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CHRIS UTILIZATION SURVEY.(U)

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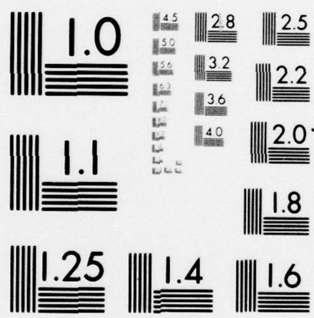

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NATIONAL BUREAU OF STANDARDS-1963-A

Report No. CG-D-8-80

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LEVEL II

CHRIS UTILIZATION SURVEY

FINAL REPORT

DECEMBER 1979

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Prepared for

U.S. DEPARTMENT OF TRANSPORTATION
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NOTICE

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The U. S. Coast Guard Office of Research and Development's technical representative for the work performed herein was Dr. M. C. Parnarouskis.

16. Abstract

The purpose of this project was to conduct a one-year review of the usefulness, adequacy, and responsiveness of the Chemical Hazards Response Information System (CHRIS) based upon actual field experiences of Coast Guard users for whom the system has been developed. In addition to identifying specific opportunities for system improvement and evolution, a second important purpose was to facilitate the initial "fine tuning" of the system following its initial deployment.

Although the study focused on emergency spill response use of CHRIS, nonemergency uses, such as contingency planning, were also examined.

The review covered the following CHRIS components and adjuncts:

- A Condensed Guide to Chemical Hazards, CG-446-1
- Hazardous Chemical Data, CG-446-2
- Hazard Assessment Handbook, CG-446-3
- Response Methods Handbook, CG-446-4
- Hazard Assessment Computer System (HACS)
- Regional Contingency Plan Data Base (part of the Regional Contingency Plan)

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Unclassified	Unclassified	93	

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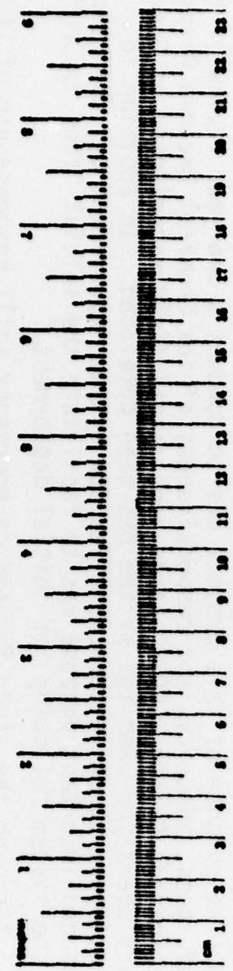
METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
		MASS (weight)		
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
		VOLUME		
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

*1 in ≡ 2.54 (exactly). For other exact conversions and more detailed tables, see NBS Misc. Publ. 286, Units of Weights and Measures, Price $2.25, SD Catalog No. C13.10:286.



Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
		AREA		
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
		MASS (weight)		
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
		VOLUME		
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
		TEMPERATURE (exact)		
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F

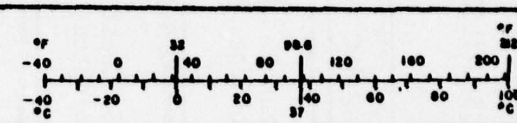


FIGURE 3. METRIC CONVERSION FACTORS

CHRIS UTILIZATION SURVEY

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CHRIS UTILIZATION SURVEY

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ACKNOWLEDGEMENTS

This CHRIS Utilization Survey by Arthur D. Little, Inc., was conducted for the Marine Safety Branch, Division of Applied Technology, Office of Research and Development, U. S. Coast Guard. The Coast Guard project leader was CDR John M. Cece.

We are indebted to several other Coast Guard personnel who have contributed materially to this work. Important guidance and support were provided by Dr. Michael C. Parnarouskis, LCDR George H. Brown III, and LT Richard Harding.

The Arthur D. Little, Inc. staff who participated in this study were the following:

Study Project Director: Dr. G. H. Harris

CHRIS Project Director: Mr. D. S. Allan

Contributing Personnel: Mr. S. Atallah
Mr. J. H. Hagopian
Mr. R. G. Potts
Mr. R. S. Stricoff

1.0 EXECUTIVE SUMMARY

1.1 Purpose and Scope

The purpose of this project was to conduct a one-year review of the usefulness, adequacy, and responsiveness of the Chemical Hazards Response Information System (CHRIS) based upon actual field experiences of Coast Guard users for whom the system has been developed. In addition to identifying specific opportunities for system improvement and evolution, a second important purpose was to facilitate the initial "fine tuning" of the system following its initial deployment.

Although the study focused on emergency spill response use of CHRIS, nonemergency uses, such as contingency planning, were also examined.

The review covered the following CHRIS components and adjuncts:

- A Condensed Guide to Chemical Hazards, CG-446-1
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- Response Methods Handbook, CG-446-4
- Hazard Assessment Computer System (HACS)
- Regional Contingency Plan Data Base (part of the Regional Contingency Plan)

The formal review began in January 1976, approximately one year following full deployment of the system.

1.2 Survey Methods

The primary mechanism for acquiring information concerning the utilization of CHRIS was the telephone interview following occurrence of an actual discharge or development of a potential discharge situation. Commandant Notice 3020, dated 13 January 1976, instructed all field units to promptly notify the National Response Center (NRC) at Coast Guard Headquarters by telephone of any incident involving any chemical other than oil. The NRC Duty Officer then contacted a member of the Arthur D. Little project team to convey incident information. The project team member subsequently contacted the Coast Guard field unit to obtain details on CHRIS utilization. The purpose of the telephone interviews was to learn what role, if any, CHRIS played in formulating response plans and whether any problems ensued or deficiencies appeared. Any other comments regarding users' experiences with CHRIS were also solicited.

During the course of the evaluation, a number of visits and meetings were held with selected Coast Guard units that had substantial experience in using CHRIS. CHRIS Evaluation Reports submitted by Coast Guard field units in compliance with Commandant Notice 3020 were of particular value in reviewing CHRIS utilization. These reports, some of which were quite detailed, present a very comprehensive picture of CHRIS use.

In total, 58 telephone interviews were conducted, 13 visits/meetings held, and 66 written Coast Guard CHRIS Evaluation Reports received.

1.3 Results

The Coast Guard's total experience to date in using CHRIS is somewhat limited in view of the infrequent occurrence of emergency spills, particularly where large volumes are involved. Many installations report that they have had no occasion in which CHRIS could have been employed productively. Nevertheless, we believe that sufficient experience has accumulated to judge the merits of the system as well as discover its principal limitations and deficiencies. Section 2.0, Major Conclusions and Recommendations, sets forth the basic findings of this initial review. It is strongly recommended that periodic reviews of CHRIS be undertaken to ensure the system's responsiveness to changing conditions and its viability.

The study confirmed that CHRIS is viewed by its Coast Guard users to be an essential and highly effective source of technical information for confronting both large and small spills of hazardous chemicals. Yet certain components of the system are definitely more successful in meeting their objectives than others.

Both CG-446-1 and CG-446-2 appear to be truly responsive to user needs; at the same time, however, there are a substantial number of improvements which can and should be made in these two manuals. CG-446-3 meets with the greatest criticism as well as considerable enthusiasm. This is the most complex manual and places the greatest demands on users.

CG-446-4 is generally regarded as a useful reference document, but not easily used during an actual emergency situation. Unfortunately, this manual, containing an appendix of commercially available response equipment and systems, is quickly outdated, as is now the case.

In summary, the system has been found to effectively meet its original design objectives, but at the same time there are a substantial number of improvements that should be made to correct deficiencies and to extend the system's capabilities. The basic structure of the system (i.e., the six components) should be retained in its present form with two possible changes. First, consideration should be given to simplifying the presentation of CG-446-3. One alternative would be to develop precalculated chemical-specific hazard assessments, and place these directly with the associated chemical data sheets in CG-446-2, effectively eliminating CG-446-3 for emergency use. Second, the utility of the Regional Contingency Plan Data Base concept requires reevaluation. Many field units are not convinced of the need to standardize this information or maintain it in up-to-date written form. It appears that circumstances may be sufficiently different at various field units to warrant more flexibility in the design of these data bases.

2.0 MAJOR CONCLUSIONS AND RECOMMENDATIONS

2.1 General

(1) Overall, CHRIS is perceived by Coast Guard personnel to be an essential and effective source of technical information for formulating responses to discharges of hazardous chemicals in navigable waters.

Respondents to this survey were highly satisfied with the content of the system, finding the information complete, accurate, easy to use, and understandable. At the same time, however, many potential users have not had occasion to use CHRIS under emergency spill conditions. Numerous suggestions for further improving CHRIS have been advanced.

(2) The CHRIS training program appears to be highly effective in familiarizing potential users with system capabilities, so that personnel are confident in its use.

However, retention of skills by field personnel remains an important problem because there is relatively infrequent occasion to confront hazardous chemical spills at most installations. Additional training at Yorktown and by Strike Teams at MSO/COTP's, as well as development of various self-training aids (e.g., programmed instruction, self-paced training package, correspondence course), would help Coast Guard personnel refresh their capabilities. Special drills and practice sessions, possibly conducted by Strike Teams, would help users maintain their skills in a state of readiness.

(3) Field personnel on occasion have need of expert guidance and counsel in formulating spill response plans.

At present, there appears to be no central resource on call within the Coast Guard for aiding field units in utilizing CHRIS in the development of proper response plans. The provision of expert backup at Headquarters would be highly beneficial in broadening and strengthening the technical base for decision-making in spill response. This aid is particularly crucial in the preparation and proper interpretation of hazard assessments.

(4) The number of hazardous chemicals recognized should be increased beyond the present 400.

The Coast Guard has recently increased the number of chemicals in CHRIS to 900. New manuals will shortly be issued to field units. A check should now to be made to establish that all intermediate-to-high production volume chemicals have been incorporated in CHRIS.

(5) Consideration should be given to extending CHRIS to chemical releases into or on media other than water.

Many hazardous chemicals confronted by Coast Guard personnel are stored or transported in the vicinity of waterfront facilities and may be accidentally released where they may not flow into water. Chemical fires on ships and shore-based facilities are not uncommon occurrences but presently lie outside the scope of CHRIS. Some users have mistakenly attempted to apply CHRIS to situations for which it is not appropriate.

(6) There is inadequate use of CHRIS for incident-specific contingency planning for identified hazardous cargo port traffic.

These detailed plans should be based on before-the-fact hazard assessments for specific, credible incidents involving known shipments passing through the region. Although some plans have been formulated for LNG/LPG shipments in specific ports, much more remains to be done for other hazardous materials in all ports. Most units fail to appreciate that the most effective use of CHRIS may be made through advanced planning for probable contingencies.

(7) CHRIS is rarely used in the evaluation and response to oil spills.

Most units are already familiar with petroleum products and appropriate response measures, and for this reason do not usually need to consult CHRIS.

(8) Coast Guard field units could play a larger role as an information resource to community emergency services.

Several MSO/COTP offices have been of considerable assistance to local emergency services, and have become valued resources in aiding spill response planning.

(9) An entire reassessment of Regional Contingency Plan (RCP) Data Bases in CHRIS is needed.

There appears to be little similarity among various RCP data bases. Many are out-of-date and incomplete. A minimum data set of local information to be maintained in an up-to-date RCP should be promulgated by the Coast Guard to all units. The formats of the data bases should be tailored to the special needs of each installation.

(10) The selection of personnel to receive formal CHRIS training should be broadened.

Presently, enlisted personnel are trained only in the use of A Condensed Guide to Chemical Hazards, CG-446-1. Many enlisted men and officers would like this restriction removed. Field units should have a greater opportunity to select their own personnel for CHRIS training at Yorktown. The lack of a port safety rating acts as a deterrent to enlisted personnel becoming highly specialized in hazardous chemical spill response.

(11) A general, nontechnical guidebook to CHRIS is needed summarizing the system's salient features.

This guidebook would highlight essential system components and limitations, providing (1) an overview for senior officers who do not actively use CHRIS and (2) an introduction and refresher for others.

2.2 CHRIS Components

2.2.1 A Condensed Guide to Chemical Hazards (CG-446-1)

(1) The manual is widely perceived to fulfill its mission (within its current limitation to 400 chemicals) in delivering succinct, easily understood, descriptive information about the hazardous nature of chemicals and situations confronted.

This manual is the most heavily used component of CHRIS.

(2) The manual is too large and bulky to be easily carried by field personnel and physically deteriorates under use.

The manual should be reduced in size (by reducing type size) and a more durable cover provided.

(3) CG-446-1 and CG-338, Chemical Data Guide for Bulk Shipment by Water, should be consolidated into a single manual.

Many port safety personnel dislike having to carry both manuals in the field, realizing that the manuals substantially overlap. Other users of CG-446-1 desire the inclusion of quantitative data in support of the qualitative guidance provided on the chemical data sheets.

(4) The Cautionary Response Index section of Table 4-1 in CG-446-4 should be included in the manual.

This table conveniently summarizes applicable cautionary responses for all hazardous chemicals in the manual.

(5) The Index of Synonyms should be expanded to include more commercial and trade names, as well as foreign names, for the hazardous chemicals in CHRIS.

This raises the problem of extending CHRIS to recognize mixtures and formulations of chemicals of both proprietary and nonproprietary origin.

(6) Toxic gases resulting from the reaction of hazardous chemicals with water, metals, oxygen, or other common materials should be incorporated in the manual.

(7) Information concerning water pollution effects is extremely limited.

Continued effort should be expended to acquire much greater knowledge regarding the effect of hazardous chemicals on fish, birds, and other wildlife.

2.2.2 Hazardous Chemical Data (CG-446-2)

(1) This handbook is widely perceived to fulfill its mission (within its current limitation to 400 chemicals) in furnishing detailed, largely quantitative chemical, physical, and biological information for formulating, evaluating, and conducting response plans.

Users generally praise this manual as the most comprehensive available source of information on hazardous chemicals. Nevertheless, continued effort should be expended to eliminate data gaps, particularly those related to toxic exposure levels and associated health effects, possibly by experimental testing.

(2) The physical property graphs have not been found useful by field personnel and should be eliminated from the manual.

Because the graphs are useful primarily for research activities, they should be collected in a companion volume for use by headquarters personnel or others on request.

(3) The development of simplified, precalculated, chemical-specific hazard assessments would largely obviate the need for the Hazard Assessment Handbook, CG-446-3.

The preparation of hazard assessments via CG-446-3 is viewed by many users as a complex, error-prone and time-consuming process. This problem could be avoided by developing precalculated, chemical-specific hazard assessments as a function of various spill parameters (e.g., spill volume) and inserting them in place of the physical property graphs to be deleted.

2.2.3 Hazard Assessment Handbook (CG-446-3)

The conclusions and recommendations in this section presume that this manual will be retained as a distinct component of CHRIS (see Section 2.2.2(3)).

(1) Field personnel generally find that this manual is quite difficult to use because of its format.

Some users have difficulty correctly following the sequence of calculations or terminate the assessment procedure prematurely. Several potential format improvements are possible to lessen the complexity of hazard assessment. For example, a color-coded, cross-reference scheme linking calculational components together would insure that the user follows the correct pathway.

(2) Hazard assessments should be extended to releases on land and into air generally.

Because CHRIS was originally developed in the context of facilitating response to water pollution incidents, land and air releases were only recognized in conjunction with water-related spills. However, many users have now requested elimination of what appears to them as an unnecessary restriction of CHRIS.

(3) Hazard assessment is most appropriately conducted for nonemergency, contingency planning situations.

Hazard assessment can rarely be conducted in real time during emergency spill situations. Events simply move too fast in most instances to benefit from detailed and time-consuming hazard assessments. Many users are understandably perplexed, feeling that valuable time spent on preparing hazard assessments is largely unproductive. It is important to impress users that assessment is best conducted before the fact.

