Marine Technology and Management Group

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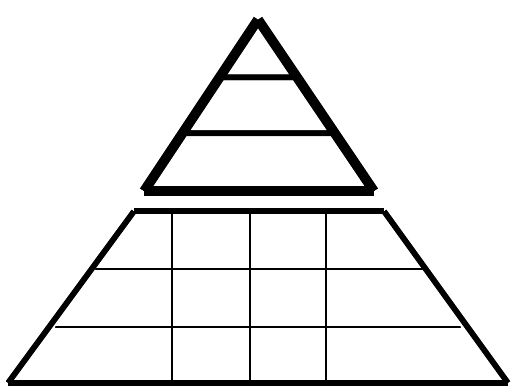
SHIP STRUCTURAL INTEGRITY INFORMATION SYSTEM: PHASE III
SSIIS III

SQIS: A framework for the development and implementation of an Industry-Wide Ship Quality Information System

Final Report



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SHIP STRUCTURAL INTEGRITY INFORMATION SYSTEM

In 1992, the SSC published a report (SSC-365) by Professor Bea of the University of California, Berkeley, that introduced the need to tie together all of the failure information on the U.S. maritime fleet. A program was proposed to mirror that which is used in other industries, particularly the airlines. This report is the final phase of a project which was initiated to provide a tool to assist the maritime industry in the management of their fleets as recommended by that report.

Phase I of the project, published as SSC-380, evaluated databases then currently in use by ship operators to monitor their vessels and proposed a system to address the data capture needs for design, construction, inspection, maintenance, and operations. Phase II, published as SSC-388, went further by examining the reengineering of the structural inspection, maintenance and repair processes to improve the integrity and quality of the operating ships' structural systems. In this final phase, a framework for the development of a Ship Quality Information System (SQIS) for use in the U. S. oil tanker trade is presented. A prototype of the software developed is included in the electronic version of the report.

This program was conducted to assist industry in developing a uniform ship structural database that can serve as a building block for a universal, industry-driven Ship Maintenance. It is hoped that this report will generate further discussion to determine exactly how such a system will function and what government agencies and commercial concerns need to be involved. The resulting system should provide safer shipping and cleaner waterways.

A glossary of terms used is provided and recommendations are presented for future research.

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Chairman, Ship Structure Committee

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16. Abstract

The Ship Structural Integrity Information System Phase III (SSIIS III) Project presents the framework for the development of an Industry-Wide Ship Quality Information System (SQIS) for use in the United States oil tanker trade. This full-scope, life-cycle, industry-wide information system provides the basis for the development of risk based inspection, maintenance, and repair (IMR) activity management tools, intended to supplement those in development by industry members. The SQIS combines information concerning structures, equipment, and operations, and provides analysis of the links between all facets of vessel management. The cooperation of all sectors of the maritime community is paramount to the successful implementation of a Industry-Wide SQIS. The recommendations and requirements of interested parties have been incorporated into the development of the SQIS framework. A prototype SQIS application, applied to crude oil tanker structures and operations, demonstrates the utility of the SQIS concept, despite its limitations in scale. The future requirements for the development and implementation of the full scale Industry-Wide SQIS have been identified.

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Table of ACRONYMS

ABS - American Bureau of Shipping
ASRS - Aviation Safety Report System
CAIP - Critical Area Inspection Plan
CSD - critical structural details
DOT - U.S. Department of Transportation
FAA - Federal Aviation Administration
HFDB - Hull Fracture Database

IMO - International Maritime Organization
IMR - inspection, maintenance and repair
MARAD - U.S. Maritime Administration
MISLE - Marine Information for Safety and Law Enforcement
MMS - Marine Management System
MSIP - Marine Structural Integrity System
MSIS - Marine Safety Information System
MSMS - Marine Safety Management System
NRC - National Research Council, National Academy of Science
PSIX - Port State Information eXchange System
PTC - Project Technical Committee
RMS - Repair Management System
SID - Structural Inspection System
SMP - Structural Maintenance Project
SQIS - Ship Quality Information System
SSIIS - Ship Structural Integrity Information System
TAC - Technical Advisory Committee
TAPS - Trans-Alaska Pipeline Service
USCG - U.S. Coast Guard

Executive Summary

The application of information technology in an increasing number of areas of tanker management presents an unprecedented opportunity; the development of a full-scope, life-cycle, industry-wide information system which could be used in the implementation of risk based inspection, maintenance, and repair activities. The Industry-Wide Ship Quality Information System (SQIS) is such a system. Collecting information covering all aspects of vessel management; structures, equipment, and operations, the SQIS allows for analysis of the relationships between these areas. The results of the analyses would be used by the United States Coast Guard in the implementation of more efficient regulations. The American Bureau of Shipping and other classification societies may develop risk assessment based rules for inspection, using the Industry-Wide SQIS to aid in the identification of high-risk situations. Vessel owners will benefit from the work of the Coast Guard and the classification societies, and will be able improve their own life-cycle management work.

A prototype Industry-Wide SQIS has been developed which demonstrates the type of information incorporated in a SQIS, and the powerful analysis capabilities of such a system. The prototype focuses on the structures and operations modules of a SQIS applied to tankers. Where the prototype is limited by scale, the possibilities for extended abilities in the full scale application are described.

The system presented describes the Industry-Wide SQIS in its fully implemented form. It represents a target system, outlining the possibilities for such systems. The requirements for the development and implementation of the full scale Industry-Wide SQIS, both systems and organizational based, are described. The successful implementation of the Industry-Wide SQIS in the tanker industry requires the full participation of all members of the maritime community, with special dedication from the regulatory bodies and the vessel owners and operators.

1. Introduction

This report documents phase three of the Ship Structural Integrity Information System Project (SSIIS III). The SSIIS project was sponsored by the U.S. Coast Guard Research & Development Center through the National Maritime Enhancement Institute of the Maritime Administration (MARAD). The project was conducted from June 1, 1996, through May 31, 1997 at the University of California at Berkeley.

The SSIIS III project began with the objectives of developing and demonstrating inspections and repair planning and information archiving tools, as a continuation of the work carried out in the first two phases of the SSIIS Project (SSIIS I [1] and SSIIS II [2]). The intent of this work was, in part, to provide owners and operators with assistance in the development of their inspection, maintenance, and repair (IMR) tools. However, at this time, owners, operators, and others in the maritime industry have already begun or are well along in the development of their own IMR tools. It was decided that the research effort would be most beneficial to the tanker industry if the work focused on the development of supplemental tools, that would provide additional input to IMR planning.

Effective, risk based inspection, maintenance, and repair (IMR) activity management, requires full-scope, life-cycle, and industry-wide considerations. Therefore, development of inspections and repair management tools is best accomplished within the framework of an Industry-Wide Ship Quality Information System (SQIS). The development, implementation, and operation of such a system requires the cooperation of all sectors of the maritime community. To facilitate such cooperation, it is necessary to establish the requirements and expectations of each sector, so that all are willing participants in the process. The SSIIS III Project set out to define the concept of the Industry-Wide SQIS, identify the framework required for the development and implementation of the system, and list the fundamental requirements which the SQIS must meet. The project then went on to develop the SQIS Prototype using commercial database software. The intent of the prototype development stage was to demonstrate the utility of the Industry-Wide SQIS in collating and analyzing information from a broad base of sources.

The background and history of the Ship Structural Integrity Information System Projects is given in Appendix A: Section 2 documents the conduct of the SSIIS III Project, including objectives and tasks. Section 3 introduces and defines the Industry-Wide SQIS, discusses its role in the industry, administration and implementation issues, and the fundamental requirements of SQIS. Section 4 describes the SQIS Prototype, explaining the philosophy behind its structure. Section 5 discusses the application of the SQIS analysis results in inspections and repair planning, the limitations of the prototype, and the requirements for further development. Finally, Section 6 provides conclusions and sets out recommendations for the further development and implementation of the Industry-Wide SQIS.

2. The SSIIS III Project

2.1 Project Objectives

The initial purpose of Phase III of the Ship Structural Integrity Information System Project was to build on the work of the SSIIS Phase I and Phase II Projects through the development of inspections and repairs planning modules for implementation in a SSIIS. The project objectives were set out as:

- Develop and document the alpha version of an inspections planning and information archiving module that will form a component in a SSIIS.
- Develop and document an outline of a repair planning and information archiving module that will form a component in a SSIIS.
- Demonstrate the practicality of the inspection and repair planning systems through application to an example tank ship.

At the SSIIS Phase III Project Initiation Meeting, it was established that members of the maritime industry, including owners, operators, classification societies, and the USCG were well along in the development of their own versions of ship information systems. It was further established that the SSIIS III project would be of more benefit to the industry if the focus was shifted to investigate the implementation of an industry-wide information system for the joint use of those involved in the oil tanker trade in the United States.

The revised purpose of the SSIIS III Project is the definition of the framework required for the development and implementation of an industry-wide information system, for application to the tanker fleet. The revised objectives of the project are:

- The characterization of the industry-wide system, including the establishment of technical and non-technical requirements for and of the information system.
- The development of an alpha prototype application which would illustrate the design, function, and output of such a system.

This intent of the work is to provide a means to evaluate the practicality of an Industry-Wide SQIS.

2.2 Project Tasks

Requirements Analysis

During SSIIS III, the properties of a Ship Quality Information System (SQIS) preferred by the end users were identified; i.e. to determine what tasks the SQIS should be able to perform. From a prioritized list of requirements for the SQIS, the inputs required to enable the SQIS can be identified, and the information system required to provide these inputs is defined.

Prototype Development

A prototype version of an Industry-Wide SQIS was developed in Microsoft Access™. The prototype provided a demonstration of the utility of an Industry-Wide SQIS. In addition, the prototype served to identify some of the infrastructure requirements necessary for the successful implementation of a full-scale SQIS.

Supporting Information

The research team held three project meetings at the University of California at Berkeley, with the Project Technical Committee (PTC). (See Appendix B for a list of PTC members and affiliations.) The first meeting, the Project Initiation Meeting, held on July 24, 1996 had three objectives: familiarize the PTC with the basis of the project through a review of previous UCB work, outline the new research plan, and receive input and direction from the PTC. The meeting resulted in a revised description of the project objectives, a new version of the SSIIS concept (SQIS), and a clarified set of tasks for the project.

The second meeting, the First Progress Meeting, held on November 14, 1996 had three objectives: present the refined Industry-Wide SQIS concept, incorporating the results of the industry survey, outline the work performed to date, and receive input and direction form the PTC.

The third meeting, the Final Project Meeting, held on April 28, 1997 had two objectives: review and revise the Draft Final Report, and demonstrate the SQIS Prototype.

The research team presented three interim reports to the TAC: Industry-Wide SQIS Architecture, First Half Progress Report, and Third Quarter Progress Report. In addition, the PTC was provided with draft copies of the Final Project Report for review and revision.

2.3 Project Schedule

The SSIIS III Project was conducted from June 1, 1996 through May 31, 1997.

3. The Industry-Wide SQIS

3.1 Requirements Analysis

Purpose and Method

The Industry-Wide SQIS represents a new application of information technology in the maritime industry. To ensure that the system is useful and productive in its final, fully implemented form, interested members of maritime industry were sought out to provide input. Because the SQIS concept is a new one, there were no pre-set limitations on it's scope or application. Therefore, there was ample room and opportunity for representatives from all sectors of the maritime industry to express their desires and expectations.

The basic concept for the Industry-Wide SQIS was developed in the SSIIS III Project Initiation Meeting. The concept is based on that of the FAA Aviation Safety Report System (ASRS). The ideas discussed there were further developed and refined by the research team. Armed with this basic concept description, the researchers then set out to gather comments and recommendations from interested parties. The motivation for this investigation was that the Industry-Wide SQIS concept necessarily requires the participation and cooperation of all sectors of the industry to be effective. Therefore, each sector must view the SQIS as a useful tool, so that they are willing to participate in its development, implementation, and operation. Hence, it is desirable to ensure that from the outset, the Industry-Wide SQIS consists of the necessary characteristics that make it useful to all sectors of the maritime industry.

The purpose of the Requirements Analysis was to develop direction for the current project and related work in the form of a prioritized listing of requirements for a SQIS, as perceived by maritime industry members.

The Industry Survey

The primary survey topic was the framework for the implementation of an Industry-Wide SQIS. The intent was to incorporate the advice of members of all sectors of the maritime industry in the development of a prioritized list of requirements for such a system. These requirements span the scope of system administration, information content, information archiving and analysis, and all other topics deemed relevant by those participating in the interview process.

Conduct Interviews

The series of interviews was conducted over the course of one week in the fall of 1996, in Houston, Texas and Washington, D. C. The participants interviewed were selected primarily based on their familiarity with the application of information technology in the maritime industry. The intent was to involve representatives from as wide a cross-section of the industry as possible. Hence, not all participants were directly involved in the tanker trade (either through participation orregulation). For example, a leading chemical tanker owner and operator was identified as a company which is a leader in the application of information technology in vessel maintenance, operations and management. The list of interview participants is as follows:

- U. C. Berkeley; Robert G. Bea, Diana L. Diettrich
- Chemical Tanker Owner / Operator, Houston
- Sea-River Maritime, Houston; Peter F. Webber, Peter B. Lacey
- ABS Americas, Houston; David W. Robinson
- USCG, Database Developers, Washington; Mark Polanskas

- USCG, Naval Architects, Washington; Paul Cojeen, LCDR Daniel T. Pippenger
- NRC, Washington; Robert A. Seilski

Summary notes of all meetings are contained in Appendix C. The recommendations and suggestions made during the interviews have been incorporated into the following description of the Industry-Wide SQIS, the SQIS Requirements, the SQIS Prototype development process, and the final project recommendations.

3.2 SQIS General Architecture

Ship Quality Information Systems (SQIS)

The primary objective of a SQIS is to achieve and maintain adequate quality in the ship [3]. Issues addressed include serviceability (ability to meet service requirements), compatibility (ability to meet economic, time, and environmental requirements), durability (freedom from unanticipated maintenance), and safety (freedom from undue threat of harm to life, property, and environment). A SQIS is full scope, addressing aspects of ship structure, equipment, operations, and personnel. It is life-cycle based, including design, construction, operation, and maintenance. The development process of a SQIS should include representatives of all sectors of the maritime industry, since it is full scope, and will be used by all persons interacting with the ship. The SQIS should take advantage of the opportunity to re-engineer key ship processes by taking an overall view of the system, and re-organizing the process flow. The SQIS should also take full advantage of the emergence of new technologies, and, in particular, utilize information technology to integrate information at a process level. The resulting system should be simple, but contain all essential information. It should identify what information is absolutely necessary to satisfy an essential information requirement, and assure that the information can be gathered effectively and efficiently. The SQIS should be developed and implemented on a modular basis, with the clear definition of the function of each module made at the outset. The modules should be fully interactive, and allow for the free flow of information between modules; an essential requirement of a successful SQIS.

Quality is defined as the ability to satisfy the requirements of serviceability, safety, compatibility, and durability. Information is defined as the data and communications used to monitor the condition of a system and provide warning to emerging problems. A ‘system’ is the collection of structures, hardware, procedures, environments and personnel in an organization. A Ship Quality Information System incorporates the elements of a system for the management of information to maintain vessel quality.

The Industry-Wide Application

The Industry-Wide SQIS is the further application of information systems to facilitate the identification of broad based trends in the shipping industry. The Industry-Wide SQIS receives summary information from the structural, equipment and operations systems of individual vessels (Figure 1). Directed trend analysis then detects common events between ships and identifies similar fields for those vessels. Pairing of common events to similar fields for a series of vessels is an indication of a cause and effect trend for those vessels. The inclusion of information from all aspects of vessel performance, structures, equipment and operations, provides for the identification of causal links between these aspects which are missed in more focused systems.

The identification of trends in vessel quality performance is of different value for different industry sectors. Government regulatory bodies would utilize such information in the formulation of regulations to ensure that the regulations are effective, efficient, and address the root cause of a problem. Classification societies are able to use the results of the trend analyses to assist them in formulating their requirements for vessels in class. Vessel owners may use the industry alerts containing the trend analysis results to pro-actively adjust their inspection, maintenance, repair or operations procedures to avoid similar quality failures.

3.3 Modular Concept

The Industry-Wide SQIS is divided into three modules; Structure, Equipment

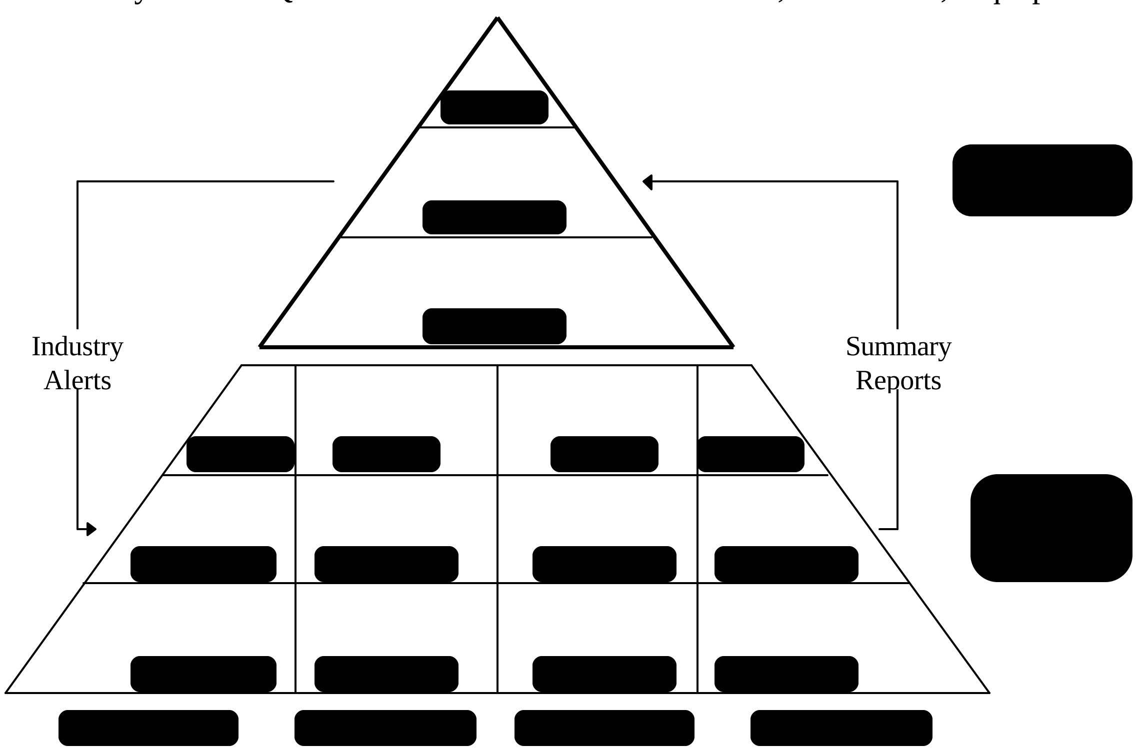

Figure 1: SQIS information flow.

and Operations. Each of these modules is further divided into sub-modules which may be implemented and altered independently. The power of the system, however, will depend on the interaction and information sharing between the modules (Figure 2).

Structure Module

The Structure Module contains sub-modules addressing the areas of defects and corrosion in the vessel structure. The Defect Sub-Module focuses on occurrences of significant fatigue defects in the structure. Such defects may include cracks, buckling, indentations, or combinations thereof. Information pertaining to the location of the defect within the ship, the type of member in which the defect occurred, the type of metal, the severity of the defect, the detection method, the time to defect occurrence (or detection) and the decision to repair are recorded. Given that the Industry-Wide SQIS is to make associations between events in ships with different structures, the fields used to describe the defect location must be sufficiently flexible to allow similar, but not identical, structural elements to be classed together. For example, the affected member location may be identified by what type of compartment it is in (engine room, cargo tank, double bottom, etc.), what percentage of the distance from mid-ships to the stern or bow it is at, and what side (port, center, starboard) it is on. The defect location on the specific member may be likewise generally defined.

The Corrosion Sub-Module contains information about significant corrosion occurrences in vessels. As in the Defect Sub-Module, the location fields are sufficiently flexible to accommodate subtle differences in ships' structures. The Corrosion Sub-Module includes information about the corrosion severity, the type of compartment affected and the corrosion protection measures employed. Information concerning the cargo or ballast carried is incorporated in the Operations Module.

The information for the Structure Module comes from summary reports created by Ship Structural Integrity Information Systems (SSIIS II's) for individual vessels. This information may be provided directly from the owner, or may be directed through the classification society, USCG or port authority.

Equipment Module

The Equipment Module covers the issues of machinery performance and maintenance. In order to maintain generality in machinery identification, on-board

Structure Module	Equipment Module	Operations Module
Defect Sub-Module	Vessel Systems	Voyage Report Sub-Module
Corrosion Sub-Module		Incident Report Sub-Module

Figure 2: Industry-Wide SQIS Modules

equipment is addressed on a system basis. The performance of each system (propulsion, cargo handling, electrical, steering) and the associated maintenance activities are monitored. The critical components of each system are specified for each vessel (e.g. main engine make and model) with regular maintenance intervals and hours of usage.

The information for the Equipment Module comes from automated summary reports provided by machinery maintenance programs such as Marine Management Systems (MMS), provided either on a vessel by vessel, or owner by owner basis (many owners have entire fleets on one system).

Operations Module

The Operations Module is composed of a Voyage Report Sub-Module and an Incident Report Sub-Module. The Voyage Report Sub-Module covers information regarding regular vessel operations. At the conclusion of each voyage, vessels send information such as voyage origin and termination times and locations, sea states encountered (as percentages of total time at sea) and cargo specific data. The cargo data specifies the type and quantity of cargo or ballast carried, and any special handling activities (e.g. heated tanks).

The vessel handling information comes from the on-board vessel monitoring systems in the form of an automated trip summary. The cargo specific handling information is provided by the summary function of the owner's cargo management system.

The Incident Report Sub-Module, in conjunction with the operational procedure monitoring provided by automated trip summaries, is intended to aid in the identification of potentially unsafe practices or conditions on board vessels. Procedures requiring stricter regulation are revealed (as are those which do not), which allows for proper direction of regulatory work. This sub-module is based on the Federal Aviation Administration (FAA) incident reporting system in which the identity of the persons filing a report is protected while the integrity of the report is maintained. In the FAA system, the incident report receiving is handled by industry professionals (usually retired pilots). These professionals screen a percentage of the reports, judge them for feasibility, and request additional information deemed relevant. These are the only individuals with the knowledge of the report origin. Once the reviewers are satisfied with the accuracy of a report, they sanitize the data to protect the source, and forward the report. While this procedure is rather labor intensive, and limits the number of reports processed, it guarantees the accuracy of the reports, and the identity of the source. This system is legally protected to ensure that report sources can never be identified.

3.4 SQIS in Industry

The Industry-Wide SQIS holds benefits for all sectors of the maritime industry, while at the same time, relying on their cooperation for its success. Without the information from the owners, the expertise of the classification societies, and the direction of the Coast Guard, the Industry-Wide SQIS will fail to satisfy and benefit anyone. Therefore, it is crucial at this stage, to examine what requirements, expectations, and reservations each group has with respect to the Industry-Wide SQIS concept.

The United States Coast Guard

The USCG has worked extensively in the area of database development, through its past work with the Marine Safety Information System (MSIS), Marine Safety Management System (MSMS) and Port State Information eXchange System (PSIX). These systems provide an archive of data generated through Coast Guard inspection activities. The current development of the Marine Information for Safety and Law Enforcement (MISLE) system is intended to produce a similar system, but with an architecture intended to facilitate analysis. The present systems contain a wealth of information with respect to the overall condition of vessels visiting United States ports, and in particular, how the condition changes with time. However, the data is not in a format which lends itself to analysis of large data blocks. For example, too many of the fields allow for general text description rather than having a set range of choices in a list.

The goal of the USCG is to develop a trend analysis system that can be used to assist in the implementation of more efficient regulations. For example, a system that can distinguish between an extraordinary incident and one that is related to other incidents, would prevent unnecessary legislation implemented to prevent 'freak' occurrences. In addition, through the formal identification of how operational parameters (such as vessel type, routes traveled, and cargo carried) impact on vessel structural performance, the Coast Guard can assign inspection, maintenance and repair requirements on a vessel by vessel basis.

The Coast Guard is working towards regulatory reform with the intention of reducing the regulatory burden, while increasing the involvement of industry in the accomplishment of its safety and environmental goals [4].

The American Bureau of Shipping

The American Bureau of Shipping has two programs which reflect a commitment to modernize the vessel classification process through the use of information systems. SafeHull™ uses a first principles approach to the design and evaluation of ship structures. SafeNet™ is a life-cycle ship management and information network which contains all classification-related technical and survey information for both the hull structure and machinery of a vessel [5]. ABS plans to use the information in SafeNet™ to fuel trend analyses. The objective is to use the trend analyses to examine ways in which survey requirements can be reduced in areas where not necessary, while still being safe. The goal is to switch away from the traditional prescriptive approach to survey requirements to a risk assessment approach. Through a risk assessment of hulls, it is possible to target the areas of greatest interest for survey.

The trend analyses to be performed by ABS using the SafeNet™ database are very similar to those which would be capable in the Industry-Wide SQIS system. Vessel summary data for vessels under ABS class may be delivered to the Industry-Wide SQIS by SafeNet™. Data for vessels classed elsewhere could be sent by other life-cycle management programs under development. The classification societies may have restricted access to the Industry-Wide SQIS database as a data source for trend analysis, increasing the power of their work.

ABS's goal is to move away from the traditional, rule based approach, to a first principles, analysis based view. For example, judgments on corrosion trends could be based on fitness for purpose, rather than conventional rule renewal criteria.

In using a risk assessment based approach to assigning inspection requirements, it is vital to incorporate operational information in the risk assessment. The interaction of the Industry-Wide SQIS modules enables that this requirement to be met.

Vessel Owners

The primary goal of oil tanker owners and operators is improved life-cycle management of vessels. They are interested in developments which enhance this goal, while reducing the regulatory burden. Various companies have been involved in database projects in the past, such as the CATSIR projects, Hull Fracture Database (HFDB), FracTrac, and Structural Inspection Database (SID). The limited resources of the companies has resulted in systems which are too focused, looking at only one aspect of the vessel (e.g. structure) and not examining the correlation between different facets of vessel performance. The Industry-Wide SQIS system will provide a means for this type of correlated event investigation, and hence, is of interest to owners.

The vessel owners wish to see the regulatory structure changed to allow for adaptive regulations (on a vessel per vessel basis), but are worried that the development of such a system will require a growing process in which the regulatory burden will be increased before it can be decreased. The owners do not want to have to increase inspection efforts in some areas due to a risk assessment approach, while still having to meet the older prescriptive regulations over the rest of the vessel. It is vital that the Coast Guard and classification societies work with the owners to ensure that this does not happen, and that the owners see a positive impact of the Industry-Wide SQIS project. Without legislation, there is no way to force the owners to allow their vessel data to be part of the system, so the cooperation of the owners is essential.

Different owners and operators may have different strategies towards vessel maintenance management, which would affect their attitude concerning involvement in an Industry-Wide SQIS. Some tanker owners and operators are concerned with life-cycle management, but many have much shorter time goals, operating vessels in marginal condition as long as they are permitted. Owners which are involved in a variety of trades may be very conscientious in one trade, but less so in others. The development and implementation of the Industry-Wide SQIS must take into account this full range of owners' objectives. Some may embrace the idea, but others totally reject it, only complying through minimum legal requirements. The latter could even use political influence to block the legal and regulatory implementation of a system.

3.5 Administration

A significant key to the successful development and implementation of the proposed Industry-Wide SQIS system is the identification of an acceptable agency to fulfill the role of system administrator, responsible for the development and maintenance of the system. The exact responsibilities of the administrator would depend on the type of agency undertaking the task, and the abilities of that agency. Some of the basic responsibilities would likely include:

- Hardware and software development and maintenance - maintaining the physical system, and performing any software upgrades required. The administrator would also have to assume the responsibility of informing the SQIS users of any changes, especially if related to data formatting for information exchange.
- Ensuring system security - if SQIS is to follow the route of being a privileged access database, then the administrator would have to assume the role of ensuring that assigned access levels are not violated or abused.

Depending on the nature of the agency acting as the system administrator, the administrator may also assume responsibility for certain data entry, verification, or analysis tasks. Some examples include:

- Vessel and company information - whenever a new vessel or organization is entered into SQIS for the fist time, background data on that vessel or company is required. This information falls outside of the realm of the standard data transfers, and would be done manually. In particular, for new vessels, structural and equipment related information would be required to be entered and analyzed.
- Incident Report sub-module - as mentioned earlier, this element of the system would require some rather sensitive data handling and cleansing. The extent of this work would depend on the level of dissemination of the information once it is entered in the system. This task may fall to the system administrator, or it could be assigned to another, intermediary agency.

There are four likely types of administering agencies, each of which has strengths and weaknesses both with respect to its' ability to fulfill the role of administrator, and with respect to how having such an agency as administrator will affect the implementation of the Industry-Wide SQIS. The four types of agencies, example organizations, and the key pro's and con's of each are highlighted in Table 1 on the next page.

Agency Type	Example Agencies	Pro's	Con's
Government	DOT (USCG, MARAD)	• Infrastructure required for system development and maintenance already in place. • Expertise for data analysis • Government funded	• Possible conflict of interest with regulation / enforcement role. Would have to have restricted access to data. • Federal funding could limit the application of SQIS to U. S. flag vessels. • Could be susceptible to political pressure.
Classification Society	ABS Lloyds	• Already exchange data with owners / operators, may be able to incorporate that data. • Have started development of related systems. It may be possible to adapt them to fulfill SQIS' role. • Expertise for data analysis	• Possible conflict of interest with regulation / enforcement role. Would have to have restricted access to data. • Further conflict of interest in handling data concerning vessels in another class.
International Body	IMO	• International basis would be instrumental in extending the SQIS to international scope. • Not directly involved in regulation.	• Funding issues may be more complex. • Gaining international acceptance of SQIS would likely be very difficult.
Independent Contractor	NASA Ames (for the FAA) universities	• Able to control data access to all parties, including USCG and class's. • Could hire expertise as required.	• Would likely have to be formed from scratch.

