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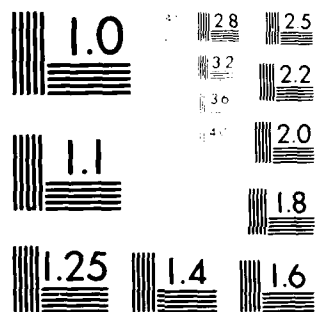
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**Commercial Vessel Safety
Economic Benefits**

PRELIMINARY

**PRC Systems Services Company
7600 Old Springhouse Road
McLean, VA 22102**



**FEBRUARY 1980
FINAL REPORT**

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Prepared for

**DEPARTMENT OF TRANSPORTATION
UNITED STATES COAST GUARD
Office of Research and Development
Washington, D.C. 20390**

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COMMERCIAL VESSEL SAFETY

ECONOMIC BENEFITS

**PRC Systems Services Company
7600 Old Springhouse Road
McLean, Virginia 22102**

FEBRUARY 1980

FINAL REPORT

Prepared for:

**DEPARTMENT OF TRANSPORTATION
UNITED STATES COAST GUARD**

**Office of Research and Development
Washington, D. C. 20590**

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16. Abstract → This report provides methods and procedures for the United States Coast Guard's assessment of the economic benefits of regulatory actions promulgated under the Commercial Vessel Safety Program. To support this effort two tasks were undertaken: (1) to develop a benefit analysis methodology and procedures manual; and (2) to provide examples of the application of the procedures to Coast Guard regulatory actions. The development of a methodology and procedures for assessing the benefits of Coast Guard regulations involved the development of step-by-step procedures in a "how to" manual format for regulations that are directed at mitigating the detrimental effects of marine casualties on: vessels, cargo, personnel, in-house and environment/property. The procedures describe, for each benefit category, what to look for in identifying benefit elements, pitfalls to be avoided, and sources for benefit inputs. In addition, formats are provided for tabulating total benefits over the life of the regulations. Two examples of the application of the procedures and formats to two current Coast Guard regulatory issues were developed. The subjects for the examples were: Procedure Example I: Proposed Tankerman Regulations; and Procedure Example II: Double Hull Retrofit for Existing Tank Barges. (NOTE: These examples are unpublished.)		
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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	cm	centimeters
ft	feet	30	m	meters
yd	yards	0.9	m	meters
mi	miles	1.6	km	kilometers

AREA

sq in	square inches	6.5	cm ²	square centimeters
sq ft	square feet	0.09	m ²	square meters
sq yd	square yards	0.8	m ²	square meters
sq mi	square miles	2.6	km ²	square kilometers
acres	acres	0.4	ha	hectares

MASS (weight)

oz	ounces	28	g	grams
lb	pounds	0.45	kg	kilograms
	short tons (2000 lb)	0.9	t	tonnes

VOLUME

cup	cup	0.24	l	liters
pt	pints	0.47	l	liters
qt	quarts	0.95	l	liters
gal	gallons	3.8	m ³	cubic meters
cu ft	cubic feet	0.03	m ³	cubic meters
yd ³	cubic yards	0.76	m ³	cubic meters

TEMPERATURE (exact)

°F	Fahrenheit temperature	5/9 (after subtracting 32)	°C	Celsius temperature
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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
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	ac

MASS (weight)

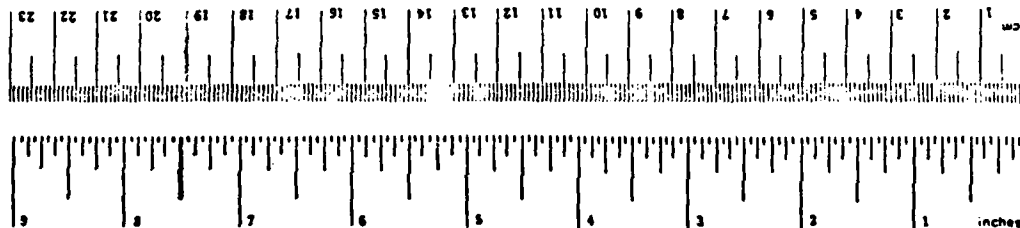
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	st

VOLUME

ml	milliliters	0.03	fluid ounces	fl oz
l	liters	1.06	quarts	qt
m ³	cubic meters	35	gallons	gal
	cubic meters	1.3	cubic feet	ft ³
			cubic yards	yd ³

TEMPERATURE (exact)

°C	Celsius temperature	9/5 (then add 32)	°F	Fahrenheit temperature
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* 1 in. = 2.54 inches. For other exact conversions and more detailed tables, see NIST Metric Publ. 286, Units of Length and Mass, Price \$2.25. 50 Celsius No. C13 10 286.

