thirds of its crew are ordered off the ship.

The shells and rockets that explode spawn fires wherever they strike on land. These include brush fires, a fire at the marina, and a fire at the sugar refinery. The shoreside fire fighting effort is ably coordinated by the State Office of Emergency Services and is directed by the local fire department, in accordance with established training and contingency planning procedures of the OES. The OES asks the Coast Guard for assistance in fighting the dock fires from the water. The Coast Guard responds that marine fire fighting equipment is fully engaged fighting marine fires. They will respond to shore fires only after marine fires are under control.

While the marine and land fire fighting forces are exploring their coordination difficulties in the game, a massive explosion occurs at the sugar refinery. An entire fire company is wiped out. An explosion also occurs on the bulk carrier, and this increases the rate and amount of oil pollution from the vessel. Although these events strain the capacity of local fire and emergency forces, under OES coordination they still respond smoothly to the basic emergencies of evacuation and public safety, fire fighting, and medical care for the injured.

The scenario calls for the marine fires to be brought under control after some time. Only then is some marine fire fighting equipment redirected to shore fires. A Navy inspection team reports that since a large quantity of explosive material has been destroyed, evacuation requirements can be shaved. It is not clear how this recommendation is transmitted to local public safety forces.

As the situation stabilizes, attention shifts to cleanup and salvage.

The game simulation concludes with a look at the purposes and phasing of the Navy, Coast Guard, and National Transportation Safety Board fact-finding investigations that may be initiated. The Coast Guard initiates a hearing conducted by the Marine Board of Investigation, which will concentrate on causes of the mishap. Changes in vessel traffic procedures could conceivably result. If it is

necessary to determine culpability of ships' officers, separate administrative law procedures will be initiated. The National Transportation Safety Board will also investigate the incident. The Navy launches its own investigations, which will include determining possible criminal liability of Navy officers. At the conclusion of the game simulation, it becomes apparent that the Navy would decline to participate in non-Navy proceedings until the conclusion of internal Navy investigations. This non-participation would stem from a desire to protect the rights of Navy personnel under the Uniform Code of Military Justice.

AN ANALYSIS OF RESPONSE CAPABILITIES

Introduction

In assessing response capabilities, the panel's aim was consistent with the nature of the study method, which allowed only inferences to be drawn and avoided definite conclusions. Information developed in the course of scenario development and the conduct of the game simulations was reviewed and analyzed by the panel and observers. These participants collectively represented the technical disciplines required for response to maritime casualties involving ship-borne hazardous cargoes. They included experts in salvage, admiralty law, naval architecture, hazardous-cargo vessel operations, political science, marine affairs, hazardous materials, and ocean engineering, as well as a gaming expert and representatives of concerned government agencies.

In the professional judgment of the panel, certain tendencies that became evident during the case studies are indicative of problem areas in national response capabilities. This section of the report identifies and describes those problem areas. Recommendations for specific improvements in national response capabilities are made in the section that follows it. The problem areas fall into four broad categories:

- The need for information or action of a preemptive nature;
- The need to clarify lines of responsibility for response actions;
- The need for additional technical knowledge regarding conditions at the site of the casualty; and
- The availability of response equipment, techniques, and expertise.

As a result of the manner in which this assessment was conducted, the identification of problem areas and recommendations is necessarily general in nature. This should not be construed as being traceable to, or critical of, any participant or organization.

Government Agency Responsibilities and Planning for Marine Casualty Response

Government Responsibilities

The federal government's major planning and coordination tools for casualty response are authorized by the Federal Water Pollution Control Act, as amended (86STAT816). Section 311 of that statute establishes the National Oil and Hazardous Substances Pollution Contingency Plan (National Contingency Plan), which is a comprehensive planning and coordination mechanism for pollution incident response. The National Contingency Plan becomes operative in instances where pollution has occurred or is threatened. The cost of government response to pollution incidents and cleanup, which can include ship salvage and other related responses to maritime casualties, can be paid for out of a contingency fund dedicated for that purpose. The fund provides cleanup and response funds with less delay and red tape then other funding mechanisms.

While pollution, or the threat of pollution, often is present in marine casualties, this is not always the case. This was particularly evident in the Savannah case study where, although the casualty posed a major public hazard, pollution could not technically occur from the LNG cargo because LNG is not a polluting substance. Furthermore, whatever LNG was accidentally released was consumed by fire. Thus, although the National Contingency Plan provides authorization and direction to government response to polluting or potentially polluting casualties, no similar comprehensive plan guides response to non-polluting casualties, even though a non-polluting marine casualty involving hazardous cargo may present more risk to the public than a polluting one.

One problem arising from the National Contingency Plan provisions concerns the delegation of responsibility for coordinating federal response actions.[10] According to the provisions of the plan, an EPA designee serves as the on-scene coordinator for inland waters.[11] In the Louisville game, however, the Coast Guard Captain of the Port was located in Louisville, while the closest EPA representative was in Atlanta, Georgia. At the time of the incident, the towboat's progress was being monitored by the Coast Guard vessel traffic system. In addition, both the Louisville district of the Army Corps of Engineers and the Coast Guard had some operational capability in Louisville for responding to the incident. EPA personnel, on the other hand, were not available in Louisville for most of the first day, and when an EPA representative did arrive on scene, his concerns were not central to many of the technical emergency response actions that had to be taken.

Further, the division of responsibility between the U.S. Navy and the Coast Guard is unclear to the public and to local agencies in the event of collision between a Navy ship and a private vessel. In the San Francisco game, the Navy--apparently without consultation with Coast Guard representatives or other public officials, and

without informing the public of its intentions--developed and intended to implement a salvage plan which conveyed the impression that the Navy valued the recovery of cargo more highly than public safety or alleviating traffic disruption.

The potential for administrative conflict between the Navy and the Coast Guard is also present when a Navy ship is damaged and causing pollution. In such a situation, the Navy could take salvage actions that might cause the Coast Guard to exercise its authority under pollution laws and redirect the Navy salvage plan.

In the event of a pollution incident, the Coast Guard notifies the vessel operator (if known) of his pollution cleanup responsibilities and monitors the operator's cleanup actions. The Coast Guard may respond unilaterally to a maritime pollution incident when the vessel owner is not known or is not responding properly.[12] In contrast to the facts of the matter, vessel operators and legal counsel have been known to construe the Coast Guard's formal notification of cleanup responsibility as a request for admission of liability for the pollution incident. This misconstruction occurred in the Louisville and San Francisco case studies. Furthermore, in the case studies the Coast Guard did not attempt to correct the vessel operators' inaccurate impressions of Coast Guard intentions. As a consequence, owners and operators proceeded very cautiously in their dealings with the Coast Guard and in their response actions. Valuable response time was consumed in unnecessary legal maneuvering because questions of legal liability were allowed to complicate response to the casualties. Since the Federal Water Pollution Control Act provides that most vessel owners, as a condition to using the navigable waters of the United States, give evidence of financial responsibility to meet the liabilities imposed by the act, there is no valid reason for either the Coast Guard or the vessel operator to consider assignment of liability for an incident as a prerequisite for incident response.

The Savannah case study provided indications that it is not well understood or publicized in the marine industry that the Navy has the authority to provide salvage services to a private owner.[13] In instances of compelling urgency, it may be necessary to bring all available resources to bear on a problem as rapidly as possible. The marine industry needs access to the procedures, ground rules, and points of contact necessary for obtaining these emergency services from the government.

The most effective response measures are those that are anticipatory in nature and that prevent further catastrophic occurrences. As was evidenced in all the game simulations, current casualty response mechanisms are activated by certain physical triggers, such as the presence or direct threat of pollution. Thus government response actions always commence in a reactive mode.

Contingency Planning

The National Contingency Plan, regional contingency plans developed pursuant to it, and local disaster plans are all forms of contingency planning. The objective of contingency planning is to produce more effective and better-coordinated actions in the event of a mishap by projecting plausible chains of events and response actions necessary to control the situation. However, in the event of an actual mishap, contingency planning is effective only to the extent that it is understood and relied upon in the field. The best way to ensure field-level familiarity with a contingency plan is to exercise it periodically.

The California Office of Emergency Services (OES) is a state-level emergency preparedness and response organization. The OES is the governor's staff office for disaster contingency planning, coordination, and management. It also operates a regional organization which maintains professional knowledge of local contingency plans and emergency procedures and provides advice to local government and other agencies on matters within its expertise. Additionally, the OES has statutory authority to coordinate state and local emergency response when ordered to do so by the governor. To assist in emergency response, the OES owns emergency equipment (such as fire engines) which is placed on permanent loan to local public safety forces. In return for such equipment, the local forces agree to place the equipment, fully manned, under the direction of OES whenever requested. When OES coordinates emergency response, individual response units remain under the direction of their parent agency while their actions are coordinated by OES.

State and local response was most effective in the San Francisco game. The panel attributes this to the existence of the OES, which maintains professional knowledge of contingency plans. Local police and fire fighting units turned to the OES for coordination in the emergency, and the OES knew how to respond at once. In the game, the OES was able to focus attention on secondary effects of the casualty, such as onshore fires and organization for evacuation, as well as to provide coordination and support for the primary response on the river.

One limitation of regional and local contingency planning that became apparent to the panel is that the local disaster response plans that were exercised did not extend to marine casualties. For example, in the San Francisco game, although the Bay Area is the subject of cooperative emergency response agreements for police protection and fire fighting, participation of at least one of the two fire boats in the Bay Area at the time would have been subject to ad hoc decisions by city governments during the emergency.*

*The decision of the Mayors of both San Francisco and Oakland and the Oakland City Manager would involve whether or not to honor a mutual aid request from the OES.

The contingency planning that does currently apply to marine casualties is heavily weighted towards pollution control. While pollution control is an important aspect of marine casualty response, it is by no means the only one. Other aspects of contingency planning for marine casualty response include:

Minimizing public hazard. This can be accomplished by including possible marine casualties in local disaster planning, as has been discussed.

Vessel Damage Control and Salvage. This is discussed more fully below under "Salvage."

Marine Traffic Control During Incident Response. One of the first actions that the Coast Guard must take in response to a marine casualty is to assess its effect on other marine traffic and take necessary measures, such as establishing a safety zone in the immediate area or even closing down the entire port.

In the carriage of hazardous cargoes, the areal extent of exposure to hazard is an important operating consideration. Accordingly, vessel traffic control systems and safety zones for hazardous cargo vessels must be designed and operated in a manner that reflects the volatility, reactivity, or thermal radiation potential of specific hazardous cargoes.

In the Louisville game simulation, the extent of hazardous exposure included the area in which anhydrous ammonia would have occurred at toxic levels. In the Savannah game the concern was the potential heat radiation from an LNG cargo fire. In the San Francisco game, the primary blast radius of the AE and the possible extent of the oil slick were important factors.

In major port areas, especially those handling hazardous cargo, port safety would be enhanced if contingency plans for emergency vessel traffic control procedures were in existence. These would include identification of remote and environmentally tolerable havens of refuge to which a stricken hazardous cargo vessel could be taken for cargo offloading, repair work, or grounding.

Establishing Coordination for Incidents Prior to their Occurrence

Developing an effective response organization, including establishing channels of information flow in the early hours of incident response, appears to be critical to the success of response efforts. There are two aspects to this problem: satisfying the legitimate need of the public and political leaders for information, and establishing appropriate operational liaison between involved agencies.

In the U.S. Coast Guard offices of the Captain of the Port, public information responsibilities in the event of an emergency are usually the responsibility of the executive officer, unless or until a Coast Guard public information support team is detailed to the scene. This means that in the early hours of incident response, establishment of good press relations and open channels of communication with political leaders may be undertaken without expert support. The Coast Guard has recognized that public support can be critical to the success of necessary response measures and has devoted considerable effort to developing public information expertise. To this end, it conducts training exercises, similar in some respects to the case study approach of this report, to sensitize its officers to the public information problem.

Despite strong efforts in this area, a public information void still tends to develop during the early hours of incident response. Furthermore, it takes time to focus on exactly what kinds of information must be relayed to the public, while at the same time safeguarding the confidentiality of technical debate necessary to an effective response strategy. The case studies provide two examples that bear on these points. In the Louisville game, divergent technical viewpoints were exposed to the press. The appearance of dissension in the technical response team undermined public support for necessary response measures. In the San Francisco game, those playing the role of local public safety forces turned to the Coast Guard for information on the incident, including data about the Navy ship. Meanwhile, those players who simulated the responsible Coast Guard officials adopted a policy of not speaking for the Navy at all, a decision acceptable to the Navy.

The problem of providing public information in the early hours of incident response is not amenable to quick solution because it is so dependent on the sensitivity and awareness of those who are responsible for it. The Coast Guard's emphasis on developing this sensitivity and awareness through training is a major step in the right direction. Other concerned agencies should consider this approach, along with other approaches to the problem. In this regard, the panel notes that the Coast Guard has recently extended invitations to those agencies that participate in the National Contingency Plan to take part in its game-simulation training sessions.

When more than one agency is closely involved in response operations, there is an urgent need to establish operational liaison at the earliest practicable time. In the San Francisco case study, the Coast Guard requested that the Navy designate a lead office for response purposes. It took some time to obtain an answer because the request had to pass through several command levels. As a consequence, timely coordination for incident response was virtually impossible. The means of establishing operational contacts should be decided before incidents occur. One method could could be by memorandum of understanding. The appropriateness and effectiveness of operational contacts can be tested by means of readiness exercises.

Technical Information

Response forces frequently need early access to technical information concerning ships, barges, hazardous cargoes, and the availability and location of emergency equipment. Although much information on cargo characteristics and emergency equipment exists, its usefulness to response forces is frequently compromised by lack of knowledge of how to acquire it or failure to understand the jargon in which the data are presented. Furthermore, there is no readily available data bank of ship and barge operational, structural, or machinery characteristics.

Two excellent sources (among many) of primary data on hazardous cargoes of a chemical nature are the U.S. Coast Guard Chemical Hazards Response Information System (CHRIS)[14] and CHEMTREC, a chemical transportation emergency center operated by the Manufacturing Chemist's Association. CHRIS handbooks are available for reference in all Coast Guard Marine Safety Offices, and CHEMTREC information is accessible through most telephones by dialing 1-800-424-9300. The Panel expressed two concerns regarding the utility of these data. The first is the necessary simplification of the CHRIS Volume I information and the type of information available by telephone from CHEMTREC. In the absence of an on-scene expert, initial guidance in handling spills must be limited to direct admonitions such as: "Wash with fresh water," "Do not inhale," "Don't touch," and so on. This simplification or generalization of technical information to make it applicable to a wide variety of situations, however necessary, limits its usefulness in the typically complex circumstances of a hazardous cargo casualty. The second, and parallel, concern is the unavoidable delay in the arrival of a qualified professional to answer detailed questions on handling hazardous cargo, lending authoritative support to incident response decisions that may have been strongly influenced by local weather or site configurations. This delay in availability of technical information can preclude valuable preventive actions.

With regard to the type of information needed in accident situations, examples developed in the anhydrous ammonia barge case include such questions as: What happens if liquid or gaseous ammonia is released under water at a low rate, or at a high rate? In removing liquid ammonia from sunken tanks, should the ammonia be displaced by water, air, or some other readily available substance?

With regard to response equipment, each Regional Contingency Plan developed under the National Contingency Plan contains lists or inventories of spill cleanup equipment, together with locations, telephone numbers, and names of contact persons. This information pertains primarily to equipment for dealing with oil spills. Any pertinence it might have to chemical spills, fire fighting, or salvage operations is coincidental. Some local disaster plans do include information on chemical, fire fighting, or salvage equipment, but the degree of coverage varies with the locality.

The availability of information on vessel characteristics is limited, to say the least. The information that exists is primarily in the hands of the vessel owners. Its accuracy and completeness varies widely with the owner, the vessel type, and the vessel's age. Outside of requirements for ships to carry a very limited amount of information on stability characteristics in various emergency situations, there are at present no regulatory requirements for bulk hazardous cargo vessels to carry a manual with information on vessel capabilities and suggested actions for response to various casualty situations. In order to be useful, such manuals would have to be readily accessible at Coast Guard offices in U.S. ports entered by hazardous cargo vessels and at Coast Guard district offices serving waterways used for transporting hazardous cargoes. Since much hazardous cargo traffic is international (foreign flag) in character, a requirement for the development of such manuals could be most effectively imposed by an organization such as the Inter-governmental Maritime Consultative Organization.

Training and Preparedness

A relatively high level of training and preparedness was apparent in the case studies, especially on the part of the Coast Guard, the State of California, and the LNG industry.

The Coast Guard's training programs have been described earlier. They include a variety of case studies, similar in many respects to those sponsored by the panel, to ensure that personnel are familiar with contingency plans. One Coast Guard case study, "Hiatusport," sensitizes on-scene coordinators to public and political pressures.[15] Since the key to effective incident response is contingency planning, and since successful implementation of a contingency plan often hinges on the level of familiarity that personnel have with a plan, the opening of Coast Guard training exercises to other agencies is an encouraging development. Systematic pursuit of such outside participation would raise the level of awareness of contingency plans among response personnel. Outside participation in Coast Guard training exercises could also inject needed realism into agency training programs.

The activities of the California Office of Emergency Services in orchestrating the smooth performance of local public safety forces in the San Francisco case study was impressive. Besides the contingency planning and level of training and readiness displayed (both due at least in part to OES programs), OES activities in regard to providing and coordinating local and state assets and in defusing the political involvement in technical response measures were especially impressive.

The California OES is believed to be the most fully developed and extensive state disaster response organization in the U.S. It could possibly serve as a model for comprehensive emergency response organizations in other states.

Industry performance was strongest in the Savannah game. Two factors contributed to this. First, the LNG industry has recognized the hazards and political sensitivity involved in the transport of LNG, and as a result has invested heavily to develop safe operating procedures, including contingency plans. Second, participation in the work of the panel afforded industry the opportunity to critically review and improve its own operating practices and contingency plans.

Two lessons may be drawn from this experience. First, in order to respond at a level commensurate with the risks that accompany marine transportation of hazardous cargoes, private industries and trade associations need to commit themselves to developing the safest practicable operating practices that are economically feasible with available technology. These practices include contingency planning. Finally, regular exercise and critical review of contingency plans--made possible in this case by the game exercise--is as important for the private sector as it is for the government.

Salvage

Salvage of both vessel and cargo is an integral part of response to marine casualties. In the present study, this aspect of response was the one that appeared to be pursued in the most ad hoc manner. Even in the case of the LNG vessel, where the owner had undertaken contingency planning as one aspect of systems development, the case study indicated additional improvements that could be made to facilitate cargo and ship salvage.

As discussed earlier, manuals specifically devoted to the details of salvage and casualty response do not exist for the overwhelming majority of hazardous cargo vessels. The only requirement in this area is a U.S. Coast Guard rule that certificated vessels* must carry on the bridge at all times certain information necessary to calculate the stability and other characteristics of the vessel under various conditions. This information does not in any sense constitute a manual that details equipment handling procedures and other step-by-step actions for emergency response.

The preparation of manuals on salvage and casualty response can be undertaken for a particular vessel at any time from design concept through any stage of operation. Ideally, however, this preparation should be preceded by consideration of salvage and casualty response procedures as an integral part of vessel design and construction. Manuals, equipment, and other special provisions developed for salvage and casualty response should be submitted to operational tests to assure their adequacy under emergency conditions. In this regard, the case study approach employed by the panel can be valuable in both the basic design and operational testing phases. During scenario preparation for the LNG incident and in the game itself,

*Vessels that have been inspected and awarded a certificate for compliance with safety equipment and information requirements.

certain types of equipment on the LNG vessel appeared to be candidates for improvement. These included cargo offloading pumps, emergency steam and power generators, ballasting valves, towing harnesses, emergency radio equipment, and deck handling gear for bringing special equipment aboard the vessel. One special concern was the probable performance of this equipment after the LNG casualty.

In addition to vessel equipment and procedures, other measures that would facilitate salvage are of concern. These include availability of inventories of shore-based salvage-related equipment, as discussed under this section on technical information, and identification of havens where damaged vessels (sometimes with temporary repairs or patches) can be towed for complete cargo offloading and preparation for permanent repairs. Because of the hazards involved in these operations, such havens must be as physically isolated and environmentally acceptable as practicable.

Technical information is needed to support decisions on the necessity of conducting hazardous cargo transfer and salvage operations prior to moving a vessel to a safe haven for offloading and temporary repairs. This question arose in connection with the decision in the San Francisco game to completely offload the Navy ammunition ship at the scene.

Questions of equipment availability and contingency planning for salvage, including the possibility of supporting development of a designated fleet of rescue tugs with deep-sea towing capability, are part of a more comprehensive problem: the need to initiate and encourage the development of more responsive salvage capabilities. A responsive salvage capability requires timely access to many kinds of very expensive equipment and specialized technical knowledge. Because of infrequent use, private enterprises have trouble justifying--not to mention paying for--such a state of readiness. There are two complementary approaches to resolving this dilemma. In major port areas, industries can band together to form cooperative salvage associations similar to existing oil spill cleanup cooperatives.[16] Another mechanism would be increased use of retainer contracts by industries with particular salvage problems, such as those engendered by hazardous cargo transportation. The purpose of the retainer contracts would be to ensure that necessary equipment is available to tackle hazardous cargo and other salvage situations.

The salvage industry also faces a number of legal barriers to responsive and effective performance. These include prohibitions against deliberate dumping of hazardous cargo even in extreme emergencies; contractual arrangements which make salvors liable for pollution that occurs incident to salving; and restrictions inherent in the cabotage laws. Another complication inhibiting to salvors is the no cure/no pay concept often used in the salvage industry, which will be discussed below.

The Federal Water Pollution Control Act prohibits any discharge of oil or hazardous substances in the waters of the

U.S. and imposes stiff penalties for such actions.[17] Section 311(d) of that act empowers the government to coordinate response efforts or to remove a vessel in the event of a substantial pollution threat resulting from a maritime casualty. The Louisville case study revealed that it remains unclear whether any exceptions to these rules would be allowed. A close examination of the legal situation could provide grounds on which to base such exceptions. For example, legal exceptions could well be in order if jettisoning cargo were the only way to lessen public risk from and exposure to a hazardous cargo (or to save a vessel), and the responsible government agency recommended or concurred in the owner's action to jettison. To guide decisions in this area, any formal government provision for jettisoning cargo without incurring civil penalties or liability for cleanup costs would have to include criteria that balance public hazard and protection, vessel and personnel safety, and environmental protection. The provision would also need to include procedures for obtaining timely decisions to support a rapid response to emergencies.

When salvage operations are contracted for on a no cure/no pay basis, unless the salvor completes the job that he has been hired for he is entitled neither to a fee nor to reimbursement for the heavy expenses incurred. This is colloquially referred to as a "Lloyd's Open Form" contract. The arrangement does not take account of modern commercial realities. Under the no cure/no pay concept, the salvor is liable for any pollution that may occur while a vessel is under his control; yet it is the owner who carries P&I and other insurance to cover pollution costs.* In the frame of reference within which the salvor operates, it is unrealistic to require that he be liable for pollution. Under these terms, no salvor will work on a marine casualty in which there is any threat of substantial pollution.

Another anachronism of the no cure/no pay concept was exposed in the Savannah case study. The salvor performed his work and was ready to deliver the stricken ship but it was feared that no port would accept a damaged hazardous cargo vessel. The political implications of providing a haven were too great. Unable to deliver the vessel, the salvor had not completed the job according to the generally accepted terms of the no cure/no pay concept, and thus was not entitled to his fee or reimbursement for his expenses. Furthermore, he was temporarily encumbered with the damaged vessel. Although this aspect of the safe haven problem was quickly solved in the Savannah case study, the problem itself is real. Unless safe havens are identified and approved before they are needed, the problem will continue to occur.

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*P&I -"Protection and Indemnity"--refers to a form of cooperative marine insurance that reimburses the shipowner for payments he may be required to make under applicable law arising out of various possible contingencies such as spill cleanup, wreck removal, salvage, death and personal injuries, property damage, etc.

The present no cure/no pay contractual basis of the salvage industry, then, provides an inadequate and inappropriate mechanism for modern salvage work. Without modernization of these contractual foundations, there will be no incentives for the conduct of salvage work. The panel's concern here is that the outmoded contractual system has the potential to inhibit salvage work in hazardous and pollution-prone situations.

The so-called Cabotage Law (46USC316) is another source of legal frustration for salvage operations because it creates operational delays. This law is protectionist legislation which provides that no foreign salvage equipment may be used in U.S. waters as long as comparable domestic equipment is available. Under its terms government permission, granted only upon proof that no U.S. salvage equipment is available, must be obtained before foreign salvage equipment can be employed. The Cabotage Law is administered by the U.S. Customs Service, which relies on the technical advice of the Coast Guard and the Office of the Supervisor of Salvage, U.S. Navy. As the Savannah case study revealed, even though foreign salvage equipment may be close at hand, considerable red tape and delay may be encountered in obtaining permission to use those salvage assets. Delay can be minimized through effective administration of the law, including public identification of an authority responsible for cabotage waivers.

The smooth and efficient conduct of salvage operations is vulnerable to delay and interruption from a variety of other legal and administrative causes. Foremost among these is occasional inability to identify the agency or authority that is authorized to contract for salvage in a particular emergency. This problem arises when responsibility for salvage operations shifts between the owner and the government (the Coast Guard, Army Corps of Engineers or the Navy), depending on the circumstances. The problem is aggravated when the owner's financial interest, as represented by his insurance, shifts from the hull insurer to the P&I insurer in the event that a vessel is declared a constructive total loss, with salvage and repair estimates exceeding the ship's market value.

Marine Fire Fighting Capability

There appears to be a dearth of marine fire fighting resources in port areas. Furthermore, marine fire fighting is not well coordinated with land fire fighting and disaster response efforts. The lack of coordination makes port areas particularly vulnerable to the consequences of poorly executed response, because fire fighting equipment can occasionally be used to fight both land and marine fires. Without prior guidance as to allocation of assets, uninformed technical decisions will almost certainly be made.

In the Savannah game simulation, no available fire fighting equipment had anywhere near the capability necessary to fight an LNG fire. In the San Francisco game simulation, marine fire fighting was conducted without coordination with onshore fire fighting efforts. When requests were made for coordination and backup, the Coast Guard responded that its equipment would be made available for shore fires only after marine fires had been brought under control.

Even though it is statistically likely that marine fires will become more numerous and severe, equipment and programs for responding to them are being cut back. Only 17 of the more than 460 commercial ports in the U.S., which include some 80 ocean ports, maintain any marine fire fighting capability, and this capability is supported with local funds. In this era of tight urban budgets, marine fire fighting assets are often being sharply cut back, as the table shows.