Table 1: Administrating Agency attributes

A U. S. government agency, such as the Coast Guard, might be capable of fulfilling the role of system administrator. Such an agency does have the benefit of having a pre-existing infrastructure, and sufficient in-house expertise, that would facilitate the system development. Since the Coast Guard may be one of the primary beneficiaries of the analysis capabilities of the system, it would be, logistically speaking, straight forward to ensure that people with the desired expertise were involved in the development process, to ensure that the system incorporates the desired analysis attributes. Having the Coast Guard as the administrating agency may also be beneficial in facilitating the process of securing enabling legislation for the system. However, too heavy a reliance on government legislation could work against the implementation of the system, if political pressure is brought to bear against the Industry-Wide SQIS. With the USCG as the system administrator, special care would have to be taken with respect to sensitive data handling. Special emphasis would have to be given to the issue of the use of information held in the SQIS system in legal proceedings.

Given their strong technical abilities, experience with information system development, significant infrastructure, and vested interest in the analysis abilities of the Industry-Wide SQIS, classification societies such as ABS could be appropriate choices for the SQIS administrator role. A number of class societies are currently developing information systems with similar goals to that of the SQIS. Adaptation of those systems to fulfill the Industry-Wide SQIS role would likely not be difficult. As with the case for the Coast Guard, handling of sensitive information poses a problem in this scenario. Owners and operators may be reluctant to divulge sensitive or proprietary information to a class society, particularly if it is not the society under which their vessel is classed. Similarly, competing class societies may not want information of vessels in their class released to the administrating society. It would likely be necessary that the SQIS administrating activities be isolated form the rest of the class' work. There would have to be assurance from the administrating class that information received under its function as SQIS administrator would not be used in its capacity as a classification society. Use of a class society as SQIS administrator does open the door to international implementation of the SQIS, assuming the issue of handling data on vessels not in class is resolved.

If the Industry-Wide SQIS were to be administered by an independent, international agency (for example, the IMO), one thought is that it should not be responsible for the analysis of information. Rather, this body would have as its main functions, the maintenance of the system and the gathering, collating, sanitizing, and dissemination of information. Regulatory agencies, such as the Coast Guard, and classification societies, would assume the job of analyzing the information held in the system. Such organizations would be given limited access, at a pre-determined level, to the information in the system. The advantage of this arrangement would be that the regulatory agencies would be freed of the requirement of administering the upper-level system, and would be able to aggressively pursue analysis activities, expending time and resources in the most beneficial manner. All results of their analyses would be passed back to the main administering body for system wide dissemination. Administration on an international basis would likely enable the SQIS to realize its maximum potential. Implementation at this level would require the world-wide marine industry to accept responsibility for its actions on a global level, and to work together to assure comprehensive implementation of regulatory standards. The benefits of a global system would be immense. Such a system could play a key role in enabling companies from poorer regions of the world to improve their operations to a level comparable with those of more prosperous areas, and coincidentally reduce the incidence of accidents and quality failures in those fleets.

The Industry-Wide SQIS could be established and maintained by an independent contractor on behalf of the Coast Guard. This arrangement would help ensure that sensitive, incident report information is not capable of being used in investigations. This is the arrangement that has been adopted by the FAA is the implementation of their Aviation Safety Reporting System (ASRS), contracting the administration responsibilities to NASA Ames. This administrating body would require a high level of expertise from all segments of industry. Hence, it would be necessary for there to be experienced members of the Coast Guard, classification societies, research institutions, and owners to be associated with the body. Whether as permanent employees, or as part of an advisory committee. The administering organization could assume the responsibility of coordinating the analysis efforts of the various classification societies and the Coast Guard, and be responsible for enforcing levels of information access. The extent of the role of the independent contractor could be anywhere from minimal data handling, storage and system maintenance, to full responsibility for data processing, analyzing, and enforcement of access. Depending on the level of expertise held by the contractor, it may be the best organization to undertake the development of the SQIS analysis components. The administering body could also be tasked with facilitating communication between the owners, classes, and Coast Guard, to ensure that the concerns of each are met. The most significant advantage of this arrangement is that the role of the agency could be well defined before its formation, and then it could be developed with the specific role of SQIS administrator in mind. This would help to produce an agency that is efficient and effective. However, such an agency would likely have to be formed from scratch, which may slow down the implementation of the Industry-Wide SQIS.

The information that is expected to be held within the Industry-Wide SQIS is of a sensitive nature. Owners and operators would release information to the system that they would not normally wish their competitors, classification society, or Coast Guard to see. This is not to imply that they would be releasing data that would expose them for illegal operations, just that they may have proprietary information that they would rather keep in-house. Users of the SQIS system may be assigned access levels, which allow them access to different parts of the database, depending on the users' function. This would include limiting the access of the Coast Guard and class societies, to protect the owners from regulation based on the information held in the system. The administrating agency would likely be responsible for ensuring that access levels are not violated. However, the assignment of access levels would probably have to be done on a consensus basis, involving all bodies associated with the SQIS system.

Funding for the administering body would depend on the agency type and the scope of the full-scale Industry-Wide SQIS. An independently administered body, for a system limited to U. S. flag tankers could most reasonably be expected to be funded jointly by the tanker industry members, classification societies and the government. A system administered through the Coast Guard or classification societies, which might be designed to emphasis their needs more, would likely be funded more by the government with some support from the industry. Funding for an internationally based system would likely come from participating countries' governments, whom would then have to decide whether or not they wish to pass the costs directly to owners / operators.

3.6 Implementation

Given that vessel life-cycle management information systems such as SafeNet™ are very much in their infancy, it is not possible to describe precisely at this point what the Industry-Wide SQIS architecture will be. As these systems develop and grow in sophistication, the utility of the Industry-Wide SQIS will increase. At this point, it is not possible to describe with certainty the various ways in which the system will be employed. Hence, it is necessary to define the initial SQIS architecture with concept of a modular growth process in mind.

It is desirable to verify the basic architecture prior to full-scale implementation. A prototype system, which uses existing or simplified information summary and transfer programs would be capable of establishing the necessary infrastructure and demonstrating the utility of the system to the maritime community. Since the Industry-Wide SQIS will depend on standard information transfer protocols, the prototype implementation will allow for development and testing of such systems, and provide opportunity for the incorporation of such protocols into the information systems expected to communicate with the Industry-Wide SQIS.

The prototype Industry-Wide SQIS would establish the basic data fields required to establish connections between the various sub-modules, but would not contain as much detailed information as the full-scale system. The level of information detail in the different sub-modules of the full-scale system will change with time to reflect varying technical concerns. The administering body would be instrumental in assuring the ability of the system to reflect the shifting focus of analysis efforts.

3.7 Fundamental Requirements of SQIS

The primary goal of the first task of the SSIIS III Project was to develop a list highlighting the most necessary requirements which must be met by a fully implemented Industry-Wide SQIS in order to gain acceptance and approval throughout the oil tanker industry. This list incorporates the work of the U. C. Berkeley research team, the input of the Technical Advisory Committee, and the advise of the members of industry participating in the interview process.

- The regular information transfers from vessel and company systems to the Industry-Wide SQIS must be as automated as possible.
- The Industry-Wide SQIS system must require only minimal additional work on the behalf of the vessel crews, or other company employees. All information required by the SQIS must come from individual data systems.
- The preceding two requirements indicate that the development process of the full-scale SQIS must involve all sectors of the industry, including information systems manufacturers, to ensure that the required infrastructure for information collection and transfer is developed.
- The database should be structured to facilitate data analysis, and not be an information sink. For this reason, the number and types of data fields should be limited. The use of free text data fields should be minimized but still included.
- The database should be constructed to enable trend analysis, which would facilitate more efficient regulation.
- A risk assessment based approach to determining inspection and repair requirements requires full scope information, including structural, systems, and operational information.
- The information sources for the SQIS will be widely varied, but the level of information detail from each source should be minimal.
- The information sources for the SQIS will be widely varied in type and in design. Therefore, the establishment early on in the SQIS development process of information transfer protocols is crucial so that the interacting information systems can be designed to ensure that information transfers may be accomplished efficiently, with minimum effort, and accurately.
- Information collated for and recorded in the Industry-Wide SQIS must not be available for utilization in legal proceedings. Hence, the system should be established and maintained as a privileged database by an independent contractor on behalf of the Coast Guard.

4. The SQIS Prototype

4.1 Basis

The information in the prototype is based on the information contained in a typical USCG required CAIP. While it is recognized that the CAIP format does not necessarily represent either an efficient or sufficient collection of data, the information contained in CAIP's is available for use at this time, and is sufficient to demonstrate the utility of the system.

The prototype is focused on illustrating the usefulness of a SQIS in identifying links between vessel operations and structural damage. Due to limited time and resources, it has not been possible to develop the necessary components of the Incident Report Sub-Module to illustrate the equally important links between vessel operations and equipment deficiencies.

4.2 Scope

The SQIS system is intended to assist in the development of safety and maintenance programmes for tankers. By identifying factors contributing to defects and corrosion damages, directed safety and management programmes will become possible. SQIS is intended only as a tool to aid in evaluations. A SQIS which identifies the existence of trends in defect and corrosion damages fulfills this role, even if the SQIS is not able to specifically identify the contributing factor. Identifying that there <u>are</u> contributing factors is the method by which the SQIS provides early warnings of trends that threaten ship quality. With this in mind, it becomes apparent that a high level of detail and specificity is not necessary for the SQIS to function. Too much detail (in specifying structural members for example) may inhibit the SQIS function of identifying related incidences, and will lead to an unnecessarily cumbersome system.

4.3 Data Input

The information in the prototype SQIS is entered by data entry users, either directly into tables, or through a series of data entry forms (Appendix D: SQIS Table Descriptions). In later versions, the primary form of data entry will be via data file download. Data files created in other applications, such as vessel SSIIS's, will be downloaded, and the data sorted and stored. Manual data-entry will still be available for small data entries, corrections or updates.

Ensuring uniformity of data is a major concern for the SQIS, given that data input will come from a wide variety of systems, representing an array of vessel configurations. Providing classes of elements, for the structure, structural details, and equipment will be necessary. In the original SQIS configuration, with manual data entry, a library of elements is provided for the user. In the advanced, automated system, data filtering will be necessary to ensure data homogeneity. While this approach will restrict some data fields, it is required to enable the queries to function. This may result in the occasional false indication of a trend (by classing unrelated elements together), these false hits should be readily identified at the next level of analysis (beyond the SQIS).

In the SQIS prototype, a library of structural elements, based on the Tanker Structure Co-operative Forum suggested nomenclature is employed. A library of common structural detail designs is also provided (Appendix E: Structural Detail Library) to provide common terminology for data input. This library only provides for classes of details, handling the specific design of details is far beyond the scope of the SQIS.

General Information

To reduce unnecessary repetition of data in the SQIS system, two background information data tables are used. The Company Directory contains general information concerning all companies related to the tankers in the SQIS database. This includes Owners, Operators, Shipyards, Classification Societies, and the USCG. The Vessel Directory contains historical, systems, and general structural information for all vessels in the database. Each company and vessel is assigned an unique identifying number by the database when it is first entered in the system. All references to that company or vessel is then made using that identifier. The data fields employed in the Company and Vessel Directories are given in Table 11 and Table 18 of Appendix D.

Structure Database

The Structure Database (comprising of the Defect Database and the Corrosion Database), is designed with a hierarchical system of location fields. This system will enable queries relating locations of damage occurrences in different vessels to identify what location field is the critical field (Figure 3 and Figure 4). Each Defect Record ultimately refers to a collection of similar structural details on a single member, located in a single tank, on a single ship. At the detail level, the material of the details is recorded, along with the percent of the details experiencing Class 1, Class 2, and Class 3 cracks. (It should be noted that, given that the Coast Guard does not currently require reporting of Class 3 cracks, complete data may be harder to come by. However, it is in the best interests of this system to encourage full disclosure of such cracks, as they are often an early warning of more serious incidents to come.) At the member level, the relative location of the member within the tank is given as a percent of the distance from the tank bulkhead to tank bulkhead in each of the vertical (positive up), longitudinal (positive forward), and horizontal (positive outward) directions. The type of member is also recorded. The tank is identified by its' centroid location, longitudinally as a percentage from midships to the aft or forward perpendicular (positive away from midships), and transversely as port, starboard or center. The vessel is identified by its' Vessel ID assigned when the vessel was first entered in the SQIS system. For each Defect Record, there are also fields to record the type of inspection in which the cracks recorded were identified, how old the vessel was at the time the record was made, and what repairs were completed subsequently.

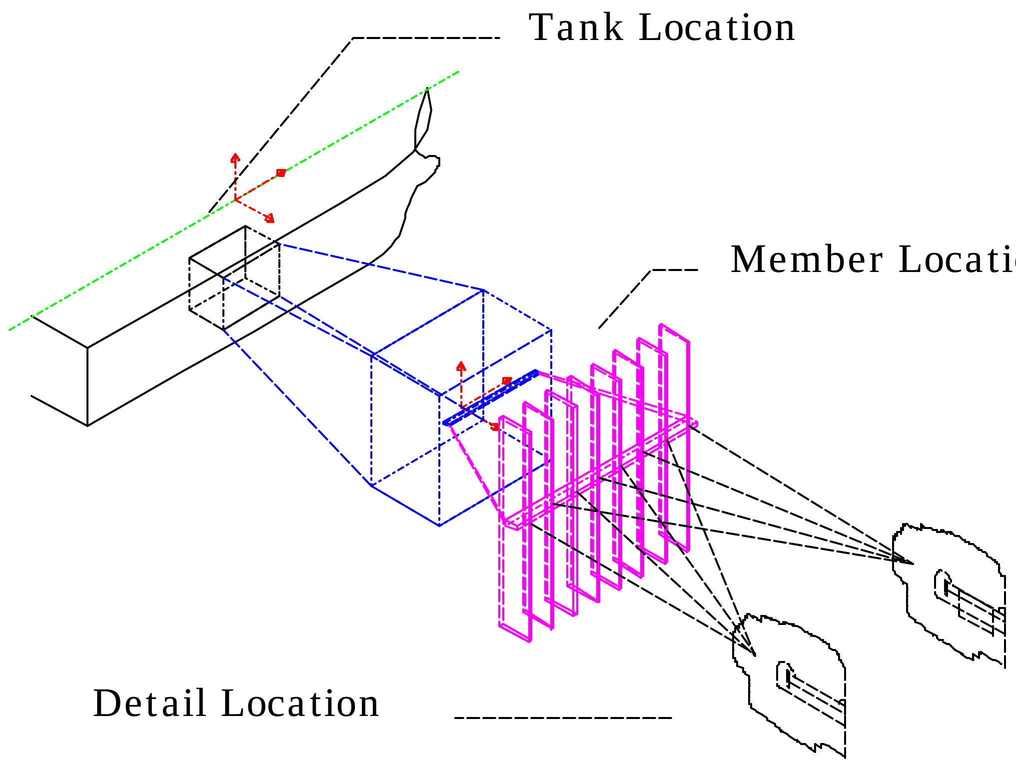

Figure 3: Hierarchy of Defect Record location fields

Each Corrosion Record refers to a section of a member within an individual tank on a vessel. The location of the section of the member within the tank, and the tank within the vessel is given in the same manner as in the Defect Database (Figure 5 and Figure 6). The fields characterizing the Corrosion Record include: the member metal type (mild steel or high tensile steel), the percentage of the area affected with pitting corrosion, the percentage of area affected with general corrosion, the depth of each type of corrosion, and the corrosion protection systems: coating type (hard, soft, or none), coating condition, and anode condition (none, good, fair, poor). In addition, the type of inspection conducted to produce the report, and the age of the vessel at the time of the report are recorded. Finally, the repair type utilized is recorded.

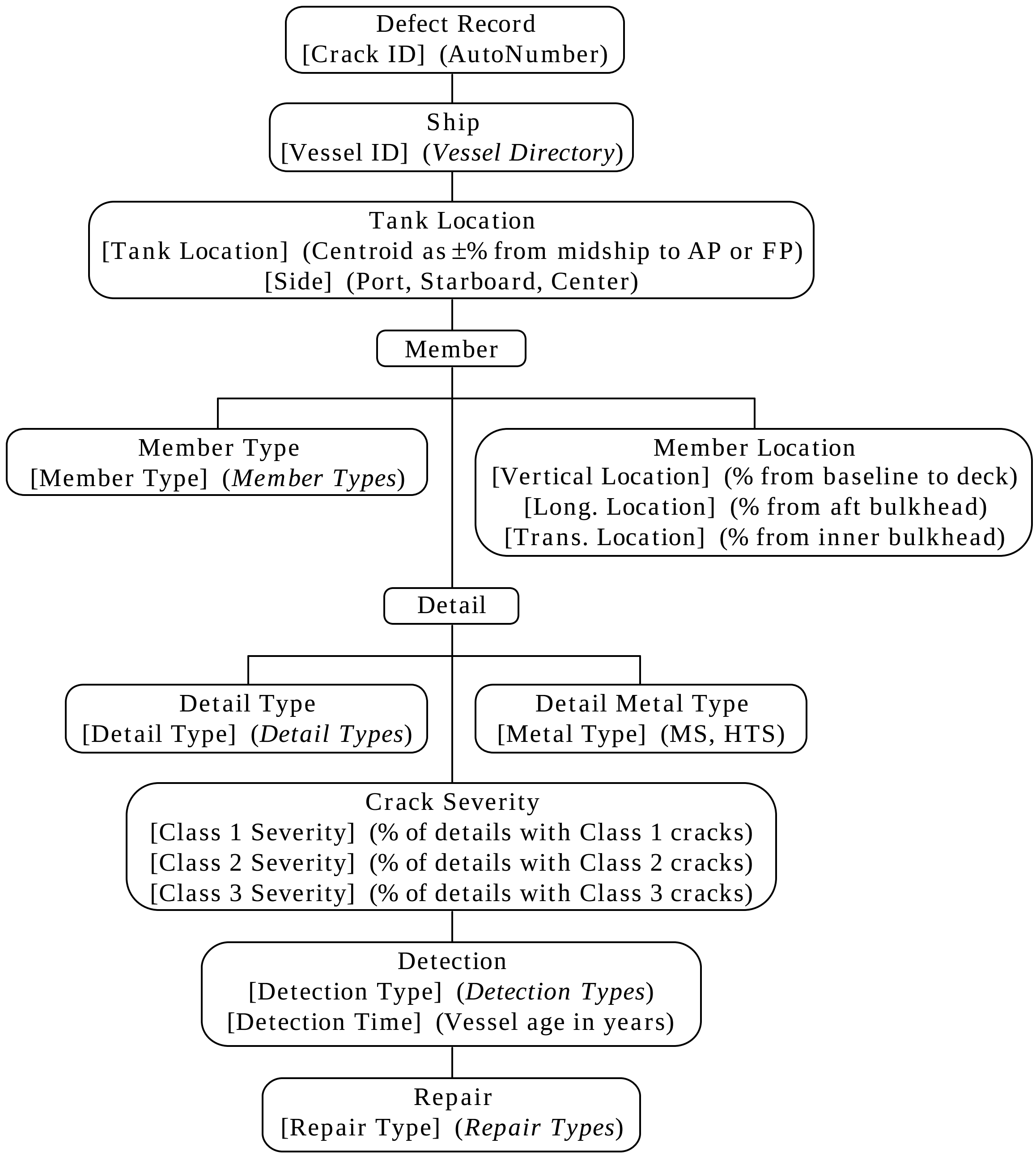

Figure 4: Flow diagram of Defect Record fields.

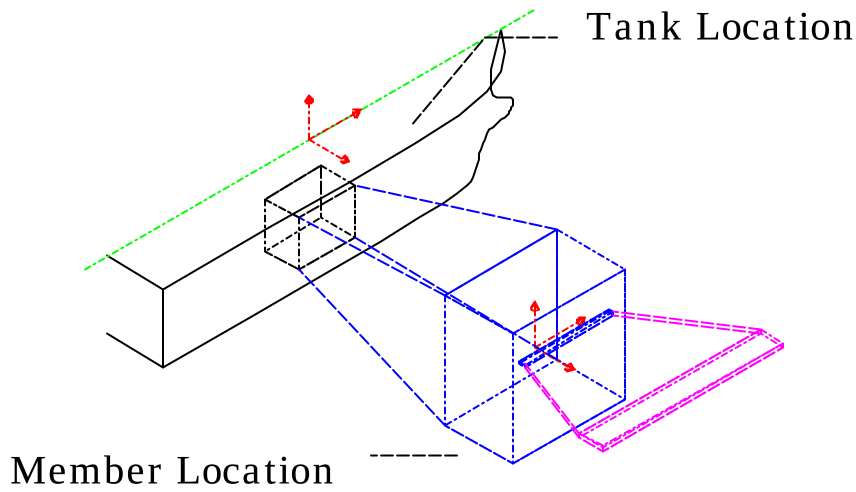

Figure 5: Hierarchy of Corrosion Record location fields

While it is recognized that the system of location fields utilized in SQIS is not a standard one, it is necessary to employ a system which can accept data for ships of all sizes and configurations. Relative positioning fields are the most effective method of associating related vessel components between different classes. Each vessel in SQIS has a record containing its major dimensions. Hence, conversion of absolute location fields to relative ones can be easily automated within SQIS, thereby relieving the incident reporting systems of the need to modify their data structure to match SQIS's. For the analysis capabilities of SQIS to be able to compare vessels of different configurations (and with different structural labeling schemes), all the vessels must be represented in the same manner. For example, Tank 6 on one vessel could be at midships on the port side, while on another vessel, Tank 6 could be 25% forward of midships on the centerline. These tanks do not represent the same relative location on the vessels, and comparing structural data about them would be misleading. But an analysis of all tanks entered into the SQIS system, labeled Tank 6, would make this comparison. One way of avoiding this type of problem would be through the adoption of the relative location scheme. The process of converting location fields from the owner's terminology to the SQIS scheme could be accomplished through the use of vessel-specific templates that would be generated for each vessel in SQIS at the time of it's initial entry into the system. When the SQIS analysis functions indicate that certain vessels should be inspected for defects, for example, they would be directed towards a broad area in the vessel (say, all tanks between -10% and +10% from midships), so it is not necessary for the SQIS system to translate location fields back to the original owner fields with which the information was entered into the system.

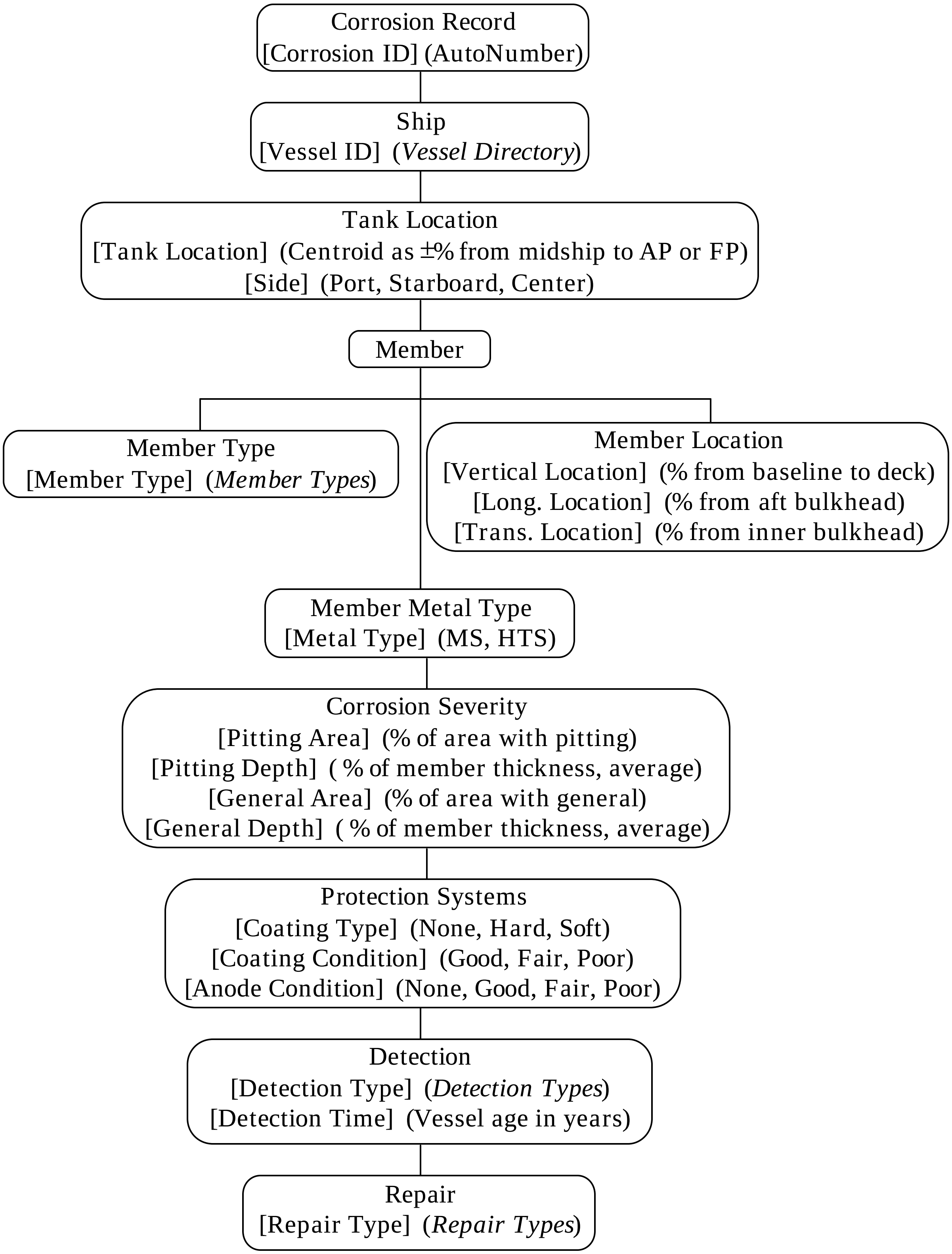

Figure 6: Flow diagram of Corrosion Record fields.

Vessel Operations Data Base

The operations information component of the SQIS Prototype consists of the Voyage Database. This table holds records for voyages conducted by the vessels in the SQIS Vessel Directory. The records consist of fundamental voyage information including: vessel and operator, port of origin and destination, date of departure and arrival, cargo and ballast volume and type, and weather and sea information. (See Table D-10 of Appendix D)

The information contained in the prototype version is necessarily brief to minimize data entry requirements. However, even with limited data fields, it is still possible to demonstrate the utility of the SQIS concept (i.e., the combining of structural and operational information in a common database). In a fully implemented SQIS, the information in the Voyage Database would be supplied via automated updates from vessel monitoring systems. The implementation of vessel voyage data recorders in tankers provides the ideal source for automated voyage reports [6]. Since voyage data recorders will contain much more information about the voyage conditions, vessel operations, and structural response than is currently available, the content of the Voyage Database in the full SQIS will likely be somewhat different than that of the prototype.

The prototype SQIS does not include the Incident Report sub-module.

4.4 Data Queries

The purpose of the Industry-Wide SQIS is to facilitate investigation of the underlying factors in tanker industry trends. To that end, SQIS provides two types of queries:

- A library of pre-programmed queries provides general activity information.
- User-directed cross-reference queries allow the authorized SQIS analyst to explore relationships between parameters.

The ability to quickly sort and filter information is the greatest asset of a database system. The presentation of query results, in the form of easily read tables and graphs, is a crucial feature of the system.

Analysis Structure

The pre-programmed queries in SQIS are divided into two categories, Organization Summary and Operations Summary. From the Organization Summary Form, the user can access forms presenting the results of queries about the ships associated with Owner / Operators, Classification Societies, and Shipyards and Table 2 to Table 4). Bar charts summarizing the query results are also provided.

Specified Fields	Resultant Fields
Company Name	Vessel Name
	Class Built
	Shipyard
	Delivery Date
	DWT
Summary Charts	Vessels per Owner Vessels per Operator

Table 2: Owner / Operator Summary

Specified Fields	Resultant Fields
Company Name	Vessel Name
	Owner
	Operator
	Shipyard
	Delivery Date
	Hull Number
	DWT
Summary Charts	Owners in Class Operators in Class Shipyards in Class Delivery Dates of Vessels in Class

Table 3: Class. Society Summary

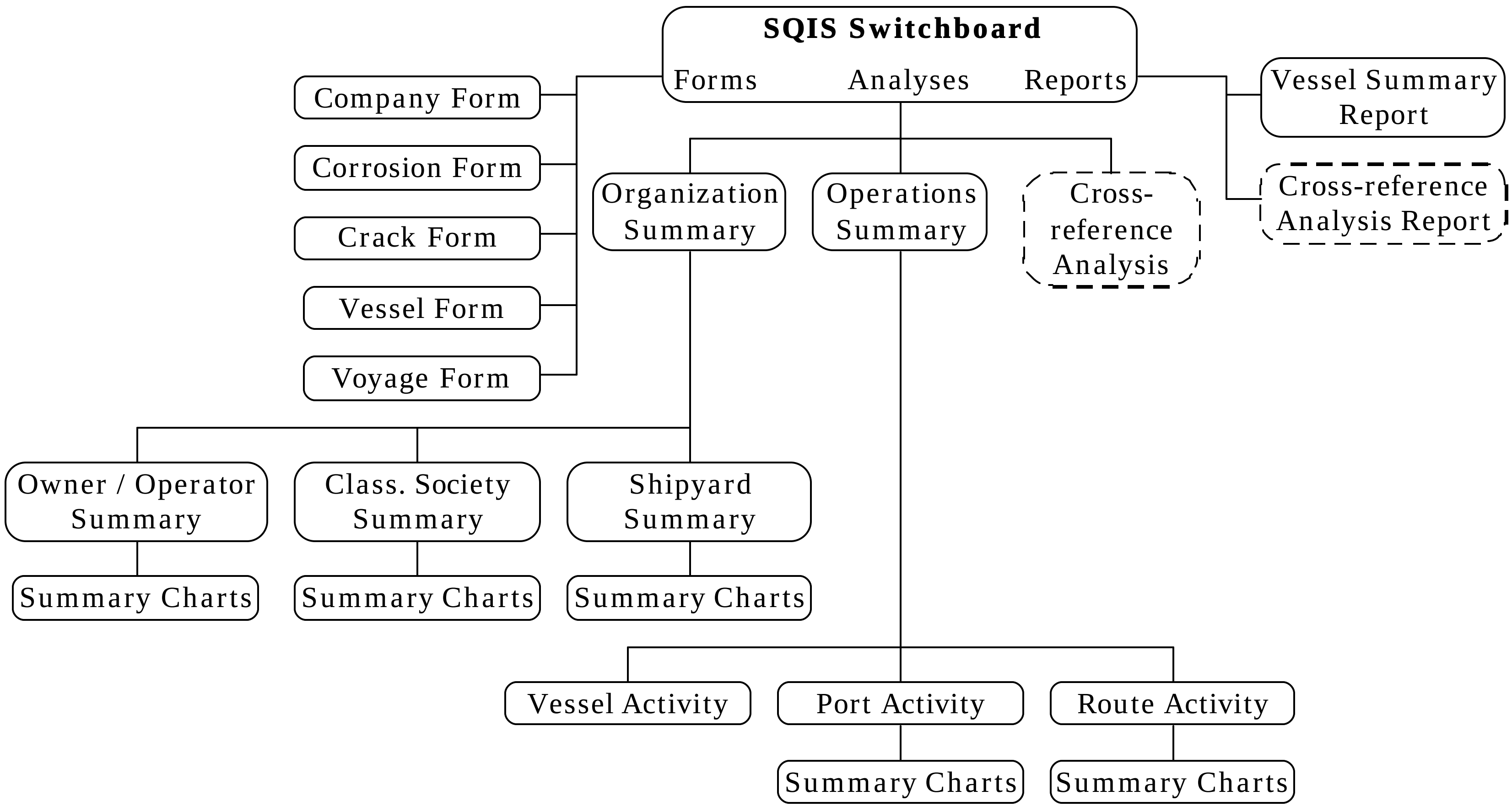

Figure 7: SQIS Prototype Layout

Specified Fields	Resultant Fields
Company Name	Vessel Name
	Owner
	Operator
	Class Built
	Delivery Date
	Hull No.
	DWT
Summary Charts	Vessels Built per Year in all Yards Vessels Built per Owner Vessels Built per Year Vessels Built per DWT

Table 4: Shipyard Summary

The Operations Analysis Form, leads to forms displaying the results of queries based on Vessel, Port, and Route fields (Table 5 to Table 7). Again, summary charts provide a graphic display of data trends.