(4) Field personnel desire and could benefit from expert assistance in preparing hazard assessments.

Headquarters should offer field units support on request, at a minimum verifying calculated results and aiding their interpretation. NRC personnel who provide emergency hazard assessments in response to field requests should receive formal training in the use of this manual and in the proper interpretation of analytical results. If and when the Hazard Assessment Computer System is installed on a time-share computer system, those field units possessing terminals should be permitted to access HACS on demand.

(5) Several instances of inappropriate use of the manual have occurred.

The manual has been used to prepare hazard assessments where no real hazards existed. Appropriate cautions should be inserted in the manual not to extend the hazard assessment code beyond that indicated.

(6) The realism of several analytical hazard assessment models can and should be improved.

Some of the models are overly conservative (i.e., exaggerate the hazard). Others include simplifying assumptions of uncertain validity and effect. Still others ignore known physical phenomena or boundary conditions. Many of the models are amenable to improvement and further research is therefore indicated.

2.2.4 Response Methods Handbook (and Appendix) (CG-446-4)

(1) The manual has been found by users to be a valuable resource on existing response methods; however, it is no longer up-to-date and requires revision.

Four years have passed since the manual was written. New equipment has been developed while some documented equipment has become obsolete.

(2) Fire-fighting methods and equipment should be added to the manual.

(3) Especially for bulk-shipped chemicals, additional tables should be constructed providing hazard estimates as a function of spill volume for worst case situations.

In particular, Tables 5-1 and 5-2 pertaining to toxic and flammable gases should be extended to include all such gases regardless of volatility.

2.2.5 Hazard Assessment Computer System (HACS)

(1) Only limited use has been made of HACS thus far, primarily because computer turn-around time has been unfavorable and because the system is quite complex.

HACS has been used for nonemergency research purposes but rarely, if at all, for emergency spill response. Recently, the computer environment has improved, so that HACS is now more readily accessible.

(2) Certain hazard assessment models produce estimates of uncertain validity.

A program for experimental validation of model results has been undertaken by the Coast Guard. This will ultimately lead to refined models of physical processes. Other studies are underway to resolve certain apparent model inaccuracies.

(3) The existence of numerous data gaps in the physical properties file should be resolved.

The Coast Guard has previously commissioned additional data collection and generation of missing chemical/physical/biological data.

2.3 Related Conclusions and Recommendations

Listed below are a number of conclusions and recommendations taken from prior CHRIS studies* which bear reemphasis on light of the completed survey of CHRIS utilization.

(1) CHRIS appears to be a major motivating force in upgrading the response capability of the Coast Guard.

Attendance at training sessions, discussions with users, the increased numerical involvement of Coast Guard personnel, and interest that CHRIS appears to have generated among response specialists have served as indicators of a growing interest, knowledge, and motivation in response methods and technology.

(2) There is an urgent need to develop the technology necessary for adequate response to hazardous chemical discharges.

The lack of corrective response methods for the discharge of many chemicals severely limits the ability of Coast Guard personnel to be effective during an emergency situation. This limitation is most noticeable in the Response Methods Handbook (CG-446-4) and greatly reduces the effectiveness of CHRIS.

(3) CHRIS can be a powerful tool in furnishing information and methods that can be used in support of activities other than, and in addition to, emergency response. For example, consideration should be given to its application to the following areas:

- Vulnerability modeling - CHRIS is currently being utilized to predict consequences of accidental discharges so as to make quantitative estimates of the risks of chemical shipments. Modifications or additions to CHRIS assessment methods that may be required to meet special needs of vulnerability modeling should be incorporated into CHRIS.

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*Development of Chemical Hazards Response Information System (CHRIS), Final Report, Arthur D. Little, Inc., October 1976.

Preliminary System Development--Chemical Hazards Response Information System (CHRIS), Final Report, Arthur D. Little, Inc., May 1972.

- Training - It has been demonstrated that training of response personnel in the use of CHRIS, in effect, trains them in response procedures at the same time. Full advantage of CHRIS to improve the training of personnel in response technology should be taken.

(4) Current and foreseeable changes in the water transportation of hazardous chemicals and in the Coast Guard's responsibilities should be reviewed to determine their future impact on CHRIS.

The implementation of spill prevention procedures, if effective, could significantly reduce the frequency with which CHRIS is applied and, in doing so, decrease the proficiency of the user. The passage of the Ports and Waterways Safety Act increases the Coast Guard's responsibilities to control and monitor hazardous chemical shipments and may eventually cause a major reduction in the number and size of accidental discharges. The effect of this new law on the usefulness and requirements of CHRIS information needs to be evaluated.

(5) The skill levels of all field personnel who deal with hazardous chemical spills need to be significantly improved.

All such field personnel should receive intensive training in chemical technology and response procedures. Dangerous-cargo officers should have formal, college-level chemical education and be trained in hazardous chemical safety. Occupational specialties in the area of chemical safety should be developed and/or improved so as to retain skilled Coast Guard personnel and to further enhance their capabilities; in this way a responsible and stable force may be created.

(6) The response to spills of hazardous chemicals has been, and will continue to be for many years, highly dependent on the judgment of (experienced or inexperienced, as the case may be) field personnel.

As hazard assessment and response technologies are significantly improved, greater reliance may be placed on documented, prescribed procedures and methods. The nature of a pollution incident is far too complex and little understood to permit detailed, quantitative analysis of alternative actions. Until the decision rules determining response actions have been defined, information system requirements cannot be known with great precision.

(7) A long-range (10-year) plan for identifying new information needs in spill response and means for satisfying them should be prepared by the Coast Guard.

This plan should be periodically reviewed and modified at two-three year intervals. It is important that the Coast Guard maintain both medium- and long-term horizons to ensure that momentum is not dissipated and that Coast Guard capabilities continue to evolve in directions of greatest return.

(8) It is highly desirable to extend 33 CFR 124.14, Advance Notice of Arrival of Vessel Laden with Explosives or Certain Specified Dangerous Cargoes, to include all hazardous or potentially hazardous chemicals, regardless of quantity shipped.

Furthermore, it would be desirable to require that all vessels, within 24 hours of arrival, report in accordance with the U.S. Coast Guard's Automated Merchant Vessel Report (AMVER) System and include the identity of any hazardous chemicals, the amounts carried, and location of stowage on board the vessel. Since AMVER reporting is presently a voluntary matter, compliance can only be assured by an amendment to the regulations.

(9) A methodology needs to be devised for conducting retrospective spill analyses so that one may learn from past experience.

There is presently no formal method for extracting the essence of an incident in order to learn principles that may be applied during later spill situations.

3.0 INTRODUCTION

3.1 Objective

The objective of this project is to perform an initial review of the usefulness, adequacy, and responsiveness of the Chemical Hazards Response Information System (CHRIS) following its operational deployment to Coast Guard field units. The review is to be based on an in-depth examination of actual field experiences of various Coast Guard users with the information system; both emergency and nonemergency spill response usage are treated, but the former is emphasized. The period of review is one year, although it is expected that other arrangements will be made by the Coast Guard to ensure that the review process continues indefinitely.

The review covers the following CHRIS components and adjuncts:

- A Condensed Guide to Chemical Hazards, CG-446-1
- Hazardous Chemical Data, CG-446-2
- Hazard Assessment Handbook, CG-446-3
- Response Methods Handbook, CG-446-4
- Hazard Assessment Computer System (HACS)
- Regional Contingency Plan Data Bases (part of the Regional Contingency Plan)

Based on the results of this survey, the system may be subsequently revised to enhance its utility to field personnel.

3.2 Need for CHRIS Utilization Review

The future need for system review was first enunciated by the Coast Guard when the CHRIS project began in 1970 and amplified in the 1972 system design final report:* "[Project personnel should] formulate and carry out a program of continued evaluation of the system, including specific observations by field personnel in incident reports upon the utility, shortcomings, or other findings with regard to the CHRIS system. In addition, [project] staff should conduct periodic visits and interviews

*Report 73096-1F, Preliminary System Development--Chemical Hazards Response Information System (CHRIS), Appendix VI--CHRIS Organization. Arthur D. Little, Inc., May 1972 (Page 14).

with field personnel to obtain first-hand reactions of field experience. Occasionally, [project staff] should visit the scene of a moderate or major spill while the response to the incident is still underway. Personal observations of this type may yield valuable information about the application and use of the CHRIS system which cannot be obtained in any other way."

A review of CHRIS is required for two basic reasons. First, it will no doubt be necessary to "fine tune" the system (i.e., correct minor problems which normally first appear when any new system is deployed). Such difficulties, hopefully minor, are inevitable, but they must be detected and corrected quickly to maintain user confidence. Second, to remain truly viable over the next five to ten years, CHRIS must evolve toward even greater utility. (Most information systems of a given design retain currency for only three to five years.) Evolution is necessary because various situational factors are changing rapidly:

- Chemical hazard response technology is still in its infancy and undergoing enormous growth;
- The industrial-societal-environmental milieu relative to hazardous chemical spills is highly dynamic, as is the Coast Guard's developing role; and
- Information system technology continues to make impressive advances.

The review process should consider not only the individual components described above but, more importantly, the overall system structure. This includes the nature of the system components and the ways in which they interact, the communication channels and related facilities for acquiring and dispatching information, and the Coast Guard users themselves--their capabilities, responsibilities, and expectations. To some extent, then, the system review process parallels the preliminary system development phase, which entailed four principal interrelated tasks:

(1) User and user need survey;

(2) Assessment of existing data and information;

(3) Preliminary system design; and

(4) Management plan.

The magnitude of the CHRIS review task, of course, is far less than that involved in the preliminary system development. The goal is not to develop a new system but to improve the one that now exists.

The foregoing analogy points out two important aspects of the review process. First, it is desired to determine whether and to what extent user needs are satisfied by CHRIS in its present form. Some user needs will have materialized or been perceived only recently. Newly developed data and information pertaining to response measures (which will not normally be known by users) must be examined for pertinence to CHRIS. Second, following the identification of system deficiencies and potential new applications, an assessment must be made as to which of these will be addressed as CHRIS improvements. It then remains to develop a specific approach to satisfying these identified user needs and to implement the necessary changes; strictly speaking, the latter task is external to the review process itself.

An important distinction should be drawn between system review, as described above, and evaluation of system effectiveness, which lies outside the intended scope of this project. In an absolute sense, the effectiveness of CHRIS is determined by the extent to which human, property, and environmental losses are reduced by the system and implies measuring or assessing its economic, social, and aesthetic benefits. This would be an exceedingly difficult task, necessitating "before and after CHRIS" comparisons of all impairments of any kind stemming from the discharge of hazardous chemicals into navigable waterways. Clearly, ascertaining system effectiveness will be primarily a judgmental matter that is best left to knowledgeable observers not associated with the development of CHRIS. Indeed, it appears doubtful that it will be possible to establish a realistic, quantitative measure of loss avoidance due to CHRIS deployment, or even to demonstrate convincingly that a causal relationship exists between the implementation of CHRIS and an overall reduction from spills.

3.3 CHRIS Status 1976

3.3.1 Purpose of CHRIS

To carry out its responsibilities in furthering maritime safety, the U.S. Coast Guard has developed an efficient system for acquiring, storing, retrieving, and utilizing technical and response information pertaining to hazardous chemical cargoes and potential pollutants. The Chemical Hazards Response Information System (CHRIS) provides timely information essential for proper decision-making by responsible Coast Guard personnel and others during emergencies involving the water transport of hazardous chemicals. In addition, it provides certain basic nonemergency-related information to support the Coast Guard in its efforts to achieve improved levels of safety in the shipment of hazardous chemicals. The system became fully operational in 1975.

3.3.2 Components

CHRIS is composed of four reference guides or manuals, a regional contingency plan data base, and a computerized hazard prediction system. The four manuals contain chemical data, hazard warnings, hazard assessment methods, and response guides.

(1) A Condensed Guide to Chemical Hazards (CG-446-1)

This handbook contains information that facilitates "early response" situations, and is a compact, convenient source of qualitative, chemical-related information. The guide is intended primarily for use by port safety personnel and others who may be the first to arrive at the site of an incident and who need readily available, easily understood, descriptive information about the hazardous nature of the chemical and situation confronted. It assists these personnel to quickly determine proper, responsible actions that must be taken immediately to safeguard life and property and reduce, insofar as may be possible, further contamination of the environment. The guide contains precautionary advice on each of 400 chemicals* and also lists its physical and biological hazards which enable field personnel to assess the threat as a prelude to determining subsequent large-scale actions.

*Soon to be expanded to 900 chemicals.

(2) Hazardous Chemical Data (CG-446-2)

This handbook is intended for use primarily in support of the On-Scene Coordinator (OSC) at his command center and at the Regional and National Response Centers. It contains detailed, largely quantitative chemical, physical, and biological data on each of 400* chemicals necessary for formulating, evaluating, and carrying out response plans.

(3) Hazard Assessment Handbook (CG-446-3)

This manual contains methods of estimating the rate and quantity of hazardous chemicals that may be released under different incident situations. It provides the means for predicting dispersion and other threats that the chemicals present after release. Procedures are provided for estimating the concentration of hazardous chemicals (both in water and in air) as a function of time and distance from the spill. Methods are also included for predicting the resulting potential toxic, fire, and explosion effects.

(4) Response Methods Handbook (CG-446-4)

This handbook is a compendium of descriptive information and technical data on existing response methods. The document has been written for use of Coast Guard personnel who have had some training or experience in pollution response. Emphasis is placed on existing or prospectively available methodologies, as opposed to research and development schemes not expected to be available for implementation for some time.

(5) Regional Contingency Plan Data Base

This data base, to be incorporated into the Regional Contingency Plans (RCP), will contain data pertinent to a specific region, subregion, or locale. Examples of such information include an inventory of physical resources and strike forces; vulnerable or exposed resources (critical water-use areas); potential pollution sources; geographic and environmental features; cooperating organizations; and recognized experts with identified skills. A Development Plan for Regional Contingency Plan Data Base has been formulated and its use illustrated by

*Soon to be expanded to 900 chemicals.

developing an RCP Data Base for Louisiana. However, the uniform plan has not yet been adopted by other USCG regions.

(6) Hazard Assessment Computer System (HACS)

This system can best be described as the computerized counterpart of CG-446-2 and CG-446-3. It enables operators at U.S.C.G. Headquarters to obtain more detailed hazard evaluations. Graphic output provides the relationships among spill concentration, thermal radiation, location and time. This information can be transmitted by facsimile. This system can also be used for emergency discharge advance planning and the development and testing of improved hazard-assessment methods. At the present, this system is not available on a real-time basis for emergency hazard assessment.

3.3.3 Training Materials

A variety of training materials is available to educate Coast Guard personnel in the proper use of CHRIS and to maintain user capabilities.

- An intensive four-day (including nights) course is given as part of the Marine Environmental Protection School at the Coast Guard Reserve Training Center at Yorktown, Virginia. This course relies on a comprehensive instructor's guide and various instructional materials, such as problem cases.
- An intensive course and instructor's guide are available for the use of personnel in the National Strike Force. Strike Teams conduct formal training sessions at COTP/MSO and other field offices.
- Additional practice problem and case books are available for use by the Strike Teams in teaching CHRIS. CHRIS problem books permit self-review by personnel already familiar with CHRIS.