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APPENDIX A ESTIMATION PROCEDURES FOR BENEFITS OF MARINE SAFETY REGULATIONS	Separate Volume
APPENDIX B PROCEDURE EXAMPLES	Unpublished

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EXECUTIVE SUMMARY

The U. S. Coast Guard has as one of its primary functions the promulgation and enforcement of regulations to enhance the safe operation of commercial vessels on the navigable waters of the United States and to protect the marine environment. The work effort documented in this report supports this objective by developing a methodology and providing procedures for analyzing the economic benefits to be derived from the promulgation and enforcement of regulations. The purpose of the procedures is to provide a standard method for comparing the relative costs and benefits of alternative courses of action.

Procedures Manual

The objective of the Benefit Procedures Manual is to apprise decision makers of the relative benefits of alternative regulatory actions. To achieve this objective it was necessary to develop a methodology and set of procedures for systematically analyzing and estimating the benefits of Coast Guard regulatory actions. The procedures were designed to be compatible with the procedures previously developed for analyzing a regulation's costs.

The procedures, as developed, are designed to be flexible enough to accommodate a wide range of regulatory actions; to be at such a level of detail that massive, time-consuming data collection can generally be avoided; and at a level of sophistication that is not too complicated for all but skilled analytical technicians.

Cost-benefit analysis can be used to find economically feasible alternatives among potential regulatory actions. In order to compare alternatives a number of issues must be decided. First is the choice of an appropriate methodology. Generally, it was found that the life cycle cost (benefit) methodology provided the most accurate estimates, at an appropriate level of detail, to handle the analysis of regulations likely to be proposed under the Commercial Vessel Safety Program.

Since regulations have costs and benefits over time, any analysis must be done over a period of years, usually less than 25, that is appropriate for the regulation under consideration. It is essential to recognize the time value of money in cost-benefit analysis since many regulations involve benefits that will accrue over a period of time. The

recommended approach is to discount future benefits to their net present value. One potentially complicating factor in this type of analysis is inflation. Only in cases where long term escalation of some factor is expected to be abnormal should an adjustment be made for inflation.

Since the state of the art in benefit analysis is not well developed, it was not feasible to attach a dollar value to all of the potential benefits of regulatory actions. One of these was the value of a human life. Rather than place a value on this benefit it was decided to include only the number of deaths prevented in the analysis.

It was found to be difficult, and in most cases infeasible, to place dollar values on the benefits to various elements in the environment/property category. The primary reasons for this are the lack of historical data bases, the state of the art in marine analyses and the stochastic nature of marine-casualty incidents. The extent of marine benefits particularly to the ecosystem should not be quantified by the regulatory staff. Rather, these benefits should be included in the analysis in descriptive, qualitative terms.

The benefit procedures are organized in five parts: vessels, cargo, personnel, in-house and environment/property. Potential benefit elements to be considered by the regulatory staff are provided. Each section details what to look for in developing benefits, potential problems that may be encountered, and sources for benefit inputs.

The direct applicability of the manual is limited to the analyses of the economic impact of proposed regulations designed to reduce marine and marine related incidents. The procedures have several limitations. One significant difficulty in performing cost-benefit analysis is data. Important data may not be available. It may not be available at the appropriate level of detail, or the regulatory staff may not be able to investigate the sources of the data. Another constraint in benefit analysis is the level of detail and quality of the casualty data bases upon which the number and severity of incidents prevented is made. The quality of these analyses will be dependent upon the quality of estimates of the number of incidents avoided, associated with each proposed regulatory action. The level of detail and degree to which the various benefit categories and elements can be quantified or described is also limited by available historical data and state-of-the-art in cost-benefit analysis. For example, both the available historical data and state-of-the-art allow for much more definitive estimates of vessel and cargo benefits than for environmental benefits.

Procedure Examples

Two examples of the application of benefit manual procedures are provided. The subjects for these examples were:

Example I: Proposed Tankerman Regulations

Example II: Double Hull Retrofit for Existing Tank Barges

The purpose of the procedure examples was to test the Manual procedures and formats using proposed regulatory actions that impact most of the benefit categories contained in the Manual. Since no incident reduction estimates have been made, the data used in these examples are hypothetical.