Specified Fields	Resultant Fields
Vessel Name	Voyage Origin
Date From	Destination
Date To	Date Depart
	Date Arrive
Trips per route	Origin, Destination, No.

Table 5: Vessel Activity Summary

Specified Fields	Resultant Fields
Port Name	Arrivals: Vessel Name
Date From	Arrivals: Voyage Origin
Date To	Arrivals: Depart Date
	Arrivals: Arrive Date
	Arrivals: Operator
	Arrivals: Cargo Type
	Arrivals: % Cargo Capacity
	Arrivals: Ballast
	Arrivals: % Ballast Capacity
	Departures: Vessel Name
	Departures: Voyage Origin
	Departures: Depart Date
	Departures: Arrive Date
	Departures: Operator
	Departures: Cargo Type
	Departures: % Cargo Capacity
	Departures: Ballast
	Departures: % Ballast Capacity
Summary Charts	Vessel Arrivals by Month / Year Vessel Departures by Month / Year Cargo Arrivals by Month / Year Cargo Outbound by Month / Year

Table 6: Port Activity Summary

Specified Fields	Resultant Fields
Route Origin	Vessel Name
Route Destination	Operator
Date From	Depart Date
Date To	Arrive Date
	% Storm Weather
	% Rough Weather
	% Calm Weather
Summary Charts	Vessel Transits Monthly Activity Route Weather

Table 7: Route Activity Summary

Cross-reference Analysis in the Full - Scale SQIS

The utility of a Industry-Wide SQIS is a function of its containing a wide variety of information, collated from a number of sources. The SQIS brings all of this information into one place and defines relations between data sets (e.g. Vessel ID and Voyage ID). These relations allow the identification of causally related events, which are, for the first time, recorded in the same system.

Level	Parameter	Example	Search	Retrieve	Calculate
4	Defect event	>2 class 2 fractures in forward-most tanks in the first inspection of the year	Crack Database	Vessel ID Crack ID	% of total vessels
5	Weather event	Experienced 2 or more voyages with >25% storm weather in the preceding 6 months	Voyage Database	Vessel ID Voyage ID	% of level 1 vessels % of total vessels
6	Port event	Visited Alyeska between Nov. and March	Voyage Database	Vessel ID Voyage ID	% of level 2 vessels % of total vessels

Table 8: Top-down analysis

Through a top-down analysis approach, it is possible to identify these causally related events. An example analysis is presented in Table 8. At each query level, the percentage of vessel records searched which meet the query criteria is calculated. This percentage represents the correlation between the successive levels. A high percentage indicates high correlation. To establish a causal link however, it is necessary to establish correlation in both directions. High correlation at all query levels in the above example would indicate that a high percentage of vessels with more than 2 class 2 fractures discovered in the first inspection of any given year had experienced 2 or more voyages with more than 25% storm weather in the preceding winter, and had visited Valdez during that time. To establish that visiting Valdez in the winter season was the cause for those fractures, the analysis must be worked from the other direction as well. That is, the query level order must be reversed, as shown in Figure 8 and Table 9.

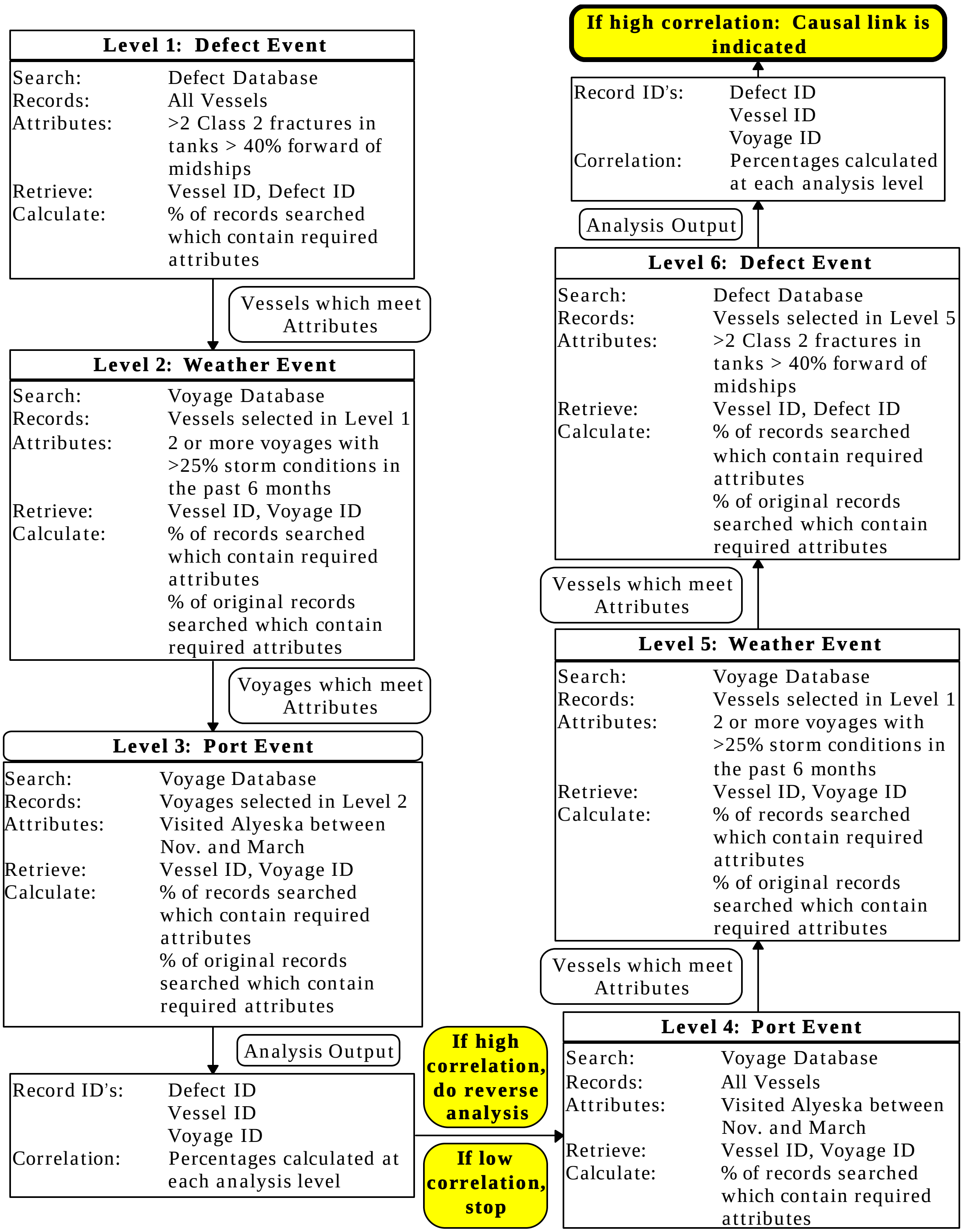

Figure 8: Cross-reference Analysis Cycle

Level	Parameter	Example	Search	Retrieve	Calculate
1	Port event	Visited Alyeska between Nov. and March	Voyage Database	Vessel ID Voyage ID	% of level 2 vessels % of total vessels
2	Weather event	Experienced 2 or more voyages with >25% storm weather in the preceding 6 months	Voyage Database	Vessel ID Voyage ID	% of level 1 vessels % of total vessels
3	Defect event	>2 class 2 fractures in forward-most tanks in the first inspection of the year	Crack Database	Vessel ID Crack ID	% of total vessels

Table 9: Top-down analysis, reverse order

If high correlation is also found in this analysis tree, then a causal link is established. It becomes clear that vessels visiting Valdez in the winter months are at high risk of developing cracks in forward compartments. This information could be incorporated within an inspection planning framework, for example in the form of a requirement that all vessels visiting Valdez in the winter season must undergo inspections of forward compartments before June 30. Given the existence of the first causal link, directed investigation might then look for correlation between crack incidences in forward compartments, and cracks in other sections of the vessel. This could be done by establishing what other areas typically are found to have cracks when cracks are found in spring inspections of forward compartments.

Automated Investigations

There are approximately 80 fields in the SQIS database which could be considered "searchable." To search all fields, in all possible orders, through manual query commands would be prohibitively time consuming. Especially given that the searches would have to be repeated each time the database received new data. While operator intuition and experience would be useful in eliminating some searches, one of the purposes of the SQIS is to identify causal linkages not previously identified. For this reason, the full implementation of the Industry-Wide SQIS should incorporate an automated "search engine" which would be capable of running through all possibilities and permutations of searches. The results of the searches would then be presented to SQIS system operators for verification. The search engine would have to incorporate a certain amount of "knowledge" in the form of some sort of rules. At the very least, rules determining the requirements for correlation would be required. However, in order to eliminate non-sensical results (for example; class 2 cracks causing severe storms), some additional "expert" rules are required. In this way, the automated investigation tool becomes an "expert system." The system would also have to contain rules governing what constitutes "usual" and "unusual" values for certain fields. The system would then search for links between "unusual" events. In the example of the previous section, the unusual events were: more than 2 class 2 cracks found in forward compartments in the first inspection of a given year, and more than 2 voyages with greater than 25% of the time in storm conditions in the preceding 6 months. The definition of "unusual" events should be done by industry professionals. There should be the capability to adjust these definitions so that the system stays current with industry standards of practice.

In addition, adjusting definitions of unusual events would allow for SQIS investigators to conduct sensitivity analyses. That is, it would become possible to determine at what point a causal link is established. This may prove to be of use in determining the strength (or validity) of causal links identified by the automated investigation system. For example, in the previous demonstration, adjusting the storm parameter from 2 voyages with 25% storm time to 2 voyages with 20% storm time, could identify more vessels with high correlation. This would suggest that the inspection recommendation should be extended to these vessels as well. Further manipulation of the storm parameter would identify a threshold value beyond which no new correlation events were identified. This threshold value would then be the relevant value to use in the inspection regulation.

This sensitivity analysis function of the SQIS could be conducted on an automated, or semi-automated basis. The system could perform a sensitivity analysis routine for all causal linkages it identifies, or such analyses could be performed at the request of a system operator. The system operator would have the ability to set limits on the range of values used in the analysis, if so desired.

Prototype Capabilities

Implementation of cross-reference queries of the sort described in the previous two sections is beyond the capabilities of the prototype platform, Microsoft Access ™. At it's limit, Access is capable of performing three successive levels of cross-tab query. However, to perform this task, all fields must be contained in the same table or query. Practically, this means that all the data contained in the SQIS database must be organized in one data structure. The number of fields in the SQIS database exceeds the limit allowed by Access. Hence, this type analysis is not possible in the prototype. However, a purpose-built application, on a workstation platform, would be entirely capable of performing the previously described analyses. The problem is one of scale, not technical difficulty. For this reason, the Cross-reference Analysis and Cross-reference Analysis Report block in Figure 7 are dashed, to indicate that they have not been implemented in the prototype.

4.5 Reports

One of the strengths of database applications, is their capabilities to generate automated reports, summarizing the information held in the database in a format suitable for printing or incorporating in reports.

Vessel Summary Reports

The Industry-Wide SQIS contains information on vessels collected from a wide variety of sources including vessel structural integrity information systems, equipment information systems, and voyage monitoring systems. The SQIS is then capable of collating this data and presenting a summary review for each vessel. At a key-stroke, the SQIS is able to produce a report summarizing all aspects of a vessel's history (to the level of detail of the information in the system). The SQIS prototype Vessel Summary Report displays general vessel administration data, crack and corrosion distributions with location and time, summaries of routes transited, and distributions of weather and seas encountered.

Cross-reference Analysis Reports

In a fully implemented Industry-Wide SQIS, with full automated cross-reference analysis capabilities as discussed above, the system would be capable of producing reports including the results of the automated investigations. The reports would contain a summary of causal links found, and sensitivity analyses performed. Various report options would be available, depending on the requirements of the operator.

5. Future SQIS Development

5.1 Application to Inspections and Repair Planning

The original objectives of the SSIIS III Project included the development and demonstration of a inspection planning and archiving tool, and the outline for a repair planning and archiving tool. These objectives were initially cast within the framework of the development of a Ship Structural Integrity Information System. Early on in this project, it was established that an effective inspection, maintenance, and repair (IMR) planning on a fleet basis could benefit from the utilization of information beyond that contained in SSIIS II type databases. A risk based approach to IMR planning requires full-scope consideration of the ship itself and its operations and management. The SSIIS III Project focused on the development of a system that is more full-scope in nature, the Ship Quality Information System (SQIS).

Through comparison of numerous vessel events and histories, the impact of vessel design, construction, historical maintenance, repair, and activity on current

IMR requirements can be established. Therefore, effective inspections and repair planning tools could benefit through a full-scope, life-cycle, industry-wide information system. Since there is no historical basis for such a system in the maritime industry, the SSIIS III Project focused on the establishment of the requirements for the development and implementation of such a system. This is a necessary precursor to the development of inspections and repair planning tools. Despite this change in focus, the SQIS Prototype is still capable of demonstrating the utility of an Industry-Wide SQIS in providing additional information which facilitates IMR planning. In the scenario presented during the discussion of automated investigations, it was shown that a SQIS would be capable of discovering that vessels visiting Valdez in the winter months routinely developed an unusually high number of cracks in the forward tanks, as discovered in spring inspections. The establishment of this link, between winter visits to Valdez, and high cracking incidents, would lead inspections planners to plan early spring inspections and repairs for all vessels visiting Valdez in the past winter season. While this is a hypothetical example, it does serve to demonstrate the basis under which the Industry-Wide SQIS is an effective additional information source for IMR planning.

5.2 Limitations of the Prototype

The Industry-Wide SQIS can be viewed as having two types of functions:

- the collection and archiving of data from a variety of sources,
- the analysis of that data.

In the fully implemented version of a SQIS, the information collection and archiving process would be almost completely automated. Regular vessel data would be transferred from vessel or company based information systems. The data transfers would be done electronically, using pre-established transfer protocols. The capability for authorized users to audit, verify, correct and update data would be incorporated in the SQIS as necessary. In addition, there would be the capability for limited manual information entry (such as the entry of a new company into the Company Database). In the SQIS Prototype, all information is entered manually directly into data tables or through a series of data entry forms. While many data fields are pre-defined, and the user picks data from lists, the process is still long and tedious. While it would be possible to set up the prototype to accept data files, without accompanying programs to produce those files.

The full-scope, life-cycle, and industry-wide nature of the SQIS requires that it contains a large and diverse collection of data fields. The management and analysis of such a database is not trivial, and the requirements of such a task are beyond the capabilities of the SQIS Prototype platform, Microsoft Access ™. At the same time, a purpose-built, workstation based application would have little difficulty meeting the necessary requirements to make the Industry-Wide SQIS a reality. Even the automated cross-reference analysis discussed previously would be a realistic and effective feature given the proper platform for the SQIS system. In the SQIS

Prototype, just the process of collating information for a single vessel for the Vessel Summary Report, had to be performed in several steps. Only through careful presentation, was it possible to give the appearance that the process was occurring in one step.

5.3 Database Development Requirements

Maritime industry members have undertaken to develop their own structural information systems, similar to those examined in the first two phases of the SSIIS Project. To supplement the work occurring in industry, it was decided to look at the development of risk based IMR management tools, for which a new type of information system was required. The SSIIS III Project did not focus on producing the inspections and repair planning tools envisioned at the beginning. Instead, the research focused on the development of the Industry-Wide SQIS, developing the framework for that system, and it's associated inspections and repair planning capabilities, to the limit of the capabilities of the chosen platform. Further development of the Industry-Wide SQIS must be done on a more powerful platform, in the form of a purpose-built application. In particular, the implementation of an expert system type automated analysis tool requires more sophisticated programming than is available in existing, Windows based databases.

Furthermore, the implementation of a full scale Industry-Wide SQIS requires the development of complementary vessel information systems. While there are a number of systems in use at present, they need to be modified to provide the type of summary data files required by the SQIS. In addition, their use is not universal, especially in vessel monitoring, which needs to change, if the Industry-Wide SQIS is to be effectively implemented.

5.4 SQIS Pilot Application

The next step in the development of the full - scale, Industry-Wide SQIS would be the development of a SQIS Pilot Application. The purpose of the application would be to verify the data requirements and the analysis capabilities of the SQIS. In order for the pilot application to be representative of the full - scale application, it would have to incorporate the significant attributes of the intended system. In particular, the Pilot SQIS should utilize automated data transfers as its primary data input mechanism, and should focus on the development of data analysis applications. These two areas represent the most technically challenging, and will likely require the most development effort. A major question raised in the description of the Industry-Wide SQIS is the level of information detail that would be required to facilitate analyses of the type desired. The pilot application could provide a useful indication of the information requirements. In order to be an effective indication of the full SQIS capabilities, the pilot system will require access to sensitive data, just as will the final system. Therefore issues concerning data access and security will have to be addressed during the pilot system development.

Selection of a system administrating agency for the Pilot SQIS could be difficult. The same issues apply as in the selection of the full - scale SQIS administrator, except the pilot program will likely run for a limited duration (say 2-3 years), so the question of what to do at the end of the pilot program must also be addressed. Of the program is evaluated to have been a success, and implementation of the full - scale Industry-Wide SQIS is undertaken, then the administrating agency would be able to continue on in that role, or pass the duties on to another body.

Most likely, the best scenario for the administration of the pilot and full - scale SQIS's would be for the pilot system to be administered by the U. S. Coast Guard. At the end of the pilot program, if it is decided to proceed with the development of the full- scale SQIS, then administration duties could be passed to an independent contractor. The most significant issue to be resolved with this scenario is that of maintaining data security and privilege during the pilot phase. This would be crucial to assuring owners and operators that data used in the pilot program would not be used in legal proceedings.

One approach to ensuring that the information used in the SQIS Pilot is not suitable for legal use would be to use outdated data in the test program. For example, the TAPS Trade tankers, as a group, have been heavily analyzed due to their structural performance. Data on those vessels could be used in the pilot system to demonstrate the SQIS analysis capabilities and requirements. A disadvantage of this approach is that it would not provide useful output from the pilot application. A Pilot SQIS which was capable of producing timely, relevant analysis results could prove to be a powerful argument for the implementation of the full - scale Industry-Wide SQIS.

6. Conclusions and Recommendations

The SSIIS III Project focused on defining a framework for the development and implementation of an Industry-Wide SQIS for tankers. The SQIS is a vital tool for the implementation of risk based inspection, maintenance and repair strategies by the maritime industry in that it provides additional input to the work of individual organizations. The Industry-Wide SQIS would be of use to all sectors of the industry; vessel owners and operators, classification societies, regulatory bodies, and research institutions. Successful implementation of an Industry-Wide SQIS requires the full cooperation of all these sectors. Hence, it was undertaken early on in the project to seek out input from representatives of all sectors of the maritime industry, and establish what essential requirements a maritime industry SQIS must fulfill to gain acceptance and support in the industry. These recommendations and requirements were incorporated into the description of the Industry-Wide SQIS architecture, and summarized in a list of fundamental requirements.

The Industry-Wide SQIS is a full-scope, life-cycle, industry-wide information system which receives, archives, and analyzes data. Being full-scope, the SQIS incorporates data covering all aspects of a vessel, including structures, equipment and vessel operations. The life-cycle nature of the SQIS requires that vessels in the SQIS be tracked throughout their life, from the design and construction phases, through its operational life, to decommissioning. The industry-wide characteristic of the SQIS provides data from a wide range of tanker vessels, operating under variety of conditions. The broad nature of the information relayed to the SQIS means that the system will receive data from a variety of sources. The SQIS and the data sources should therefore be developed in concert to ensure that the transfer of information is efficient and accurate. The development of the Industry-Wide SQIS would best be accomplished with the participation of all sectors of the maritime industry. Especially those which will be responsible for developing, maintaining, and operating the interacting information systems. Those that will be operating the vessels which will be providing information to the system. And those which will be responsible for analyzing the output from the SQIS and using that output to enhance the tanker vessel fleet quality.

When the Federal Aviation Administration (FAA) and Department of Transportation (DOT) decided that the aviation industry needed to change its focus on safety, and set a “zero accident challenge,” they gathered more than 1,000 members of the aviation community together for a working session to address aviation safety [7]. The key implication being that aviation safety is the responsibility of all members of the community. The recommendations arising from that workshop have had a dramatic effect on the aviation industry since that time.

The successful development of the Industry-Wide SQIS would require the full cooperation of the entire tanker industry. This type of commitment would be best generated through the development of a mission and vision statement for the SQIS. All those whose participation is paramount to the success of the system should recognize the utility and importance of SQIS. The most effective manner of developing the necessary inertia to push the Industry-Wide SQIS to the next phase of development may be through a workshop of the kind held by the FAA and DOT. A clear presentation of the benefits, requirements, and costs of the Industry-Wide SQIS to the industry members could produce the necessary support for the SQIS development. With the support of the industry, the development of the Pilot SQIS could proceed. At the end of the pilot project, a second workshop could be held during which the successes and shortcomings of the pilot would be discussed and resolved. From there, with the further support of the tanker industry, the implementation of the full - scale SQIS could proceed.

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APPENDICES

Appendix A: Historical Review

A.1 Structural Maintenance for New and Existing Ships Project (SMP)

During the period from 1990 through 1995, the Department of Naval Architecture and Offshore Engineering at the University of California at Berkeley conducted the Structural Maintenance for New and Existing Ships Project. A coordinated research effort covering a wide range of aspects concerning the problems associated with the structural maintenance of existing ships and design of new ship hull structures [1].

The technical objectives of the project were two-fold: To develop practical tools and procedures for analysis of proposed ship structure repairs. And to provide guidelines for the cost effective design and construction of lower-maintenance ship structures which also facilitate future inspection, maintenance, and repair (IMR) activities. In addition to the technical objectives, the project had organizational objectives in that it was meant to act as an open forum in which all sectors of the maritime industry could come together and work to develop new and innovative strategies in the maintenance and design of hull structures. The project focused primarily on the fatigue and corrosion effects on the performance of critical internal structural components of existing and new hulls.

SMP I

The first phase of the project, SMP I, consisted of six inter-related studies. The first, Fatigue Damage Evaluations, developed and verified engineering approaches to asses fatigue effects on the performance characteristics of critical structural details (CSD) in tanker hulls, including the effects of inspection, maintenance and repair (IMR) activities. A database on fatigue cracking in tankers was developed and simplified procedures for evaluation of the fatigue durability of CSD were derived. Including a long-term hot-spot stress range - number of cycles (S-N) approach and a fracture mechanics based approach.

The second study of SMP I, Corrosion Damage Evaluations, developed and verified engineering approaches to evaluate internal corrosion effects on the structural strength and leak integrity characteristics of critical components. This study produced a general tanker corrosion database which could interface with the fatigue database mentioned above. The statistical characteristics of the corrosion rates for various elements and locations in tankers were studied, and an approach to evaluate conditions in which plate renewals were warranted was developed.

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[1] Bea, R. G., *"The Ship Structural Maintenance Projects", Ship Maintenance Project - Volume 1 - Fatigue Damage Evaluations*, Ship Structure Committee Report SSC- 386, Washington, D.C., 1995.

The third study, Interaction of Details with Adjacent Structure, developed an analytical tool to enable engineers to make structural system evaluations to aid in repair and maintenance activities. It provided an accurate and efficient model of the load-displacement behavior of the detail in conjunction with the adjacent structural components, and the stress distribution characteristics at the element level for use in the fatigue, corrosion, and repair evaluations. The study was divided into a structural analysis component, and an evaluation of loading characteristics. The result of the study was the development of global and local loading transfer functions that could be utilized in the long-term sea-state, heading, speed, and cargo or ballast condition dependent characterization of mid-ship hull loadings. Given the local primary loadings acting on a the boundaries of a given CSD, detailed finite element models were developed to define the crack-opening hot-spot stresses at pre-defined locations on the CSD.

Study four, Fatigue and Corrosion Repair Assessments, used ship service data to develop guidelines for the evaluation of fatigue and corrosion repairs to CSD and to develop general guidelines for new builds to help maximize inspectability and minimize repairs. The study produced a program that could be used to rapidly determine the comparative fatigue performance characteristics of alternative repairs to CSD.

Study five, Durability Guidelines for New Ships, addressed new build ship life-cycle phases, structural and operational aspects, inspection and quality control, and design considerations, incorporated in Marine Structural Integrity Programs (MSIP). A practical approach for the development of life-cycle MSIP for new builds was defined, as was a system for the life-cycle management of the structural integrity of ships. A handbook providing practical information on the development and repair of durable CSD in ships, and software to guide repair engineers in the evaluation of alternative repairs were the products of this study.

The final study of the first phase of SMP, Development of Software and Applications Examples, provided the background, standards, and support for the programs written in the other studies.

SMP II

The second phase of the SMP research project consisted of four studies, addressing high priority areas identified during SMP I. Study 1, Fatigue Classifications, developed methods to assist naval architects in evaluations of CSD fatigue lives. The two topics covered were fatigue classifications and development of a system for the selection of S-N curves. A procedure using the stresses at the hot spots of proposed CSD was developed, based on detailed finite element analysis. This study showed that the wide variety of S-N curves could be represented through only two fundamental S-N curves, one for welds and one for plate edges. A management system to assist naval architects in the selection of S-N curves for given CSD was also produced.

The second study, Fatigue of Proposed CSD, conducted analytical studies of proposed CSD for new double hull tankers to evaluate their durability and robustness. The objective of the analyses was to determine if the proposed CSD possessed desirable degrees of durability, and to evaluate the properties of possible alternative configurations. The study examined a wide variety of CSD types, and utilized a number of analysis methods. In the process, the importance of the need for a consistent procedure was highlighted.

Study 3, Rational Corrosion Limits, developed a rational basis for the definition of corrosion limits and permissible wastage in tankers. The statistical properties of corrosion rates for various structural details, tank types, and locations were studied. The distribution of corrosion through the ship primary structure as a function of time, service, and protective measures was determined. Studies were performed to define how different rates and locations of corrosion affect the local leak integrity and global capacity of the hull structure. Procedures for the evaluation of the effects of corrosion on the strength characteristics of components, and evaluation of the limit state characteristics of the hull structure were developed.

The final study of SMP II, Repair Management System (RMS), furthered the development of the computer based RMS introduced in SMP I[2]. The objective of this study was to assist tanker maintenance engineers in defining more efficient and effective steel repairs. It produced a procedure to estimate the long term cyclic stress range characteristics for a particular ship and developed stress modification factors for CSD modifications. The project produced a windows based, user friendly, system which, given information on CSD geometry and crack initiation, would rank repair alternatives according to expected life (assuming the same loading conditions would prevail).

SMP III

The third phase of the SMP project focused on four high priority problems identified during the course of SMP II. The first study, Fitness for Purpose of Cracked CSD, developed S-N curves for welds, accounting for the presence of through-thickness cracks, based on linear fracture mechanics results. The issue of load shedding due to the boundaries of the CSD or intersection of cracks with other structural members was also addressed. Finally, the results from the first two portions were incorporated in a the development of a probability based inspection and repair methodology.

The second study, Ship Structural Integrity Information System (SSIIS) Phase I, will be discussed in a following section.

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[2] MA, Kai-tung, and Bea, R. G., *RMS - Repair Management System - Further Development*, Structural Maintenance for New and Existing Ships, Report SMP 4-2, 1993.

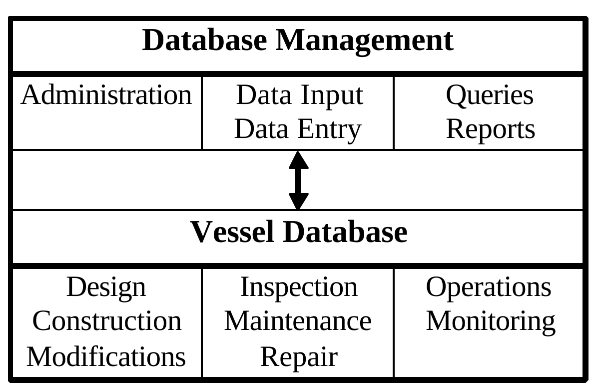
The third study, Maintenance of Marine Structures, developed an overview of the current state of the art in maintaining ship structures[3]. The project investigated a variety of topics including; design for durability, maintenance, and repair; probability based design; steel structure assembly and welding; structural fastenings; vibration control; fatigue; structure fractures; corrosion protection and rates; corrosion surveys; inspections; non-destructive testing; in-service monitoring and instrumentation systems; and database systems.

The final study, Inspection of Marine Structures, developed a better understanding of the probability of detection of fatigue cracks in tanker CSD, an important factor in the timing, effectiveness, and utility of probability based inspection and repair methods. The factors affecting probability of detection were researched, and four methods for evaluating inspection performance were developed.