4.0 SURVEY METHODS

4.1 Planning

4.1.1 Commandant Notice

Commandant Notice 3020 dated 13 January 1976 was sent to all Coast Guard field units informing them of the commencement 1 January 1976 of the twelve-month CHRIS utilization survey by Arthur D. Little, Inc. (ADL). Commanding Officers and Officers-in-Charge of units holding CHRIS manuals were instructed, during the period 1 January 1976 to 31 December 1976, to:

- Immediately notify the NRC by telephone when an incident occurs which involves any chemical other than oil.
- Ensure that certain specified data be recorded at the scene of the incident to document CHRIS usage as the basis for later discussion and evaluation. These data included the following:
  - (1) Date and location of spill;
  - (2) Hazardous chemical and quantity discharged or potentially discharged;
  - (3) Brief description of the incident and extenuating circumstances;
  - (4) Coast Guard personnel involved in CHRIS utilization;
  - (5) CHRIS components utilized, strong and weak points, and recommendations;
  - (6) Outcome of incident.
- Submit a letter report via the Chain of Command to Commandant (G-WEP/73) commenting on the utility of CHRIS, following the general outline provided, no later than 30 September 1976. Negative reports are required.

Furthermore, the nature of incident debriefings to be conducted by ADL personnel was described.

"The ADL evaluation will be conducted by means of telephone and personal interviews, on-scene observations at incidents, reports and mail questionnaires, and user group meetings. A team of Coast

Guard and ADL personnel will visit each district office to discuss CHRIS and the evaluation prior to 1 March 1976. These visits will be the subject of separate correspondence to each district. Procedures have been established at the National Response Center (NRC) for the immediate alerting of the ADL evaluation team when a hazardous chemical incident occurs. The NRC must receive timely notice of each incident so that the ADL evaluation team may be afforded the maximum opportunity to evaluate the use of CHRIS. Because of the small number of occurrences, it is anticipated that most incidents will result in telephone interviews of key personnel and possibly a visit to the unit. The ADL evaluation team must be afforded open access to Coast Guard records and experience to make this evaluation a success. Visits by personnel of the ADL evaluation team will be confirmed by message from Commandant (G-WEP). A list of the personnel assigned to the ADL evaluation team will be provided during the visits to the district offices discussed above."

4.1.2 District Presentations

During the first few months of the project, presentations were made to each of the ten Coast Guard districts within the continental United States. Management personnel invited to these meetings included the following: district representatives, COTP's, Chief Marine Safety Officer, Chief Port Security Officer, MEP Officers, and other interested parties. The purpose of the presentations was to inform key Coast Guard personnel of the study and its requirements, particularly in the conduct of personnel incident debriefings and interviews. By presenting the basic study design plan at these district meetings, it was hoped that the early cooperation of Coast Guard management could be secured as well as an appreciation gained of any potential problem areas or difficulties. The districts receiving presentations and corresponding dates are listed below.

1st Coast Guard District, Boston, MA	22 January 1976
2nd Coast Guard District, St. Louis, MO	18 March 1976
3rd Coast Guard District, New York, NY	23 January 1976

5th Coast Guard District, Portsmouth, VA	11 February 1976
7th Coast Guard District, Miami, FL	13 February 1976
8th Coast Guard District, New Orleans, LA	12 February 1976
9th Coast Guard District, Cleveland, OH	6 February 1976
11th Coast Guard District, Long Beach, CA	3 February 1976
12th Coast Guard District, San Francisco, CA	4 February 1976
13th Coast Guard District, Seattle, WA	5 February 1976

4.2 Telephone Interviews

A primary mechanism for acquiring information concerning the utilization of CHRIS was the telephone interview following occurrence of an actual incident or development of a potential spill situation. Commandant Notice 3020 of 13 January 1976 instructed Commanding Officers and Officers-in-Charge of units holding CHRIS manuals to immediately notify the NRC by telephone of any incident involving any chemical other than oil. The NRC Duty Officer prepared an Oil/Hazardous Substance Discharge Report (see Figure 4-1) and duly recorded the incident in the NRC activity log. The NRC Duty Officer then immediately contacted a predetermined member of the ADL evaluation team on a 24-hour-a-day basis to convey incident information.

Usually within 24 hours of notification, an ADL evaluation team member contacted the individual originally reporting the incident to the NRC. Care was exercised to avoid unnecessarily diverting the attention of Coast Guard response personnel from on-going emergencies. In conducting incident debriefings, special effort was exercised to interview all personnel who had used CHRIS.

The primary purpose of the telephone interview, of course, was to learn what role, if any, CHRIS played in formulating response plans and whether any problems ensued or deficiencies appeared. A secondary purpose was to obtain sufficient information to determine whether a site visit, either during or upon conclusion of the incident, was indicated. A site visit during the incident would permit first-hand observation of how the response was conducted and particularly of how CHRIS is used. A site debriefing on conclusion of the incident would permit more detailed discussion of CHRIS utilization with response personnel than could be achieved

FIGURE 4-1 (NRC FORM 4--8/22/74)

OIL/HAZARDOUS SUBSTANCE DISCHARGE REPORT

1. DATE__________ TIME________ DUTY OFFICER__________ NUMBER________

2. PERSON REPORTING____________________

   TITLE/POSITION; ORGANIZATION____________________

   ADDRESS____________________

   TELEPHONE____________________

3. TIME/DATE OF DISCHARGE____________________

4. POLLUTANT____________________

5. QUANTITY DISCHARGED____________________

6. QUANTITY ENTERING WATER(OR SIZE ESTIMATE)____________________

7. BODY OF WATER____________________

8. LOCATION (NEAREST CITY(OR COUNTY); STATE; SPECIFIC LOCATION)__________

9. WEATHER ON SCENE____________________

10. SOURCE OF DISCHARGE (FACILITY: NAME;ADDRESS;TELEPHONE;TYPE;REPRESENTATIVE) (VESSEL: NAME; NATIONALITY; OFFICIAL NUMBER; CALL SIGN; TYPE; OWNER)

11. CAUSE____________________

12. PERSONNEL CASUALTIES____________________

13. CONTINUING DANGERS____________________

14. ACTIONS TAKEN THUS FAR (SECURING/CONTAIN/REMOVE)__________

15. ADDITIONAL INFORMATION____________________

16. DUTY OFFICER'S ACTIONS____________________

by telephone. In actuality, however, no site visits during emergency operations were made due to the suddenness of such situations and their infrequency.

The following information was sought via telephone interviews:

(1) Names of all USCG users and respondents; their addresses and telephone numbers.

- Who reported the incident to the NRC and when?
- CHRIS Utilization Survey Number (obtain from NRC)
- OSC

(2) Incident descriptors

- Chemicals involved
- Quantity at risk and discharged
- Vessel or container
- Location
- Times of discharge and USCG notification
- Source
- Body of water
- Estimated duration of incident
- Agencies and organizations involved

(3) Brief description of incident

- Means of USCG notification
- Presumed cause
- Damage or potential damage assessment
- Special considerations
- Hazards
- Response actions
- Consequences
- Final outcome

(4) Use of CHRIS

- Which components were used, how, in what sequence, and for what purposes?

- What information was obtained from CHRIS and how was it used?
- Was it understandable and useful?
- Was NRC contacted during incident; if so, why and with what results?
- What reports were filed?
- Other information sources used
- Problems encountered
- Notable system strengths and deficiencies
- USCG recommendations for improvement
- Overall sense by respondent of CHRIS adequacy

(5) <u>Experience and training of CHRIS users</u>

- Chemical background
- MEP School
- Strike team training

Furthermore, if the Hazard Assessment Handbook (CG-446-3) was used, we reviewed in detail how the respondent conducted the hazard evaluation, what data were used, what results were obtained, and how these results were actually used.

Each interview was documented and, where appropriate, we attempted to assess:

- CHRIS adequacy in the reported situation
- System strengths and weaknesses
- User errors and misapplications, and reasons therefor
- User misunderstandings or apparent lack of knowledge
- Recommendations for improvement
- Suggestions for future interview follow-up

In total, 58 incident debriefings were conducted by telephone with field units identified in Table 4-1.

TABLE 4-1

TELEPHONE SPILL INCIDENT DEBRIEFINGS (58)

MSO/COTP/Port Safety Stations	No. of Reports
Albany, NY	1
Baltimore, MD	11
Buffalo, NY	2
Chicago, IL	3
Cincinnati, OH	2
Cleveland, OH	3
Detroit, MI	1
Galveston, TX	2
Huntington, WV	2
Los Angeles/Long Beach, CA	5
Milwaukee, WI	1
New Orleans, LA	4
New York, NY	3
Norfolk, VA	2
Paducah, KY	1
Port Arthur, TX	2
Portland, OR	4
St. Louis, MO	2
San Francisco, CA	1
Savannah, GA	1
Seattle, WA	1
Tampa, FL	3
Toledo, OH	1
	58

4.3 Visits and Meetings

Thirteen visits were made to conduct in-depth reviews of CHRIS utilization and training; these are identified in Table 4-2. Seven visits were made to MSO/COTP installations selected on the basis of (1) significant experience with hazardous materials and/or (2) having reported several incidents during the prior six months of the survey. During the visits, interviews were conducted with all CHRIS users and others in a position to direct response operations.

Several unsuccessful efforts were made to meet with Atlantic Strike Team personnel.

TABLE 4-2

VISITS/MEETINGS (13)

MSO	Baltimore, MD	4 August 1976
COTP	Los Angeles/Long Beach, CA	18 October 1976
MSO	New Orleans, LA	19 August 1976
COTP	New York, NY	2 August 1976
MSO	Norfolk, VA	26 August 1976
COTP	Philadelphia (Gloucester, NJ)	3 August 1976
MSO	Portland, OR	22 October 1976
	Representatives of 2nd and 9th U.S. Coast Guard Districts attending Hazardous Materials Pollution Control Symposium, Chicago, IL	18 May 1976
	Gulf Strike Team, Bay St. Louis, MS	20 August 1976
	Pacific Strike Team, Hamilton Air Force Base, GA	17 October 1976 24 September 1976
	National Response Center, U.S. Coast Guard Headquarters, Washington, D.C.	18 August 1976
	Marine Environmental Protection School, Yorktown, VA	26 June 1976

4.4 CHRIS Evaluation Reports

In compliance with Commandant Notice 3020 of 13 January 1976, 66 CHRIS Evaluation Reports were submitted by Coast Guard field units prior to 30 September 1976. Of these, 29 constituted negative reports (i.e., no CHRIS use) or the equivalent. In totality, these reports present a very comprehensive picture of CHRIS utilization and were an invaluable input to this report. Many respondents prepared very thoughtful, in-depth reviews of system strengths and weaknesses; as such these reports alone testify to the system's overall utility.

4.5 Requests for CHRIS Data

Beginning July 1974, the NRC has routinely recorded the nature of requests for data on hazardous chemicals (see Figure 4-2). Through mid-August 1976, some 85 requests for data have been received, of which 33 could not be satisfied by CHRIS information. With the recent addition of 500 hazardous chemicals to CHRIS, most of these unsatisfied requests could now be handled. The various sources of requests were:

USCG	42
Federal & State government	17
Emergency services (e.g., fire, police)	13
Industry (primarily transportation)	13
	85

In general, assistance was requested regarding:

- Confirmation of knowledge
- What are hazardous characteristics and properties?
- What is maximum extent of hazard?
- What would happen if...?
- What actions should be taken to respond to spill?
- How to dispose of material?
- How to handle material?
- How is material used?

FIGURE 4-2

Request For CHRIS Data

1. TIME/DATE/LOCATION OF DISCHARGE

2. TIME/DATE OF REQUEST

3. TYPE OF POLLUTANT

4. NAME OF PERSON CALLING

5. ORGANIZATION/ADDRESS/TELEPHONE #

6. INFORMATION REQUESTED

7. INFORMATION PROVIDED

8. PERSON PROVIDING INFORMATION/SOURCE

5.0 DETAILED FINDINGS

The detailed findings reported in this chapter address in turn each of the CHRIS components as well as the training/education function. Findings based on a consensus of field comments and/or those which we find compelling are denoted as "supported observations;" findings with a definite minority backing of those expressing an opinion and/or those with which we disagree are denoted as "unsupported observations." However, all observations concerning CHRIS, supported or not, are documented here. Single asterisks identify the more important findings in our opinion; double asterisks signify matters that merit immediate consideration.

5.1 Basic System Concept and Design

5.1.1 Utilization

5.1.1.1 Supported Observations

*(1) Contingency Planning (Nonemergency Use)

Only a few installations appear to have used CHRIS for contingency planning, including an analysis of hazardous cargo port traffic. Methods and procedures usefully employed should be communicated to other field units. Perhaps CGHQ should instruct units on methodology for preplanning for spill response. Indeed, some units have stated that "the system lends itself more readily to formulating contingency plans rather than response strategies since emergency situations rarely occur." Nevertheless, most units fail to appreciate that the most effective use of CHRIS may be made through advanced planning for probable contingencies (based on local knowledge of hazardous commodities in the area).

(2) Oil Spills

CHRIS is rarely used in the evaluation and response to petroleum spills primarily because most units are already familiar with these products and the relatively advanced technology that exists for response to these incidents. At the same time, some users have commented very favorably on the usefulness of CG-446-4 in summarizing the state-of-the art on oil spill response technology.

**(3) Expert Backup

Expert backup on call at CGHQ would greatly benefit field units and has been requested by several respondents. One observer has commented "To function efficiently, the OSC requires an immediately available source of expertise to broaden and support his actions in controlling hazardous material incidents." Maintenance of skills in the proper use of CHRIS remains a problem due to the low incidence of spills for most installations. To the extent that a centralized resource can be made available on request to field units, this resource could acquire the breadth and depth of exposure to real problems denied to individual installations, thereby developing an expertise base. Indeed, without such a centralized base of expertise, no other mechanism appears to be available for institutional learning as a result of the collective Coast Guard response to hazardous chemical spills.

(4) Performance Measures

Consideration should be given to devising objective performance measures regarding field unit effectiveness in responding to hazardous chemical incidents and in using CHRIS. Application and use of these measures would greatly aid in the achievement of overall system improvement.

(5) Port Safety Rating

The lack of a port safety rating acts as a deterrent to enlisted personnel becoming highly specialized in hazardous chemical spill response. Although interested in this operational activity, these personnel feel that an exceptional expenditure of effort in this area will go unrewarded.

(6) Recipients of CHRIS

Some observers have commented that the complete concept of CHRIS appears geared toward the MSO framework of response rather than field group stations and support units. For these latter organizations the overall display of information is both informative and helpful during the initial reporting stage of an incident (i.e., CG-446-1), but

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(6) Recipients of CHRIS

Some observers have commented that the complete concept of CHRIS appears geared toward the MSO framework of response rather than field group stations and support units. For these latter organizations the overall display of information is both informative and helpful during the initial reporting stage of an incident (i.e., CG-446-1), but thereafter contributes more towards confusion than assistance. All other elements of command are excluded from distribution for manuals CG-446-2, -3, and -4. Accessibility of advanced information and contingency plan data for group units can only be accomplished through direct contact with MSO personnel. Air station personnel have commented that they are not equipped or trained to respond to hazardous chemical spills nor are they tasked with this mission other than to provide transportation of men and equipment and aerial surveillance as directed. Air stations have requested that they be deleted from the distribution list for CHRIS.

(7) Community Assistance

Coast Guard field units might play a larger role as an information resource to community emergency services by heightening USCG visibility. For example, the Los Angeles/Long Beach MSO has developed excellent relations with both police and fire departments in that locality. In so doing, they have become a valued resource to these local emergency services.