SECTION I

INTRODUCTION

The U. S. Coast Guard is the Federal Agency charged with the responsibility for the safe operation of all commercial vessels operating in U. S. waters and all U. S. flag commercial vessels operating worldwide. In addition, the Coast Guard has broad safety and environmental authority for U. S. waterways and ports. The Coast Guard carries out this responsibility by administering and enforcing laws, rules and regulations associated with navigation and inspection of vessels, licensing and certificating marine personnel, cargo handling requirements for waterfront facilities and operational regulations to ensure ports and waterways safety. This responsibility includes the promulgation of regulations that have an economic impact on government, industry and society. In this context, one of the Coast Guard's objectives is to develop a methodology and procedures for assessing the economic effect of these regulations. The purpose of these procedures is to provide a standard method for comparing the relative costs and benefits of alternative courses of action.

Procedures for assessing the costs of regulations promulgated under the Coast Guard's Commercial Vessel Safety (CVS) Program were the subject of a previous report. This report contains procedures for assessing the benefits of these regulations.

To support this effort to assess the benefits of Coast Guard regulatory actions a study was undertaken to: (1) develop a benefit analysis methodology and procedures manual; and, (2) provide examples of the application of the procedures for two Coast Guard actions.

The procedures manual provides a systematic method of assessing the benefits of Coast Guard regulations under the CVS Program. Specific procedures were designed for estimating the benefits of preventing detrimental events through implementation of new marine safety regulations. The procedures are directed at the primary effects of marine casualties, namely vessels, cargo, crew and shoreside personnel, in-house government functions and the marine environment. The methodology and procedures used to assign dollar values to these benefits is consistent with the methodology and procedures used to estimate costs of Coast Guard regulations.

Development of both the cost and benefit procedures was accomplished with several considerations in mind to ensure the usefulness of the procedures to the Coast Guard regulatory staff. These considerations were:

- o Sophistication - are the mathematical or statistical techniques employed in the procedures too complicated or confusing to all but the most skilled technician?
- o Level of Detail - is the level of detail of the procedures such that massive data collection and time-consuming input formulation/manipulation can be avoided to arrive at reasonable results?
- o Flexibility - are the procedures capable of being exercised for generic groups (e.g., ports or vessels in general) or must the analyst be specific?

Two examples of the application of the benefit procedures to Coast Guard regulations are provided to aid the regulatory staff in the application of the procedures and formats. The subjects for these examples are:

- o Proposed Tankerman Regulations
- o Double Hull Retrofit for Existing Tank Barges

These examples show the application of the procedures to vessel, cargo, personnel, in-house and environment/property benefits.

This report is divided into sections as follows. Section II describes the approach, capabilities and limitations of the Benefit Procedures Manual. The Procedures Manual itself is contained in Appendix A, under separate cover. Section III describes the Procedure Examples undertaken to provide the regulatory staff with examples of the application of the Manual to two different types of regulations. The Examples themselves are included in Appendix B, a separate volume. Section IV contains recommendations for further research. Section V provides a bibliography of the maritime industry and cost-benefit analysis references.

SECTION II

DESCRIPTION OF THE DEVELOPMENT OF PROCEDURES FOR MEASURING ECONOMIC BENEFITS OF MARINE SAFETY REGULATIONS

The purpose of this section is to provide background information on the objectives of the research and to document the scope, work effort and decisions underlying the development of the Benefit Procedures Manual sections.

This section is divided into five parts as follows:

- A. Objectives of the Research
- B. Main Lines of Investigation and Scope of Effort
- C. Critical Issues
- D. Description of the Manual Segments
- E. Capabilities and Limitations of the Manual

A. Objectives of the Research

Initially the development of a benefit procedures manual was part of a task to develop a Risk Management Methodology. The objectives of this task were:

- (1) To quantify benefits of marine system casualty reductions.
- (2) To exercise the risk management methodology with test cases.
- (3) To develop a management plan that would allow the Coast Guard to use the risk management methodology in the decision making process.

Only the work effort required to meet the first of these objectives was undertaken under this contract, as modified.

The objectives of the first item stated above, development of a benefit manual, are:

- (1) To define a model and methodology comparable with the cost model.
- (2) To develop a model that would include methods of assigning dollar values to the detrimental results of events prevented by Coast Guard marine safety activities.
- (3) Provide examples of the use of the benefit manual for two different regulatory actions.