A.2 SSIIS Phases I and II

Structural Integrity Information System

A Ship Structural Integrity Information System (SSIIS) is one component of a Ship Quality Information System. To realize maximum benefit of the system to all sectors of the maritime industry, it must encompass the objectives of all sectors that have responsibilities for a ship. The SSIIS database is comprised of two primary components, the Database Management System (DBMS), and the Vessel Database (Figure 1). The DBMS manipulates the information in the Vessel Database. The eight module Vessel Database is divided into three areas; vessel configuration, vessel maintenance, and vessel operation (Figure A-2). This structure allows for step-by-step development and implementation.



[3] Bea, R. G. And Hutchinson, S. C., *Maintenance of Marine Structures; A State of the Art Summary*, Ship Structure Committee Report SSC-372, Washington, D. C., 1993.

Figure A-1: SSIIS Components

Vessel Database		
Design	**Inspections**	**Operations**
Plans	Type	Cargos
Class	Company	Routes
Vessel	Cracks	Weather
Hull Form	Corrosion	Ballasting
Tanks	Buckling	Personnel
	Denting	Accidents
Construction	**Maintenance**	**Monitoring**
Specifications	Cleaning	Weather
Materials	Coatings	Seas
Structure	Anodes	Motions
Details	Structure	Structure
QA/QC		
Drawings		
Repairs	**Modifications**	
Cracks	Hull	
Buckling	Tanks / Holds	
Denting	Details	
Steel Renewals		

Figure A-2: Vessel Database

SSIIS I

The objectives of the first SSIIS project were to develop and document the standards for the development of a computerized SSIIS, and the demonstration of the application of these standards with a prototype PC based database system[4]. The project tasks included a review and evaluation of existing crack and corrosion databases in use in the maritime industry. The evaluation of the data needs of various vessel analysis software. The review and evaluation of existing Critical Area Inspection Plans (CAIP's). The development of the data structure necessary for the storage, evaluation, and analysis of survey results. The development of a prototype inspection module which is capable of producing a CAIP in a new, defined format.

The project demonstrated the utility of an integrated information system in the management of all aspects of running a commercial tanker, and provided an outline

[4] Schulte-Strathaus, R., Bea, R. G., *Ship Structural Integrity Information System*, Ship Structure Committee Report No. 372, Washington, D. C., 1993

for the future work necessary to refine the definition of the data structure required to enable a SSIIS.

SSIIS II

The second phase of the SSIIS project had as its objectives the continuation of the development and documentation of standards for the development of a SSIIS through a review of existing database components and protocols, and the demonstration of the application of these standards through a PC prototype SSIIS[5]. This project worked to develop and demonstrate the tools necessary to build a full scope SSIIS. The project reviewed and applied the concepts of process innovation and business process engineering. It defined the processes involved in the management of a ship structure within the framework of an Information System, and developed a SSIIS database prototype in Microsoft Access™ to demonstrate the application of information technology in the management of ship structures. The database structure developed in the project is outlined in Figure A-3.

General	**Vessel Operations**	**Report Selection**
Vessels Companies People Rules	Structural IMR (Mechanical IMR) (Cargo Mgmt.) (On-Board Mgmt.)	Vessel Details IMR Reports CAIP Reports
Vessel	**Inspection Database**	
General Arrangement Insp. Schd. Tanks Frames Bulkheads Details	General CAIP Details Tank Coatings Cracks / Corrosion	

Figure A-3: SSIIS II database structure

[5] Dry, M., Bea, R. G., Ship Structural Integrity Information System, Phase II, Ship Structure Committee Report SSC-380, Washington, D. C., 1996

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Appendix C: Industry Survey Notes

This Appendix contains the rough notes from the series of interviews held with members of the maritime industry. The notes are taken from tapes of the interviews, but reflect the researchers' reactions to the discussion as much as the actual content of the discussion itself. The interview sources have been grouped by type. The three types of sources are:

- USCG / Class
- Owners / Operators
- Others

C.1 USCG / Class

- On the need to record cracks
    - some owners may want to record cracks (with pictures)
    - other owners just want the repairs done
    - recording crack is necessary for the analysis
    - is in the interest of the USCG / Class to record cracks
- Owners may not be ready for risk assessment of hulls
- Goal in structural evaluation: to get away from prescriptive approach to survey, switch to risk assessment approach
    - target areas of greatest interest
- Problem: Owners don't want to be told to increase inspection effort in one area due to risk assessment approach while still being required to follow old prescriptive approach. Don't want to increase the amount of survey that they must do.
- Use SQIS as a tool to examine ways in which survey requirements can be reduced in area where not necessary while still being safe.
- But need to keep old regulations while system is implemented.
- Agency Issue:
    - Can only be government or class run
    - The anonymous reporting module is not critical to the system
    - Extraordinary incident reporting removed
    - The need for this reporting would be fulfilled by technology through the installation of trip recording "black boxes" with radar recorders
        - these would allow evaluation of near miss situations
    - Is all information on system to be anonymous?
- Human Factors Issues
    - to include effect of human actions on the vessel would be a huge undertaking
    - the best opportunity will arise once black boxes are installed on ships
    - then trip reporting could be automated just to give the highlights of the trip to the system

- Actively encouraging the concept of trip recorders for some years, but has been disappointed with the take up.

- The focus on tankers may limit the apparent usefulness of the system. Given that tankers are already the safest ships out there, the return on investment of this system to improving safety will be less then it would be if applied to say the bulker fleet.
- Glasgow project: Using SafeHull to study the sensitivity of the typical tanker hull to corrosion from a failure point of view.
    - How does corrosion pattern affect the importance of different failure modes?
    - If the system is going to make judgments on the basis of a particular trend in corrosion, is the judgment to be based on conventional rule renewal criteria or on fitness for purpose
- Where do we go from here?
- Big question:
    - the information flow from the operations into the decision making process (trend analysis?)
    - some of the information is obvious;
        - the details of a loading configuration that gives a ship problems
        - the physical characteristics of the ship
        - the route
        - environmental conditions
    - what other information do we need to collect to make the judgment about trends
    - hopeful that this question will be answered with time
- Have been asked to hold info from individual owners that would be useful for the owners to have analyzed, but who's analysis will not directly help USCG / Class.
- Casualty database from the Institute of London Underwriters - used to determine the frequency of certain types of problems on ships
    - USCG / Class may want to do that type of analysis in a different way
- Define relationships between info fields in the casualty and the operations database with the structure database
- Primacy of bringing the operations module up to the same state of development as the structures module
- The operational aspect will often hold the key bit of info for solving a problem
- Example of application of system;
    - bulker failure - caused initially by side structure corrosion in most cases, all other aspects were secondary or tertiary
    - a SQIS would have identified that all bulkers sinking had no corrosion protection in holds
    - would have demonstrated that perhaps coating in bulker holds is important
- Difficult for USCG / Class

- need the experience of an owner in order to ask the right questions, to know what info needs to be held in the operations database to be linked to the others
- The MISLE system, similar to Marine Safety Information System (MSIS)
  - Analysis tools which will be focused to assist CG work
  - Holding a workshop with inspectors soon to establish their requirements
- Marine Safety Management System (MSMS)
  - Database of inspection reports for all vessels inspected by USCG inspectors
  - Could be a / the source of structural data either for the prototype or actual system.
- Port State Information eXchange System (PSIX)
  - Contains commercial vessel information taken from MSIS. Gives a "snapshot" of MSIS as a particular date
  - Search for particular vessels, and get detailed vessel information
  - The data format does not really lend itself to automated entry into our system (As with MSMS)
- Concept of the prototype / development system
  - Need to prove system viability / attributes / benefit to owners
  - Need to verify the fields needed to make it work
  - Want to do this on a large enough scale to establish viability, but small enough so that it can be done within an existing database architecture (Access) without too much special programming
  - Consider the aspect of how the switch to the real system will work, set up the prototype as best as possible to facilitate the transfer
- Develop a trend analysis system that can be used to assist USCG / Class in the generation of more efficient regulation
  - For instance, could identify freak occurrences as such, and prevent unnecessary legislation for incidences which do not warrant regulation
- Through identification of how conditions encountered / routes traveled affect vessel structural performance, they can start to specialize IMR requirements by vessel type / route / cargo.
- They definitely see the need to keep the incident reporting section as part of this system, even though it may not be implemented at first
- Require modular growth ability, add new modules as they become important
- Clarify the relation between us, CG work, and ABS work on SQIS's
- Also, clarify who will have responsibility for the information analyzing work (eliminate unnecessary duplication of work).

C.2 Owners / Operators

- Definition of operations fields
  - trading pattern
  - cargo
  - loading stress

    - draft / trim
    - heating
- Program
    - cargo management system
    - checks assignments of cargo to tank
    - performs 12,000 checks on each loading
        - compatibility of cargo with tank and last 3 cargoes
        - handling requirements
        - over / under booking
        - print manifest
- MMS (Marine Management Systems) (Fleet Works) program
    - machinery maintenance
    - inventory
    - adapted to show fleet performance
- Personnel system
    - payroll
    - crewing
    - performance evaluations
- Interested in fleet maintenance aspects
    - Example of the effect of extending main engine maintenance interval from 8,000 to 9,000 hours, on the breakdown rate
- Believes in fleet-wide trend analysis, not industry-wide
- General operational patterns would not help in some cases, because the ships go on a variety of routes
    - what about effect of storms etc.
- Applicability of an industry-wide database would be due to general uniqueness of vessels, you don't get a lot of ships of the same class
- Is this system redundant with the USCG / ABS systems
- Does the uniqueness of ships ruin the analogy to the FAA system
- Information quality issue. The inspection information for ships is not as good as for airplanes
- The strong regulation in the airline industry produces more regulated inspections. This gives more consistent data, which make the implementation in a database much easier and more productive.
- Effect on Owners
    - Feel that the system would cause them significant administrative costs
    - What benefits do they see for those extra costs
- Also worried about exposure of data once it's in the upper system
    - access to data by competitors
- Is it achievable to come up with meaningful, overall statements about a problem that is really very detail oriented
- Can you link why a particular detail in a particular ship design cracks on a particular route with a particular operating companies philosophy in place.

- is there a way to handle that in a big picture way without getting into those kinds of details
- what if a ship went through a bad storm, how do you capture that and still make meaningful overall global statements about structure condition
- can it be done in a timely manner and ahead of the natural intuition that will get you to the same point

- Additional work load would be acceptable if there was a demonstrable benefit
- Like the concept of a dedicated administration organization to handle the more "intelligent" routines
    - who would run / fund the upper system
    - funding? Taxes vs. industry
    - economic drivers
- They are at the upper end of the scale of owner performance. This system would level the playing field, bringing others up to their level.
- Therefore, need the incentive of less regulatory impact on the industry as pay back for being involved
    - although, at this stage, it "smells" like it's going to raise the regulation
- CATSIR project, had a ton of data in a crack database, but had yet to see the benefit
- The analysis is not telling them much that they don't already know. You find a crack, you fix it. Depending on the nature of the crack, you decide if you need a technical solution, or if it can be handled through inspection and repair
- The risk assessments and cost analyses, so far, have not been that complicated, you can focus in on what you need to do
- The focus has been in structures so far. Does not believe that the problems in corrosion and equipment approach structure in magnitude
    - Deal with corrosion problem instances on an isolated basis
    - Deal with equipment problems through the original manufacturer
- The scale of things (numbers of units) presents the biggest problem to making the database work
    - assessments may start on the global level, but need to get down to the detail level to make it unique.
- The "blind system" feature, feel that it's a necessity. The information is fed in, but knowledge as to who the owner / operator is, is not generally known. It is the role of. USCG or ABS to ensure that.

C.3 Others

- There needs to be a way to compare structure dependent information between different ships. To do this, must be able to compare information from corresponding locations on different ships.
- How to do this for ships with different structures and different structure naming systems.

- Convert detailed structure information into a template form. The template carries the detailed information, but provides a simplified reference system for use in analysis.
- Other systems use the template system, need to standardize templates
- How detailed does the structure information have to be for the system to be effective.
    - Example: Corrosion rates are measured on an panel by panel averaged basis. Is this type of level good enough?
- There is already a transfer of structural IMR information from owners to Coast Guard and classification societies.
- Current information flow
    - What is it?
    - good?
    - bad?
- Do we want to add to / modify / utilize the current reporting system?
- Use the classification society as an information filter for structure and equipment information
- Operational information reported directly?
- The most efficient implementation of the system may come through utilizing information transfer systems already in place. Why recreate what is already in place? Also, reduces the burden of the new system on operators.

Factors in considering what analysis functions should be included in the system are:

- What level of analysis should the system be expected to perform
- What analysis functions are required
- What analysis functions are desired
- What analysis functions are possible
- What information is required to drive the analyses
- The system will do basic analysis
    - Ask a set of questions based on the type of incident
    - Three basic types of incidents
        - Fracture
        - Corrosion
        - Loss of vessel
    - For each of these incidents, there are a number of basic questions to be asked.
        - Fracture
            - material
            - member type
            - member location
            - corroded
        - Corrosion
            - material

        - member location
        - coating
        - corrosion rate
        - corrosion source
    - Loss of Vessel
        - location of critical failure
        - condition of failed member
        - loading on member /vessel
- Role of people in sorting trends
    - The system will be used as a tool to aid in investigations. Trend analysis will still require intuition
- Scenarios: When will an analysis be done?
    - Routine
    - Special event (catastrophic failure)
- Design the system to assist in these types of investigations
- Information flow that we need may not match up with that required by class or CG
    - May need information sources outside of inspection database and MMS
- We should look away from structure module as the primary development element
- The USCG may be too focused on tankers
- The trade route factor may be organizational, i.e. different companies treat conditions differently (like the example of why some TAPS trade ships had problems while others didn't, they were been driven too hard).

Appendix D: SQIS Table Descriptions

Field Name	Data Type	Description
Cargo Type ID	AutoNumber	Numerical Identifier
Cargo Type Name	Text	Full Name
Specific Gravity×1000	Number	Characteristic Field (@ 60 °F)
Viscosity (centistokes)	Number	Characteristic Field (@ 70 °F)
Pour Point (F)	Number	Characteristic Field
Wax (%wt)	Number	Characteristic Field
H_2S (ppm)	Number	Characteristic Field (as loaded)
Heating	Yes / No	Transportation Consideration

Table D-1: Cargo / Ballast Type

Field Name	Data Type	Description
Company ID	AutoNumber	Numerical Identifier
Full Name	Text	Full Name
Short Name	Text	Abbreviated Name
Street	Text	Address Field
City	Text	Address Field
State	Text	Address Field
Zip	Text	Address Field
Country	Text	Address Field
Company Type	Text	Select from list
Memo	Memo	Notes

Table D-2: Company Directory

Field Name	Data Type	Description
Corr ID	AutoNumber	Numerical Identifier
Vessel ID	Number	Numerical Identifier
Tank Location	Number	Longitudinal Location
Tank Side	Text	Port, Starboard, Center
Vertical Location	Number	Member location in tank
Long Location	Number	Member location in tank
Trans Location	Number	Member location in tank
Member Type	Text	Affected member type, *Member Type*
Metal Type	Text	Type of metal of affected piece
Pitting Area	Number	Percent of surface area affected
Pitting Depth	Number	Average percent wastage in affected area
General Area	Number	Percent of surface area affected
General Depth	Number	Average percent wastage in affected area
Coating Type	Text	None, Hard, Soft
Coating Condition	Text	Good, Fair, Poor
Anode Condition	Text	None, Good, Fair, Poor
Detection Type	Text	Type of inspection when failure was detected, *Inspection Type*
Detection Time	Date	Date when corrosion was detected
Repair Type	Text	*Repair Type*

Table D-3: Corrosion Database

Field Name	Data Type	Description
Crack ID	AutoNumber	Numerical Identifier
Vessel ID	Number	Numerical Identifier
Tank Location	Number	Longitudinal Location
Tank Side	Text	Port, Starboard, Center
Vertical Location	Number	Member location in tank
Long Location	Number	Member location in tank
Trans Location	Number	Member location in tank
Member Type	Text	Affected member type, *Member Type*
Detail Type	Text	Affected detail type, *Detail Type*
Metal Type	Text	Type of metal of affected piece
Class 1 Severity	Number	Percent of Detail Type with Class 1 cracks
Class 2 Severity	Number	Percent of Detail Type with Class 2 cracks
Class 3 Severity	Number	Percent of Detail Type with Class 3 cracks
Detection Type	Text	Type of inspection when failure was detected, *Inspection Type*
Detection Time	Date	Date when crack was detected
Repair Type	Number	*Repair Type*

Table D-4: Defect Database

Field Name	Data Type	Description
Detail Type ID	Text	Text Identifier
Description	Text	General Description

Table D-5: Detail Type

Field Name	Data Type	Description
Inspection Type ID	Text	Text Identifier
Inspection Description	Text	General Description

Table D-6: Inspection Type

Field Name	Data Type	Description
Inspection Type ID	Text	Text Identifier
Inspection Description	Text	General Description

Table D-7: Member Type

Field Name	Data Type	Description
Repair Type ID	Text	Text Identifier
General Description	Text	Repair Name

Table D-8: Repair Type

Field Name	Data Type	Description
Vessel ID	AutoNumber	Numerical Identifier
Vessel Name	Text	Current Name
Owner ID	Number	*Company Directory*
Operator ID	Number	*Company Directory*
Class Built	Number	Original Class *Company Directory*
Shipyard ID	Number	Original Builder *Company Directory*
Delivery Date	Number	Year
Hull Number	Number	Original Hull Number
DWT	Number	Vessel Tonnage
LOA	Number	Vessel Dimension
LBP	Number	Vessel Dimension
Depth	Number	Vessel Dimension
Draft	Number	Vessel Dimension
IGS	Yes / No	Vessel Systems
COW	Yes / No	Vessel Systems
Deck Material	Text	Mild Steel, High Tensile Steel
Bottom Material	Text	Mild Steel, High Tensile Steel
Side Material	Text	Mild Steel, High Tensile Steel
Long Bhd Material	Text	Mild Steel, High Tensile Steel
Trv Bhd Material	Text	Mild Steel, High Tensile Steel
Web Frame Spacing	Number	Vessel Dimension
Cross Ties WF	Number	Vessel Dimension
Long Ties in CT	Number	Vessel Dimension
Long Girders in WT	Number	Vessel Dimension
Double Bottom	Yes / No	Vessel Characteristic
Double Side	Yes / No	Vessel Characteristic

Table D-9: Vessel Directory

Field Name	**Data Type**	**Description**
Voyage ID	AutoNumber	Numerical Identifier
Vessel ID	Number	Numerical Identifier
Operator ID	Number	*Company Directory*
Port of Origin	Number	*Company Directory*
Port of Destination	Number	*Company Directory*
Date Depart	Date	DD / MM / YY
Date Arrive	Date	DD / MM / YY
Cargo Volume	Number	Percent Full
Cargo Type	Text	*Cargo / Ballast Type*
Ballast Volume	Number	Percent Full
Ballast Type	Text	*Cargo / Ballast Type*
Storm Weather	Number	Percent of time
Rough Weather	Number	Percent of time
Calm Weather	Number	Percent of time

Table D-10: Voyage Database

Appendix E: SQIS Structural Detail Library

Group No.	Description of Structural Detail Group
1	Connection of longitudinals to transverse webs.
2	Connection of longitudinals to plane transverse bulkheads.
3	Connection of longitudinals to corrugated transverse bulkheads.
4	Connection of longitudinals to floors in double bottom.
5	Fore peak structure.
6	Longitudinal girder end brackets.
7	Transverse web frame end brackets.
8	Primary web face plate end connection.
9	Cross-ties and their connections.
10	Transverse bulkhead horizontal stringer.
11	Transverse bulkhead stiffener / primary web intersection.
12	Lightening holes and openings in primary webs and wash bhds.
13	Bilge keels.
14	Miscellaneous.

Group 1:	Connection of longitudinals to transverse webs.
Detail No.	**Title**
1	Web and flat bar fractures at cut-outs for longitudinal stiffener.
2	Side shell fractures at cut-outs for longitudinal stiffener connections.
3	Side shell fractures at cut-outs for longitudinal stiffener connections due to single lug on underside.
4	Web and flat bar fractures with face plate attached to underside of web, flat bar lap welded.
5	Web and flat bar fractures with face plate attached to underside of web, flat bar butt welded.
6	Fractured side shell longitudinal at tripping bracket connection, no backing bracket.
7	Fractured side shell at tripping bracket, backing bracket too small.
8	Bottom weld and flat bar fractures at the cut-out for the longitudinal connections.

Table E-1: List of Structural Grouping.

Group 2:	Connection of longitudinals to plane transverse bulkheads.
Detail No.	**Title**
9	Fractured side shell longitudinal, bulkhead horizontally stiffened.
10	Fractured bulkhead end bracket at side shell, bulkhead horizontally stiffened.
11	Fractured side shell longitudinal at forward transverse bulkhead.
12	Fractured side shell longitudinal at forward transverse bulkhead.

Group 3:	Connection of longitudinals to corrugated transverse bulkheads.
Detail No.	**Title**
13	Bulkhead fractured at toe of horizontal flat bar stiffener, vertically corrugated bulkhead.
14	Bulkhead fractured at passage of side longitudinal, bulkhead horizontally corrugated.

Group 4:	Connection of longitudinals to floors in double bottom.
Detail No.	**Title**
15	Fractured stiffener connection to bottom and inner bottom.

Group 5:	Fore peak structure
Detail No.	**Title**
16	Fractured vertical web at the longitudinal stiffener ending in way of the parabolic bow structure.
17	Fractured stringer end connection in way of parabolic bow structure.
18	Fracture at end of longitudinal in bow structure.
19	Fracture at toe of web frame bracket connection to stringer platform bracket.
20	Fracture and buckle of bow transverse web frame in way of longitudinal cut-outs.

Table E-1: List of Structural Grouping (continued)

Group 6: Longitudinal girder end brackets	
Detail No.	**Title**
21	Fractured bottom centerline girder at the end bracket connection to O.T. bulkhead.
22	Fractured and buckled buttress in way of bracket connection to O.T. bulkhead.
23	Fractured vertical web bracket connection to bottom centerline girder.
24	Buckled and fractured vertical web and bottom centerline girder bracket connection.
25	Fractured bottom girder brackets in way of pipe opening.
26	Fractured and buckled bottom side girder in way of end connections to O.T. bulkhead.
27	Fractured intercostal bottom girder fitted without bracket in way of wash bulkhead.

Group 7: Transverse web frame end brackets	
Detail No.	**Title**
28	Fractured wing tank deck transverse bracket, continuous face plate.
29	Fractured wing tank deck transverse bracket, face plate sniped.
30	Fractured centre tank bottom transverse end bracket, asymmetrical face plate.
31	Fractured centre tank bottom transverse end bracket, symmetrical face plate.
32	Fractured wing tank bottom transverse end bracket, asymmetrical face plate.

Group 8: Primary web face plate end connections	
Detail No.	**Title**
33	Fractured centre tank deck transverse.
34	Fractured centre tank bottom transverse.
35	Fractured centre girder at intersection with the bottom transverse.

Group 9: Cross-ties and their end connections	
Detail No.	**Title**
36	Fractured and buckled web plate and fractured face plate.

Table E-1: List of Structural Grouping (continued)

Group 10:	Transverse bulkhead horizontal stringer
Detail No.	**Title**
37	Fractured face plate and web at the radiused end brackets, vertically corrugated bulkheads.
38	Fractured web of stringer at the radiused bracket in way of centerline vertical web.
39	Fractured centre tank stringer bracket connection to the longitudinal bulkhead.
40	Fractured wing tank stringer bracket and side shell longitudinal in way.
41	Fractured web of buttress at connection to shell.

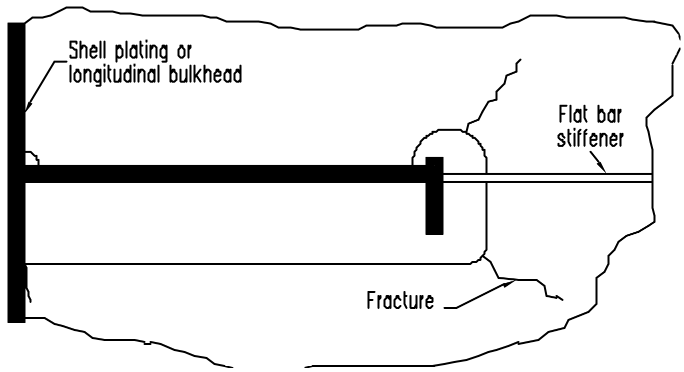
Group 11:	Transverse bulkhead stiffener / primary web intersection
Detail No.	**Title**
42	Fractured web at cut-outs for vertical stiffener.
43	Fractured flat bar connection to vertical stiffener.

Group 12:	Lightening holes and openings in primary webs and wash bulkheads
Detail No.	**Title**
44	Buckled and fractured centre line vertical web and stringer in way of intersection.
45	Fractures in way of lightening hole in stringer platform.
46	Fractured web of bottom transverse in way of lightening holes.
47	Fractures of longitudinal flume / swash bulkhead plating at openings.
48	Fracture at corner of flume opening in longitudinal bulkhead.

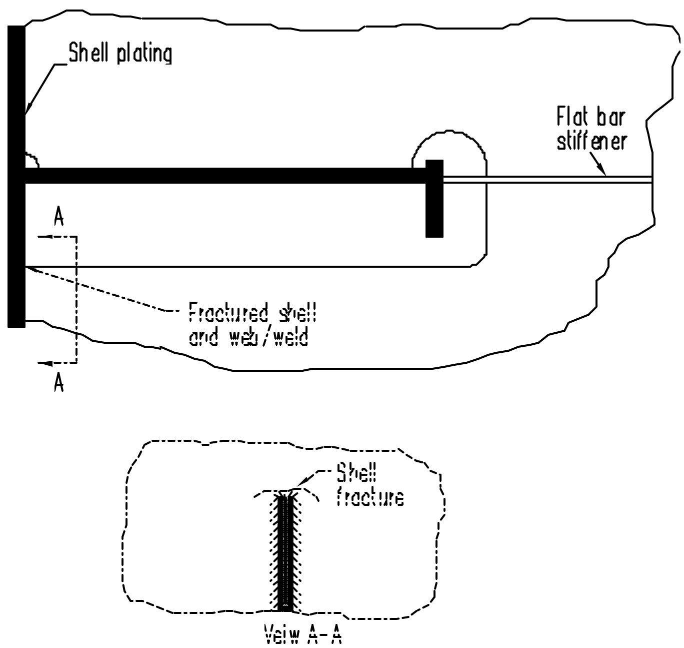
Group 13:	Bilge keels
Detail No.	**Title**
49	Fractures in continuous bilge keel and ground bar.
50	Fracture in continuous bilge keel and flat bar.
51	Fracture in continuous scalloped flat bar for intermittent bilge keel.

Group 14:	Miscellaneous
Detail No.	**Title**
52	Shell fracture at sniped ends of bilge longitudinals
53	Fractured butt welds in shell and bottom longitudinals.

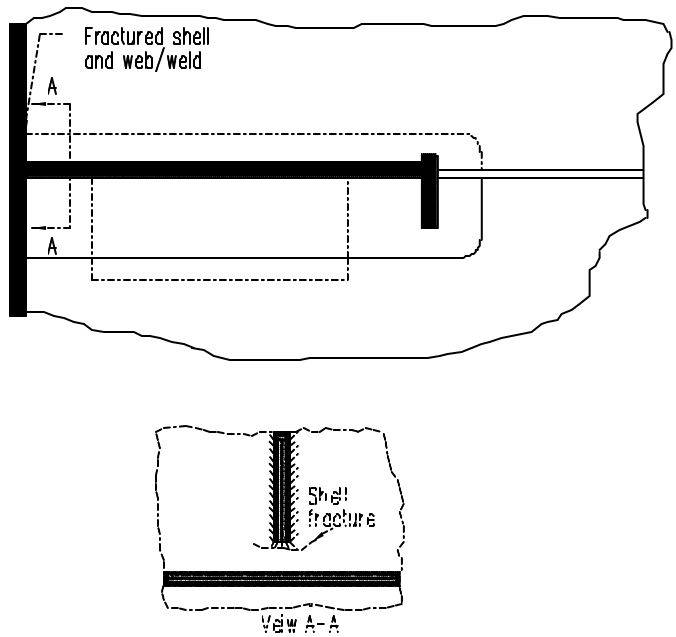
Table E-1: List of Structural Grouping (continued)



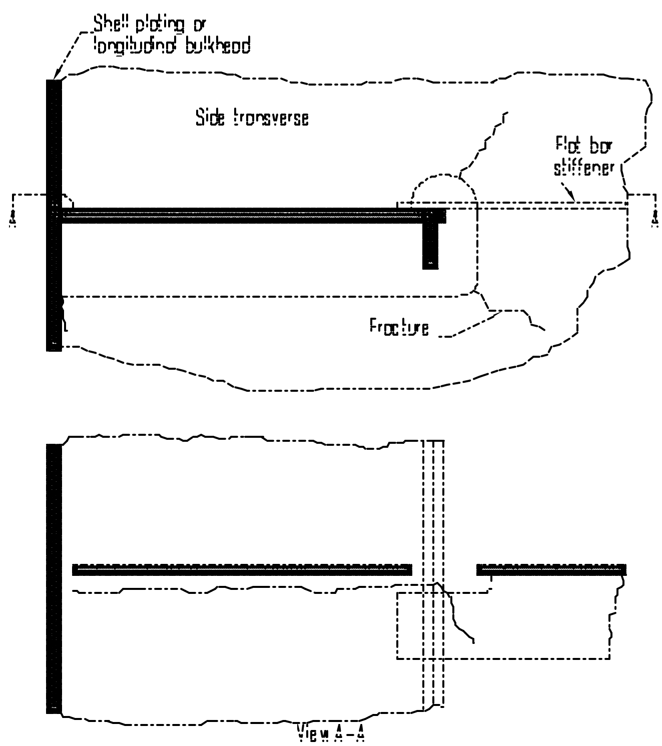
Detail 1: Web and flat bar fractures at cut-outs for longitudinal stiffener connections.



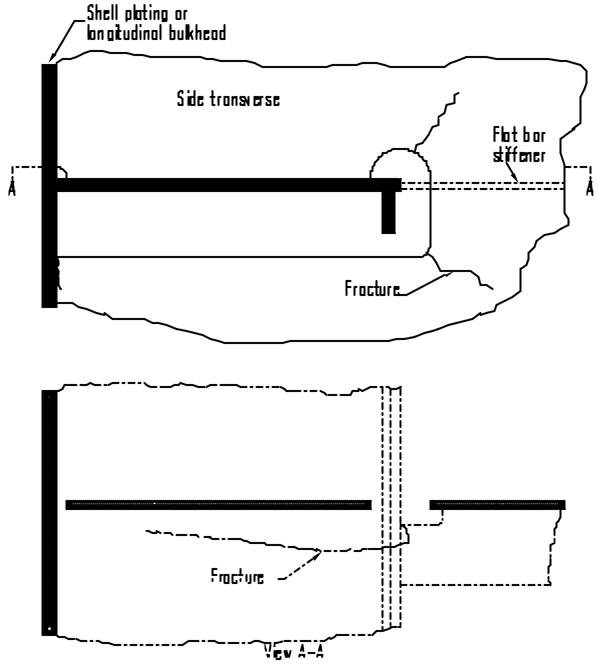
Detail 2: Side shell fractures at cut-outs for longitudinal stiffener connections.



