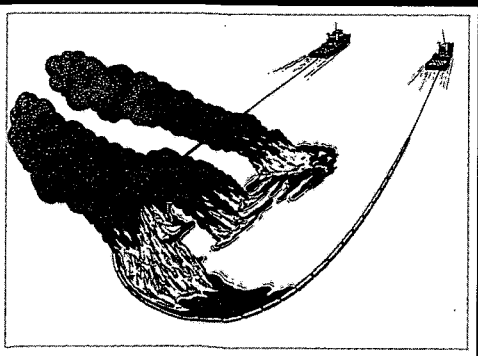
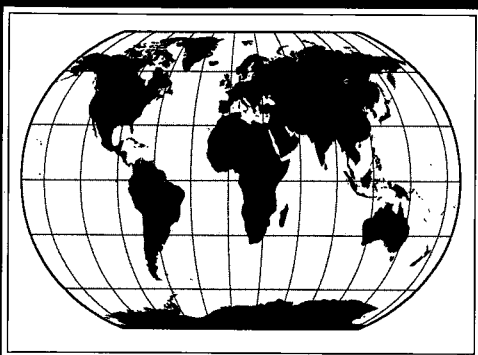


# IMPLEMENTING AN EFFECTIVE RESPONSE MANAGEMENT SYSTEM



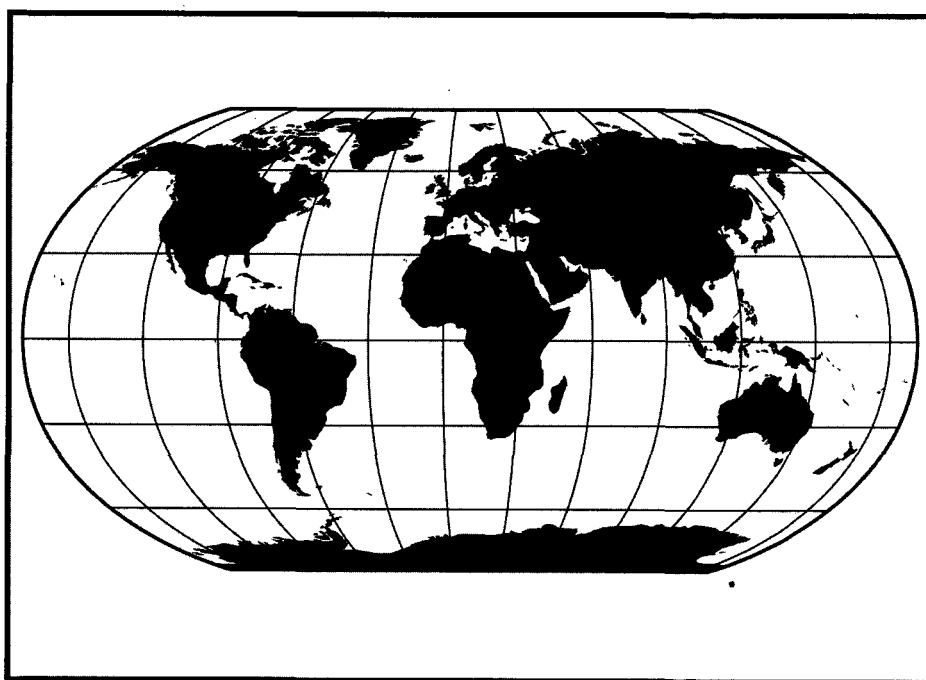
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# IMPLEMENTING AN EFFECTIVE RESPONSE MANAGEMENT SYSTEM



*A White Paper Prepared for the  
1995 International Oil Spill Conference*

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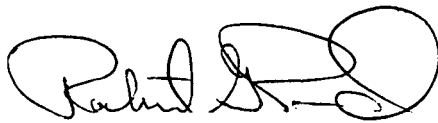
# PREFACE

The 1995 International Oil Spill Conference sponsors, American Petroleum Institute, U.S. Coast Guard, U.S. Environmental Protection Agency, International Maritime Organization, and International Petroleum Industry Environmental Conservation Association, commissioned three white papers to address issues of special importance to the oil spill community. They assigned the responsibility for general management and oversight, scope definition, peer review, and publication of the white papers to the Program Committee.

The goals of the white papers are to educate the spill community, to stimulate open discussion of complex and controversial issues, and balance the diverse positions of stakeholders. Each topic addresses varying scientific/technical and socio/political concerns. Therefore, each white paper differs as to depth of study and breadth of conclusions. The views and opinions presented are those of the authors solely and do not represent the views, opinions, or policies of the International Oil Spill Conference or its sponsors.

During the 1995 Conference, each white paper will be the topic of a special panel session. Separate publication of the white papers initiates the International Oil Spill Conference Technical Report Series. The Technical Reports are to be published in conjunction with the International Oil Spill Conference on a biennial basis.

It is the Program Committee's hope that each white paper will stimulate substantive discussion and serve as a catalyst for solutions.



Robert G. Pond  
*CDR, U.S. Coast Guard*  
*Chairman, Program Committee*



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# ABSTRACT

The challenge for oil spill response professionals is to develop a process during pre-spill planning that enables a responder to incorporate the positive aspects of both closed and open management systems. By building a system that has the potential for operational efficiency offered by closed systems and the adaptability of open systems, the capability to successfully manage the full range oil spill response operations can be developed. Developing and implementing an effective Response Management System is difficult due to the technological, political, economic and socio-cultural differences between organizations and nations. It can best be accomplished during the preparedness process by reaching detailed organizational agreements among members of the response community on how organizations will respond together, and then reinforcing and/or modifying those agreements at the outset of a response. This paper is intended to stimulate thoughtful discussion within the spill response community on how to better address these problems associated with managing response operations.

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# EXECUTIVE SUMMARY

Management of oil spill response operations throughout the world is the subject of continuing discussion, particularly in light of the high visibility of oil spills and evolving requirements for a unified command form of spill management resulting from the Oil Pollution Act of 1990. This paper considers response management systems (RMSs) in terms of theoretical research and the practical experience of response specialists. As used in this paper, **a response management system (RMS) is the combination of organizational structure, management processes, individual roles, and operational strategy employed during an oil spill response.** The focus of this paper is on the design and implementation of an RMS which brings together the organizational entities in spill response, that is, the overall system that connects the individual RMSs of responding organizations.

This paper is intended to stimulate thoughtful discussion within the spill response community on how to better address the problems associated with managing response operations. This paper:

- Reviews the background, including the historical perspective, of RMSs used for oil spill response;
- Presents a systems view of response management based on theoretical research and field studies in various crises and disasters, including oil spills;
- Identifies types of RMS applicable to oil spill response operations;
- Presents Critical Success Factors and system design requirements for effective RMS;
- Describes general types of RMS in use worldwide;
- Presents a view of future actions that could improve response management; and,
- Proposes unresolved issues in RMSs.

The general conclusion reached in this paper is that the types of RMSs comprise a continuum, with no system exhibiting characteristics of a single system type. Towards one end of the organizational spectrum is the open, problem solving system, characterized by a reliance on flexibility and improvisation by team members, decentralized or distributed decision making (often by *ad hoc* functional groups) and a high degree of both internal and external communication and feedback. These types of organizations have proven to be very adaptive, learning quickly and using a wide range of resources from both the internal and external environments. Such a system tends to lose effectiveness when the various components,

either individuals or groups, are “strangers,” that is, they do not work together regularly. In that case, the lack of common culture and shared goals can lead to dissolution and lack of purpose. The recent revision of the US National Contingency Plan calls for a system that is to operate in an open manner, one that integrates the organizations of the On-Scene Coordinator, state representative and responsible party into a single, highly interactive and purposeful organization.

Towards the other end of the continuum are closed types of RMSs, typical throughout the world and characterized by structured, hierarchical, command and control design. Closed systems work quite well in managing spills with little or no interaction with outside influences or organizations; usually these are routine spills, which comprise the majority of incidents. The success in these relatively controlled circumstances can be attributed to the emphasis on centralized decision making and direction of operations by a single person and execution of pre-spill planned actions. Closed systems tend to fall short of their ability to achieve success as perceived by external organizations, including the public. Closed systems have difficulty in the complex, highly turbulent environment of significant oil spills. The two typical weakness in the closed system design are the inability to adequately address the concerns of emergent groups and the inadequacy of feedback mechanisms to enable the organization to determine how the response as a whole is progressing, and to make the necessary adjustments. The closed system typically does not respond well when, as the significance of an operation increases, the organization must get not only bigger, but different — when the fundamental nature of the response changes.

The Incident Command System, which is being widely adapted for use as an RMS for oil spill response, is based on a closed system design but offers the potential to be implemented as an open type of system.

The challenge for government and private industry oil spill response professionals is to develop a process during pre-spill planning that enables a responder to incorporate the positive aspects of closed systems, with the ability of open systems to respond to the external influences that are predicted to emerge in a significant or catastrophic oil spill. This challenge is difficult, made more so by the technological, political, economic and socio-cultural differences between organizations, and the fact that oil spill planning and response activities are collateral duties in most organizations. However, by building a system that has the potential for operational efficiency offered

by closed systems and the adaptability of open type of systems, the capability to successfully manage the full range oil spill response operations can be developed. Developing and implementing an effective RMS, especially for significant events, is a sufficiently complex activity that can best be

accomplished during the preparedness process by reaching detailed organizational agreements among members of the response community on how organizations will respond together, and then reinforcing and/or modifying those agreements at the outset of a response.

## SECTION 1.0

# INTRODUCTION AND APPROACH

This paper examines organizational systems used to manage oil spills which affect navigable waters in the US and other countries. This paper describes current response management systems (RMSs) in terms of theoretical research findings and practical experience of response specialists as a way of exploring how to implement an effective RMS during oil spill preparedness and response.

### 1.1 PROJECT OBJECTIVES

Since the *Torrey Canyon* oil spill in 1967, governments and private entities throughout the world have become more aggressively involved in managing oil spill response operations. Many governments around the world have recognized a need for and value in cleaning up the after-effects created by accidental releases of oil into the environment. As governments have developed regulations and procedures to minimize the political, economic, socio-cultural and environmental impacts of spills, managing spill response has become more complex. Consequently, the issue of how oil spills should be managed to enhance the potential for success has become an issue of widespread interest and discussion.

This paper was commissioned by the five sponsors of the 1995 International Oil Spill Conference as a reference and discussion document to describe:

- The historical evolution of RMSs;
- The state of knowledge of RMSs, including the institutional approaches used for managing spill response operations throughout the world and the types of RMSs that are currently in use; and,
- Unresolved issues and a view of the future of spill RMS design and implementation.

In addressing these objectives, this effort examined and analyzed what the authors believe to be the critical factors influencing the design and effectiveness of oil pollution RMS. In doing so, it was also necessary to:

- Examine the applicability of academic research on organizational behavior during emergencies to the management of spill response operations; and
- Discuss the factors that influence RMS effectiveness during spill response operations.

### 1.2 RESPONSE MANAGEMENT SYSTEMS: DEFINITION AND CONTEXT

As used in this paper, **an RMS is the combination of organizational structure, management processes, indi-**

**vidual roles, and operational strategy employed during an oil spill response.** In this respect, almost every organization that responds to oil spills, whether government or industry, as a single entity or as part of a multi-entity organization, is using some form of RMS. However, not all RMSs are formalized to the same extent, i.e., written down and agreed upon by the internal and external entities which interact with that organization.

There are two basic types of organizational activities which occur in an RMS: the first is making decisions about what to do; the second is executing or implementing the decisions, including how to appropriately implement decisions. The issue of who makes the decisions regarding response activities is a key factor in the design and implementation of an RMS. Command levels of organizations are responsible for making the fundamental decision on objectives, priorities, and strategy which guide the overall management of the spill event. The execution of decisions is carried out by the functional portions of response organizations.

How decisions will be made and the identification of the entities having decision making authority is traditionally the right and function of government and is communicated through the laws, regulations, and policies for specific political units, e.g., national, regional, state, and local levels of government. The governments of many countries have established laws and regulations requiring the clean up of oil. Institutional requirements comprise the basis of policy, i.e., a high level overall plan that reflects the general goals and acceptable procedures of a governmental body.

Generally, the government policies which deal with oil spill response have addressed the roles of government and the private entity responsible for the event, known as the Responsible Party (RP). In some countries and under some circumstances, a single entity in government clearly has the decision making and operational responsibility for response, with the RP having a financial responsibility, i.e., paying for the cost of response. Singapore is an example of this institutional approach for response management (Garnett, pers. comm., 1994). In these situations, the RMS is fairly one dimensional; a single entity makes decisions and executes the response. In other countries, such as the US, the RP and other agencies also participate, along with government agencies, and have decision making and operational, as well as financial, roles. In these situations, the RMS becomes an approach used to unify the organizational structures, roles and responsibilities of the principal entities involved in the response.



Spitzer (1992) notes that the multiple organizations involved in spill response can be combined in three ways; they are listed in order of decreasing linkage:

- **Integrated** — One organization formed out of resources and components furnished by participating organizations. The individuals assigned are governed by the goals, objectives and rules of the integrated system.
- **Unified** — A single organizational structure formed through the mutual agreement of cooperating organizations. Individuals are governed by both the goals of the unified organization and the goals, objectives, and rules of their “home” organization, e.g., Spill of National Significance organization.
- **Coordinated** — Cooperating organizations maintain their independent identity, but cooperate to achieve mutual goals, e.g., pre-OPA 90 response organization, and the Federal response plan organization for natural disasters.

The principal entities who have responsibilities and actions during response are the national government (e.g., Federal government in the US); sub-national level(s) of government (e.g., state and/or local governments in the US); the RP; and the private contractors whose business function is the removal and cleanup of oil, i.e., oil spill removal organizations (OSROs).

Because oil spills are accidents, the above principal entities who respond to spills actually have two modes of operation: (1) normal, or steady state, used for day-to-day operations, and (2) emergency, used for oil spill response (and perhaps other types of emergencies). In the steady state mode, these entities make decisions and work independently of one another; in the emergency mode these organizations may make and execute decisions together, depending upon the government policies that determine how response will be conducted in a particular geographic area. The dilemma for developing an effective RMS is determining the optimal way for these organizations to be brought together to make and execute spill response decisions, when they normally operate independently of one another.

The focus of this paper is on the design and implementation of an RMS which brings together the organizational entities in spill response, that is, the overall system for inter-connecting the individual RMSs of responding organizations. To accomplish this, general organizational principals relevant to emergency management will be reviewed to provide a foundation for considering the overall, unifying RMS. Also, some existing systems will be reviewed to explore the commonalities and differences among their organizational relationships that would have to be resolved before a unifying system could be developed.

It is important to recognize that organizational diagrams are one of the most common tools used to describe a system. Yet these two-dimensional diagrams are an overly simplified way to describe a system that is multi-dimensional. Readers are reminded that the organizational diagrams displayed in this paper are being used to graphically represent only a portion, i.e., structure, of the overall system. Considering that organizational structure refers to formal patterns of authority, responsi-

bility, and communications organizational diagrams actually give only a limited view of organizational structure.

## 1.3 ORGANIZATION OF THIS REPORT

**Section 1: Introduction and Approach.** This section identifies the project objectives and defines RMS as used in this paper. This section also describes the potential utility of this document and the approach used in compiling this report.

**Section 2: Background.** This section lays the conceptual foundation and perspective for discussions of RMSs in the remainder of the report. It provides an overview of the RMS problem in spill response, and discusses the concepts of response goals, objectives, effectiveness and efficiency, and their relationships to implementing effective RMSs. This section also examines the historical evolution of RMSs used in managing oil spills. To relate theoretical research findings on post-disaster organizational behavior, this section also describes the relative significance of spills that response organizations are typically required to manage, and two central organizational concepts relevant to emergency management.

**Section 3: Systems View of Response Management.** This section discusses a systems view of response management. This section of the paper discusses the theoretical considerations for RMS design and implementation, and provides a model for the organizational environment that influences RMS design and implementation. Two basic types of RMSs are identified and discussed: open and closed systems. Section 3 also describes the conceptual components of RMSs and the theoretical factors which influence their development, design, implementation and adaptation during a spill response. Both theoretical research findings and opinions of responders are used as the basis for this discussion.

**Section 4: Current State of Knowledge.** This section begins with a discussion of the critical factors that must be accomplished for a spill to be managed successfully. This section contains a detailed discussion of current RMSs in use internationally and in the US.

**Section 5: View of the Future.** Based on the research conducted during this effort, this section discusses the trends in RMS that are likely to continue in the immediate future, and the implications for implementing effective RMSs. A summary of important points and concluding remarks are also presented.

**Section 6: Unresolved Issues.** This section identifies those RMS issues that warrant additional attention from oil spill professionals. These issues which need to be resolved before an effective RMS for oil spill response can be developed. This section also discusses organizational challenges which are likely to impede implementing a successful RMS.

**References and Bibliography.** These include all written and verbal references cited in this document. It excludes the sources of opinions described in the Appendix B.

The appendices contain detailed information which is referenced in the report, including a Glossary and the summary of responses obtained from oil spill professionals on their opinions for implementing effective RMSs.

## 1.4 USE OF THIS REPORT

This report has been developed to foster thoughtful discussions among the international and US response community on oil spill RMS issues to be considered during each country's preparedness process. Since it is based in part on the opinions of a wide range of oil spill professionals, the report is intended to facilitate this community discourse by discussing RMS issues that affect all responders. Given the theoretical research which has been integrated into this report, this document is intended to serve as a general reference document and conceptual foundation for understanding the design and implementation of effective RMSs.

In the US, this document may enhance the planning and preparedness efforts of the National Response System, particularly the Area Planning Committees, as well as vessel and facility response plan users. For the international readers, this report advances the organizational development trends which are predicted to occur during emergencies, including significant oil spills, by the theoretical researchers.

This report can also be used to provide feedback to the research community on those RMS issues that warrant further examination.

## 1.5 SCOPE AND LIMITATIONS

This paper considers the organizational systems that are in use worldwide to manage oil spills which can affect navigable waters. The primary focus is on those discharges affecting open ocean and coastal waters. The spills might originate from manned and unmanned tank vessels; commercial vessels carrying fuel in bunkers; facilities ashore which store, handle or use oil; transportation pipelines; or offshore platforms.

The scope and time available to conduct this project resulted in distinct limitations, specifically:

- The theoretical literature reviewed is broad but incomplete, and comes primarily from US sources. The sources for information on international response systems and government policies were the International Maritime Organization (IMO) and International Tanker Owners Pollution Federation (ITOPF). The ITOPF information was used without direct confirmation of the authors' interpretation of information from countries. However, since the information was used primarily as a classification mechanism for gross comparisons, this was not judged to be a significant shortcoming.
- The information is significantly more detailed in the area of marine oil spills. An effort was made to gather equivalent information, both in terms of quality and level of detail, on inland/freshwater spills and those that originate from facilities. However, the information was not readily available from existing sources and an extensive research effort was beyond the scope of this project.
- The information is more detailed for the US than for other countries. This is a distinctive aspect of this report since detailed information on other countries was not readily available from existing sources, other than ITOPF.
- The opinions solicited from the response community are

neither representative of all viewpoints, nor was this information gathered in a statistical manner. The collection method was informal, and would not meet the rigors of a peer-reviewed research methodology. The only new information generated during this project is that derived from the opinion solicitation.

## 1.6 APPROACH

The approach used to achieve the project objectives was to integrate the theoretical research in the area of organizational design for crisis management and disaster decision making, with the practical experience and personal observations of spill response professionals. The intent of this approach was to provide a well-reasoned basis for considering what constitutes an effective RMS and how RMSs can be designed and implemented. Specific steps included:

1. Define RMS.
2. Conduct a search of the theoretical literature, then compile and organize the research findings related to oil spill RMSs.
3. Obtain information on international and US RMSs, including various government, industry and responder systems.
4. Develop considerations for what constitutes an effective RMS.
5. Identify ways to enhance existing approaches to RMS to increase response effectiveness and success.
6. Identify issues which may limit effectiveness of RMS.
7. Describe existing RMS approaches.
8. Identify possible advantages of resolving RMS issues.