TABLE I

OPERATING FIREBOATS IN SELECTED PORT CITIES

City	Peak Strength	Current Strength (1979)
Boston	3	2
New York	10	4
Long Beach	7	7
San Francisco Bay Area	2	1
Philadelphia	2	2
Seattle	2	2

Source: Panel on Response to Casualties Involving Ship-Borne Hazardous Cargoes

Marine fire fighting has traditionally been treated as a port city responsibility. There are no Coast Guard, Maritime Administration, or other government programs available to support the development of marine fire fighting capability. Further, in the development of regional and local disaster contingency plans, there are no requirements to coordinate an area's marine fire fighting capability. Hard-pressed by financial limitations, many port cities have wielded the budget axe against marine fire fighting because it is an expensive operation that is rarely called upon. The risk of serious marine fires is also increased by the trend to relocate bulk cargo facilities in ports outside of urban areas; these areas may not have the tax base to support an adequate incident response capability.

Public decisions to cut back marine fire fighting capability in the face of increasing public hazard from marine fires must be

considered false economy. Since cities apparently can no longer afford to provide adequate marine fire response capability, alternative means of support must be considered if such a capability is to be maintained. This could take the form of direct federal entry into the field or the creation of tax incentives (possibly coupled with regulatory requirements) for the private sector to provide its own marine fire fighting capability whenever private operations create public risk.

Communications

There are two aspects to communications in incident response. One concerns establishing lines of information flow between the owner, government agencies, and the public. This has been discussed above under the section "Government Agency Responsibilities and Planning for Marine Casualty Response." The other aspect of communications is more mechanical and deals with the adequacy of available communications gear and notification procedures.

The notification of all concerned parties that must occur at the time of a marine casualty was well handled in each of the case studies. In the National Contingency Plan, a notification list is appended to the regional contingency plan,[19] with names and telephone numbers of all contacts in federal, state, and local agencies who should be informed. It is a credit to the agencies involved that this extensive notification can be conducted as a matter of routine, without extensive procedural delay.

After notification has been made, however, communications problems may begin in earnest. The San Francisco case study dramatically brought out the fact that different agencies communicate on different radio frequencies. There is no commonly held frequency dedicated for emergency use. Thus in the game, until costly emergency communications gear was provided by the OES and the Coast Guard Strike Team, local public safety forces had no way of establishing open radio contact with the Navy and the Coast Guard. This communications barrier contributed to the lack of coordination between land and marine forces that characterized the San Francisco case study.

The technology for a commonly held, dedicated emergency communications frequency in port areas is readily available. Establishing it would require regulatory action and installation of the necessary hardware.

Emergency situations also stress available communications systems, so that messages are not as easily passed as usual. The importance of telephone lines and other facilities dedicated for emergency use and operated by trained personnel cannot be overemphasized. Also, in the event of physical damage to communications systems, it is important that alternate backup communications systems be readily available. In the Savannah and San Francisco case studies, physical damage to vessels knocked out communications gear.

For some time, the only means of ship-to-shore communications was via hand-held radio. All messages had to be relayed by a Coast Guard escort boat. In Louisville, a tornado interrupted telephone communications.

In each of the game simulations, then, the need became evident for communications networks that can survive the possible damage and the vastly increased demands created by a hazardous cargo disaster.

FINDINGS AND RECOMMENDED ACTIONS

General Findings

Analyses of possible problem areas that were identified in the case studies and in panel deliberations were presented in the preceding section of the report. These analyses indicate that, although there is national capability to respond to most marine casualties involving hazardous cargoes, some important aspects of response require attention and improvement.

This section of the report synthesizes the results of the analyses and recommends specific actions. These are presented under headings denoting the various organizations and government agencies that should undertake the actions. Some of the recommended actions may require legislation. Other recommendations which pertain to vessels should be brought to the attention of the American Institute of Merchant Shipping, the Inter-governmental Maritime Consultative Organization, and the International Chamber of Shipping (the latter two because much of the marine transportation of hazardous cargoes is done by foreign flag vessels).[20]

Recommended Actions

Recommendations to Industry

Hazardous-Cargo Shipping Industry The panel noted that the LNG branch of the marine transportation industry appears to have a high level of casualty response capability. A similarly high level of capability needs to be reached by other elements of the marine transportation industry involved in the transport of hazardous cargoes.

The panel recommends that the industry:

1. Assemble selected technical information necessary for casualty response concerning vessels designed to carry bulk hazardous cargoes. This should include descriptions of vessel characteristics and configurations as well as details of emergency systems. The information should be available on board bulk hazardous cargo vessels. It should also be filed at the Coast Guard Captain of the Port Office for the principal ports of call of each vessel. If a standby or contingency

contract exists between the carrier or cargo owner and salvage firms, the material should also be on file with those firms.

2. Consider casualty survival and salvage, as well as damage control, in the design of bulk hazardous cargo vessels and equipment. For instance, the design work should include systems analyses that consider the casualty integrity of such items as piping systems essential for survival and damage control, emergency power, communications equipment, etc.

3. Prepare specific salvage and casualty response manuals for each bulk hazardous cargo vessel. These manuals should complement currently required documentation of stability and other characteristics. The shipping industry should enlist the aid of professional salvors, designers, and naval architects in the preparation of these manuals to make certain that they contain adequate and clearly enunciated "how to do it" instructions for the necessary actions.

4. Exercise, at regular intervals, salvage and casualty-related equipment such as offloading pumps, emergency power systems, towing harnesses, etc. under simulated emergency conditions to assure their adequacy when needed.

5. Consider the use of contingency salvage contracts and casualty response cooperative groups (similar to present oil spill coops) to encourage effective response capability.

6. Work together with insurance and salvage industries to modernize financial and legal arrangements in the salvage industries.

7. Consider using casualty response scenario preparation and game-simulation exercises, in addition to conventional systems analysis techniques, in designing hazardous cargo vessels and in operational readiness testing of the vessels and their personnel.

8. Urge that coastal and inland waterway operators consider adapting these recommendations for vessels and barges transporting hazardous cargoes.

Hazardous Materials Industry The principal sources of information on the characteristics of hazardous material cargoes that the panel encountered in its work were the Manufacturing Chemists Association's CHEMTREC (Chemical Transportation Emergency Center) and the U.S. Coast Guard's CHRIS Manual (Chemical Hazards Response Information System). In both cases, it appeared that the data were extensive, accurate, and readily accessible. The panel was concerned, however, that the information on hazardous materials that is easily available is often too generalized to be useful in incident response. Also, it is difficult and often impossible to locate on-scene professional assistance with experience in hazardous materials handling and emergency action. This assistance is needed early in the casualty response.

The panel recommends that manufacturers of hazardous materials continue to work with CHEMTREC, CHRIS, and other systems to develop more specific hazardous materials handling and incident response information and to improve systems for factoring sophisticated technical information into incident responses.

Salvage Industry Most areas of concern noted by the panel appear to be beyond the control of the salvage industry acting alone. As noted in the panel's recommendations to the shipping industry, however, there are areas where cooperative efforts between the two groups would be of value.

The panel recognizes the advantages of joint efforts between the salvage industry and the government for contingency planning, keeping abreast of innovations in transportation systems and techniques, reviewing and planning response to hazardous cargo casualties, and developing inventories of appropriate salvage equipment. While these capability improvement objectives may be difficult to achieve, the panel recommends that, in trying to attain them, the Navy and Coast Guard tap the resources and expertise available through industrial trade associations and professional societies.

Recommendations to the Federal Government

As noted, government response to marine hazardous cargo casualties where pollution has occurred is made considerably more effective by the provisions of the National Contingency Plan. However, the plan does not cover response to casualties in which pollution has not occurred or is not threatened. It should be noted that there is no counterpart to the National Contingency Plan for coordinating a response to hazardous cargo casualties in which pollution has neither occurred nor is threatened. Authorization for government intervention or assistance in non-polluting marine hazardous cargo casualties is neither well-known nor clearly understood.

The panel recommends that:

1. The various federal agencies that would be involved in the response to non-polluting hazardous cargo casualties* take steps to clarify and publicize the circumstances under which their intervention or assistance is authorized.

2. The Coast Guard, as lead agency, develop and support whatever legislative action may be required to authorize government assistance in non-polluting hazardous cargo casualties.

3. Agencies involved in contingency planning

   a) Pay greater attention to the salvage and damage-limiting aspects of casualty response;

   b) Consider establishing a common frequency dedicated emergency radio network for use in major casualty response activities; and

   c) Implement the actions recommended in this report, including modifying contingency plans as necessary.

4. The use of game simulations or similar activities be be encouraged to:

   a) Improve overall contingency planning;

   b) Increase the level of training and contingency plan familiarity on the part of local personnel;

   c) Increase general local awareness of possible secondary disaster effects such as the sugar refinery fire in the panel's San Francisco case study; and

   d) Improve the mechanics and procedures for satisfying the information interests of the public and public officials in casualty response activities.

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*The primary agencies identified as being responsible for planning in the National Contingency Plan are the Departments of Transportation, Defense, Commerce, Interior, and the Environmental Protection Agency.

In particular, the Coast Guard should expand its simulation exercises and open them to other agencies and industries involved in emergency response. In addition, other agencies with significant responsibilities in emergencies should use simulations in the development and testing of contingency plans and for training and preparedness assessments.

Further recommendations, aimed at the specific agencies who would deliberate and act on them, are discussed below.

National Response Team The panel noted several ways in which the National Contingency Plan should be updated and improved. It recommends that the National Response Team immediately review the applicability of the plan, which applies to all pollution incidents, to the specific need to respond to marine casualties involving hazardous cargoes. This review should consider not only the present report, but also such materials as may be found in accident reports prepared by the Coast Guard Headquarters Marine Safety Office and National Transportation Safety Board. Specific topics for review should include, but not be limited to, the following suggestions:

1. Regional Response Team (RRT) activities and on-scene coordination in marine casualty situations should always be directed by the Coast Guard, without regard to whether the incident occurs in offshore, coastal, or inland waters.

2. When more than one agency is involved in response operations, a central public information point of contact (PIO) should be established. Continuity in PIO functions should be maintained even if operational responsibility is shifted from one agency to another.

3. The various agency points of contact listed in the notification annexes to regional response plans should be reviewed to assure that these points of contact understand their roles and responsibilities.

U.S. Coast Guard The panel noted that the Coast Guard has relatively strong training, contingency planning, and incident response programs.

The panel did note some areas for improvement, and recommends, that the Coast Guard:

1. Assert authority over civil-sector salvage functions of the U.S. Government, including marshalling U.S. Government (including U.S. Navy) salvage equipment for civilian incident response and directing salvage assistance whenever appropriate.

2. Develop clear and unequivocal criteria and procedures to enable Coast Guard authorities to take unilateral preventive actions in pollution and salvage emergencies whenever the need becomes apparent.

3. Take particular care when vessel operators are notified of their pollution control responsibilities to explain that acceptance and exercise of pollution control responsibilities is not equivalent to acceptance of liability for a pollution incident. Furthermore, ship operators should be informed that the only criterion for determining whether the government will take unilateral action will be whether or not the owner is taking proper action.

4. Develop and maintain lists of casualty-response and salvage-related equipment similar to the spill cleanup equipment lists that are annexed to regional contingency plans of the National Contingency Plan.

5. Encourage, support, and subsidize (if necessary) the development and maintenance of a fleet of "rescue" tugs with automatic towing winches that will be readily available and strategically located for assistance in marine casualty response activities in U.S. coastal waters.

6. Encourage and support improved marine fire fighting capabilities in major ports.

7. Maintain files of selected technical information on vessel and equipment characteristics for selected bulk hazardous cargo vessels at each relevant Coast Guard Captain of the Port Office (see Recommendation #1 to the hazardous cargo shipping industry).

8. Extend CHRIS information capability and develop systems to deliver technical information that may be crucial to hazardous cargo incident response in time to support emergency measures.

9. Require the preparation of salvage and casualty-response manuals for all bulk hazardous cargo vessels that enter U.S. ports.

10. Develop guidelines for applying the concept of triage* to emergency response situations, enabling a ship's master, salvage master, or responsible government official to exercise greater freedom to waive legal requirements and exercise on-the-spot judgment as to the best course of action in emergency response. Such an application of the triage concept would minimize pollution or public danger from hazardous cargoes, while freeing the decision-maker from the fear of incurring unwarranted (albeit legal) financial or other liabilities.

11. Include industry and government agency representatives in its game-simulation activities for training, contingency planning, and incident response.

U.S. Navy The panel's major concern with Navy response activities were in the area of responsibility and authority. In addition to pertinent recommendations made elsewhere, the panel recommends that the U.S. Navy:

1. Clearly define, in consultation with the Coast Guard, its operational responsibilities for response when a naval vessel is involved unilaterally in a marine casualty and when a commercial vessel is also involved. This definition of responsiblity should cover situations in which the National Contingency Plan is and is not activated. Security

*Triage is a system of assigning emergency operational priorities in which field judgments that are made without headquarters consultation receive full headquarters support in any follow up justification which may be necessary. In marine casualty situations, triage would apply to ship damage control and response, especially action taken by a responsible ship officer or on-scene commander who believes he must take a short-term action that pollutes to avoid a larger pollution effect that would be caused by non-action. It would also apply to initial salvage actions.

privileges should be invoked by the Navy only under the most critical circumstances, as in situations involving ships in nuclear power propulsion or having nuclear warheads aboard.

2. Coordinate and cooperate to the extent possible with other marine casualty response agencies in making information available to public officials and the news media.

3. Improve cooperation and coordination with other agencies in the conduct of post-incident investigations.

4. Work with the Coast Guard to develop stronger civil-sector salvage capability in the government.

5. Establish a mechanism for situations in which an ammunition vessel (AE) is involved in a casualty in proximity to a populated or otherwise sensitive area, including guidelines and procedures for consultation with concerned public officials, to guide the decision of whether to offload ammunition at the casualty site or make temporary repairs and tow the vessel to a safe haven for offloading.

6. Extend the use of game simulations to marine casualty contingency planning.

Environmental Protection Agency (EPA), Army Corps of Engineers (COE), and Maritime Administration (MARAD)

The panel recommends that:

1. These agencies coordinate fully with other agencies in the critical review and improvement of contingency plans and that they consider the panel's overall recommendations on contingency planning and the active testing of contingency plans;

2. The Army Corps of Engineers develop clear and unequivocal procedures and criteria for taking unilateral preventive actions to protect navigational structures whenever the need becomes apparent; and that

3. MARAD stress the importance of coordination between land and marine fire fighting efforts in the marine fire fighting manual it is developing.

Customs Bureau (Department of the Treasury) The panel recommends that the Customs Bureau publicly identify the executive office responsible for waivers of the cabotage laws, as well as the communications duty offficer at the Customs Bureau. This information should be added to the notification annexes of regional contingency plans.

State and Local Agencies

The panel was not able, in its limited study, to be as specific in its consideration of state and local agency response capabilities as it was for those of industry and federal agencies. Some general findings and recommendations were made, however, as follows:

1. The panel recommends that other states and localities consider developing organizations similar to the California State Office of Emergency Services (OES). Panel members were impressed by the greater degree of local coordination and cooperation that was apparent in the San Francisco game as compared to the other two games; this seemed to be due primarily to the existence and active cooperation of the OES.

2. The panel recommends that local disaster and emergency contingency plans include specific planning and coordination for marine casualties. This recommendation was prompted by the apparent deficiency of coordination between marine and onshore fire fighting in the San Francisco Bay area.

3. The panel also recommends that state and local agencies, through their activities in Regional Response Team meetings, press for the regular exercise of contingency plans and response systems.

Recommended Legislative Actions

In its analysis of national marine casualty response capabilities, the panel identified several areas where additional or modified statutory authority may be needed by some agencies or where present or proposed legislation might prevent the implementation of some of the panel's recommended actions. In other cases, new

legislation that might serve to actively encourage the implementation of some recommendations should be considered. This area of the panel's findings and recommendations is summarized below.

Suggested Improvements to the Federal Water Pollution Control Act, as amended (86STAT816) (FWPCA) The panel recommends that Section 311 of the FWPCA be critically reviewed and amended, if necessary, to authorize or permit actions to alleviate the problems discussed below.

1. Although the federal government can usually make a substantial contribution in terms of equipment, coordination, and resources to marine casualty response when it is empowered to act, its authority to respond to incidents (even when they may pose tremendous public hazard) is limited and strictly defined. In the FWPCA, activation of the National Contingency Plan is dependent on the presence or threat of pollution; contingency funds to pay for casualty response can only be made available after pollution has occurred. As a result of the close link between the government's major hazardous cargo casualty response mechanism and pollution control, the ability of the government to respond to marine casualties where great public hazard may be present but not the threat or incidence of pollution--as can happen in an LNG casualty--is distinctly circumscribed.

2. Section 311 of the FWPCA prohibits deliberate discharges of oil and hazardous substances. However, situations can arise where jettisoning of some polluting cargo may be more in the national interest than avoiding the pollution or hazard that would ultimately result from not taking such action.

3. The strict liability provisions of the FWPCA saddle the working salvor with pollution liability for the vessel that he is attempting to salve. The panel considers this an unreasonable working requirement that not only inhibits the salvage operation itself, but also has the potential to undermine the financial basis of the salvage industry.

Suggested Improvements to the Salvage Law (10 USC 7361; 33 USC 1471-1478; P.L. 95-302 The authorizing statutes for salvage-related government activities should be critically reviewed and amended, if

necessary, to authorize or permit the following practices or activities:

1. Assertion of authority by the Coast Guard over civilian salvage functions of the U.S. government, as urged in the panel's Recommendation No. 1 to the Coast Guard; and

2. Development and maintenance of a fleet of "rescue tugs," as urged in Recommendation No. 4 to the Coast Guard.

Other Legislative Needs The panel found that the U.S. marine fire fighting capability is not adequate to deal with existing hazards and is, in fact, declining. One reason is that marine fire fighting is funded entirely through municipal funds; there are no federal subsidy programs or incentives for development of such a capability in the private sector. The panel recommends that legislative action be considered to bring national capability in marine fire fighting up to a level commensurate with the public fire hazards that now exist.

The panel also concluded that the United States should give careful consideration to ratifying the 1969 Oil Pollution Civil Liability Convention. This convention, which has been ratified by most other leading maritime nations, establishes a system for compensating those who suffer economic loss from oil pollution that occurs in international waters. It places strict liability on the owners of a vessel that causes pollution damage. Since much potential hazard to the environment is the result of incidents outside the territorial waters of the United States, and even though the United States has ratified the Intervention Convention of 1969 (88 STAT 8), protection of U.S. interests will be incomplete unless and until the United States becomes a party to the Civil Liability Convention.

If the United States does not ratify the Civil Liability Convention, it should at least enact similar domestic legislation so that final responsibility for minimizing environmental and other damages from marine casualties would rest with the federal government.

In its analysis of the games, the panel came to the conclusion that an adaptation of the concept of triage to marine casualty response would result in more rapid and effective decisions and actions (see Recommendation No. 10 to the Coast Guard). This would almost certainly entail violation of environmental and other statutes, as well as of international treaties as they now exist. The panel recommends that the Coast Guard provide recommendations for legislation that would suspend pertinent statutory and treaty

liabilities in salvage situations where the triage concept is relevant. A parallel action suggested by the panel would be for the Coast Guard, as the U.S. representative, to initiate consideration by the Inter-governmental Maritime Consultative Organization (IMCO) of the concept of triage for incorporation into the body of international rules.

AFTERWORD

The Utility of Game Simulations as a Tool for Policy and Program Development and Evaluation

Game simulations are used extensively by many organizations, including the U.S. Coast Guard and the U.S. Navy, for training purposes, but they have rarely, if ever, been used as a tool for policy and program development and evaluation. Although the case study approach was successful insofar as it did significantly assist the panel's assessment of casualty response capabilities, the panel members' experience with this approach produced mixed reviews. Reservations were expressed, for instance, because game simulation required significantly more professional effort and participation than more conventional approaches. Nevertheless, there was a consensus among the panel that game simulation is a useful approach to policy and program development and evaluation.

Since success of the approach hinges on the quality of information in the scenario and the level of expertise of participants in the game, a broad range of background disciplines and occupations is needed. Each simulation required the active participation of dozens of government and industry people in critical positions. Although this brought a wide variety of interests and expertise to bear on the problem, it is possible that other study methods could have produced similar results.

The game simulation did, however, produce certain side benefits whose importance may eventually overshadow the assessment of incident response capabilities which was their intended purpose. These incidental benefits included the experience of contingency planning in preparation for the game simulations, along with exercising and consequent testing of contingency plans in the course of the game simulations, realistic training for participants, and familarization of those who must respond to incidents with each other's responsibilities and concerns.

There is a very close relationship between scenario development and contingency planning. Industry representatives who participated in scenario development seized the opportunity to refine and augment their vessel damage control manuals and other contingency documents. Where this occurred, the effort paid off in terms of strong industry performance in the game simulation. This preparation would carry over into any response to future casualty incidents. Furthermore, those who participated actively in scenario development and game

simulations have a greater appreciation for contingency planning for incident response. Presumably, if other industries were to participate in scenario development and game simulation, they also would emerge from the process with stronger contingency plans.

Another side effect of the case study approach was the exercising of existing contingency plans by a variety of participants who would not ordinarily have had such an opportunity. Contingency plans are not especially useful unless those whose actions they are intended to define and expedite are familiar with their contents. The opportunity for many people who would be involved in incident response, including public agency personnel as well as industry representatives, to periodically "work through" an incident and become familiar with carefully detailed (but often neglected) plans can result in smoother, better-coordinated response actions in the event of an actual incident.

Most game simulation participants stated that they found their participation to be an extremely valuable training exercise. Public agency participants noted that their parent agencies occasionally hold game simulations for training purposes, but whenever agency personnel fill all roles in the games, the realism that they found in the panel's games is missing. Many participants urged that game simulations with wide and relevant participation be held periodically for training purposes. In this regard, it is noted that the U.S. Coast Guard, which has for some time used game simulations to train Coast Guard personnel, has recently (in the Fifth District) extended invitations to participate in its training simulations to those federal agencies that make up the Regional Response Team for pollution control.

Finally, the game simulations made it possible for participants to become familiar with the responsibilities and concerns of other officials who must respond to emergencies. In the event of a real incident, this undoubtedly will produce better understanding and coordination for a smoother response.

NOTES

1. See, for example, "Waste Management for the Coastal Zone: Concepts for the Assessment of Ocean Outfalls," Marine Board, National Academy of Sciences, Washington, D.C., 1976.

2. 40 CFR 16-119 (as proposed).

3. Hazardous materials and dangerous cargo are the subject of numerous Coast Guard regulations. See, for example: 46 CFR 38 (ships carrying liquefied flammable gases); 46 CFR 98 (ships carrying dangerous (hazardous but not flammable) cargoes); 46 CFR 146 (military explosives); 46 CFR 147 (hazardous solids); 46 CFR 151 (unmanned barges carrying dangerous liquids); 46 CFR 153 (ships carrying hazardous liquids); 49 CFR 100-189 (packaged dangerous cargo including commercial explosives).

4. This discussion is based on "Carriage of LNG--State-of-the-Art," a paper delivered by Capt. Warren LeBack (a panel member) at the American Petroleum Institute's Tanker Conference in March 1978.

5. Department of Transportation regulations, Sec. 171.15, 171.16.

6. An example of technology assessment is "Transportation of Liquefied Natural Gas," Office of Technology Assessment, Washington, D.C., 1977.

7. A description and evaluation of risk analyses of marine transportation of hazardous cargoes is contained in "Analysis of Risk in the Water Transportation of Hazardous Materials," Committee on Hazardous Materials, National Research Council, Washington, D.C., 1976.

8. See, for example, "Draft Environmental Impact Report, Western LNG Terminal Company, Berth 308, Los Angeles Harbor," prepared by Harbor the Environmental Staff, Port of Los Angeles, 1974.

9. See, for example, "LNG Contingency Plan for the Port of Savannah," U. S. Coast Guard, Savannah, Georgia, June 29, 1977.

10. "A Dynamic Regional Response Team," CDR Charles R. Corbett, U.S. Coast Guard, Washington, D.C., 1978.

11. "National Oil and Hazardous Substances Pollution Contingency Plan," 40 CFR 1510.35(b), February 10, 1975.

12. 40 CFR 1510.42.

13. 10 USC 7361.

14. "Chemical Hazards Response Information System Handbooks," U.S. Coast Guard Publication CG-446, 1974.

15. "Hiatusport--An On-Scene Coordinator Role-Playing Exercise," E. B. Kangeter III, Proceedings of the 1977 Oil Spill Conference, American Petroleum Institute Publication No. 4284, 1977.

16. Two examples are Clean Gulf Associates and Clean Atlantic Associates. Both of these organizations are oil industry cooperatives.

17. Federal Water Pollution Control Act, as amended (86 STAT 816), Sec. 311(b).

18. "Cost Effectiveness of Marine Fire Protection Programs," Maritime Administration, 1978.

19. 40 CFR 1510.53 (2).

20. The Inter-governmental Maritime Consultative Organization has established at least five codes which establish recommended standards for the construction off hazardous cargo carriers. These include the International Maritime Dangerous Goods Code, the Code for Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk (Res. No. A.212(F) as amended); Code for Construction and Equipment of Ships Carrying Liquefied Gases in Bulk (Res. No. A.328(9) as amended); Code for Existing Ships Carrying Liquefied Gases in Bulk; and Recommendations Concerning Ships Not Covered by the Code for Construction and Equipment of Ships Carrying Liquefied Gases in Bulk (Res. No. A.329(9), as amended).

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APPENDIX A

The Panel's Case Study Method

This section provides more detailed information on scenario development and game simulations. Case study scenarios are descriptive documents that describe the occurrence of an incident, along with plausible events that may occur and actions that may be taken in the response to the incident. In the sense that the scenarios project contingencies that may occur, they are similar in many respects, if not in purpose, to contingency planning documents developed by public agencies and industries for use in managing emergencies. The panel developed three case study scenarios, which are presented in Appendix B.

The scenarios were developed in an interactive process. Each was prepared by separate working groups consisting of several panel members and experts knowledgable about the specific cargoes and locations that were the subject of the scenario. These scenarios, as developed by the working groups, were then reviewed and modified as necessary by the panel. Finally, the scenarios were reviewed by the "game director," a panel member chosen for his expertise in game techniques, to ensure that sufficient information was available to conduct the game simulations. The case study scenarios then provided the "plot" for game simulations of the incidents.

In the course of developing the three scenarios discussed in this report, the panel obtained information regarding contingency planning, operating procedures, equipment availability, etc., that contributed to its assessment of response capabilities.