(8) Federal Guides to Hazardous Chemicals

Several users have commented on the proliferation of Federal guides to hazardous chemicals and the apparent lack of coordination among Federal Agencies. Users are sometimes perplexed when comparing information in CHRIS to less technical sources. Terminology sometimes differs and occasionally data appear to be inconsistent. Alternative data sources mentioned were EPA's OHM-TADS, DOT's Hazardous Materials - Emergency Action Guide, 1976, and the Coast Guard's Chemical Data Guide for Bulk Shipment by Water (CG-388). This concern is compounded by several additional publications prepared by the private sector, e.g., CHEMTREC, material safety data sheets, National Fire Protection Association warnings. Perhaps the introductory material in CG-446-1 and -2 concerning other information systems should be expanded to resolve ambiguities with regard to CHRIS and to indicate the utility of these other systems.

5.1.2 Information Content

5.1.2.1 Supported Observations

*(1) Master Index

Several respondents have requested that a master index covering all volumes be prepared, as well as separate indexes for each volume. This would be of great assistance to those who do not employ the system on a regular basis.

*(2) Terminology/Glossary

Most observers have commented that the terminology is understandable and consistent with current Coast Guard usage. At the same time, however, a glossary/thesaurus of terms is needed, particularly for generic chemical names. Another observer has commented that "The terminology used in CHRIS is similar to that used in numerous NFPA and other publications, but this is unfamiliar to some users of the system." Contrarywise, another observer states "The terminology is well beyond the understanding of the average enlisted user."

*(3) Regional Contingency Plan Data Bases

A reassessment of the need for and content of regional contingency plan data bases in CHRIS is indicated. It appears that most units do not feel the effort required to maintain an RCP data base is worthwhile, probably because (1) there are competing demands for personnel resources, and (2) there are relatively few occasions when this information is actually utilized or needed. Typically these units find that it is easier to consult directly with someone in the office concerning area-specific information rather than refer to the RCP data base which usually contains outdated information. On the other hand, one unit (MSO Baltimore) placed very considerable emphasis on the need for developing comprehensive local data bases which should be updated continuously. Furthermore, MSO Baltimore has progressed significantly in developing an automated RCP data base; this effort should be appraised for possible extension to other units.

In retrospect, a formal, detailed, up-to-date RCP data base may not be essential for all units provided that there is an alternative mechanism for obtaining the desired information when needed. Alternatively, the existing specification for an RCP data base is probably too comprehensive, making its realization an onerous task. It should be possible, instead, to indicate the relative priority of different information items, with the highest categories being mandatory. For example, it may be essential to list all cooperating agencies and vulnerable resources, whereas it may not be essential to identify the location of all physical resources to aid in an emergency, provided that instructions are given on how to obtain this information when it is needed. In other words, a minimum data set of local information to be maintained in an up-to-date regional contingency plan should be promulgated by the Coast Guard to all units. At present, localized data is not maintained in a consistent, standardized form; the situation requires a comprehensive review.

*(4) General Guidebook

A general guidebook to CHRIS is needed as an instruction for senior officers who do not actively use CHRIS but wish to know more about the system. The guidebook would also be helpful as a refresher for Port Safety and MEP personnel, summarizing key information and principles. The guidebook would be at most 50 pages in length and would highlight essential features and limitations of the system. Areas of greatest effectiveness and least effectiveness would be documented, along with areas deserving greater attention, such as the RCP data base problem.

(5) System Maintenance

Some users have expressed concern that system maintenance may become a problem. They are troubled by an inability to order replacements for pages which have been lost or destroyed. They point out that while the present publications are considered complete and current, failure to update the system would result in a rapid loss of user confidence. The updating problem has been raised most frequently in the context of CG-446-1 since it is permanently bound.

5.2 A Condensed Guide to Chemical Hazards, CG-446-1

5.2.1 Presentation Characteristics

5.2.1.1 Supported Observations

**(1) Physical Size

The present version of the manual containing 400 chemical data sheets, measuring 8-1/2 in. x 11 in. x 1-1/4 in. and weighing 2.75 lbs., is criticized as being too large and bulky, thereby inhibiting portability by field personnel. Specifically, field personnel would prefer a manual which may be readily carried on their persons. This concern is heightened when viewing the forthcoming expansion of the manual from 400 to 900 chemical data sheets. This attitude is widely held by respondents.

Many comments appearing below suggest that additional information items and data (e.g., labels, physical properties, CFR citations, etc.) be incorporated in the manual in order to increase its overall utility. If all such potentially desirable information elements are added to the manual, compactness will be further sacrificed. Thus, careful consideration should be given to the likely increase in size of the manual associated with the inclusion of new or expanded data items.

Three alternative page sizes (2-7/8 in. x 3-5/8 in., 4-1/4 in. x 5-5/8 in., and 5-5/8 in. x 7-5/8 in.) have been distributed to field units and their preferences requested. Of those units expressing an opinion, a substantial majority requested a reduction in size but cautioned against adopting a print size that would make the manual difficult to read under adverse on-scene conditions, such as at night, on board ship, etc. Approximately two-thirds of those expressing a definite opinion preferred the largest (5-5/8 in. x 7-5/8 in.) of the three alternative reduced page sizes. Approximately equal fractions preferred the intermediate size (4-1/4 in. x 5-5/8 in.) and the current size, whereas no one preferred the smallest size (2-7/8 in. x 5-5/8 in.), which is quite difficult to read. Most units would prefer to have a pocket-sized manual, but realize that legibility would be impaired. One respondent stated that he would prefer a pocket-sized edition (4-1/4 in. x 5-5/8 in.) even if it were in two volumes. Another individual suggested that the intermediate-sized data sheet format should be placed in four to the standard page size presently in used. This will retain the present length and width dimensions (8-1/2 in. x 11 in.) but reduce the manual to one-fourth its present thickness and weight. However, this would impair the ease of incorporating new chemical data sheets in the future.

Clearly, almost all units desire to see a reduction in the size and bulk of this manual, but do not agree on the extent of reduction sought. A satisfactory compromise between convenience and legibility would appear to be the 5-5/8 in. x 7-5/8 in. page size. Again, the final decision on page size reduction must await a determination of what additional information elements will be included on the data sheet; these are discussed below.

There are several alternative means for reducing the size of the manual that may be considered in conjunction with an optical reduction of current page size. The existing chemical data sheet could be reformatted in such a way as to conserve space, possibly by consolidating the information shown. This might result in a maximum 25% page reduction, but would be expensive to achieve because each chemical data sheet would have to be typeset anew. A second alternative would be to reduce certain portions of the data sheet but not others. For example, the chemical name, common synonyms, and observable characteristics sections might be reduced in size.

Finally, the weight of the manual may be diminished by reducing the page weight or thickness to the minimum available. So-called "bible paper" is recommended.

(2) Type Size and Color

Large type is desirable to enhance readibility of the manual, particularly where poor lighting or and/or motion of a small boat or vehicle makes reading difficult. This comment has been discussed above in the context of establishing the minimum size of CG-446-1.

Red print now used in the manual can be difficult to read under red running lights on board a ship at night. Consideration should be given to using a more visible color, such as yellow.

**(3) Binding and Cover

The present form of the manual, being paperbound, tends to deteriorate badly under heavy use in the field. The soft cover does not provide sufficient protection against physical damage and pages tend to tear out readily. Thus a sturdier cover made of a plastic or vinyl material, and therefore waterproof, is indicated. A loose-leaf ring binder with ten or more rings would facilitate the addition of new chemical data sheets and provide a more secure means for retaining the pages. Although it should be possible to make the manual more durable, there is no way to make it indestructible or to prevent personnel from removing pages and failing to replace them after use.

5.2.1.2 Unsupported Observations

(1) Permanent Binding

A pocket-sized, permanently (perfect) bound book should be developed containing the most common chemicals. However, a permanently bound volume will increase the weight of the manual and prevent the addition of new chemical data sheets. Furthermore, because the "most common chemicals" will vary from one USCG installation to another, it will be difficult to gain concurrence on which chemicals should be included.

(2) Page Durability

Pages should be plasticized or laminated to make them waterproof. This is a good idea in principle; however, it will increase both the weight and thickness of the manual, both deterrents to convenient use.

5.2.2 Conceptualization

5.2.2.1 Supported Observations

**(1) CG-446-1 vs. CG-388

A definite concensus has emerged that CG-446-1 should be closely coordinated with CG-388, Chemical Data Guide for Bulk Shipment by Water, so that only one dual-purpose manual survives. This recommendation stems from three related considerations: (1) because there is a substantial overlap between the two manuals, many users dislike having to carry both manuals in the field, (2) certain data in CG-388 not available in CG-446-1 are essential for port safety personnel, and (3) many users of CG-446-1 have requested the inclusion of quantitative data in support of the qualitative guidance provided on the chemical data sheets. The following CG-388 information categories have frequently been mentioned as useful additions to CG-446-1: chemical family, specific gravity, boiling point, vapor pressure, Reid vapor pressure, vapor density, freezing point, flashpoint, and flammable limits in air. In addition, others have suggested inclusion in CG-446-1 of shipping label information, particular hazard information, chemical reactivity (explosive nature), types of fire extinguishing agents that may be used, special fire hazards and procedures, grade of flammable/combustible liquid, etc.

We subscribe in principle to the view that CG-446-1 and CG-388 should be combined into a single manual for the benefit of Coast Guard field personnel. We also agree that it would be desirable to include more quantitative information in CG-446-1 in order to be responsive to the desires of many field units. The practical problem is that the inclusion of this additional information, not to mention other information categories discussed below, will substantially increase the size of CG-446-1 as well as alter its expressed intent. We believe that, unless all of the information in CG-388 now missing from CG-446-1 is included in the latter, some users of CG-388 will still find this volume preferrable for certain purposes. It is recommended that a joint committee comprised of representatives from the Office of Merchant Marine Safety and the Office of Marine Environment and Systems convene to develop the specifications for a common guide to chemical hazards. Although the original intent of CG-446-1 was to provide "readily available, easily understood, qualitative information on the hazardous nature of the chemical and situation confronted," the addition of quantitative and technical information should not subvert this objective provided that none of the existing CG-446-1 information is deleted.

(2) Other Chemicals

Since CG-446-1 is made available to other agencies and personnel, it has been suggested that this manual should contain those chemicals, such as liquid oxygen, also found in other applications and modes of transportation not necessarily associated with water transportation. This is certainly a desirable goal to the extent that funds are available to prepare the necessary data sheets.

(3) Identification of Hazardous Chemicals

To help in the identification of unknown chemicals, it has been suggested that a scheme be devised for classifying chemicals by observable characteristics, e.g., miscibility, buoyancy, color, odor, etc. First, it should be recognized that only infrequently is the identity of a spilled chemical unknown. Second, relatively few chemicals possess unusual observable characteristics which may permit their identification, especially when diluted in water. Nevertheless, it would be desirable to develop an observable property matrix for chemicals, along with a thesaurus of recognized descriptive terms. In this way, it would be possible to easily identify, for example, all floating chemicals possessing a particular color-odor combination.

(4) Hazard Assessment Guide

A rough hazard assessment guide indicating the extent of hazard as a function of spill quantity or size of spill, similar to the evacuation tables provided in the Department of Transportation publication Hazardous Materials - Emergency Action Guide, 1976, would be a useful addition to the manual. Such a table or chart would provide a convenient means for indicating to the user the approximate scale of hazard confronted. The extent of hazard calculations would necessarily have to assume certain standard environmental conditions (e.g., wind speed, current speed, etc.). For releases of hazardous gases, consideration should be given to inserting on the applicable data pages of CG-446-1, pertinent data from the toxic and flammable gas hazard charts in section 3.1 of CG-446-4. This would give response personnel a preliminary indication of the downwind extent of a hazardous gas cloud based on the amount of material spilled.

*(5) Cautionary Response Guide

Similarly, it would be desirable to include in CG-446-1 the Cautionary Response Index section of Table 4-1 in CG-446-4, along with the Reference as liquid oxygen, also found in other applications and modes of transportation not necessarily associated with water transportation. This is certainly a desirable goal to the extent that funds are available to prepare the necessary data sheets.

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*(5) Cautionary Response Guide

Similarly, it would be desirable to include in CG-446-1 the Cautionary Response Index section of Table 4-1 in CG-446-4, along with the Reference

Key to Special Precautions Information when these data would not be redundant. This table conveniently summarizes applicable cautionary responses for all hazardous chemicals in the manual.

5.2.2.2 Unsupported Observations

(1) Conservative Hazard Descriptions

The manual seems overly conservative in describing hazards, blurring comparative hazard distinctions among chemicals. For example, moderately hazardous chemicals are not easily distinguished by users from very hazardous ones. We do not concur with this objection raised by a single respondent. This manual was intentionally designed toward convervatism as a precaution against overlooking or inadvertently minimizing chemical hzards. There is no way that we know of to succinctly and unambiguously state the hazardous nature of a chemical in simple terms. The user who desires a more specific, scientific description of the hazard is advised to consult CG-466-2, which has been designed for this purpose. CG-446-1 is intended to provide readily-understood, non-technical information describing chemical hazards.

(2) CG-446-3 Information Needs

The information needs for CG-446-3 requested in CG-446-1 are too detailed; insufficient guidance is provided for collecting this information; certain guidance provided is extraneous and/or obvious. We do not concur with the single respondent making this observation.

(3) More Detailed Exposure Information

The health hazard (exposure) information on each chemical data sheet should be replaced by the more detailed and complete information contained in Sections 5.1, 5.2, 5.3, 5.8, and 5.9 of CG-446-2. We do not agree with this comment as it is antithetical to the stated purpose of CG-446-1. The health hazard information in CG-446-2 is more detailed and technical in nature than necessary or desirable for Coast Guard personnel first to arrive on-scene.

(4) Code of Federal Regulations

The applicable portions of the Code of Federal Regulations pertaining to each chemical should be incorporated in the manual. Again, such information would be of little or no value to personnel who first arrive at the site of a pollution incident.

5.2.3 Information Content

5.2.3.1 Supported Observations

(1) High-Production Chemicals

An examination should be made to determine whether all hazardous chemicals currently produced in intermediate to high volume have been incorporated in CHRIS. Although it is believed that all hazardous chemicals produced in substantial volume have been included in CHRIS, a check should be made that this is indeed the case. Once a definition has been made as to the minimum production volume of interest, a determination can then be made whether all chemicals exceeding this production threshhold have been included in CHRIS.

(2) Shipping Labels

DOT and IMCO shipping labels should appear in the description block for each chemical data sheet. Introductory sections 4.2.3, International Maritime Consulting Organization (IMCO) and 4.2.4, Department of Transportation (DOT), as well as Figure 4.2, IMCO Shipping Labels, can then be eliminated. These labels can be an important guide for field personnel in attempting to identify spilled materials and in evaluating the hazards associated with a particular chemical. By providing these labels on the appropriate data sheets rather than in Chapter 4, field personnel would have a positive cross check on any labeled substance with which they come in contact.

(3) NFPA Warning Symbol

An explanation of the NFPA system contained in Table 2 of CG-446-2, pages 3-13 and 3-14, should be added to Section 4.2.2 in CG-446-1. This will aid response personnel to readily determine the significance of symbol numbers.

(4) Telephone Numbers

It was suggested that the telephone numbers for CHEMTREC, OHM-TADS (EPA), National Response Center, and Poison Control Centers, be printed in appropriate boxes on the inside front cover.

(5) Compatibility Chart

A cautionary note should be placed on page 7-3 of CG-446-1 warning users of the Compatibility Chart that the table of Combinations Not Dangerously Reactive (pages 7-12 through 7-14) applies to this chart. The Compatibility Guide is not current with Navigation and Vessel Inspection Circular No. 4-75, Guide to Compatibility.