The principal types of information used to develop this report are existing literature sources and personal communication with oil spill response specialists and organizations.

## LITERATURE SEARCH

The theoretical research incorporated in this paper concerns the field of organizational development for emergency, crisis, and disaster response. The majority of this information was derived from refereed literature. The theoretical research was used as the basis for understanding how people and organizations behave during emergencies. This knowledge is based on accepted social science principles and field research, and encompasses such disciplines as human systems engineering and management, organizational behavior, decision sciences, political science and sociology, among others. Most of the research findings are based on extensive field studies of organizational performance during technological and natural emergencies over the last 25 years.

Both peer-reviewed literature and other publications, e.g., government documents and regulations, in-house reports and the Proceedings of the International Oil Spill Conferences from 1969 through 1993, were reviewed. The libraries of the paper authors and oil spill professionals contacted during the project were additional sources used in the literature search. The principal sources of information on international approaches to response management were publications of the IMO regula-

tions and agreements; ITOPF presentations and publications, including a draft of their Countries Summaries document; and one document from International Petroleum Industry Environmental Protection Council (IPIECA). Other sources included in-house documents of various industry and government agencies.

### OPINIONS OF RESPONSE SPECIALISTS AND ORGANIZATIONS

Although research provided valuable insight into organizational development and behavior, most of the theoretical researchers, with the exception of one of the authors who served as a United States Coast Guard (USCG) On-Scene Coordinator (OSC) have not actually had the responsibility for managing oil spills. The other two authors also have had actual management experience in oil spill responses — one served as a Scientific Support Coordinator (SSC) from 1980–1990, and the other was responsible for coordinating Dept. of Defense support on the Ashland and Exxon Valdez oil spills. The authors, therefore, believed that including the broad practical views and experience of oil spill response specialists and organizations would be of significant value to the community.

The views of oil spill response professionals and organizations were solicited during the project in two ways. First, teleconferences and face-to-face meetings were held with several individuals having in-depth and extensive oil spill response experience. Second, a questionnaire was distributed to a broad cross-section of response professionals to obtain their views on what constitutes effective response management and the variables that influence the effectiveness of an RMS.

To provide a diversity of experience and, hence, perspectives, a total of 51 questionnaires were distributed to a selected audience, as depicted in Table 1, with the types of experience listed below:

- USCG and US Environmental Protection Agency (EPA) representatives;
- Federal On-Scene Coordinators;
- State oil spill response representatives;
- Representatives of potential RPs, both large and small, operating vessels and facilities internationally and in the US in coastal and inland environments;
- Technical Advisors, both international and US; and
- Response contractors.

The questionnaire was designed to solicit open ended comments, rather than a choice of limited responses, with the hope that the observations would more adequately reflect the respondents' experience and judgment. While compiling and analyzing the responses proved to be somewhat subjective, this method was generally successful in obtaining an insightful look at the perspective of experienced spill response professionals. Although it is not a statistically verifiable survey, the results reflect, nonetheless, the reasoned thinking of experienced response professionals from a variety of backgrounds.

A total of 34 individuals responded. Table 1 also depicts the number of response for each type of perspective that was solicited. Appendix A includes a sample questionnaire and a list of individuals to whom the form was sent. Appendix B contains a summary of respondents' comments. Some of the opinions received are explicitly discussed in Section 2.3; other opinions are woven into the overall fabric of this paper.

TABLE 1. SUMMARY OF SURVEY RESPONSES

| Background of Questionnaire Recipient | Number of Questionnaires Distributed | Number of Completed Questionnaires Received |
|---------------------------------------|--------------------------------------|---------------------------------------------|
| Potential RP (Coastal vessels)        | 2                                    | 2                                           |
| Potential RP (Inland vessels)         | 2                                    | 2                                           |
| Potential RP (Coastal facilities)     | 3                                    | 0                                           |
| Potential RP (Vessel/facility)        | 5                                    | 5                                           |
| Potential RP (International vessels)  | 4                                    | 3                                           |
| Potential RP (Pipeline)               | 1                                    | 0                                           |
| Potential RP (Utility)                | 1                                    | 0                                           |
| Potential RP (Technical advisor)      | 4                                    | 3                                           |
| US Coast Guard                        | 6                                    | 6                                           |
| Environmental Protection Agency       | 7                                    | 3                                           |
| State representative—Gulf Coast       | 2                                    | 1                                           |
| State representative—East Coast       | 3                                    | 2                                           |
| State representative—West Coast       | 2                                    | 2                                           |
| Response contractor                   | 8                                    | 5                                           |
| <b>TOTAL</b>                          | <b>50</b>                            |                                             |

## SECTION 2.0

# BACKGROUND

This section provides a background and context for the remainder of this paper by exploring the philosophical rationale that underlies spill response, as well as the evolution of some RMS models for spill response. This section also begins to develop the relationship between the theoretical literature, which will be explored in detail in Section 4, and current thinking about oil spill response.

## 2.1 OVERVIEW OF THE OIL SPILL RESPONSE PROBLEM

The *Exxon Valdez* oil spill in Alaska on March 24, 1989 focused the attention of the world on marine oil pollution and ushered in a new era in oil spill planning and response, not only in the United States, but in the international community as well. The *Exxon Valdez* spill and others, such as the *Mega Borg*, *World Prodigy*, *Presidente Rivera*, and *American Trader*, reinforced US public opinion that oil spills are unacceptable, and led the US Congress to pass the Oil Pollution Act of 1990 (OPA 90). This law requires, among other things, the submission of response plans by owners and operators of vessels and facilities which could discharge oil into the navigable waters of the US. Government and industry leaders alike attest that one of the most critical components of these response plans is that they must describe the corporate organizational structure and the spill management team that will be used to manage response actions (US Coast Guard, 1993a, §154.1045 [for facilities] and US Coast Guard, 1993b, §155.1035 [manned vessels carrying oil as primary cargo], US Coast Guard, 1993b, §155.1040 [unmanned tank barges carrying oil as primary cargo] and US Coast Guard, 1993b, §155.1045 [vessels carrying oil as secondary cargo]).

While the US attention has focused on OPA 90 and its requirements, the international community also has reacted to minimize the effects of catastrophic discharges of oil into sensitive environmental areas. In October 1989 the IMO, working through its Marine Environment Protection Committee (MEPC), began two initiatives which would later become agreements intended to enhance international response capabilities. MEPC sponsored a series of conferences which led to the adoption on November 30, 1990 of the International Convention on Oil Pollution Preparedness, Response, and Cooperation, 1990 (OPRC). This Convention provides a framework for international cooperation in combating major oil pollution events. Principal activities under the OPRC Convention are conducting

specific preparedness activities in cooperation with the oil and shipping entities, and establishing a national system within signatory countries for responding promptly and effectively to oil pollution incidents (IMO, 1991). In addition, MEPC also began preparation of guidelines for the development of shipboard oil pollution emergency plans for oil tankers of 150 gross tonnage and above, and every other ship of 450 gross tonnage and above. These guidelines, approved on March 6, 1992 with the passage of resolution MEPC.54(32), are now incorporated into MARPOL 73/78 as Regulation 26 to Annex I. MARPOL 73/78 is the legal instrument for making shipboard emergency plans a mandatory prerequisite for receiving an International Oil Pollution Prevention (IOPP) Certificate (IMO, 1992). New vessels were required to have plans by April 15, 1994, and existing vessels by April 15, 1995.

The reasons for conducting spill response operations may be complex and dynamic, involving statutory requirements, economic impacts, public perception, company image, criminal and civil penalties and environmental concerns. However, the authors accept IMO's fundamental rationale, reflected in the OPRC, that industry and governments are "conscious of the need to preserve the human environment in general and the marine environment in particular" and that they "recognize the serious threat posed to the marine environment by oil pollution incidents involving ships, offshore units, sea ports and oil handling facilities." It is this social dimension to both the impact of the spill and the conduct of the response that leads the authors to suggest that consideration of social science theory and research may provide a more inclusive approach to the question "What can the response community do to implement an effective management system which will support the overall goals and objectives of the response?"

The rationale for taking action to manage the effects of marine oil spills is the belief that doing something better is preferred to just doing something or doing nothing at all. There appears to be widespread concurrence that it is possible to act in ways that will positively change the outcome of a spill response — changes that would not occur if no actions were taken. It should be noted, however, that in some limited cases, doing nothing can be better for the environment than other options, such as aggressive actions to remove oil from some types of shoreline. Nevertheless, the overriding goal in response is to rapidly intervene in the natural course of events following an oil spill to reduce the adverse effects that would otherwise occur if no actions were taken, or if actions were taken too late to be of any net benefit.

When an oil spill occurs, a response organization must be mobilized to direct response operations, address public and government concerns and provide accurate, timely information to the public. The organization must be operating effectively within a very short period of time at a location determined by the spill event (Harrald *et al.*, 1992). The rationale for a rapid mobilization of resources is defined by Lindstedt-Siva (1992) in describing three windows of opportunity when human intervention can make a significant difference in the environmental outcome of a spill:

- **Very early** — Responders can “attack” the oil to contain, collect and remove it while it is concentrated near the source of the discharge;
- **Early** — Responders deploy resources to protect environmentally sensitive areas; and
- **Later** — Responders can use ecologically sound methods to clean up shorelines or other impacted areas.

In addition to taking immediate action to mitigate adverse effects, there is a general assumption on the part of government oversight agencies and the public that all post-spill actions will be managed effectively to ensure that they are appropriate and effective. The common term “managing the response” implies that the decisions are being made in a way that enables the organization to achieve pre-determined operational and social goals and that activities are being directed with a reasonable degree of skill. Yet, the environmental effects of oil spills are influenced by many variables, such as the type and quantity of oil spilled, prevailing weather conditions, location of the spill, time of year, availability of the proper equipment, among others, over which even the most responsive and qualified managers have no control.

As the principal strategy for reducing adverse effects, a primary emphasis in spill response in the US, since 1966 when the Oil Pollution Act of 1924 was amended, has been removal of spilled oil from the environment. Yet removing oil as quickly and effectively as possible in order to reduce the overall adverse effects is challenging, both in those countries that require the use of mechanical equipment as the primary response strategy, as well as those, such as Great Britain, that rely on dispersants as the first line of defense for oil spills (US Congress, 1990).

No organization, even with the best resources available, can recover the majority of oil from open water once it has spilled. Mielke (1990) notes — and the history of spill response operations substantiates — that it is unusual for more than 10% to 15% of the oil to be recovered from a large spill. It is widely accepted that the effectiveness of oil booms and skimmers are significantly constrained by sea, wind, and current conditions. Use of newer technologies, specifically dispersants and *in situ* burning, remain the subject of discussion related to the window of opportunity for use, effectiveness on various types of oil, impact of use in highly sensitive areas, seasonality, government approval, pre-use testing and post-application monitoring, toxicity relative to the undispersed oil, and availability of adequate logistical support. In short, attempts to recover large quantities of oil after a significant spill have been likened to

trying to pick up mercury from a broken thermometer with one's fingertips (McCall, pers. comm., 1994), or emptying a very large swimming pool with eyedroppers (Ott *et al.*, 1993) — except that picking up mercury or emptying the pool with eyedroppers is easier. Two important realities reflected in this paper are that: (1) nature is uncontrollable and (2) technology limitations tend to hinder the ability of responding organizations to succeed in removing spilled oil from the environment. These two realities are acknowledged and not explored further in this paper. The effect of these realities on spill response activities is unpredictable; sometimes spill conditions are fortuitous, as when prevailing winds carry spilled oil away from shore, and sometimes spill conditions are unfortunate as when prevailing winds carry oil toward shore. Yet, organizations still persevere under the belief that taking action is better than no action.

All responders aim for an effective response but there is a public perception that few of the well-known responses to major or significant spills have been successful. The *Exxon Valdez* may be the premier example in the US public's memory of an oil spill response that did not go well. On the other hand, the *American Trader* spill which occurred in California in 1990 is an example of a response that is widely viewed as having been successful (Card *et al.*, 1991; Rolan and Cameron, 1991). If history demonstrates, and the entire response community accepts, that removing all spilled oil from the environment is unrealistic, then what are the goals and objectives of spill response? This paper is optimistic; it presumes that implementing an effective RMS can improve the ability of spill responders to succeed.

## 2.2 GOALS AND OBJECTIVES OF OIL SPILL RESPONSE OPERATIONS

The response community, those involved in or affected by an oil spill, is comprised of multiple private and public groups, as well as individuals. For purposes of this paper, the primary components of the response community whose goals and objectives must be satisfied to achieve a successful response are the government, the RP, and the public.

### RESPONSE GOALS

Goals are the **articulation of what is considered important**, and they are likely to vary with different groups. What is considered important to one group may not be the same to another, even within the same country or city. One of the characteristics of all disaster or crisis response operations, including oil spills, is that multiple groups of people, all of whom have something at stake but who do not know each other well or at all, are involved in responding. The goals of responding entities may be shared (agreed upon among all groups), conflicting (agreed upon in some areas but mutually exclusive in some other, or potentially all, areas), or unique (having no common elements) (USCG Marine Safety School, 1994). Understanding that this spectrum of goals exists for each element involved in the response enhances the probability that the organization as a whole can function effectively



and increases the potential for achieving a successful response. Yet the existing literature suggests that for any organization to succeed in responding to an oil spill, clear and meaningful strategic goals must be established (USCG Marine Safety School, 1994). It follows that **shared goals** would be a prerequisite for a unified or integrated RMS, comprised of multiple, diverse organizations, to execute a successful response. The theoretical literature supports this premise; one of the characteristics of high performing systems, i.e., ones that succeed, is clarity of purpose (Vaill, 1982).

The previous discussion suggests that some spill response goals, such as mitigating adverse effects on the environment or protecting human life and safety, are fundamental. Thus, they do not change from event to event; they can be identified during preparedness activities as part of a contingency or response planning process. Some of the most obvious sources of goal definition are the laws, regulations and agreements (such as OPA 90 and the OPRC), which provide the regulatory framework for response activities. If a country has established a set of national goals, then the minimum goals of every responding element must conform. For example, the US establishes its goals as the National Response Priorities in the National Oil and Hazardous Substances Pollution Contingency Plan (called the National Contingency Plan (NCP)) (US EPA, 1994a, §300.317). All response operations in the US must be conducted with the following three goals of the federal government, in priority order, clearly in mind.

1. Safety of human life;
2. Stabilizing the situation to preclude the event from worsening; and
3. Use of all necessary containment and removal tactics in a coordinated manner to ensure a timely, effective response that minimizes adverse impact to the environment.

Although individual principal components of the response community may have goals which may be the same or different from those articulated in laws and regulations, agreement on goals is fundamental to managing a spill response. Therefore, RMSs must be centered upon overall goals which do not change from spill to spill, such as those in laws or regulations.

### EVENT-SPECIFIC OBJECTIVES

The agreement upon event-specific strategic objectives, which we will call **event objectives** should provide the basis for all response activities, including deployment and use of resources. The event objectives should aim to achieve the overall fundamental goals while taking into account the nature and details of the particular spill. The absence of well-defined event objectives from the outset of a response could result in: the lack of clear priorities and tactical objectives; misdirected organizational focus; confusion in deployment of resources; internal dissent as divergent groups work to meet their own, rather than the common, objectives; and a perception of failure within the responding organizations and by the public. The agreement on initial event-specific objectives as soon as possible during the emergency phase of a response is essential, even though some objectives may change and others may

be added as the long range requirements for response become clearer.

**Operational objectives** implement the event objectives. They provide the foundation necessary for the preparation of **action plans**, which specify the detailed tactics for operational level activities. These four elements — shared goals, event (strategic) objectives, operational (tactical) objectives and action plans — form a hierarchical framework for translating the highest level policy decisions into supporting actions “on the water” or “on the ground.” The following example illustrates this decision making and implementation framework.

|                                         |                                                                                                                                                                                                                                                                                                                                                                                                          |
|-----------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Goal</b>                             | Use all necessary containment and removal tactics in a coordinated manner to ensure a timely, effective response that minimizes adverse impact to the environment. (Third National Response Priority from the US NCP.)                                                                                                                                                                                   |
| <b>Event (strategic) Objective</b>      | Protect all sensitive environmental areas listed in the Area Contingency Plan.                                                                                                                                                                                                                                                                                                                           |
| <b>Operational (tactical) Objective</b> | Boom the marsh on the south side of the entrance to Smith Creek no later than 6 hours prior to projected landfall.                                                                                                                                                                                                                                                                                       |
| <b>Action Plan</b>                      | Have Jones Response Company boom the area south of the entrance to Smith Creek using 18” harbor boom and boom anchoring kits. Anchor the boom north of the boat landing and south of the bend near the old fishing pier. Make sure one boom tending boat in the area is assigned to maintain the boom. Use sorbent pads and a vacuum truck at the boat landing to remove oil if it gets inside the boom. |

### EFFECTIVENESS VERSUS EFFICIENCY

A central issue to considering how to implement an effective RMS is understanding how “effective” can be defined. The authors offer the following definitions to distinguish between effectiveness and efficiency. Both concepts reflect value judgments that are related to response goals and objectives.

Response **effectiveness** relates to the accomplishment of response objectives — **doing the right things** (or getting the right things done) — such as:

1. Conducting the response safely, without injuries or deaths;
2. Preventing further spillage of oil;
3. Maximizing the recovery of oil;
4. Minimizing the environmental impact of the spill; and
5. Ensuring the media and the public perceive the response as effective.

Response **efficiency** relates to the ability to use resources appropriately — **doing the right things correctly** (or getting the right things done with the right amount of resources) — including:

1. Mobilizing and using only the type and number of resources appropriate for the spill;

2. Attaining the sustained maximum output from available resources;
3. Keeping the scale of the response effort in proportion to the size of the spill and the threat of environmental damage; and
4. Drawing a balance between the cost of damage mitigation and the damage that might otherwise occur (Gilbert, 1983).

Oil spill response organizations are under intense pressure to be both **effective** and **efficient**. The pressure for effectiveness appears to come from those external to the oil transport community, such as government agencies, elected officials, the public and public interest groups, media and environmental groups, while the pressure for efficiency comes from within, including oil company management, stockholders, Prevention and Indemnity (P&I) clubs and other insurers. This context leads one to reason that responding both effectively and efficiently will increase the probability for the spill response to be perceived as successful. The findings of researchers will be used to further explore this premise in subsequent sections.

## 2.3 PRACTICAL VIEWS ON RESPONSE MANAGEMENT SYSTEMS

Successful response to an oil spill is a mixture of real and perceived accomplishment of goals and objectives. In part to access what experienced government and industry response managers think constitutes a successful response, and to determine if there was any agreement among them, questionnaires were sent to 51 individuals in the spill response community (see Appendices A and B).

An interesting observation from this solicitation of viewpoints was that the perception of success or effectiveness of a spill response was not necessarily linked to the objectives. A review and comparison of questionnaire responses illustrates this point. First, consider the following top ten responses to the question "What is a successful response?"

TABLE 2. INDICATORS OF A SUCCESSFUL SPILL RESPONSE

| Response                                                                                     | Number | Percentage |
|----------------------------------------------------------------------------------------------|--------|------------|
| Damage to the environment is minimized                                                       | 18     | 53         |
| The public and media perceive success and are satisfied with the response                    | 14     | 41         |
| The spread of oil is minimized                                                               | 10     | 29         |
| The response occurred in an expeditious manner                                               | 10     | 29         |
| The government, Responsible Party and other involved parties are satisfied with the response | 8      | 24         |
| The maximum amount of oil possible is removed                                                | 8      | 24         |
| There is multi-party synergism                                                               | 6      | 18         |
| There are no fatalities or injuries                                                          | 5      | 15         |
| Costs are controlled                                                                         | 4      | 12         |

Note: **Percentage** indicates the percentage of the 34 respondents who gave that particular answer.