Game simulations have been used for many years to explore the behavior of complex systems and organizations under relatively realistic conditions. The realism derives mainly from two factors. First, scenarios that are developed to guide the simulations closely mirror real-life situations. They do not suffer from abstract artificialities that other means of simulation usually impose on problem definition. Second, game simulations utilize and depend upon participants to carry out roles--generally their own roles--from the "real world." This face-to-face contact obviates the need for a further level of abstraction in the simulation, a level dealing with what are generally the most poorly understood phenomena in any given situation: human interactions.

Games are of many varieties. They range from two-sided exercises in which one side loses while the other wins (most commonly referred to as "war games") to many-sided games in which different combinations of participants pursue a variety of goals in varying alliances.

Games also differ with respect to the amount of information the players have and the way in which they discharge their specific roles. In an umpired game, the players generally know only what the game controllers, or umpires, deem they would know in the real world. The consequences of their actions are assessed by those same umpires,

who then feed back to the players only as much information as they might realistically be aware of in their actual outside roles. At the other extreme are seminar games, in which players carry out their roles, under the supervision of the game director, with full information about the problem, its setting, and the actions taken. Seminar game players voluntarily refrain from using any information they would not have access to in the real world, thereby serving as both game participants and game controllers.

The games sponsored by the panel were hybrid seminar/umpired games in which the players had, if not perfect information, at least a great deal more information than they might otherwise have had in a real situation. They were thus able to contribute more insight as to how problems would be realistically tackled, constraining factors that might become apparent, and other aspects of casualty response. At the same time, a game control group fed necessary information to the players to move the simulation forward. The control group also monitored and evaluated the consequences of actions to ensure that they were properly reflected in further developments.

The essential elements of any game are the scenario, which defines the problem and the environment in which it is set, and the actions of the players. The simulation is driven by independent actions taken by individual players and by their responses to each other's actions. In a seminar game, where the players are not sequestered from each other, an additional--and equally important--element is the interaction among the players as they discuss and justify their reasons for taking specified actions. This interaction also serves to elicit any additional information each may require to determine future actions.

The activities involved in the game are divided among three groups located in three separate areas, described below.

The Game Room

This is the seat of the action of the game. Role players are seated, seminar style, around a table to discuss, make decisions, and take actions. The players have access to the scenario only up to the time of the incident. After this point they function independently, and each describes the actions he would take in the situation under discussion. In describing an action, each player addresses the following elements: the action taken, what precipitated it, the time at which it was taken, how the action will affect the other players, the means by which it is communicated to them, and any specific facilities or equipment required to execute it. The players are linked by telephone to the game control team and the outside community, but not to the panel. If the players need any outside information, they can obtain it either by recourse to the game control team or by direct communication with an outside source. They also receive information regarding events from the game control team. Each player is assigned a controller on the game control team whose primary responsibility is to provide this information flow. Another

important function of the role players is to discuss the various events that occur in the scenario, their own response options, and the actions that they take. The perceptions of expert participants regarding the events and actions were important information sources for the panel.

The roles that were simulated were identified in the course of developing the scenarios. In some cases, however, roles were added, deleted, or clarified, based on discussion that occurred in the course of locating experts to participate in the simulations. Subject to certain necessary artificialities which are described elsewhere, every effort was made to obtain the services of experts in outside roles to play those same roles in the game; for instance, the Captain of the Port of Louisville played that role in the simulation.

The game director, who is the sole link between role players and the panel, is also located in the game room. His principal function is to keep the game moving in accordance with the time constraints of the schedule and the objectives of the panel. To this end, he regulates the amount of time that individual players spend in describing their activities. He also calls for discussion of specific events, delays the action of the game when information flow from the control team is backlogged, and calls out "time steps" to accelerate the game over stretches where the course of events is not considered particularly interesting or significant by the panel.

The Game Control, or Information/Assessor, Room

The information/assessor participants function in a support mode to specific role players. They serve three purposes:

- They provide their players with information regarding events occurring in the outside world as the scenario unfolds. To this end, they have access to the control scenario, which extends beyond the critical event and specifies certain actions that occur at specific times thereafter.

- They assess the consequences of any actions taken by players and pass necessary information to the players at the appropriate point in the game.

- They provide a conduit to the real world for the players. They may be required to obtain information from various sources in response to player requests, as well as to meet the requirements of their assessment roles.

Information/assessor participants were chosen for their expertise and their familiarity with technical information sources; for instance, EPA representatives served as the EPA information/assessors contact. Information/assessor groups members were linked by telephone to the outside world and to their corresponding role players, and through a coordinator (who was a panel member) to the game director and the panel room.

The Panel Room

Members of the panel and liaison representatives were sequestered here to observe the game; to discuss events and implications as they unfolded; and to instruct the game director (via telephone) on the course of the simulation in order to explore, in depth, specific aspects of the problem. The panel had telephone access to the game director and the information/assessors, but not to the role players.

The action in the game room was covered by closed circuit television for simultaneous observation in both the game control room and the panel room. Sources of information produced in the game simulations that the panel used in its analysis included a written log of the course of the game maintained by observers (see Appendix B), telephone logs, notes, and random observations recorded by participants on forms provided for that purpose. In addition, each participant's observations were aired and recorded in a critique session held immediately after the conclusion of each game.

APPENDIX B

Case Documentation

This Appendix provides the case background information, scenarios, and descriptions of the three seminar games conducted by the panel. Section I covers the Louisville case situation; a barge mishap involving release of anhydrous ammonia on the Ohio River near Louisville, Kentucky. Section II presents the Savannah case; a collision between a liquified natural gas tanker and a container vessel in the sea lanes off Savannah, Georgia. Section III deals with the San Francisco case, in which a Navy ammunition ship collides with a bulk sugar ship in the Carquinez Strait of the Sacramento River in northeastern San Francisco Bay. A list of abbreviations used in the game descriptions appears on page 164.

Each section presents the following information:

1. Background for Casualty and Response Scenario

This section contains information on geography and weather, waterborne traffic, and the civil situation at the time of the incident. Events that lead up to the casualty are also presented.

2. Scenario Proposed for Game Simulation

To prepare for the simulations, the panel devoted considerable effort to developing a plausible scenario to guide the players. Developing the scenarios was tantamount to preplanning, or developing a contingency plan, for the actual transportation of hazardous cargoes. Scenarios were developed by working groups chaired by experts in the region and/or the technology under consideration. In addition, the scenarios follow regulatory requirements for traffic control and port safety. The scenarios were used by the panel to monitor the progress of the simulation. Divergences between the scenario as developed by the panel and the simulations may occasionally indicate matters of significance, such as weaknesses in traffic control procedures or other problems in planning for the transportation of hazardous cargoes. A more complete discussion of problem areas appears in the body of the report.

3. Area Chart

A chart of the river, bay, or sea area involved in each scenario is included.

4. Game Event Tree

In the course of developing the scenario, the panel prepared block diagrams showing plausible courses of events that could result from the incidents. Since it was not physically possible to explore

all the ramifications of each incident in the course of the simulations, the panel directed the simulations down those avenues which appeared most interesting from a technical and informational standpoint. Courses of events actually explored in the simulations are indicated on the block diagrams.

5. Record of the Seminar Game

These charts record the game as it actually occurred. In order to present an often confusing array of information in a readily understandable form, dialogue has been condensed and some explanatory notes have been added. The record is the product of direct observation and written recording of the events and responses.

6. Game Participants

Two lists of participants are provided: those who acted out roles in the game and those who staffed the information/assessor room.

SECTION I

ANHYDROUS AMMONIA BARGE COLLISION
LOUISVILLE, KENTUCKY

I. Background for Casualty and Response Scenario

A. Geography and Weather

1. See charts and descriptions below for details on locks, dam, tainter gates, currents, and illustration of incident.

2. Population of adjacent communities is:

Louisville	340,000
Jeffersonville	21,700
Clarksville	15,300
New Albany	37,500

The combined metropolitan area population is estimated at one million.

3. Two railroad and two highway bridges provide transportation across the Ohio River in the immediate vicinity of the incident. One combined highway and railroad bridge downstream of the locks and dam is also in the vicinity of the incident and may be affected in the event of a large release of NH_3.

4. The event takes place during mid-to-late afternoon on the Saturday of Memorial Day weekend. Weather conditions postulated in the scenario are unstable, with tornado warnings in effect until midnight.

5. The wind is mainly southerly at 18-28 knots, and skies are cloudy with visibility from 5-7 miles. The barometric pressure is 29.75 and falling rapidly. Air temperature is $82^{o}F$.

6. The river is at flood stage. The navigation pool at McAlpine Lock and Dam is at 14 feet. Heavy rains of the past week are likely to cause the river to continue to rise. The current is estimated at 5.1 to 5.2 kts. Temperature of water is 65^{o}. All tainter gates, both upper and lower, are opened. The depth of the water at J.F. Kennedy Bridge, where the barge sinks, is 20 feet.

B. Waterborne Traffic

1. The towboat Red Rover with a fleet of seven general cargo barges is locking down in the main lock chamber to the lower navigation pool.

2. The towboat Diamond Nugget, with a fleet of nine general cargo barges, is at mile 599 bound for Cincinnati. The Diamond Nugget's speed of advance is approximately two knots.

3. Numerous other barges and several unattended towboats are moored in fleeting areas, wharves, and piers along the shore upstream from the Big Four Railroad Bridge.

4. The Coast Guard Vessel Traffic Service (VTS) is operational (goes into operation when the river reaches 13 feet). VTS communications are handled over Channel 13 FM (bridge-to-bridge communications). The above-mentioned vessels are the only tows other than the Ammonia Progress that have checked in with the Louisville VTS.

5. Description of Vessels:

a. Ammonia Barges:

Length	310 feet
Breadth	50 feet
Height	12 feet

Two tanks per barge; 1300 tons per tank of ammonia.
Cargo is refrigerated.
Relief value set at 10 psi.

b. Towboat Ammonia Progress:

Length	135 feet
Breadth	38 feet
Depth	7 feet
Propulsion	Twin Diesel
HP	5500

C. Civil Situation

1. Four municipal and three county governments are included in the Louisville metropolitan area: New Albany in Floyd County, Indiana; Clarksville and Jeffersonville in Clark County, Indiana; and Louisville in Jefferson County, Kentucky. Each county has its own civil preparedness office, and each governmental entity has its own police and fire department. Health advisors are available through the Department of Public Health for Jefferson County.

2. Radio communications capabilities for the key participants include the following:

   a. The Corps of Engineers lock operator monitors Channels 13 and 14. He also has Channels 12 and 16 available for his use.

   b. The Pennsylvania Railroad Bridge monitors Channel 13.

   c. The Coast Guard has Channels 6, 12, 13, 14, 16, 21, 22. Most towboats have Channels 6, 7, 13, 14, 16, 22.

3. Emergency Response Forces:

   a. The Coast Guard Marine Safety Office (MSO) in Louisville is on holiday routine with normal watchstanders (one officer and one enlisted man) onboard, with one officer and one enlisted man at home on standby. An alert has been passed to standby personnel of the tornado warning.

   b. Industries in the Louisville metropolitan area have formed two chemical spill group cooperatives. The Louisville Area Industry Mutual Assistance Coop (LAIMA) responds to incidents in the upper pool and the Rubbertown Area Mutual Aid Coop responds to incidents in the lower pool.

c. The Ohio River Valley Water Sanitation Commission (ORSANCO) is an organization established by an eight-state compact to combat water pollution in and along the Ohio River.

D. Events Prior to the Casualty

1. At 1400 Saturday, 27 May (Memorial Day weekend), the towboat Ammonia Progress with four barges of Anhydrous Ammonia (NH_3) is downbound in Ohio River 500 feet above Big Four Railroad Bridge off Townhead Island (KY). Mr. Jones, on the bridge, shifts rudder 20^{o} to starboard to adjust heading slightly to stay right of the channel when passing under Big Four Railroad Bridge.

2. At 1401, barges and tug begin to swing to starboard and Mr. Jones shifts his wheel to slow the swing. The rudder fails to respond and Mr. Jones immediately alerts the crew of the situation, requesting someone to head for steering room to repair the casualty. Mr. Jones attempts to correct heading by using engines.

3. At 1403, operator of the tug, Mr. Smith, arrives on bridge to relieve Jones as helmsman.

4. At 1410, the port forward barge strikes the bridge abutment of Clark Memorial Highway Bridge.

II. Post-Collision Scenario Proposed for Game Simulation

A. Events After Collision

1. At 1410, immediately after impact, the tug and barges swing around abutment with the tug's stern heading toward downriver. The forward two barges are separated from tow, while the tug and remaining two barges drift downstream with Mr. Smith attempting to control the heading. Of the two barges adrift, the starboard barge breaks free of port barge and floats downriver. Smith advises MSO Louisville of accident: "This is tug Ammonia

Progress. Struck Clark Memorial Highway Bridge and lost leading two barges. Attempting to maneuver into Louisville Canal entrance. Lost rudder. One barge sank immediately and the other is floating downriver. Both barges contain ammonia."

2. At 1430, using engines, Smith is able to maneuver tug and remaining two barges into slack water at canal entrance.

3. At 1435, Smith ties up remaining barges within canal and heads back to retrieve the drifting barge and notify MSO Louisville of his intentions.

4. At 1455, Smith locates the other barge aground on Shippingport Island, Ky. midway between Pennsylvania RR Bridge and weirs of electric plant. Advises MSO Louisville of information. Smith unable to retrieve barge due to danger of striking debris in vicinity of grounded barge.

5. At 1520, several funnel clouds were sighted southwest of the Louisville city limits. The clouds were moving in a northeasterly direction. At 1530, a tornado passed through Louisville and caused extensive damage in the Germantown area. Strong winds caused widespread power outages and telephone service interruptions.

6. The barges are owned by Ajax Towing Company, Inc., Caruthersville, MO. The cargo was loaded at the Ammonia, Inc., plant at Charleston, WV.

B. Other Traffic

1. Towboat Red Rover has successfully locked down to the lower pool and is enroute to Cairo, Illinois.

2. Towboat Diamond Nugget continues at same speed of advance bound for Cincinnati.

C. Emergency Resources

1. Police and fire communications networks of Louisville and Clark County are flooded with calls for assistance.

2. Telephone service in portions of Louisville and Jeffersonville have been interrupted.

3. U.S. Coast Guard forces are available for recall.

4. Corps of Engineers personnel are present, operating the locks and manning the adjacent substation.

5. The Department of Public Health for Jefferson County is extremely busy mitigating damages caused by the tornado and coordinating medical treatment of those injured.

6. No oil or hazardous-substance incidents in other locations of the region would delay a meeting of the Regional Response Team.

7. The governor of Kentucky has activated the National Guard to assist municipal agencies in mitigating damages from the tornado. The Indiana governor has not activated his forces.

D. Game Simulation Comments for "Game Director"

1. The "simulation tree," page 71 represents events that may be included in the simulations. Weather and river conditions may be superimposed on these options; the following points may be considered in directing the game activity:

   a. With the weather conditions postulated, very little downwind hazard exists. If an inversion existed, a significant downwind threat might exist.

   b. The NH_3 barge that struck the bridge abutment could drift downriver before sinking. This action may complicate locating the vessel.

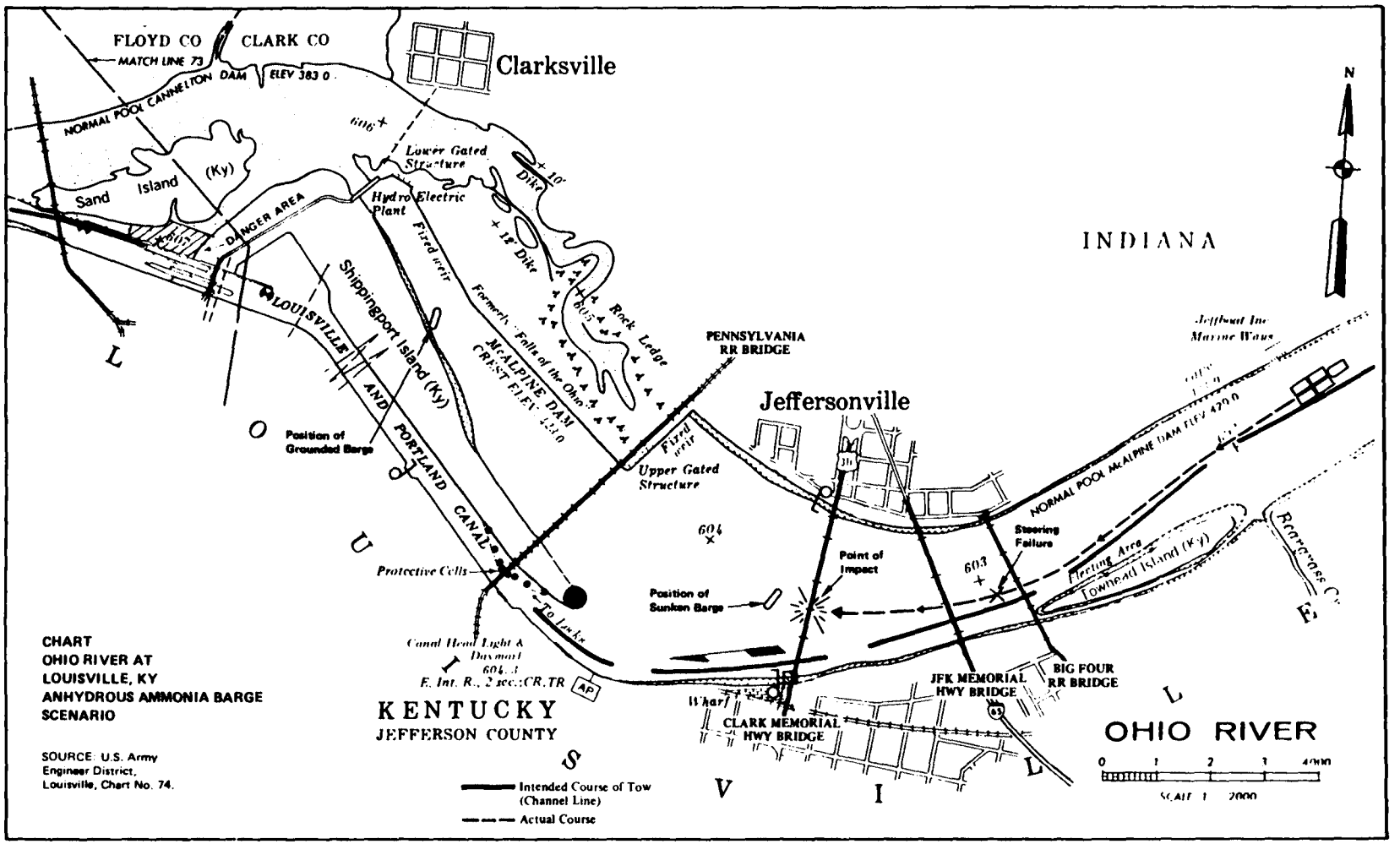
   c. Throughout the flow diagram, it is noted that one of the alternative routes the floating barge can take is toward the tainter gates. The barge can as easily drift into the hydroelectric power plant located adjacent to the downstream tainter gates.

d. Under ordinary circumstances, the owner of the barges would take necessary action to salvage the barges and cargo. What if the owner refuses to assume salvage responsibility? The Navy's Supervisor of Salvage may play a key role under such circumstances.

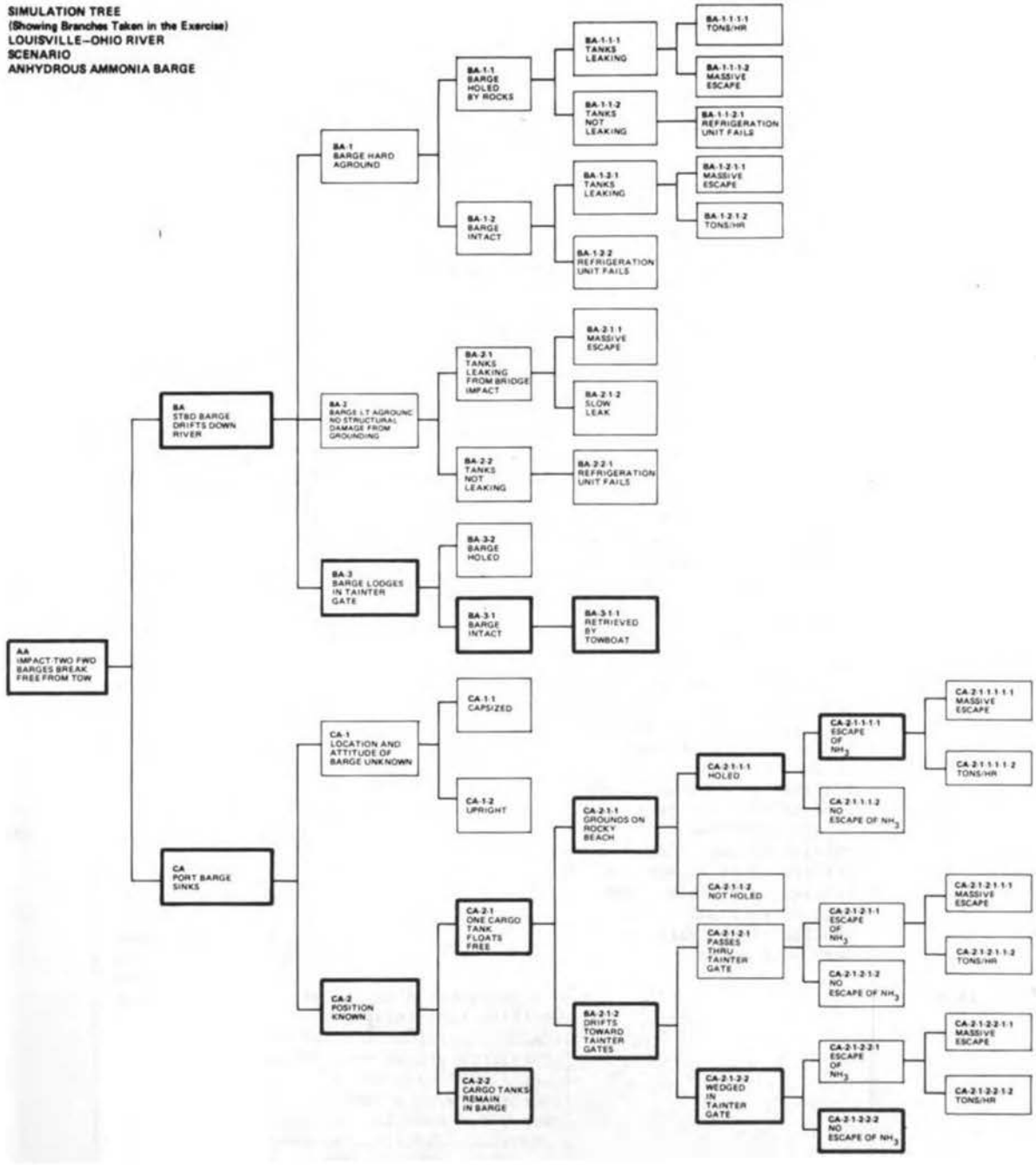
e. As previously mentioned, adjusting the weather conditions and river stages can significantly alter the scenario.

f. Federal, state, and local resources may not be readily available to respond to a particular branch of the scenario.

g. Consider what events take place if evacuation of an area becomes necessary.


FLOYD CO
CLARK CO
MATCH LINE 73
NORMAL POOL CANNELTON DAM
ELEV 383.0
Clarksville
Lower Gated Structure
Hydro Electric Plant
Fixed weir
10' Dike
12' Dike
Rock Ledge
Sand Island (Ky)
DANGER AREA
INDIANA
LOUISVILLE AND PORTLAND CANAL
Shippingport Island (Ky)
McALPINE DAM
CREST ELEV 422.0
Formerly Falls of the Ohio
PENNSYLVANIA RR BRIDGE
Jeffersonville
Position of Grounded Barge
Upper Gated Structure
NORMAL POOL McALPINE DAM ELEV 420.0
Steering Failure
Point of Impact
Fleeting Area
Towhead Island (Ky)
Protective Cells
To Locks
Position of Sunken Barge
Canal Head Light & Daymark
E. Int. R., 2 sec.: CR.TR
AP
Wharf
JFK MEMORIAL HWY BRIDGE
BIG FOUR RR BRIDGE
CLARK MEMORIAL HWY BRIDGE
KENTUCKY
JEFFERSON COUNTY
OHIO RIVER
N
0 1 2 3 4000
SCALE 1 : 2000
Intended Course of Tow (Channel Line)
Actual Course
CHART
OHIO RIVER AT
LOUISVILLE, KY
ANHYDROUS AMMONIA BARGE
SCENARIO
SOURCE: U.S. Army
Engineer District,
Louisville, Chart No. 74.

SIMULATION TREE
(Showing Branches Taken in the Exercise)
LOUISVILLE–OHIO RIVER
SCENARIO
ANHYDROUS AMMONIA BARGE



RECORD OF GAME: LOUISVILLE, KENTUCKY BARGE/BRIDGE COLLISION

TIME	SCENARIO EVENT	ACTION TAKEN	DISCUSSION
1400 (Saturday, Memorial Day Weekend	Towboat with 4 barges of anhydrous ammonia (NH_3) is downbound in Ohio River 500' above Big Four RR Bridge off Townhead Island, Kentucky.	Shift course 20° to pass under Big Four Railroad Bridge.	
1401	Barges and tug begin to swing to starboard. Course corrected to slow the swing. Rudder fails to respond.	Helmsman alerts crew, requests someone to head for steering room to repair steering gear. Helmsman attempts to correct heading by using engines.	
1403		Master relieves helmsman on bridge.	
1410	Port forward barge strikes the bridge abutment of Clark Memorial Highway Bridge. Immediately after impact, the tug and barges swing around the abutment with the tug's stern heading down river. The forward two barges are separated from the tow, while the tug and remaining two barges drift downstream with the Master attempting to control the heading. Of the two barges adrift, the starboard barge breaks free of the port barge and floats downriver. A slow release of NH_3, due to failure of refrigeration system, is visible. The port barge sinks. The venting of NH_3 makes a very loud noise.	Master notifies CG.	
1413		CG initiates a series of notification telephone calls according to standard emergency procedure. These notifications cover all agencies with a need to know; for example, federal, state, and local government agencies, ORSANCO, and CHEMTREC.	