All of the subtasks of the original task were not undertaken. This posed some obstacles in the development of the Benefit Procedures Manual. The main problem was not knowing the level of detail and type of data that would generally be produced in an incident reduction estimate. Some details of the potential problems resulting from this problem are discussed more fully below. See Section E: Capabilities and Limitations of the Manual.

B. Main Lines of Investigation and Scope of Effort

The main lines of investigation and scope of effort were directed toward development of a benefit manual that would assess the benefits of specific Coast Guard actions which prevented events that would otherwise adversely affect:

- (1) Vessels
- (2) Cargo
- (3) Personnel
- (4) In-House Activities
- (5) Environment/Property

The scope of the effort had as its objective the development of procedures that would be generally applicable to assessing the benefits of proposed regulatory actions. These regulatory actions, subjected to analysis, would have significant quantifiable impacts on the marine transportation industry, government and society.

The manual, its procedures and formats, is designed to handle complex regulatory actions affecting many aspects of industry, government and society. However, the manual was also designed in a modular fashion so that the regulatory staff could use the manual for regulations affecting limited numbers of benefit categories and elements and a variety of time horizons. As is discussed below and in the manual itself the regulatory staff must choose the level of detail and time frame that is applicable to the proposed regulatory action.

Limitations were placed on the investigation due to limits on personnel time and resource availability. The limitations affected the scope of the problems and issues that the final procedures manual is specifically designed to handle. The focus of the procedures contained in the Benefit Manual is on U.S. industry, government and consumers. However, the procedures as developed are applicable to determining foreign benefits. Additionally, the orientation of the manual is on analyzing regulatory actions, specifically those regulations that would reduce marine casualty incidents. Other types of cost-benefit analyses problems encountered by the marine industry were not investigated.

C. Critical Issues

The purposes of cost-benefit analysis are: to determine the economic feasibility of a defined project, project component or system; to determine the most economically feasible alternative among regulations, projects or systems that have a similar function; and, to provide a systematic approach to weighing the costs against the benefits of each alternative under consideration.

The life cycle cost methodology is a comprehensive approach for comparing alternatives. It provides a flexible but structured framework for aggregating the costs and benefits of various components over the life of the regulation, project, system or project component. A number of techniques are available for estimating the dollar value of the various elements of a regulation's benefits. The choice of an appropriate technique for estimating the value of benefits is dependent upon the regulation under analysis, the degree of accuracy required and the availability of data. Four costing techniques were identified and examined in detail to determine their applicability to assessing the dollar value of the benefits of Coast Guard regulatory actions under the CVS Program. Each of these is discussed below.

Other issues that are key factors in any benefit estimation include the use of discounting, an appropriate time horizon, escalation factors, identification of applicable levels of detail for benefit elements, the desirability of attaching a dollar value to human life and the feasibility of accounting for environmental and property damages averted.

Benefit Estimating (Costing) Techniques

The four techniques discussed below are listed in the preferred sequence of choice for the analysis of regulations. The first method discussed will, in most cases, result in a more detailed and defensible estimate of future benefits. However, those methods are dependent upon the availability of data. The discussion of these techniques is in terms of 'costs' since the techniques were developed primarily for cost estimating. However, since benefits are 'costs not incurred' the techniques are equally applicable to the estimation of benefits.

1. Engineering

This method is often applied to the estimation of incremental component costs. It aggregates individual cost component estimates into a total project estimate. This method can be used whenever detailed cost estimates are required and data are available. Its benefits are its functional simplicity and general applicability. The fundamental problem with this method is that original value factor estimates are required for each regulation analyzed.

2. Parametric

The cost of an alternative, using this method, is based upon performance and physical characteristics and their relationship to aggregated component costs. A functional relationship must be established between the total cost of an alternative and the parameters of the alternative. The method requires that the data used to determine the parameters are representative of current conditions.

3. Analogy

Analogy costing draws an analogy between the characteristics of a system with known costs and the system under consideration. This technique is critically dependent upon the analysts' ability to accurately formulate the required analogy for the system under consideration.

4. Delphi

This is an estimating technique based upon expert opinion, used primarily when historical data do not exist or are unavailable. The accuracy and reliability of this technique is highly dependent upon the group of experts performing the analysis and the manner in which the exercises are conducted.