Next consider the top nine responses to the question "What are the legitimate objectives of response activities?"

A comparison of responses to the two questions reveals an inconsistency between the answers. Of those responding, 71% said prevention or minimization of environmental damage is a legitimate objective of a spill response operation, while only 53% of the same group said it is an indicator of success. At

TABLE 3. OBJECTIVES OF SPILL RESPONSES

| Response                                                                                      | Number | Percentage |
|-----------------------------------------------------------------------------------------------|--------|------------|
| Prevent or minimize environmental damage                                                      | 24     | 71         |
| Remove the oil effectively and with proper techniques limiting human impact on the activities | 14     | 41         |
| Safety and protection of human health and property                                            | 13     | 38         |
| Control the source                                                                            | 6      | 18         |
| Control costs                                                                                 | 6      | 18         |
| Create a "team" approach to solve problems and work with the government and local communities | 6      | 18         |
| Get the message and facts to the public and create a positive image                           | 3      | 9          |
| Leave the environment in a position to recover on its own within a short period of time       | 2      | 6          |
| Establish a command and control environment                                                   | 2      | 6          |

Note: **Percentage** indicates the percentage of the 34 respondents who gave that particular answer.

the other end of the scale, only 9% said creating a positive public image was an objective, but 41% said it was an indicator of success.

Why is there a discrepancy in the two indicators? One might expect a one-to-one correlation — that the number of respondents who indicated that a function was both an Objective and an Indicator of Success would be the same. Yet, these data suggest that while 24 individuals (71% of the respondents) said "minimizing environmental damage" is an Objective, only 18 (53% of the respondents) think it is an Indicator of Success (Table 4). If an action is not required for success, why make it an Objective — in short, why do it at all? Similarly, if 14 individuals (41% of the respondents) believe that good public affairs, in one form or another, is a prerequisite for success, why did only 3 (9%) list it as an objective? The effect of this inconsistency, i.e., when the responders' objectives do not address what they believe is required for success, on response management, is an issue worth pondering. In such an ambivalent environment, how can response managers provide event objectives, operational objectives, guidance, focus and direction to the overall effort?

TABLE 4. COMPARISON OF SURVEY RESPONSES

| Response                                                                                      | Indicator of Success | "Legitimate" Objective |
|-----------------------------------------------------------------------------------------------|----------------------|------------------------|
| Prevent or minimize environmental damage                                                      | 53                   | 71                     |
| Remove the oil effectively and with proper techniques                                         | 24                   | 41                     |
| Safety and protection of human health and property                                            | 15                   | 38                     |
| Control the source                                                                            | 29                   | 18                     |
| Create a "team" approach to solve problems and work with the government and local communities | 18                   | 18                     |
| Get the message and facts to the public and create a positive image                           | 44                   | 9                      |

Note: Numbers in column headed **Success** and **Objective** are the percentages of the 34 respondents who gave that particular answer.

Another noteworthy result from the questionnaires is that only 19% of the respondents agreed that developing some form of team approach to response management was both an Objective and Indicator of Success. Considering this low percentage, the implications for those who develop and evaluate RMs appear to be that a minority of respondents believe that a team-based form of response management will lead to a successful response.

One of the questions, from the questionnaire, concerned the relationship between an effective response and a successful response. Approximately 79% of the respondents indicated that the two concepts are different; an effective response is defined in operational and technical terms while a successful response is defined in terms of more subjective and political

issues. The common theme expressed was that a response could be effective, given the circumstances of the spill, but still might not be considered successful by the media or the public.

Just 15% of respondents indicated that the concepts are the same; both effectiveness and success are needed to satisfy the RP and the public. One individual specifically stated that they are not different because in a command and control environment, the response organization knows exactly what is being done, by whom and where; that the organization uses this information to monitor, and therefore achieve, effectiveness in the response operation. This is a significant answer because it reflects a widely held presumption that command and control management environments are conducive to achieving an effective response.

The next section explores how different types of RMS models evolved, including the command and control model.

## 2.4 HISTORICAL PERSPECTIVE

As a means of understanding the rationale behind the current RMSs used for oil spill response, it is enlightening to examine the roots of the present organizational systems for response to understand how management of oil spills has evolved in recent times.

### EVOLUTION OF OIL SPILL RESPONSE

The *Torrey Canyon* spill off the coast of Great Britain on March 3, 1967 is frequently viewed as the catalyst that initiated modern governmental planning and response activities for marine oil spills. Certainly there were other oil spills prior to the *Torrey Canyon*, such as the loss of 2 million gallons of crude oil from the tanker *Thomas W. Lawson* off Sicily in 1907 (Biglane, 1969), but this 860,000 bbl marine spill of Kuwait crude oil received worldwide attention and prompted many countries to begin looking at oil spills as a specific regulatory issue, primarily because it was a catastrophic release of oil relatively close to shore that caused international and significant environmental impacts. The OSC for the *Torrey Canyon*, Capt. Mike Garnett (retired) who was a Royal Navy junior officer at the time, emphatically noted that there was no management system in place for the *Torrey Canyon* (Garnett, pers. comm., 1994).

The US began formally developing a federal plan as a direct result of the *Torrey Canyon* incident. A Presidential memorandum dated 26 May 1967 directed the Secretaries of the Interior and Transportation to conduct a joint study on how best to mobilize the resources of the federal government and the nation to prevent disasters involving major spillage of oil. The President's directive stated that a required action was development of contingency plans to deal with these emergencies (Charter, 1971). Consequently, the first edition of the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) was issued in September, 1968. In fact, the opening of this NCP stated, "The development of a national awareness and concern over the hazards and damages to water related resources from oil pollution can be traced in large part

to the sinking of the tanker, *Torrey Canyon*." This first NCP defined the management framework for oil spill response in the US.

### EVOLUTION OF RESPONSE MANAGEMENT SYSTEMS

When considering the evolution of RMSs is it useful to consider all oil spills as a type of emergency. Given this context, a brief review of the RMSs used during emergency response, as well as oil spill-specific RMSs, is warranted. There are three trends in the historical evolution of RMSs that are related to oil spills: the command and control or "military" model; the response system prescribed by the US National Contingency Plan which we call the US model for oil spill response; and the Incident Command System (ICS). This section presents the history and description of these three models for oil spill response management.

#### MILITARY (COMMAND AND CONTROL) MODEL

The dominant civilian emergency management model has been described by Dynes (1990) as the "military model." This formal, centralized command and control structure and process of the World War II military was imported into the emergency management community through the passage of the Federal Civil Defense Act of 1950, the first comprehensive legislation in the US to deal with emergency planning. The prime focus of this legislation was on enemy nuclear attack, although the legislation indicated that the organizational structure could be used to provide relief and assistance for other types of emergencies. The development of civil defense policy and programs was assigned to the Secretary of Defense. Later these responsibilities were transferred to new civilian agencies, such as the Defense Civil Preparedness Agency, which staffed the civil defense positions of the Korean War era with retired military offices.

In 1970 when the Disaster Relief Act was passed, various emergency planning activities were merged into the Federal Emergency Management Agency (FEMA). FEMA was designed to coordinate the federal response and encourage state and local planning in shared governance of emergencies (May and Williams, 1986 as cited in Dynes, 1990). The command and control model, although it does not address shared governance well, was widely retained and remains the dominant model used in emergency planning and response today.

Historically in the US, a military approach to oil spill response was used, with the Secretary of the Army given the authority under and responsibility for administering the Oil Pollution Act of 1924.

Although the authors had little historical information available on the how international response systems evolved — which appear to be command and control type RMSs — some inferences can be drawn from the present systems. In many places throughout the world and particularly for the countries bordering the North Sea, military organizations are the primary agencies used by government to oversee the response to oil spills at sea (Archer and White, 1985). In a number of countries the preparation and implementation of spill response plans is the responsibility of the naval service within a navy.

istry of Defense. This is the case, for example, in both Belgium and France. In the former, the Navy has the responsibility for responding to oil spills in the Belgian zone of the North Sea and the Scheldt Estuary. In France the coastline is divided into three maritime regions, each of which is headed by a Maritime Prefect, a naval authority responsible to the Ministry of Defense. Singapore and South Africa also have used traditional command and control approaches for oil spill management (Garnett, pers. comm., 1994). It appears that the military model also has been applied, in a civilian context, for emergency planning and response operations to an undetermined extent internationally.

## US MODEL FOR OIL SPILL RESPONSE

This section describes how the pre-OPA 90 response organization evolved in the US. The US evolved a unique system of oil spill response management because of historical and organizational influences. In the context of this paper, it is not feasible to discuss the historical evolution of RMS(s) used for oil spill response in other countries.

The primary influence over how oil spills are managed in the US has been government legislation and regulations, especially at the federal and state levels. The early government organization with a response role was the USCG, which was responsible for enforcing the Oil Pollution Act of 1924, that was aimed at reducing the occurrence of oil slicks. As described in the minutes of a 1964 conference, as recounted by Charter (1971), "this responsibility was concomitant with the duties related to the safety of vessels and waterfront structures. The Coast Guard operates through the Captain of the Port, a Coast Guard officer assigned to the area to supervise Coast Guard law enforcement, safety, search and rescue (SAR), and similar duties. In addition to reporting spills and citations of violations, the duty of the Captain of the Port includes evaluation and recommendation for proper action on the cleanup of oil spills."

The NCP is the single most influential document that addresses response organization. The first NCP was issued in September, 1968 following the *Torrey Canyon* as an interagency agreement. The next version of the NCP, published by the Council on Environmental Quality in 1970, was the first federal spill response regulation to be issued. The NCP has been revised numerous times since 1968 to incorporate the changes resulting from new laws, e.g., OPA 90, and amendments to existing laws.

The basis for the regulatory philosophy regarding oil spill management in the US comes from the founding documents in US history, i.e., the Declaration of Independence and the Constitution. In these documents, the philosophy underlying federal-state relationships is articulated. The constitutional framework for the division of powers between the federal and state governments has been summarized and its effect on oil spill regulations has been described (Wilkes, 1971).

With regard to oil spill response, the federal OSC's authority supersedes if there is a disagreement with a state, however US regulations provide for a strong state input to the decision making process (US EPA, 1994a). The following summarizes

the unique aspects of federal-state relationships in the US:

"The central paradox of American politics has always been, from the time of the Declaration and of the Constitution, the existence of ineradicable states within a indissoluble Union. The sovereignty of the people, from whom both the national and state governments derive their just powers, is the basis for the distinctively American form of Federalism. Neither is the central government the creature of the states nor do the states exist at the mercy of the central government, but both exercise those limited and delegate powers that are assigned them by the people" (Levy *et al.*, 1986).

This paradox is a distinguishing characteristic of the US National Response System (NRS) described in the NCP and used during oil spill response operations, and is one of the reasons that OPA 90 and the latest NCP call for a unified command form of RMS. Another reason the states have a substantial role in spill response is because at the time the first draft of the NCP was developed in 1970, the states were the principal government entities involved in on-site response. Therefore, it appeared reasonable to include them as specific components of the US national response system (Biglane, pers. comm., 1994).

The other major party in spill response is the RP. There is a history within the US of having the RP take an active role in response. In the Oil Pollution Act of 1924, violators were assessed a penalty of no more than \$2,500, but it did not require specific response activities. In 1966, prior to the *Torrey Canyon* incident, it is interesting to note, Congress amended the 1924 Act to require that the spiller remove the oil from navigable waters. If the discharger failed to do so, the federal government then was authorized to take action and seek reimbursement for the clean up. Thus, the concept of environmental protection through direct action was clearly established (Biglane and Wyer, 1971). In fact, the RP was considered the entity with primary responsibility for oil removal, until the passage of OPA 90 and the issuance of the revised NCP tasked the RP and government to respond as partners.

The team aspect of the NRS reinforces the requirement for an RMS that provides for the participation of groups representing various entities. Since the first versions of the NCP, multiple federal agencies have provided representatives to the National Response Team (NRT), Regional Response Teams (RRT) and the Special Forces (now called Special Teams), that are active components of the NRS. The rationale behind their inclusion in the system is to provide appropriate response resources and capabilities during spill response operations. When the NRS was established, there were very few private resources available and the only substantial resources were from the various agencies. Therefore, it made sense to also include them in the NRS (Biglane, pers. comm., 1994).

As the NRS evolved, it relied upon the Coast Guard to be the nucleus of the federal spill response organization, as noted earlier. However, in 1968 the President assigned responsibility for response **planning** to the Department of the Interior (DOI). Coast Guard units were then directed to work with the Federal Water Pollution Control Administration in DOI, which became the Water Quality Office in the EPA, when EPA was

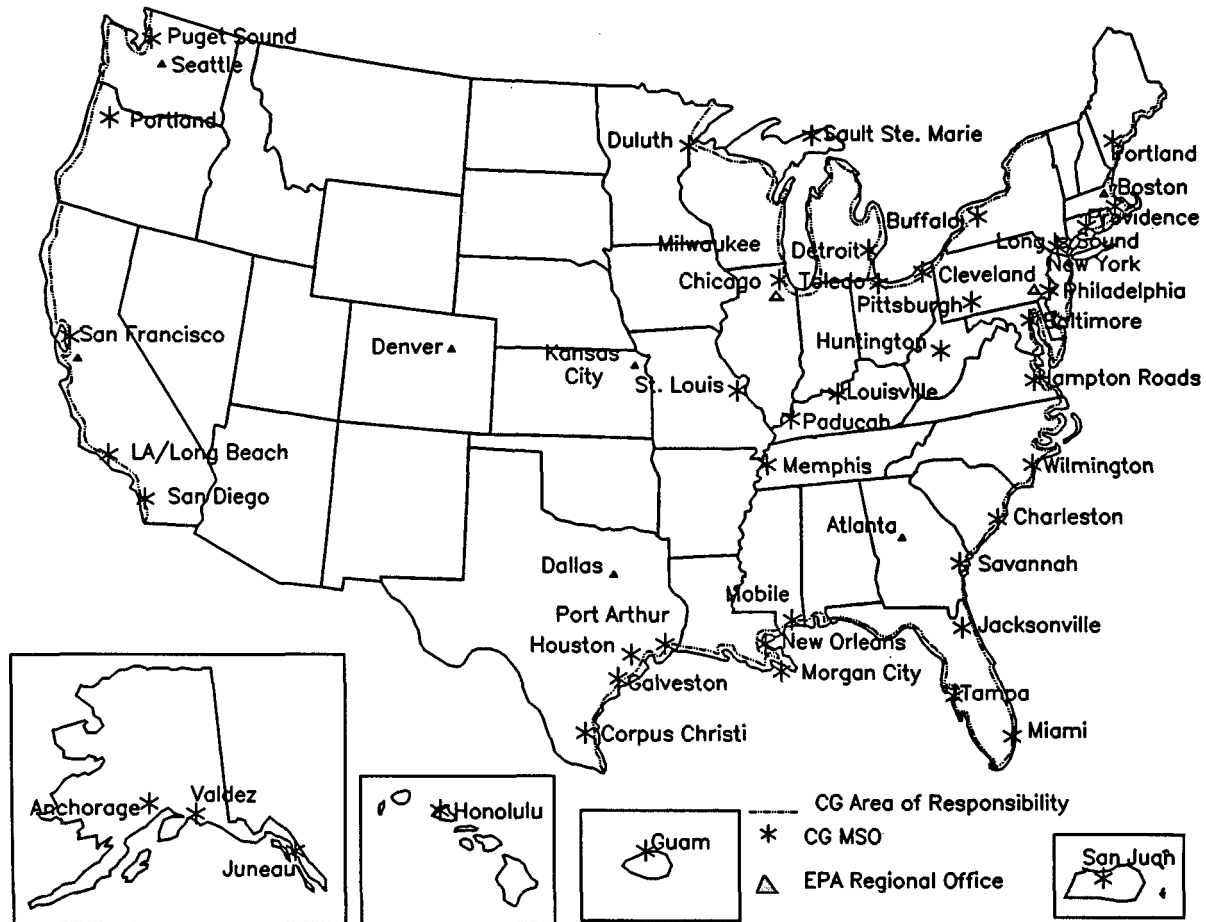


FIGURE 1. GEOGRAPHICAL BOUNDARIES OF EPA AND USCG

established in early 1970. The present agreement on planning and response responsibilities, i.e., the Coast Guard is responsible for planning and providing pre-designated On-Scene Coordinators in the coastal areas and EPA does the same for inland areas, is a result of meetings in early 1970.

The geographic boundaries of the two agencies, which have changed little in 24 years, are illustrated in Figure 1. This figure is enlightening. It clearly indicates that EPA has an immense domestic area in which to manage spills from primarily fixed facilities (by mutual agreement, the USCG retains OSC responsibility over spills from commercial vessels on inland waters), while the Coast Guard must manage spills resulting from the vessels, and facilities, which operate in the comparatively narrow coastal zone. These significant differences between the Coast Guard and EPA, coupled with their style differences, i.e., the hierarchical, military-based management structure of the Coast Guard in contrast to EPA's decentralized, regional approach, has significant implications for developing a single RMS for use during oil spills in the US. These implications will be explored in Section 4.4.

The differences inherent in USCG, EPA, state and RP organizational concepts quickly became evident during the *Exxon Valdez* response operation, leading to the creation of an *ad hoc* response organization (Harrald, *et al.* 1992). The resulting

pre-OPA 90 response organization is perceived to have failed during the *Exxon Valdez*. This perceived break down of response management, which prevents most citizens from considering the *Exxon Valdez* a success even though tremendous resources were deployed, has precipitated considerable interest in how to manage spill responses effectively.

#### THE NATIONAL INTERAGENCY INCIDENT MANAGEMENT SYSTEM (NIIMS) INCIDENT COMMAND SYSTEM (ICS)

During the last several years, a type of RMS, known as the Incident Command System (ICS), has become the prominent model used in oil spill response. ICS is one subsystem of the National Interagency Incident Management System (NIIMS). The five sub-systems that make up the NIIMS are: ICS, Training, Qualifications and Certification, Publications Management, and Supporting Technologies (NIIMS, 1981). ICS is based upon a command and control model for emergency management.

This section describes the history of ICS as a model for emergency management and the NIIMS ICS, as it was originally designed. The traditional design of the Incident Command System (ICS) is derived from the command and control model. The NIIMS form of ICS has been modified in numerous different ways by various entities for oil spill

response management. The ICS variants for oil spill response are discussed in Section 3.4.

ICS was developed as a result of major fires in Southern California in the early 1970s, when a need was identified for a system whereby different agencies could work towards a common goal in an effective and efficient manner. Problems which ICS was designed to remedy included different organizational structures, terminology, communications between agencies and during operations, poor joint planning and information gathering and dissemination, and inadequate prediction capability (Miller and Gallagher, 1993). The standardization of organization, terminology, procedures and communications resulted in the development of the NIIMS ICS.

The Operational System Descriptions (ICS-220) and the Field Operations Guide (ICS-420) (Incident Command System, 1983) establish the standard system, including management concepts, organizational design, guidelines for incremental increase of resources, description of both section functions and individual roles and responsibilities, and explanation of system components. These two documents provide a structured and detailed design that enhances the effectiveness of fire fighting operations in the forest and wildfire environment. The advantages of the system are clear — its use enables the organization, regardless of which entity has overall management responsibility, to quickly integrate management resources, all of whom have common training and skills and a consistent understanding of the procedures, into an effective, productive goal oriented team.