**(6) Synonyms

Many respondents have requested that the Index of Synonyms be expanded to include more commercial and trade names, as well as foreign names for the hazardous chemicals in CHRIS. During the development of the system, it was not within the scope of effort to collect common trade-names. This now appears to be a desirable objective in spite of the difficulty of the task. First, it will be necessary to communicate with all chemical producers and specialty manufacturers to identify trade names in use. Second, it may be expected that the list of trade names will have to be updated frequently. Third, proprietary and other mixtures of hazardous chemicals will require special consideration. Should each such mixture be regarded as a unique hazardous chemical or several hazardous chemicals depending on the number of dangerous ingredients? Until this issue is resolved, field personnel should be advised to contact CHEMTREC for advice concerning the identity of substances for which the trade name is known.

Closely associated with the preceding comment is the intent to extend CHRIS to recognize mixtures and formulations of chemicals of both proprietary and nonproprietary nature. Presently, the system is essentially restricted to pure substances.

A number of the common synonyms listed on the chemical data sheets are not contained in the Index of Synonyms. A check should be made to determine which synonyms are missing from the Index as a first step in correcting this problem. Furthermore, it would be desirable to indicate the reactivity group to which each chemical belongs as an aid in using the compatibility chart on page 7-3 in CG-446-1. It is probably easiest to add this information to the existing Index of Synonyms, but an alternative would be to place the reactivity group directly on each chemical data sheet.

(7) Pronunciation Guide

A pronunciation guide would be helpful for compounds with names which are difficult to pronounce. Although the three-character alphabetic code has been provided for convenience in written and oral communication, several respondents have requested that a phonetic pronunciation guide be provided as well.

**(8) Release into Media Other than Water

Consideration should be given to extending CG-446-1 to chemical releases into media other than water. Although in certain circumstances information in CG-446-1 may be applicable to other media, this is not necessarily explained in the manual. Many of the chemicals are stored or transported in the vicinity of waterfront facilities and may be accidentally released where they will not flow into water. Recognition of other media is also important because CG-446-1 has been made available to response agencies and groups other than the Coast Guard. In general, the only changes required in CG-446-1 are to Sections 1-5, which explain the nature of the information in the manual and how it is to be used.

(9) Chemical Reactivity and Explosiveness

More information should be included in the manual concerning chemical reactivity and explosiveness. A good example is furnished by sulfur monochloride. The manual indicates that the chemical mixes and reacts with water, producing a poisonous vapor. However, not indicated is the fact that the liquid dissolves rubber and plastics. Furthermore, after reaction with water the hydrochloric acid formed attacks metals, generating flammable hydrogen gas which may explode if ignited in a confined area.

(10) Fire

It appears that the instruction to shut off ignition sources only applies to flammable liquids and gases for Phase I chemicals but also includes combustible liquids for Phase II and III chemicals. This inconsistency should be rectified.

The addition of information that might distinguish between small and large fires may be helpful in recommending preferred extinguishing agents.

*(11) Exposure

Consideration should be given to identifying poisonous gases that can result from certain chemicals reacting with water, metals, or oxygen and to indicating the respective first-aid measures that should be taken.

**(12) Water Pollution

Water pollution descriptions are very general. More information is needed, for example, to answer questions concerning the extent of pollution in large bodies of flowing water such as San Francisco Bay. Very little distinction is made between birds and marine life, nor are distinctions made between different kinds of birds. Continued effort should be expended to acquire greater knowledge concerning the effect of hazardous chemicals on aquatic life.

5.2.3.2 Unsupported Observations

(1) Redundant Information

The manual contains redundant information that is believed to be detrimental to the system (e.g., Sections 4.1, CHRIS, 5.1, General Format, and 5.2, Colors and Symbols). One respondent has commented as follows: "There is a certain redundancy and duplication of non-essential material within and between books of the system. This redundancy is felt to be detrimental to the system because the presence of material not needed in solving response problems serves to render the material that is needed less accessible. This difficulty is most acute in CG-446-1, a book that has supposedly been kept simplified so that response personnel may easily and rapidly evaluate the hazards associated with a particular discharge while in the field."

We do not concur with this observation and believe it to lack substance.

(2) Table of Chemicals

A Table of Chemicals should be adopted, similar to the Index of Synonyms, which provides the following information in matrix form: synonym, 3-letter code, page number, compound name, reactivity group. Page references should be used rather than compound names. The alphabetical listing of compounds, reactivity groups, Index of Synonyms, and Index of Codes presently contained in Chapters 7, 8, and 9 can be eliminated.

We agree that the reactivity group should be assigned to each chemical but are opposed to using a page reference because of updating problems that would be created. Although the present paper-bound version of CG-446-1 employs pagination, future loose-leaf versions should ease the incorporation of new chemical data sheets.

(3) Water Solubility

Water solubility is omitted as to whether a chemical floats, sinks, or emulsifies. We do not agree with this comment. To quote from the paragraph entitled Action on Release, page 5-3 of the manual: "Also given is a description of the behavior of the chemical when it is spilled on water -- that is, whether it sinks or floats and whether or not it mixes with water." Perhaps the respondent did not appreciate that water solubility is taken into consideration when stating the chemical's reaction on release.

5.2.4 Specific Data Sheets

5.2.5.1 Supported Observations

(1) Physical State and Action on Release

For data sheet, Liquidified Natural Gas (page 6-217), the physical state as shipped should be changed from "Liquified compressed gas" to "Liquified gas." For data sheet Methane (page 6-223), the physical state as shipped should be changed from "Liquified compressed gas" to "Liquified or compressed gas" and action on release into water should be changed from "Floats and boils on water. Flammable visible vapor cloud is produced." to "Liquified gas floats and boils on water and produces a flammable visible vapor cloud."

For data sheet Ammonia, Anydrous (page 6-18), the part of the action on release phrase that reads "Poisonous, visible vapor cloud is produced" should be changed to read "Poisonous vapor is produced, which may or may not be visible." Consideration should also be given to changing the explanation on page 5-3 to indicate that a cold, colorless gas or vapor may be rendered visible when it condenses atmospheric moisture.

(2) Odor

Some fourteen Phase I chemicals have no information provided for odor. They are:

Benzoyl chloride (page 6-35)
1,4-butynediol (page 6-51)
Diisobutylcarbinol (page 6-109)
Diphenylmethane diisocyanate (page 6-122)
2-ethyl-3-propylacrolein (page 6-161)
Latex, liquid synthetic (page 6-213)
Oils: clarified (page 6-260)
Oil, edible: olive (page 6-266)
Oils, miscellaneous: sperm (page 6-288)
Oils, miscellaneous: tanner's (page 6-292)
Pentachlorophenol (page 6-298)
Propylene butylene polymer (page 6-328)
Propylene tetramer (page 6-332)
Toxaphene (page 6-372)

Additional effort is needed to determine whether these chemicals are indeed odorless or to find descriptions for their characteristic odors.

Also, more attention needs to be given to odor descriptions applied to Phase I chemicals. For example, on page 6-360 the odor is cited as being acrid. This terminology is not expected to be familiar to most users of the manual. On page 6-283 the odor is stated to be peculiar. This appears to be unsatisfactory.

(3) Fire

According to CG-446-2 data sheet for Polypropylene Glycol Methyl Ether, there had been considerable difficulty obtaining any relevant data, especially on flammability. This is reflected in the CG-446-1 data sheet (page 6-316), which states "fire data not available." The general directions state "shut off ignition sources and call the fire department" because this is deemed to be the safest procedure even though the material may not be flammable or combustible. Effort should be expended to derive missing information on flammability for chemicals where none had been found in the literature.

Fire is highlighted for Allylchloroformate but not for tetraethyl lead even though they have similar hazards.

(4) Exposure

It is not obvious why for Hydrogen Cyanide (page 6-190) it is stated "Wear chemical protective suit with self-contained breathing apparatus," yet this statement is omitted for Hydrogen Fluoride (page 6-191). The use of this statement should be reviewed for all chemicals in CG-446-1.

(5) Xylene

Xylene, when in contact with the skin, causes a burning sensation which can be relieved by application of lube oil, mineral oil, motor oil, etc., after washing with soap and water. This treatment for exposure may be added to the chemical data sheets concerned.

(6) Water Pollution

There is some inconsistency in phrasing as, for example, between that for Caustic Soda Solution (page 6-66) and Sodium Hydroxide (page 6-346) in that one states "Notify local health and pollution control officials" and the other "Notify local health and wildlife officials."

5.2.5 Miscellaneous

5.2.5.1 Supported Observations

(1) Data Review

The original schedule for completing CG-446-1 required some of the information to be derived from CG-446-2 before the latter had been finally reviewed and checked. A recheck of CG-446-1 information against the final CG-446-2 data might remove deficiencies and/or errors in CG-446-1. (This applies only to the 400 Phase I chemicals.)

(2) Consistency of Phrasing

The development of standard phrasing for CG-446-1 evolved as the data sheets were developed, so that some of the earlier (Phase I) sheets differ in relatively minor aspects from those that were prepared later. Again, a recheck would eliminate these minor differences.

5.3 Hazardous Chemical Data, CG-446-2

5.3.1 Presentation Characteristics

5.3.1.1 Supported Observations

(1) Construction

The particular binding being employed is not well designed from the users' point of view. When the manyal is opened to any particular place, the pages do not lie flat. After repeated use the pages begin to tear out. Finally, the binder seems ponderous for the purpose intended. To rectify these problems it is suggested that a loose-leaf binder with ten or more rings and a hard cover be supplied instead of the current swing-hinge binder.

(2) Paper

The use of a more durable paper is also recommended. Possibilities include a synthetic waterproof olefinic paper which is nearly impossible to tear or paper with a reinforced edge to inhibit page tearing at the point of binding.

(3) Type Size

The type size is fairly small, inhibiting readibility. This could lead to a user misreading critical information during an emergency. Type size should be increased or the typeface made bolder. However, criticism of type size by users was quite limited.

5.3.1.2 Unsupported Observations

(1) Because the data pages in CG-446-2 are unnumbered, locating and referencing chemical data sheets in the manual is made difficult. We agree that pagination would reduce this problem, but would also interfere with the addition of new chemical data sheets in the future. For the latter reason, pages were intentionally left unnumbered.

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*These comments apply equally to CG-446-3 and -4.

5.3.2 Conceptualization

5.3.2.1 Supported Observations

(1) Minimum Spill Volume

A rough estimate of the minimum spill volume necessitating quantitative hazard assessment would be a useful addition to the manual in order to obviate unnecessary calculations for insignificant spills. Several respondents have noted that they have made detailed hazard assessments only to discover that the amount of material released was too small to consitute a significant risk. The provision of an approximate guideline might aid users in distinguishing between minor spills for which hazard assessment calculations are unwarranted and larger spills for which such calculations may prove helpful. Because hazards are determined, in part, by environmental conditions, assumptions will have to be made concerning various factors influencing spill risk in order to develop the desired guidelines.

**(2) Hazard Assessment

Serious consideration should be given to developing simplified chemical-specific hazard assessments for incorporation in CG-446-2. Emphasis should be placed on the 284 chemicals* shipped in bulk. By using the hazard evaluation formulas and tables in CG-446-3 or HACS, chemical-specific hazard assessments may be precalculated as a function of various spill parameters (e.g., spill volume, wind velocity) and displayed in tables, graphs, or nomograms (possibly on the reverse side of CG-446-2 chemical data sheets, replacing the physical property graphs--see Section 5.3.3.1 (1)). The development of precalculated hazard assessments would greatly simplify and speed the task of risk estimation for users (see also Section 5.4.2.1 (1)). Those users desiring more precise hazard estimates could still utilize CG-446-3 or HACS, if available. For most users, however, the availability of precalculated, chemical-specific hazard assessments would largely obviate the need for CG-446-3. Due to the very substantial effort that would be required to implement this new approach, the utility of field-generated hazard assessments in general should be reviewed carefully (see Section 5.4.2.1 (3)). Nevertheless, we are of the opinion that the modification would go far toward improving the usefulness of CHRIS.

*46CFR151, Cargoes Regulated by Subchapter O (Table 151.01-10b) and Cargoes Regulated by Subchapter D (Table 151.01-10d).

(3) Response Method Selection

Section 4.0, Selection of Response Method, in CG-446-4 should also be included in CG-446-2 to enable immediate and correct reaction by the responding unit. This is not felt to be an essential need.

(4) Reaction Products

Information on the reaction products of certain chemicals (especially with water) contained in CG-446-3 should also be incorporated in CG-446-2 for quick reference. Table 0.1 on page 233, Liquid Chemicals Which React with Water, in CG-446-3, should be added to Section 7.1, Reactivity with Water, in CG-446-2. Where possible, Section 6.5, Special Hazards of Combustion Products, and Section 7.2, Reactivity with Common Materials, in CG-446-2, should identify reaction products.

5.3.2.2 Unsupported Observations

(1) Chemical Dictionary

Use of CHRIS has frequently required additional reference to a chemical dictionary; such a dictionary should be included in CHRIS and new editions distributed as part of system maintenance. It is suggested instead that the desirability of having a chemical dictionary available be mentioned in CHRIS. However, each unit should independently reach a decision whether or not a chemical dictionary is necessary and, if so, obtain one on their own.

(2) Reactions Between Chemical Groupings

In incidents involving mixed chemical families, as found in freight train derailments, a listing of expected reactions between various groupings would be useful. The compatibility chart furnished in CG-446-2 is designed to show chemical combinations believed to be dangerously reactive in the event of accidental mixing. We believe that the listing of expected reactions between various chemical groupings would probably not be very useful.

(3) Duplication of CG-446-1

CG-446-2 appears to be an unnecessary duplication of CG-446-1. As it stands, this comment is unacceptable. Perhaps the respondent was expressing concern about the duplication of the CG-446-1 chemical data sheet in CG-446-2. Reprinting the CG-446-1 data sheet was done for the convenience of the CG-446-2 user, who would then not have to refer again to the former manual. In addition, the CG-446-1 data sheet provides a very handy summary of principal hazards and cautionary response actions.

5.3.3 Information Content

5.3.3.1 Supported Observations

*(1) Physical Property Graphs

The physical property graphs have not been found useful by any of the respondents. They observe that no instructions are provided anywhere in CHRIS for the use of these graphs and recommend that they be removed from CG-446-2. We are in agreement; the graphs will be found useful primarily by individuals engaging in research on chemical properties or hazard assessment techniques. It is recommended, therefore, that the physical property graphs be removed from CG-446-2 propert, and collected in a companion volume for use by headquarters personnel or others on request.

(2) Health Hazards Data

Data gaps, particularly with regard to quantitative health hazards, are especially troublesome and limit the effectiveness of hazard assessment. For example, the unavailability of short-term toxicity limits for sulfuric acid prevent the prediction of safe concentration limits for this material. Experimental testing is required in order to eliminate these data gaps for many common hazardous chemicals. At the same time, every effort should be made to obtain and publish new and updated biological data as soon as they become available. Furthermore, it is suggested that whenever possible, quantitative toxicity data should be provided, regardless of how minimal, since this would aid in some computations.

(3) Synonyms

As in CG-446-1, CG-446-2 would benefit substantially from a complete index of commercial and trade names for hazardous chemicals.

(4) Terminology

Terminology, such as toxicity limits, LD_{50}, and BOD, presents concepts that are admittedly difficult for some users to grasp. We concur with this observation but do not find it particularly surprising.

(5) Molecular Weights

The majority of listed petroleum products do not have their molecular weights given. However, MEP School teaches students to use the molecular weight of similar products. We conclude that an approximate molecular weight should be provided in the manual where necessary.

(6) Label

The "present" label, whose commercial usage terminated on 1 January 1974, should be eliminated from Section 2 of the chemical data sheet.

(7) Mixtures

All of the data given in CG-446-2 are, unless indicated otherwise, for pure chemical compounds. Since some chemicals may not be shipped in their pure form, but as mixtures of chemicals, critical physical characteristics of the mixtures may differ considerably from those for the pure compounds.