Other Issues

1. Discounting

The Benefit Manual procedures recommend the use of discounting as the means of recognizing the time value of money in cost-benefit analysis. Money is a productive resource that commands a price for its use. A dollar today is not the same as a dollar five years from today. Decisions about whether to undertake projects involve the realization of benefits in the future as well as in the present. Discounting converts dollar amounts of benefits received in different years into their present value.

The interest rate at which future benefits are discounted to present value is the discount rate. Any project analysis is sensitive to the value of the discount rate. Discounting at a positive rate gives greater weight to benefits the earlier they occur. High discount rates tend to favor those alternatives with costs occurring relatively late and benefits occurring relatively early. The discount rate represents the return foregone by investing in one project (or complying with a regulation) over another investment alternative.

2. Time Horizon

Another decision that must be made in assessing the benefits of regulations is the choice of a time horizon. Theoretically, the time horizon for the analysis of a regulation should be the effective life of the regulation. Realistically, the time horizon must be limited. In all cases the time horizon chosen for benefit estimation should be the same as that used for the cost estimates of the same regulation.

The suggested method of limiting the time horizon is to limit it to the economic life of the alternative. Three factors that limit the duration of economic life are: mission life, the period over which the asset is needed; physical life, the period over which the asset will last physically; the technological life, the time before obsolescence would require replacement. Economic life should generally be the lesser of these three time periods. It is recommended that the maximum time horizon for any regulatory analysis be limited to 25 years. There are two reasons for this. One is that forecasts beyond that period are highly subjective. Second, and probably more important, the use of discount factors makes the benefits that would accrue in later years of little significance in the overall regulatory analysis.

3. Inflation

Inflation can be a complicating factor in any economic analysis of alternatives since the trend in prices, rate of inflation, can only be estimated. The recommended method for comparing regulatory alternatives is to estimate all benefits in constant dollars. The only exception would be cases in which some benefit element(s) is expected to experience abnormal long term escalation.

4. Sensitivity Analysis

The process of estimating the benefits of regulatory actions requires that assumptions be made at each step of the process. Since the benefits are estimates, the decision maker may want to know if the alternative selected by the estimating process would change if one or more variables, parameters or assumptions were varied within a reasonable range. Sensitivity analysis provides the means to test alternatives when there is uncertainty regarding the assumptions used in selecting the "best alternative."

In general, sensitivity analysis is required only when an economic choice is not clear cut. When the benefits of the alternative chosen are clearly superior to all other alternatives, the analyst need not be concerned about the sensitivity of input parameters to nominal variations. In cases where sensitivity analysis is appropriate, there are two criteria for selecting the variables to be tested. The analyst should test dominant input variables, those which have a significant impact on the benefits associated with an alternative, dependent upon the degree of confidence which can be placed on the estimate.

5. Level of Detail

The level of detail that is desirable or achievable in estimating the benefits of regulatory actions will be limited by the time available to perform the analysis, the level of detail at which incident reduction assessment can be conducted, the degree of accuracy required and the availability of data. Examples of data constraints are: the level of detail of vessel population available in fleet forecasts; the availability of cost data for the system under consideration; and, the difficulty in placing dollar values on some costs such as lost cargo capacity. In all cases the analyst must exercise judgment in determining the appropriate level of detail.

6. Environment/Property

The state-of-the-art in benefit analysis places a sizeable constraint on the feasibility of accounting for these benefits at the level of detail or sophistication that is applied to other benefit categories. There are a number of reasons for this.

One is the lack of historical data. The impact of marine incidents on most of the elements in this category has not been collected in a systematic way. This is particularly true of incidents in which the damages are small or moderate. Only major incidents such as major oil spills receive much attention and documentation. The literature on long-run effects of past major incidents such as oil spills is virtually non-existent. For all types of incidents it is impossible, based on data currently available, to generalize about the benefits that would accrue from a reduction in incidents.

The state of the art in assessing ecosystem damages from oil and chemical spills, particularly in the long run, is unknown. Again, this has been due largely to the lack of effective data collection efforts in the past.

A third constraint is the stochastic nature of marine incidents. Numerous conditions such as wind, weather, accident location, etc., all conditions outside human control, play a major role in the effect on incidents on property and environmental elements. The analyst is thus unable to clearly define the number and type of benefits that may accrue.

The fourth constraint is the problem of placing dollar values on some benefit elements identified and counted. Many of the elements in this category have no recognized commercial value, e.g., non-commercial fish and fauna. While some attempts have been made to place dollar values on these benefits, the value levels and even the desirability of doing so remain highly controversial.