Over time, the fire fighting community began to understand that ICS was useful in a wide range of non-fire events to which public safety organizations respond. As it was applied more widely to responses to both natural disasters (hurricanes, tornadoes, floods, earthquakes), technological accidents (plane crashes, oil and hazardous material spills, transportation accidents, pest control programs, search and rescue) and planned events such as major athletic events and parades, the system became more generic, while purportedly retaining the fundamental concepts that made it valuable during fire fighting operations (Josephson, pers. comm., 1994; Gallimore, pers. comm., 1994). Current training programs emphasize that ICS is an “all hazards, all risk” type of RMS (Jensen, pers. comm., 1994).

The standard ICS components that work interactively to provide the basis for its concept of operation (Incident Command System, 1983) are:

1. Common terminology,
2. Modular organization,
3. Integrated communications,
4. Unified command structure,
5. Consolidated action plan,
6. Manageable span of control,
7. Pre-designated incident facilities, and
8. Comprehensive resource management.

Operating under the NIIMS ICS, once a decision is made to expand a fire fighting force, the leaders can rely on getting people who are trained, qualified and certified in the specific duties they are to assume, using a common terminology and a

standard set of publications and training materials. They know, for example, that if someone asks for a “Type 2 Engine” over the radio, they are talking about a truck with a 500 gallons per minute pump, a 400 gallon water tank, 100 feet of 2 1/2” hose, 500 feet of 1 1/2” hose and 300 feet of 1” hose, a 20 foot extension ladder and 3 people.

An underlying principle is that the system must have the flexibility to adapt so that it can be used to manage the response to various types of situations. Major fires, such as those in Yellowstone National Park in 1989 and throughout the western United States in the summer of 1994, required augmentation of forces by a variety of federal and state agencies. In the case of military personnel assigned to assist, the managers quickly identified the training required and qualified fire bosses to conduct it, for example, so that the soldiers could be utilized effectively as quickly as possible. Private organizations are seldom, if ever, used in the NIIMS ICS.

The specific organizational structure established for any given event will be based on the management needs of the situation (Incident Command System, 1983). However, the principal functional areas of the standard ICS organizational structure for a single jurisdiction are displayed in Figure 2. As designed by NIIMS, ICS has the flexibility to adapt to multiple jurisdictions by the addition of a unified command structure at the highest decision making level, i.e., Incident Commander.

According to the NIIMS ICS, a unified command structure is called for when:

- (1) The incident is totally contained within a single jurisdiction but more than one entity shares management responsibility, e.g., airplane crash.
- (2) The incident crosses multiple geographic jurisdictions.

NIIMS offers an organizational structure to accommodate each of the above situations. Oil spills, however, generally involve both situations simultaneously. In a unified command structure, the individuals designated by their jurisdictions **jointly** determine objectives, strategy, and priorities. The determination of which entity serves as the operations chief must be made by mutual agreement. This can be done on the basis of existing statutory authority, greatest jurisdictional involvement in the response, mutual concurrence of the knowledge needed for the specific incident (Incident Com-

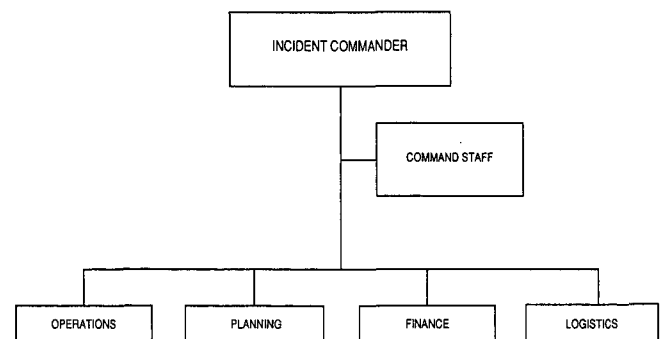


FIGURE 2. THE FIVE PRINCIPAL COMPONENTS OF THE INCIDENT COMMAND SYSTEM (ICS) (FROM: ROLAN AND CAMERON, 1991)

mand System, 1983). Unified command has taken on special meaning in the context of oil spill response. This will be discussed in Section 4.4.

One critical issue regarding ICS is what the term means when someone refers to "ICS." For those who originated it, "ICS" has a very specific meaning. It refers to the complete and detailed system defined in two documents, noted above. The NIIMS doctrine, including the ICS sub-system, is maintained by the National Wildfire Coordination Group, currently headed by a representative of the United States Forest Service. As a wide range of organizations with emergency management and response duties have adopted incident management systems based on the standard ICS, the principles of the system have been inconsistently embedded in the variant organizations. Many of these agencies call their systems "ICS," and state that they are using the standard ICS, when, in fact, they are using only parts of one of the five interrelated NIIMS sub-systems. Those in the oil spill response community who are adopting ICS as the basis for their RMS tend to adopt the basic organizational structure, as depicted in Figure 2 (5 components of ICS), and the concepts of flexible expandability, including the Unified Command Structure for managing multiple jurisdictions.

**For the remainder of this paper, the term ICS refers to the oil spill variants which consist of primarily five principal components of the ICS structure, including the Unified Command Structure. In this context, ICS is not a complete system but a conceptual building block on which numerous RMSs for managing response to signifi-**

**cant oil spills are being developed by various government and industry organizations. The term NIIMS ICS refers to the formal system maintained by the National Wildfire Coordinating Group.**

The previous discussion identified three organizational models which over time have been used to manage oil spills and other emergencies. Given the topic of this paper, "Implementing an Effective Response Management System," the authors needed to consider whether or not one model can be used to manage all spills, regardless of size and complexity. The next section considers the effect of the complexity of spill on RMS design and implementation.

## 2.5 THE RELATIONSHIP OF RMS AND SPILL SIGNIFICANCE

The complexity and magnitude of spill response activities, including spill management, will vary with the significance of the spill, which is a function of its size, type of oil, location, environmentally sensitive resources at risk, weather, timing, public and government concerns and expectations. Determining the appropriate RMS for a spill event involves considering:

- The relative significance of the spill;
- The legal and institutional requirements of the jurisdictions in the affected area;
- The economic characteristics and socio-cultural values of the affected area; and

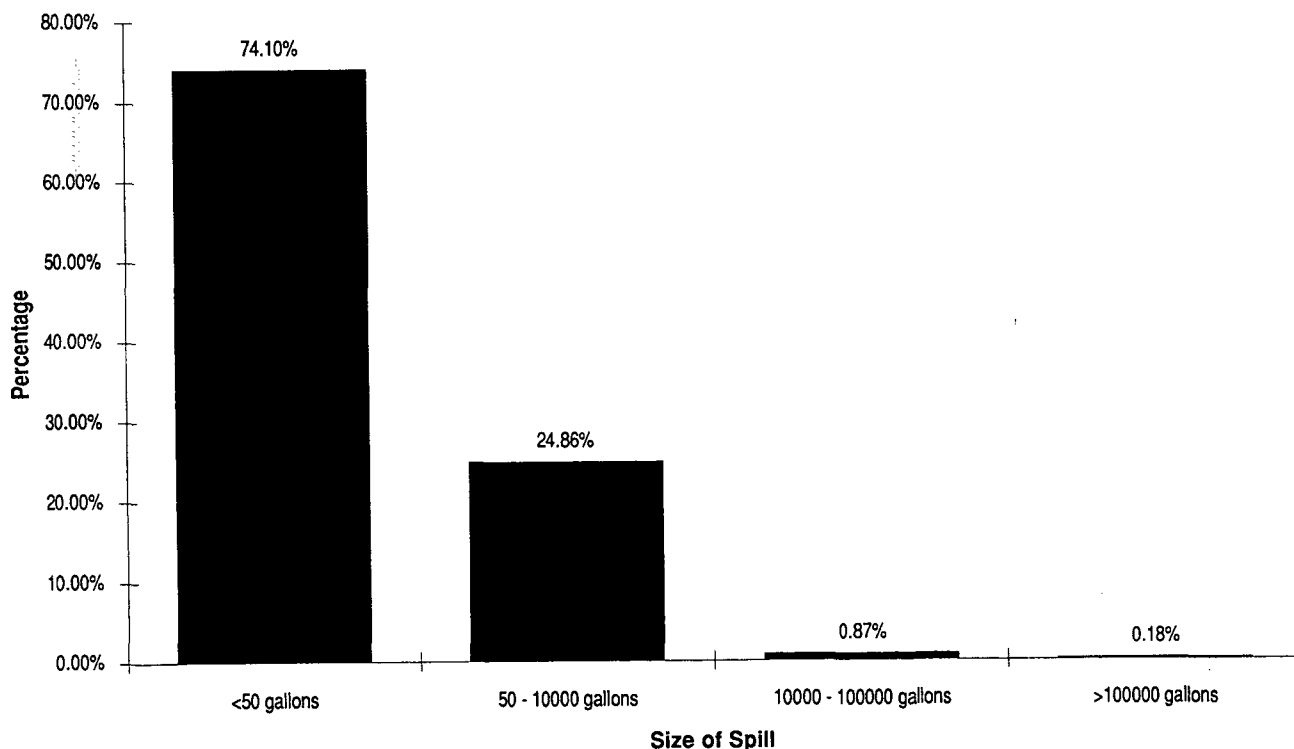


FIGURE 3. PERCENTAGE OF SPILLS BY AVERAGE SIZE (1974-1991) (FROM: USCG, 1993c)



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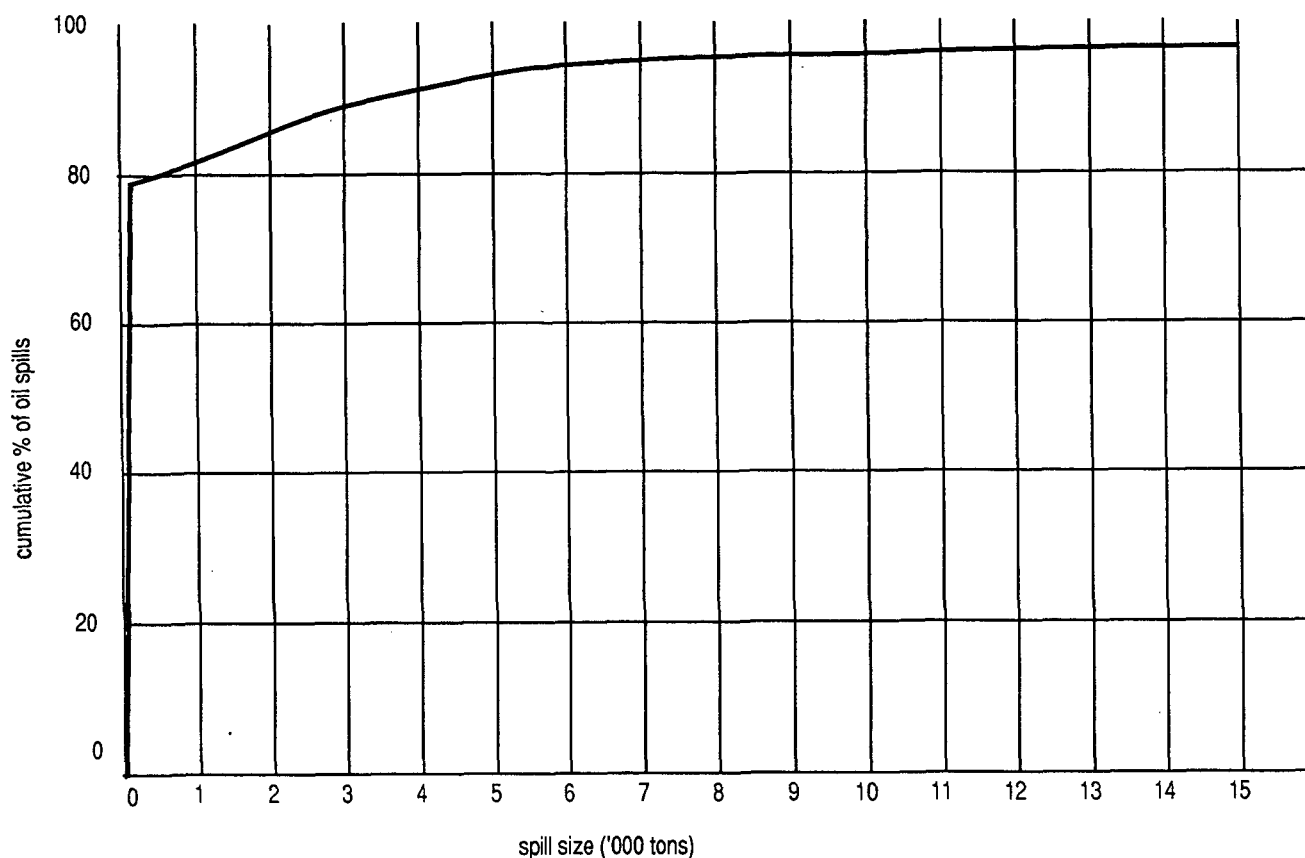


FIGURE 4. CUMULATIVE PERCENTAGE OF SPILLS VERSUS SPILL SIZE (FROM: IPIECA, 1991)

- The response resources and technology available.

Relative significance is discussed in this section. Previewing available worldwide and US spill statistics provides a useful context for considering spill significance and whether:

- A single, basic RMS, designed to become larger or “ramp up” in significant and catastrophic spills, is appropriate for the majority of spills; or,
- The basic functional design of an RMS should vary with the significance of the spill.

Most oil spills are not of the magnitude or scope of the *Exxon Valdez*, which was a rare event, a catastrophic event and a spill of national significance. The only other US spill that approached the magnitude of the *Exxon Valdez* was the Ixtoc I blowout in the Gulf of Mexico in 1978. The 68 million gallon spill from the *Amoco Cadiz* off the coast of France in 1978 is another example of a catastrophic spill, as was the *Torrey Canyon* spill. However, these spills are an anomaly. During the period 1974 to 1991, nearly 99% of all spills in the US were less than 10,000 gallons, and over 75% were less than 50 gallons. In fact, in 1991, 81.4% were less than 25 gallons (USCG, 1993c). Figure 3 on page 27 graphically depicts the number of spills which occurred in the US from 1974–1991.

Figure 4 provides a similar view of spills which occurred worldwide (including the US) from 1974–1990 (IPIECA, 1991). During these years there were 774 spills involving the loss of more than 7 tons or approximately 2,058 gallons of oil.<sup>1</sup>

Smaller spills are omitted from the IPIECA summary. Over 80% were less than 315,000 gallons (7,500 bbls) and over 95% were less than 3,150,000 gallons (75,000 bbls). Since spills of less than 7 tons were not included in calculation of the percentages, it is clear that only a very small percentage of spills could be considered catastrophic by any standard.

The principal cause of spills less than 7 tons is routine operations, i.e., loading and discharging, which accounted for 77% of the discharges. Loading and discharging accidents are still the prime cause (43.5%) of spills between 7–700 tons; however, collisions are also a significant cause (26.6%). For the major spills, those over 700 tons, grounding (50.6%) and collisions (40.6%) are the major causes; only 8.8% of the major accidental spills resulted from loading and discharge errors.

How can response organizations best prepare with limited resources (i.e. funds, equipment, personnel, manpower) to deal with catastrophic events, when most of the spills to which it responds are routine? Since most of the spills are routine, how can operators justify spending the majority of their preparedness efforts on catastrophic events? Since catastrophic large spills are rare, should there be a simple RMS for routine spills?

The determination of significance is a relative and qualitative process, depending on assessment of a combination of event-specific conditions, such as quantity and type of oil,

<sup>1</sup>While the conversion factor from tons to gallons varies based on the specific gravity of a given type of oil, one ton is assumed to equal 7.0 barrels or approximately 294 gallons.

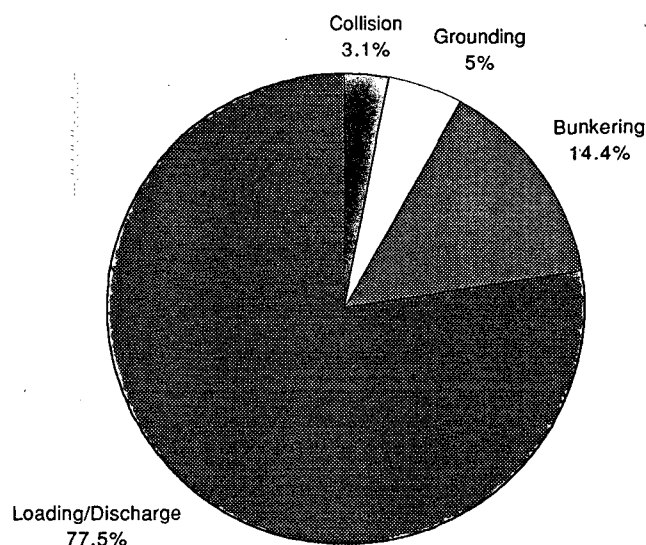


**FIGURE 5. MAJOR CAUSES (SPILLS < 7 TONS)  
1974-1990 (FROM IPIECA, 1991)**

location in relation to sensitive resources, on-scene weather, available response resources, timing and public perception, among others. For example, a spill of 20,000 gallons of diesel fuel, which naturally dissipates more readily than crude or #6 oils, into a large, fast flowing river near highly urbanized areas may not be significant. The same type and quantity of oil

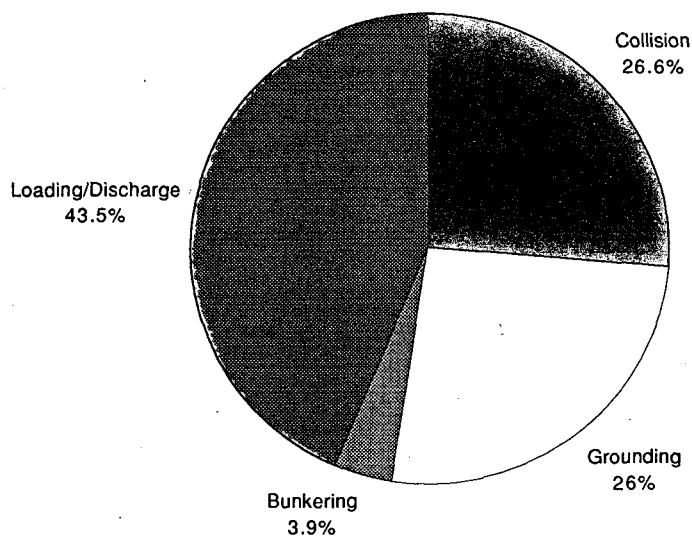


**FIGURE 6. MAJOR CAUSES (SPILLS 7-700 TONS)  
1974-1990 (FROM IPIECA, 1991)**

released in shallow, calm, estuarine areas near seed oyster beds around spawning time could be a very significant event, because of the potential for adverse environmental effects and the requirement to take quick, effective action. The *American Trader* event is an example of the influence of weather — an

external, uncontrollable variable — on a spill's significance. Although the vessel spilled just under 400,000 gallons of Alaska North Slope crude oil only 1.3 miles from the shore, prevailing winds held the oil offshore for almost 6 days, which allowed for mobilization of response resources and initiation of protective measures on the shore. Calm weather conditions at the same time facilitated a massive open water recovery (Card and Meehan, 1991). The spill was perceived as significant, because of the proximity of a large marine spill to high-amenity beach areas, a National Wildlife Refuge, sensitive wetlands, nesting and feeding grounds for coastal bird species and estuaries for mollusks, crustaceans and other marine biota (Card and Meehan, 1991). Yet helpful on-scene weather conditions, in combination with the availability of containment and recovery resources and aggressive action by both the USCG

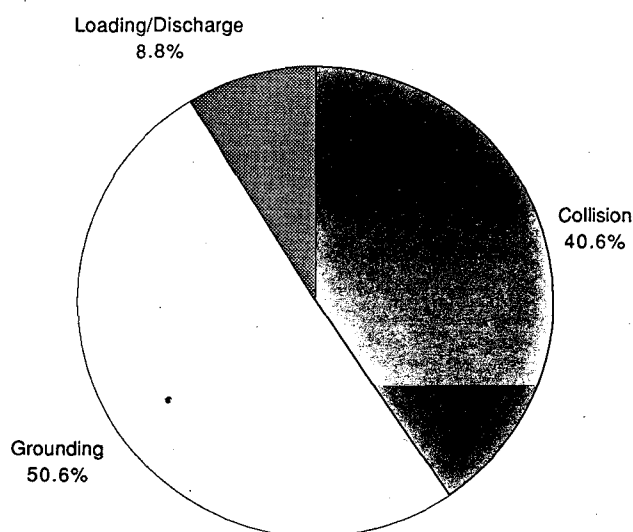


**FIGURE 7. MAJOR CAUSES (SPILLS > 700 TONS)  
1974-1990 (FROM IPIECA, 1991)**

and the RP, dramatically reduced the effects of the spill from what they could have been had different conditions prevailed.