TIME	SCENARIO EVENT	ACTION TAKEN	DISCUSSION
1413 (cont'd)		COTP initiates early on-site assessment. Water intakes at power plant, etc. shut down (standard emergency procedure). River traffic and operations halted by COE (standard emergency procedure).	
1430	Red Rover, a downbound tow, moors her barges and stands by to assist as needed.	The media picks up the action on the scanner; wants live coverage from the Clark Bridge. EPA computer information on NH_3 magnafaxed to CG. City closes bridge to traffic. Mayor and Kentucky governor are in Louisville, and arrange helicopter flight over the site.	COTP would not recommend halting traffic on the bridge unless a significant release of NH_3 had occurred.
1433	The starboard barge grounds just above the tainter gate (BA-3-1).	COE assess the situation on site. Three employees are on duty. COTP's executive officer will serve as P.I.O. Louisville Department of Public Safety (LDPS) will allow media to have pool coverage only from the bridge.	
1440	Towboat's rudder problem is repaired. The boat is now available to reassemble the tow. Proceeds to secure the two nearby barges.	Master contacts owner by radio. COTP arrives at the office from home; surveys his telephone logs: sends for additional manpower; requests public information assistance from the district.	Owner assembles his response team: lawyer, salvor, surveyor, etc.

TIME	SCENARIO EVENT	ACTION TAKEN	DISCUSSION
1490		COTP requests that the Chairman of the RRT activate the RRT.	The mechanism for activating the RRT is a phone call.
1500		COTP makes personal inspection of the incident.	
		Crowds begin to watch river activity from the shore.	
		Salvor and COE discuss availability of equipment.	
		LDPS & Governor request information. Should the riverfront be evacuated?	So far, the only major public safety action has been to close the highway bridge.
		Media requests additional information.	COE & CG switchboards are jammed with incoming calls.
1510		EPA notifies CG that the National Contingency Plan organization is available to provide needed expertise and direction.	The supporting organization of the National Contingency Plan can be utilized to provide needed expertise and direction.
		COE requests that the RR bridge be closed and raised.	
		Media pressing for information on the nature of the hazard. How does this incident compare with the chlorine barge casualty of 1972?	The media has facts on the incident; now they are focusing on possible hazards.
		Owner engages salvor.	The salvor had picked the incident up on his scanner and notified CG of his availability.
		Politicians set up command post in riverfront hotel.	Politicians are visible early in the incident and are pressing for accurate information.

TIME	SCENARIO EVENT	ACTION TAKEN	DISCUSSION
1510 (cont'd)		Owner, using CHEMTREC information, suggests that CG spray the venting NH_3 with water; CG locates a tug and fire nozzle.	Cargo owner's access channels to government decision process are not clearly marked.
		CG office is now fully staffed.	
		OSC holds a press briefing. There has been some release of NH_3 vapor. Information on the hazard has been requested from CHEMTREC. According to EPA, the issue of whether or not NH_3 and other chemicals are hazardous substances is before the courts.	A small discharge poses a salvage problem, but not a threat to public safety. This meeting satisfies some of the media and politicians' need for information.
		COE has contacted owner and CHEMTREC for information on NH_3.	Information could have been requested to be sent to both COE and CG simultaneously.
1525		CG asks LDPS to clear small boats from the river. Three police launches are available for this task.	
		EPA is en route.	
		CG requests that tourist boats cancel their harbor area excursions. The river is closed to all traffic.	
			COE is concerned with locating the floating barge. A repair party is being mobilized.
1530	A tornado touches down in Georgetown section of Louisville. One city block has been levelled. Power is out in the Federal Building.	A weather service warning is spread by the Media.	
		CG and COE communications centers switch to emergency power.	

TIME	SCENARIO EVENT	ACTION TAKEN	DISCUSSION
1530. (cont'd)		COE relocates to field office at the lock, which still has telephone service. CG communicating by radio. LDPS-public safety forces are increasing spontaneously in response to the tornado. Orders voluntary evacuation of waterfront. Estimates 2 hours to clear the harbor front. Governor calls out the National Guard. COE contacting the owner to determine his plans for barge removal.	Contacted by the owner, the salvor and the diver are collecting equipment, etc. The salvor will need a 4,000 HP tug (commonly available). The surveyor is locating empty barges for possible cargo transfer operations.
1600	Towboat retrieves floating barge (BA-3-1-1).	COE and CG inspect the sunken barge from shore in order to determine its status. Owner's local representative arrives to work with the CG and others. LDPS-harbor area evacuation made mandatory. COE awaiting owner/salvor salvage plans before deciding whether or not to intervene to clear obstruction.	
	One tank on sunken barge breaks free and floats down river. It could ground 3,000' down from the head of the island (CA-2-1).	Situation report (Sitrep)	Response to tornado: Media - major attention has been diverted from the barge incident to the tornado. Governor - although the National Guard has been called out, they will not be on the scene and active for 2-4 hours.

TIME	SCENARIO EVENT	ACTION TAKEN	DISCUSSION
1600 (cont'd)			
			LDPS - joint city/county disaster plan is in effect. All city police, fire, etc. forces are mobilized. Media cooperation has been requested.
			COE & CG - tornado has slowed their actions.
		Indiana governor informed of the threat of a leak.	Because the tank is floating, it must be intact.
1630	The free-floating tank approaches the railroad bridge. It could lodge there within 10 minutes or it could pass through and continue on to the dam.		LDPS is totally occupied by the tornado. Its only interest in the river incident is if the wind should shift and blow an ammonia plume down on the city.
		Owner and team are now on the scene.	Owner team is assessing the situation and discussing it with CG and COE. The lawyer is gathering facts.
		Media still wants to know who is in charge.	
			COE has the power to take all actions necessary to safeguard the lock and dam structure. CG can act to remove safety or pollution hazard if owner fails to act responsibly.
		CG determines, from discussions with the owner, that if the tank holes on rocks there would be a 1,300 ton release of NH_3. A one-mile radius evacuation would be necessary.	
	COE closes tainter gates - takes 15-20 minutes.	COE has supply of Scott Air-Paks.	Protects lock and dam structure and raises level of the pool.

TIME	SCENARIO EVENT	ACTION TAKEN	DISCUSSION
1630 (cont'd)		Indiana officials still not on scene.	
		EPA air-monitoring team due 1655, RRT officials due 1730. Air-monitoring station will be set up ½ mile from the incident.	
		COTP recommends precautionary one-mile evacuation to LDPS, etc.	City and state government command post is fully operational for both tornado and barge incidents.
			Louisville will not have a public safety problem unless the wind shifts.
1640	Tank passes under the railroad bridge. Due at the tainter gate at 1710 (CA-2-1-2).	COE notifies the owner that if the tank should lodge at the tainter gate, COE may take direct action to remove the obstruction. Salvor arrives; he has located diving equipment; he wants to know if the tank can be beached without damage.	COE concerned about the danger of rupture if the tank should lodge in a gate. Since the tank is floating upside down, the CG is worried that it might damage its superstructure or the tank might even be ruptured.
		COE lowers gates to protect the lock; sends boats out to try and secure the tank; once the tank nears the gate, all lock personnel would be evacuated.	How can a line from a towboat be safely attached to the tank? Can a net be used?
1700	Wind blowing from the southwest.	EPA-RRT arrives. EPA becomes the OSC of the RRT.	Prior to this time, COTP was OSC.
		LDPS orders one-mile evacuation; schools and buses readied. Police start door-to-door notification.	
1710	Tank grounds on island; massive rupture occurs (CA-2-1-1-1-1).	LDPS seeks technical information on how people can protect themselves for use in media broadcast.	
		Media want to photograph the action. COTP o.k.'s one helicopter overflight for pool coverage.	CG must work with FAA to restrict air traffic.

TIME	SCENARIO EVENT	ACTION TAKEN	DISCUSSION
1710 (cont'd)		Salvor tells owner to protect his crew and the public; salvage operations cannot help at this time.	
1745	NH_3 cloud has dissipated.	COTP's concern shifts to the tank that is still on the sunken barge; will it break free like the first tank?	Although the lack of a formal disaster plan slowed local and state government response, the early move toward voluntary evacuation proved to be a good decision.
		EPA-OSC holds a press briefing, and provides an update to the politicians. The air pollution monitoring team reports severe irritation levels. The "coffee can" breathing technique is discussed.	
		CG continues to monitor sunken barge. The COTP urges the RRT to develop a plan of action for the next day.	
		Owner asks salvor to figure out a way to offload the cargo.	
		Salvor says top priority is to secure the barge. A naval architect must figure buoyancy of the barge before unloading can begin. Also, the barge must be capped and safeties set for the diver. All of this will take 1-2 days.	The ruptured tank is now the owner's, COE's, and CG's problem. EPA is no longer involved because the threat of massive pollution has been eliminated. While the cargo poses a public threat, the barge is only an obstruction to navigation.
		RRT convenes to discuss the sunken barge and to map a strategy for the following day.	
		RRT defines 4 options: a) Release the barge cargo into the water in a controlled manner. This would require emergency heating of the cargo. The cargo could be buffered as it entered the water to nullify water quality impacts. This	Lack of technical information on the barge's integrity and availability of equipment complicates decision process.
		(cont'd)	

TIME	SCENARIO EVENT	ACTION TAKEN	DISCUSSION
1745 (cont'd)		alternative would be a high risk operation requiring evacuation for 3-5 days. b) Locate a transfer barge and offload the cargo. This would require more time than "a", but would be less risky. c) Use shaped charges to put a small hole in the tank. Total release of the cargo would occur over about 18 hours, and could lead to the formation of another vapor cloud. The city could return to normal in about 24 hours. d) Cause a rapid dump of the cargo by bombing or otherwise rupturing the tank. Diver says he can cut the second tank free from the sunken barge and tow it upstream away from Louisville. This work would be dependent on the integrity of the barge and the availability of tools, especially a floating crane. Also, what buoyancy or lift is required to refloat the barge? Cutting the second tank loose would reduce the barge's byoyancy. LDPS comments that public airing of technical disagreement on choosing a course of action undermines public confidence.	EPA notes that in its experience evacuations of more than 3 days are hard to enforce and trigger civil unrest. Local political leaders prefer "c" because business as usual can be resumed at an early time. However, the FWPCA prohibits the owner from voluntarily doing this ($5 million fine) This prohibition can possibly be resolved by either CG or EPA at the RRT level. What are acceptable levels of public risk and economic disruption? Do you secure the barge and take days or a week to salvage requiring total evacuation of downtown Louisville, or do you blow up the tank while the area is already evacuated?

TIME	SCENARIO EVENT	ACTION TAKEN	DISCUSSION
1745 (cont'd)		EPA notes that controlled releases are difficult to manage, take time, and require longer evacuations.	
	END OF BRANCH		
1710	One barge has sunk in mid-river and is resting at a 30° tilt, tending downstream.	RRT is convened, EPA is OSC.	
		Owner's team is meeting.	
	One of the two tanks on the sunken barge has floated free and is lodged against the tainter gate, upside down, partially submerged but not ruptured (CA-2-1-2-2-2).	RRT has a defense civil preparedness team assisting in evacuation plans.	RRT also has its own press officer. The press wants to visit the site.
		The CG strike team is on its way to provide communications support, advice, and assistance to the COTP for oil and hazardous material removal on the river.	COTP is in radio contact with the RRT and COE, which is based at the lock.
		COE is monitoring the condition of the tank, reporting regularly to RRT, and contacting local salvors, etc., to determine capabilities.	
		Governor has called NG; a voluntary evacuation is in force in Indiana.	Tornado situation is coming under control.
		OSC o.k.'s an escorted press visit to the site.	
		Owner's team uses towboat to conduct on-site assessment. Owner is consulting with RRT to obtain advice on a course of action.	Since the OSC is the government decision coordinator, plans for action will be formulated through him.
		Salvor recommends options to the owner, who relays them to the OSC: a) Send a diver down to assess the situation, feasibility of offloading, etc. Secure the tank by line or net to the towboat, then offload sufficient	The availability of equipment determines the course of action.
		(cont'd)	

TIME	SCENARIO EVENT	ACTION TAKEN	DISCUSSION
1710 (cont'd)		cargo to refloat the tank so that it can be towed away. Alternatively, the pool level could be raised to refloat the tank; b) Find cranes to lift the tank, then siphon the cargo and tow the empty tank. This would require less time than "a"; or c) Open the gates and let the tank ride through the tainter gate (very risky). Surveyor notes that since the tank has survived so far, it is probably pretty tough and might survive a tow upstream.	
1800	Wind from SW; weather appears to be stabilizing.	In the face of favorable weather and public pressure, EPA would recommend shaving down evacuation requirements. COTP reviewing the diver's recommendations; he is concerned about displacing NH_3 with water during offloading. He is awaiting information on hazards associated with this point from ORSANCO. COE discussing cargo transfer and salvage with the owner. Owner reluctant to tow an inverted tank. He would prefer to roll the tank over at the dam, then tow it away from the structure.	EPA, CG, and state officials, may be present. If the tank can be rolled, then the NH_3 can be flared at the vent with natural gas. This would speed its vaporization. Tanks could be designed to float upright; they could also be designed so as not to float off the barge.

TIME	SCENARIO EVENT	ACTION TAKEN	DISCUSSION
1800 (cont'd)		EPA more worried about air pollution than water pollution. Acceptable air pollution would be 100 PPM after 8 hours at a distance of ½ mile. This level would cause some eye and throat irritation. Governor recommends a voluntary evacuation. EPA suggests a mandatory evacuation to ½ mile and voluntary evacuation to one mile. Salvor and owner agree to roll the tank and tow it off; a crane and other equipment will be needed. COE says crane on the dam is too small. A floating crane will be necessary. The gate will be lowered to increase diver safety. Lawyer says no real legal problem yet, although the owner has a $250,000 cargo loss to worry about.	
1830		RRT press conference with Governor in attendance.	EPA explains role of OSC and RRT. Governor and others remain in charge of evacuation and public safety. COTP remains in charge of river operations. COE remains in charge of lock operations and obstructions of navigation. EPA is in charge of air quality monitoring. The RRT is a coordination mechanism. It rationalizes all inputs for decision makers, but it is not in charge; the RRT also acts as the sole information spokesman for federal agencies.

TIME	SCENARIO EVENT	ACTION TAKEN	DISCUSSION
1830 (cont'd)		CG strike team has located a floating crane. Tank trucks are available for offloading. Salvor will set up during the night and undertake to roll the tank two hours after daylight. COE accepts salvor's plan and will stand by to assist. However, the owner will be billed for all assistance rendered.	COE thinks this would take two days in real life. The tank must be secured so that it doesn't float off during offloading.
	E N D O F B R A N C H		
1410	The scenario is as described above. The problem shifts to salvage of the sunken barge (30° tilt, 1 cargo tank still on board). Weather - very unsettled.	CG monitoring barge location and movement. A small boat is attending; its crew is equipped with air packs.	
1500	The barge is sliding on the bottom, moving intermittently towards the railroad bridge. Its rate of movement is approximately 1000' every 15 minutes (CA-1).	COE en route; maintaining radio contact with the CG boat. If the barge should move towards the tainter gates, it would require 15-20 minutes to close the gates. Media: Why can't you attach a line to the barge and tow it upstream? CG says the river is moving too fast for safe salvage operations.	Closing the gates would cause the level of the pool to rise about 2' and slacken the current. This, in turn, would make it harder to track a sunken moving barge. On deep ocean tows, a line with marker buoy is regularly trailed for use in the event of tow line failure. Such a system might be workable on inland waterways.
1520	The barge stops sideways, with its downstream edge submerged, 3,200' from the railroad bridge. The tornado occurs.		

TIME	SCENARIO EVENT	ACTION TAKEN	DISCUSSION
1600		CG monitoring by radio. COE maintaining gates in defensive position. Owner intends to secure the barge and offload the cargo into the water. Salvor needs a diver inspection to determine the extent of flooding in the barge.	The salvor notes that the river bottom is rock; it is not possible to anchor the barge. The cargo owner is unsure whether in offloading it is better to replace the cargo with air or water. He needs technical advice on cargo characteristics.
1700		EPA advises owner by telephone that the dumping of cargo into the river makes the owner liable for a stiff fine. Lawyer advises owner not to dump the cargo without some kind of waiver in writing from EPA. CG assisting owner in affixing a line to the barge. COE wants the barge anchored to protect its structures. Owner suggests tying an empty barge to the sunken barge to serve as a work platform. He is also negotiating with EPA about his fine. He points out that, because of the high water flow, the discharge would rapidly be dissipated.	Impasse developing.
1720	The barge slips another 600' downriver. It is now 3,800' downriver from the railroad bridge.	Owner trying to locate an empty barge. Governor calls EPA to discuss the matter of the fine. EPA replies that it does not have discretion in the matter. Only the President can declare a state of emergency and waive the legal requirement.	

TIME	SCENARIO EVENT	ACTION TAKEN	DISCUSSION
1720 (cont'd)		Lawyer advises the owner to wait until the government or a court orders him to dump the cargo.	In practice, those who have dumped hazardous cargo after being ordered to do so have not been prosecuted or fined.
		EPA tells the owner that he cannot use the fine as a basis for not getting the cargo out of the river.	
		Owner getting empty barge into position.	
		Diver readying equipment for next day's operations. His operations will take 8 hours after the barge stops drifting.	
1900	Barge shifts again.	COE worried that the barge could move into tainter gate. (Owner's team not yet able to act.)	
		Governor will call the President on the matter of dumping cargo.	
		Owner not convinced that there is any safe way to dump the cargo into the water. Acetic acid could be mixed with the NH_3 to form a harmless precipitate, but this would take 3 days.	
		Barge tied down for the night. Cargo boils slowly out of the relief valves; CG monitoring overnight.	
			The lawyer feels the owner should let the government make the decision on intentional release. The EPA concurs with this position.
			The cargo owner must still solve the technical problem of what to replace the offloaded cargo with (air or water) and whether the release should be buffered with acetic acid.
	END OF BRANCH		

ROLE PLAYERS IN GAME SIMULATION

NAME	AFFILIATION	ROLE
Louis Frueh	Cairo Marine Services, Inc.	Marine Surveyor
Leland N. Gregg, Jr.	U. S. Coast Guard	Captain of the Port
Richard Griggs	U. S. Coast Guard	Media Representative
Phillip Laemmle	University of Louisville	City Director of Public Safety
Russell Light	Consultant	Diver
Wilder Lucas	Lucas & Murphy, Inc.	Marine Attorney
Joseph F. Pawlikowski	E. I. Dupont de Nemours & Company	Cargo Owner
Steven R. Smith	University of Louisville	Kentucky State Executive
Frank T. Stegbauer	Southern Towing Company	Tow Boat Operator/ Owner
Robert K. Thurman	Consultant	Salvor
William Whitlock	U. S. Army Corps of Engineers	District Engineer

ASSESSOR/INFORMATION CENTER PARTICIPANTS

NAME	AFFILIATION	SUPPORTING ROLE
John Bailey	U. S. Coast Guard	Captain of the Port
Ralph Bartels	U. S. Coast Guard	Regional Response Team
Martin Biemer	Louisville Times	Media Representative
Michael J. Donohoe	Gulf Strike Team	Strike Team Activity
Dennis Gilbert	University of Louisville	Office of the Mayor, City of Louisville
William C. Hardy	Ketron, Inc.	Public Reaction
George Lindauer	University of Louisville	Indiana State and Regional Governments
Kenneth Matthews	U. S. Army Engineer District	U. S. Army Corps of Engineers
Al Smith	Environmental Protection Agency	Regional Response Team
Paul Weber	University of Louisville	Jefferson County (Kentucky) Executive
Gerald Yankee	University of Louisville	Jefferson County (Kentucky) Public Safety

SECTION II

LIQUIFIED NATURAL GAS (LNG) TANKER AND CONTAINER SHIP COLLISION SAVANNAH, GEORGIA

I. Background for Casualty and Response Scenario

A. Geography and Weather

1. Savannah is the second largest city (population: 110,000)* and the chief port of the State of Georgia. The city has considerable coastwise and foreign trade. It is connected with coastal cities to the north and south by the Intracoastal Waterway, which intersects with the Savannah River approximately 6 miles upriver from the jetties.

2. Waterborne commerce is widely varied in nature and includes imports of petroleum products, sugar, lumber, cement, gypsum, fertilizer materials, newsprint, tea, coffee, burlap, molten sulfur, chemicals, iron and steel products, and agricultural machinery. Exports include petroleum products, kaolin clay, lumber, textiles, naval stores, kraft paper, scrap iron, and agricultural machinery. Approximately 1400 inbound and outbound voyages were made by dry cargo and passenger ships in 1975. Corresponding tanker traffic involved 300 voyages.

3. The Savannah River separates Georgia and South Carolina and is navigable for deep-draft vessels to the upper end of Savannah Harbor, some 19 miles above the seaward ends of the entrance jetties. Deep-draft vessels approach the Savannah Light from the east-southeast. The Corps of Engineers provides for a 40-foot channel (MLW) across the bar through Tybee Roads; thence 38 feet for the balance of the channel past the jetties to the terminal. Channel width varies from 600 feet at the sea buoy to 500 feet at the terminal.

4. The general location of the scenario is offshore from Tybee Roads, outside the sea buoy (Tybee Lighted Whistle Buoy T, 31°58.3'N, 80°44.0'W), and in the vicinity of the Savannah Light (Gp Fl (2) HORN, 31°56.9'N, 80°41.0'W), which is located approximately three miles to the east-southeast

*Statistical Abstract of the U.S. 1977, population figures for 1975.

of the sea buoy. The Savannah Light is approximately nine nautical miles east of the Little Tybee Island shoreline, 8.5 nautical miles from the nearest shore at Savannah Beach, and 20 nautical miles east of Savannah. The accompanying chart (page 101) illustrates local navigational and geographical features.

5. The weather forecast for Saturday, 19 August indicated that fair weather was expected to continue. Visibility was good. A ten-mile-per-hour wind was blowing from the east, considered to be an abnormal wind direction. (The most probable wind direction is offshore, i.e., blowing from the west.)

6. Normal summer populations were at Savannah Beach, Hilton Head Island, and other local areas.

B. Vessel Scheduling

1. Scheduling of vessel arrivals at the Elba Island Terminal is predicated on passage up the channel on a rising tide and on berthing during the slack water associated with high tide at the terminal.

2. High water at the Savannah River Entrance on this date occurred at 0827 hours. Slack water at the terminal was estimated to occur at approximately 0900 hours. Since the passage to the LNG terminal requires approximately 90 minutes, the arrival at the sea buoy was scheduled for 0700 which also allowed time to take on the pilot.

C. Prearrival Activities and Notifications*

1. Since this scenario involves an ongoing operation, the pre-arrival conference required by the U.S. Coast Guard Liquefied Natural Gas Contingency Plan for the Port of Savannah was previously satisfied. In brief, this conference included a review of all Captain of the Port (COTP) requirements with representatives of the Coast Guard, shipping companies, facility owners, and local police and fire agencies. Periodic reviews of these regulations and operations are conducted.

2. Prior to vessel arrival, the following requirements were satisfied by the vessel:

*U.S. Coast Guard LNG Contingency Plan for the Port of Savannah; 29 June 1977; Phase 1.

a. The Savannah COTP was notified 72 hours in advance of vessel arrival. An additional notification was made at 48 hours. These reports were accomplished on 16 and 17 August no later than 0700.

b. Confirmation of arrival was made 24 and 12 hours prior to arrival of the vessel at the Savannah Channel Entrance by the LNG ship owner's operations manager. This report was made on Friday, 18 August at 0700 and at 1900 hours.

c. Prior to arrival at the Sea buoy, the message concerning operational status and readiness was sent.

3. Based on the initial notification of the tanker's arrival, the Vessel Movement Officer maintained a daily update for the COTP on the vessel's estimated time of arrival. This officer also notified the Savannah River pilots of any special requirements or restrictions which might have affected the transit.

4. Also based on the initial notification of arrival, the Chief, Port Safety Section:

a. Arranged for the Marine Safety Inspection Team;

b. Issued a "Notice to Mariners" 24 hours prior to arrival;

c. Made provision for vessel traffic control to be provided around the vessel during the river transit;

d. Arranged for the escort vessel detail as directed by the COTP; and

e. Monitored all significant weather changes or incidents potentially affecting safe passage of the LNG tanker.

5. Onboard the LNG tanker 18 August, preparation for passage up the river and cargo discharge at the terminal was completed and included:

a. Emergency diesel generator start-up and test;

b. Steering gear and circuits checked for proper operation;

c. Internal communications and radios test;

d. Bow thruster operation and checkout;

e. Astern and ahead propulsion and control system tests;

f. General alarms, fire alarms, and whistles operation;

g. Fire pump tests; and

h. Cargo control and monitoring systems checkout, gas detection, and temperature sensing.

D. Events Prior to the Casualty

1. LNG tanker actions:

0600 All onboard inspections and pre-arrival arrangements have been completed. The two-man anchor watch and lookout forward have been set. The bridge is manned by the master, the chief mate, a mate, and a quartermaster. The engine room is manned by the chief, the first assistant, a third assistant, and a QMED. The stewards are preparing for 0700 breakfast. The balance of the crew is either asleep or just arising.

0615 The ship is ten miles from the sea buoy and traveling at 15 knots, and is in maneuvering mode.

0620 The master is informed that an outbound container ship is scheduled to clear the sea buoy at 0630 after dropping the Savannah River pilot. To avoid the container ship at the sea buoy, the master reduces LNG tanker speed to delay her scheduled arrival of 0700 at the sea buoy.

0635 The Master confirms that the container ship is delayed enroute by 15 minutes and as a result will not clear the sea buoy until approximately 0645. The pilot station suggests by radio that the master hold the LNG tanker just outside the Savannah Light to assure that sufficient sea room is available for both ships and two other

ships at the anchorage in the area north and northwest of the Savannah sea buoy.*

0645 LNG tanker heaves to with the Savannah Light off the port quarter. The container ship position is monitored on the collision avoidance radar.

0650 The container ship is observed to depart the sea buoy. Bridge-to-bridge communication between the ships indicates that the container ship will also pass the Savannah Light to port, approximately one mile from the LNG tanker. The LNG tanker master requests that wider berth be given. No response is received.

0653 Visual observation indicates that the container ship has taken a sharp turn to port. Radio communication between the ships indicates it has suffered a steering gear failure. Her speed is concluded to be eight knots and increasing. Following this communication, a collision appears to be possible.

0654 The master on the LNG tanker orders emergency ahead and the rudder hard over to maneuver the vessels head-to-head. The master on the LNG tanker also sounds General Alarm and orders that the fire pumps and water curtains (surrounding the cargo control room and forward side of the accommodations) be activated.

0655 Collision occurs.

2. Container Ship Actions

0645 The Savannah River pilot is discharged at the sea buoy, BW"T" (refer to chart on page 101). The master leaves orders for course and retires to his quarters. The chief mate assumes the watch.

0650 The chief mate reports to the LNG tanker that his passage will clear the Savannah Light to port and that the Savannah pilot is awaiting the arrival of the LNG tanker at the sea buoy.

*Reference Marine Safety International-Savannah River Port Information.