As a result of the above constraints the most that can be expected of the regulatory staff is to put these issues in perspective by identifying in qualitative terms those elements that may benefit and, if feasible, quantifying the detrimental effects of individual past incidents.

7. Deaths

The mitigation of many types of marine casualties will result in a reduction in numbers of deaths. Attaching a dollar value to this particular benefit is constrained by the lack of a generally acceptable dollar amount or method of valuing human lives. Other studies have placed the value at from \$200,000 to \$3 million. The preferred approach for regulatory analyses is to include the numbers of deaths avoided in the analysis without placing a dollar value on these numbers.

8. Cost-Benefit Ratio

Another important issue is the use of cost-benefit ratios. Under no circumstances should the regulatory staff and/or decision-making process use or place significant weight on the quantified values resulting from regulation cost and benefit estimations, for the

following reasons. The most important is the relative state of the art of cost versus benefit analysis. In most cases cost estimates will be more complete and definitive. Many benefit elements cannot be quantified at all, e.g., deaths and environmental impacts. Secondly, predicting the future is a highly subjective process, especially when looking 10, 15, 25 years into the future.

C. Description of the Manual Segments

During development of the Cost Manual it became apparent it would be beneficial to the Coast Guard to use a "how to" format which would provide step-by-step cost procedures pertinent to several aspects of the Commercial Vessel Safety Program. The principal advantages of developing such a manual include: (a) having an open-ended document which can be supplemented with additional material; and (b) providing a document which can be updated annually and used regularly rather than a one-time report. This Benefit Manual has been designed in the same manner.

The manual is designed to aid in the regulatory evaluation process. To meet this goal the manual contains procedures for calculating benefits, formats for categorizing and tallying the benefits, and benefit factors and data sources for estimating the dollar value of these benefits.

The procedures manual is divided into eight sections as follows:

I. INTRODUCTION

A brief description of the objectives of the manual.

II. METHODOLOGY OVERVIEW

A discussion of how marine safety cost-benefit analysis relates to overall marine safety programs for reducing marine accidents, including basic steps in conducting cost-benefit analyses.

III. ASSUMPTIONS AND DEFINITIONS

This section is used to define the scope and ground rules of the cost-benefit analyses to be conducted. It itemizes commonly used techniques and assumptions employed in cost-benefit analysis.

IV. BENEFIT CATEGORIES AND ELEMENTS

Provides a listing of benefit categories and benefit elements used to collect benefits of regulatory actions.

V. FORMATS FOR BENEFIT MEASUREMENT

Formats contained in this section provide the structure for calculating total benefits to be incurred by industry, government and society from the implementation of a regulation. This section contains an example set of completed formats plus a complete set of blank formats.

VI. BENEFIT PROCEDURES AND FACTOR DEVELOPMENT

This section explains how to develop benefit factors, defines techniques to be employed in making benefit estimates and provides guidance on what to look for in developing benefits of regulations to vessels, cargo, personnel, property and the environment.

VII. BENEFIT FACTORS

This section contains a collection of selected benefit factors which may be employed to fill in formats contained in Section V.

VIII. FLEET FORECAST

This section contains forecasts of changes in U.S. and world fleet sizes by vessel groupings. This is useful in estimating benefits to different vessels that are impacted by regulatory changes.

E. Capabilities and Limitations of the Manual

This section describes the capabilities and limitations of the Benefit Manual. Each section of the manual is discussed separately. The discussion is divided into two parts, capabilities and limitations. The limitations section includes a discussion of the technical problems likely to be encountered. These include unavailability of data, and lack of direct access to certain data. Sections II and III of the manual are devoted to Methodology Overview and Assumptions and Definitions. These will only be mentioned where they are germane to the discussion of the procedures development.

1. Benefit Measurement Procedure Capabilities

These capabilities are broken down into four areas:

(a) Benefit Categories and Elements (Section IV)

All of the benefit elements for most benefit measurement analyses must be categorized so that the analyst will have a uniform system for collecting and calculating benefits. It is assumed that the categories and particularly the elements within these categories will be changed as the Manual is put into use.