The issue of significance also involves perception. Some spills may be perceived as significant by elected officials, the media, the public and public interest groups, while being viewed as routine — not significant — by responders. Consider the real-world case of an 80 gallon crude oil discharge that occurred on a beautiful winter day in Norfolk, Virginia and created a tar-ball type of impact on a nearby residential beach. This event became significant only when a local newspaper photographer happened to take a picture of a seagull with a 3/4" diameter spot of oil on its chest, then publish it as a 6x8 inch photograph on page 2 of a local newspaper. To spill response professionals, this was not a significant event. But because it was a slow news day and residents were taking advantage of the lull in winter weather to enjoy a stroll on the beach, this minor event prompted heightened media attention and the application of rigorous clean up standards. Clearly significance is relative and subjective, and can vary within the

value-based judgments of a wide range of different organizations and individuals.

Potential discharges can also be significant events. The grounding of a tanker or barge close to shore with millions of gallons of oil on board could be viewed as a significant event, and response resources mobilized based on the seriousness of the perceived threat. Whether the grounding occurs on a hard or soft bottom, whether the on-scene weather conditions are predicted to worsen, and whether the vessel has a history of marine safety violations all could contribute to the perceived significance of the threat.

Any event that is considered to be significant will have an effect on the ability of responders to succeed. Overwhelmingly, the results of responders' opinions indicated that highly significant events attract more attention from politicians, interest groups and the media, and this excessive attention will impact the ability of responders to succeed. Spill responders often are compelled to take actions to alleviate perceived concerns over the priority actions identified by response professionals. Opinions also indicated that the numbers of stakeholders involved increases with the perceived significance of the spill. These factors all contribute to the complexity of the spill response.

The simplest way to classify the significance of a spill is by volumetric size, yet using size as the only distinguishing factor is a gross over-simplification of the issue of spill significance. For purposes of this paper, however, it is helpful to use volume as a starting point for classifying the relative significance of oil spills which occur.

Table 5 relates three categories of spills (routine, significant, and catastrophic) to the classification schemes used in the US and IPIECA. These different classes of spills have direct implications for designing and implementing an RMS. Table 6 suggests general response management implications for different sizes of oil spills. This table has been developed on the basis of the experience of the authors to illustrate the relative magnitude of geographic scope, personnel and equipment resources that a RMS could be required to oversee.

## ROUTINE SPILLS

**Routine spills** are typically small, frequently occurring operational spills that generate little outside attention, and although they require prompt action, can generally be effectively managed with local resources. As discussed earlier, approximately 99% of all spills that occur in the US can be categorized as "routine." Routine events would include small spills for which the RP is known, or small "mystery (marine)

spills." Most of these spills occur at or near a company's facilities. These spills usually are managed by a small, integrated RMS. In the US for example, when the RP is known, the RP's intended action plan will be discussed over the phone or on-scene among the OSC, the RP, and frequently the state representative for the local area. The company would then provide resources to respond to the spill. In the US, most minor or IPIECA-defined Tier 1 spills, including visible sheens which must be reported, are handled in this way.

**TABLE 6. OIL SPILL SIZE IMPLICATIONS FOR RESPONSE MANAGEMENT**

| SIZE                           | DURATION         | NUMBER OF RESPONDERS                           | RESPONSE RESOURCES                             | AREA IMPACTED          |
|--------------------------------|------------------|------------------------------------------------|------------------------------------------------|------------------------|
| Less than 1,000 gallons        | Up to a few days | Less than 15                                   | Facility/vessel resources plus local OSRO      | Localized              |
| 1,000 – 10,000 gallons         | Days – weeks     | 15 – 100                                       | Local OSRO – OSRO network – national responder | 10 – 30 miles          |
| Greater than 10,000 gallons    | Weeks – months   | 100 – 2,000                                    | All                                            | 20 – 100 miles         |
| Spill of National Significance | Months – years   | More than 2,000 (Exxon – Valdez – peak 36,000) | All                                            | Greater than 100 miles |

## SIGNIFICANT SPILLS

A **significant** spill is one which usually involves a discharge of medium or major spill volume, accompanied by the potential for substantial environmental and economic impact and a high level of outside interest, and which requires additional personnel and equipment to augment the resources readily available. IPIECA defines Tier 2 spills as a larger spill in the vicinity of a company's facilities where resources from another company, industry and possibly government response agencies would be called on for assistance. However, depending upon specific conditions, it is possible that a "volumetrically" minor discharge could become a significant spill in a particular area. These spills are of interest to the public, for any number of reasons, e.g., oiling of recreational facilities during a summer holiday period, impact on sensitive environmental areas, or imminent political elections. For the most part, these spills require intensive on scene activity for a period of time (on the order of weeks) by various levels of government, the RP, and response contractors. Widely recognized spills, such as the *American Trader* (which occurred in 1990 in California), *Rosebay* (1990, England), *Mega Borg* (1990, Texas), *Morris J. Berman* (1994, Puerto Rico) and *Shell Isomeria* (1994, Virginia), could be classed as **significant** under this definition.

## CATASTROPHIC SPILLS

**Catastrophic spills** are those rare events which involve a release on the order of millions of gallons of oil into the marine environment in a location and under such conditions that economic, environmental, political, social and cultural impacts result. These major spills are of national, and can be of international, significance — hence the emergence of the term Spill of National Significance (SONS) in the US. A catastrophic spill would generally meet the

**TABLE 5. COMPARISON OF EVENT CATEGORIES**

| SIGNIFICANCE | NCP Categories                                                                                                    | IPIECA Tiers |
|--------------|-------------------------------------------------------------------------------------------------------------------|--------------|
| Routine      | Minor<br>coastal < 10,000 gals<br>inland < 1,000 gals                                                             | Tier 1       |
| Significant  | Medium<br>coastal > 10,000 gals<br>inland > 1,000 gals<br>Major<br>coastal > 100,000 gals<br>inland > 10,000 gals | Tier 2       |
| Catastrophic | Spill of National Significance (SONS)                                                                             | Tier 3       |

Tier 3 spill — the large spills where substantial resources will be required and support from a national or international cooperative stockpile will be necessary. These spills could be either close to or remote from company facilities. The *Torrey Canyon*, *Amoco Cadiz*, Ixtoc I blowout and the *Exxon Valdez* events are examples of catastrophic spills. The *Braer* spill is an interesting example of a catastrophic release which, because of the type of oil released (light crude oil) and on-scene weather conditions (storm) resulted in a relatively localized impact.

The significance of the spill has important implications for spill management. The RMS for routine spills is likely to be simple, with a limited number of people addressing all the functions required, and working interactively to resolve the problem. For significant and catastrophic spills, the numbers of functions, people and equipment involved in response can be quite large, and require a RMS that is not only larger and more robust, but with the capability to effectively address a range of external influences which might not have been able to be considered in the planning and preparedness process.

To illustrate the dimensions of the management scope in relation to spill significance, it is useful to compare a small set of data from two actual spills, as displayed in Table 7. The *Rosebay* spill was similar to the *American Trader* in a number of ways, including the type and amount of oil discharged and the extent and type of shoreline contaminated. Yet the number of responders, duration of on-scene activity and clean up and clean up costs clearly indicates a difference in the management significance of the two events. Some responders suggest that the main difference between these two events, and the reason for the difference in significance, is their respective geographic locations, i.e., the *American Trader* occurred in the US and the *Rosebay* occurred in Great Britain), and the corresponding difference in regulatory perspective. The socio-economic influences on the design and implementation of RMSs is discussed in Section 3.3.

Although empirical proof is not possible, many response professionals would agree that the differences are due to qualitative factors such as the political and social and economic environment in the US. These factors contribute to a heightened significance, requiring more response managers, personnel and equipment to resolve the event. Not surprisingly, then, the cost of clean up corresponds to the significance of the spill. Interesting questions to consider are “Did the extra effort and cost in one event correspond to increased environmental benefit or a reduction in the adverse environmental impacts?” and “Could the RMSs have worked any more efficiently and effectively?”

A central observation is that RMSs which most effectively manage a response are those that can most readily adapt their size, complexity and functionality based on the significance of the event. The theoretical literature suggests that significant and catastrophic oil spills are not just big routine spills, but more complex organizational events. They are characterized by a high velocity environment in which information is often not available or is incorrect, and a higher volume of decisions must be made more quickly (Carley and Harrauld, in press).

TABLE 7. COMPARISON OF THE *AMERICAN TRADER* AND  
*ROSEBAY* OIL SPILLS

| Event Date Location                                                   | Oil type                  | Quantity Spilled | Estimated Number of Responders | Duration (on-scene) | Clean-up Costs |
|-----------------------------------------------------------------------|---------------------------|------------------|--------------------------------|---------------------|----------------|
| <i>American Trader</i><br>February 7, 1990<br>Southern California USA | Alaskan North Slope Crude | 9,458 bbl        | 2,000                          | 36 days             | \$47 million   |
| <i>Rosebay</i><br>May 12, 1990<br>Southern England                    | Iranian heavy crude       | 7,700 bbl        | 200                            | 30 days             | \$2 million    |

(Adapted from ITOFF Incident Summaries, and Rolan and Cameron, 1991)

Since this finding has been verified in several studies, the common wisdom that a system simply has to “ramp up” or add more people and functions to handle larger spills is misleading. It does not address how the RMS must adapt to meet not simply more, but fundamentally **different** requirements. How organizations react during crisis or disaster events has been extensively studied by researchers in the social sciences, to the point that predictions can be made on how and why organizations break down when managing events of this type. Successfully managing spills that take on the organizational characteristics of an emergency, crisis or disaster requires: (1) Understanding how the organizations typically weaken or break down so that an RMS can be designed to adapt or grow to address the predictable causes of the breakdown — this is a preparedness step; and (2) Early recognition of significant or catastrophic events (or potentially significant or catastrophic events) based not only on quantitative criteria, but on more qualitative, external factors — this is a response step.

Regardless of the classification or size of a spill, the theoretical literature provides insights into factors which are critical to a successful response, called Critical Success Factors (addressed in detail in Section 4). Researchers who have studied over 500 emergencies, crises and disasters, including oil spills, over the last 25 years predict the organizational implications of such events. As a result of these studies, an extensive body of knowledge is relevant to understanding how to implement an effective RMS for oil spills. Understanding two particular concepts is important background before proceeding further. First, many oil spills are socially defined as disasters and, second, emergent organizations are a sociological phenomena which are characteristic of disasters. The next two sections explain these concepts in greater detail.

## 2.6 OIL SPILLS AS DISASTERS

Oil spills are **emergencies**; they are **unforeseen situations that call for immediate action**. Regardless of whether one defines an oil spill as a crisis, a disaster, or simply a mess to be cleaned up, made into something more by the politics involved (Garnett, pers. comm., 1994), it is typically a situation that calls for doing something immediately.

As discussed earlier, routine spills usually are emergencies that require immediate action. Yet not all oil spills are crises and disasters. The theoretical literature dealing with crisis and disaster response defines an oil spill as a “disaster agent,” the

cause of the emergency, crisis or disaster. The **disaster** is a human relations and organizational event, one in which many people are trying to do very rapidly things they do not ordinarily do, in an unfamiliar and rapidly changing environment (Tierney, 1994). In this respect, oil spills, particularly the significant and catastrophic events, are potential disaster situations. The turbulence and complexity of the decision making environment, the fact that each spill is characterized by a unique set of circumstances, and the general unfamiliarity of the public with specific knowledge about oil spill effects can lead to a situation that is socially defined as a disaster. In addition to the effect on the community at large, the social effect on responding organizations is also significant. They *must process information and think, decide, and act quickly* in a situation that is characterized by multiple, stranger organizations, where the various responding organizations, who normally work independently of one another, must collaborate to varying degrees on making decisions and implementing them.

## 2.7 THE PHENOMENA OF EMERGING ORGANIZATIONS

The Disaster Research Center (DRC) at the University of Delaware has been observing organizational phenomena during more than 500 disaster responses since 1968. Dynes and Quarantelli of the DRC have developed a fundamental typology describing the evolution of organizations during crisis situations, such as during significant and catastrophic oil spill emergencies. Two dimensions, (1) the nature of the disaster tasks undertaken by organizations and (2) the organizational structure during the disaster period, are used to identify the type of organization that evolves during a disaster. The task continuum ranges from routine to non-routine. The organizational structure continuum extends from long-standing organizational entities to new or recently developed forms. The resulting four types of organizations (Established, Extending, Expanding, and Emergent) are shown in the four-fold typology of organizational involvement in emergencies and disasters in Figure 8 (Dynes and Quarantelli, 1968).

Police and fire departments and the USCG could be considered Type I organizations that routinely handle "emergency events." A small oil spill, for example, is a routine emergency task handled by the pre-designated OSC organization.

During a larger scale event, Type II, III and IV organizations all exist. Some organizations are required to extend their normal operations to encompass new tasks. Operational units of the USCG or of Naval forces in other countries that are not routinely involved in or trained for oil spill response may be pressed into action. Other organizations such as the American Red Cross Disaster Services routinely expand to meet the new, higher level demands by mobilizing trained personnel and assigning them to an expanded, but pre-determined organizational structure appropriate to the scale of the event. One of the attractive features of the standard ICS, is that it is designed to facilitate simple organizational expansion.

Emergent organizations, which are comprised of new people performing new tasks within unfamiliar organizational

|                          |                     | Tasks                 |                       |
|--------------------------|---------------------|-----------------------|-----------------------|
|                          |                     | Routine               | Nonroutine            |
| Organizational Structure | Same as Predisaster | Type I<br>Established | Type III<br>Extending |
|                          | New                 | Type II<br>Expanding  | Type IV<br>Emergent   |

FIGURE 8. ORGANIZATIONAL ADAPPTIONS IN CRISIS SITUATIONS

structures, have appeared at all significant and catastrophic oil spills. Leadership and structure emerge in an *ad hoc* manner in response to the external demands of the disaster operation. Quarantelli is quick to point out that the phenomena of emergence "is not necessarily dysfunctional, bad, or inappropriate ... emergence represents an effort to solve problems." Examples of both functional and dysfunctional organizational emergence were evident during the *Exxon Valdez* spill response.

"Coast Guard officials were taken by surprise by the urgency which local fishermen, who organized their own efforts to protect hatcheries in the path of the spill, attached to the protection of fishery resources."

"... the active participation in the shoreline clean up of volunteer organizations, particularly during the winter when Exxon operations were suspended, proved problematic for the FOSC."

"When other resource agencies took highly proprietary interests and aggressive postures in the name of protecting resources under their jurisdictions, the FOSC frequently found himself faced with difficult to meet demands which required political rather than science based solutions" (US DOT, 1993, p. 561).

Dynes and Quarantelli (1976) extended their analysis of crisis organizations beyond the organizational structure and tasks dimension to include a third dimension, i.e., mechanisms of organizational coordination, as a distinguishing characteristic among organizations during crises. They state:

"Coordination was seen as the degree to which there is adequate linkage among the organizational parts. It was suggested that organizations tend to coordinate either by plan or by feedback. Crisis situations produce conditions of greater uncertainty, greater diversity, decreased formalization and decreased centralization. Increased complexity of organizations and the non-routine nature of crisis tasks move all organizations toward coordination by feedback ... factors present in crisis situations tend to move all organizations in the direction of coordination by feedback. Such movement runs counter to the usual normative prescription which orients most emergency planning to emphasize coordination by plan. A more effective direction might be

to plan to facilitate coordination by feedback in organizations in crisis.”

“Looking more specifically at the consequences of change in organizational structure and their implications for patterns of communication, all of the changes during the emergency period would seem to increase the rate of task communication and the proportion of horizontal task communication. The acceptance of new tasks or new structure would increase organizational complexity and decrease the degree of formalization and centralization. Thus these changes which increase the rate and direction of communication which, in turn would facilitate coordination by feedback.”

“It is not by chance that Type IV [Emergent organizations] in the previous typology is illustrated by a group whose function was purely one of coordination. These factors also suggest the difficulty of Type I [Established organizations] in maintaining their pre-disaster coordination structure, since it is usually one of coordination by plan. Coordination by plan characterizes many of the traditional emergency organizations, such as police and fire departments. These conditions also explain why such organizations have great difficulty in utilizing volunteers.... Rather than increase their capabilities to meet the increased demands, such organizations tend to accept only those demands which are within their present capabilities.... When most of

the organizations in emergency operations are moving toward coordination by feedback, established organizations are, in many ways, ‘out of step.’ There is a discontinuity between their attempt to maintain internal coordination by plan when the conditions relating to the emergency period are such as to move most other organizations further toward coordination by feedback.”

Emergent organizations are made necessary by: (1) the perception that problems crucial to certain groups or individuals are unresolved, and (2) the heightened necessity for organizational coordination during crisis. Quarantelli concludes that prior planning can preclude dysfunctional or unnecessary emergence. If the response management organization is sensitive to external concerns and responses, they will recognize the presence of emergent groups early, and can incorporate them into the process. There will be no need for groups to emerge spontaneously and informally. Since plans can not, and should not try to, anticipate all problems, some emergence will always occur. Therefore, **the response organization must be flexible enough to manage by feedback** and to allow, perhaps even encourage, the emergence of problem solving *ad hoc* organizational elements. It should be anticipated and managed by the RMS. However, if the core activities of the response are perceived as unresponsive and failing to resolve the concerns of stakeholders, as they were after the *Exxon Valdez* oil spill and Hurricane Andrew, the phenomena of emergence can significantly hinder or disrupt a response.



## SECTION 3.0

# SYSTEM VIEW OF RESPONSE MANAGEMENT

One of the aims of this paper is to provide both a description of existing systems and an evaluation of what makes an effective RMSs for oil spills. To evaluate RMSs, a framework and qualitative measures for evaluation must be constructed. The authors do so in the next two sections by extracting information that is relevant to the design (Section 3) and evaluation (Section 4) of RMSs from the extensive body of literature on organization theory. This section discusses a systems view of response organizations; it also identifies and compares two fundamental types of organizations, those that are closed and those that are open. Given the need to consider in oil spills an RMS which provides for inter-connections among multiple responding organizations, the systems theory offers a holistic foundation for viewing the organizational environment in which oil spill response is conducted. Section 4 develops measures for evaluating RMSs and applies these measures to existing and evolving RMSs.

### 3.1 A SYSTEMS VIEW OF RESPONSE MANAGEMENT

Two views of organizations as systems provide useful perspectives for analysis of the pollution RMSs. Schoderbek *et al.* (1985) view organizations as purposeful systems that can be modeled in terms of goals, inputs, processes, outputs, and feedback. A view of the organization as a system of inter-relations is furnished by Rockhard (1981) and Morton (1991). They describe an organization in terms of its strategy, technology, structure, people, and management processes and the interactions between these five elements.

#### THE ORGANIZATION AS A PURPOSEFUL SYSTEM

Schoderbek *et al.* (1985) define an organization as a set of related parts, working together to achieve some goal or objective. Six characteristics of systems in general, and organizational systems in particular, may be inferred from this definition:

1. Systems are purposeful.
2. Systems are differentiated; the parts of a system can be identified.
3. Systems are synergistic; the whole is greater than the sum of the parts.
4. Systems are holistic; they can not be understood in terms of their component parts.
5. Systems are hierarchical; subsystems exist within systems.