(8) Deletions

Some chemicals listed in CG-446-1 and CG-446-2 may no longer be items of commerce and should be deleted from the handbooks.

(9) Errors

Various errors have been identified after the manual was printed. These have been recorded in a master file and should be corrected when this handbook is revised.

(10) Data Gaps

Separate reports containing lists of data that are needed for CHRIS but not found in the literature and are not amenable to estimation methods have been submitted to the Coast Guard. These data should be either collected or derived by experimental means. Estimated values should be replaced with experimentally confirmed data as they become available.

(11) Additional Chemicals

Some products of chemicals that react rapidly with water are not now contained in CHRIS data sheets. Since they may be hazardous, data sheets should be prepared for each of these materials that may be produced in significant amounts. Candidate chemicals are listed, as follows:

Aluminum Hydroxide	Lead Dioxide
Aluminum Oxide	Lithium Hydroxide
P-anisic Acid	Methanephosphonothioic Acid
Antimonic Acid	Nitrogen Dioxide
Antimonous Acid	Phosphine
Benzenearsenic Acid	Phosphorous Acid
Benzenephosphorous Acid	Selenic Acid
Benzenethiophosphoric Acid	Silica Gel
Chromic Acid	O-silicic Acid
Chromium Dioxide	Sulfur, Solid
Ethanephosphonothioic Acid	Thionophosphoric Acid
Ethyl Dihydrogen Phosphate	Titanium Dioxide
Hydrobromic Acid	Trimethylsilanol
Hydroxyacetophenone	Vanadic Acid
	Zinc Oxide

(12) Compatability Guide

The present Compatability Guide should be modified to conform to Navigation and Vessel Inspection Circular No. 4-75, Guide to Compatability.

(13) Item 1 - Response to Discharge

The responses itemized in this box were developed prior to the establishment of standard phrasing for CG-446-4, Response Methods Handbook. The responses given under item 1 should be changed to conform with the present CG-446-4 responses for each chemical.

The definition of flammability of materials has been changed in the Code of Federal Regulations. This change should be reflected in the recommended responses for certain chemicals.

(14) Item 2 - Labels

The change in the CFR relating to the definition of flammability of materials should also result in changing the labels for certain chemicals.

(15) Item 5 - Health Hazards

The Occupational Safety and Health Administration (OSHA) has issued extensive regulations on carcinogenic chemicals. These carcinogenic chemicals should be identified in CHRIS.

(16) Item 5.4 - Toxicity of Inhalation (Threshhold Limit Value)

TLV's, when used to estimate the extent over which a toxic vapor cloud is hazardous, gives overly conservative results. TLV's are intended to provide limits for 8 hours' continuous exposure each day over a 40-hour work week. In most cases much higher values may be tolerated over relatively short time periods during an emergency.

As an example, the maximum downwind distances for specific concentrations of sulfur dioxide (SFD) and the effect of these concentrations on people are presented in the following table for a 100-ton instantaneous release on water, assuming weather condition D. It can be seen that the distance over which the vapor cloud is lethal is only one-seventh the distance based on the TLV.

100-Ton Instantaneous Release of Sulfur Dioxide

Weather Condition D

Concentration	Effect	Max. Hazard Extent
3-5 ppm	detectable odor (TLV)	55 n. mi.
8-12 ppm	slight nose and throat irritation	42 n. mi.
20 ppm	some coughing and eye irritation	31 n. mi.
50 ppm	strong irritation of eyes, throat, and lower respiratory tract	20 n. mi.
150 ppm	severely irritating, can be endured for only a few minutes	12 n. mi.
400-500 ppm	dangerous to life immediately	8 n. mi.

(17) Item 8.1 - Aquatic Toxicity

An attempt should be made to improve aquatic toxicity data to provide more information on acute effects, and to broaden the coverage of this data item to include, for example, shellfish and aqueous plant life.

(18) Items 10.2 - Storage Temperature, 10.3 - Inert Atmosphere, and 10.4 - Venting

Data for these items should be deleted unless also contained in the Code of Federal Regulations for a given chemical. Alternatively, the fact that the data are not supported by the CFR should be so noted.

(19) Item 11 - Hazard Assessment Code

There are some inconsistencies in the assignment of hazard assessment code "O" for chemicals that react with water slowly and for the water reactive chemicals listed in Table 0.1, Liquid Chemicals Which React with Water of CG-446-3, for Phase I, II, and III chemicals.

(20) Item 12.1 - NAS Hazard Rating for Bulk Water Transportation

A new hazard rating system developed by the National Academy of Sciences Advisory Committee should be submitted for the ratings that are now contained in CG-446-2.

(21) Items 13.10 - Vapor (Gas) Specific Gravity and 13.23 - Saturated Vapor Density

Neither CG-446-1 nor CG-446-2 make special note of the density of vapor created by an accidental release relative to ambient air. Vapors having a density less than that of ambient air will tend to rise, and their hazardous effects may not be realized at sea level for distances very far from the discharge. On the other hand, if vapor density is greater than that of air, vapor clouds may extend for considerable distances at sea level, depending upon the quantity and rate of spill.

The density of the vapor at the temperature at which it is formed generally has the most significance. For example, liquefied natural gas (LNG) that is mostly methane will have a vapor density greater than air since the vapor as it is initially formed is near the boiling point of methane. Vapor clouds produced by spills of LNG may travel for considerable distances downwind at sea level. This is in contrast to warm methane gas which is less dense than air.

5.3.3.2 Unsupported Observations

(1) Response to Discharge

The Response to Discharge section receives inadequate amplification in CG-446-4 and would be more useful if stated fully in CG-446-2. The meaning of this observation is not clear; we presume the user is troubled by the brevity of the Response to Discharge section in CG-446-2. However, the purpose of the terms used in this section is to describe in a general way the cautionary and correct responses that are described in greater detail in the Response Method Handbook, CG-446-4.

(2) Redundant Information

Chapter 2, sections 3.1 and 4, contains information that is either duplicated elsewhere or simply not needed by response personnel or personnel analyzing the extent of hazardous material discharge. We do not agree with this observation.

5.4 Hazard Assessment Handbook, CG-446-3

5.4.1 Presentation Characteristics

5.4.1.1 Supported Observations

**(1) Calculational Procedures

There is widespread argreement by users that, in general, the presentation of calculational procedures needs substantial improvement to enhance comprehension, accuracy, ease of use, and speed. Because the hazard assessment routes were laid out in such a way as to avoid unnecessary duplication of calculational procedures common to two or more different routes, the user is often required to cross-reference among different sections of the manual. It is quite easy, therefore, for the user to lose his or her way or terminate the set of calculations before reaching the final hazard assessment. One way to ease the problem of cross-referencing among different sections of the manual would be to use a color-coded, or other special marking system, to better define a pathway through the calculational routes. Another possibility would be to provide a special check list for each hazard assessment route which would help ensure that the user follows the correct pathway and does not get sidetracked inadvertently.

Important items to be computed under the various hazard assessment codes should be set apart from the text proper. This could be accomplished by underlining, color-coding, or making an identifying mark in the margin. End data items should be set off in a similar manner. Another suggestion might be to use a different color-tabbed page for displaying a summary of hazards for a particular hazard assessment code. This special page might also contain the above-mentioned check list.

Several observations emphasizing the extent of this problem have been received from respondents:

- The layout of calculational procedures could be improved. A specific example is Hazard Assessment Code APQRS. The calculation of the extent of hazard to humans should precede the calculation of concentration at a user-selected point downstream. Instructions on the effect of air current on vapor dispersion should precede instructions that sent the user to another part of the book.

- Introductory discussion accompanying each major assessment code (each tab) should highlight the parameters to be calculated for each sub-code. This should help users select the relevant calculational procedures and provide some perspective for performing the calculations.
- Users have trouble reading certain graphs because the parameters and units of the variable to be read from each graph are not identified with sufficient clarity.
- The instructions for Hazard Assessment Code II and others without models tend to confuse users.
- When the code AO appears, it should be highlighted. In many cases this code should be considered first but now tends to go unnoticed.

(2) Conversion Factors

The conversion factors contained in Appendix A of this manual and the Table of Useful Formulas on Page 34 are difficult to locate rapidly. This information should be relocated to the inside front cover of CG-446-3 or consolidated elsewhere in this publication. Additional formulas should be provided for converting gallons to tons and cubic feet of gas to tons, since the amount of spilled material is not usually expressed in tons, as required for the use of various charts.

(3) Document Protectors

Permanent or temporary transparent document protectors would permit the use of a grease pencil, thereby facilitating calculations. An alternative would be to laminate the pages with plastic.

5.4.1.2 Unsupported Observations

(1) Format

The format of the manual is too complicated for rapid understanding by untrained personnel; a format that is more self-explanatory would enhance the potential for using this volume. However, it has never been intended that this manual be used by untrained personnel. Indded, considerable training is required before users can properly perform and interpret hazard assessments. This does not mean, though, that the format cannot be improved to facilitate use.

(2) Hazard Assessment Tree

Figure 2-1, Hazard Assessment Tree: (Events Chart), on page 10 of CG-446-3, is difficult to comprehend initially. However, the great majority of respondents welcome this diagram and report that it greatly aids their understanding of the manual's organization.

5.4.2 Conceptualization

5.4.2.1 Supported Observations

**(1) Chemical-Specific Models

Hazard assessments, particularly for the 284 materials shipped in bulk, should be precalculated on a chemical-specific basis, in addition to or possibly eliminating the need for the generalized models in CG-446-3. Assessments would thereby be greatly simplified and the opportunity for calculational errors reduced. These chemical-specific hazard assessments would be based upon the generalized models contained in CG-446-3 or upon HACS, and would indicate the extent and severity of hazards as a function of various spill parameters (e.g., spill volume). Unique hazard assessment models for certain chemicals may be warranted where the results obtained may be far more accurate than those of CG-446-4. If this new concept were adopted, it would then be desirable to locate the hazard assessment models in CG-446-2 in place of the physical property graphs to be deleted. This should result in a great simplification in the complex and slow hazard assessment process that users must follow. (See also Section 5.3.2.1 (2).)

**(2) Media Other than Water

Hazard assessment methods should be extended to releases on land and into air generally. For example, chemical fires on ships and shore-based facilities are fairly common occurrences but presently lie outside the scope of CHRIS. Because CHRIS was originally developed in the context of facilitating response to water pollution incidents, land and air pollution situations were only recognized in conjunction with water-related spills. It now appears, however, that users require a similar information system for aiding response to nonwater-related spills of hazardous chemicals. During the utilization survey several situations occurred wherein users attempted to apply CHRIS to incidents for which it was not applicable. An acrylonitrile fire in a tank struck by lightning was one example. Users, not realizing the well-defined scope of CHRIS, are quick to criticize the system when it is not applicable to a particular situation at hand. For this reason, it no longer seems appropriate to limit the applicability of CHRIS to water-related spills in view of the magnitude of unmet user needs. Until the scope of CHRIS has been suitably extended, prominent warnings should be placed in the manuals to alert users to inappropriate applications of the system.

**(3) Timeliness of Results

Many users have observed that hazard assessment can rarely be conducted in real time. That is, in the vast majority of emergency incidents, a hazard assessment cannot be completed in sufficient time to plan and execute response actions. Indeed, even if the assessment could be conducted instantaneously, there is often insufficient time to utilize the information available. Because of this perception, many users regard hazard assessment as a highly complex, time-consuming, and ineffective activity which steals valuable time from more productive operations. This has prompted one observer to note that "the manual is far too academic and comprehensive. Detailed calculations in CG-446-3 could take longer to complete than the actual emergency." On the other hand, another observer has stated that "The manual is best utilized in a nonemergency planning mode whereby likely spill scenarios are evaluated for normally handled commodities." This statement seems more to the point;

however, very few field units employ CHRIS in this manner. In the same vein, another observer has remarked that "CG-446-3 would be better suited for preplanning spill problems and contingency planning than for use during an actual incident because of inevitable time delays. Therefore, techniques in preplanning problems based on local knowledge should be addressed."

The principal reasons underlying the lack of timeliness in preparing hazard assessments are threefold. First, initial reports of the incident are often delayed, so much so that the threat may be over by the time the Coast Guard has learned of the discharge; second, information needs for hazard assessment may not be satisfied for an appreciable time; and third, the calculations themselves may be time-consuming, especially if performed by personnel who are less than proficient. The latter reason has led many respondents to suggest means for speeding the calculations.

**(4) Assistance

Field personnel have requested external support in the preparation of hazard assessments via the National Response Center and/or computer terminals interfacing to the Hazard Assessment Computer System (HACS). During the utilization survey this has been one of the most commonly expressed needs by users who feel that they require support in order to speed calculations, check accuracy of results obtained, and obtain guidance and/or interpretation of results.

Whereas automation may well speed hazard assessment calculations and improve their accuracy, we do not believe that this will also lead to more timely results. The main problems delaying a timely hazard assessment are late notification and receipt of incident-related information rather than trying to perform calculations. Also, if users have only infrequent occasion to perform hazard assessments, use of terminals for accessing HACS may well be more difficult than using a manual due to changing input conventions. Nevertheless, if and when HACS is installed on a time-shared computer system, we suggest that those field units possessing terminals be permitted to access HACS on demand. If users have the desire and facilities to use HACS, they should be allowed to do so.

We also believe that support in the conduct of hazard assessments should be furnished by Coast Guard headquarters personnel when requested by the field. CHRIS headquarters personnel will have more opportunity to become expert in the use of the system than will field units who experience only infrequent opportunity to use CHRIS. Given the realities of hazardous chemical spills, certain units will probably never acquire sufficient experience in the use of CHRIS to engender confidence. These units should be given support from headquarters when requested.

If precalculated values from chemical-specific hazard assessments are inserted in CG-446-2, users will be less troubled in the future by complex calculational procedures.

(5) Understanding

Users have expressed considerable difficulty relating calculational procedures to actual physical processes. It is easy for users now to get sidetracked during calculations because instructions occasionally direct the reader from one path to another. Again, we have previously offered a number of suggestions to lessen this problem, including the use of color coding and chemical-specific hazard assessments in CG-446-2. This observation may imply that a new training book is required dealing explicitly with the physical processes attendent to spills of hazardous chemicals. Specifically, the book would explain the physics and chemistry of spills so that users have a better foundation for understanding and interpreting hazard assessments.

(6) Usefulness and Accuracy

The utility and accuracy of certain models have been called into question. For example, the value of the time-to-sink calculation has been doubted; therefore, explanations may be in order justifying the need for various models in CG-446-3. The question of model accuracy has no doubt arisen because of the stress placed on conservatism, i.e., the prediliction to overestimate a hazard rather than to underestimate it. This concern has prompted one observer to note that "The hazard assessment models provide for the maximum hazard expected, which would therefore require greater utilization of resources than might otherwise be necessary." Unfortunately, only extremely general statements can be made concerning the accuracy of generalized hazard assessment models. It is hoped, however, that the use of chemical-specific models might lead to more precise statements regarding accuracy.

*(7) Inappropriate Uses

Some users have attempted to second-guess the appropriate hazard assessment route by recognizing limited hazards noted in CG-446-1. These users have failed to recognize a major difference in the focus of manuals CG-446-1 and CG-446-3. The former is concerned with local hazards to personnel in the immediate vicinity of the spill site, whereas the latter is concerned with the effects of large-scale hazards. A good example is furnished by xylene. CG-446-1 indicates that this chemical presents a toxic vapor hazard to personnel in the vicinity of the spill. However, because xylene has a relatively low vapor pressure, it will not present a vapor hazard at significant distances from the spill site. For this reason, no toxic vapor hazard assessment is indicated in CG-446-3, yet one field unit attempted to extend the hazard assessment code to recognize a toxic vapor hazard. Such an extension is unwarranted and incorrect. A caution needs to be inserted in CG-446-3 warning the user not to extend the hazard assessment code beyond that indicated. If a particular pathway is omitted for a chemical, it signifies that this hazard is nonexistent or inconsequential.