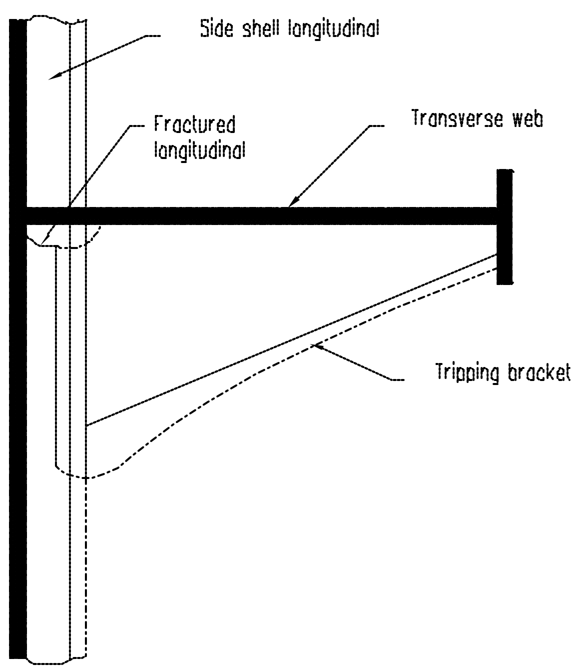
Detail 3: Side shell fractures at cut-outs for longitudinal stiffener connections due to single lug on underside.



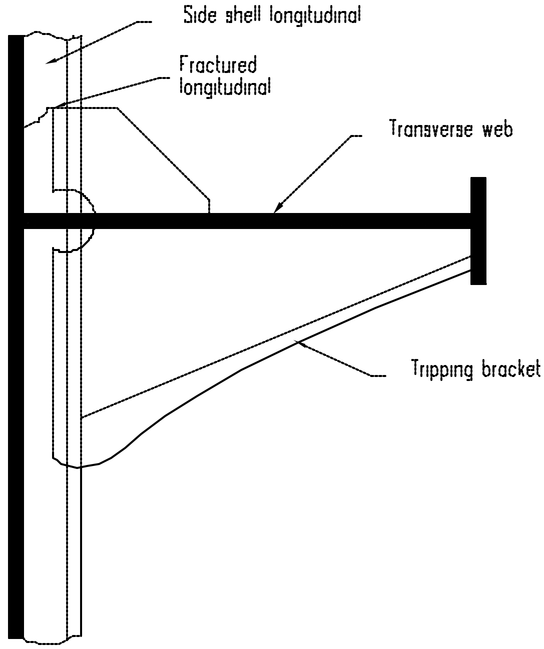
Detail 4: Web and flat bar fractures with face plate attached to underside of web, flat bar lap welded.



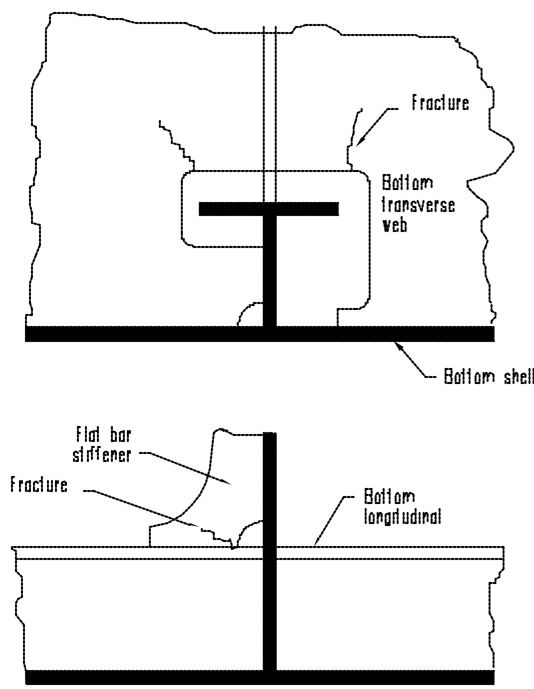
Detail 5: Web and flat bar fractures with face plate attached to underside of web, flat bar butt welded.



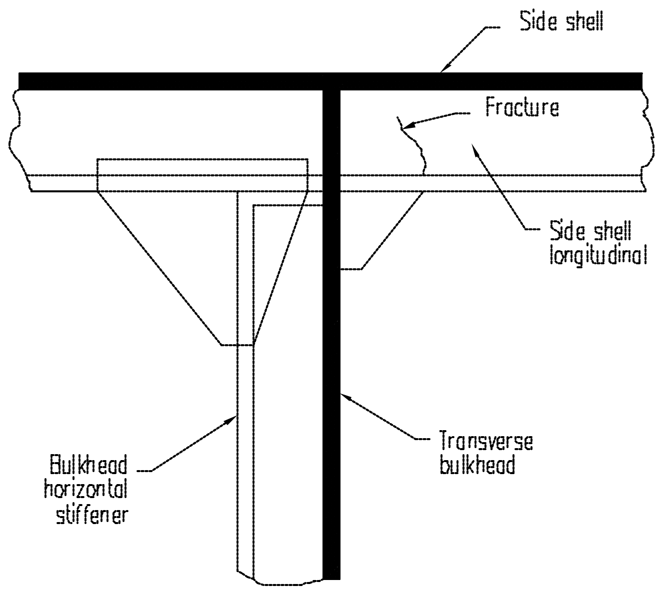
Detail 6: Fractured side shell longitudinal at tripping bracket connection, no backing bracket.



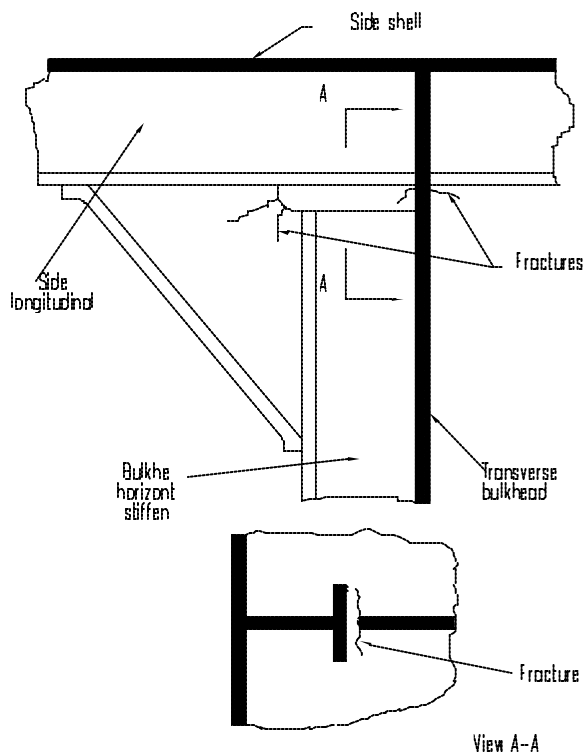
Detail 7: Fractured side shell at tripping bracket, backing bracket too small.



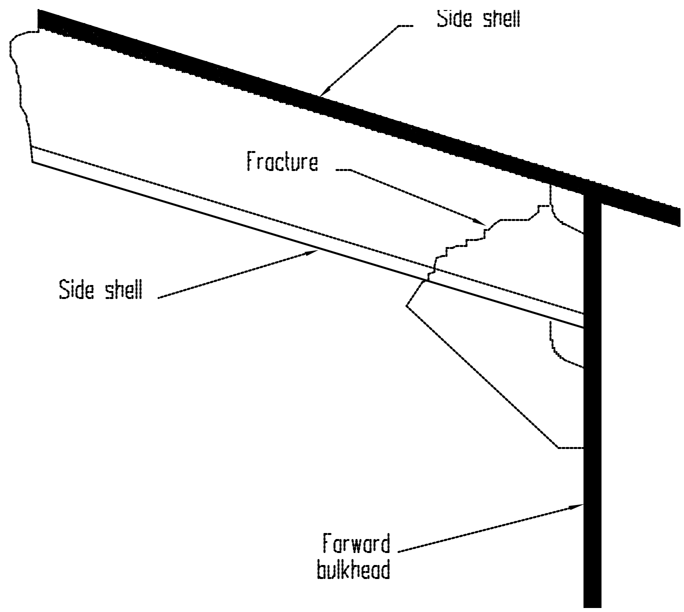
Detail 8: Bottom weld and flat bar fractures at the cut-out for the longitudinal connections.



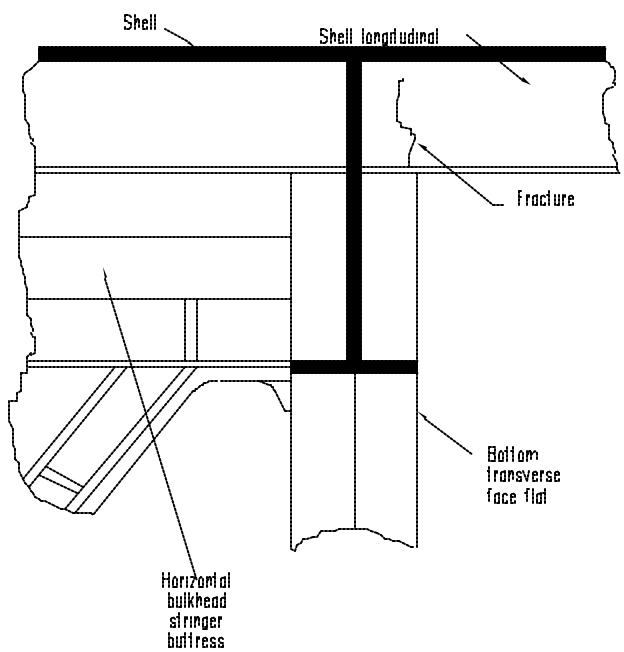
Detail 9: Fractured side shell longitudinal, bulkhead horizontally stiffened.



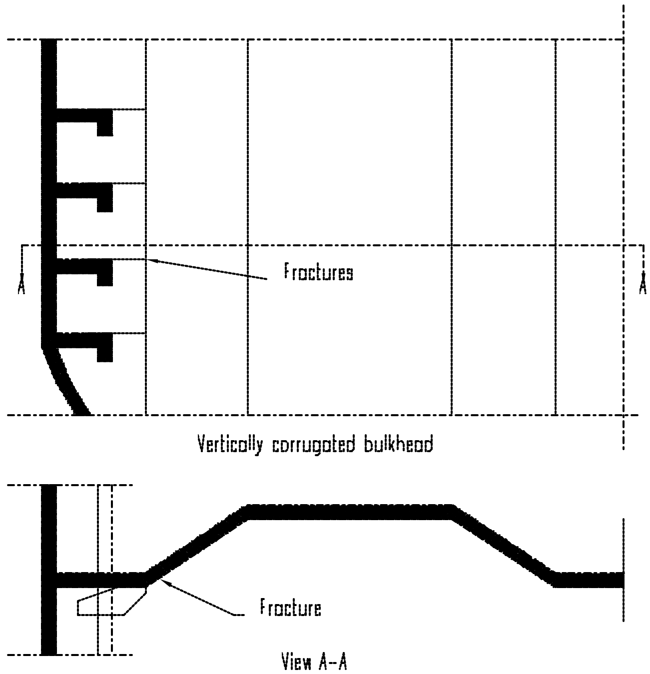
Detail 10: Fractured bulkhead end bracket at side shell, bulkhead horizontally stiffened.



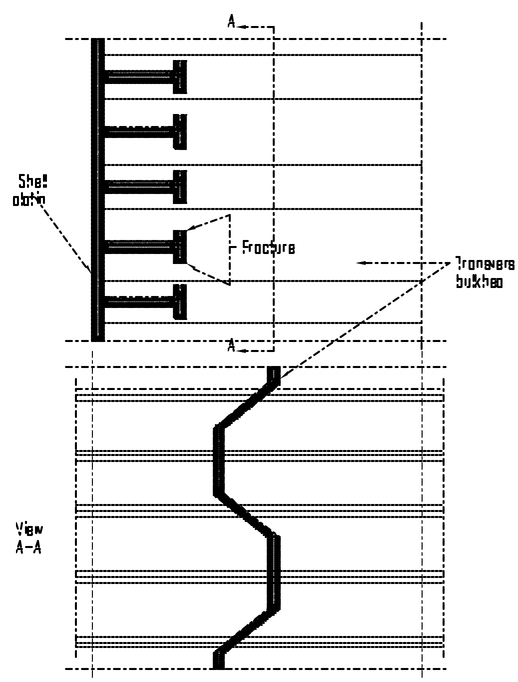
Detail 11: Fractured side shell longitudinal at forward transverse bulkhead.



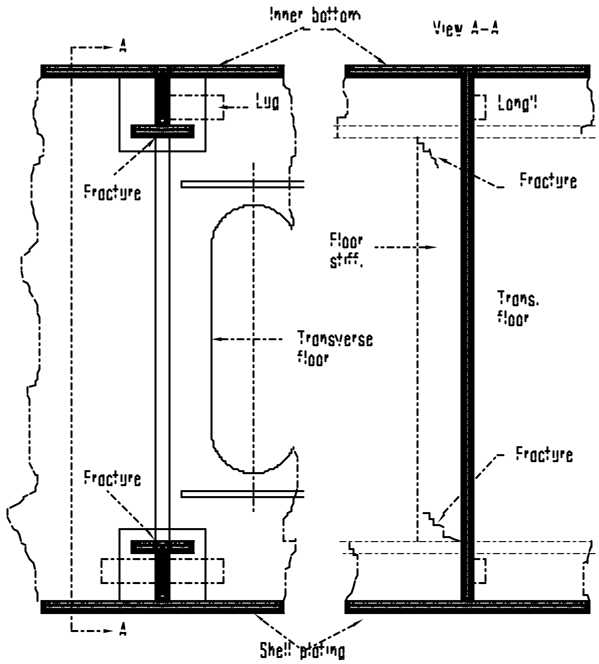
Detail 12: Fractured side shell longitudinal at transverse bulkhead buttress.



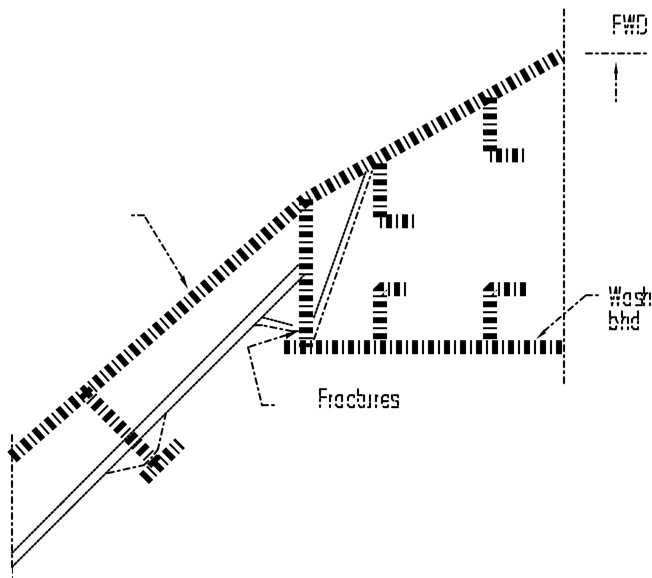
Detail 13: Bulkhead fracture at toe of horizontal flat bar stiffener, vertically corrugated bulkhead.



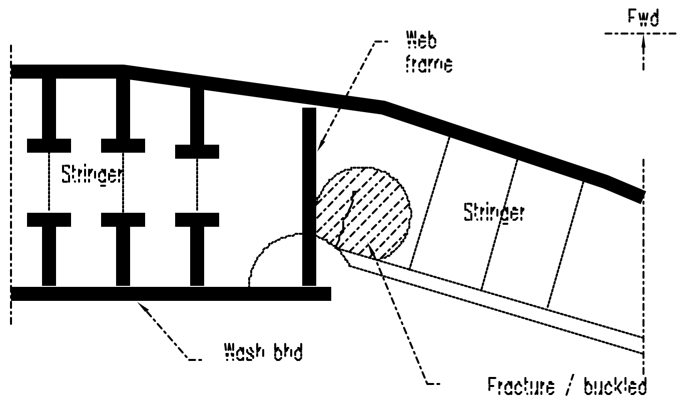
Detail 14: Bulkhead fractured at passage of side longitudinal, bulkhead horizontally corrugated.



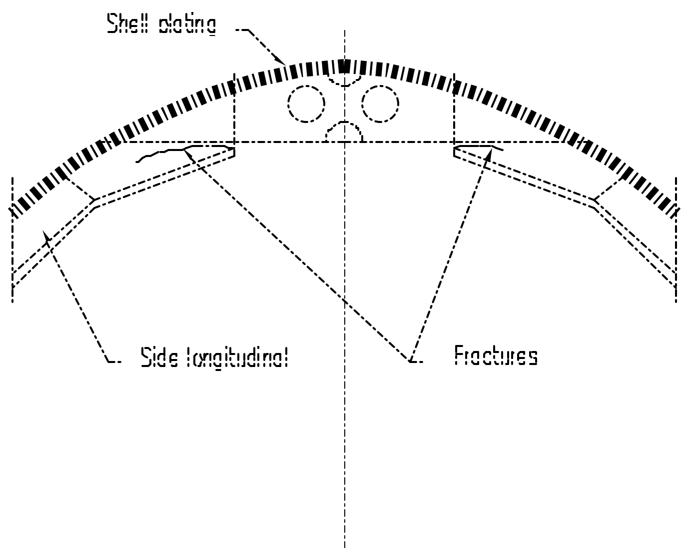
Detail 15: Fractured stiffener connection to bottom and inner bottom longitudinals.



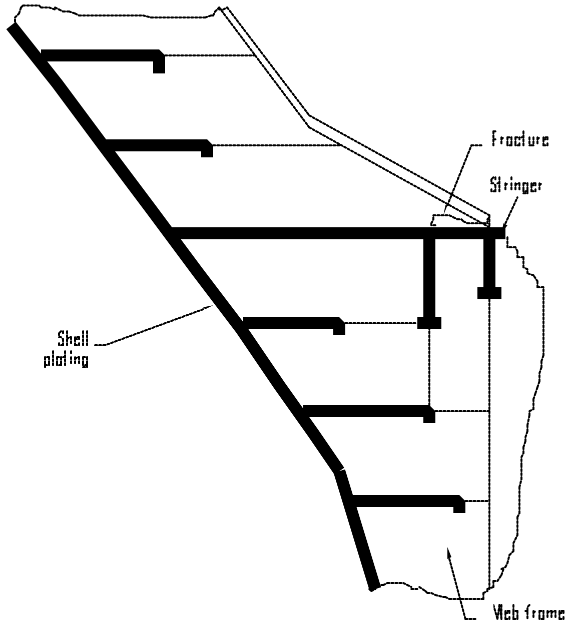
Detail 16: Fractured vertical web at the longitudinal stiffener ending in way of the parabolic bow structure.



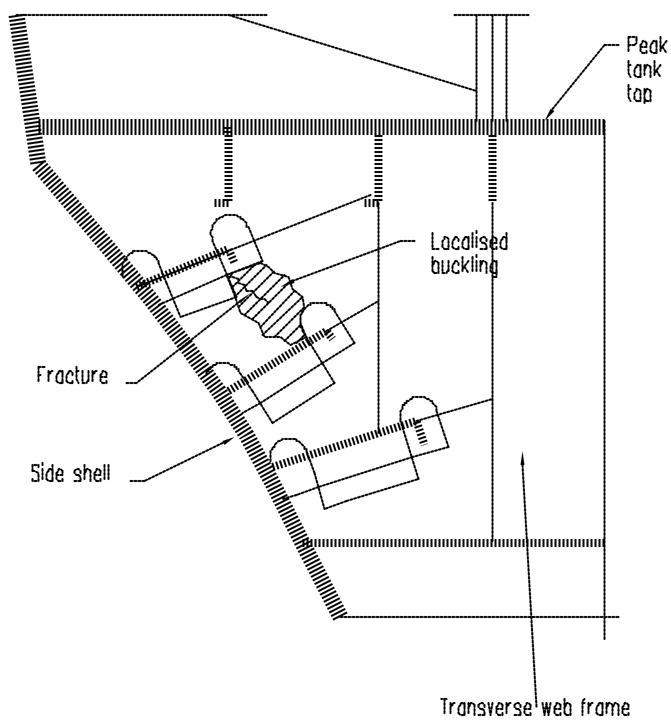
Detail 17: Fractured stringer end connection in way of the parabolic bow structure.



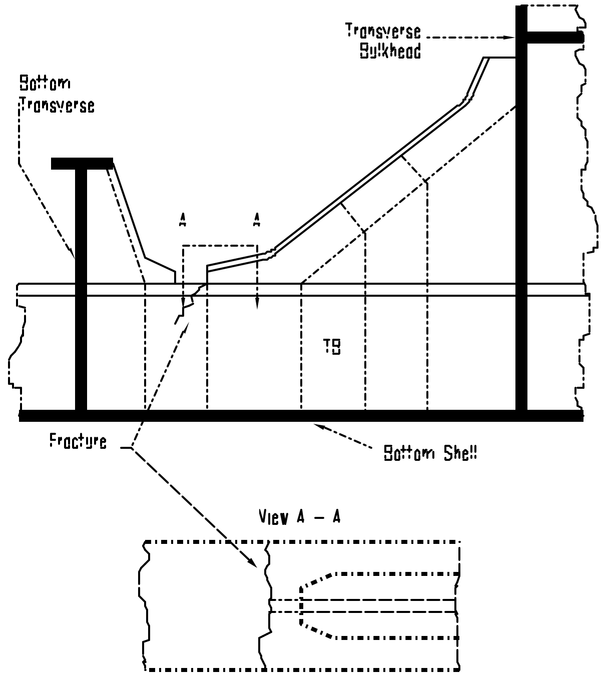
Detail 18: Fracture at end of longitudinal at bow structure.



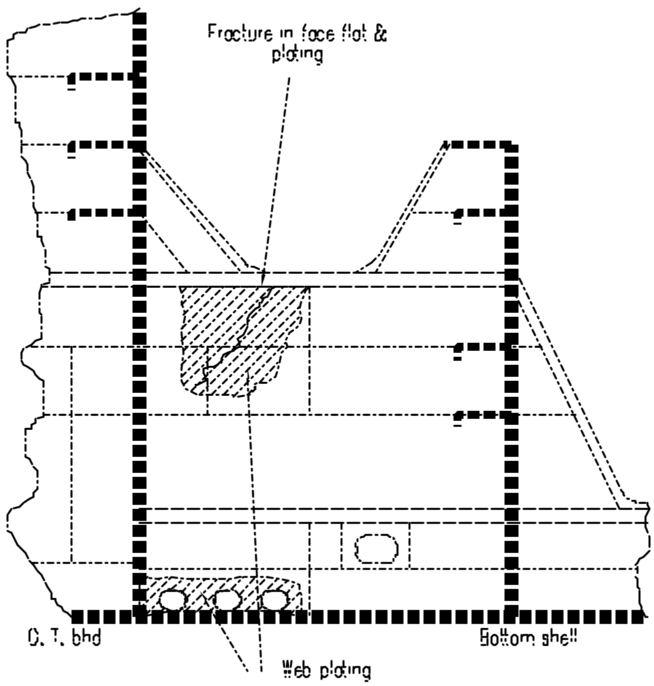
Detail 19: Fracture at toe of web frame bracket connection to stringer platform bracket.



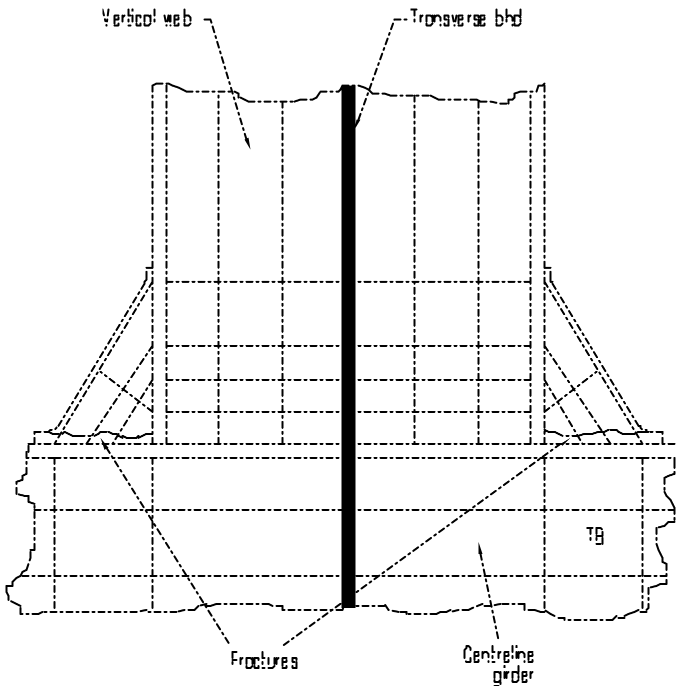
Detail 20: Fracture and buckle of bow transverse web frame in way of longitudinal cut-outs.



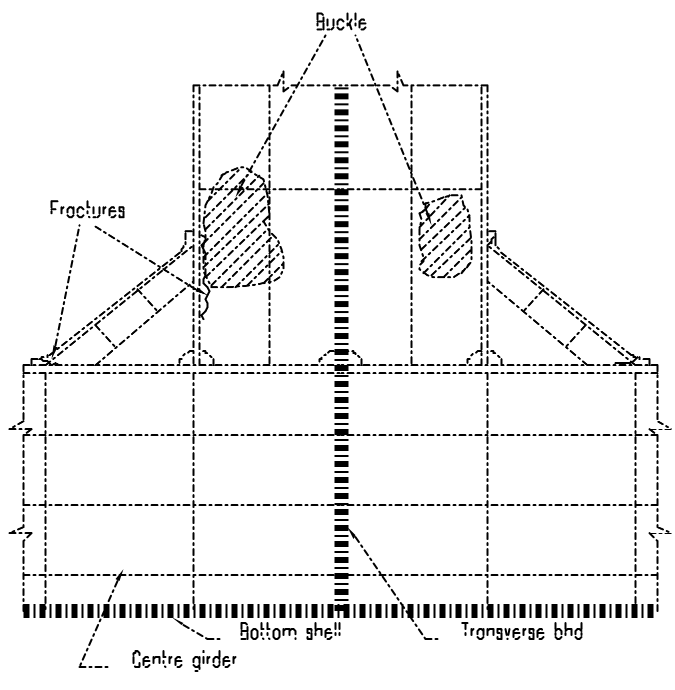
Detail 21: Fractured bottom centre line girder at the end bracket connection to O. T. bulkhead.



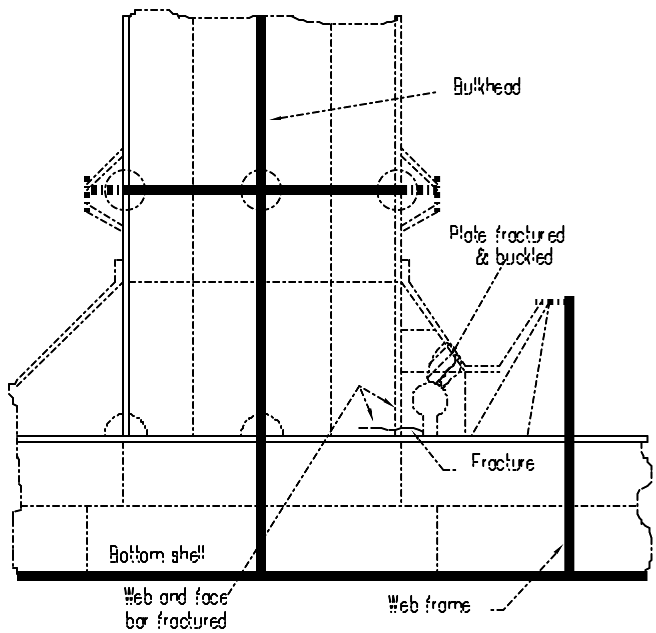
Detail 22: Fractured and buckled buttress in way of bracket connection to O.T. bulkhead.



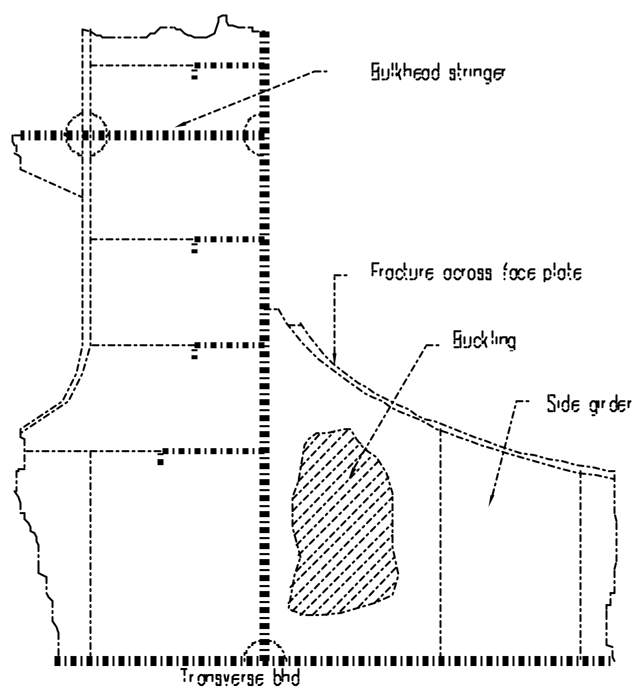
Detail 23: Fractured vertical web bracket connection to bottom centreline girder.