6. Systems are regulated by both external factors — the environment — and internal factors — feedback.

Schoderbek's definition implies that the successful response system must be goal directed; a clear, shared, and accepted concept of success must exist. Similar goals, such as the US national response priorities discussed in Section 2, and objectives must be agreed upon at a minimum. A second implication of their system view of the organization is that control of the system requires comparison of some system characteristics against standards or expectations. Feedback loops, in which collection and transmission of information are central, are required in order to control the system.

In general, large, complex organizational systems are difficult to comprehend or to manage as a whole. Often, it is advantageous to decouple subsystems in order to minimize the essential interactions and increase the responsiveness of the system. Tight coupling refers to systems where there are invariant sequences (short time sequences, irreversible sequences of actions), limited flexibility in methods of achieving the goal, and limited ability to substitute equipment, supplies and personnel. Loose coupling refers to systems where delay is possible, the order of sequence can be changed, alternative methods of achieving the goal are available, system buffers and redundancies exist, and unplanned emergency substitutions are available (Perrow, 1994).

Large tightly coupled systems can exhibit physical problems associated with resource movement coordination, as well as problems of communication. Large systems may also run down or decay (the process of entropy, or the tendency toward disorder). Tight coupling can magnify the impact of system failures (Perrow, 1984). Decoupling tightly coupled systems, which reduces the need for communication and allows subsystems to communicate with each other on an exception basis, has a number of benefits but also some costs. For instance, there are costs associated with maintaining decoupling mechanisms (i.e., buffers such as stockpiled removal equipment, booms, and dispersant; redundancies such as pre spill contracts with multiple suppliers); further, each subsystem may operate in a manner not optimal for the organization as a whole (suboptimization).

Inferences for oil spill RMSs of the traditional systems view of organizations include:

1. Organizational goals must be clearly stated and universally accepted if the organization is to be a purposeful system.
2. Performance measures must be developed that will

enable a response organization to evaluate its performance and will enable it to adjust its processes (strategy, tactics, and procedures).

3. Feedback loops that will provide critical control information must be established prior to an event.
4. Distributed decision making will reduce the need for communication, increase the responsiveness of the system, and will reduce the potential for system failure.

### THE ORGANIZATION AS A SYSTEM OF INTER-RELATIONSHIPS

Another theoretical view of organizational behavior is relevant to oil spills RMSs. Morton's (1991) model of the organization as a system was used as the basis for his MIT study of the Corporation of the 1990s. Morton defines the organization as a system of five interacting components and two categories of external influences as shown in Figure 9.

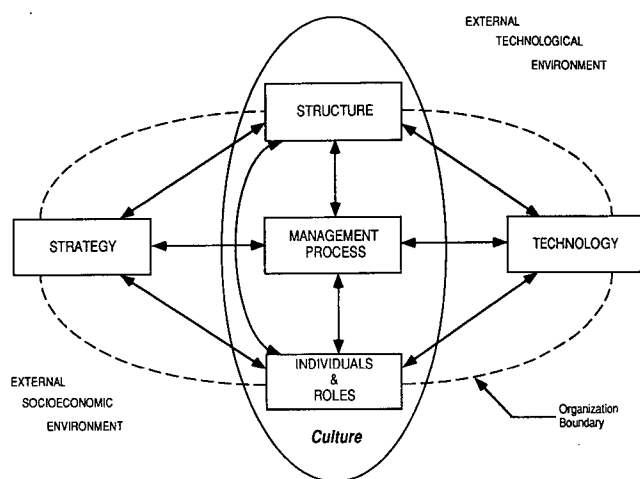


FIGURE 9. THE ORGANIZATION AS A SET OF RELATIONSHIPS IN EQUILIBRIUM (FROM: MORTON, 1991)

The three central elements of the system — structure, management processes and individuals and roles — describe the inter-relationships of people in the organization. Taken together, these elements describe the organizational culture of the system: norms, values, beliefs, and behavior patterns that characterize relationships inside and between groups.

1. Organizational **structure** is the basis of putting the organization together; it defines the formal patterns of authority and responsibility. As pointed out by Senge (1990), structure means the basic inter-relationships that control behavior; structure should not be confused with organization diagrams.
2. **Management processes** are the functions of the organization (planning, control, and management of information) and the decision processes used by the organization.
3. Taken collectively **individuals and roles** is the element that defines the human resources for the system: the development of individual skills and knowledge and the assignment of job tasks and responsibilities.

The two non-cultural components of the organizational sys-

tem, i.e., technology and strategy, describe what the organization is attempting to do and the financial and technical resources that are available to the organization.

4. **Technology** component consists of the tools and techniques available for the achievement of organizational goals
5. **Strategy** component is composed of the shared knowledge and assumptions about organization, goals, objectives, milestones, budgets, and plans.

An important element of the Morton model is the description of the two external influences, shown as existing outside the "organizational boundary" on the diagram in Figure 9, on an organizational system. Understanding the impacts of these two influences on oil spill response operations is a key element in developing effective RMSs.

1. The external **technological** environment describes the state of the technology relevant or available to the organizations to accomplish its tasks — what is the technological capability of the organization — and the availability of the technology to the organization.
2. The external **socioeconomic** environment consists of the social, cultural, economic, and legal framework in which the organization must operate.

External technological and socioeconomic factors must be considered differently during the pre- and post-event phases of a response. The planning process can establish who needs to interact with whom, by what means and for what reasons, and can establish a set of agreed upon expectations. In a response to an emergency situation, whether a natural disaster or significant spill, event-specific considerations tend to supersede the more general assumptions as the situation unfolds and details emerge (Harrald *et al.*, 1992; Card and Meehan, 1991; and Rolan and Cameron, 1991).

Morton suggests that external technological and socioeconomic factors, including political, economic and sociocultural factors, impact all organizations. He contends that the organizations which can most readily accommodate the influence of these factors are more likely to attain organizational goals. The next two sections look at these factors in the context of spill response operations.

## 3.2. THE INFLUENCE OF TECHNOLOGY

Technological limitations affect an organization's ability to respond adequately under various spill, e.g., weather, conditions. Most importantly, as mentioned in Section 2.1, existing oil spill technology has operational limitations that significantly limit the ability of response organizations to contain and recover the majority of spilled oil, except under the most helpful of circumstances. Wind and wave conditions also restrict the effectiveness of existing technology. For example, offshore recovery rates and the opportunity for the use of dispersants or *in situ* burning diminishes with high wind and wave conditions. A second consideration is whether the resources necessary to respond are available. Resources required to respond to a particular scenario are typically identified during a contin-

gency planning process, then contracted for or pre-staged. If the resources are not available due to other response commitments, maintenance difficulties or inadequate staffing, then the RMS may have to significantly increase its logistical capability to develop alternate sources of support. Recognizing the implications of technological capabilities, OPA 90 has provided a mechanism to assure that adequate response resources are available in the US for significant spills.

A third consideration is the availability of infrastructure support, such as multi-modal transportation, communications, facilities, lodging/feeding, etc. If the infrastructure is not present, or can not be used, then the RMS must also consider different options to support the response. Prince William Sound is the most obvious example of a spill response effort constrained by the difficult logistical problems encountered.

These technological factors vary widely throughout the world. The availability of response technology is very different in the technological environments of non-industrialized countries or in the US, Europe, and Japan. This directly impacts response strategy: in non-industrialized countries, for example, the primary task may be to mobilize resources from outside the affected area, usually from outside the affected country, while initial response efforts in industrialized countries might be to deploy pre-sited resources and activate pre-planned response organizations.

### 3.3 THE INFLUENCE OF THE SOCIO-ECONOMIC ENVIRONMENT

The other group of external factors that influence organizations are socio-economic. These factors vary among geographic areas and include politics, economics, and sociocultural aspects.

#### POLITICAL FACTORS

The political framework of laws, regulations, policies and international agreements is developed to direct or guide pre-event planning, training and operational response actions for specific geo-political units, e.g., national, regional, state and local jurisdictions. This framework generally applies to government agencies and commercial entities with specific responsibilities for prevention of and response to spills, as well as such matters as vessel inspection and financial responsibility. Included in each overall national structure are international treaties or conventions, such as MARPOL 73/78 and OPRC, and multi- and bi-lateral agreements, to which the country may be a signatory. Political sub-units within each country may also affect the political framework for spill response. Wilkes (1971) discusses the effects of jurisdictional overlap between federal and state regulations on spill response operations. One area of potential jurisdictional overlap at the federal level which should be considered is the relationship between the National Contingency Plan and the Federal Response Plan. This overlap could pose a significant jurisdictional dilemma in situations where the Federal Response Plan has clear purview, e.g., a community disaster resulting from a flood, which also causes an oil spill.

This framework of laws, regulations, conventions and agreements lays down the overall preparedness and response

requirements for industry operating within the jurisdiction, and may include factors such as response planning, notification, emergency actions, resource identification and contracting, protection of the environment, development of an RMS and funding for response operations.

These laws and other binding agreements establish the statutory requirements that all parties must meet in responding to a spill. Each entity with operational, post-event responsibilities — such as government agencies or the RP — must logically have some form of RMS to oversee and supervise every response operation, regardless of how minor or routine. This system should create the maximum probability that the response manager can conduct an effective operation. The authors contend that the RMS must have the capability to adapt to outside pressures, such as emergent political interests, which will likely be present in a significant spill, but are not specifically addressed in law or regulation.

Political factors may exert a substantially different influence over the design into which an RMS evolves after a spill occurs. For example, a combination of factors, including the size and location of the spill, often causes government agencies at all levels, that may not have been included in the planning process, to become involved. What appears to occur is that, in spite of extensive planning, and often approval of plans by various levels of government, elected leaders and government agencies determine that the situation demands a higher and more influential level of oversight, and create new systems that supplant, if not the existence, at least the authority of the RMS. This is one type of emergency that frequently occurs in significant oil spills. Additionally, the individuals involved in the basic technical planning — who develop clear, mutual understanding of response organizations' capabilities, expectations and philosophies — are often replaced by senior officials, with greater political sensitivity but less technical understanding of the issues, once an event occurs. These changes, taken to defuse potential or perceived political issues, tend to remove or limit the personnel with the most knowledge and understanding of response operations in general and the RMS, in particular.

This was the case during the *Torrey Canyon* response in 1967, in which the OSC noted that there appeared to be "more cabinet ministers on scene than in London," and that it appeared that "the Prime Minister managed the spill response" (Garnett, pers. comm., 1994). This apparently characteristic elevation of management also occurred during the *Exxon Valdez* response, as evidenced by the recommendation by Secretary of Transportation Samuel Skinner to the White House Chief of Staff that the response be "federalized"; that a "troika" comprised of Alaska Governor Steve Cowper, VADM Clyde Robbins, USCG FOSC, and Mr. Otto Harrison, Exxon's Operations Manager above both the Steering and Operations Committees (Harrauld *et al.*, 1992; US DOT, 1993) be established; and that the Department of Defense also assume substantial responsibility for operations (Smith, pers. comm., 1989; Smith, pers. comm., 1994). Even in those spill response operations characterized as "successful," such as the *American Trader*, the same elevation of guidance or control existed.

(Card and Meehan, 1991; Rolan and Cameron, 1991). In the US, the proposed system for management of SONS appears to recognize this phenomena and establishes, in policy, an expanded RMS once a SONS is declared (US DOT, 1992; Jensen *et al.*, 1993). It is interesting to note that the same phenomena appears to occur during natural disasters, as indicated by the establishment of the Presidential Task Force, headed by Secretary of Transportation Andrew Card, during the response to Hurricane Andrew in Florida in August 1992 (Carley and Harrauld, in press).

Adding to the complexity during the response is that political concerns unrelated to the spill itself or the response may influence decisions. Elected officials are sensitive to issues raised by constituents, and political issues can emerge which may run counter to stated government policy, particularly during election cycles. For example, Carley and Harrauld (in press) suggest that during the response to Hurricane Andrew, concern about the 1992 presidential election, in which winning the electoral votes in Florida would be a key objective, may have influenced President Bush's decisions, particularly establishment of the Presidential Task Force, to enhance the Administration's image as responsive and committed.

## ECONOMIC FACTORS

Another factor affecting RMS design and implementation is the impact of economic considerations and financial obligations on the management of the spill response. During pre-spill planning, companies appear to focus on requirements of the laws and regulations in those countries in which the company is operating. In the US, for example, this may include obtaining Certificates of Financial Responsibility; maintaining protection through membership in a P&I Club; entering into contracts or other agreements with Oil Spill Removal Organizations (OSRO) such as the Marine Spill Response Corporation (MSRC), National Response Corporation (NRC), spill response cooperatives or other contractors; training Qualified Individuals (QI) and Spill Management Teams (SMT); and conducting drills and exercises. Additionally, it can be reasonably assumed that each company recognizes the impact not only of the spill response operation, but also of the attendant business disruption (for example, closing a terminal or bulk storage facility during a response operation), on its overall activities and plans for, or at least considers, reestablishment of operations even during the response, if possible. For example, following the March 24, 1989 *Exxon Valdez* spill, the port of Valdez was reopened to limited tanker traffic under tight controls on the morning of March 28, 1989, and by 2:00 pm that afternoon to all traffic. The COTP indicated that in hindsight he should not have done so. He noted that he was already under pressure from the US Department of Energy, ARCO and other members of industry and believed that, if he had not opened the port, he would have been "forced by political pressures to do so ..." in light of the percentages of national oil moving through the port of Valdez (US DOT, 1993, pp. 23-24).

Once a spill occurs, however, a wide range of economic considerations among responders can impact the decision

making processes in the RMS. Since each entity involved in the response potentially views the economic or financial concerns differently, the entire issue has the potential to become very complex. Differences in financial perspectives, which can be indicators of conflicting goals, tend to promote adversarial behavior and erode whatever trust exists among responders. When extreme differences or a lack of understanding of the different perspectives occur, there exists a potential for weakening the linkages among the decision making portions of the response organization.

It can be safely assumed that whoever is responsible for paying for clean up operations will probably try to control, if not minimize the costs, while conducting an effective response that complies with the intent of the law and direction of the appropriate government agency. Given that RPs operate on a profit-making basis, this outlook is certainly rational. What constitutes an effective and efficient response is a question that drives many decisions and has financial implications. The RP, in keeping with its fiduciary obligations to its stockholders, investors, and the P&I Club, representing the insurers of the RP, can be expected to press for realistic and reasonable decisions that focus on reducing the damage on the environment. In fact, ITOPF, the technical representative to the P&I Clubs, has developed criteria to assess the reasonableness of claims, where reasonableness generally means "that the measures taken or equipment used in response to an incident were, on the basis of a technical appraisal at the time the decision was taken, likely to have been successful in minimizing pollution damage" (ITOPF, 1994). Both the RP and the P&I Clubs can be expected to support aggressive commitment of all available resources during the emergency phase of an operation, but scaling back as time passes in proportion to operational requirements. Both the RP and the Clubs are likely to oppose inflated government agency staffs, such as personnel included in the response for training purposes, deployment of equipment in a standby status, use of government equipment when less expensive commercial equipment is adequate. P&I Clubs might be expected to also oppose actions taken primarily to satisfy public opinion or media criticism; RPs may or may not consider such actions reasonable.

Some of the responders' opinions believe that if the RP is performing adequately that publicly-owned response equipment is not necessary. Other responders indicated that activities should not be funded if they will be more environmentally damaging than the oil, ineffectual, or unrelated to response priorities. Activities specifically mentioned include research that does not directly contribute to the response and public relations "blitzes."

Government agencies do not share the same view of cost control as RPs and P&I Clubs because response costs are not funded out of agency budgets. In the US, a public fund, the Oil Spill Liability Trust Fund (OSLTF), is used to fund government response actions, including those spills when no RP has been identified. For spills where the RP is known, RPs will be presented with a bill for government response costs to reimburse the OSLTF. Where the RP must reimburse the government, or where the government costs are funded by

non-taxpayer sources (such as the OSLTF), there is no apparent imperative for the government to consider the economics in the decision making process. At the time of the *Exxon Valdez* spill there was only \$6.7 million in the USCG-administered Oil Pollution Fund, and the USCG would have had to receive special funding arrangements if it were to assume the lead financial role. This funding issues was a factor in the decision not to federalize the response, but to let Exxon, which had pledged from the early hours of the response to fund response operations, continue as the lead response entity (US DOT, 1993).

The difference in viewpoints on financial issues between government and the RP, and their insurers, and the effect the differences can have on effective management of a spill, has been formally recognized by a government/industry Quality Action Team in the New Orleans area. In a letter to the Commander of the Eighth Coast Guard District (Wells, 1994), the Quality Action Team makes recommendations to address issues of concern about the reasonableness and accuracy of bills for government removal costs that are presented to responsible parties following oil spills. The Quality Action Team recommended actions to ensure that response actions are reasonable and implementing the actions would "ensure a more effective overall spill response" (Wells, 1994).

A secondary cost to the government may be compensation for the social impact of the spill, such as claims by individuals who can not work because of the spill. These costs are typically not the responsibility or immediate concern of the response organization. In many cases, it would seem that these impacts can be mitigated to some extent by using the maximum number of local workers in the spill response. A larger consideration that may govern the design of the emerging RMS is the economic impact on the local industry and population in the area affected by the spill. The concerns of the fishing industry, both commercial and subsistence, in Alaska during the *Exxon Valdez* response operation, dictated inclusion of representative groups in the decision making process (US DOT, 1993; Walker and Field, 1991).

## SOCIO-CULTURAL FACTORS

A third external set of factors that affects the design and implementation of an RMS are the sociological and cultural characteristics of an area. In the US, for example, socio-cultural differences between the North and the South, and the East and the West are well-recognized. These types of differences certainly also apply to other countries. The socio-cultural differences of various areas influence people both internal and external to response organizations. These factors can compel an RMS to adapt in order to adequately address socio-cultural concerns associated with a spill event, which can differ at the country, regional, and even community levels.

Research into disaster response indicates that when the social fabric of a community is disrupted, the community tends to turn to the responding organization for assistance in meeting basic needs. After Hurricane Andrew, for example, multi-denominational church groups formed a network of food and shelter providers, reaching significant numbers of

victims that the government and American Red Cross could not (Carley and Harrauld, in press). While the bulk of the research has addressed the ability of responders to provide for basic survival needs after natural disasters, there may be some of the same dynamics at work after an oil spill. After the *Exxon Valdez* spill, for example, the concerns of native Alaskans about the effects of the oil on subsistence fishing and other marine harvesting, the source of the majority of the protein in their diet, led to formation of the Alaska Oil Spill Health Task Force (Walker and Field, 1991). While this group, comprised of state, federal, commercial and local representatives was successful in initiating appropriate action, it indicates how indirect social impacts can cause an RMS to adapt to include emerging interests and groups. Other potential social impacts appear to be the effect of the shutdown of local businesses, even if temporary, with the resultant job loss; the impact of environmental damage on lifestyle, such as recreation; and the specific impact of the spill on ethnic or social groups. The social and cultural impacts of the *Exxon Valdez* spill were major factors in the State of Alaska's decision making process during the spill response and were the basis for many of the areas of conflict with the Federal OSC (Alaska DEC, 1993).

The socio-cultural environment includes other factors that, although less clearly defined, significantly impact response management. These include:

1. The organization, skills, resources, and objectives of other stakeholders such as environmental groups and citizen groups;
2. The society's expectations about the likelihood of an oil spill, the environmental impact of oil spills, and organizational performance of the oil spill response organization;
3. The willingness to spend public funds on spill response preparation; and
4. The ability of citizens to influence government actions during a crisis response through public, political, and media pressure.