0653 The helmsman reports the ship is drifting off course to port. The mate inspects the steering controls and navigation equipment and determines that the steering gear has malfunctioned. The mate summons the master to the bridge and also attempts to regain helm control. Bridge-to-bridge contact with the LNG tanker is established and a warning sent.

0654 The master reaches the bridge, having already felt the course change. After sighting the LNG tanker proximity and the closing angle of approach, he orders full astern power. Since the helm is not responding, the master orders engineering to investigate.

0655 The collision occurs despite the efforts of both masters to take evasive action.

II. Post-Collision Scenario Proposed for Game

A. Events after Collision

1. LNG tanker situation and action:

0655 The collision occurs. The LNG tanker is struck abeam of the No. 6 cofferdam located between the No. 6 cargo tank and engine room. The master immediately stops all engines and shuts down all ventilation. The emergency diesel picks up the appropriate loads. The damage extends into No. 6 cargo tank and the forward area of the engine room, port side. Due to the flare of the container ship bow, the majority of the damage is to the cargo tank. Some of the LNG immediately starts to vaporize. The bulbous bow on the container ship has caused an extensive penetration below the waterline in way of the engine room.

0655.5 The master contacts the engine room. Flooding is reported. No deaths are reported, although minor injuries have been incurred from the impact. Chief engineer is told to secure the engine room area, clear the space, and get his crew to the accommodations area and those on the emergency squad to their stations.

0656 The bridge contacts the Coast Guard on Channel 16 and informs them of the collision. The bridge is cleared and ordered to assemble in the captain's quarters one deck below.

0657 Because the container ship had her engines going full astern, the ships separate. This causes a release of the LNG from cargo tank No. 6: LNG vapors are ignited. Due to damage below the waterline, uncontrolled flooding occurs in the engine room immediately after the ships separate.

0658 The master's radio contact with the lookout and anchor watch indicate no casualties. These crewmen are directed to seek cover and wait the fire out. Radio contact is maintained with all of these parties.

0700 The emergency squad is organized and given orders to extinguish any Class A fires in the accommodations.

0712 Exterior LNG vapor fires burn out. The ship has settled by the stern. A damage inspection party is sent out to make an assessment of below-deck flooding and hull structural damage. Small fires in the accommodation spaces continue.

0725 The master receives a report from the emergency squad that all fires are extinguished. The damage inspection party reports that the ship has grounded by the stern in approximately 50 feet of water. The stabilizer tank has been penetrated, as well as an area at the forward end of the engine room. The aft peak tank is flooded due to upward penetration of the rudder. The master contacts the anchor watch by radio and orders the forward anchors dropped. The immediate situation on board is stabilized.

0727 Attempts to make radio contact continue to be hampered by the loss of communication antennas atop the navigating bridge. The master orders the second mate to break out the radio in the starboard lifeboat and that contact with the Coast Guard be reestablished (Channel 16 is used).

2. Container ship situation and actions:

0655 The severely raked bow of the container ship (some 48 feet forward of the forward perpendicular) has penetrated the LNG tanker hull from the 42 foot waterline and down, in an area just forward of the aft deck house. The master also thinks the bulbous bow must have penetrated the LNG tanker below the waterline. The bulb is 25 feet long and 17 feet in diameter.

0657 The Coast Guard is informed of the collision.

The container ship separates from the LNG tanker under full astern power and continues astern, backing away from the collision site. Rudder control is achieved by the chief engineer and QMED in the steering gear room they have been sent to investigate. A faulty electrical signal is suspected to have been the cause.

0658 The master contacts the steering gear room and orders the rudder put hard to starboard so as to direct the ship into deeper water and away from the vicinity of the LNG tanker. All ventilation in the forward accommodations house is shut down to preclude drawing LNG vapors into the space. The forward part of the ship is exposed to a significant level of thermal radiation.

0703 The container ship is approximately a mile away from the LNG tanker and is no longer within range of any hazardous thermal radiation. The master sends a damage party forward for inspection with orders to report back by radio.

0710 The mate reports that the flooding has been limited to those spaces forward of the collision bulkhead. Both anchors are jammed in position and cannot be lowered.

0711 Radio contact with the Coast Guard is made. It is reported that the situation is stabilized and that tug assistance is needed to assure ship maneuverability and control. The engines are used to keep position several miles east and upwind of the LNG tanker.

0830 Tug assistance arrives and is used to move the container ship into port.

B. Coast Guard Responses

0656 U.S. Coast Guard radio operator receives notice from the LNG tanker of an emergency--that a collision involving the LNG tanker and container ship has occurred.

The Officer of the Day responds as follows:

1. Notifies the Captain of the Port, the Executive Officer, the Port Safety Officer, and the Commander-Coast Guard District Seven Operations Center.

2. Directs the escort vessel at the sea buoy to lend assistance.

3. Requests that commercial tug assistance be alerted and readied.

4. Requests that assistance from Group Commander, Charleston be put on ready status.

5. Provides patrol craft for control of traffic in area.

6. Issues an emergency Notice to Mariners broadcast to all ships in immediate waters.

7. Activates helicopter assistance for aerial surveillance and emergency evacuation, located at U.S. Coast Guard Air Station.

8. Notifies Savannah River Pilots Association.

9. Notifies the Marine Operations Manager at Elba Island.

0657 U.S. Coast Guard radio operator receives notice of collision from the container ship.

Radio contact with the LNG tanker is lost.

0703 The escort vessel arrives and prepares to lend assistance to the LNG tanker. An initial survey of the situation is made to the COTP. Close access to the LNG tanker is precluded because of the fire. The container ship is observed to be backing away from the accident area.

0705 The On-Scene Coordinator (OSC) prepares to survey the accident scene by helicopter.

0706 Escort vessels are directed to establish a Security Zone around the Savannah Light area. Additional patrol craft are enroute.

0711 The container ship reports that tug assistance is needed.

0712 The commercial tug, in readiness state, is directed to provide assistance to the container ship.

0730 Those with injuries are removed to shore by Coast Guard patrol craft.

C. LNG Tanker Salvage

The introduction to the damage control manual provides naval architecture and stability principles, information on trim, loose water, list, flooding, rolling, flume stabilization, sloshing, and hydrostatic parameters. Major sections are devoted to general damage control, preventive damage control, modes of ship loss and damage, damage effects, damage situation appraisal, damage corrective measures, specific damage, flooding and countermeasure information, and damage control check off lists and message reminders.

The damage postulated by this hypothetical collision scenario is closely representative of the damage condition 31-1 reported in this manual.

1. Damage Definition

Cargo tank No. 6 is flooded.

Ballast tanks -- No. 6 wing tank, port, and No. 6 double bottom, port are flooded between frames 74 and 110.

No. 6 cofferdam is flooded.

Stabilizer tank, frames 58-74, is empty.

2. Damage Stability/Assessment

The vessel is expected to assume the following characteristics for the above damage conditions (preliminary data):

Draft fwd	29	feet
Draft aft	50	feet

Trim by stern	20.5 feet
Heel angle	13 degrees
Metacentric height	7.4 feet
Maximum safe angle for heel	27 degrees
Heel angle at maximum righting arm	40 degrees
Range of stability	49 degrees

Damage stability calculations show that neither freeboard nor stability are critical.

3. Refloating of the Vessel

LNG tanker departure following cargo discharge from the East Coast will average approximately one every two to three days. An average of 2.5 days will be used. Assuming this departure takes place from Cove Point, Maryland, and that the sailing time is 33 hours, it would take approximately four days to provide an empty LNG tanker for lightering the disabled carrier at Savannah sea buoy.

4. Preparation for Cargo Transfer

Cargo transfer gear will be brought by service craft from the Norfolk storage facility. This equipment consists of:

U-200 high holding power and stockless anchors

Anchor buoys and pendant

Three rubber fenders with pendants

Four (25-foot) sections of cryogenic transfer hose, blanks, gaskets, spools, and adapters

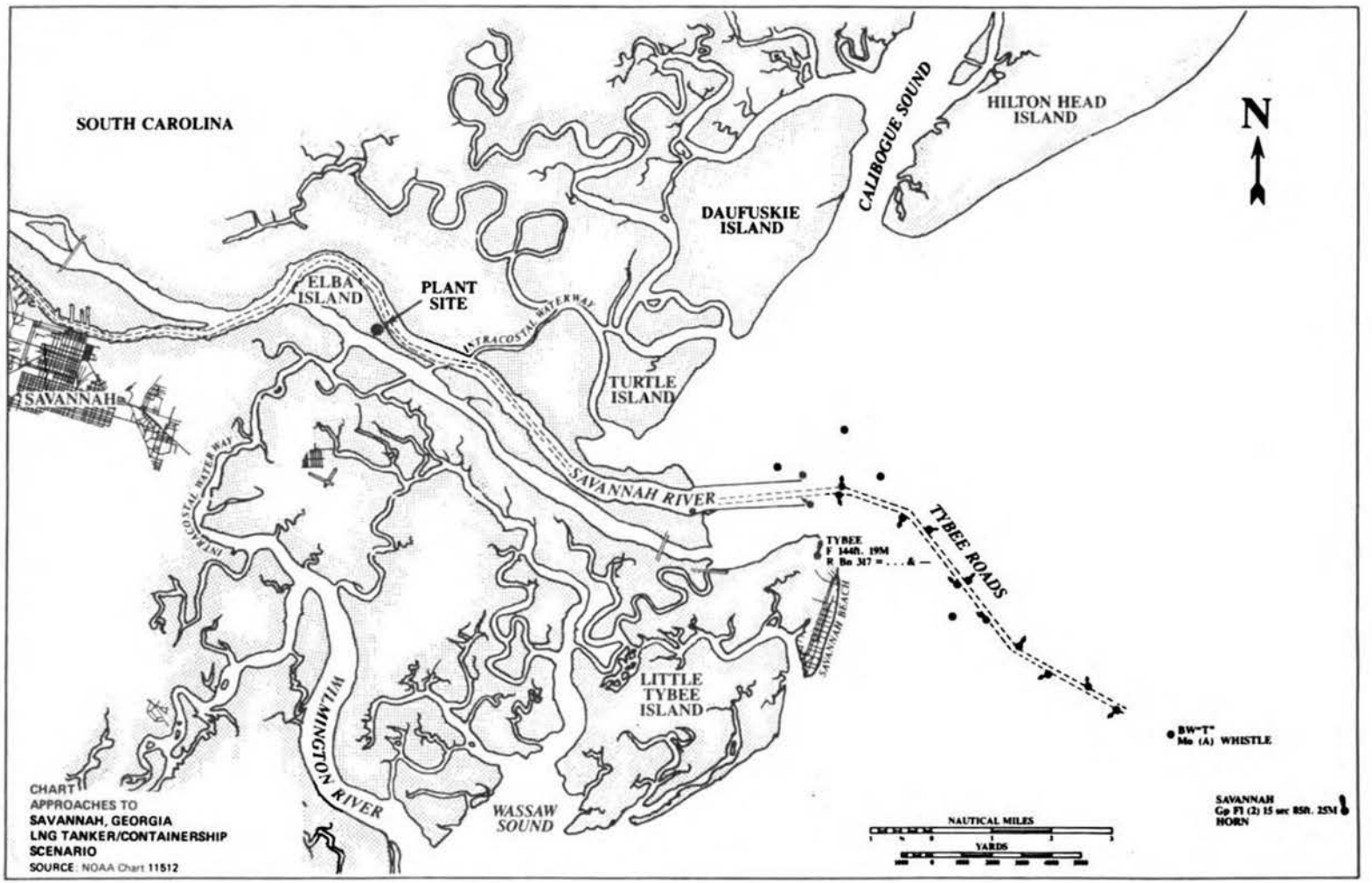
Hose support system consisting of tripods, suspension wires, air-powered winches, air hose, hand-powered winches, nylon pendants

Diesel generator and related electric power cabling

Air compressor

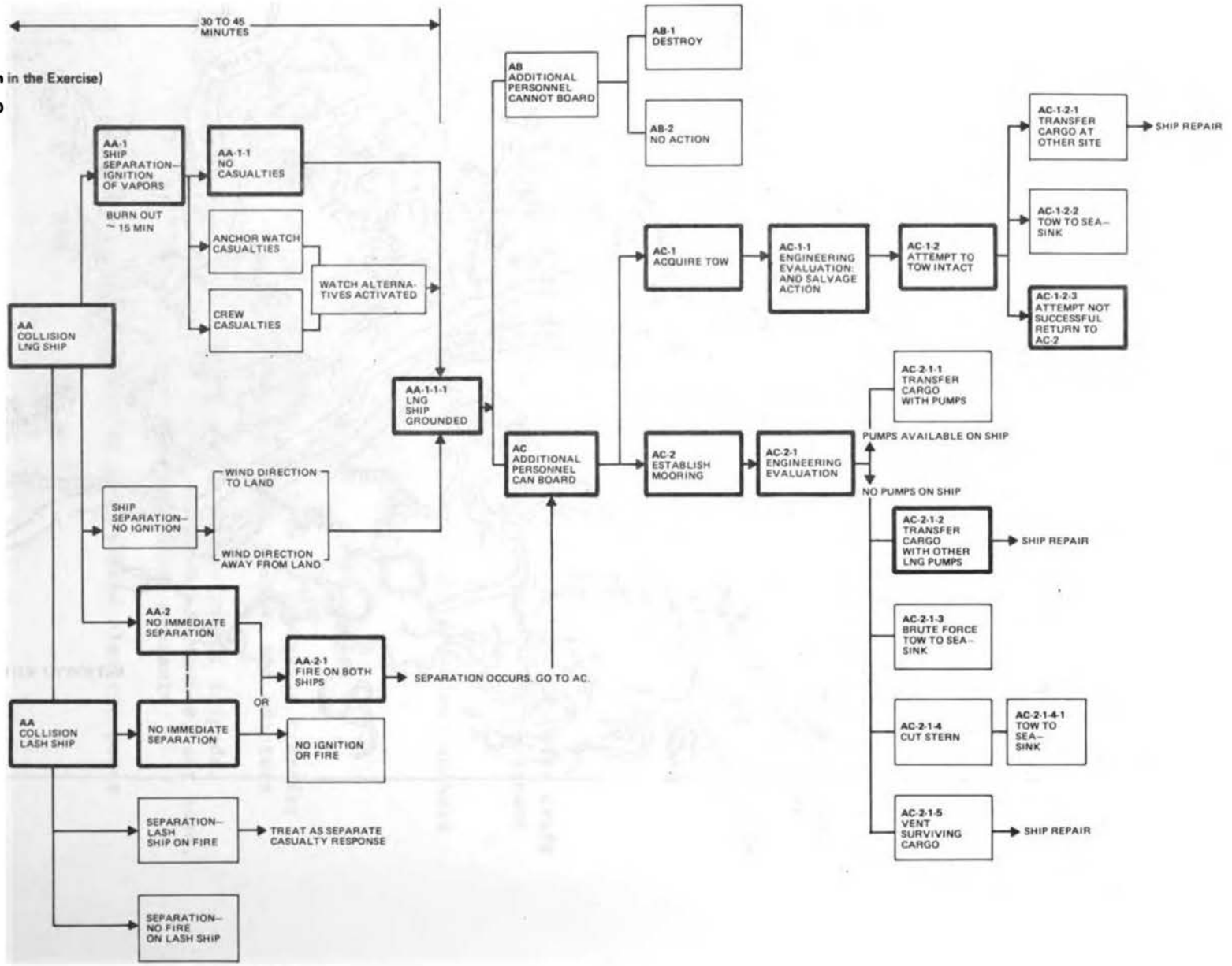
Protective clothing and firefighting suits

Emergency radio equipment


SOUTH CAROLINA
HILTON HEAD ISLAND
CALIBOGUE SOUND
DAUFUSKIE ISLAND
N
ELBA ISLAND
PLANT SITE
INTRACOSTAL WATERWAY
SAVANNAH
TURTLE ISLAND
SAVANNAH RIVER
TYBEE ROADS
TYBEE
F 144ft. 19M
R Bn 317 = . . . & —
SAVANNAH BEACH
LITTLE TYBEE ISLAND
WILMINGTON RIVER
WASSAW SOUND
BW"T"
Mo (A) WHISTLE
NAUTICAL MILES
YARDS
SAVANNAH
Gp Fl (2) 15 sec 85ft. 25M
HORN
CHART
APPROACHES TO
SAVANNAH, GEORGIA
LNG TANKER/CONTAINERSHIP
SCENARIO
SOURCE: NOAA Chart 11512

SIMULATION TREE
(Showing Branches Taken in the Exercise)

SAVANNAH SCENARIO
LNG TANKER AND
CONTAINER SHIP



Record of Game, Savannah Incident: LNG Tanker/Container Ship Collision

TIME	SCENARIO EVENT	ACTION TAKEN	DISCUSSION
August 18 (Saturday)			
0600	LNG tanker approaching Port of Savannah.		See written scenario.
0615	LNG tanker is 10 miles from sea buoy, traveling at 15 knots in maneuvering mode.		
0620	LNG reduces speed.	Master confirms that an outbound container ship is scheduled to clear the sea buoy at 0630. Master reduces speed to delay arrival.	The objective of this delay is to provide adequate separation between vessels.
0635	Container ship departure from sea buoy rescheduled for 0645.	Pilot station suggests that LNG tanker hold just outside Savannah Light to assure sufficient sea room between ships.	
0645	LNG tanker lays to.		Light is off port quarter; container ship monitored on collision avoidance radar.
0650	Container ship departs.	Bridge-to-bridge communication. LNG requests wider berth be given (greater than 1 mile). No response. Container ship passing 1 mile to port.	
0653	Container ship veers to port.	Container ship steering gear failure. Container ship speed 8 kt. and increasing.	Collision appears possible.
0654	LNG Master takes evasive action: emergency ahead rudder hard to port.	Master sounds general alarm; orders fire pumps and water curtains.	
0655	Collision occurs (AA).*	Master shuts down engine and ventilation systems, emergency diesel picks up appropriate loads, notifies engine room, etc. to seek protection and put emergency crews on station; radioed. LNG Master evacuates bridge to take refuge in fire protected area.	
0656			If no fire, Master worries about the ship; if fire, he worries about the crew.
	(*index number references simulation tree)	LNG Master informs CG of collision.	

TIME	SCENARIO EVENT	ACTION TAKEN	DISCUSSION
0657	Vessels separate and cargo vapors ignited.	COTP establishes 5-mile security zone around vessel via emergency notice to mariners. COTP gears up office, initiates notifications, including local and state officials, RRT, federal govt. agencies, CG District Headquarters Group Charleston; also LNG carrier owner.	Full office is 10 officers, 14 support; because incident occurs on a Sat., it will take some time (1-1 1/2 hrs.) to staff up COTP office. However, CG rep. would be on escort boat (standard LNG practice).
0658	1st media contact to CG office.	COTP would request helicopter to take a first-hand look.	Picked up collision on radio.
0700	Master receives damage reports.	All personnel apparently safe; No. 6 tank is ruptured and burning. Other tanks are buttoned up.	
0705			CG escort boat sees the fire. Fire has knocked out all LNG tanker radios except hand-held sets and destroyed antennas. Fire viewed from shore local calls to CG and media.
0710	Gas fires out - contents of one tank (25,000m^3) has been consumed (AA-1).	Master initiates teams to control Class A fires; secures ship; checks personnel; establishing communications with escort boat by hand sets and lifeboat radios. CG notifies strike team and RRT.	Only communications by hand sets with escort boat for relay; within minutes LNG terminal will relay communications between owner and vessel. RRT alerted because of threat of oil pollution although none has occurred.
0725	Ship aground in 50' water (AA-1-1-1).	Master lowers 2 bow anchors. Via radio, provides owner preliminary description of damage; intends to secure ship before disembarking unnecessary crew. Owner begins to assemble his team, many of whom are on contingency contract; calls salvage engineer, salvor, lawyer, management in Houston (including emergency team); initiates check on other LNG ships in area to offload cargo.	Aground at stern (flooded engine room); 14' increase in stern draft; stabilizers appear holed; #6 cargo tank now partially flooded with seawater. LNG terminal now relaying owner/ship communications.

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TIME	SCENARIO EVENT	ACTION TAKEN	DISCUSSION
0725 (cont'd)			CG Executive Officer is on escort boat. He has the option of remaining as on-scene liaison, either on the escort boat where he has communications and flexibilit or on board the LNG ship, or returning to the office to serve as Public Information Officer. Container ship down by bow, some fire but not threatening crew; ship is positioning with engines, trying to anchor by bow, manual steering.
		COTP shuts down port after he learns of fire; requests 95' workboat from Group Charleston.	
0800	Port closed.	COTP requests assistance from District.	Has 41' boat on scene as escort; 95' boat is due from Group Charleston at 0900; 180' buoytender Paw Paw available as work platform but can't sail from Jacksonville for 24 hours. RRT mobilized. Owner finds two Curtis Bay tugs (4700 HP) in area - diverted to scene; request 5-day weather forecast--good; acting for P&I notifies P&I clients staff lawyer stands by at COTP's office; Salvor, while traveling check region for equipment. He will learn results upon arrival.
		Owner orders emergency gear from Norfolk (fenders, transfer hoses, etc.). Houston public affairs and technical response team still gearing up.	
		CG strike team ask for OSC to request Navy salvor; Navy salvor learns that foreign salvage tug (22,000 HP) is 1 hr away; diverted by its owner to scene. CG pumps on way from Elizabeth City, N.C.	The request for Navy will be directed to the RRT by the OSC. Cabotage law prevents use of foreign flag salvor unless U.S. assets are not available and this is certified by the government. Need Customs Bureau waiver of Cabotage restriction.
		PIO briefs media and govt a collision has occurred, fire is over, no serious injuries, no threat to public.	

TAKEN	SCENARIO EVENT	ACTION TAKEN	DISCUSSION
0800 (cont'd)		PIO requests information assistance from CG district. Navy salvor sending salvage team by air. Asks strike team whether oil skimmers are needed. COTP tells Navy salvor that there is no visible oil in water.	
			Mayor of Savannah volunteers help.
			Navy salvor advises COTP (OSC). Question on skimmers should be addressed to OSC.
			Without oil pollution, federal pollution contingency funds cannot be made available. Any CG intervention would have to draw on operating funds.
	Additional personnel will be allowed to board LNG tanker (AC).	Master will allow 1 boat at a time to approach LNG stern; requests CG deploy preventive oil boom around the ship; continues to assess underwater damage following last report at 0725. CG enforces security zone.	LNG in unruptured tanks appears to be venting normally through 1 stack; fire protection afforded by flame screens.
		COTP will not let any boat alongside LNG unless he thinks it is safe. For this decision, he will rely on LNG master; also requests FAA to set air security zone.	Press wants helicopter pictures for 12:00 news. Owner discuss foreign tug Cabotage situation with lawyers & Navy salvor.
		Owner locates LNG ship to offload cargo; on site in 2 1/2 - 3 days. Lawyer asks COTP to permit lawyers aboard ship to get statements.	
1000		News bulletins aired, which arouse curiosity about the level of risk and danger in the situation.	CG & owner reps. have boarded. Navy salvor lining up equipment; 3 tugs ordered from Jacksonville, due 1600;
1200		Navy salvor provides technical certification (cont'd)	Navy salvor would take back seat or go home if (cont'd)

TIME	SCENARIO EVENT	ACTION TAKEN	DISCUSSION
1200 (cont'd)		that no adequate U.S. salvage assets are available. Recommend Customs waive Cabotage Act	foreign tug is hired and if it is the owner's intention to tow the ship out to high seas.
		Governor's office complains of COTP about lack of information. Needs answers to respond to local officials' questions, etc. Mayor of Savannah expresses similar concern.	TV news broadcasts story that 1 LNG ship has energy equivalent of 4 atom bombs, then notes closed port and air security zone without comment.
1400		COTP won't intervene in owner/master actions unless definite hazard is present, such as oil spill and owner is not acting responsibly, i.e., working to effect salvage by his own contractor or by USN.	
	Master throws line to 22000 HP Tug (AC-1) foreign.	Owner tells master to throw line to foreign tug; try to tow off at high tide (2000 Hrs.). Salvage engineer figuring buoyancy for tow. Salvor aboard ship, waiting for additional tugs.	Trim by filling bow ballast tanks? Foreign tug & 3 U.S. tugs should be able to tow ship to sea. Questions: how much ballasting is necessary and how much HP is required to tow?
		Lawyer needs estimates of damage from owner to determine amount of security to demand from container ship; two ships cooperating in setting security, preventing further damage, reviewing documents interviewing personnel.	
		Master rigging for the tow, ballasting, etc.	Once the ship is lightened, trimmed, and towed off, where should she be towed to for offloading?
			Ship appears well designed for towing.

TIME	SCENARIO EVENT	ACTION TAKEN	DISCUSSION
1400 (cont'd)			If it is necessary to trim the ship before towing, the ship may not be ready for the tow by the next high tide.
1500		PIO holds news conference: no danger to Savannah; describes salvage preparations; Mayor says he has confidence in CG and owner; COTP explains need for larger security area "better safe than sorry"; little environmental impact, cargo transfer will take 3 days; COTP admits that a wider vessel trafic control zone around LNG ship could possibly have been safer. CG will formally investigate incident; news reports of congressional interest.	Acting on request from mayor, media; also, media wants films for evening news.
	(AC-1-1)	Owner asks SUPSALV to advise on salvage; other salvors and tugs are subcontracted for by foreign salvor.	Total of 4 tugs available; (foreign tug plus 3 that owner requested).
		Master still preparing for tow; hydraulic valves to ballast tanks are out; must be operated manually.	
		CG strike team has conducted preliminary survey. Some flammable gases present; recommend flooding forward tanks and pulling to sea.	Owner favors this approach, rather than offload bunker fuel in stern (environmental reasons); initially, tow out to sea (about 50 mi.), but west of Gulf Stream.
1800	(AC-1-2)	Salvage tugs in place, start tow.	4 tugs on line; SUPSALV advising CG and owner on LNG salvage.
		Master used foreign tug pumps to de-water stern & ballast forward tanks. Ship at 13° list.	