(b) Formats for Benefit Measurement (Section V)

In order to estimate the total benefits that will accrue from the implementation of a regulation, it is necessary to cumulate the expected benefits over the life cycle of the system being evaluated. The life cycle, time span, chosen for use in analyzing regulations under the CVS Program will be variable, depending on the regulation under analysis and particularly the primary elements affected by the regulation, e.g., vessels or personnel. The maximum time frame for any regulatory analysis should be twenty-five years. Twenty-five years is representative of the life cycle of an average vessel. Additionally, since discounting is employed, costs become increasingly insignificant in the later years of a twenty-five year time horizon. However, there will be many regulations that will not require a twenty-five year analysis, for instance, regulations affecting vessels with an average life of ten years. As discussed above, benefit measurement should be carried out for the same time horizon chosen for cost measurement.

To keep track of the time frame when benefits are received it was necessary to design a series of ten individual formats to tabulate annual quantifiable benefits to industry, government and society. An additional format tabulates benefits of a regulation that are not quantifiable and cannot be attributed to a particular year of the analysis.

Format 1 provides industry benefit categories. Format 2 allows for the collection of industry vessel, cargo and personnel benefits over the applicable time horizon for one vessel class. Format 3 summarizes industry benefits by category for one vessel class, while Format 4 summarizes benefits for all vessel classes and includes provisions for discounting. Formats 5 and 6 do essentially the same thing as Formats 1 through 4 except they are designed to calculate government benefits. Formats 7 through 9 collect quantifiable societal benefits, namely those that will accrue to individuals, either dock workers or the general population. Format 10 summarizes in qualitative terms, the benefits to society that result from a reduction in property and environmental damages. Format 10A allows the analyst to estimate, in quantitative terms, the dollar value of property and environmental benefits for a specific incident, under a specified set of circumstances. Format 11 allows for a comparison of industry, government and societal quantified benefits for various regulatory alternatives.

(c) Benefit Procedures

This Section is divided into five parts discussing benefit procedures for vessels, cargo, personnel, in-house and environment/property benefits. Without dwelling on the specifics of each of these sections, the general thrust of each involved detailing:

- o What to look for when developing benefits,
- o Pitfalls to avoid in developing benefit estimates, and
- o Who to contact to obtain inputs for benefits.

In many instances, the unit values for benefit estimates must be furnished by government sources which maintain data bases or have special estimating capabilities. One such agency is the U. S. Maritime Administration. Various offices within this administration

can provide virtually all of the vessel and commercial vessel personnel data or estimates of these data. The Commerce Department collects and publishes numerous reports on cargo movements into and out of the U.S. These data include volume of cargo moved and value by commodity. Breakdowns of the data are available by geographic area, vessel type - dry cargo or tanker - and either broad or detailed commodity groupings. The Corps of Engineers publishes data on domestic cargo movements by vessel type, waterway and specific commodity types.

Other sources of information such as shipyards, associations of vessel operators or unions may make some of their data available. However, obtaining data from these sources may be difficult and time consuming.

(d) Benefit Factors (Section VII)

This section contains data and summaries of data that will be useful to the regulatory staff. These data are a by-product of the procedures development effort. The tables included in this section contain commonly used benefit factors for vessel, cargo and personnel. In addition some value data are provided for elements of the environment/property category, as well as summary descriptive information on the detrimental effects of past marine incidents.

2. Benefit Measurement Procedure Limitations

(a) Formats for Benefit Measurement

Using these formats correctly requires paying a great deal of attention to detail. The formats are designed for application to a variety of types of regulatory actions. It is not necessary, or feasible, that the analyst strictly conform to the formats as originally designed. Formats can and should be modified for the specific regulatory action under analysis.

(b) Fleet Forecast

One of the main problems confronted in developing formats and procedures was identifying a suitable forecast of the size and mix of vessels phasing into and out of the fleet over future years. There is a general consensus that, as vessels increase in size, the number within the fleet will decline. One of the few comprehensive fleet forecasts which shows annual incremental changes is a recently completed Temple, Barker and Sloane, Inc., study done for the Office of Commercial Development, U.S. Maritime Administration. The TBS methodology is the best available current source for a fleet forecast. The TBS report has some limitations including: a classification system for vessel types which may not readily satisfy the Coast Guard analysts' requirements; a focus upon the worldwide fleet rather than U.S. flag fleet; a tendency toward aggregated data which cannot be broken down easily into detailed levels; and, a time horizon extending only to the year 2000. The Fleet Forecast section of this Manual recommends methods of adapting the forecast to meet the analysts' needs.