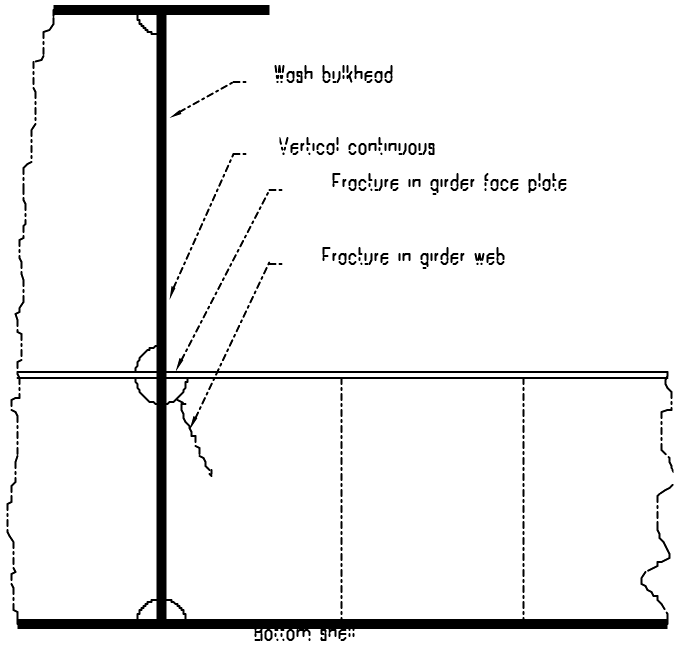
Detail 24: Buckled and fractured vertical web and bottom centreline girder bracket connection.



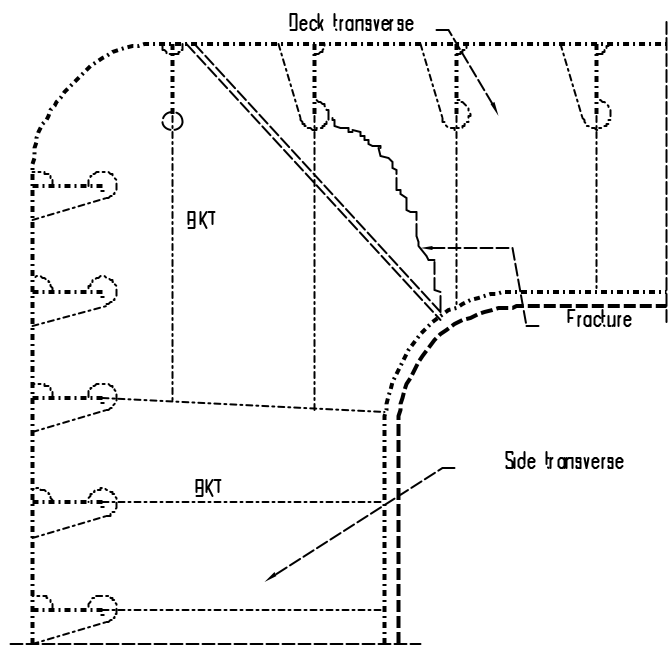
Detail 25: Fractured bottom girder brackets in way of pipe opening.



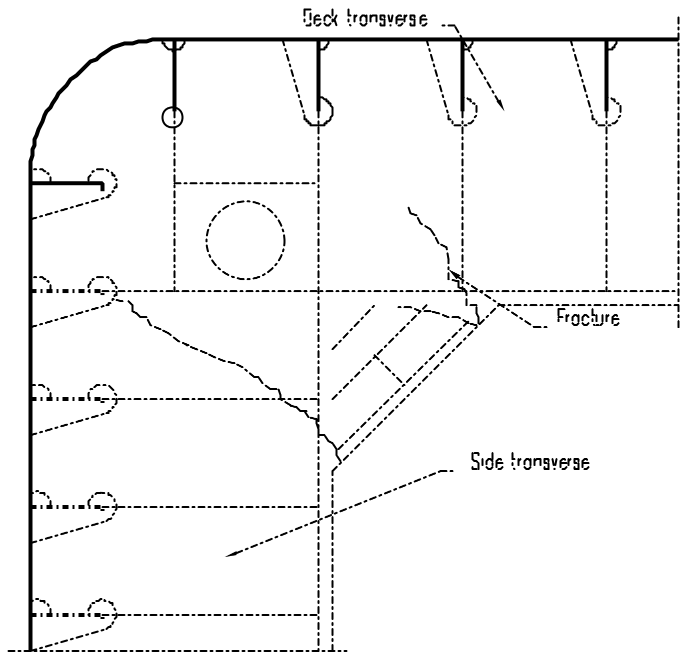
Detail 26: Fractured and buckled bottom side girder in way of end connections to O.T. bulkhead.



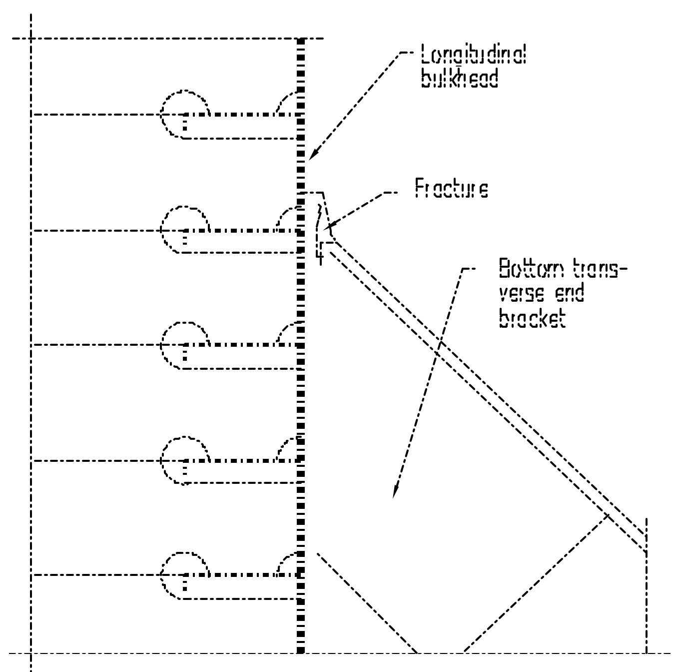
Detail 27: Fractured intercostal bottom girder fitted without an end bracket in way of the wash bulkhead.



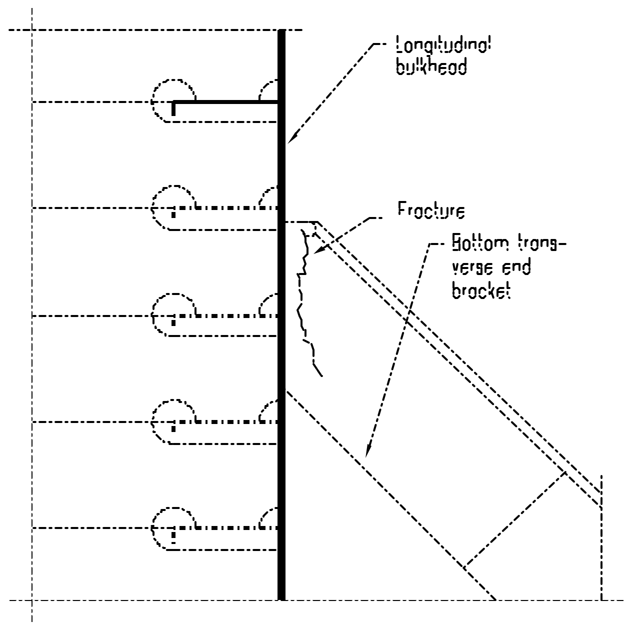
Detail 28: Fractured wing tank deck transverse bracket, continuous face plate.



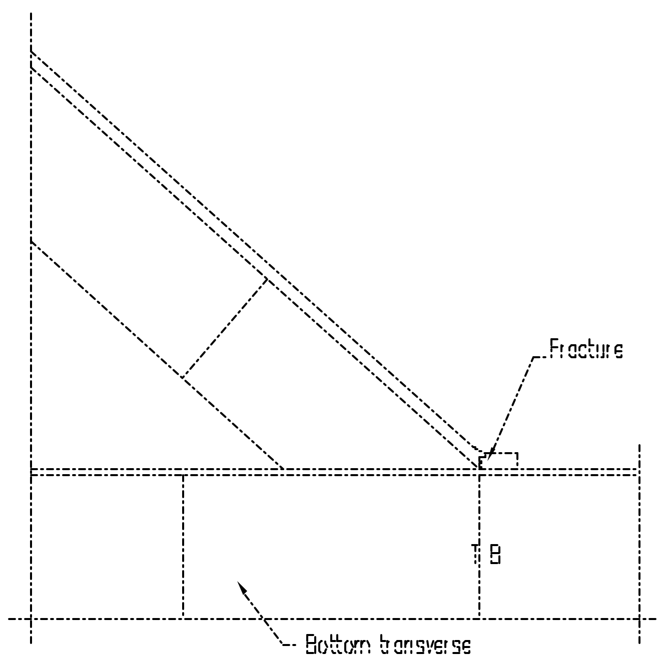
Detail 29: Fractured wing tank deck transverse bracket, face plate sniped.



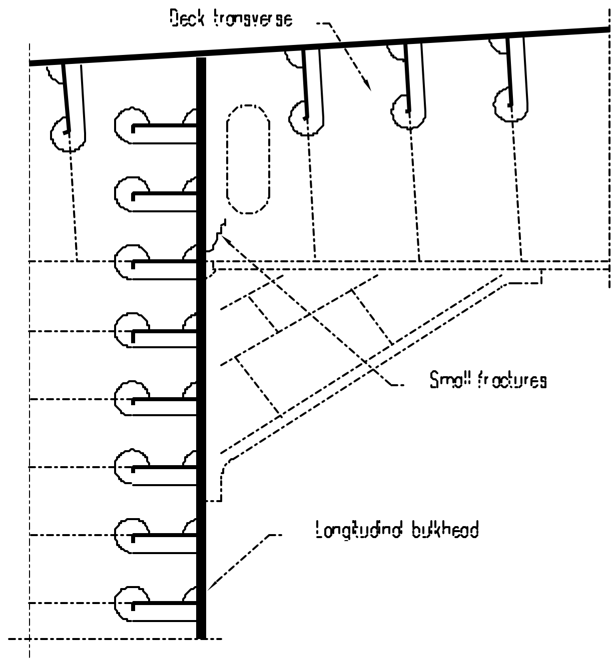
Detail 30: Fractured centre tank bottom transverse end brackets, asymmetrical face plate.



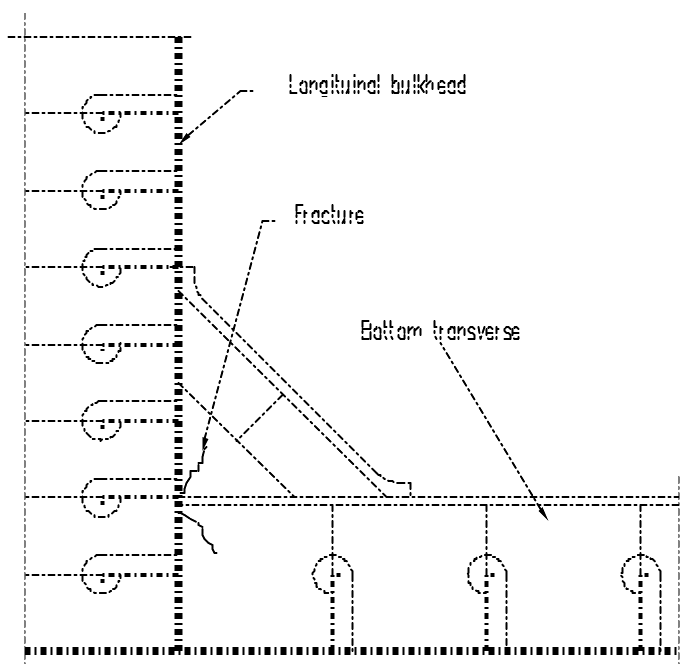
Detail 31: Fractured centre tank bottom transverse end bracket, symmetrical face plate.



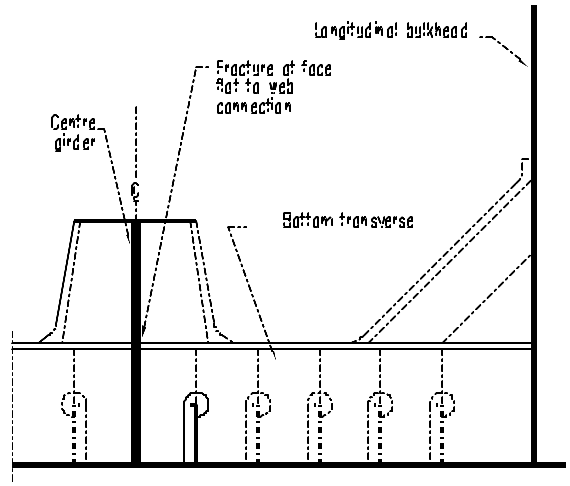
Detail 32: Fractured wing tank bottom transverse end bracket, asymmetrical face plate.



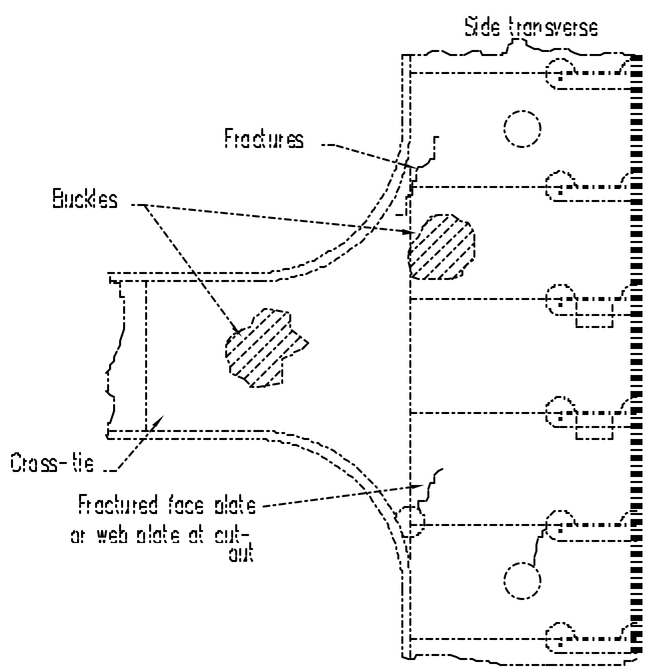
Detail 33: Fractured centre tank deck transverse.



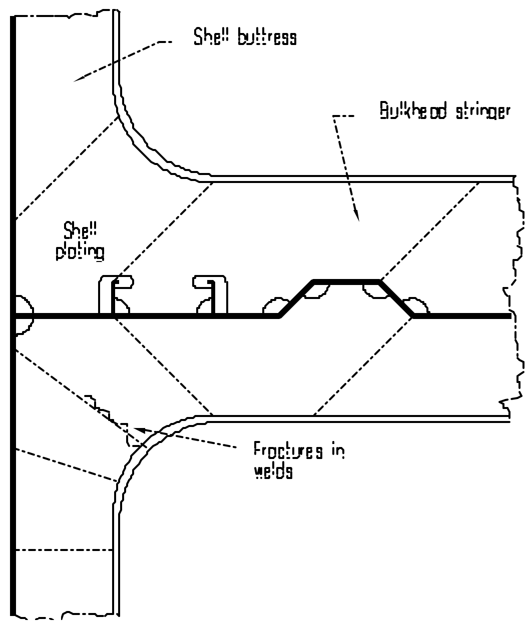
Detail 34: Fractured centre tank, bottom transverse.



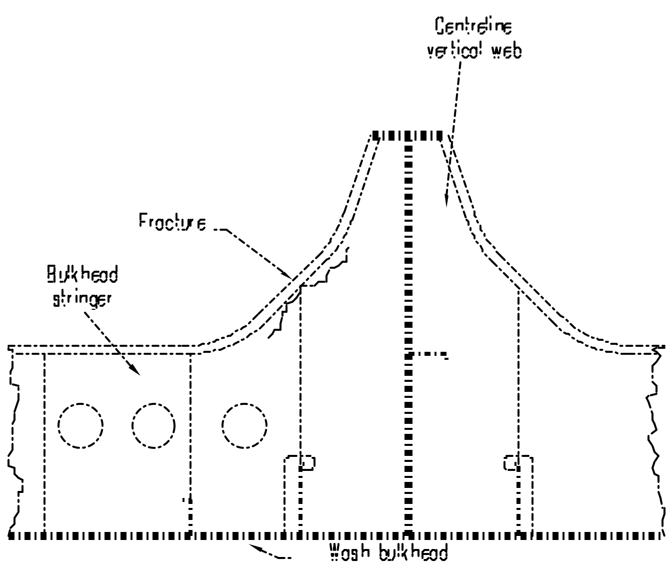
Detail 35: Fractured centre girder at intersection with the bottom transverse.



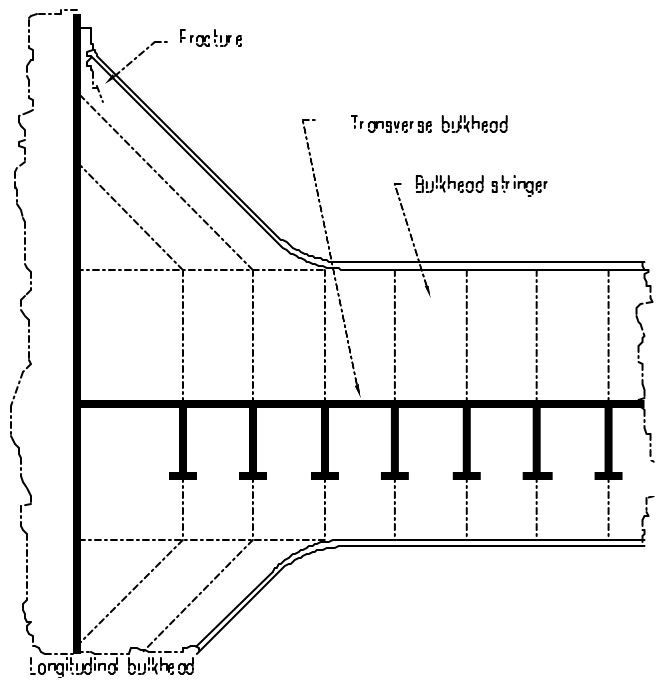
Detail 36: Fractured and buckled web plate and fractured face plate.



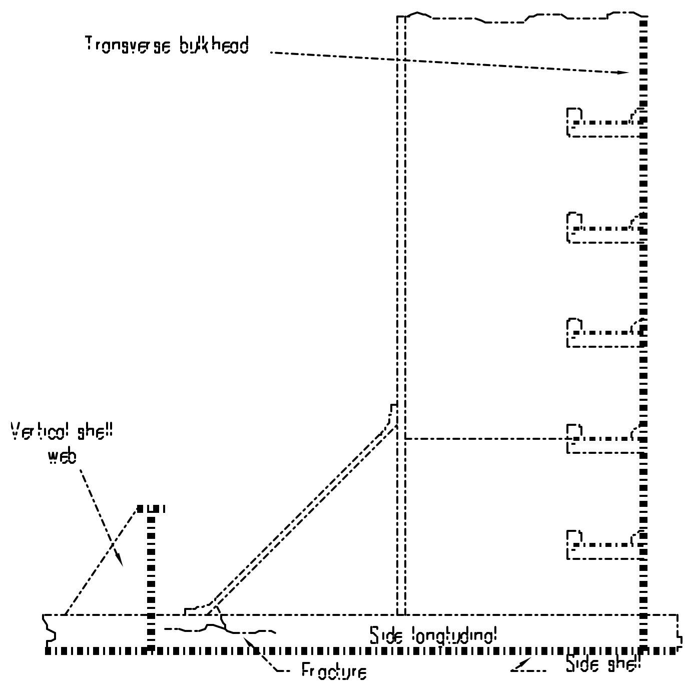
Detail 37: Fractured face plate and web at the radiused end brackets, vertically corrugated bulkheads.



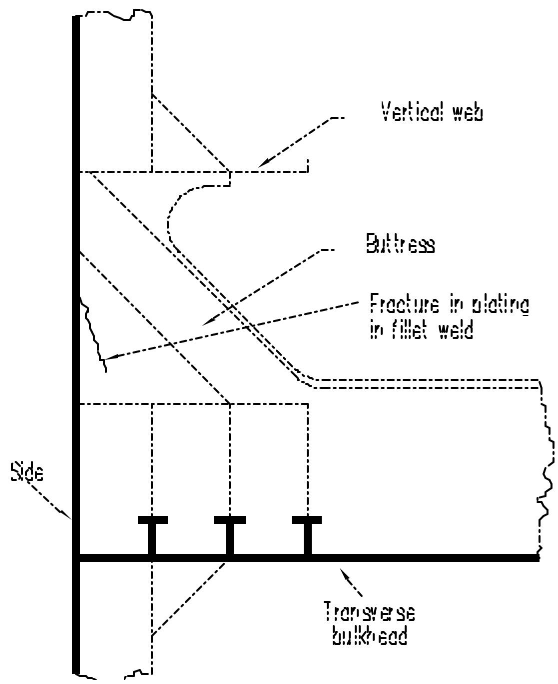
Detail 38: Fractured web of stringer at the radiused bracket in way of centreline vertical web.



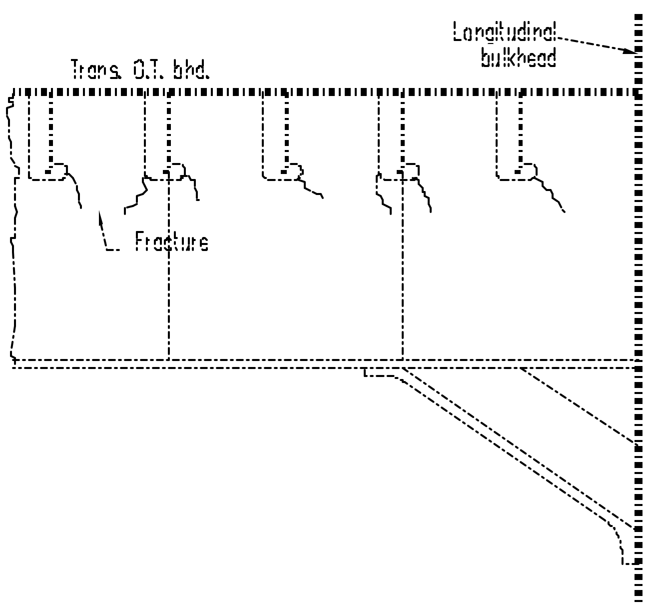
Detail 39: Fractured centre tank stringer bracket connection to the longitudinal bulkhead.



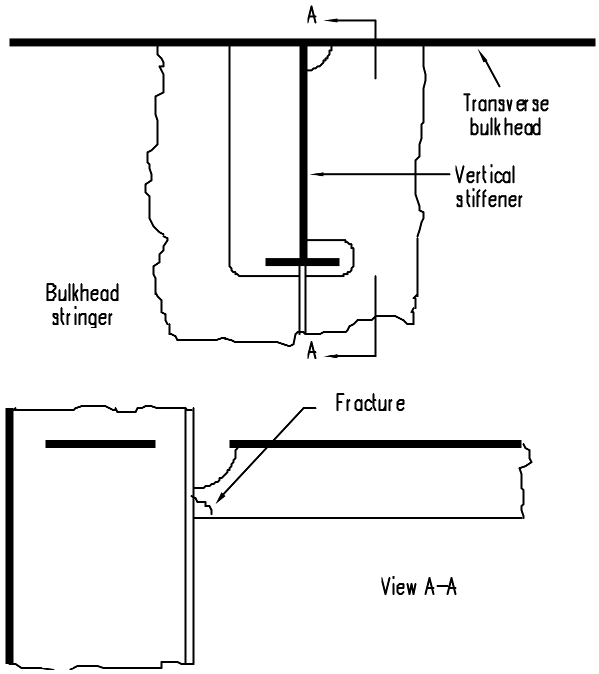
Detail 40: Fractured wing tank stringer bracket and side shell longitudinal in way.



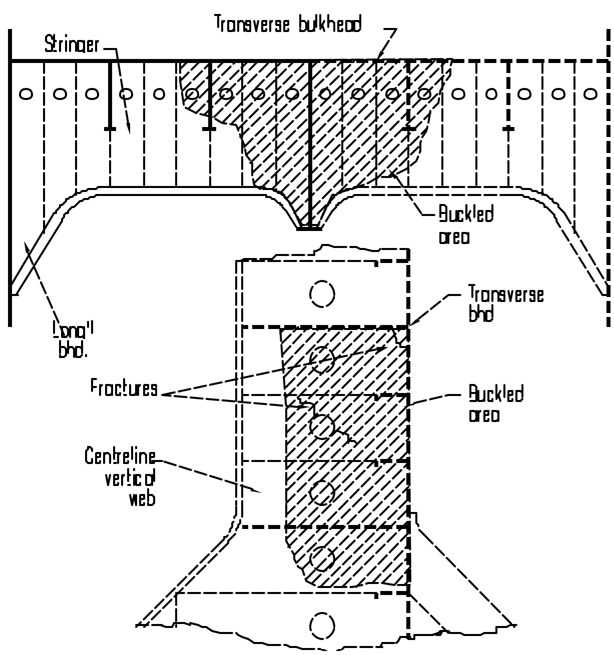
Detail 41: Fractured web of buttress at connection to shell.



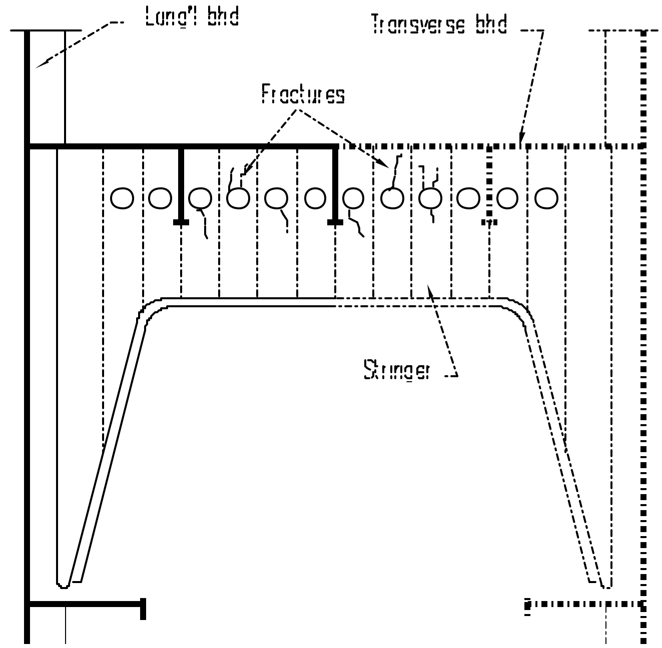
Detail 42: Fractured web at cut-outs for vertical stiffeners.



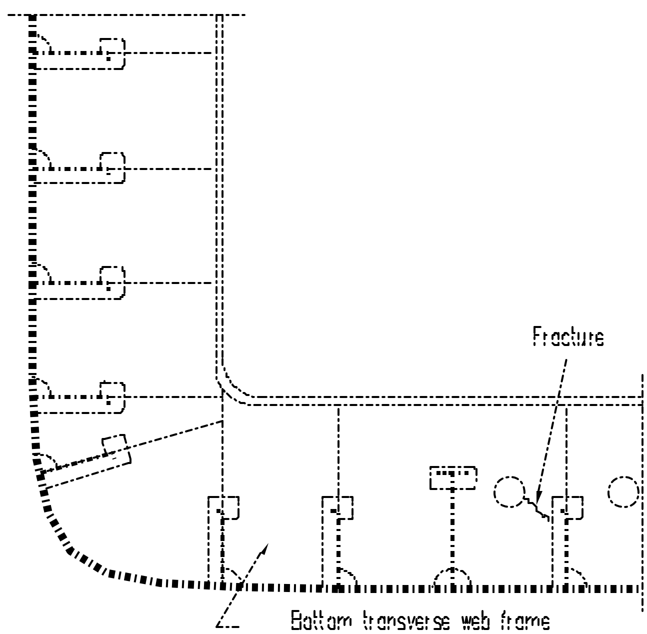
Detail 43: Fractured flat bar connection to vertical stiffener.



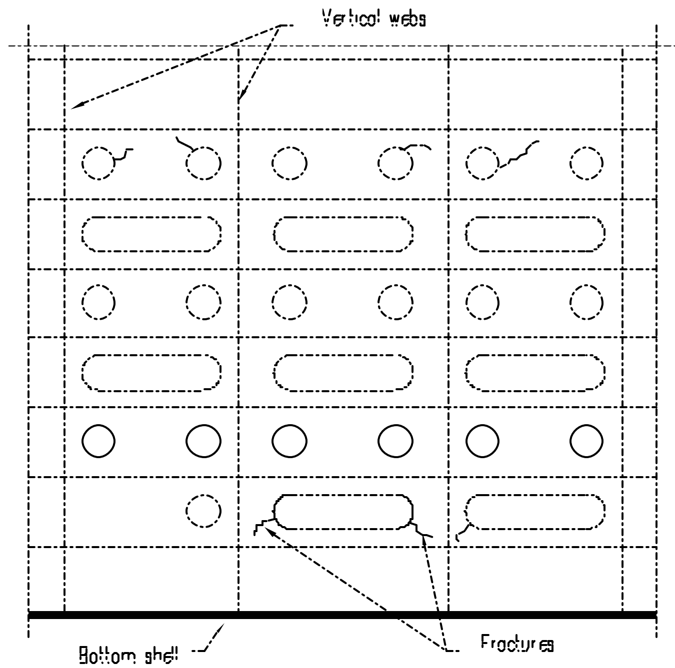
Detail 44: Buckled and fractured centreline vertical web and stringer in way of intersection.



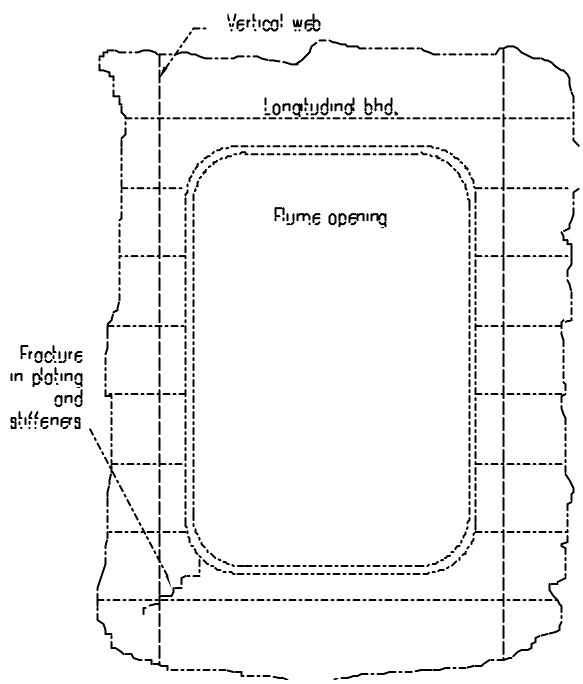
Detail 45: Fractures in way of lightening hole in stringer.