TIME	SCENARIO EVENT	ACTION TAKEN	DISCUSSION
1800 (cont'd)		Lawyers disagree on security, but agree that litigation should be in Savannah, although there could be jurisdictional problems due to international waters. Legal discussions with CG re possible violations of environmental law, but no pollution incident yet; however, lawyer advises client to be careful.	
		SUPSALV asks owner for tow plans.	Owner would like to lay at sea and wait for transfer gear and transfer ship and transfer on high seas.
		SUPSALV recommends owner ask CG to find safe haven for transfer.	
		CG looks for safe haven.	Master would like vessel towed to Hampton Roads, Va. dry dock.
		Owner: emergency cargo pumps on vessel not adequate for cargo transfer. Need additional emergency pumps (on way from Norfolk).	
2100	Ship afloat (AC-1- 2-1).	CG obtains permission from Wilmington, NC Marine Safety Office to use Frying Pan Bight as a safe haven for cargo transfer, provided LNG ship is kept at least 8 mi from shore.	
		Owner accepts safe haven arrangements.	CG looking for safe haven. Reentry of a crippled ship could be a matter of high-level political interest. The safe haven problem can also cause technical problems for the salvor.
		SUPSALV recommends discharging foreign tug. The other 3 can tow to safe haven.	
	END OF BRANCH		

TIME	SCENARIO EVENT	ACTION TAKEN	DISCUSSION
2000	Tow fails - ship still aground. Cargo must be transferred on site using emergency pumps (AC-2).	Master checking food, water, lifesaving gear; secure ship for 2 ½ days.	SUPSALV advising owner on salvage matters. Ship will have to wait 2 1/2 days for transfer ship.
	(AC-2-1).	SUPSALV recommends head ship into wind and ballast down good and heavy; divers to survey bottom in morning for this.	Owner's divers are on hand for survey.
		CG strike team had conducted survey which should be adequate for emergency purposes.	
		Master says he is already hard aground by the stern.	
		Owner keeping tugs on standby alongside.	
		Master recommends refloating ship by removing just enough cargo to refloat, then tow out.	Questions on ballasting/lightering: Where do you ballast? What are stresses, and can burned ship withstand additional stress? How much ballast? How much offloading to refloat?
		SUPSALV recommends lightering as follows: ballast ship; lighter enough cargo to refloat LNG deballasted ship; then deballast and refloat ship; Lawyers agree on security; agree not to object to U.S. court asserting jurisdiction.	
	END OF BRANCH		CG monitoring operations and bearing brunt of public inquiry; owner is in total charge of salvage.
2000	Foreign tug not on scene; SUPSALV advising CG; owner's salvor in charge; U.S. tugs (3) attempted tow by anchor chain. Cut chain to tow - anchor is on bottom near ship - could hole ship. Thrust of this branch: how to ballast (AC-2-1).	Owner says emergency ballasting can be accomplished by flooding spaces through upper sea chest; ballast valves can	
		(cont'd)	

TIME	SCENARIO EVENT	ACTION TAKEN	DISCUSSION
		be remotely operated hydraulically from on-deck locations (or by manually operated hand wheels); engine room flooding has made use of electric ballast pumps impossible; or divers can go into engine room and open ballast valves manually.	
		COTP wants to board strike team to survey damage and situation; sets up command post at Savannah Beach, opens channel partially, respecting security zone; all vessels to pass upwind of LNG.	Owner concerned that combination of ship hard aground and swell could further damage vessel, or even rupture other tanks.
		SUPSALV says weather determines how you ballast; in bad weather, flood wing tanks, not double bottom tanks.	
		CG and owner divers will dive together with owner approval. Salvor: have tugs keep tension to hold ship in place.	
2200	Master ballasting to ground ship hard - will take 7 hours. #5 double bottom tank flooded, #5 LNG tank leaking into wing tank. All forward of #5 appear in good shape are possible	Salvor: beach gear available. COTP: strike team has completed survey.	
		Owner says to flood #5 wing tank first, water pressure head will stop #5 leak.	
0600 (Sunday)	Container vessel requests to resume voyage.	Master says vessel has been ballasted in preparation for cargo transfer.	Next port is in U.S.
		Lawyer says surveyor is inspecting and interviewing on container ship prior to its sailing; keep P&I informed about salvage work and possible claims.	Still waiting for off-loading equipment; lightering vessel still 32 hours away; additional tugs for towing are 30 hours away; portable generators 12 hours away.
		Gov. complains to COTP about not being kept well informed.	COTP feels vessel is no threat to Georgia or Savannah but apologizes and will try to do better.

TIME	SCENARIO EVENT	ACTION TAKEN	DISCUSSION
0600 (cont'd)		PIO assigns man on staff to inform government and politicians on a regular basis.	PIO preparing for 0800 press conference.
		Lawyer suggests CG conduct immediate inquiry on board vessels before container vessel is allowed to sail.	
		COTP would delay container vessel departure; couldn't it wait until port?	
		Master protests an on-board inquiry would be great imposition on LNG crew; could interfere with salvage and lightering.	
		COTP makes compromise: statements will be obtained (one man at a time) from personnel on both boats before permission given to container vessel to sail.	
	Adjust scenario - lightering set-up equipment sent by truck, not tug (3 times as fast); this allows set-up prior to arrival of lightering vessel (AC-2-1-2).		U.S. salvage company representative assumes the role of P&I representati
0800			Although the owner has not relinquished responsibility and is in full charge of salvage, etc., the RRT is available to provide assistance as needed.
		COTP as OSC convenes RRT, first of daily planning and coordination meetings; salvor addresses meeting; describes arrival and deployment of gear; lightering scheduled for 1200 tomorrow (Monday)	
		Owner says 8 hours to hook up for ligher; 24-36 hours lightering; then deballast and tow to Norfolk.	Lightering will be accomplished with LNG ship's pumps; electric power for the pumps will be supplied by the transfer ship.

TIME	SCENARIO EVENT	ACTION TAKEN	DISCUSSION
0800 (cont'd)		COTP strike team says there is too much activity on ship, too many people; risk is too great. Owner removing extraneous crew; inert gas generator on way to degas after lightering; lightered to 36' draft; will moor ship bow to stern; tow to Norfolk will take 4 days; degassing operations will take a week; transfer vessel will discharge cargo in Savannah. SUPSALV recommends more complete underwater survey; conducted with owner-approval by strike team; results: 2 holes too big to patch at sea; 1 can be dewatered; 1 cannot.	
	END OF BRANCH		
0655 (Saturday)	Collision, as before; early player actions as before.		
0657	Ships locked together; fire at point of impact (AA-2-1), CV cargo on fire; finite flooding in LNG engine room because ships are locked together; however, LNG draft increasing; no casualties on LNG; CV has casualties in fo'c'sle and bridge; CV bridge wiped out; no communications; fire burns for 1 hour; CV crew abandon ship - assume no crew on CV for 4 hrs; crack in CV hull; both ships dead in water; LNG drifts aground at 0725.	Bridge contact CG; bridge cleared, LNG personnel seek safety. Master orders engineers to control flooding (pumps) as long as it's safe to do so; emergency squads handling class "A" fires; LNG allowed to burn; forward anchors set to try to forestall grounding; COTP notification, etc., actions as before; CG escort boat witnesses CV, assumes casualties and would rush boats and helicopters to the scene.	Focus is on technical problem of separating the ships. Can the ship fire safety area withstand a fire of this magnitude? LNG Master would not see CV casualties because his personnel would be waiting out fire in protected portion of ship.
0730	Fire on LNG, CV starboard; CV stern is clear; bow of LNG is clear; LNG cargo loss is steady, consumed by fire as it leaks out.	Master says LNG ship still has power, no LNG in engine room; will pull forward to break ships apart; clear engine room immediately following maneuvers.	Master wants to break ships apart because it would be better for the container vessel. Also, the large fire of short duration that would probably result from breaking the ships apart (cont'd)

TIME	SCENARIO EVENT	ACTION TAKEN	DISCUSSION
0730 (cont'd)			(total loss of #6 cargo tank) would be preferable to the potential hazard that would result from keeping the vessels locked together.
		COTP has reports from scene, SAR in progress (CG escort boat and helicopter).	Once ships part, LNG will move from controlled flooding to uncontrolled flooding.
		Master says could launch some starboard lifeboats to assist in SAR; also discharge non-essential crew.	Owner: LNG has made CV bow very brittle (cold). Ships will probably separate because CV bow may shear off.
			SAR assets at 0730: CG escort boats, some LNG lifeboats, helicopters.
			COTP: depending on type of container ship, crew could take refuge aft; does not think CV crew would necessarily have to abandon.
0800	Weather mildly unstable; Owner boat on scene (from terminal).	Master has shut down engine room; assumes ship will ground.	COTP: strike team and diver due late morning; pumps 1530, command post 1930.
	Ships breaking apart on their own accord - slowly, total loss of #6 cargo; fire for 10-12 mins; LNG on port side.		
	SAR over.		Game focus shifts to salvage
0900	Ships still loosely together. LNG fire out. CV cargo burning.	First national news report; owner tells captain to take tow line from tug, try to tow both ships to sea.	CV cargo is petroleum-based insecticide and volatile naval stores.
		Long-range objective is lightering, as before.	
		Master wants to keep CV fire from his vessel; tells COTP he is willing to assist in fire fighting; he is watering CV bow, has dry fire fighting chemicals, etc. LNG vent mast is flaring.	Only pump (emergency) is operating.

TIME	SCENARIO EVENT	ACTION TAKEN	DISCUSSION
0900 (cont'd)		COTP orders all tugs in area to scene; 25KHP on scene can pull ships slowly in calm sea.	
		Governor makes first statement volunteering state help.	
	CV Captain & Chief Engineer, 6 men total, still on board.	CV trying to fire up 1 boiler; some fire hoses on line.	
		COTP notes lube oil sheen on water; pollution incident, therefore, federal cleanup funds available, through owner will assume financial responsibility for cleanup.	
	LNG-45' aft, 28' forward (draft).	COTP would like ships towed to deeper water, then pull apart.	
		Master says LNG has 9 air packs, fire suits, etc.; able to fight any Class "A" fire; therefore, not worried about any hazard from CV except ignition of any subsequent LNG cargo leaks.	
		Master says major concern is to fight fire to protect LNG vessel.	
		COTP says CG officer has been landed on LNG as liaison with master; a COE barge with limited fire fighting capability could be towed out from Savannah to fight CV fire and to assist in marshalling resources.	
		RRT organized to assist as necessary.	
		NAVSALV locating assets, as before.	
1200	CV fire out, small fires being extinguished.	Master requests relief personnel from CG.	Men exhausted from fire-fighting.
		COTP recommended keeping vessels together pending further assessment (RRT recommendation).	CV repairs underway - 1 boiler on line; steering partially repaired; no big salvage.

TIME	SCENARIO EVENT	ACTION TAKEN	DISCUSSION
1200 (cont'd)		Master says once fires under control, he will start to prepare for lightering and tow; restore systems as feasible.	
		PIO media update: all fires almost out; tow will be attempted, with ships together, if necessary, it will be possible to separate ships with CV's power.	
		Media inquiry: how did it happen?	
		Master says tugs due 1600, personnel 2000, lighter-ship 0600; also ordered compressors, pumps, hoses.	
1230		RRT meeting recommends keeping ships together pending further assessment; owner wants to pull ships apart - willing to accept pollution and cleanup but not CV liability.	As long as owner acts responsibly, OSC will not intervene and owner is in charge; after intervention, owner faces criminal and civil liability for any actions not approved by OSC.
		RRT defers to owner; next question: when to separate ships? Before or after survey or tow?	
1400		SALV engineer says boats are locked because LNG is down at stern; to separate, lighten LNG or ballast CV to even out load.	
1600	Onset of salvage operations.	Tugs have arrived; towing expert is on board the LNG ship.	
		NAVSALV says CV will float after separation.	
		SALV engineer recommends blow water out of #6 tank with nitrogen gas (to the extent possible).	
		COTP says strike team has performed inspection underwater. O.K. for tow, although separation of ships expected within 15 mins of onset of tow.	

TIME	SCENARIO EVENT	ACTION TAKEN	DISCUSSION
1600 (cont'd)		Master wants to tow to 10 miles east of Savannah light. Anchor there for lightering; security zone will remain, etc.	
1730	Ships separate.	COTP will permit CV to proceed to port for repairs Master requires steam from tugs for forward vent mast heater, so that venting LNG will mix with atmosphere, not drop and flow over deck.	
0600 (Sunday)	Offloading vessel arrives.		
0800	Begin cargo transfer operations. (AC-2-1-2).	Master deploying equipment. Commence transfer operations around noon. Vapor and other systems are being run off the lightering ship. Lawyers preserving evidence. CV has petitioned for limitation of liability; this action is good for LNG because it requires CV to post security. Surveyor - two jobs: a) Survey for preliminary damage estimate. b) Estimate premium for insurance to cover	
		Transfer operations; salvor assisting with transfer equipment - hoses cables, etc.	Owner preplanning, including stockpiling of hoses cables etc. needed for salvage, has increased efficiency of incident response.
		SALV engineer looking at ballast and other problems associated with ocean tow after lightering.	
		Owner says transfer will take 24-30 hours. In event of bad weather, disconnect will be necessary.	

TIME	SCENARIO EVENT	ACTION TAKEN	DISCUSSION
		Salvor-survey during lightering - need before dry dock. Salvage engineer checks feasibility of patching hull before tow.	Transfer gear included anchors, buoys, fenders, 2 hoses, bolts, flanges, hose support system, winches; Ships have mounting gear for all of this.
0800 (Monday)	Transfer in progress (almost completed). Weather deteriorates.	Use tugs to reorient ships (bow to weather). Not bad enough to disconnect. Shut down transfer operations during maneuvers. COTP monitors tranfer for fire hazard, etc. Surveyor urges start preserving machinery from salt! Master in charge of transfer, setting up degas equipment, preparing for tow.	
	Post game comments		Since LNG owner was well prepared for response and never relinquished responsibility, CG did not assume primary reaponse role.

ROLE PLAYERS IN GAME SIMULATION

NAME	AFFILIATION	ROLE
J. Huntley Boyd, Jr.	U. S. Navy	Supervisor of Salvage, U. S. Navy
John W. Boylston	El Paso Marine Company	Ship Owner, LNG Tanker
Jerry Carlton	U. S. Coast Guard	Captain of the Port
George H. Chamblee	Chamblee, Dubus, and Sipple	Lawyer for LNG Ship
Andrew W. D'Angelo	Consultant	Salvage Engineer
Richard Griggs	U. S. Coast Guard	Public Information Officer
Leonard G. Goodwin	Moran Towing Company	Civilian Salvor
Harold Parker	El Paso Marine Company	Chief Engineer, LNG Tanker
James Stilwell	El Paso Marine Company	Ship Captain, LNG Tanker
Robert G. Walsh, Jr.	U. S. Salvage Association, Inc.	Surveyor

ASSESSOR/INFORMATION CENTER PARTICIPANTS

NAME	AFFILIATION	SUPPORTING ROLE
Joseph T. Arnett	El Paso Company	Local Politician Representation
John Clay	U. S. Coast Guard	Coast Guard Strike Team
Irwin Goodwin	National Research Council	Media (Civilian)
W. C. Hardy	Ketron, Inc.	Public Reaction
Colin Jones	U.S. Navy	Salvage Operations, U.S. Navy
Roger Madson	U.S. Coast Guard	Regional Response Team and Captain of the Port
Clarence C. Martin	U.S. Coast Guard	Media
Charles Odell	Consultant	Congressional Representative
Harry Otto	Delaware Department of Natural Resources	State Environmental Interests
Claude R. Thompson	U.S. Coast Guard	Port Operations

SECTION III

NAVY AMMUNITION SHIP/BULK SUGAR CARRIER COLLISION SAN FRANCISCO, CALIFORNIA

I. Background for Casualty and Response Scenario

A. Geography and Weather

1. Location - San Francisco Bay Area on lower Sacramento River near Crockett, California, 23.5 miles from San Francisco Ferry Building. Affected area, as shown on the chart (page 135), includes the counties of Contra Costa and Solano.

2. Population - Combined population of two counties is 758,000. Major cities within five-mile radius of incident are Vallejo, Benicia, Martinez, Crockett and Pinole. Population of these cities is 123,168. Various smaller incorporated cities are scattered throughout the area.

3. Transportation - Network includes major highways, railways, navigable waters, and local airports. The major highway arteries for these two counties are Interstates 80 and 680/780. These interstates provide the only two crossings over the Carquinez Strait and are the only connection of the two counties in the area of the incident. Various smaller highways interconnect the towns and cities of the immediate area. A major rail transportation system exists in the area. Amtrak railway system is located on the southern shore of the Carquinez Strait.

4. The weather is clear with scattered clouds at 30,000 feet; visibility, 20 miles. Winds are from 300° at 22 knots with gusts up to 28 knots. Temperature at 0700 is 54°F and rising. The forecast is for the same general situation, but warmer during the day.

5. Currents - Tuesday, 23 May 1978

Slack Water	Maximum Current		
Time:	Time:	Current:	
0421	0741	4.6 kts	Ebb
1129	1431	3.7 kts	Flood
1758	2015	2.5 kts	Ebb
2322	0218	2.6 kts	Flood

B. Waterborne Traffic

1. There is no major traffic in Carquinez Strait within five miles either direction of incident location (38°-05.6'N, 122°-13.3'W).

2. USS Mount Hood (AE-29), U.S. Navy ammunition ship (AE), is located 38°03.2'N 122°-17.1'W at 0745, course 070°T, speed 12 knots - maximum allowable speed for transporting ammunition. Ship in transit from sea to Port Chicago explosive dock. Ship in full-load condition with draft of 26'7 3/4". No pilot is on board. Cargo is standard AE configuration. Maximum speed is 24.3 knots. Intention of AE is to continue east to Port Chicago, passing under southern span of the Carquinez Strait bridge.

3. Sea Lord One, a Panamanian registered bulk sugar carrier-container ship is alongside berth at C&H Sugar Refinery at 0730. Ship draft is 19 ft. in light load condition; normal displacement is 15,000 tons. Bulk molasses and sugar cargo has been offloaded. The only cargo is 31,000 bbls fuel oil (Bunker C). Intentions are to clear pier and proceed to north side of Carquinez Strait and turn ship around.

4. U.S. Coast Guard 41 foot UTB is acting as escort for USS Mount Hood. At 0745 this UTB is on northern edge of Carquinez Strait.

C. Pre-arrival Notifications

State Office of Emergency Services has been alerted by U.S. Coast Guard that a U.S. Navy ammunition ship is in transit in the lower Sacramento River. No special precaution is in effect for ammunition transfer.

D. Environment in Area of Collision

1. Near the Carquinez Strait are the Carquinez Strait bridge, a small-boat marina, C and H Sugar factory, and the towns of Crockett and Valona (total population 9,000). The bridge is a two-span construction supported in the center by a cement structure. Each span is 998 feet long with vertical clearances of 146 feet at the north span and 134 feet at the south span. Various small craft and buildings are located at the marina.

2. The river has navigable waters adjacent to the northern and southern bridge abutments.

3. Union 76 oil refinery is located near Davis Point. As part of the refinery facilities, there is a pier used for offloading petroleum products. The pier extends into the river about 700 yards.

E. Events Prior to the Casualty

1. A small fishing boat with three people on board capsized at 0730 near the Carquinez Bridge. Three persons are hanging on to sides of overturned fishing boat, which is drifting westerly.

2. The bulk molasses carrier has been moored alongside the C&H Sugar Refinery pier 1800, 22 May 78, for the offloading of bulk molasses. The offloading was completed, and at 0745 the pilot and master agreed to clear the pier and proceed outbound for Oakland. The bulk molasses container ship carried a pilot but did not check with the U.S. Coast Guard vessel traffic system (VTS) because of radio transmission problems. This is not a mandatory requirement. The pilots normally do not check into VTS until near Davis Point due to poor radio communications in the Crockett area. No other ship traffic existed because the movement of ammunition prohibits shipping to pass ammunition ships in restricted waters. The intentions of the pilot were to clear the sugar refinery pier, move across the north channel of the river, turn in the strait and proceed west, and allow the ammunition ship to pass in the south channel. The ship would then proceed outbound to Oakland, Seventh Street terminal. The container ship commenced unberthing at 0745. The vessel traffic system did not detect this movement because radar coverage does not extend upriver to this position.

3. The U.S. Coast Guard 41 foot URB escorting the ammunition ship was committed to assisting a small craft that had foundered near the north shore of the river at Semple Point. The movement of the bulk molasses container ship was not detected by the 41 foot UTB.

4. As the container ship was moving from the berth and making a turn to starboard, all propulsion was lost and the ahead movement of the vessel slowed. Time

was 0758. The two vessels were approximately 600 yards apart at this time. The container ship proceeded to drop port anchor until its propulsion problems could be resolved. At this time the ammunition ship was in severely restricted waters and could not turn away to port or starboard to avoid the container ship. However, sufficient distance existed for the ammunition ship to pass between the container ship and the sugar factory pier. As the ammunition ship approached the container ship, the safe passage distance was reduced. Because of the strong ebb currents in this area, the container ship was abruptly swung to port into the oncoming path of the ammunition ship.

5. A collision occurs about 200 yards north of C&H sugar refinery, about 250 yards east of Carquinez Strait bridge.

Sequence of Events
(Refer to area chart for positions noted below.)

TIME	SEA LORD ONE	USS MOUNT HOOD
0745	Position A* C&H Pier, 2 tugs standing by.	Position A, 16 knots.** Rapid (bridge to bridge) communications between ships.
0748	Position B, in stream, one tug standing by, speed a/a 2/3 (turns for 10 kts).	Position B, 16 kts. No visual sighting of Sea Lord One, course 070°.
0751	Position C, in stream, commencing starboard turn, speed 10 kts. (turns for) one tug pushing bow to starboard.	Position C, 16 kts. No visual sighting (AE behind center of bridge). Course 090°.
0754	Position D, in stream, continuing starboard turn, tug cast off, speed 1/3, (turns for 5 kts).	Position D, 16 kts. No visual sighting. Course 090°.
0757	Position E, in stream, continuing starboard turn, speed 1/3.	Position E, 16 kts. Course 090°. Visual contact made.
0758	Lost propulsion, commence preparations to anchor with port anchor, advised AE of intentions.	Reduce speed to 12 kts. Course 090°.
0800	Position F, in stream, heading approximately 270, speed, all stop. Anchoring in progress. Current swinging ship stern to port.	Position F, speed all stop, rudder right standard.
0801	Same as above.	Commenced backing full, bow falling to starboard.
0805	Collision at heading 290°.	Position G, heading 120°.

* Normally bulk sugar carriers berth portside to sugar pier to facilitate unberthing on a flood tide. Sea Lord One berthed starboard side because of lack of familiarity with local region. Tides were ebbing when Sea Lord One berthed. Starboard side to was easiest and safest method without tugs. Offloading would be complete on ebb tide and this would also permit easier unberthing.

** 16 knot speed necessary to maintain 12 knot SOA against 4.6 ebb tide.

II. Post Collision Scenario Proposed for Game

A. Condition of Affected Ships

1. The collision occurred aft of the container ship's bow, port side. The initial impact parted the container ship's port anchor chain. The ammunition ship proceeded to hole the container ship's port side above and below the waterline with her port side. The ammunition ship was making a starboard turn to avoid the container ship. Because the container ship was without propulsion, it drifted with the ebb tide, under the bridge towards Davis Point. The ammunition ship continued to starboard and struck the sugar pier and was pushed by the current to a position beneath the bridge aground by the stern just east of the small boat marina. Ammunition ship had initial ground reaction (lost buoyancy) of 900 tons that increased due to flooding, heading 355°, draft 24′ aft, 30′ forward, 4′ down by the bow. The container ship grounded at 38°-3.4′N, 122°-15.2′W in 18′ water. Container ship initial ground reaction (lost buoyancy) 700 tons, heading 255°, draft 16′ forward, 22′ aft, 15° port list. Fires started on both vessels immediately after impact. Oil was being discharged from holed wing tanks on the container ship. The AE eventually sank by the bow in 49′ of water due to flooded number one cargo hold and flooded forward spaces.

B. Shipboard Actions Taken

1. USS Mount Hood sounded "collision at sea" just prior to collision. Condition ZEBRA set throughout the ship. Damage to port side bow is reported by damage control parties: Class A fires (combustible materials) were caused by electrical fires in boatswain storeroom, auxiliary radio room, carpenter shop, and forward emergency generator room. Sides were holed 2′ by 60′ at waterline in forward peak tank, chain locker, emergency generator room, and number one cargo hold (from frame 7 to frame 27). Immediate reaction of damage control parties was to try to bring fires under control. Flooding of number one cargo hold continued, aided by fire fighting efforts. Personnel injury: 5 deck seamen injured seriously on impact, moved to sick bay; no key personnel injured.

2. USS Mount Hood contacted San Francisco Port Control and U.S. Coast Guard and advised of collision, fire, and grounding.

3. Sea Lord One took immediate measure to combat list caused by flooding. Inspection revealed holes 1′ by 200′ from frame 20 to frame 100. Ship's crew commenced ballasting to starboard to compensate for port list. Class B (oil products) fires caused by Class A fire on ammunition ship are out of control port side, from bow to frame 200. Personnel injuries: slight burns to 4 seamen on bow, moved aft to safety; no key personnel injured.

4. U.S. Coast Guard 41′ UTB escort immediately informed Captain of the Port of collision incident via the vessel traffic communications system.

C. Coast Guard Responses

1. Following the report of the collision, the Captain of the Port immediately assumed on-scene command (OCS) of the incident. As OCS, the Captain of the Port will prohibit all river traffic, establish and man a command post onshore or onboard a vessel near the incident, notify local fire department, notify California Office of Emergency Services, notify all government agencies such as U.S. Navy Weapons Station Concord (includes explosive ordinance disposal), and U.S. Navy Shipyard Mare Island, etc., and will notify the U.S. Coast Guard Pacific Strike Team. Since both vessels have grounded, the most immediate concern is to extinguish all fires onboard the ships. The initial reaction of notifying the local fire department will cause all land-based resources in this particular response to be alerted and brought to the scene as needed. This is the responsibility of the local fire department of the town of Crockett. Contra Costa County Consolidated Fire Protection District will assist. The U.S. Coast Guard will notify all fire boats in the immediate area. Fireboats were sent to the scene from Naval Weapons Station Concord, Reserve Fleet Suisun Bay, Mare Island Naval Shipyard, Stockton City Fire Department, and Naval Communications Station, Stockton. The owners of the container ship and U.S. Navy Commander Service Group ONE and U.S. Navy Eleventh Naval District Representative were notified of the collision.

D. Traffic Control Situation

Bridge traffic in both directions was disrupted by the collision. Traffic was extremely heavy because of the rush hour and both lanes were immediately clogged. Bridge officials stopped all approaching cars and trucks prior to arriving at the bridge because of the fires.

E. Local Police and Fire Response

1. The California Office of Emergency Services (OES) responds by notifying all applicable agencies in accordance with existing emergency plan operating procedures for peacetime emergencies. For instance the OES, through its existing communications network, notified all local law enforcement agencies, county governments, city governments, and military explosive ordinance disposal units, and activated the Regional Response Team for reaction to the collision-related oil spill.

2. The local Crockett fire department assumed responsibility as the on-scene commander in charge of directing civilian fire fighting operations. The Crockett fire department notified all assets in the area, which included the fire departments from Rodeo, Vallejo, Martinez, and Pinole.