## 3.4 ORGANIZATIONAL RELATIONSHIPS IN TRANSITION

A spill response is a dynamic organizational event. The effect of resource mobilization on the size of the response organization is shown in Figure 10. As the organization expands, it goes through three organizational stages: the emergency phase, the transition phase, and the production phase. During the emergency phase, the response organization consists of initial responders. The organization is required to absorb the mobilized external resources during the integration phase and reaches organizational stability during the production phase. Organizational changes must occur as the response progresses from a pre-event organization through the three response phases. The transition between these phases is, as represented in Figure 11, often marked by an initial regression in organizational output and effectiveness. This

degradation in effectiveness is, as pointed out by Chew *et al.* (1991) a common, but not inevitable result of organizational change or transition. The avoidance of the drop in performance at critical points in the spill response is a primary objective of an RMS. Organizational performance and facilitating organizational change during these transitions is enhanced by understanding and balancing the inter-relationships in the organizational system between the **organizational culture** (structure, roles, and processes) and the **organizational strategy and technology** (Morton, 1991).

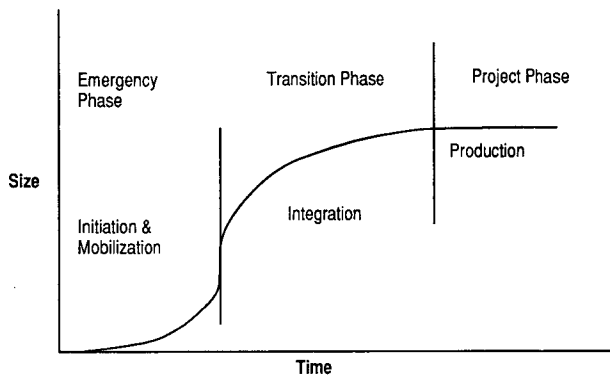


FIGURE 10. STAGES OF A SPILL RESPONSE

The emergency (mobilization and initial response) phase, is marked by the execution of tasks that are pre-defined by the contingency plan. The success or failure of the mobilization effort depends upon the adequacy of the plan and the ability of the various entities to immediately execute the plan. Mobilization is virtually impossible if organizational requirements and resources to be mobilized have not been identified in pre-spill planning. There is agreement between theorists and practitioners on this point. Some practitioners believe that RMS should be initiated with a small emergency group of two to four individuals who are cross-trained in functionality and will form the nucleus of the RMS as it builds over the transition phase (O'Brien, pers. comm., 1994). The theorists note that in the short run, small teams that form on the fly and are empowered to act on the basis of their experience and knowledge effectively deal with crisis (Carley and Harrald, in press). At the same time, inadequate mobilization or lack of resources can doom the response effort from the start. In the *Exxon Valdez* response, for example, the unavailability of Alyeska response equipment, upon which Exxon was relying, caused significant problems in the very early hours of the response. Additionally, the remote location of the spill delayed the arrival of equipment needed to contain the spill near the source during the emergency phase. Likewise, the Coast Guard did not have a well defined billet (staffing) structure until a month after the spill and did not have a smoothly operating personnel mobilization system until the end of the summer (US DOT, 1993).

The second stage of a crisis response, the transition phase, is the period required for the responding forces to arrive on scene and, using the emergency phase as the starting point, develop an effective operating system that can manage the response in the project or production phase. Tuckman (1965)

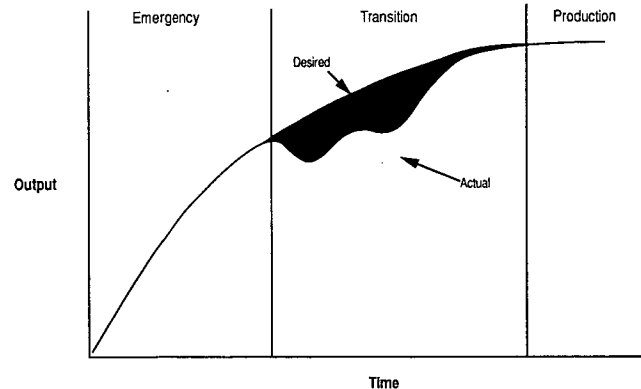


FIGURE 11. TRANSITION THROUGH THE STAGES

has pointed out that all groups go through the stages that may be categorized as orientation, internal problem solving, growth, and productivity and control. He termed these stages as "forming," "storming," "norming" and "performing." The RMS should focus on getting the entire response organization through the integration phase and into the production phase as quickly as possible, while effectively managing the ongoing operations. The ultimate, and unattainable, goal should be to reduce the duration of the transition phase to zero. In optimal situations, transitions can occur over a period of hours or days. For example, some responders are now planning for a one day emergency phase, a one day transition phase, and being in the production phase by the third day of a significant event.

Three factors can impede the transition to the production phase:

1. *task complexity* — the tasks facing the organization can not be centrally coordinated during the time frame available due to lack of resources or capability. The existence of unresolved problems may lead to the emergence of *ad hoc* organizational groups engaged in problem solving behavior (Dynes and Quarantelli, 1968). A maritime casualty may involve multiple and diverse tasks such as rescue, salvage, firefighting, and pollution response. A weakness of the US system is that the expertise for these tasks resides in different formal organizations and must be integrated during emergency conditions. The pollution response and casualty response systems must either be integrated or coordination channels established to enable managers to make resource trade-offs and avoid conflicts.
2. *organizational incompatibility* — the organizations that must operate as an integrated or unified entity in the response subsystem may be incompatible along one or more dimensions. They may be culturally incompatible, geographically incompatible (e.g., land based or maritime based) and/or functionally incompatible (conflicting functional responsibilities).
3. *political incompatibility* — organizations may not rely on the same processes or same criteria to make decisions. In the extreme case, decision authority may be withheld from the members assigned to the response.

organization by the parent organization. A more typical example of this incompatibility would be a conflict between organizations used to centralized autocratic decision making and organizations accustomed to decentralized or group decision making processes. Spill response organizations, particularly those that integrate various levels of government jurisdiction and the RP, may have to accommodate very diverse organizations.

The difficulty of integrating multiple, stranger organizations into a single response organization to manage a significant or catastrophic spill response should not be underestimated. The cultural, organizational, and political capabilities and incompatibilities must be recognized and resolved prior to the event. As stated in the *Exxon Valdez* FOSC report:

"The common theme of the organizational problems described above is the difficulty of developing, under the conditions of extreme emergency that mark a spill of national significance, an organization which is both politically attuned at the relevant government levels and operationally efficient for the task at hand" (US DOT, 1993).

The objective of the integration/transition phase is to achieve the organizational and functional stability of the pro-

duction phase. The organization that emerges in the production phase, however, looks and acts quite differently from the organization that responded during the emergency phase. Ott *et al.* (1993) suggests a two phase organizational taxonomy during response with a post-response investigation phase. An emergency phase and a project (or production) phase differ significantly in their tasks, decision structure, and planning methodology as shown in Figure 12. Note that Ott *et al.* suggests that these two phases necessarily overlap for a period of time, creating the transition phase described above. In the emergency phase, decisive action is particularly time critical to making a difference in the outcome. During this period, principal activities include minimizing the spillage at the source and coordinating salvage and rescue operations. These emergency activities are most appropriately handled using an autocratic, or command and control type of organization. In the project management phase, however, response activities occur over a longer time frame and a formal process to plan for future requirements and to meet both anticipated and emergent demands is required. The easing of time pressures allows for a decision making process that accommodates multiple organizations and stakeholders.

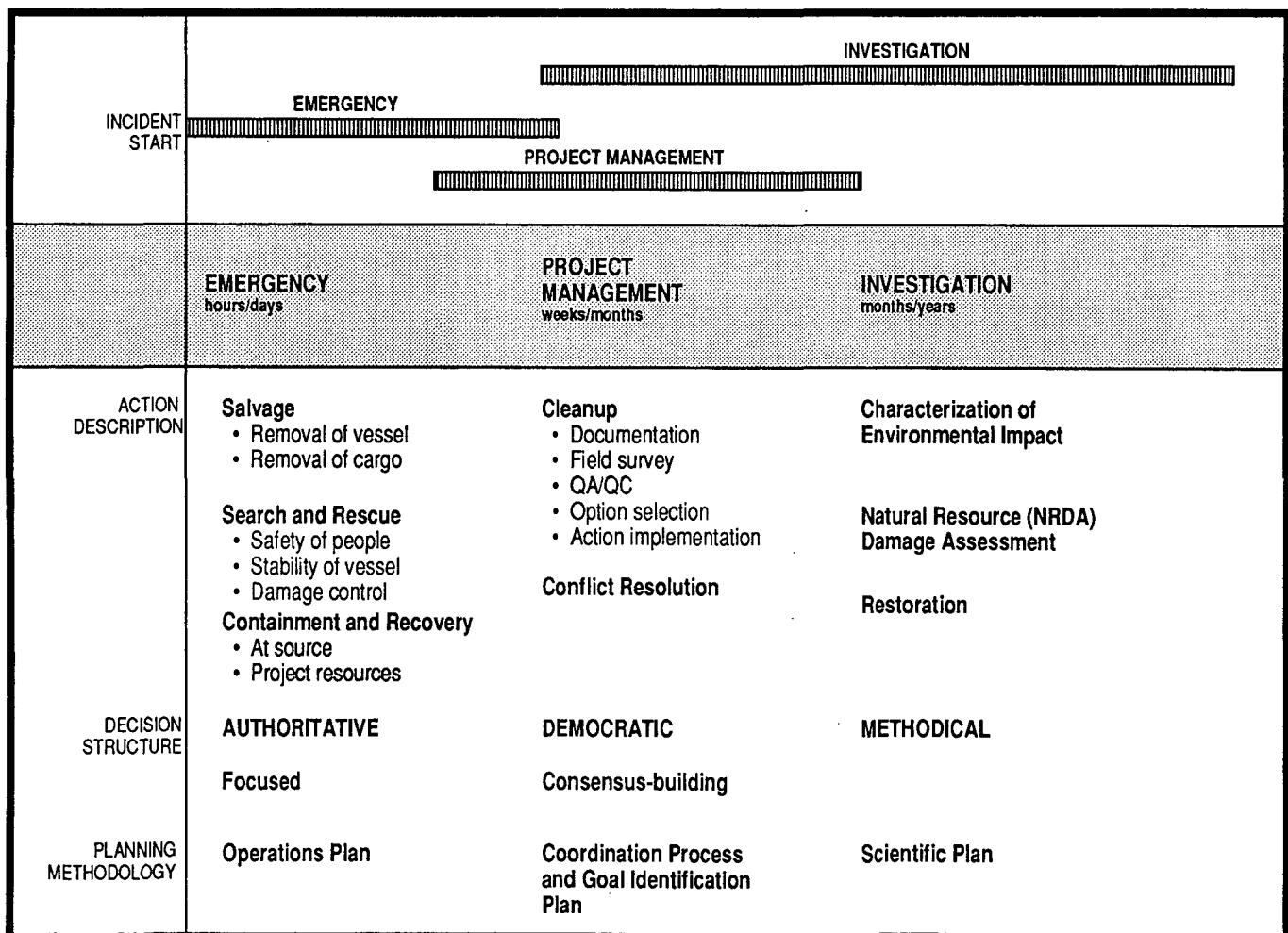


FIGURE 12. OVERVIEW OF THE OVERLAPPING PHASES OF A SIGNIFICANT OIL SPILL INCIDENT (ADAPTED FROM OTT ET AL., 1993)

## 3.5 TYPES OF RESPONSE MANAGEMENT SYSTEMS

During spill response multiple, separate organizations must collaborate to achieve response goals, event-specific objectives and operational objectives, and implement action plans. The need for an effective RMS to bring these organizations together is obvious. Review of the systems used to manage spill responses seems to suggest that, while there are many variations, there are two types of organizations: closed systems and open systems. These types of RMSs represent two opposite ends of the spectrum of how organizations can operate with regard to their external environment. Organizations typically fall somewhere on a continuum between being totally closed and totally open. The following section describes systems that are **relatively** closed as **closed**, and systems that are **relatively** open as **open**.

### CLOSED SYSTEM

Strictly speaking, a closed system is one that does not interact with its technological, political, economic, or socio-cultural environments. Such an organization operates within the organization boundary, as depicted in the Morton diagram (Figure 9). There is a little impetus to consider or address external influences. All feedback systems are internal to the system. The traditional "command and control" or military model is an example of this type of system; it was originally designed to operate in a closed manner.

The characteristics below generally apply to closed, command and control-type, systems:

1. Hierarchical structure with clear lines of command and supervision;
2. Centralized direction is provided by a single person who is in command or in charge;
3. The overall structure is developed in the planning stages with little provision made for adaptation to emergent groups;
4. Communications are normally conducted through formalized channels;
5. Activities are directed by official (internal) entities with little requirement for outside assistance; and
6. Separate crisis organization, staffed by individuals from separate organizations, is formed to manage the response.

The traditional NIIMS ICS was designed as a closed, command and control system, and it operates effectively in emergency situations where groups of fire fighters are integrated within a single organization and have little interaction with non-fire fighting groups. Generally, their activities are separate and relatively insulated from the political, economic or socio-cultural elements of the environment; and they focus on the same goal, the fire. This is partly because most of their response activities are concentrated in the emergency phase, as depicted in Figure 12 (Ott *et al.*, 1993), where an autocratic or command and control form of management is most appropriate and effective.

The "command and control" type system appears to be a common model for normal, day to day (steady state) opera-

tions and crisis management, used by both private and public organizations. It appears that closed systems frequently are used by steady state organizations and then applied to emergency situations. The researchers have documented numerous occasions when closed systems have been ineffective in the overall management of disasters and other emergencies, i.e., Chernobyl, Hurricane Hugo, Hurricane Andrew, *Exxon Valdez*.

Given the reality that multiple organizations must work collaboratively during all phases of response and accommodate emergent groups, however, the closed form of management system does not appear to meet the fundamental organizational needs for most significant oil spills. What is needed is an RMS that allows for multiple organizations, using Spitzer's terminology from Section 1.2, to integrate, or at least unify. A closed system, one perhaps which is command and control based, however, may be a very appropriate organizational model for individual organizations involved in a response, who will execute the decisions made at the command level. For example, the internal organizations of an RP, clean up contractor, or OSRO might function most effectively using a closed type of organizational system. The system that brings together the various entities, who have some shared and different goals, cultures, and responsibilities requires the more open organizational characteristics.

The use of command and control systems in disaster response operations has been strongly criticized by some leading disaster researchers. In particular, many of these researchers see the broad acceptance and application of ICS variants as a significant concern. Careful analysis of the literature, however, suggests that this type of system can be appropriate for managing routine oil spill response operations, and executing decisions made during to significant and catastrophic spills. The single point for decision making, such as the Incident Commander in ICS, does not appear to be appropriate for overall management of significant spills.

1. The organizational cultures of responding organizations are relatively homogeneous.
2. The skills and knowledge of people match tasks and responsibilities required by the jobs to which they are assigned.
3. The goals and objectives of participating organizations and individuals are congruent.

Therefore, the success of command and control models in a significant oil spill situation is problematic, both at the command (decision making) and functional (decision implementation) levels.

Dynes' research indicates that these assumptions inherent in command and control models have been absent in over 50 technological and natural disaster response operations. It is instructive to note that these three assumptions are very similar to the factors, i.e., decentralized decision making and flexibility, that Roberts (1989) independently identifies as necessary for a high reliability or high performance organization, i.e., a human system that performs at levels of excellence far beyond those of comparable systems. It is important to understand that high reliability does not mean perfectly functioning. It means that a

system avoids fatal errors and catches small problems before they become major ones. Spill management systems can and should become high reliability systems.

Dynes also points to two assumptions concerning the external environment, identified by Morton (1991), which are typically not true in any disaster event, or a significant oil spill, but are central to ICS success:

1. Adequate resources and technology are available.
2. The response can be shielded from external socio-economic forces.

A discussion about adequate resources is beyond the scope of this paper, although the issue is touched upon in Section 2.1. Because the effects of oil spills are so visible and the public tends to react to oil spills in emotional ways, spill response can seldom be shielded from external forces. The next section describes a type of system which is relatively more capable of dealing with forces external to the organization than closed systems.

## OPEN SYSTEMS

The second type of organizational system is the open or "problem solving" system (Tierney, 1994 Notes — Red Cross IRM). An open system, strictly speaking, is one in which feedback from external environments is the critical determinant of system behavior, and ultimately, system success. Such a system relies on internal and external feedback, organizational learning from the reactions of the external environments to its decisions, distributed decision making by small *ad hoc* teams and a high degree of flexibility and innovation.

The characteristics noted below generally apply to open, or problem solving systems.

1. Decision making authority is distributed to the lowest possible level;
2. Response organizations are flexible and particularly sensitive to outside influences;
3. Response organizations are capable of improvising based on the results of feedback and analysis of the success of prior actions;
4. Organization relies on informal functionally-based decision making groups, which include both internal and external member, which form as necessary to address specific problems, then disband;
5. Complete details of the structure and process are not pre-event planned; the organization relies on the ability of the organization to learn and develop new appropriate ways to deal with problems; and
6. Response builds on existing organizations.

No discrete example of an open system was identified during the preparation of this paper, probably because of the above characteristics, i.e., open systems are dynamic and evolve during emergencies. However, the response to the *American Trader* oil spill is an example of an open form of ICS which evolved over time. Figure 13 displays the crisis management command staff developed by BP America (BPA) prior to the spill. The BPA organization is an ICS variant. During the

oil spill, the basic organization was modified and expanded as displayed in Figure 14 (expansion of the operations section) and Figure 15 (expansion for the planning, logistics, and finance sections). This evolution of the organization during the incident represents organizational learning, one of the characteristics of open systems. This learning continued after the spill, as evidenced by comparing the environmental section in Figure 15 with Figure 16, because BPA saw that the structure needed to provide for expanded functions in the environmental area (Rolan and Cameron, 1991). The openness of the RMS used during the *American Trader* is displayed in Figure 17, which represents the response organization for this incident as presented by the OSC (Card and Meehan, 1991). The command and control and liaison/advisory lines indicate a noticeable degree of integration among the responding entities. The OSC stated in his paper that, "Overall intergovernmental coordination and cooperation ... was exceptional ... this aspect of the response may be considered its hallmark. The Federal OSC's decision to include all concerned federal, state, and local agencies in the daily planning sessions with British Petroleum helped achieve this solidarity."