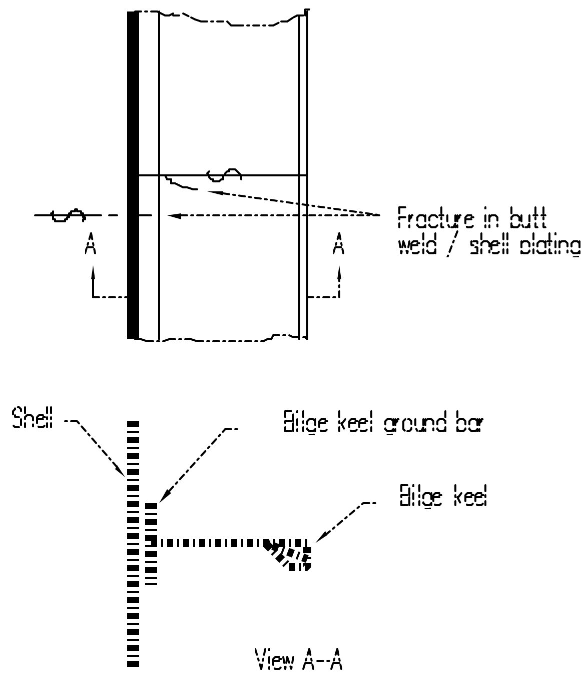
Detail 46: Fractured web of bottom transverse in way of lightening holes.



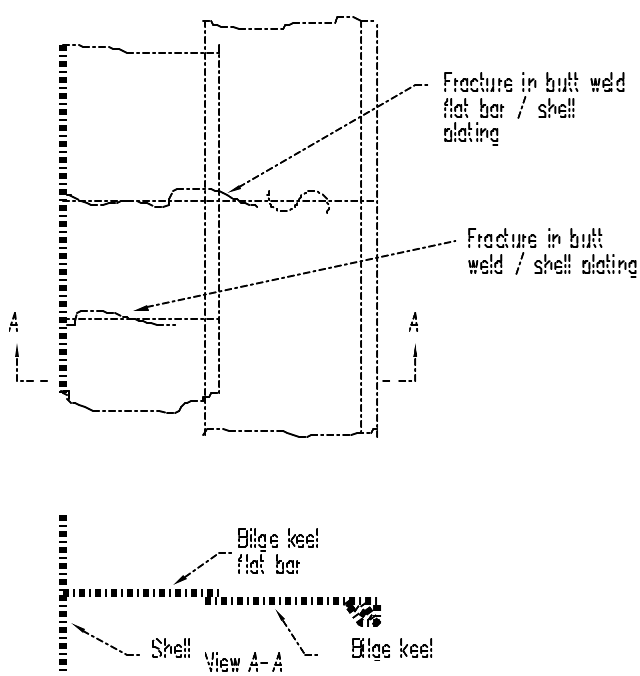
Detail 47: Fractures of longitudinal flume / swash bulkhead plating at openings.



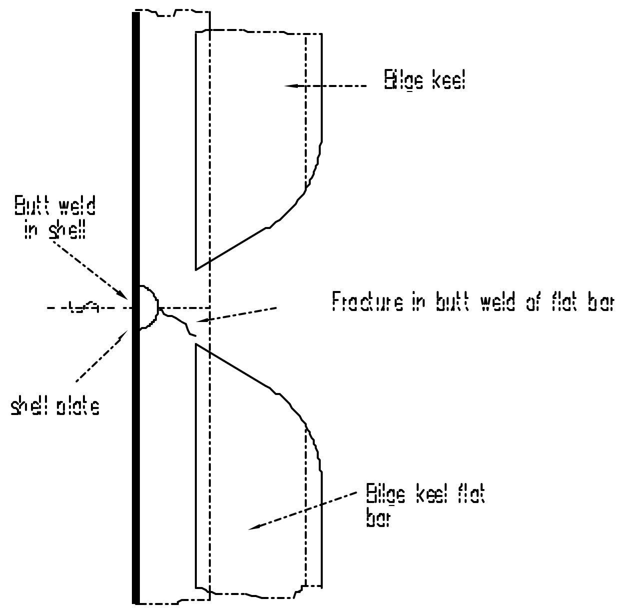
Detail 48: Fracture at corner of flume in longitudinal bulkhead.



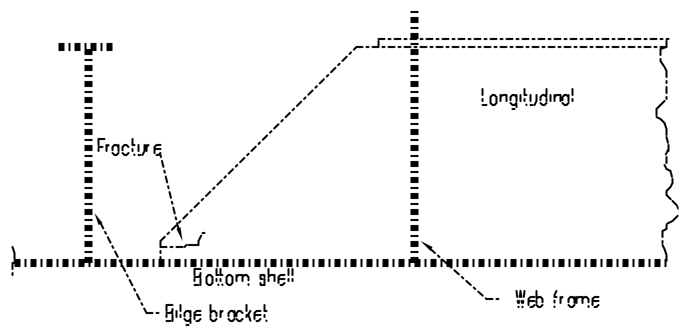
Detail 49: Fracture in continuous bilge keel & ground bar.



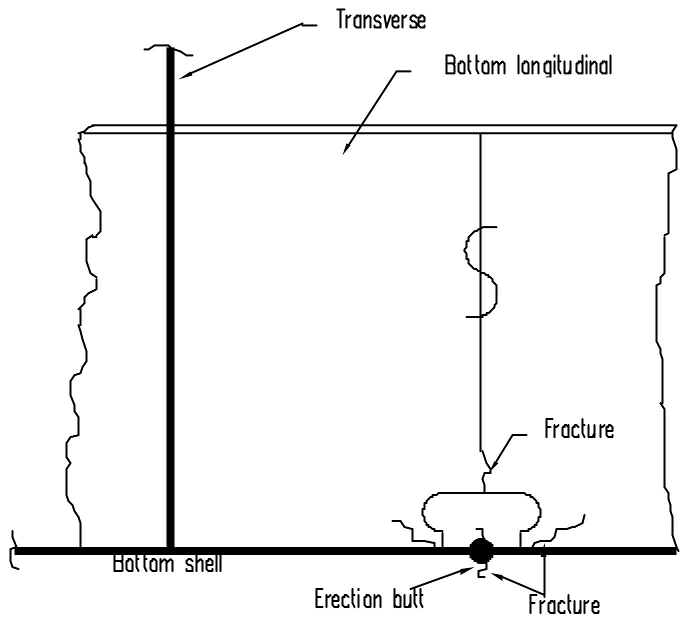
Detail 50: Fracture in continuous bilge keel and flat bar.



Detail 51: Fracture in continuous scalloped flat bar for intermittent bilge keel.



Detail 52: Shell fracture at sniped ends of bilge longitudinals.



Detail 53: Fractured butt welds in shell and bottom longitudinals.

Appendix F: SQIS User's Manual

F.1 Introduction

This manual provides the information necessary to navigate through the Ship Quality Information System (SQIS) Prototype database. The manual assumes that the user has a basic familiarity with Microsoft Access™. Note that tables which are referenced in multiple forms are at the end of this manual.

This program is a prototype application of an Industry-Wide SQIS.

F.2 System Requirements

SQIS is built in Microsoft Access ™ for PC's, to run SQIS, you must have Access 7.0 or later (i.e. Office 95 or later). SQIS cannot be run on earlier versions of Access. System requirements are a Pentium 75 MHz, with 12Mb of RAM, minimum. Suggested capabilities are a Pentium 150 MHz, with 24Mb of RAM.

To install SQIS on your computer, you will require a working copy of WinZip® 6.2 by Nico Mac Computing.

F.3 Installation and Getting Started

The SQIS Database, is in a zipped format on two 1.4Mb disks, in a file called SQIS.zip. To extract the file SQIS.mdb, the Access file, insert the disk labeled "SQIS Database: Disk 1" into your drive, start WinZip, and open the SQIS archive file SQIS.zip. Upon executing the "extract" command, you will be required to specify a destination location for the extracted file. A Word 7.0 file of the accompanying report is in a zipped file, Report.zip on a third disk. Please note, the inflated versions of these files will take up approximately 30Mb of hard-drive space in total.

To open the SQIS database, start Access, and open the file SQIS.mdb. This will bring up the *SQIS Switchboard*.

F.4 SQIS Switchboard

The *SQIS Switchboard* provides access to all the forms in SQIS. The forms are divided in three groups: Input, Analyses, and Reports (Figure F-1).

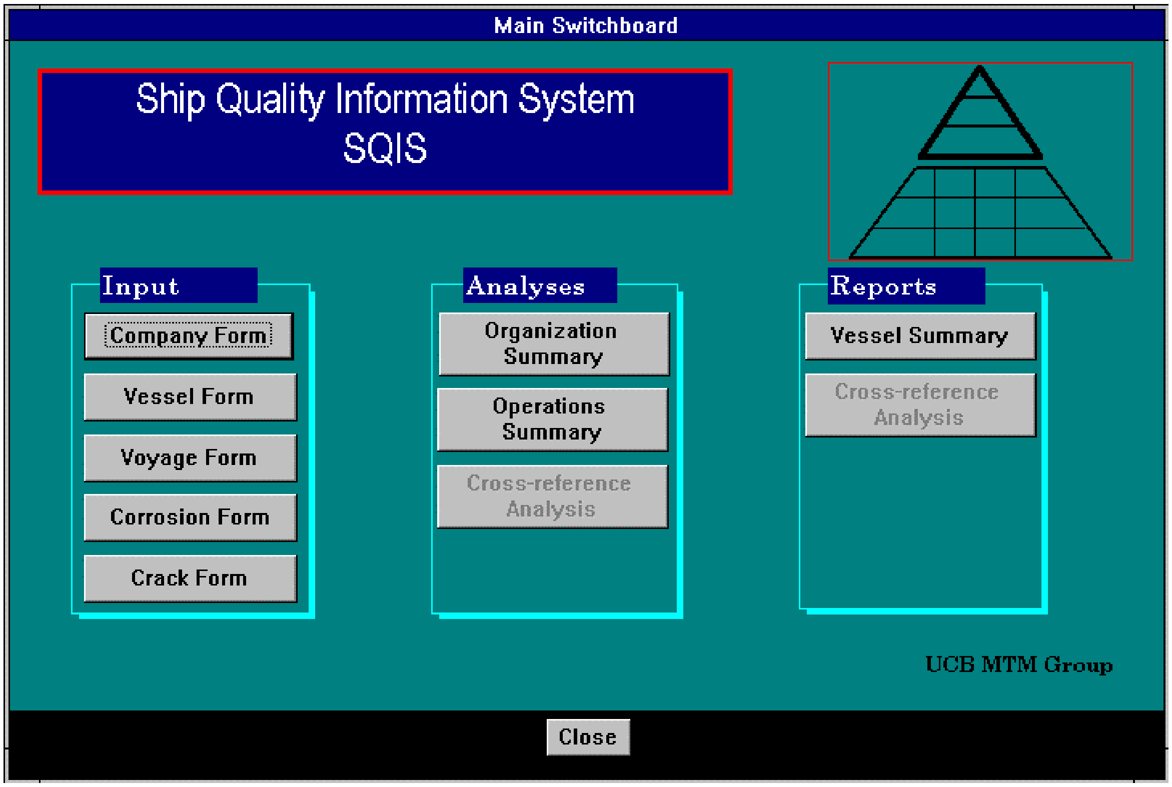


Figure F-1: SQIS Switchboard

The **Close** button at the bottom of the *SQIS Switchboard* closes that form, revealing the *Background Form*. The *Background Form* may be closed using the "Close" command in the "File" pull-down menu. The user can access the underlying tables and queries in the SQIS database by choosing the "SQIS : Database" window under the "Window" pull-down menu.

F.5 Data Input

In the SQIS Prototype, all data is input manually through a series of data-entry forms, accessed from the *SQIS Switchboard*.

Company Form

The *Company Form* allows the user to enter or edit general company information. The user can scroll through records using the navigation buttons at the bottom of the form. Accessed by clicking the **Company Form** button on the *SQIS Switchboard* (Figure F-2). The information in this form would be entered only once for each company, when the first records for that company are entered in the SQIS system.

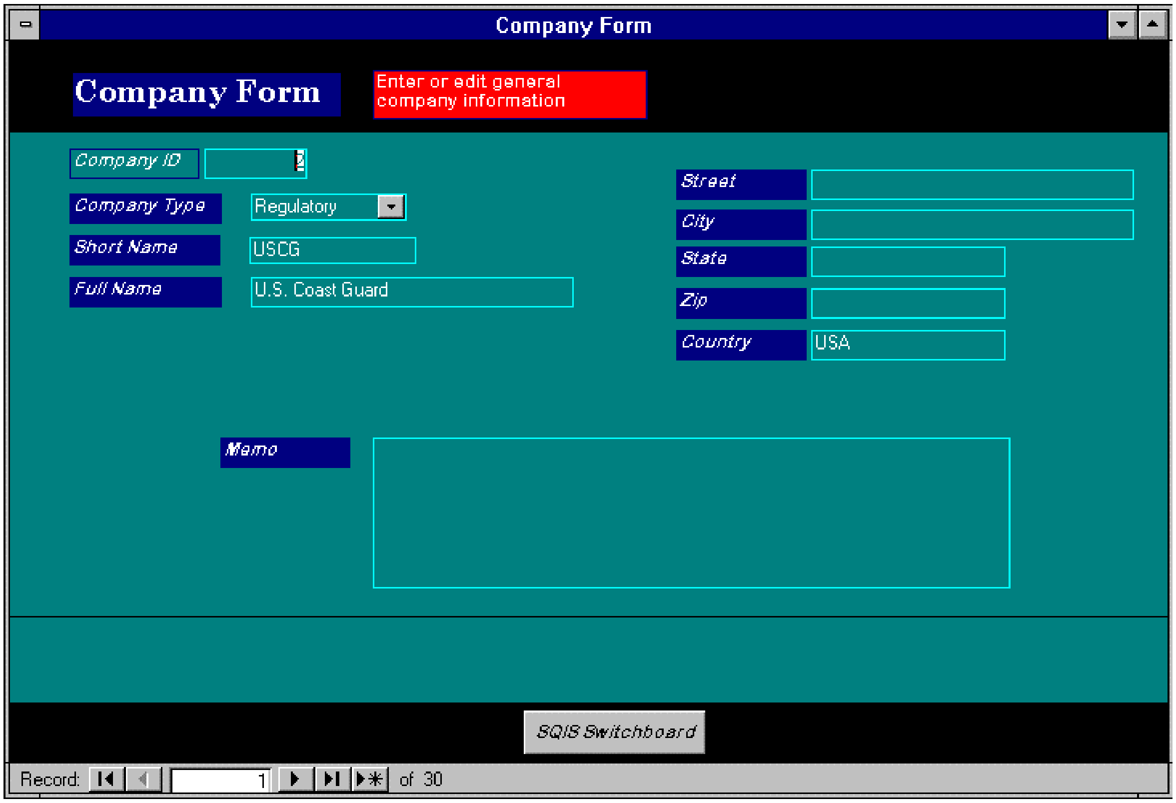


Figure F-2: Company Form

Company ID

The **Company ID** field is automatically assigned to each new company entered in the database.

Company Type

The **Company Type** field describes the type of work the company performs. The user chooses from a list of: Owner, Operator, Regulatory, Class. Society, Inspection, Shipyard, or Port.

Short Name

The **Short Name** field is the common usage abbreviation of a company name (e.g. ABS). For companies with more than one office, a different short name should be used for each address (e.g. ABS, Americas and ABS, Europe).

Full Name

The proper corporate name of the company.

Street, City, State, Zip, Country

The working address of the office of the company in question. For companies with more than one office, a different short name should be used for each address.

Memo

Additional notes about the company.

SQIS Switchboard

On all forms, the **SQIS Switchboard** button returns the user to the *SQIS Switchboard*.

Vessel Form

The *Vessel Form* allows the user to enter or edit general vessel information. The user can scroll through records using the navigation buttons at the bottom of the form. Accessed by clicking the **Vessel Form** button on the *SQIS Switchboard* (Figure F-3). This information would be entered only once for each vessel, when records for that vessel are first entered into the SQIS system.

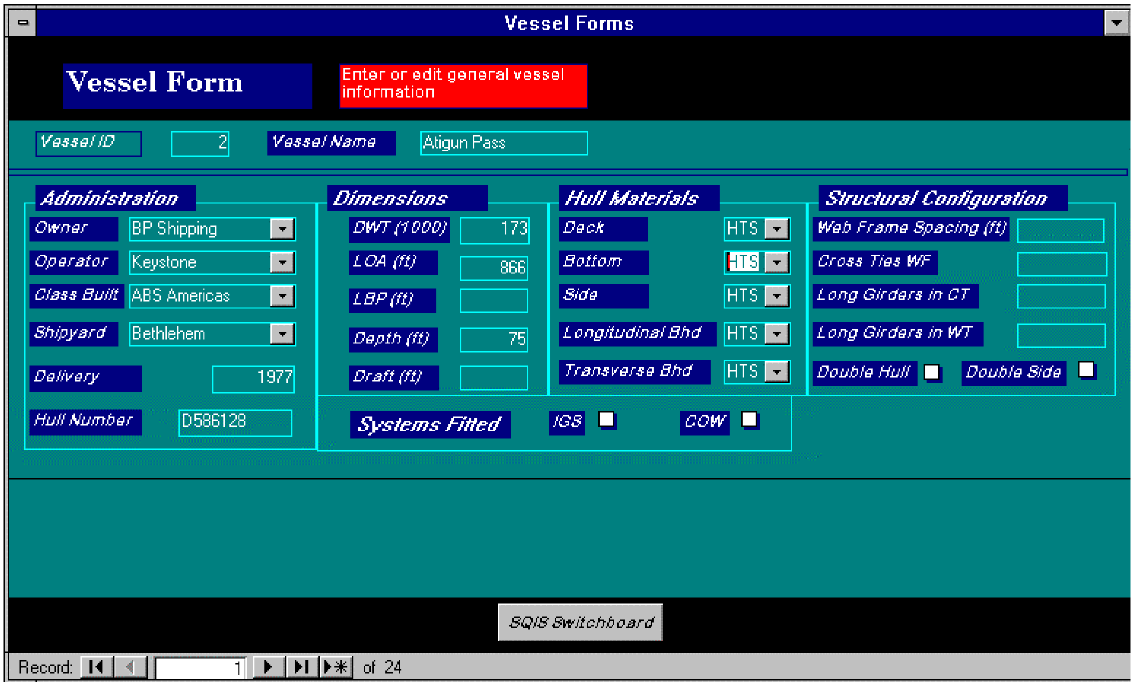


Figure F-3: Vessel Form

Vessel ID

The **Vessel ID** field is automatically assigned to each new vessel entered in the database.

Vessel Name

The **Vessel Name** field is the current name of the vessel.

Owner

The current owner company, chosen from a list of those companies in the *Company Directory* with a **Company Type** designation of “Owner” or “Operator”.

Operator

The current operator company, chosen from a list of those companies in the *Company Directory* with a **Company Type** designation of “Owner” or “Operator”.

Class Built

The classification society under whose rules the vessel was originally built. Chosen from a list of those companies in the *Company Directory* with a **Company Type** designation of “Class. Society”.

Shipyard

The shipyard in charge of the original vessel construction. Chosen from a list of those companies in the *Company Directory* with a **Company Type** designation of “Shipyard”.

Delivery

The original delivery date of the vessel from the shipyard to the first owner. Year only.

Hull Number

Permanent Vessel Identification Number (VIN).

DWT, LOA, LBP, Depth, Draft

General vessel dimensions.

Hull Materials

Materials used in the original construction of various parts of the vessel. Specify for: **Deck**, **Bottom**, **Side**, **Longitudinal Bhd**., and **Transverse Bhd**.

Structural Configuration

Web Frame Spacing - Distance between web frames (ft).
Cross Ties WF - Number of cross ties in web frame.
Long Girders in CT - Number of longitudinal girders in center tanks.
Long Girders in WT - Number of longitudinal girders in wing tanks.
Double Hull - Check box for double bottom.
Double Side - Check box for double side.

Systems Fitted

IGS - Check box for Inert Gas System.
COW - Check bow for Crude Oil Washing System.

Voyage Form

The *Voyage Form* allows the user to enter or edit individual voyage information. The user can scroll through records using the navigation buttons at the bottom of the form. Accessed by clicking the **Voyage Form** button on the *SQIS Switchboard* (Figure F-4).

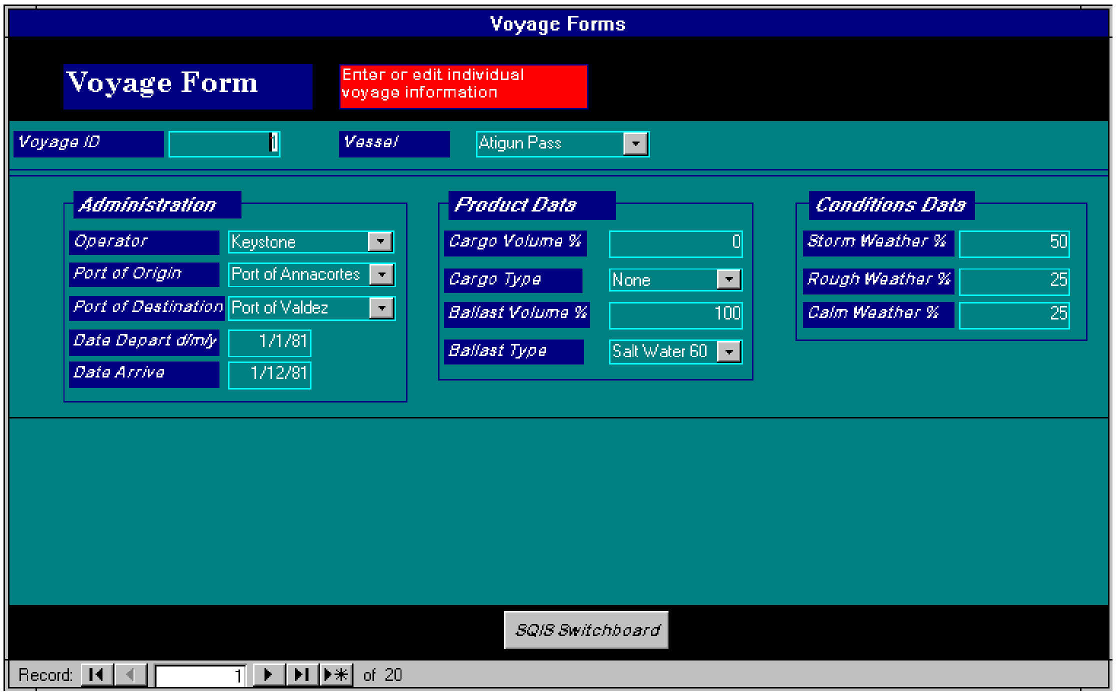


Figure F-4: Voyage Form

Voyage ID

The **Voyage ID** field is automatically assigned to each new voyage record entered in the database.

Vessel Name

The **Vessel Name** field is the current name of the vessel, chosen from a list of all vessels in the *Vessel Directory*.

Operator

The current operator company, chosen from a list of those companies in the *Company Directory* with a **Company Type** designation of “Owner” or “Operator”.

Port of Origin

The port at which the vessel began the voyage, chosen from a list of those companies in the *Company Directory* with a **Company Type** designation of “Port”.

Port of Destination

The port at which the vessel ended the voyage, chosen from a list of those companies in the *Company Directory* with a **Company Type** designation of “Port”.

Date Depart, Date Arrive

The dates on which the vessel began and ended the voyage. Entered as dd/mm/yy.

Product Data

Cargo Volume % - The actual percentage of the vessel’s total cargo capacity which is being used for cargo.

Cargo Type - The type of cargo being carried, chosen from a list of standard crude and ballast types.

Ballast Volume % - The actual percentage of the vessel’s total ballast capacity which is being used for ballast.

Ballast Type - The type of cargo being carried, chosen from a list of standard crude and ballast types.

Conditions Data

Storm Weather % - The percent of time during the voyage the vessel encountered storm conditions.

Rough Weather % - The percent of time during the voyage the vessel encountered rough conditions.

Calm Weather % - The percent of time during the voyage the vessel encountered calm conditions.

Corrosion Form

The *Corrosion Form* allows the user to enter corrosion information for a member in a tank. The user can scroll through records using the navigation buttons at the bottom of the form. Accessed by clicking the **Corrosion Form** button on the *SQIS Switchboard* (Figure F-5).

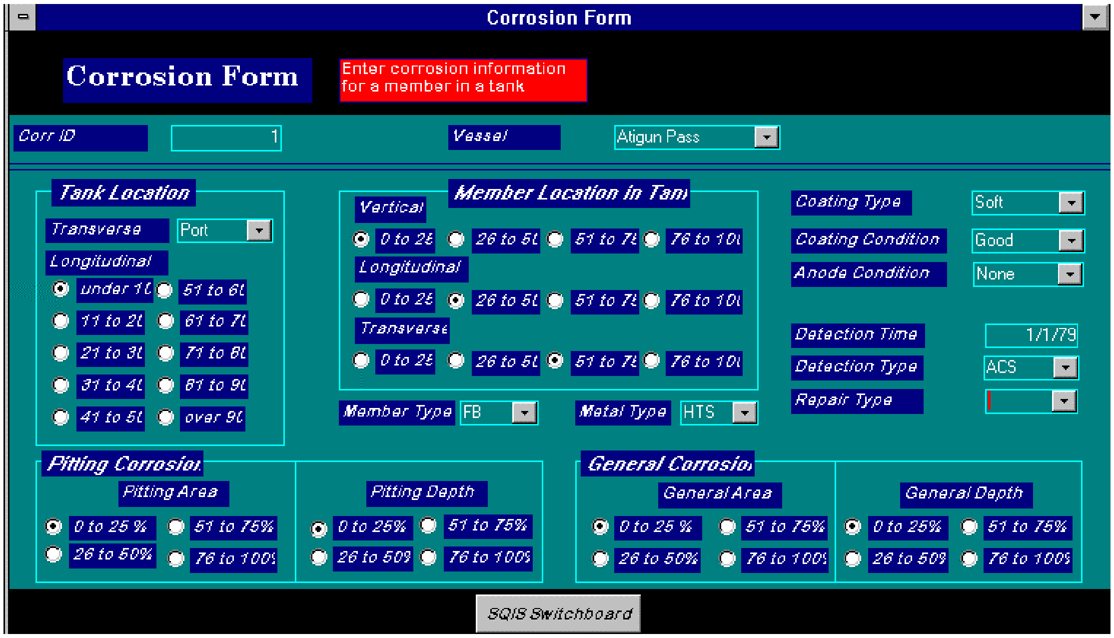


Figure F-5: Corrosion Form

Corr ID

The **Corr ID** field is automatically assigned to each new corrosion record entered in the database.

Vessel

The **Vessel** field is the current name of the vessel, chosen from a list of all vessels in the *Vessel Directory*.

Tank Location

Transverse - The athwartships location of the tank, chosen from a list of; “Port”, “Starboard”, and “Center”.

Longitudinal - The relative longitudinal location of the tank, defined as the location of the centroid of the tank, expressed as a percentage of the distance from midships to the aft perpendicular (-50%) or to the forward perpendicular (+50%). Pick from list of ten ranges of percentage (each range covers ten percent).

Member Location in Tank

Vertical - The relative vertical location of the member within the tank, expressed as a percentage of the total distance from the baseline to the deck. Pick from list of four ranges of percentage (each range covers 25 percent).

Longitudinal - The relative longitudinal location of the member within the tank, expressed as a percentage of the total distance from the aft bulkhead to the forward bulkhead of the tank. Pick from list of four ranges of percentage (each range covers 25 percent).

Transverse - The relative transverse location of the member within the tank, expressed as a percentage of the total distance from the inboard bulkhead to the outboard bulkhead of the tank. Pick from list of four ranges of percentage (each range covers 25 percent).

Member Type

The type of structural member, chosen from list of *Member Types*.

Metal Type

The type of metal of the structural member, chosen from list; "HTS" (High Tensile Steel) or "MS" (Mild Steel).

Pitting Area

The percentage of the surface area member affected by pitting corrosion. Pick from list of four ranges of percentage (each range covers 25 percent).

Pitting Depth

The average wastage percentage of the pitting corrosion affected areas. Pick from list of four ranges of percentage (each range covers 25 percent).

General Area

The percentage of the surface area member affected by general corrosion. Pick from list of four ranges of percentage (each range covers 25 percent).

General Depth

The average wastage percentage of the general corrosion affected areas. Pick from list of four ranges of percentage (each range covers 25 percent).

Coating Type

Type of protective coating on the member. Chose from list of; "None", "Soft", or "Hard".

Coating Condition

Condition of the protective coating on the member. Chose from list of; "Good", "Fair", or "Poor".

Anode Condition

Condition of the sacrificial anode on the member. Chose from list of; "None", "Good", "Fair", or "Poor".

Detection Time

The date of the inspection during which the recorded data were observed (dd/mm/yy).

Detection Type

The type of inspection during which the recorded data were observed. Chose from list of *Inspection Types* (Table F-1).

Repair Type

The type of repair used to fix the recorded defects. Chose from list of *Repair Types* (Table F-3).

Crack Form

The *Crack Form* allows the user to enter crack information for a series of details on a member in a tank. The user can scroll through records using the navigation buttons at the bottom of the form. Accessed by clicking the **Crack Form** button on the *SQIS Switchboard*.(Table F-6)

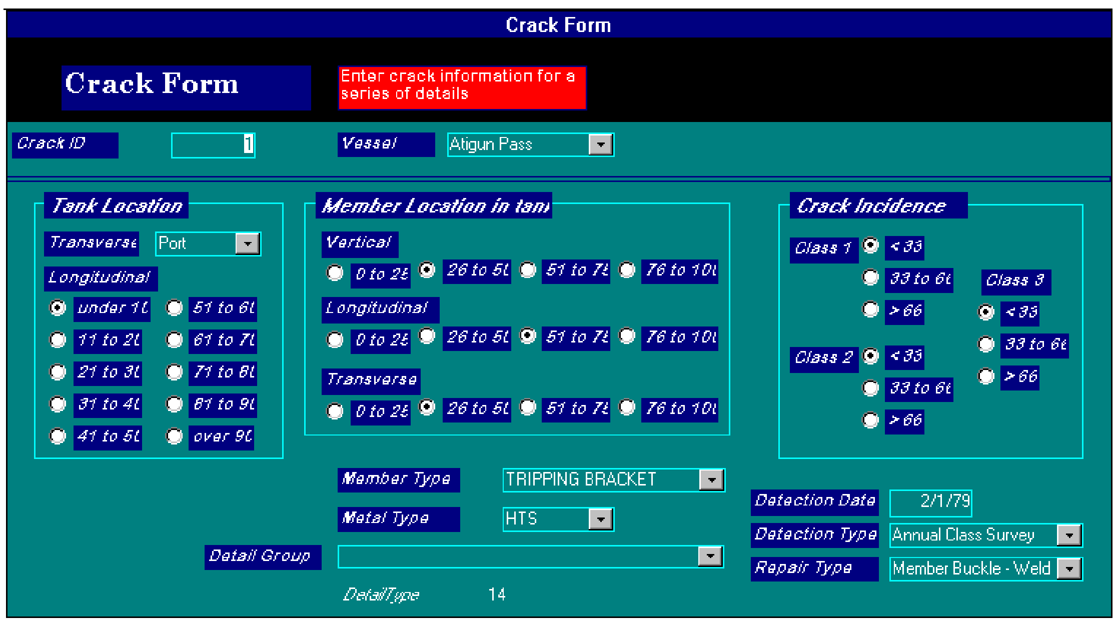


Figure F-6: Crack Form

Crack ID

The **Crack ID** field is automatically assigned to each new crack record entered in the database.