5.4.2.2 Unsupported Observations

(1) Ease of Use

This manual (together with CG-446-2) is not readily usable by someone not thoroughly familiar with the manual. We agree with this observation; training is absolutely essential to effective use of these manuals.

5.4.3 Information Content

5.4.3.1 Supported Observations

(1) Mixtures

Additional guidance should be provided in the manual for conducting hazard assessments of mixtures of known composition. At the present time, the models only recognize pure substances and mixtures listed in the Code of Federal Regulations. Extension to mixtures of known composition is straight-forward.

(2) Combustion Products

Hazard assessments are not usually available for combustion products of chemicals contained in CHRIS. Perhaps an explanatory note should be inserted in the manual indicating the difficulty of predicting both the identity and quantity of products resulting from incomplete combustion.

(3) Omitted Data

Tables omitting data for a specific chemical, (e.g., Tables V.1, V.2), sometimes advise the user to substitute data for a similar chemical. This is not particularly helpful to one unfamiliar with constructing chemical analogies. Instead, approximate values should be inserted in the tables as an aid to users.

(4) Small Spills

Most nomograms, tables, and graphs are intended for larger spills so that rough extrapolation is often necessary for smaller ones. This limitation should be removed by extending these data sources to smaller spill sizes.

(5) Information Needs

The information needs section will require updating as regulations are revised and as the shipping and chemical industries change. Examples of data that may be revised in the future include Table 3-1, MCA Cargo Information Cards, Placards, List of 40 specific dangerous cargoes, CHEMTREC, TEAP, and the Oceanographic Atlas.

(6) Item 3.5.3 - Wind Speed and Direction...

On page 43 under Estimation of Wind Direction, it is suggested that the observer generate smoke and observe the direction in which it is blown. Improved suggestions are needed.

On page 46 terms such as "amplitude" and "period" should be clarified and/or included in Appendix B, Explanation of Terms.

(7) Organization

Section 3.5.2, Rate-of-Release Estimation Techniques--Unpressurized Tanks, is a hazard assessment model and as such should be tabbed, elevated to the status of other models, and positioned within the manual at a more appropriate location.

(8) Hazard Assessment for Slow or "Non-Instantaneous" Discharges

In general, CG-446-3 provides hazard assessments for instantaneous (very rapid) discharges of hazardous chemicals into water. If the actual spill takes some time to occur, then the CG-446-3 hazard assessments will generally be conservative (i.e., the estimated extent of the hazard will be too large). Consideration should be given to incorporating new assessments that will account for slow discharges. Such assessments are already included in HACS.

(9) Item 3.5.2 - Rate of Release Estimation Techniques--Unpressurized Tanks (Model A)

Methods of estimating the rate of displacement of cargo with sea water may help to provide more accurate estimates of rate and quantity released for vessel accidents. The rate of release estimates from liquid level measurements may be made easier by providing appropriate tables for possible conditions that may occur. Information on cargo tank configurations and other characteristics of specific vessels would enhance estimates of quantity and rate of release--as for example, specifying the dimensions of the most commonly employed barges and tankers.

(10) Acetaldehyde

The hazard assessment code for acetaldehyde considers this material as a liquid that boils at ambient temperature, whereas its actual boiling point is 59°F. If acetaldehyde is discharged during cold weather, the air and water temperature could be such that acetaldehyde will not boil at ambient conditions. The user is then prevented from performing an assessment for volatile liquid vapor dispersion because this calculation employs a chemical-specific graph that does not include acetaldehyde.

**(11) Hazard Assessment Models

The remainder of the comments in this section relate to specific characteristics of the analytical models that were used to develop the tables, graphs, and calculational procedures described in this handbook. These comments highlight deficiencies or overconservatism in the models and are indicative of the need to perform additional research to provide more reaslitic assessments. It is not intended that these comments contain a complete analysis of all approximations, deficiencies, and lack of confirmation for all of the models.

(a) Model B: Vapor Flame Size and Thermal Radiation

- The safe separation distance from a vent flame assumes that the flame is vertical. The sufficiency of this assumption needs to be reevaluated.

- A single (average) flame temperature is used as the basis for calculating flame length. True adiabatic flame temperatures should be derived and employed for each chemical for which this model applies.

- A single value (1600°F=871.1°C) is used for the flame temperature in estimating safe separation distances, whereas HACS uses a default value of 800°C. This discrepancy needs to be resolved.

(b) Model C: Vapor Dispersion

- Vapor dispersion estimates are based on the assumption that discharges occur instantaneously (very rapidly). This can result in excessively conservative estimates of downwind hazardous distances when the hazardous cargo is spilled gradually or continuously from its container. HACS considers continuous releases, and these vapor dispersion methods could be added to CG-446-3.

- The buoyancy of vapor clouds is not taken into account in the CG-446-3 calculation methods. Since some clouds are sufficiently buoyant for the cloud to rise thereby eliminating sea level hazards in the vicinity of the spill, current calculation procedures can result in excessive overestimates of the hazards presented.

- Downwind distances over which toxic vapor clouds may be hazardous are based on threshhold limit values (TLV's) given in CG-446-2. As discussed in Section 5.3, Hazardous Chemical Data, CG-446-2, these values may lead to estimates of excessive distances, at least in terms of responses that may be made during emergencies.

(c) Model D: Pool Size (Insoluble, Floats)

- Improved models for estimating pool size have been developed and should be considered as a replacement for the existing calculational procedure.

- Current models do not allow for a portion of some refrigerated (cold) liquids to be immediately converted into vapor when they are released. That is, upon reducing the presure within the container to atmospheric, some of the liquid will flash vaporize. Flash vaporization would probably have its greatest impact relative to "continuous" releases, were these to be considered.

- The effect of confinement of the pool by the banks of a channel, or other restrictions to the development and expansion of a spreading pool of liquid, is not considered in CG-446-3 but is taken into account in HACS.

- For instantaneous spills, both CG-446-3 and HACS calculate the vapor emission rate on the basis of the total quantity spilled divided by the total time to evaporate. This assumption should be reconsidered.

- The effect of plume burning on pool size is not now considered.

(d) Model E: Flammability Hazard of Burning Pool

- The criteria (flux levels) for safe separation distances should be reevaluated. For example, the safe distance for people in fire-protective clothing should be reexamined.
- Reduced thermal radiation from flames due to smoke obscuration is not presently taken into account. This results in very excessive (if not absurd) separation distances for some pool fires, e.g, the burning of gasoline. (This is not true for LNG fires.)
- The reduction in thermal radiation by absorption of radiation by water vapor in the air is not taken into account.
- It is suggested that CG-446-3 also provide a means of estimating safe distances upwind from the fire.
- A new model involving the exposure of a tank containing a compressed or liquefied gas to an external fire has been added to HACS. It might also be used to increase the utility of CG-446-3.

(e) Model H: Flame Size (Heavier-Than-Water, Insoluble)

- This model is very approximate. Although only two chemicals employ this model, research is needed to provide a more accurate representation of the phenomena involved.

(f) Model I: Boiling Rate (Heavier-Than-Water, Insoluble)

- This model assumes that the liquid breaks up into small droplets and that the evaporation time is quite short. Research is needed to provide an improved model.

(g) Model J: Vapor Dispersion (Heavier-Than-Water, Insoluble)

- This model simply assumes that the pool diameter is ten feet in all cases. Again research is needed to develop a better model.

(h) Model K: Mixing and Dilution (Soluble)

- The assumptions that enter into the determination of pool size should be checked by further analysis, and perhaps verified by experiment.
- Water pollution estimates may be overly conservative because all of the vapor is assumed to go into solution. More research also should be applied to this model.

(i) Model O: Water-Reactive

- In Table O.1, Liquid Chemicals that React with Water, only those Phase I chemicals that react rapidly with water are included. Consideration might be given to those chemicals that react slowly with water.
- Certain chemicals are given special treatment in HACS. It might be helpful to treat them separately in CG-446-3 as well.

(j) Model P: Water Dispersion

- Better data on toxicity by ingestion would improve the utility of this model. Where LD_{50} values are given, the limiting exposure is based on a 100-pound person drinking two glasses of polluted water; a "safety factor" of 3 is used in developing the limiting concentration. This assumption should be further examined.
- For spills into still water, dispersion is estimated on the basis of molecular diffusion. Molecular diffusion times are divided by 1000. These assumptions should be reexamined.

- The utility of this model is reduced by the difficulty of obtaining input data for estuaries.

(k) Model S: Vapor Dispersion (Soluble)

- This model assumes that the vapor is emitted as a point source, resulting in overestimates of hazardous distances. Further research could provide a more realistic model.

5.5 Response Methods Handbook (and Appendix), CG-446-4

5.5.1 Presentation Characteristics

No observations on this subject.

5.5.2 Conceptualization

5.5.2.1 Supported Observations

*(1) Hazard Estimate Tables

Additional tables might be constructed giving "quick and dirty" hazard estimates as a function of spill volume for worst-case situations. This is especially desirable for bulk-shipped chemicals, e.g., sulfuric acid.

*(2) Fire-fighting Methods

Fire-fighting methods and equipment should be incorporated in the manual. Presently, no information pertaining to fire hazards is included.

5.5.3 Information Content

5.5.3.1 Supported Observations

**(1) Toxic or Flammable Gases

Tables 5-1 and 5-2, Maximum Distances Over Which Toxic Gases May Be Harmful and Over Which Inflammable Gases May Ignite, should be extended to all chemicals shipped in bulk possessing hazard assessment codes indicating toxic or flammable gas, regardless of volatility. The present list excludes low volatility chemicals.

**(2) Review of Current Response Methods

Response methods generally should be reviewed to be certain they reflect currently accepted practice. Some four years have passed since the response methods were originally compiled. Similarly, the equipment descriptions (Appendix) are no longer up to date, and therefore, require revision. New equipment has been developed while some documented equipment has become obsolete.

(3) Hazardous Chemicals Recognized

This manual concentrates primarily on removal of oil from the water and has been of limited use in responding to the removal and control of chemical discharges generally. Response methods for spills of chemicals other than oil are either lacking or poorly developed. The manual should be expanded to address the techniques and methods for clean-up and control of oil and chemicals, as well as the equipment that exists. Unfortunately, most of what is known about hazardous chemical spill response pertains to oil and other petroleum-related products. This handbook should be continuously updated as new and improved response methods are developed.

(4) IMCO Manual on Response to Oil Spills

This IMCO manual contains additional information that could improve the utility of CG-446-4 for response to oil spills. An evaluation should be made to establish the specific information to be introduced from this manual.

(5) Transport, Treatment, and Disposal

Consideration should be given to adding chapters on the transport, treatment and disposal of chemicals that have been recovered from the water bodies in which they were spilled.

(6) Table 4-1, Cautionary and Corrective Response Index

The criteria for employment of cautionary and corrective responses were refined when this table was expanded to include Phase II and III chemicals. These improved criteria should also be applied to Phase I chemicals. The revised criteria are included in the Appendix to this report.

5.5.3.2 Unsupported Observations

(1) Training Guide

This manual is best viewed as a training guide for the system as a whole in preparing response personnel to act more efficiently, professionally, and intelligently when faced with a discharge situation. The non-response information found in other portions of CHRIS should be concentrated in

CG-446-4, specifically Chapters 1, 2, 3, 4, 7, and 8 and Appendices B and C in CG-446-3. We do not agree that these materials should be transferred from CG-446-3 to CG-446-4 unless the former manual is discontinued.

(2) Unnecessary Detail

Certain items are explained in unnecessary detail, perhaps capable of sidetracking the reader:

- Section 6.4.4.2.2, Precipitation, and Section 6.4.4.2.3, Coagulants and Flocculants, provide no real advice, only facts and definitions that appear overly academic.
- Section 6.3.2, Recovery Systems, is extraneous and irrelevant for intended purposes.
- Section 6.3.2.1.1, Centrifugal, and 6.3.2.1.2, Vortex, read more like a physics textbook than a practical users' guide.
- Section 6.3.2.1.3, Linear, is especially "less than clear."
- Section 6.6.2, Salvage Methods for Oiled Birds, Section 6.6.2.1, Cleaning Operations, Section 6.6.2.2, Feeding, and Section 6.6.2.3, Release, are best omitted due to the present level of public education and possible irrelevancy.
- Section 7.0, Protective Clothing and Equipment, is not very informative, but Tables 7-1 and 7-2 appear very practical and helpful in procuring protective clothing.

In the interest of codifying whatever information is known in a central reference document, providing it is relevant to the situation, we believe this information should be retained in the manual but expanded and strengthened wherever possible.

5.6 Hazard Assessment Computer System (HACS)

**(1) Field Access

Many field personnel have requested external support in the preparation of hazard assessments; several have specifically asked for permission to access HACS via remote computer terminals (see Section 5.4.2.1(4)). It is recommended that if and when HACS is installed on a time-shared computer system, those field units possessing terminals should be permitted to access HACS on demand. There is no assurance, however, that this arrangement will definitely improve the timeliness of hazard assessments because most incidents are so short-lived.

(2) Complexity of Use

Preparation of input data and interpretation of results require a basic understanding of the chemical spill phenomena that are modeled and the limitations of the modelling techniques. Substantial improvements have been, and are continuing to be, incorporated to facilitate the use of HACS, e.g., minimizing difficulties associated with preparing input data. However, these will not alleviate the requirement for specialized user knowledge. For this reason, field access will require substantial user knowledge of the system.

(3) Model Assumptions

The assumptions and limitations of individual hazard assessment models, and the manner in which simultaneous damage mechanisms are sequentially modeled, produce deficiencies of somewhat uncertain impact. One example is the assumption of neutrally buoyant vapor clouds, and the inability of HACS to consider terrain or barriers influencing dispersion. The significance of these assumptions has in the past been properly considered in the use of HACS for modeling spill situations of certain types; the limitations of modeling actual physical dispersion are acceptable in this sense. The Coast Guard has initiated a program of experimental validation and analysis that will ultimately produce refined models of the physical processes and remove or reduce some of the current limitations.

(4) Possible Model Errors or Deficiencies

In related work undertaken by Enviro Control, Inc. for the Coast Guard, the basic dispersion and hazard assessment models utilized by HACS were reviewed* and several possible errors or deficiencies were noted.

In several instances deficiencies appear to be due to differences in the intent of use of these models in HACS and the Vulnerability Model; these differences do not therefore relate to any requirements for correction or revision to the models. In other instances several differences were reported between the logic implemented in computer code and the underlying mathematical analyses. Model improvements incorporated over the past 18 months are believed to have corrected a substantial portion, if not all, of these, and it is believed that the review was conducted using earlier versions of the models. The findings of these reviews are being studied and compared to the current versions of the models to determine whether any further revisions are required.

(5) Data Gaps

In a number of cases, data items for the chemical property file were not available and estimates were recorded instead. The Coast Guard is continuing to expand the physical property data base which is available for HACS computations.

**(6) Computer Environment

In the past, the operation of HACS in an over-the-counter batch mode on the CDC 3300 at USCG Headquarters inhibited the use of the system to support real-time spill response assessments. The current availability of HACS on CDC's Cybernet System, and the recent installation of a remote terminal in the National Response Center, is leading to substantial improvement in the availability of the system. However, the use of HACS for research and investigative purposes does not require a fast-response time.

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*"A Critical Technical Review of Six Hazard Assessment Models," NTIS AD A035599, December 1975.
"A Critical Technical Review of Six Additional Hazard Assessment Models," Enviro Control Inc., March 1977.