Whether or not this area will be a problem for benefit estimating will depend upon the data generated from the incident reduction estimating process. In all regulatory analyses the staff performing the benefit analysis should coordinate its efforts with the individuals performing the cost estimate. The definition of the fleet in future years is one example of the need for coordination.

(c) Benefit Procedures

Most of the limitations associated with benefit procedure development are fully documented in Section VI of the Manual. One area of interest in the future is refinement and development of the procedures for assessing environmental and property benefits.

Another is to review and refine all of the procedures dependent upon an incident reduction estimation output. Once incident reduction estimating techniques have defined the type of data that can be developed the procedures as contained in this report should be carefully reviewed and revised.

(d) Benefit Factors

There are three primary limitations in developing benefit factors. One is the inability to investigate many of the sources of the numbers. One example of this is vessel operating cost data. MarAd generates averages for these data by using industry furnished actual data which are proprietary.

The second limitation is the type and level of detail of data supplied by the incident reduction estimating process. At present this is an unknown. However, what is known is that any incident reduction estimate will be constrained by the available casualty data bases.

The third limitation involves those benefits that will not be the subject of the incident reduction estimating process. These will include in-house benefits and environment/property benefits. The latter benefits are particularly difficult to quantify since many elements have no commercial value. In other cases there is no generally acceptable method of quantifying these benefits, e.g., identification of all of the sub-elements that represent costs not incurred.

SECTION III

DESCRIPTION OF PROCEDURE EXAMPLES

Two examples of the application of the procedures manual to Coast Guard regulatory actions are provided. They are:

Example I: Proposed Tankerman Regulations

Example II: Double Hull Retrofit for Existing Tank Barges

The objective of the procedure examples is to provide the regulatory staff with a useful reference for analyzing similar future regulatory actions. All benefit analyses of regulations directed at reducing marine incidents will require that an incident reduction estimate be performed to estimate the number and types of incidents avoided. Since no incident reduction estimate of these regulations has been performed, it was necessary that hypothetical risk output data be generated and used as the basis for estimating the economic benefits of these regulations.

A brief description of each of the exercises is provided below. A complete report on each exercise including background information, technical approach and problems that may be encountered in analyzing this type of regulation is provided in Appendix B of this report.

Example I - Proposed Tankerman Regulations

The subject for this example was proposed Coast Guard regulations governing the qualifications of personnel involved in handling, transfer and transportation of dangerous cargoes in bulk aboard ships and barges. The purpose of the regulations is to redefine and establish more satisfactory criteria for certifying individuals engaged in the carriage of dangerous bulk cargoes. The regulations, as proposed, would require new and/or additional classroom and field training for new and existing personnel.

It was assumed in the example that the following benefit categories would be affected by such a regulation: vessels, cargo, personnel (crew), in-house and environment/property.

The example describes the approach to follow for this type of example, technical problems that may be encountered and step-by-step procedures for completing the applicable Formats.

Example II - Double Hull Retrofit For Existing Tank Barges

This example involved proposed Coast Guard regulations to require design changes in existing tank barges carrying oil in bulk. In addition, the regulations would increase inspection frequency and repair standards for barges that were not retrofitted. This example was limited to the benefits of retrofitting existing barges. The purpose of the regulation is to reduce pollution in the navigable waters of the U. S.

This example assumes that the benefit categories likely to be affected by this type of regulation are: cargo, in-house and environment/property. The procedures described in the manual were used to analyze the subelements within these categories that may benefit from a change in vessel design. A completed set of applicable formats is contained in the example.

SECTION IV

RECOMMENDATIONS

Based upon the work effort described in the preceding Sections, the following recommendations are made:

- o It is concluded that special economics expertise is required to maintain the manual. There are two feasible alternatives (1) add an additional senior economist billet to the Coast Guard staff or (2) contract with a professional services firm to maintain the manual and perform cost-benefit analyses as required.
- o The formats developed during this task require numerous manual calculations and a great deal of attention to detail. It is recommended that consideration be given to automating both these formats and the formats developed for the Cost Manual.
- o Procedures and formats were developed for this manual without an understanding of the type of data that may be generated by an incident reduction estimating process. It is recommended that this estimation phase of this analysis be completed and this manual reviewed and revised to make it compatible with the available risk output.
- o Currently it is not feasible to place dollar values on many benefit elements. It is recommended that as a first step a consensus be reached on which of these elements should be included in regulatory analyses in quantified form and then develop a consistent methodology for valuing these elements.

SECTION V
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