F. Logical Chain of Events - Game Simulation Comments for "Game Director"

1. Following the collision of the two vessels, the most apparent danger is explosion of cargo caused by fires onboard the USS Mount Hood. The most probable consequence if this occurs is heavy loss of life and property destruction (factory, bridge, ship, marina, houses, and buildings) in the nearby areas.

2. If the fires are extinguished onboard the USS Mount Hood and the ammunition explosion averted, then the next most apparent danger is the fire onboard the container ship. If the fire gets completely out of control, it could spread to the oil refinery at Davis Point. This could also cause widespread danger and destruction to the population and property through explosion and fire at the refinery.

3. Assuming that the fires are contained and extinguished onboard the container vessel, the next apparent step would be to contain the oil pollution

caused by loss of Bunker C fuel oil from the container ship. The Coast Guard Pacific Strike Team would oversee this operation and would monitor those companies who were contracted for cleanup operations.

4. The above sequence of events could be drastically changed if the original danger of fires cannot be contained. If an explosion occurs on the ammunition ship, then the problem of ship salvage would be eliminated. New problems of widespread fires, loss of life, and injury would probably occur. The river could be blocked by destruction of the bridge. The OES would make the decision to evacuate certain areas if necessary. The above situation would be compounded if the oil refinery exploded.

5. If the fires onboard the ships were extinguished, the possibility exists (because of holes in each ship) that each could sink prior to grounding. If this were to happen, the river would be partially blocked, oil pollution would probably increase, and the salvage problem would increase many times over.

6. Post-collision action to be taken:

   a. Coast Guard (COTP San Francisco) assumes role of on-scene commander and notifies the following agencies;

      1) California Office of Emergency Services: responsible for alerting all state agencies to react to emergency

      2) U.S. Army Corps of Engineers: responsible for maintaining a navigational capability of inland waterways

      3) U.S. Navy:

         Commander Service Group (COMSERVGRU ONE) - the administrative commander for ammunition

         Ship Commander Naval Surface Force Pacific Fleet - above COMSERVGRU ONE in Navy Administrative Command; responsible for the fleet salvage assets

Supervisor of Salvage - responsible for salvage under public law; technical advisor to Chief Naval Operations (CNO) for salvage matters

Eleventh Naval District Northern Representative, administrative support activity

4) U.S. Coast Guard Strike Team

5) Vessel Owners

b. Navy ammunition ship commences damage control procedures.

c. Bulk carrier commences fire fighting procedures.

d. Initial mobilization of emergency assets:

1) OSC - establish emergency operating center for coordinating afloat fire fighting and oil pollution efforts

2) OES - establish emergency operating center for coordinating ashore fire fighting units, emergency reserve units, and traffic control; establish state/region communications systems; alert all local emergency agencies, such as

Local Police California
California Highway Patrol
Contra Costa County Consolidated Fire Protection Department
Crockett Fire Department
Local Hospitals

3) Commence fire fighting efforts afloat and ashore

e. All concerned parties meet with OSC to establish plan of action and establish or shift responsibilities for salvage, oil pollution cleanup and cargo offload. In addition to the OSC, OES, Corps of Engineers, U.S. Navy, and

vessel owners, the following agents would be present:

Ships agent
P&I insurer representative
Hull underwriter's representative
Owner's attorney
Government attorney

f. At this time the decision must be made to determine who has responsibility for the salvage of the AE and bulk carrier. Since the ammunition ship is now blocking navigable waters, the responsibility for removal shifts to the U.S. Army Corps of Engineers. The bulk carrier is not blocking navigable waters but is a major oil polluter; therefore the U.S. Coast Guard is charged to ensure the removal of the oil pollutants and the salvage of the ship. Options for salvage of each vessel are:

1) U.S. Navy Surface Force Pacific Fleet - for salvage of AE.

2) U.S. Navy Supervisor of Salvage - for salvage of AE by using commercial salvage contractors.

3) Commercial salvage companies - for salvage of bulk carrier for owners.

4) If the owners abandon the vessel, the Coast Guard could request assistance from the Supervisor of Salvage to complete salvage of the vessel. For fleet or Supervisor of Salvage involvement, CNO would be involved. There would be a delay before fleet or SUPSALV would mobilize.

g. Coast Guard would oversee oil pollution cleanup efforts by the ship (bulk carrier) owners. The owners would contract local commercial oil pollution firms to complete operations. If beyond their capabilities or if response is too slow and pollution continues, then Coast Guard could take over the spill. The Regional Response Team is activated to bring all assets to bear on the pollution problem.

h. Bulk carrier salvage would be undertaken by commercial salvage companies for the ship's

owner and would require patching, dewatering, and retracting ship. There would probably be delays with owners, underwriters, and salvors regarding salvage contract.

i. The U.S. Navy would be responsible for the salvage of the ammunition ship. It would be the responsibility of the U.S. Naval Surface Force to respond with floating salvage assets. There would be a delay because of lack of assets in the San Francisco Bay area. Supervisor of Salvage, U.S. Navy, could also respond to AE salvage with local salvage contractors. CNO would decide salvage efforts. Plan for salvage would be to patch damage, dewater, and retract ship. Ammunition would be removed prior to salvage.

FLOW OF EVENTS OUTLINE

A. Collision
   1. Fires on Ships
   2. Flooding
   3. Grounding
   4. Sinking

B. Initial Mobilization of Emergency Actions
   1. OSC establishment - Captain of the Port
   2. OES establish emergency operating center
   3. Afloat fire fighting - Government agencies, San Francisco/Oakland Fire Department
   4. Ashore fire fighting - Crockett and Rodeo Districts, Contra Costa Consolidated Fire District
   5. Traffic rerouting - COTP, California Highway Patrol
   6. Communications setup
   7. Alert local authorities - Action by the OES and COTP

C. Plan of Action Meeting
   1. USCG - COTP
   2. U.S. Army Corps of Engineers
   3. U.S. Navy
   4. Vessel owners
   5. California OES
   6. USCG Strike Team
   7. Regional Response Team
   8. Ship's agents
   9. Underwriters
   10. Attorneys
   11. Action:
       Determine responsibilities for salvage, of ships, oil recovery, monitoring, etc.

D. Oil Pollution Operations
   1. Regional Response Team
   2. Commercial Pollution Contractor
   3. USCG Pacific Strike Team
   4. Actions:
       Helo overflight (continuous daily)
       Oil containment, deploy boom around
       Offload remaining oil
       Shoreline cleanup
       Oil slick cleanup

E. Bulk Carrier Salvage
   1. Ship's owners
   2. Underwriters
   3. Commercial salvage companies
   4. Actions:
      Survey internal and underwater damage, compute stability, ground reactions
      Repair damage, patch holes
      Rig dewatering equipment; rig retraction gear
      Dewater, retraction
      Tow to safe anchorage

F. Ammunition Ship Salvage
   1. U.S. Navy fleet salvors
   2. Supervisor of Salvage
   3. Actions:
      Offload ammunition
      Survey internal, underwater damage; compute stability, ground reaction; complete salvage plan
      Repair damage, patch holes
      Rig dewatering equipment; rig retraction gear
      Dewater, retraction
      Tow to safe anchorage

G. Demobilization of initial emergency assets
   1. Fire fighting
   2. Local police
   3. Traffic rerouting
   4. Hospitals stand down
   5. Disband emergency center

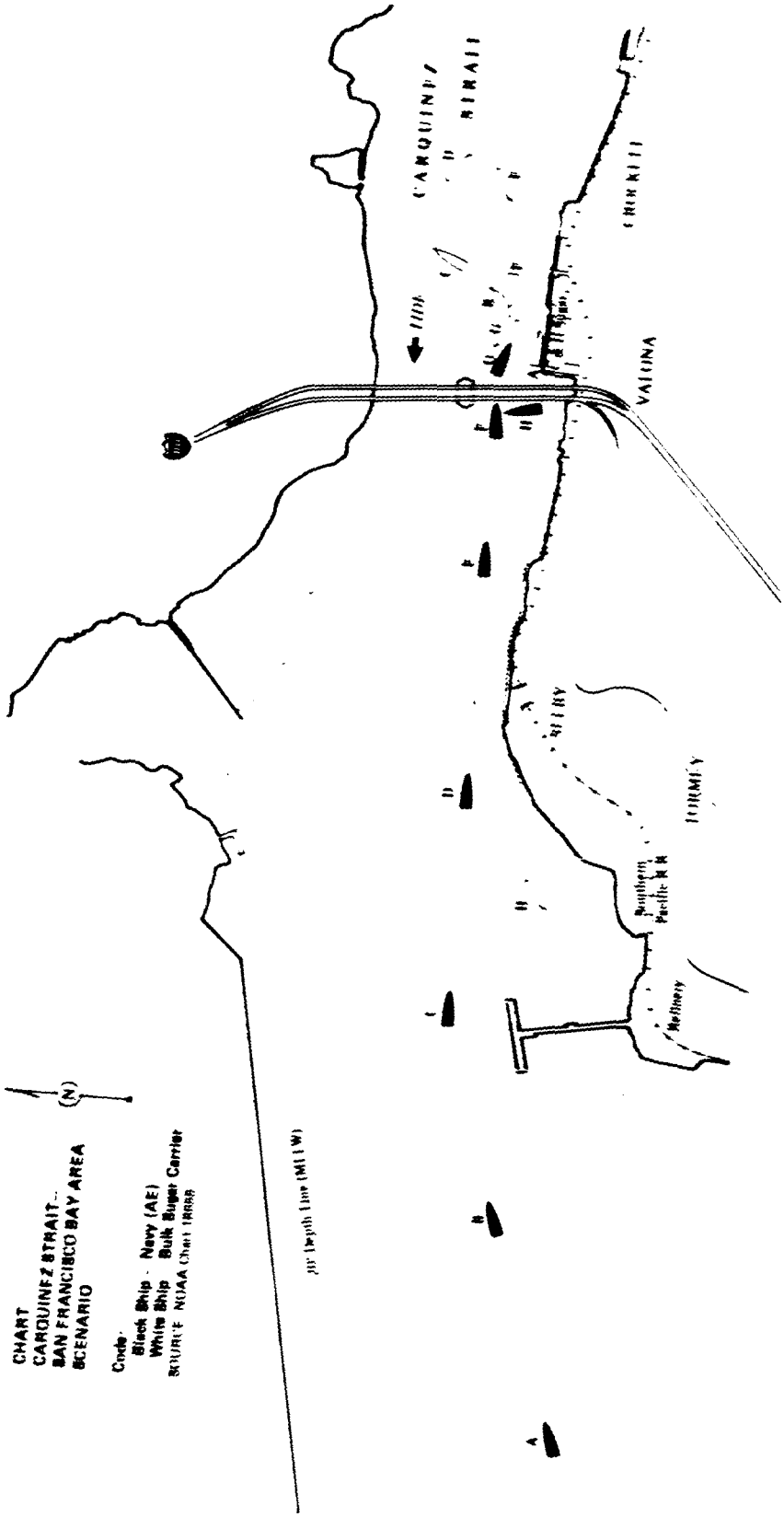
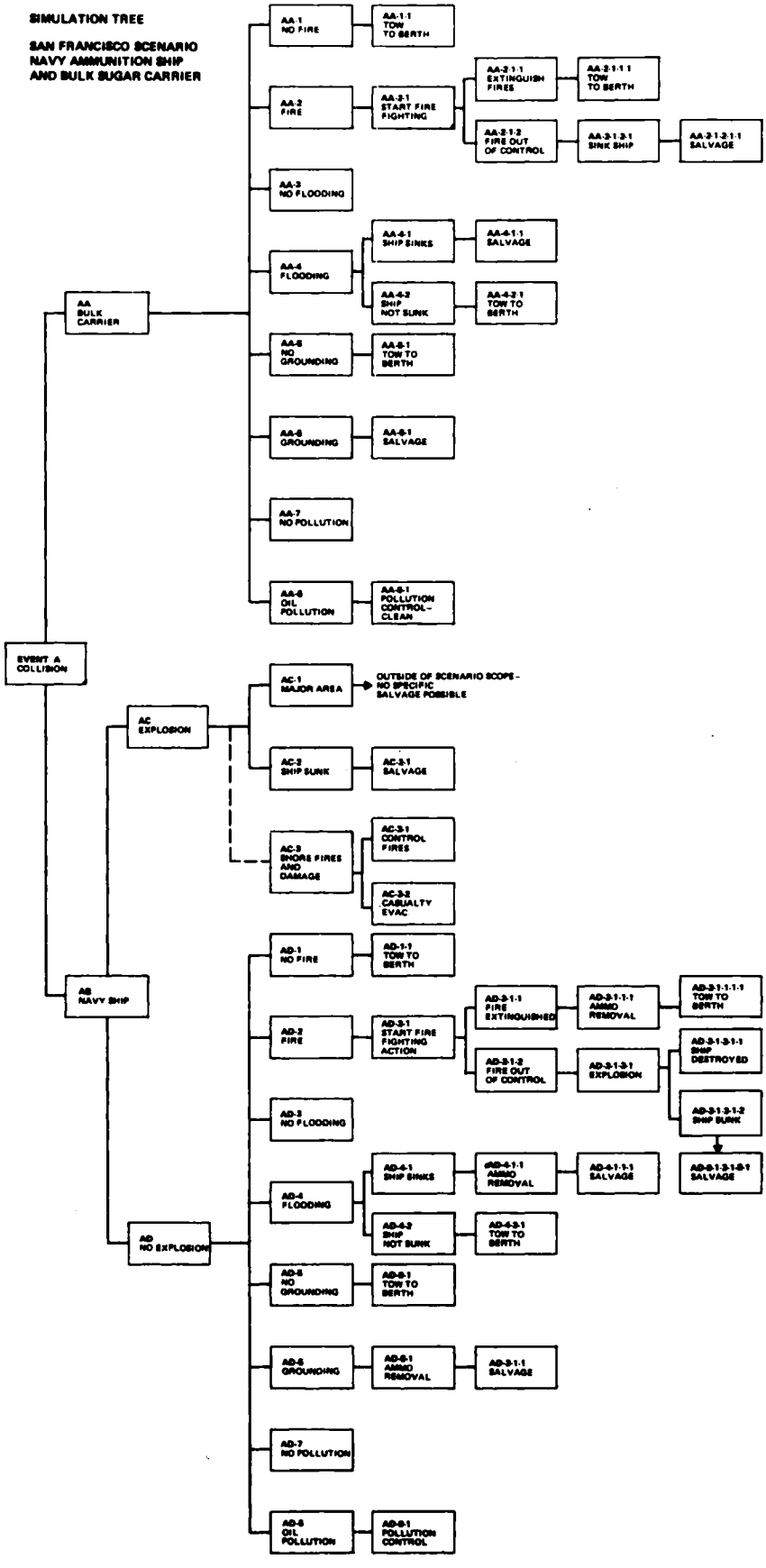


CHART
CARQUINEZ STRAIT-
SAN FRANCISCO BAY AREA
SCENARIO
Code:
Black Ship - Navy (AE)
White Ship Bulk Sugar Carrier
SOURCE: NOAA Chart 18652
(N)
CARQUINEZ
STRAIT
VALLEJO
MARE ISLAND
Southern Pacific R.R.
Refinery
Mean Low Water (MLW)


SIMULATION TREE
SAN FRANCISCO SCENARIO
NAVY AMMUNITION SHIP
AND BULK SUGAR CARRIER
EVENT A
COLLISION
AA
BULK
CARRIER
AA-1
NO FIRE
AA-1-1
TOW
TO BERTH
AA-2
FIRE
AA-2-1
START FIRE
FIGHTING
AA-2-1-1
EXTINGUISH
FIRES
AA-2-1-1-1
TOW
TO BERTH
AA-2-1-2
FIRE OUT
OF CONTROL
AA-2-1-2-1
SINK SHIP
AA-2-1-2-1-1
SALVAGE
AA-3
NO FLOODING
AA-4
FLOODING
AA-4-1
SHIP SINKS
AA-4-1-1
SALVAGE
AA-4-2
SHIP
NOT SUNK
AA-4-2-1
TOW TO
BERTH
AA-5
NO
GROUNDING
AA-5-1
TOW TO
BERTH
AA-6
GROUNDING
AA-6-1
SALVAGE
AA-7
NO POLLUTION
AA-8
OIL
POLLUTION
AA-8-1
POLLUTION
CONTROL -
CLEAN
AC
EXPLOSION
AC-1
MAJOR AREA
OUTSIDE OF SCENARIO SCOPE -
NO SPECIFIC
SALVAGE POSSIBLE
AC-2
SHIP SUNK
AC-2-1
SALVAGE
AC-3
SHORE FIRES
AND
DAMAGE
AC-3-1
CONTROL
FIRES
AC-3-2
CASUALTY
EVAC
AB
NAVY SHIP
AB-1
NO FIRE
AB-1-1
TOW TO
BERTH
AB-2
FIRE
AB-2-1
START FIRE
FIGHTING
ACTION
AB-2-1-1
FIRE
EXTINGUISHED
AB-2-1-1-1
AMMO
REMOVAL
AB-2-1-1-1-1
TOW TO
BERTH
AB-2-1-2
FIRE OUT
OF CONTROL
AB-2-1-2-1
EXPLOSION
AB-2-1-2-1-1
SHIP
DESTROYED
AB-2-1-2-1-2
SHIP SUNK
AB-3
NO FLOODING
AB-4
FLOODING
AB-4-1
SHIP SINKS
AB-4-1-1
AMMO
REMOVAL
AB-4-1-1-1
SALVAGE
AB-4-1-1-1-1
SALVAGE
AB-4-2
SHIP
NOT SUNK
AB-4-2-1
TOW TO
BERTH
AB
NO EXPLOSION
AB-5
NO
GROUNDING
AB-5-1
TOW TO
BERTH
AB-6
GROUNDING
AB-6-1
AMMO
REMOVAL
AB-2-1-1
SALVAGE
AB-7
NO POLLUTION
AB-8
OIL
POLLUTION
AB-8-1
POLLUTION
CONTROL

RECORD OF GAME: SAN FRANCISCO AE CARRIER AND BULK CARRIER

TIME	SCENARIO/EVENT	ACTION TAKEN	DISCUSSION
0800	Navy AE is inbound to Port Chicago with typical ammunition load. Foreign registered bulk molasses container ship (bulk) is outbound from C&H Sugar Refinery in Crockett. (See map.)		Coast Guard regulations prohibit passing an AE ship in restricted waters. Bulk carrier had not checked into the Vessel Traffic System (VTS), therefore, did not know of AE transit. CG did not know of AE transit and did not detect bulk movement because VTS radar does not extend to Carquinez Straits.
0805	Container ship is hit on port bow by AE(A)*; loses port anchor; holed portside forward; fire on port bow; (AA-2)* vessel drifting downstream; oil sheen appears (AA-8); vessel is empty of cargo but has full bunkers; four seamen injured on bow. AE - Class A fires near bow. Vessel down by bow; five injuries.	Bulk master radios CG; crew to fire stations; also calls Crockett Fire Dept. thru VTS radio. AE - Crew to general quarters; notifies Navy by radio. OPNAV Duty CAPT requests tugs and assistance from MARE Island and Concord; notifies district. COTP stops vessel traffic in area thru VTS radio; notifies State Office of Emergency Services (OES), Southern Pacific railroad; alerts strike team (1 1/2 hrs. to get a HQ van on scene); other notifications as in contingency plan. Helicopter assessment of the scene (begins 0815). Crockett Fire Dept. sees the incident. Alerts Rodeo FD after bulk drifts downstream. Bridge tender calls Calif. Hwy. Patrol. Sees smoke. CHP dispatches four units for crowd control. No HQ involvement at this time. Crocket FD calls CG to determine ship's contents. Assessing situation.	Any land-based fire fighting would be dependent on ship's contents.

*(Index number references simulation tree)

TIME	SCENARIO/EVENT	ACTION TAKEN	DISCUSSION
		CG - The fact that AE's cargo is explosive is on file with VTS. This information passed to OES.	Call to OES was to alert shore fire fighting assets. Shore-based units, however, have no means to fight ammo fire.
0810		CG activitates RRT. Requests public information assistance from District HQ.	In S.F. Bay, COTP Is OSC for RRT.
0815		Bulk master says damage control team checking, but no detailed info yet. Expect report by 0830. Ship believed to be holed and on fire.	CG helo assessment in progress; 41'-patrol boat en route from Mare Island (ETA 15 mins.); 32' boat with 500 gpm fire fighting pump due within the hour.
		AE - 1st damage reports in.	Why hasn't the AE CAPT flooded the ammo storage areas?
	AE - Class A fires (AD-2); 2'x60' hole at waterline; flooding; five personal injuries; the 3,000 tons of ammunition and 1,000 tons of explosives which are on board are not endangered by fire. No. 1 cargo hold is flooded.		
		CG contacting bulk ship agent for tugs; also requests any Navy help that can be made available in general, mobilizing CG forces and response teams. First public news broadcast.	
		Navy - Type commander also mobilizing, esp. salvor; one good Navy tug in area; others are one day's sail away.	
		CG - RQ Navy establish a liaison point.	Reply will come from district level, but liaison will be located at field level.
0830		Crockett FD wants to know if AE will explode. What should they do?	Expertise to answer appears limited, even in the Navy.
		CG responds "Yes, there is danger"; CG relays question to Navy.	
		CG strike team advises COTP of its assets, adapts pumps, etc.	

TIME	SCENARIO/EVENT	ACTION TAKEN	DISCUSSION
0830 (cont'd)		CHP command post established at Bridge Toll Plaza. Three CHP districts involved; although there's smoke, on the bridge CHP is still focused on traffic control.	CHP would obtain information on AE from fire dept. and would rely on FD for technical assessment of whether or not to close bridge; FD obtains its info from CG; CG from Navy. All of this notwithstanding, any CHP officer has the authority to close the bridge.
	AE - down by bow; fire out; no pollution. 39 1/2' of water, five injuries, 900 tons aground.		
	Bulk - port bow fire burning out of control adrift, with 12° list to port (AA-2-1); four injuries; anchor detail must be replaced before a tow line can be taken; oil loss from port side.	CG communicating with bulk via pilot's radio; has notified Union Oil to ready its fire apparatus.	Bulk master wants to drop starboard anchor when he's in a good place.
		FD knows bulk fire's out of control.	
		CG recommends to CHP that bridge be closed because of threat of AE explosion.	
		CHP closes bridge, but would reopen when AE fire definitely out and threat of explosion has passed; remains on-scene for crowd control.	Bridge closes only briefly.
		CG obtaining assets and organizing. Union Oil volunteers its fire equipment.	If ships had been at Union Oil Pier, CG would have ordered them to move.
		Atty (bulk) alerted by agent, who received CG call. He asks CG to relay his communications with vessel. Assembles his team-lawyer to CG HQ, alerts Commercial cleanup contractor, calls tugs, salvor, medical help, etc.	
		Atty deals with CG at COTP level.	
		CG pressing Atty for release of clean up responsibility, so CG can initiate response measures and bill owner (or whoever is at fault).	Unless the spiller was not acting promptly or correctly, the COTP would not act independently.

(cont'd)

TIME	SCENARIO/EVENT	ACTION TAKEN	DISCUSSION
0830 (cont'd)			to control the spill unless the owner voluntarily released his responsibilities in this regard.
		Navy - No local response assets; tide ebbing; AE is 900 tons aground with small oil leak: AE will require tugs for salvage; these are on way, with ETA in several days.	Often, the first step for cleanup is to secure such a release from the owner. In this instance, the CG urges the attorney to assume responsibility for cleanup and thus avoid additional costs that would be incurred by CG personnel; i.e., if the attorney assumes responsibility he pays only for the cleanup contractor. If he does not assume responsibility and the CG takes action, then the spiller would be liable for CG expenses in addition to cleanup contractor expenses.
		Bulk master not able to attend to injured; CG cutter will have to off-load bulk and AE injured; crew fighting fire; communications with CG easiest via pilot's radio.	Panamanian ship, Spanish officers, Taiwanese crew.
		CG Public Info Officer (PIO) will refer questions about the AE to the Navy. All information he furnishes about the Navy's involvement will be cross-checked with the Navy.	
0900		Rodeo FD notified Contra Costa (COCO) FD, which is the country coordinator. COCO notifies State Office of Emergency Services (OES).	OES coordinates state and local response to emergencies. OES also serves as fire and police interface with political forces. The OES role is apparently unique to California.
			CHP clarifies responsibilities for civil disturbance. Sheriff's office would be in charge of evacuation if one were ordered.

TIME	SCENARIO/EVENT	ACTION TAKEN	DISCUSSION
0900 (cont'd)			
		OES monitors radio communications for information. Informs governor. Officially notifies surrounding county governments; Asks CG if AE should explode, what's the primary blast radius, and should the area be evacuated?	
		Additional news report, echoing info supplied by CG; one wild fact: "Molasses fumes are volatile."	A lack of technical knowledge about hazards associated with molasses, as well as explosives.
		AE making arrangements to offload nonessential crew; 2400 bbl. oil leak from frame 24. Recommend to CG that primary blast radius (2 mi.) be evacuated.	
	Bulk damage assessment - hole 1'x 80', from 20' abaft the port bow to frame 100. The bow crew may have jumped overboard. Aground at bow. Leaking oil.	Bulk master says if fire worsens, he'll abandon ship; hasn't contacted agent yet to order oil booms, etc. No line attached by a tug yet. No fire fighting capability.	Bulk - no thoughts about spill cleanup yet; still too much other action.
		CHP will close shore highway to facilitate rendering assistance from the shore.	Marine firefighting: shoreside assets are not useful. CG & Navy are on their own; however, if ship were at a pier, FD's could provide assistance.
		CG - Two tugs from commercial salvor have been contracted for and will be on scene by 1000. Rescue boats assisted AE fires; 82' boat carrying fire fighting foam due 1000. Notice of discharge issued to bulk; small boats stand by to assist as necessary (evacuation,	
		State Fish & Game (SF&G) responds to oil spill.	

TIME	SCENARIO/EVENT	ACTION TAKEN	DISCUSSION
0900 (cont'd)			
0905		Atty (Bulk) assumes CG has initiated cleanup. Requests that CG continue to conduct cleanup because no one else on the scene is able to. Dispatches investigator; calls in surveyor experienced in oil containment and cleanup. In touch with salvor. CG - Rescue Coordination Center will coordinate helo of injured personel to hospital. Strike team advises COTP of diver assets, although limited by current in the straits. Also has pollution monitoring team available. Advises Atty (Bulk) they'll conduct containment and cleanup operations and will bill accordingly. COTP helos to command post (and overflies the scene). Located at Union dock. CG with eight people on switchboard, is at communications capacity. RQ aid from strike team. Navy has spill containment equipment in Stockton; tug in Oakland due 1000 422 on board; survey condition of explosives; will evacuate to 100 people on board; will use tug to maneuver parallel to shore; divers available; general message sent.	Atty has no interest in working at cross purposes with CG. The questions of liability and finances should be sorted out later. Don't let these issues impede operations. Also, telephone company assistance.