5.7 Training/Education

5.7.1 Supported Observations

**(1) Skill Maintenance

Retention of skills in the use of CHRIS by field personnel remains an important problem. Doubtless the source of this problem is the infrequency of hazardous chemical spills for most installations. Thus, users have few opportunities to practice the skills they learn at the Yorktown MEP School. Continuous effort should be made to renew user skills via additional training at Yorktown and the MSO/COTP. The problem books which have been distributed to field units should be helpful in this regard, but we believe that greater emphasis should be placed on formal training methods at the MSO/COTP. This might be accomplished by formal, periodic, unannounced drills administered by the NRC or Strike Teams to field units. The Philadelphia MSO (Gloucester City, New Jersey) has developed what appears to be a very effective drill procedure which might be used as a model for other units. These drills focus on potentially likely situations involving hazardous chemicals known to pass through the port. Supporting emergency services, such as police, fire, and civil defense, participate actively in the drills and a written critique is prepared.

(2) Correspondence Course

A CHRIS correspondence course (via the Coast Guard Institute in Oklahoma) would permit the training of personnel who may not otherwise have an opportunity to attend the Yorktown School, and at the same time would serve as a refresher course for those who had.

(3) Understanding of Physical Processes

Many users possess only a rudimentary understanding of the physical and chemical behavior of liquids and gases, which inhibits truly effective use of CHRIS. Because of this, they may not be able to judge the reasonability of computed hazard assessments. Indeed, this has been observed in Yorktown students who often seem to have difficulty using the results of the hazard assessment in evaluating a particular situation. Not enough attention has been devoted to educating personnel on the fundamentals of hazardous chemical behavior. An introductory text on the subject may be desirable.

(4) Selection of Personnel for Training

Field units should have a greater opportunity to select their own personnel for CHRIS training at Yorktown. It is our understanding that the unit is not given the opportunity to select personnel to attend Yorktown. In certain cases, therefore, some units may have no personnel who have attended Yorktown recently, whereas others may have several.

*(5) Enlisted Personnel

There is substantial disagreement in the field as to whether enlisted personnel should also receive training in CG-446-2, -3, and -4. At the present time, enlisted personnel are trained only in the use of CG-446-1. We met several highly motivated enlisted personnel who were quite disappointed that they were not given the opportunity to learn about the other manuals of CHRIS. At the same time, many officers felt that enlisted men in their units would benefit greatly from such exposure.

(6) Error Incidence

The infrequent user of CHRIS is prone to making many errors in problem solving (e.g., graph misinterpretations, use of incorrect graphs, overlooking footnotes). Previously, some of these errors have been attributed to inadequacies in the design of CG-446-3. Although this may be true, users often do not exert sufficient care in the conduct of hazard assessments. The magnitude of this problem argues for frequent reeducation and retraining, support and guidance by the NRC or through automation in the preparation of hazard assessments, and careful review of the results obtained for reasonability and common sense before use.

Appendix

Revised Criteria for Table 4-1, CG-446-1

Cautionary and Corrective Response Index

The criteria employed in designating responses for Phase II and III chemicals are described below. For each response the response definition cited in the manual is given. This is then followed by the additional criteria that were employed for the 500 Phase II and Phase III chemicals.

Restrict Access

"This response is invoked when appreciable danger arises from a flammable or toxic spill, and the general public (spectators) should be kept from the spill area. Access is restricted if ignition is considered possible (restrict ignition), or if evacuation is recommended."

It is more convenient to specify the conditions under which this response is not invoked than when it is, since the majority of chemicals in Phase II and Phase III will require the response. Simply stated, the conditions are that the responses Restrict Ignition and Evacuate are not invoked when the chemical does not present a significant hazard by inhalation, ingestion, eye contact or skin contact; and if reactive, the products of reaction are not significantly hazardous, nor is the reaction vigorous or prone to produce an explosion or fire potential.

Restrict Ignition

"This response is invoked when chemicals are involved which develop flammable vapors."

A liquid chemical is considered to be flammable if its flash point is 80°F or less. This response is invoked when a liquid is classified as being flammable under the above guideline or when Manual 2 states the substance is a flammable solid. Exceptions to the 80°F guideline may be made for substances with flash points between 80° - 100°F, if they are considered to present a significant fire hazard.

Oxidizers which have the potential of causing combustible materials to ignite or form heat or friction sensitive explosives have this response specified.

Chemicals which react with water to produce highly flammable gases also have this response invoked. A prime example of such a substance is calcium carbide, which generates acetylene in the presence of water.

Evacuate

"This response is invoked when there is a very real danger that a highly flammable or toxic spill may spread, or develop a detrimental reaction with water. This category includes flammable chemicals and extremely toxic chemicals, e.g., poisonous gases."

The response is invoked if the chemical has a boiling point less than normal ambient temperatures and produces a toxic or flammable vapor cloud. It is also invoked for substances which have a high vapor pressure at ambient temperatures and have hazardous vapors, and for solids which are extremely toxic of inhaled. Although the areas of evaluation needed may differ by orders of magnitude for these types of substances, the necessity to evacuate some area about or downwind of the spill site is evident.

This response is also invoked when the substance itself spontaneously ignites in air and produces toxic vapors or fumes, or if the material reacts with water in a manner which might produce a significant amount of hazardous vapors or mists. Finally, it is invoked if the chemical may react with common materials to form an easily detonated explosive. The response is not specified when the substance is simply flammable and has toxic products of combustion. Nor is it specified when the chemical can only ignite if mixed with combustible materials.

Restrict Human Use

"This response is invoked when mostly soluble substances or those which are exceptionally toxic are involved in a spill. The primary danger is that of ingesting the chemical in drinking water."

It is assumed by the manual that any water intended for human consumption will be at least filtered to remove insoluble solids and will have its pH checked often enough that significantly acidic or basic liquids will not enter a water supply. Hence, this response is invoked for miscible liquids or solids which are of slight or greater toxicity by ingestion and partially soluble liquids or solids which are of moderate or greater toxicity. It is not specified when the substance, or its products of reaction with water, are simple acids and bases, or when the substance is an insoluble solid or liquid. On a case by case basis, exceptions to all these guidelines may be made if the chemical is extremely toxic, or conversely, is of negligible toxicity when diluted with water.

By definition (Gleason, et al.), the term "slightly toxic" applies to substances which have a probable human lethal dose of 5 - 15 gm/kg or body weight. "Moderately toxic" is applied to the range of 0.5 - 5 gm/kg, "very toxic" to 50 - 500 mg/kg, and "extremely toxic" to 5 - 50 mg/kg.

Restrict Farm Use

"This response is invoked when a toxic chemical contaminant is spilled in water used for irrigation or animals."

With the assumption that water intakes are rarely, if ever, on the very surface of a water body, this response applies when:

a) The substance is soluble and of moderate or greater toxicity;
b) The substance is an insoluble solid of moderate or greater toxicity; and
c) The substance is a heavier-than-water insoluble liquid with moderate or greater toxicity.

The reason for the first guideline is self-evident. The second guideline takes care of the situation where a solid might be suspended in the water column. The third recognizes the fact that water intakes are usually at the bottom of a water body or at mid-depth.

Restrict Industrial Use

"This response is invoked when the spill contains chemicals which could corrode machinery, or if the possibility of ignition from insoluble, highly flammable organics is developed. Those chemicals which upon heating could release poisonous gases could also cause this response to be invoked; as could those which might form an insulating film on internal boiler surfaces."

As stated, this response will be invoked when the substance can corrode or foul machinery, is an insoluble, flammable liquid, or can release highly toxic vapors upon heating. Additionally, it should be invoked for those few miscible liquids which are extremely flammable and might cause explosions or fires in heat exchangers or boilers.

Dilute and Disperse

"This response is invoked to handle spills primarily involving dissolved species which are dangerous in a concentrated state."

Item 1 of CG-446-2 is entitled "Response to Discharge." For most chemicals it either states "disperse and flush" or "should be removed." To facilitate decisions regarding this response, and to ensure consistency between CG-446-2 and CG-446-4, this response will be invoked when CG-446-2 recommends "disperse and flush."

Contain

"This response is invoked to contain spills involving species which form surface slicks."

This response is instigated when an insoluble or slightly soluble liquid has a density close to (<1.1) or less than that of water. It is also invoked for insoluble or slightly soluble solids which are less dense than water or which may be shipped in powdered form and do not wet easily.

Skim

"This response is invoked to handle insoluble species which float and form surface slicks. Corrosivity with respect to hoses and pumps should be considered."

Skimming involves the mechanical removal of some portion of the top layer of the surface of a water body for the ultimate purpose of removing floating contaminants. Although primarily developed for removal of liquid contaminants, a number of devices are available which can also recover floating solids of particular physical characteristics. This response, therefore, is invoked for all liquids which form surface slicks and all insoluble solids which may float.

Pump

"This response is invoked to handle insoluble species which sink (particularly liquids or finely divided solid), but which may be pumped directly from the spill. Again, corrosivity should be considered."

Although the above indicates that the response may be applied to solids, it is usually applied to heavy, insoluble liquids.

Dredge

"This response is invoked for all completely insoluble, heavy liquids and all heavy, insoluble or slightly soluble solids."

Burn

"This response is invoked to handle highly flammable floating chemicals. Even though there is an ignition danger, the 'contain' category is checked. Containment may have to be accomplished by air barriers..."

This response is specified whenever the chemical is flammable, insoluble or slightly soluble, less dense than water, and not prone to produce irritating or toxic products of combustion. Additionally, it may be applied to substances which have a normal boiling point less than normal ambient temperatures and which are significantly soluble in water, since a large portion of the spilled amount may vaporize before dissolving. In making a decision whether to specify the response, consideration should be given to whether or not a fire might result in an explosion. Furthermore, the definition of "flammable" should be loosely interpreted, since it is quite easy to ignite a substance with a flash point in the 80°F to roughly 150°F or more range (depending on ambient temperature) with a rag soaked in gasoline.

Neutralize

"This response is invoked to handle acids, bases, oxidants, or reductants."

Neutralization is a proper response when the spilled material is a strong acid or base, or reacts with water to form a strong acide or base.

Absorption

"This response is invoked to handle chemical species which can be absorbed or adsorbed. These species which form surface slicks (float) and include: oil-like chemicals, solvents, toxic compounds (e.g., pesticides and halogenated hydrocarbons). Treatment by ion exchange is also possible for miscible chemicals..."

Sorption may be an appropriate response for all insoluble or slightly soluble liquids which float, except if the liquid is a strong oxidizer which may develop a fire or explosion hazard in contact with organic matter.

Clean Shore Line

"This response is invoked to handle insolubles (especially oils) with high surface tensions."

Shore lines should be cleaned whenever they are contaminated with insoluble or slightly soluble substances which are toxic or aesthetically detrimental. Consequently, this response is invoked for liquids which form surface slicks, and which are not highly volatile, and for solids which because of low density or wettability characteristics may wash-up onto the shore.

Salvage Waterfowl

"This response is invoked when it is deemed feasible to salvage waterfowl that have been exposed to an oil discharge."

This response will be invoked, with exceptions, whenever the Clean Shore Line response is called for. Taking into account the fact that birds are usually cleaned by volunteers, it will not be specified when the substance is corrosive to the skin and/or has highly toxic vapors.

Reference Key to Response Index

On the very right margins of Table 4-1, there are a series of numbers keyed to special precautions and information given at the end of the table. The phrases given and their definitions are as follows:

1. Avoid inhalation. Vapors or dust are irritating or toxic.

   Applied to any toxic or irritating dust or vapor.

2. Avoid direct contact. Contact with skin or eyes can cause irritation or burns.

   Applied to any skin or eye irritant; even something like gasoline.

3. No ignition hazard once material is dissolved, reacted or covered with water.

   Applied to flammable and miscible liquids which can rapidly be diluted to concentrations in water which do not generate flammable vapors, flammable substances which quickly react with water to form non-flammable products, and heavy, insoluble liquids which cannot be ignited if covered with a layer of water.

4. Burning may be prohibited by anti-air pollution laws and regulations.

   Applied whenever response "burn" invoked.

5. Poisonous gas or vapor danger, substance is highly volatile.

   Applied to highly volatile liquids with toxic vapors and to compressed gases or liquefied compressed gases which are toxic.

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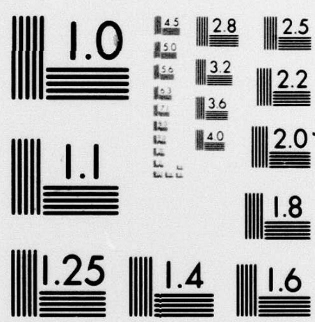

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6. <u>Flammable or explosive gas or vapor danger. Substance is highly volatile.</u>

Applied to highly volatile liquids with flammable vapors, and to compressed gases or liquefied compressed gases which are flammable.

7. <u>Powerful oxidant - explosion and/or fire hazard in the presence of organic matter.</u>

Applied to all strong oxidizers.

8. <u>Highly corrosive, particularly to eyes and skin.</u>

Applied to anything which is corrosive or severely irritating to skin or eyes upon contact.

9. <u>Sorbs strongly on bottom sediments. Substance is not at all soluble or reactive.</u>

Applied to liquids which are heavier than water and completely insoluble.

10. <u>Reacts with water to form explosive or flammable gas or vapor.</u>

Applied to water reactive substances which generate flammable gases or vapors.

11. <u>Water reactive compound which reacts vigorously or violently. Disperse or neutralize contaminated waters after reaction subsides.</u>

Used for substances which react vigorously or violently and form water contaminants.

12. <u>Burning not recommended; fire difficult to control and/or poisonous gas is formed.</u>

Application is self-evident.

13. <u>Cover with organic sulfur-containing compounds or free sulfur.</u>

Special phrase for mercury only.

14. Clean burning.

15. Sooty burning.

Self-evident applications. These are only used when the response "burn" is invoked.

16. DO NOT ADD water to chemical. AFTER the chemical has reacted with water, the resulting alkaline solution can be diluted.

Special phrase for sodium, lithium, lithium hydride and similar substances.

17. Floating solid.

18. Strong acid formed in water.

Self-evident applications for these.

19. First try to contain and skim; THEN dilute and disperse what has dissolved in the water.

Applied to slightly soluble liquids which form surface slicks.

20. Chemical shipped as gas or compressed gas...

Self-evident application.

21. Has unusual fire or toxicity hazards. See CG-446-2, Hazardous Chemical Data Sheets for chemical.

This is a proposed new criterion for substances which self-ignite or present unusual hazards when released. Used for substances with unusual toxicity (e.g., carcinogens) or with flammability or explosive hazards not indicated by other notes above (e.g., substances which are pryophoric or which can cause explosions under some circumstances).

22. May float or sink as insoluble substance or dissolve like miscible substance. See CG-446-2, Hazardous Chemical Data sheets for chemical.

A few chemical names in CHRIS refer to a family of chemicals rather than to an individual and specific chemical. Use of this phrase is sufficient to indicate to the user that CG-446-2 must be accessed for a reasonable assessment of hazards and responses.

Denotations for Response Applicability

A number of substances covered by CHRIS have chemical and physical characteristics which result in their actions on release and hazards to be sensitive to environmental conditions. For example, a liquid with a flash point of 80°F may pose a severe flammability hazard on a day with an air temperature of 100°F, but pose little hazard at 30°F. Similarly, a liquid which floats at 80°F may sink at 30°F.

To account for such "unusual" characteristics and to further ensure that Coast Guard personnel are given as much information as possible within the limited scope of Table 4-1, two separate symbols are used to designate the applicability of responses. An "X" is used to indicate that a given response will be advisable under most environmental and accident conditions. A "?" is used to denote that the response may or may not be appropriate, depending upon the circumstances of the spill and the particular characteristics of the chemical.