The high performing or high reliability organizations described by Vaill and Roberts provide insight on models for organizational design and development for spill situations, particularly significant or catastrophic events. High performing systems are those that perform at levels of excellence far beyond those of comparable systems (Vaill, 1982). High-reliability organizations are defined as large scale organizations with complex technical, human, organizational and cultural components which necessitate the development and proliferation of high degrees of organizational reliability and safety (Roberts, 1994). Review of the literature seems to indicate that the Vaill model, with its emphasis on integrated action, innovation and creativity, communication and decision making by *ad hoc* groups and

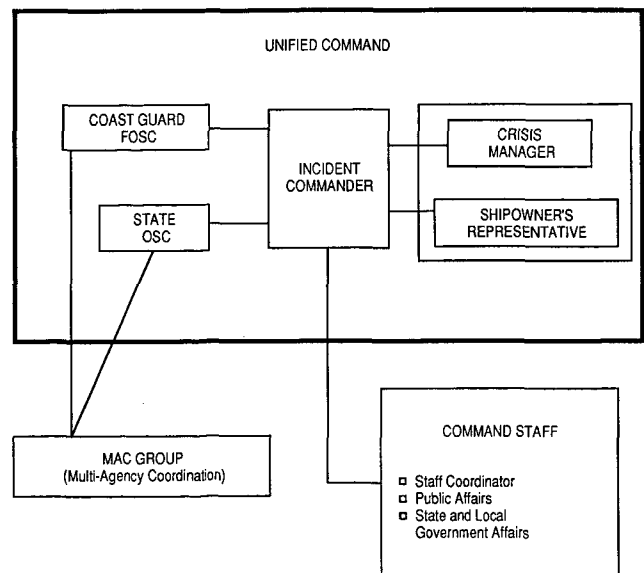


FIGURE 13. MODIFIED VERSION OF THE ICS COMMAND STAFF IN EFFECT  
PRIOR TO THE *AMERICAN TRADER* SPILL  
(FROM: ROLAN AND CAMERON, 1991)

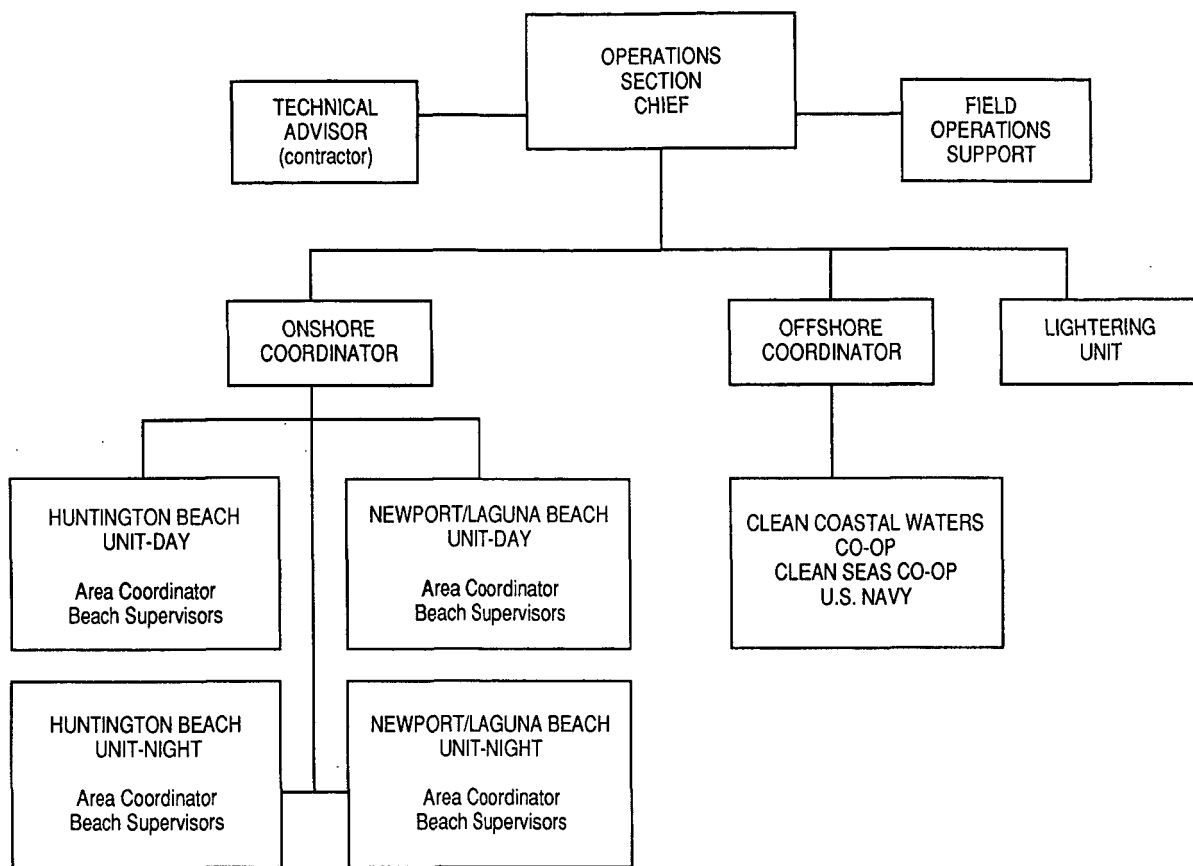


FIGURE 14. STRUCTURE OF THE OPERATIONS SECTION AS EXPANDED FOR THE *AMERICAN TRADER* SPILL RESPONSE (FROM: ROLAN AND CAMERON, 1991)

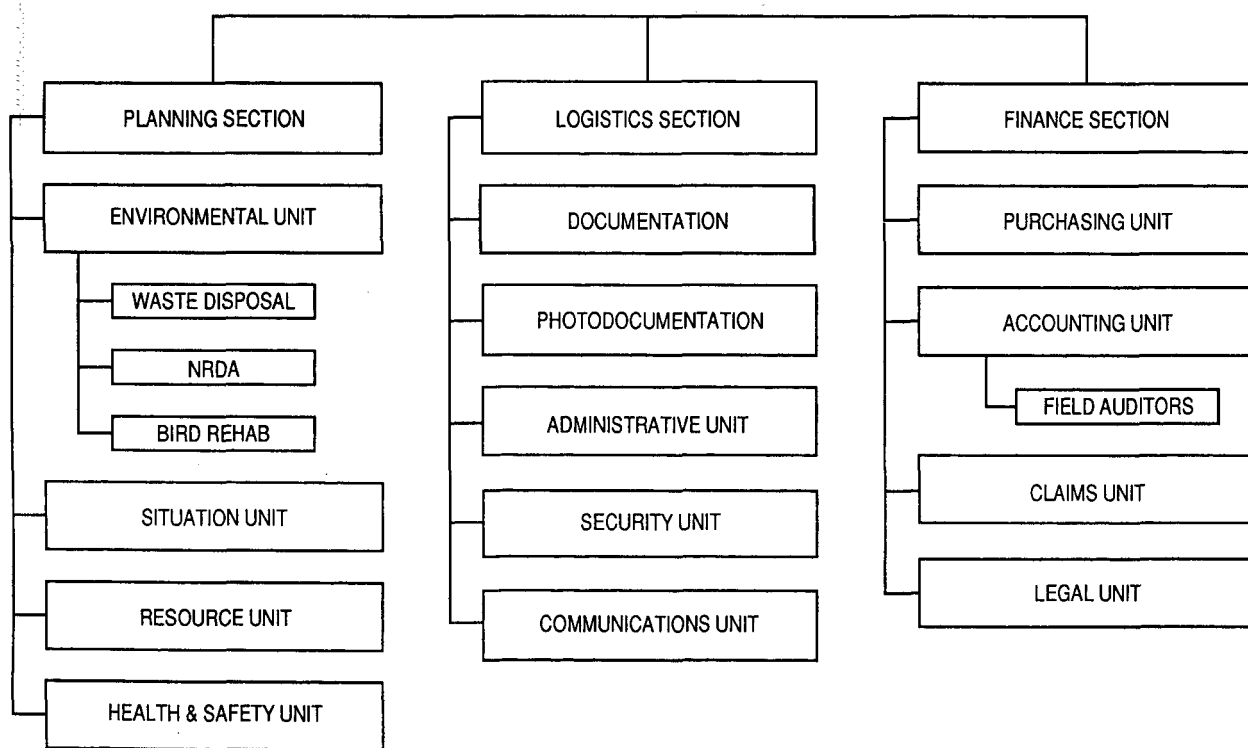


FIGURE 15. STRUCTURE OF THE PLANNING, LOGISTICS, AND FINANCE SECTIONS AS EXPANDED FOR THE *AMERICAN TRADER* SPILL RESPONSE (FROM: ROLAN AND CAMERON, 1991)

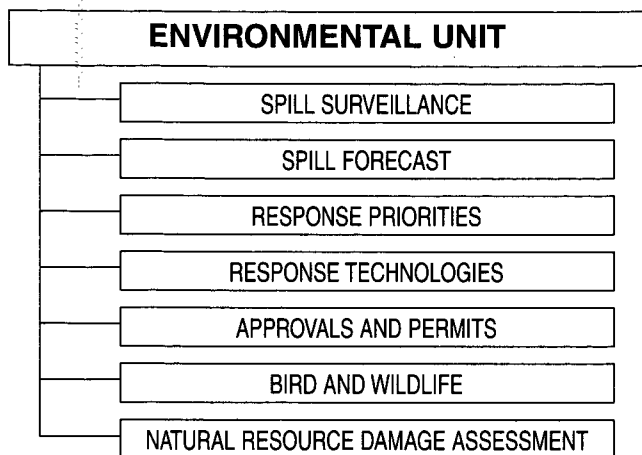


FIGURE 16. STRUCTURE OF THE ENVIRONMENTAL UNIT ESTABLISHED AFTER *AMERICAN TRADER* SPILL (FROM: ROLAN AND CAMERON, 1991)

strong commitment to purpose, can be closely identified with the characteristics most normally associated with open, problem solving systems. The characteristics of high reliability organizations are not incompatible with hierarchical systems typically viewed as command and control systems. The system used as a model by Roberts in her studies of high reliability organizations was, in fact, a military system — a US Navy aircraft carrier during flight operations — although she notes that the Navy, like other DOD services, is moving away from centralized, relatively inflexible command and control systems due to complexities of integrating multiple warfighting functions.

Existing systems, even closed systems, have the potential to undergo change and be **implemented** as open systems during emergencies. The authors consider a fully integrated Unified Command Structure of an ICS variant to function as an open-type of system. The Unified Command Structure as mentioned in the recently published revision of the US NCP also appears to be an open type of RMS. These applications of unified command will be discussed in the next section.

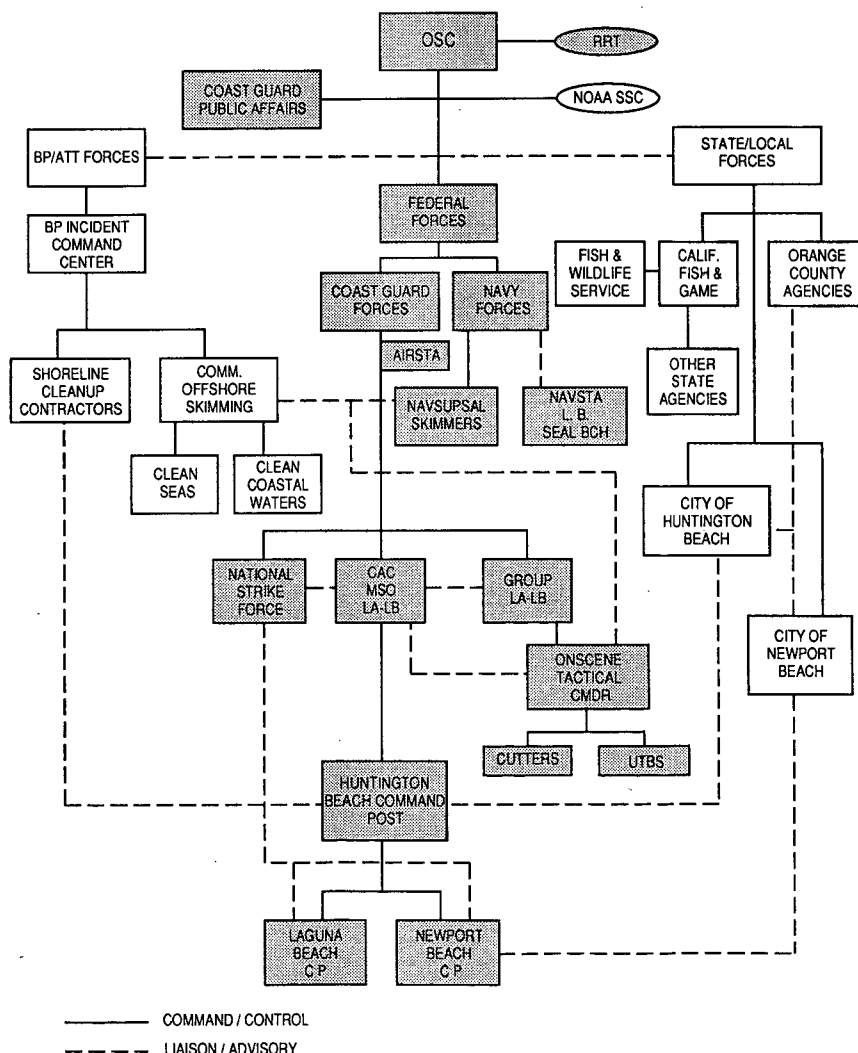


FIGURE 17. DIAGRAM OF THE RESPONSE ORGANIZATION FOR THE *AMERICAN TRADER* (FROM: CARD AND MEEHAN, 1991)

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## SECTION 4.0

# CURRENT STATE OF KNOWLEDGE

The objective of this section is to describe current RMSs in use internationally and in the US and to consider them in light of the theoretical aspects of sound RMSs design and implementation that were set forth in the previous section. To provide a framework for discussion and comparison of existing systems. Section 4.1 also identifies qualitative factors by which RMSs can be thoughtfully considered. Because the available information on existing systems widely varied on type of information and detail, the review and discussion of these systems is necessarily different.

The aim of an RMS is to manage a successful response. As discussed in the first section, definitions of success are qualitative and variable. However, the practitioners have provided a reasonable basis for considering the extent to which an RMS can enhance the potential to achieve a successful response through the identification of Critical Success Factors (CSFs).

## 4.1 CRITICAL SUCCESS FACTORS

CSFs are defined by Rockhard (1981) as the set of things that must go right if an operation is to succeed. The identification of these factors for an oil spill response was the objective of a series of scenario-based exercises conducted by Harrauld (1994) at the USCG On Scene Coordinator Course, the State of Texas General Land Office, Marine Spill Response Corporation and Local Area Team in the Port of New York. Over 100 experts participated in the exercises and identified the following six Critical Success Factors.

1. *The salvage operation for a vessel spill, or emergency response operation at a facility, must minimize spillage of oil and must not interfere with pollution response operations.*

The best way to minimize the environmental impact of a marine casualty is to secure the source. Yet, this is difficult to accomplish without impeding pollution operations, when only limited resources are available during the emergency phase. This implies the close coordination of search and rescue, salvage and response operations.

2. *The immediate response by the RP and the Coast Guard must mobilize enough appropriate response resources (people and equipment) to contain most of the oil at or near the source and to protect sensitive areas.*

The second most obvious way to minimize environmental impacts is to prevent the pollutant from spreading to sensitive areas. This can be done only if

appropriate response resources can be quickly and effectively brought to bear by the RP and OSC to contain, deflect, disperse, or remove the oil before it comes ashore. This factor is obviously dependent upon the location of the casualty and the forces of wind and weather. In many cases, achievement of this CSF may be physically impossible.

3. *The response organization must be able to communicate and manage information internally and externally.*

Feedback on the effectiveness of strategy and tactics must be provided to decision makers if the response system is to adapt its strategy and tactics and remain goal directed. Accurate and timely information also must be provided to the media and public. Effective information flow is critical to spill management and expectation management of the public. The problem of management of internal feedback (within the response organization) and external communications (between the response organization and outside entities) must be recognized and solved.

4. *Coordination between federal, state, and local organizations and the RP must be pre-planned, account for stakeholder interests and ensure a response organization that will be cohesive and effective.*

The response organization must work effectively during the immediate initiation and mobilization phase, while supporting the rapid transition into the production or project phase without losing organizational effectiveness. Integration must be achieved without public conflict. Pre-spill planning must identify and account for stakeholder interests and resolve potential organizational conflicts.

5. *The response organization must be capable of sustained effective operations.*

Sustained effective operations means that, throughout the phases of response, those in charge must be technically able to identify useful response strategies, recognize when a response strategy is inappropriate, and quickly adjust strategy and tactics to the actual situation. Adequate personnel and equipment capabilities, and logistics support, must be maintained. The success of the response will be jeopardized if appropriate operations can not be sustained.

6. *The response organization must meet the public's realistic and achievable expectation for pollution response.*

If the public and the media have established and

accepted a pre-event definition of success that can not be achieved such as zero environmental impact or immediate and effective response under all weather conditions, the response will be perceived as a failure regardless of how it is conducted. Communications with the public, both during preparedness and response, need to focus on providing them with realistic expectations.

## 4.2 ORGANIZATIONAL CAPABILITIES AND DESIGN REQUIREMENTS FOR RMSs

Ideally, the scholarly literature should provide clear research findings that describe how to create effective RMSs to support achievement of the CSFs. Unfortunately, as Roberts (1994) points out, the disaster response community does not have an (research-based) understanding of the organizational behavior of **systems of multiple and large organizations**. What follows is an attempt to develop some basic considerations based on implications derived from review of literature that addresses organizations which may be similar to those created to manage spill response operations. According to a USCG representative, response management consists of directing, supervising, and carrying out actions to clean up oil spilled into the marine environment and/or to prevent the discharge of such oil into the marine environment (Giacoma, pers. comm., 1994). Note that there is no size or significance criteria attached to the definition. Therefore, it must be assumed that RMSs must be designed and implemented to manage the response to all spills, from the routine to the catastrophic. According to the opinions of responders, a minimum organizational design requirement is needed for a successful response. Most agreed that it should be based on the ICS, which allows for standardization, expandability and is multi-jurisdictional. Others suggested that there should be, at least, an one person for each of the five functional areas in ICS, plus a individual dedicated to public affairs.

Further research is needed to validate the hypothesis that there may be factors, unrelated to the specific type of organizational design, that must be addressed in order to create the potential for successful management of a spill response. Such research could have significant implications for RMSs design and implementation. These factors could be viewed as fundamental management functions that guide both the internal and external operations of the RMS. As suggested by Dynes and Quarantelli (1976), they must be planned for during the preparedness phase, but constantly evaluated and adapted during the operation.

These observations indicate that, since response to a significant or catastrophic spill is so complex and dynamic, any emergency organization, regardless of the validity of its original design, will change over time. This is consistent with Quarantelli's suggestion that the phenomena of emergence, or the tendency of organizations to adapt as functions change, "is not necessarily dysfunctional, bad, or inappropriate ... emergence represents an effort to solve problems." (Quarantelli,

1983) Examination of three US spill response operations — the *Exxon Valdez*, *American Trader* and *Morris J. Berman* — seems to validate this thought. The challenge would then become creating not only an organizational design, reflected in a contingency or response plan, that would be appropriate for routine spills while serving as the basic structure for more substantial spills, but also a careful and well-considered process to guide the adaptation or growth during significant or catastrophic spills.

### ORGANIZATIONAL CAPABILITIES

A well-designed RMS appears to be a necessary condition for, but does not guarantee, a successful response to an oil pollution event. The CSFs discussed in Section 4.1 suggest that the **organizational capabilities** described below must be created in order for a RMS to be both effective and efficient in all three stages of the response. The authors believe that, to achieve the CSFs listed in the previous section, an organization must possess the following attributes of open, high reliability systems.

1. *Ensure goals and objectives are clearly stated and accepted by the entire organization.*

Schoderbek *et al.* (1985) suggest that the successful response system must be goal directed, that organizational goals must be clearly stated and universally accepted concept of success must exist if the organization is to be effective. It is clear from the practitioners' responses, discussed in Section 2.3, that views on this subject vary considerably. This can contribute to a less than effective response. Vaill (1982) found that high performing systems have clear objectives and strong commitment to purpose, while Roberts (1989) states that high reliability organizations ensure that goals are clearly stated and universally understood.

The system must provide the ability to grow a response organization that is organizationally and politically compatible, comprised of multi-agency stranger groups in a very time constrained period. It appears that expeditious definition and allocation of decision making authority, and validation of overall goals and definition of strategic or event objectives may be particularly important in a unified or integrated structure. Such a structure would likely be made up of stranger groups, comprised of participants from the various entities that enter the system with their own organization goals foremost in mind.

This requirement for goal resolution among stranger groups is an apparently unavoidable feature of emergency management. The response organizations that must make crisis decisions, e.g., Unified Command, as opposed to those that provide resources, such as response contractors, do not typically exist as discrete entities in the non-emergency state. The USCG recognizes this potential problem by listing "develop(ing) a set of incident goals" as the first priority in the Response Considerations (USCG, 1993b). If all participants in the system do not agree with the goals and objectives, then