TIME	SCENARIO/EVENT	ACTION TAKEN	DISCUSSION
0905 (cont'd)		No imminent danger of explosion; much ammo is wet; recommend no evacuation at this time.	Recommendation to CG, which passes it to OES and local Sheriff.
		SHERIFF says (via phone) will act on Navy recommendation, not public pressure.	
		CHP has shore roadblocked; I-80 and bridge open; traffic control operations in effect; if roads are to be closed for a long time they would obtain wooden barricades from Transportation Dept.	Who determines this?
		FDs taking measures (short of evacuation) to protect life and property.	
		FDs set up command post overlooking closed shore road; suggest CG co-locate locate; OES there too.	CG command post is on Union dock.
		Atty (Bulk) talked to Navy lawyer; they will cooperate on information exchange, vessel survey, etc.	
	Bulk - wing tank explosion; 8,000 bbls of oil leaking out; fire still out of control; order abandon ship.	CG will assist bulk in abandoning, as necessary. Navy tug arrives to assist 32' boat in playing water on fire; no radio on bulk anymore.	CG says in the absence of adequate marine fire fighting capability, the only way to extinguish the fire is to use the assets of the burning ship. Abandon-ship action precludes this.
	AE - stable; flooded holds.	CG has PIO assistance at command post as well as HQ. National level assistance due this evening. COTP command post at Union dock is hampered by communications - more phones needed. Strike Team asks RRT to check possible explosive nature of molasses tanks.	

TIME	SCENARIO/EVENT	ACTION TAKEN	DISCUSSION
1000 (cont'd)		CG says spill is "major." Commercial spill cleanup company already has been activated. Four skimmers are now in the immediate area. FD checking shore for survivors of bulk as CG checks water. OES monitoring situation; without evacuation and shore fires, there has been no need for mutual aid. Their command post has moved to co-locate with CG Salvor hasn't been hired yet, but he's aware of the situation from his radio; he's already locating assets - tugs, cranes, oil lightering barges. Atty (Bulk) attaches a lawyer to CG command post; won't participate in any public press briefings; also, advises bulk master and crew not to give statements; press must obtain its info from CG and Navy. Navy requests bond from bulk carrier owner because of foreign flag ownership. Atty (Bulk) replies "ship's not going anywhere." Navy - COMSERVGRU I is in charge.	
1030	Bulk abandoned, burning. AE ammo secured; crew reduced.	CG - COTP convenes press conference. The Navy has contracted with a commercial organization that provides oil (cont'd)	Navy and Atty are only observing. Basic info: vessels on scene picked up all survivors; no imminent danger to shore areas or to oil refinery; bulk is 2 1/2 mi. downstream from bridge, 300 yards. offshore; oil containment equipment is being deployed prior to tide switch; 8,000 bbls (cont'd)

TIME	SCENARIO/EVENT	ACTION TAKEN	DISCUSSION
1030 (cont'd)		spill cleanup service. State F&G are gearing up to save oily wildfowl. Spill control costs are being paid by Contingency Fund. Eventually courts will determine liability and assign financial respondibility. The Carquinez Strait will be closed to shipping until the fire's out and the spill has been contained.	of oil have leaked so far. The bridge has suffered minimal smoke damage. The CG has initiated an investigation to determine the cause of the collision.
1400		Navy fleet tug has arrived, is monitoring attitude. Navy developing salvage plan: patch the AE, pump it, then employ beach gear and salvage vessels.	
		Atty (Bulk) discussing salvage with salvor and bulk capt.	
		CG - Firefighting making progress. Assets that could be required include: 32' boat, Navy tug, S.F. & Oakland fireboats, buoy tender; also RQ FAA designate controlled air space 1,000', 2 mi. radius. PIO making provisions for press inspections of scene about 1600. Strategy is to pur out fire, then attempt to pump oil from bulk's leaking tanks.	This represents the major marine fire fighting assets in the Bay area. Marine fires are not part of regional disaster plans.
		CHP's traffic control operations still in effect. They'll reopen the shore road after the bulk fire has been extinguished. Recommend that the railway be reopened.	
		FDs still in readiness. Will remain so until CG assures them that marine fires are out and won't reoccur.	
		OES - The public safety emergency is winding down, with the exception of oil spill operations.	

TIME	SCENARIO/EVENT	ACTION TAKEN	DISCUSSION
1500	AE putting out an anchor because he's so close to a bridge abutment (25 yards).		
	Bulk fire out (AA-2-1-2-1) (AA-6-1).	CG seeking technical advice re bulk; what is its stability? This will be critical in offloading and dewatering operations.	
		Atty (Bulk) meets with CG to discuss their oil offloading (and salvage) plans.	
		CG says bulk now is obstruction to navigation. Requests that Corps of Engineers so designate and mark. Anticipates oil on both sides of the strait. Asks Corps to run the spill thru their Bay Model to verify.	
1530		Begin oil transfer operations, moving oil from damaged and vulnerable tanks to stronger tanks. Containment strategy is to halt outflow, then concentrate on containment and cleanup.	
			CG says spill containment will take several days. Adequate assets in Bay Area. Prevent oil moving up river above Benicia (into Suisun Bay) at all costs. Minimize cost of operations so that responsible party can pay for cleanup.
1600		Bulk master will return to ship to assist CG as necessary.	
		Salvor retains salvage engineer to work with Navy.	
		AE recommends that bridge stay open and salvage begin. No immediate explosive threat. Ship aground its full length and appears stable.	

TIME	SCENARIO/EVENT	ACTION TAKEN	DISCUSSION
1600 (cont'd)		CG says bulk oil leak will be stopped (by offloading or leakage) by midnight. Therefore the strait can be reopened tomorrow, with a security zone around the wrecks.	
		Atty (Bulk) cables owner that bulk may be a constructive total loss (CTL). Owner should consult salvors, surveyors, hull, and P&I underwriters on this. He also advises CG of CTL possibility.	Surveyor's estimate of salvage cost is a key decision factor here. A CTL declaration involves possible conflict beteen the hull insurer (who would rather not have the vessel declared a CTL because that would require his paying full insured value to the owner), the P&I insurer (who would have to assume liabilities to third parties for wreck removal, etc. if vessel is abandoned), and the owner (who bases his decision on cost to him and market conditions for his ship). He will base his advice to owner on the best possible estimates as to possibility and cost of salvage, and the value of the vessel in damaged condition after salvage is completed.
		CG passes this information on to its lawyers and Corps of Engineers lawyers.	
		OES locating dump for oil debris.	
		Salvor working with a salvage engineer; will establish a bulk salvage plan and estimate cost.	
1700		CG - with fire out and threat to lives lessened, marine environmental protection becomes top priority. State F&G is setting up bird cleaning stations.	
		AE monitored to ensure stability. A salvage plan is being developed. A survey will be completed by late evening. Legal teams gearing up.	

TIME	SCENARIO/EVENT	ACTION TAKEN	DISCUSSION
1700 (cont'd)		Bulk master has a volunteer crew on board to assist in pumping operations.	
		Salvor says bulk survey (necessary for salvage plan) won't be feasible until the ship cools off. Survey should be underway by 1800.	
		CG to develop plans for further action. Will have plans ready for RRT meeting at 2000.	
		CG holds Press Conference (with Navy in attendance).	
		Navy says AE salvage could take as long as a month.	Navy intends to offload, and therefore recover, much cargo as it can prior to salvaging the vessel.
		CG says this was a freak incident. Pending conclusions of the investigation, there's no need to change procedures, etc.	
		OES - Governor has expressed interest in the incident.	
2000		RRT Planning Meeting, chaired by COTP.	RRT Planning Meeting: Atty says too early for owner's plan of action.
			CG - at a minimum, mark the wreck.
			Navy says MARE Is. Shipyar will build a patch for the AE. Salvage vessels will be sent from Pearl Harbor. Cargo will be offloaded prior to salvage. Offloading will take ten days salvage will take thirty days.
			CG will escort the explosives lightering operstions.
			Once wrecks are marked, channel will be usable.

TIME	SCENARIO/EVENT	ACTION TAKEN	DISCUSSION
2000 (cont'd)			Spill cleanup: The quicker the cleanup, the less the cost. Wardens and biologist will survey the marshes for birds. Fortunately no large bird populations are in the area at this season (May). Skimmers will transfer oil to barges for refinery delivery. Straw, etc. for shore cleanup will move via trucks to dumps. CHP will cooperate in managing this traffic. Atty, in consultation with owners and insurers, pending salvage and repair estimates, recommends that RRT proceed on the basis of "Prudent owner uninsured", i.e., without worrying about who's going to pay, take measures to preserve the situation for salvage or wreck removal. In other words, don't let the situation deteriorate through neglect. (Advice to owner)
2000 (cont'd)	(ref. AA-8-1) (ref. AD-2-1-1-1, AD-4-1-1-1, AD-6-1-1)	OES - Governor visited at 1800; he was distressed that the bridge wasn't shut when AE was on fire. Navy containment and cleanup (minor) handled by commerical salvor. CG contracts with three commercial organizations for bulk containment and cleanup. AE salvage plan is under development. Current thinking is to offload explosives (ten days' lightering); complete a survey; make mold, then a patch. By then the two salvage ships will have (Cont'd.)	CG satisfied with cooperation from bulk. Was OES or CHP ever told of dangerous cargo early in the incident? CG plan is to deploy and tend containment booms through the night. Coordination of efforts?

TIME	SCENARIO/EVENT	ACTION TAKEN	DISCUSSION
2000 (cont'd)		arrived. Dewatering pumping will start in about twenty days. The salvage ships will keep AE off the bridge as she refloats. Operations, safety zones, etc. will be coordinated with CG and OES.	
			What's involved in closing bridge and evacuation? a) 60,000 cars/day use bridge. b) Detour would add 45 mins. to major trucking routes. c) No sense in just closing bridge if town is also in the blast zone; also sugar refinery. d) Blast zone: one 2,000 lb. bomb will distribute fragments over 6,000'. However, if one goes, they're all likely to go. e) Political and "people management" considerations appear to dictate either rigorous, full evacuation, or very limited operation at just those times when big bombs are moved. f) A two-mile evacuation would be safe. Navy would have to demonstrate that a smaller area would do. g) Navy & CG should take a positive approach and present OES, etc. with alternatives.
		Surveyor's report on bulk ship condition: fire damaged the forward 200' of bulk; bulk aground from midships to bow; cargo areas and bulkheads damaged. Cost estimates due shortly.	

TIME	SCENARIO/EVENT	ACTION TAKEN	DISCUSSION
2000 (cont'd.)		CG initiating its investigation. At minimum, wants depositions from Navy.	Under most circumstances, Navy not required to participate in CG proceedings. The exception to this rule is certain hearings conducted by the NTSB.
		Salvor has worked up costs for bulk salvage. Patch - $75K materials and ten days time at $30K/day= $300K. Also, three days' pumping and towing. Therefore salvage cost is $400K-$500K exclusive of repair. Repair costs: $4M (twice the ship's worth).	
		Atty asks salvor whether he's working on no cure, no pay basis.	
		Salvor says because of notoriety, age of vessel, he'd work on per diem basis only.	
		Atty recommends to owner that bulk be declared a CTL. Assume that hull underwriter accepts and pays. It then becomes a matter of wreck removal which would be paid for by the P&I club who will wait to see who USCG decides is liable for the wreck. P&I reimburses owner.	
		CG - During investigation, owner should ensure that wreck is stabilized and provide watchman on board if feasible, etc.	CG - FWPCA Contingency Fund used to pay cleanup bills. Bulk's FWPCA bond is also at their disposal. CG speculates that P&I club will figure out that cleanup costs already exceed their liability, so they'll also pay promptly and be released of further obligation.
		Atty agrees. This protects against creation of more liability.	

TIME	SCENARIO/EVENT	ACTION TAKEN	DISCUSSION
			ATTY (for bulk owner) won't admit to an obligation to remove the wreck. Corps or CG will have to remove the wreck and bill the party found to be at fault. Wreck removal: Corps of Engineers has to face the fact that the bulk carrier has been abandoned and remove it. However, they wouldn't "accept abandonment" in the legal sense of accepting costs as well. COE would sue whoever is found liable for the wreck to recover costs. If the wreck contains oil or hazardous substances, FWPCA will cover costs of wreck removal. This would be done by CG.
	END OF BRANCH		

TIME	SCENARIO/EVENT	ACTION TAKEN	DISCUSSION
0800	Collision: bulk as before AE - significant fire. (AD-2)	Early actions as before contacts CG for info on ship fire. Learns of explosive content. Recommends to CHP that bridge be closed.	
0815		CHP closes Carquinez Bridge. AE - preliminary damage report: 60' hole on port bow; #1 cargo area flooded; ship is afloat but on fire.	
0830	Fires on AE cause explosion in #2 hold; several shells "cook off" and cause fires in Crockett, and at C&H sugar refinery; brush fires just W. of Straits; dock fire at marina just W. of bridge; still no major detonation.	CG helo overflight sees fires: Requests strike team and mobile HQ (as before). AE prepared to abandon ship. OES notified, and notifies governor; mobilizes fire assets; OES role: a coordinator of response forces. Assumes operating role only when an incident escalates beyond the capability of local government. CG closes in marine fire assest: 2 fireboart (ETA 1 1/2-2 hours), 10,000 gpm pump (close); 82' foam-equipped boat from Mare Island (1 1/2 hours). OES recommends to local government that evacuation be ordered of primary blast area (2 miles). AE flooding; 8 killed, 6 burned; 2/3 of crew ordered to abandon ship immediately. FDs under OES coordination and country direction; Crockett FD is fighting the marina fire and C&H Refinery (with county assets & coordination); Rodeo is fighting brush fires.	In addition to coordinating role, OES serves as staff to governor on "emergency" matters; also, regional offices maintain technical knowledge of disaster plans, etc. Evacuation decision is made by county government and effected by Sheriff's offic

TIME	SCENARIO/EVENT	ACTION TAKEN	DISCUSSION
0845 (Cont.)		RQ CG assistance in fighting dock fires from water. OES declares local emergency; working with county to start evacuation; however, still no county request for mutual aid.	
0900	Bulk aground, on fire near Davis Point (as before). AE aground & on fire 25 yds. from bridge. Fires coming under control.	CG - Navy tugs with fire fighting capability are on their way; (500-1,000 gpm); RQ. FAA establish restricted airspace. Will respond to shore fires (as requested by FDs with marine assets only after marine fires are under control & CG firefighting forces are at strength.	Duration of fires & fire fighting efforts shortened to keep game action moving. For example, fireboats would take longer than 2 hrs. to reach Crockett. A sugar refinery would probably burn for 3-5 days.
		FD assets - 10 units in area; 20 more units are on the way from other parts of the county. 10 rescue units on hand; add'l due shortly. 25 injured at C&H refinery. CHP - 55-60 units in area.	Provisions for marine/land fire coordination?
	Bulk communicating via pilot's radio.	Atty (bulk) Mobilizing as before; however, CG is too busy to assist. OES - wants to know if all the missiles hit the Contra Costa side.	
	C&H refinery explodes; 125 casualties; an entire fire unit is wiped out.		

TIME	SCENARIO/EVENT	ACTION TAKEN	DISCUSSION
0915		CG can made ADAPTS pumps available to FD's for filling fire trucks. Locating all available fire assets: 2 - 32' boats, 5 - 41' boats, 1 - 95', 1 - 180', 1 - 210'; trailer equipment; 6 - NAVY crash fire vehicles with 4000 lbs. CO_2; NAVY fire tugs; NAVY foam & pumps & trailer mounted boats to deploy; trucks & tugs from Treasure Is., 2 fire tugs from Marad reserve fleets; field hospital; all have same capability, all due by 1000; also queried Travis AFB about their firefighting capabilities AE - Fire almost out. Explosive Ordnance Detail (EOD) conducting survey to determine risk & hazard; 3400 T of explosives on board. Bulk master makes radio contact with agent. Fires - Marina fires out; C&H refinery fire 75% under control; brush fires now being handled by State crews - will be out in 20-40 mins. CG commands post established at Union Oil. All notifications completed and mobilizations underway (oil spill cleanup company, Fish & Game, etc.) CHP reports looting and confusion in Crockett, offers to assist sheriff with civil disturbance problems. Sheriff (via phone): Crockett will be evacuated until Navy says it's safe. OES, CG, CHP, etc., all co-locate command posts at Union pier.	Who coordinates all this equipment? Furthermore, is it randomly assembled, or balanced in some way to meet bay area fire needs (planning).

TIME	SCENARIO/EVENT	ACTION TAKEN	DISCUSSION
0930		CG - AE fire reported out; NAVY tugs will be directed to bulk fire; Gov. calls inquiring whether Nat'l. Guard is needed.	8 hrs. needed to mobilize. Their only conceivable role would be to secure an evacuation. OES says better to draw on public safety mutual aid than to use Nat'l. Guard.
	Bulk-fuel oil tank explodes; massive leak. Fire still out of control (AA-2-1-2) (AA-8-1).	Bulk master orders abandon ship. Fires - C&H fire out; 8 rescue units, 15 ambulances, 15 pumpers sent to assist State brush fire crew. ATTY (bulk) as before. Salvor as before. First detailed public newscast (CG input).	
1000		Spill response forces mobilizing; commercial salvor and oil spill cleanup companies; also, refinery is making containment equipment available. CG - intentions for bulk: put fire out; reboard; pump out leaking tanks to stop leak; AE - All crew evacuated except for 6 volunteers & 4 EOD. SERVGRU 1 is NAVY OSC. He'll recommend maintaining 2 mi. evacuation until he has further information. Bulk remains abandoned, 4 injuries. CHP - roads & bridge closed. 2 helos are available - offered to CG. Fires under control &/or out; injured on way to hospital. 15 fire pumps will remain in reserve. They concur with NAVY recommendation on evacuation.	
	(AC-3-1, AC-3-2).		

TIME	SCENARIO/EVENT	ACTION TAKEN	DISCUSSION
		OES wants to know from CG if state oil spill plan should be implemented.	
		Sheriff is evacuating 4,000 people: OES is coordinating assistance from CHP and FD, etc. Notification by air, etc.; buses to schools; aerial surveillance for enforcement; 3-4 hrs. to complete the operation.	CHP capability: upon RQ 150 officers can be on scene anywhere in Bay area within one hour.
		Fire - 2nd explosion at C&H refinery.	
		OES - Lt. Gov. is enroute. Natl. Guard on alert. County still hasn't requested mutual aid. Marine rescues under CG & Navy jurisdiction. On shore, sheriffs and FDs are handling. Emergency morgue has been established.	
1030		CG - Press conference; available info. assembled & presented. In sum, although all assets are deployed, there is no shortage of equipment.	
		CG is boarding bulk to set up pumps. Commercial salvor has located empty barges for offloading; ebb tide is sending oil into the bay.	
		Atty - team is at CG command post; salvor is engaged.	
		Salvor is nogotiating with Navy SUPSALV about acting as their civilian contractor.	
		Navy - EOD has reported that early explosions destroyed a large quantity of explosive weight. Recommend that civilian evacuation be reduced to 1 mile. EOD is flooding vulnerable magazines.	

TIME	SCENARIO/EVENT	ACTION TAKEN	DISCUSSION
		CHP - could have 400-500 officers on scene by afternoon. No need for Natl. Guard involvement.	
		OES - responding to political pressures to call out Natl. Guard even though they aren't needed. A one mile evacuation would require 50 public safety officers.	From mayor, county execs; their direct request to the Governor is a highly visible action.
		Fires - should be out by 1200 (FD estimate).	
		CG - bulk oil leak has slowed to a trickle. Bulk fire's under control; PIO team on the way from D.C. Corps of Engineers; model says spilled oil will ride flood tide up to Suisun Bay. CG will install a series of containment booms in the straits to prevent this. Deployment should be completed by 1600.	Prompt boom deployment is helped by the fact that the commercial oil cleanup company has a large warehouse of equipment nearby.
		AE - situation appears to be stabilizing.	
		CHP inspects bridge so that it can reopen as soon as the Navy gives the okay.	
1600	Demobilization and Salvage	CG - Ships' situations have stabilized. Light oil sheen E. of Benicia (mouth of Suisun Bay), but most of the oil has been contained by a series of three booms.	

TIME	SCENARIO/EVENT	ACTION TAKEN	DISCUSSION
	See note in Discussion column.	CHP - bridge still closed. AE - 100% aground, all holds flooded: no explosive danger, however, cargo has been subject to shock damage &. must be considered unstable. Recommend maintaining 1 mi. evacuation during cargo handling incident to salvage. CG - water safety zone established around AE, but strait reopened to traffic. Bulk master is ashore with Atty. Atty says damage survey is underway. Salvor - developing Navy salvage plan. AE cargo lightering will require 10 days @ 10-12 hours/day. Governor's concern: don't start offloading until you've investigated all the options.	NOTE: Subsequent to this point, AE gamers thought hold 3 & 4 remained unflooded: Hold: 1 damaged & flooded 2 flooded 3 undamaged & unflooded 4 undamaged & unflooded Evacuation requirement - decision would be forged by Governor in consultation with Navy. Level of risk will be key factor.
2 days later:			
1600		CG - spill cleanup proceeding well. Pressing bulk for decision on what to do with the ship. A NOAA support team has arrived to coorinate scientific aspects of spill response. Conducting investigation into causes of incident (run by CG Marine Safety Office). The Navy has declined to participate in CG proceedings until its own investigation has concluded. Also, Navy personnel won't be made available for CG depositions until Navy proceed-	

TIME	SCENARIO/EVENT	ACTION TAKEN	DISCUSSION
		ings have concluded (one week). CG intends to proceed with civilian aspects of hearing only; will reconvene for Navy's side of the story when Navy's available.	
		Atty & Navy JAG: property damages claims are rolling in.	
		Atty - pressuring Navy through CG for cooperation in CG proceedings.	
		CG - is bowing to pressure, hearings will be delayed until all parties can participate, unless one party wants to discharge their obligation to give depositions, etc., at an earlier time.	
		Navy JAG - Navy investigation is proceeding. Upon completion of NAVY investigation, NAVY will cooperate with other investigations. Reports and personnel will be made available.	Consequences of delay?
		CG - In addition to MSO investigation, a formal Marine Board of Inquiry will be convened.	
		Atty - Due to loss of life & seriousness of incident, the National Transportation Safety Board will be called in.	Navy personnel should be examined by the CG & cross-examined by Atty after conclusion of Navy inquiry.
		Atty - All proceedings can be used as discovery for a suit which may be filed against the Navy immediately.	CG hearings are discovery in nature; timeliness is important. Atty suit would circumvent Navy procedures to get at Navy evidence.
		Navy JAG - Navy is concerned with pinpointing cause of criminal liability to prevent other incidents. Their proceedings may or may not suit	

TIME	SCENARIO/EVENT	ACTION TAKEN	DISCUSSION
		other purposes. Under Uniform Code of Military Justice, those suspected of offenses have the right NOT to make statements in non-military proceedings.	
		Atty - proposes that Navy witness be made available to CG after they've testified but before proceedings have concluded.	Saves time.
	END BRANCH		

ROLE PLAYERS IN GAME SIMULATION

NAME	AFFILIATION	ROLE
Thomas E. Birdwell	Rodeo Fire Protection District	Local Fire District Representative
Robert A. Bornholdt	U. S. Navy	Type Commander
George H. Brown	U. S. Coast Guard	Public Information Officer
William D. Craig	California Maritime Academy	Bulk Carrier Master
Richard Kerri	California Highway Patrol	Highway Patrol
Robert M. McAllister	U. S. Coast Guard	Pacific Strike Team
Ernest Murdock	U. S. Coast Guard	Captain of the Port
Frank Ochinero	Crockett/Carquinez Fire Protection District	Local Fire District Representative
Graydon S. Staring	Lillick, McHose & Charles	Owner/Attorney for Bulk Carrier
Benjamin F. Strickland	Crowley Maritime Salvage, Inc.	Salvor

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Jerry Totten	Naval Sea Systems Command	Supervisor of Salvage, U. S. Navy
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ABBREVIATIONS

AE	Ammunition ship
Atty	Attorney
bbl	Barrel
Bulk	Cargo ship for containers and bulk (sugar) cargo
Capt	Captain
CG	Coast Guard
CHEMTREC	A chemical industry consortium whose purpose is to furnish information on handling hazardous substances
CHP	California Highway Patrol
COE	Corps of Engineers, U.S. Army
COTP	Captain of the Port (Coast Guard)
CTL	Constructive total loss, a term that means salvage and repair costs exceed the value of the vessel
CV	Container vessel (Savannah scenario)
D.C.	Washington, D.C.
DOJ	Department of Justice
EPA	Environmental Protection Agency
ETA	Estimated time of arrival
FAA	Federal Aviation Administration
FD	Fire department
F&G	Fish and game department, state
FWPCA	Federal Water Pollution Control Act
Gov	Governor
Helo	Helicopter
HP	Horsepower

HQ	Headquarters
JAG	Judge Advocate General (office), Navy
LDPS	Louisville Department of Public Safety
LNG	Liquid natural gas
MSO	Marine Safety Office, Coast Guard
NAVSALV	(See also SUPSALV) Office of Supervisor of Salvage, U.S. Navy
NG	National Guard
NH_3	Anhydrous ammonia
NTSB	National Transportation Safety Board
OES	Office of Emergency Services (State of California)
ORSANCO	Ohio River Valley Water Sanitation Commission
OSC	On-scene coordinator (of the Regional Response Team)
P&I CLUB	Property and indemnity insurance - fills in gaps in coverage, such as wreck removal required by law, spills, and pollution clean-up liability, salvage; P&I clubs are mutual associations of shipowners formed to provide P&I insurance.
PIO	Public Information Officer
QMED	Qualified member, engine and deck - an unlicensed rating for member of ships crew
Polln	Pollution (abbreviation)
RQ	Request (abbreviation)
RRT	Regional Response Team
SAR	Search and rescue
SF	San Francisco

SITREP	Situation Report
SUPSALV	Supervisor of Salvage, U.S. Navy
USN	U.S. Navy
VTS	Vessel traffic system

APPENDIX C

CONTRIBUTORS TO THE STUDY

A number of people other than those directly serving on the panel made valuable contributions to the study, especially in the preparation of the scenarios and the conduct of the game simulations. The panel gratefully acknowledges this assistance. Names and affiliations of these contributors are listed below:

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