Vessel

The **Vessel** field is the current name of the vessel, chosen from a list of all vessels in the *Vessel Directory*.

Tank Location

Transverse - The athwartships location of the tank, chosen from a list of; "Port", "Starboard", and "Center".

Longitudinal - The relative longitudinal location of the tank, defined as the location of the centroid of the tank, expressed as a percentage of the distance from midships to the aft perpendicular (-50%) or to the forward perpendicular (+50%). Pick from list of ten ranges of percentage (each range covers ten percent).

Member Location in Tank

Vertical - The relative vertical location of the member within the tank, expressed as a percentage of the total distance from the baseline to the deck. Pick from list of four ranges of percentage (each range covers 25 percent).

Longitudinal - The relative longitudinal location of the member within the tank, expressed as a percentage of the total distance from the aft bulkhead to the forward bulkhead of the tank. Pick from list of four ranges of percentage (each range covers 25 percent).

Transverse - The relative transverse location of the member within the tank, expressed as a percentage of the total distance from the inboard bulkhead to the outboard bulkhead of the tank. Pick from list of four ranges of percentage (each range covers 25 percent).

Member Type

The type of structural member, chosen from list of *Member Types* (Table F-2).

Metal Type

The type of metal of the structural member, chosen from list; "HTS" (High Tensile Steel) or "MS" (Mild Steel).

Detail Group and **Detail Group**

The **Detail Group** is the classification group for the type of detail (as given in **Error! Reference source not found.**E-1), chosen from the list of *Detail Groups*. The selection of a **Detail Group** opens up the *Group Form* associated with that group. On that form, each **Detail Type** is shown in a picture, with a text description. Double clicking on either a picture, or its accompanying text description will select that detail as the **Detail Type** and close the *Group Form*, returning the user to the *Crack Form*. The list of available **Detail Type**s, and the pictures used in SQIS are included in **Error! Reference source not found.**.

Crack Incidence

The percentages of the **Detail Type** associated with the specific member with **Class 1**, **Class 2**, and **Class 3** cracking. For each class, pick from list of three ranges of percentage (each range covers 33 percent).

Detection Time

The date of the inspection during which the recorded data were observed (dd/mm/yy).

Detection Type

The type of inspection during which the recorded data were observed. Chose from list of *Inspection Types* (Table F-1).

Repair Type

The type of repair used to fix the recorded defects. Chose from list of *Repair Types* (Table F-3).

F.6 Data Analysis

The SQIS Prototype has a series of data analysis summary forms which are accessed from the *SQIS Switchboard*. There are three groups of analyses; **Organization Summary**, **Operations Summary**, and **Cross-reference Analysis**. The first two are accessed by clicking on the appropriately labeled button in the *SQIS Switchboard*. The third option is not available in the SQIS Prototype.

Organization Summary

The *Organization Summary* form provides access to forms with information on three types of companies. Users can select between; **Owner / Operator Summary**, **Class. Society Summary**, or **Shipyard Summary** (Figure F-7).

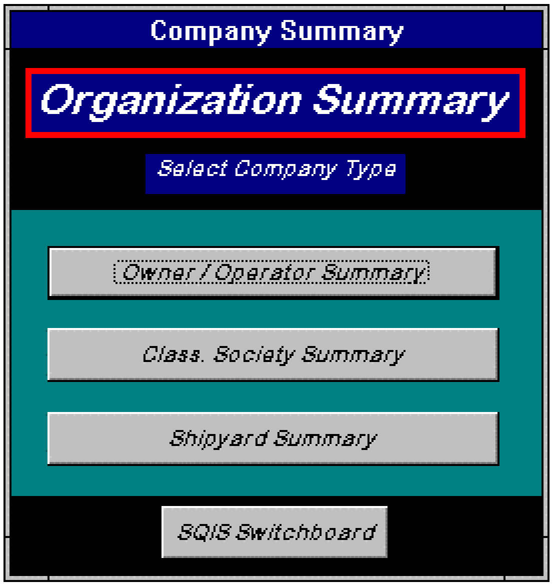


Figure F-7: Organization Summary form

Owner / Operator Company Summary

This form provides information on all the ships owned or operated by a selected company. The user selects the company in the **Select Company** DWT (Figure F-8). field from a list of all companies in the SQIS *Company Directory* with a **Company Type** of “Owner” or “Operator”. The information displayed includes: “Vessel Name”, “Class Built”, “Shipyard”, “Delivery Date”, and Clicking on the **Summary Charts** button opens the *Owner / Operator Company Summary Charts* form, which shows the number of vessels belonging to each owner and run by each operator in the SQIS database (F-9).

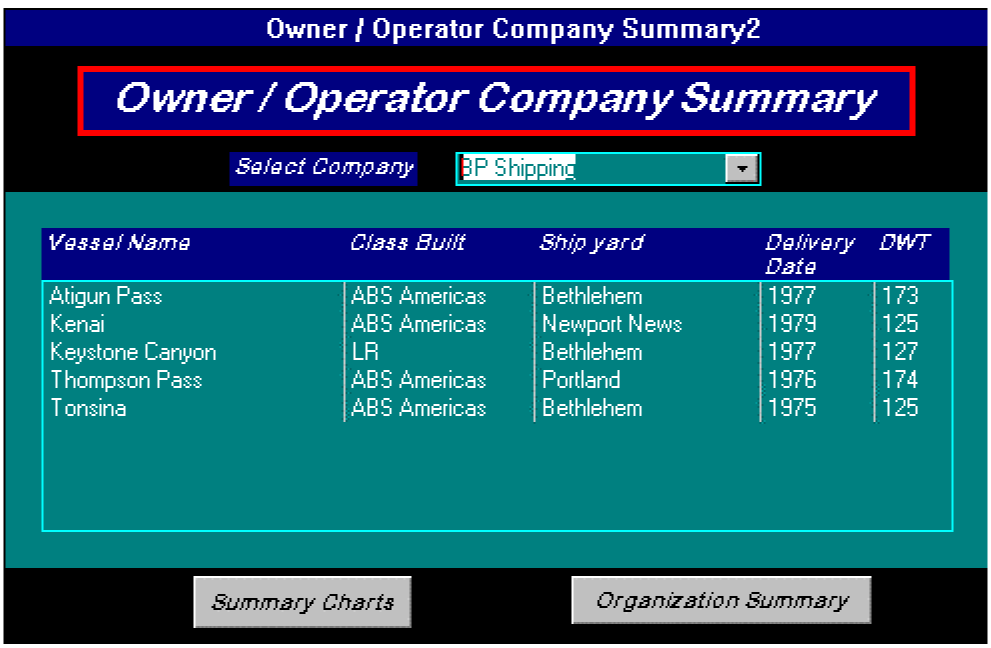


Figure F-8: Owner/ Operator Company Summary form

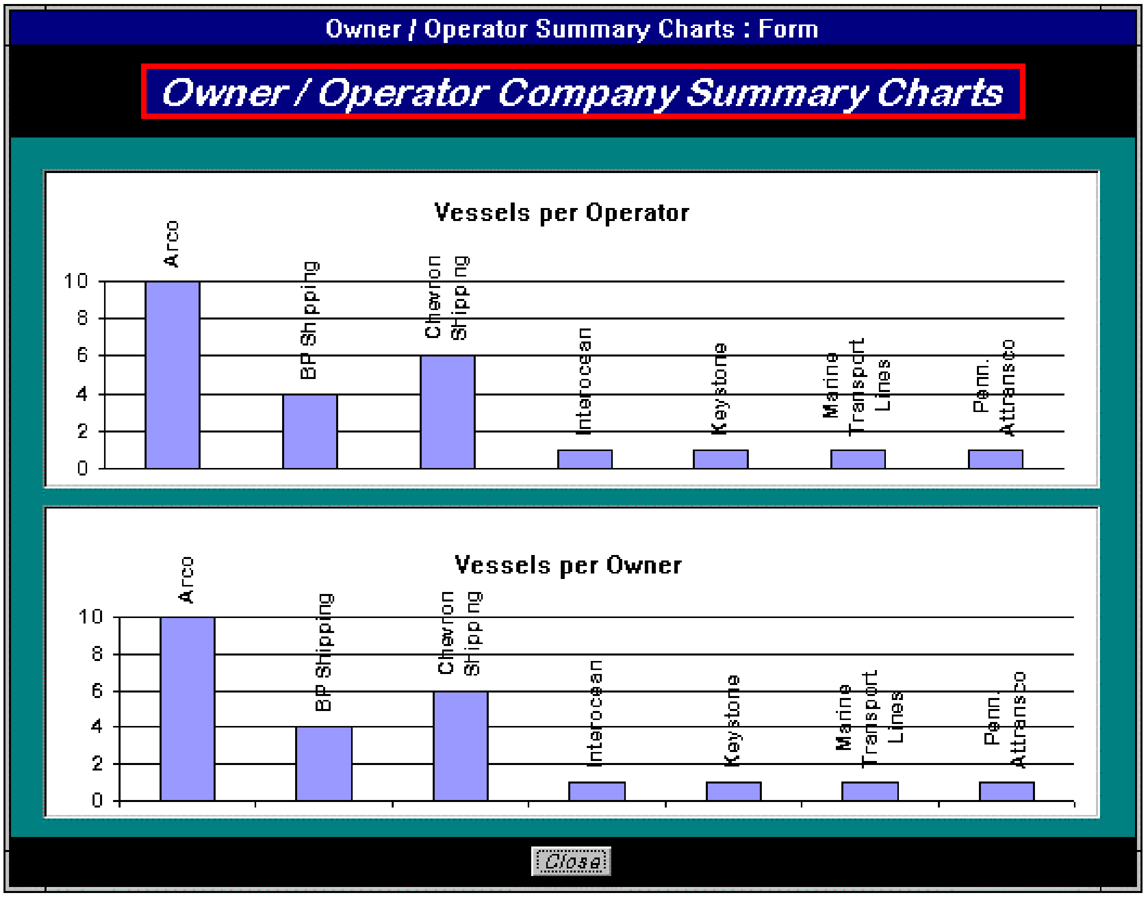


Figure F-9: Owner / Operator Company Summary Charts form

Class. Society Summary

This form provides information on all the vessels classed by a selected society at the time of construction. The user selects the company in the **Select Company** field from a list of all companies in the SQIS *Company Directory* with a **Company Type** of "Class. Society". The information displayed includes: "Vessel Name", "Owner", "Operator", "Shipyard", "Delivery Date", "Hull No.", and DWT (Figure F-10). The **Summary Charts** button opens the *Class. Society Summary Charts* for the selected company. The charts display the distributions of owners, operators, and shipyards with vessels in class, and the distribution of the delivery dates of vessels in class (Figure F-11).

Vessel Name	Owner	Operator	Shipyard	Delivery Date	Hull No.	DWT
Arco Alaska	Arco	Arco	Newport News	1977		191
Arco Anchorage	Arco	Arco	Bethlehem	1973		122
Atigun Pass	BP Shipping	Keystone	Bethlehem	1977	D586128	173
Brooks Range	Interocean	Interocean	Bethlehem	1978		176
Chevron California	Chevron Shipping	Chevron Shipping	Newport News	1980		71
Chevron Louisiana	Chevron Shipping	Chevron Shipping	Newport News	1977		40
Kenai	BP Shipping	Keystone	Newport News	1979		125
Thompson Pass	BP Shipping	Interocean	Portland	1976		174
Tonsina	BP Shipping	Keystone	Bethlehem	1975		125

Figure F-10: Class. Society Summary Form

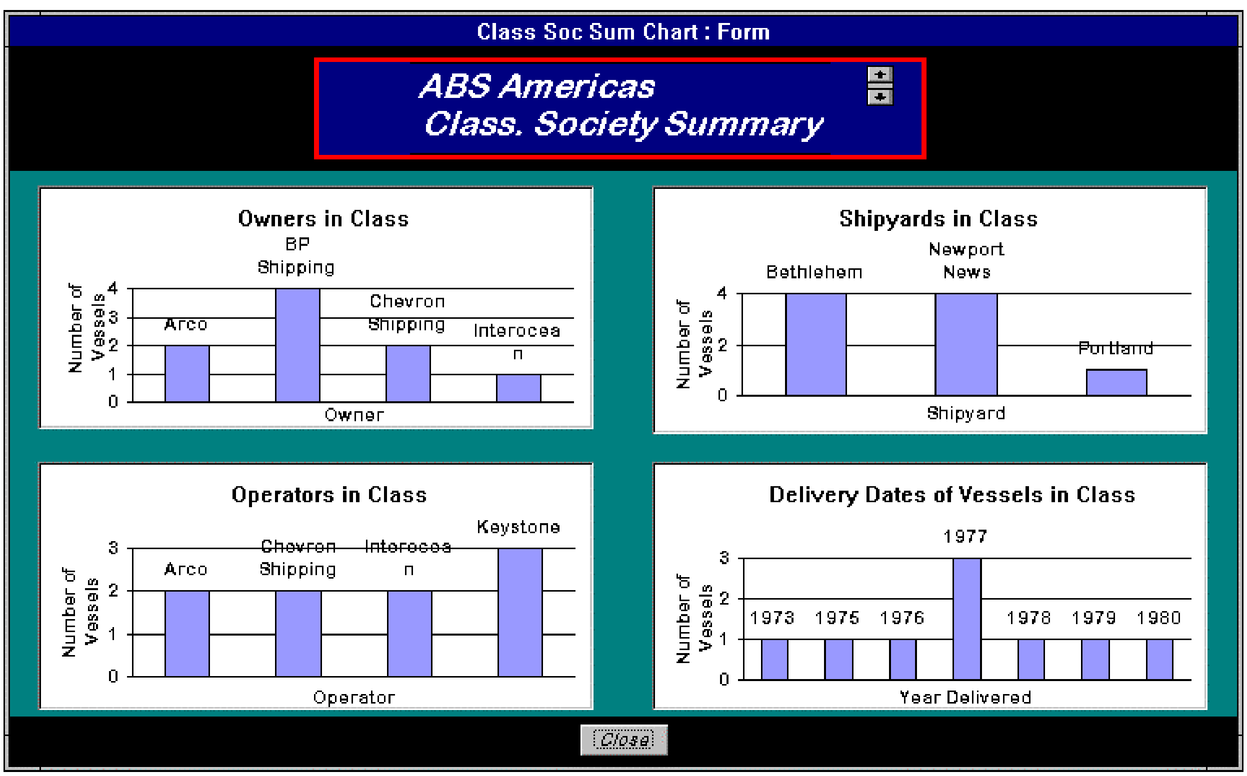
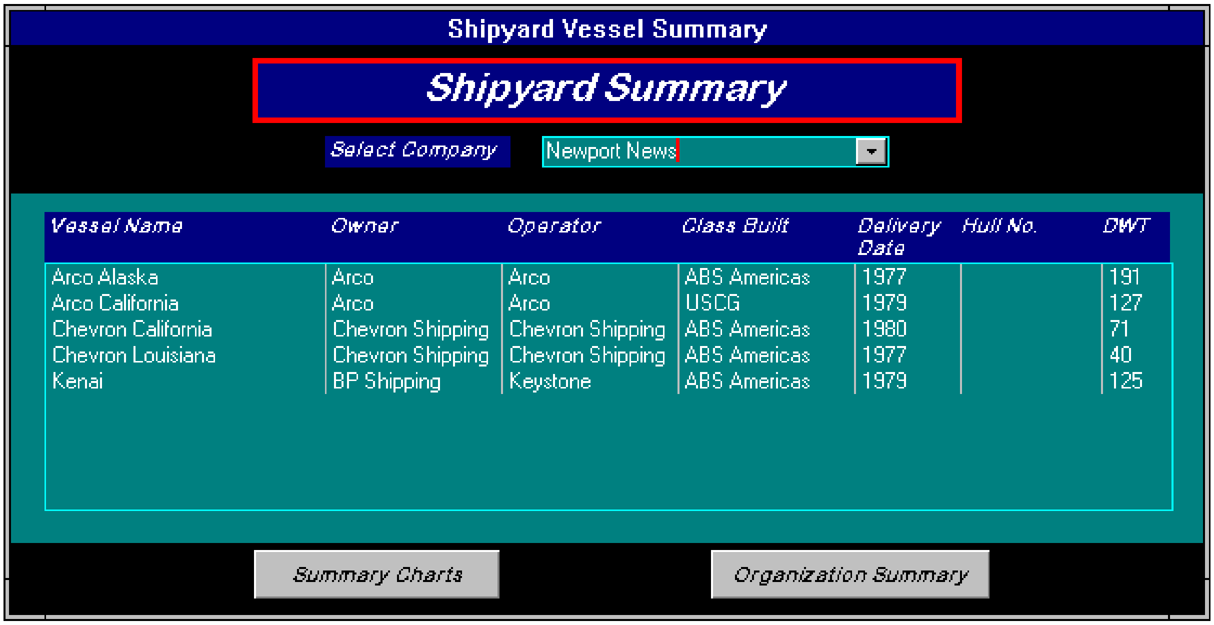


Figure F-11: Class. Society Summary Charts Form

Shipyard Summary

The user chooses a company from the **Select Company** list, which is compiled from all companies in the *Company Directory* of type “Shipyard”. The form displays information on all vessels in the SQIS database originally built at the yard of choice. Data fields include; “Vessel Name”, “Owner”, “Operator”, Class Built”, “Delivery Date”, “Hull No.”, and “DWT” (Figure F-12). The *Shipyard Summary Charts* form is opened by clicking on the **Summary Charts** button. This form displays the age distribution of the entire fleet in the SQIS system, as well as just those vessels built at the chosen yard. There are also charts displaying the owner and size distributions for the vessels built at that yard (Figure F-13).



Shipyard Vessel Summary

Shipyard Summary

Select Company: Newport News

Vessel Name	Owner	Operator	Class Built	Delivery Date	Hull No.	DWT
Arco Alaska	Arco	Arco	ABS Americas	1977		191
Arco California	Arco	Arco	USCG	1979		127
Chevron California	Chevron Shipping	Chevron Shipping	ABS Americas	1980		71
Chevron Louisiana	Chevron Shipping	Chevron Shipping	ABS Americas	1977		40
Kenai	BP Shipping	Keystone	ABS Americas	1979		125

Summary Charts

Organization Summary

Figure F-12: Shipyard Summary Form

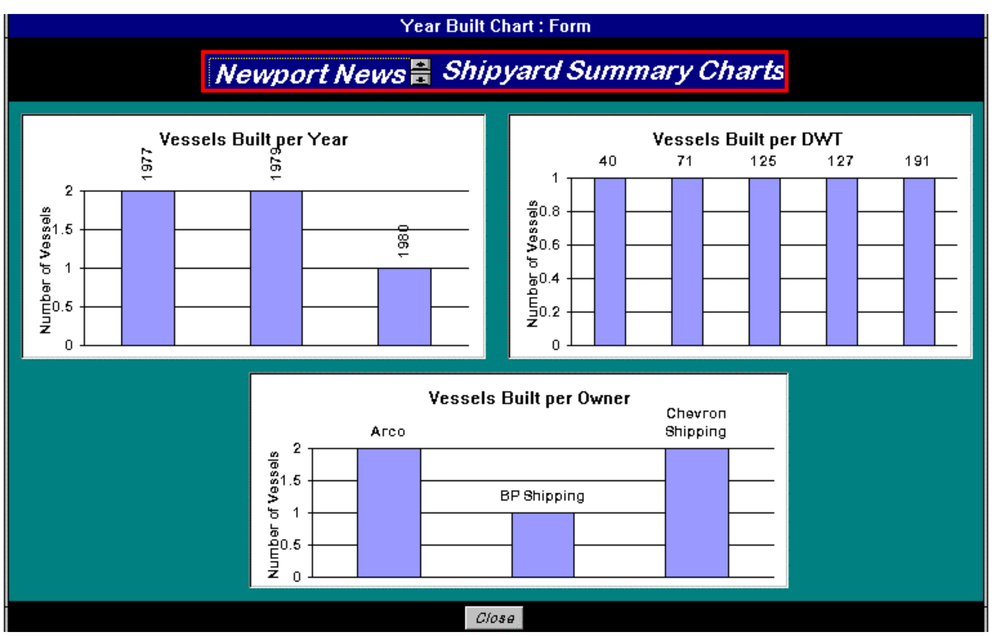


Figure F-13: Shipyard Summary Charts form

Operations Summary

The *Operations Summary* form provides access to a series of five forms summarizing the operations data contained in the SQIS database. The data is grouped in three ways; by vessel, by port, and by route. The relevant forms are reached by clicking the **Vessel Activity**, **Port Activity**, or **Route Activity** button respectively (Figure F-14).

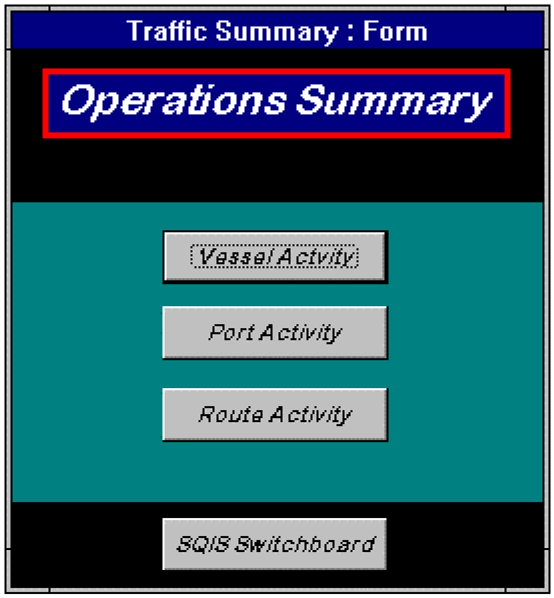


Figure F-14: Operations Summary form

Vessel Activity Summary

The user can access information on the ports visited and routes traveled within a given period. The **Vessel Name** field contains a list of all vessels in the database. The **Date From** and **Date To** fields allow the user to select the dates of interest. The form shows the origin, destination, and dates of all voyages made in the chosen period in the first table. The second table counts the number of trips made over each route in that time (Figure F-15).

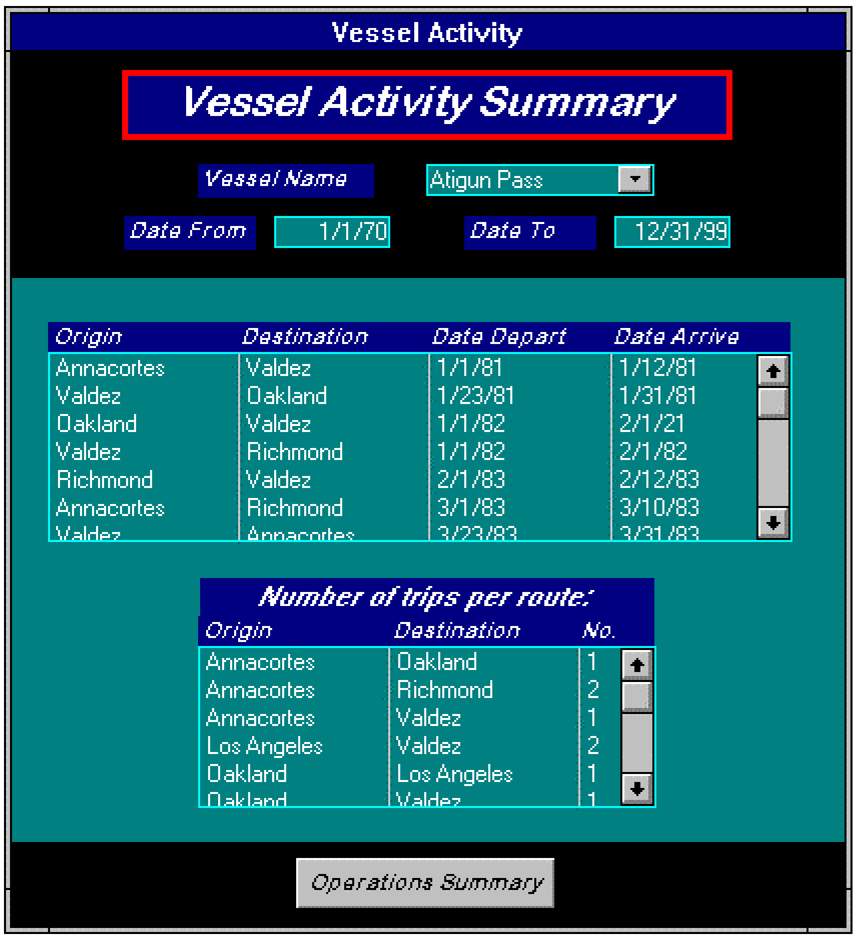
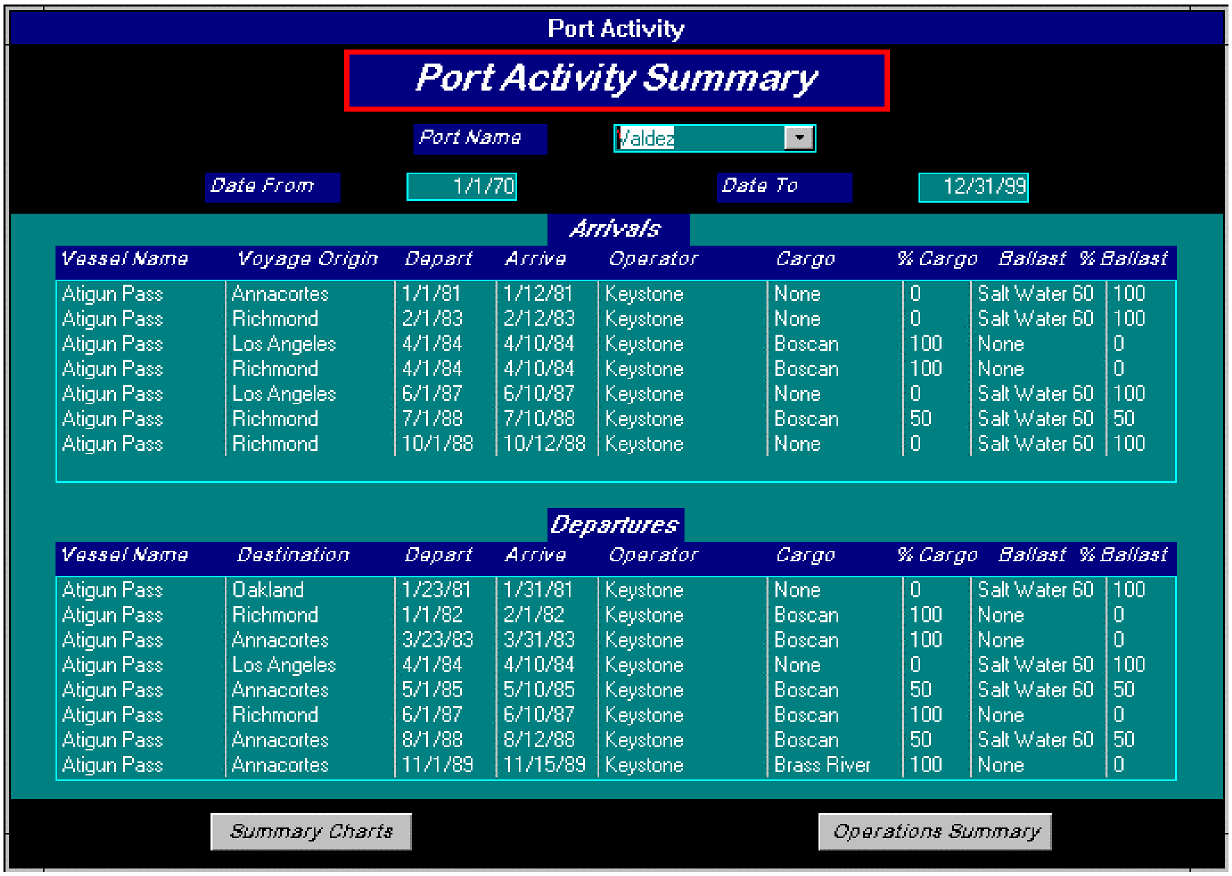


Figure F-15: Vessel Activity Summary form

Port Activity Summary

This form summarizes the activity at a chosen port over a chosen range of dates. The **Port Name** is chosen from a list of all companies in the SQIS *Company Directory* of **Company Type** “Port”. The date range is set in the **Date From** and **Date To** fields. For both Arrivals and Departures, the form displays the name of the vessel, the other end of the voyage, the voyage dates, the operator, and cargo and ballast data (Figure F-16).



Port Activity

Port Activity Summary

Port Name: Valdez

Date From: 1/1/70 Date To: 12/31/99

Arrivals

Vessel Name	Voyage Origin	Depart	Arrive	Operator	Cargo	% Cargo	Ballast	% Ballast
Atigun Pass	Annacortes	1/1/81	1/12/81	Keystone	None	0	Salt Water 60	100
Atigun Pass	Richmond	2/1/83	2/12/83	Keystone	None	0	Salt Water 60	100
Atigun Pass	Los Angeles	4/1/84	4/10/84	Keystone	Boscan	100	None	0
Atigun Pass	Richmond	4/1/84	4/10/84	Keystone	Boscan	100	None	0
Atigun Pass	Los Angeles	6/1/87	6/10/87	Keystone	None	0	Salt Water 60	100
Atigun Pass	Richmond	7/1/88	7/10/88	Keystone	Boscan	50	Salt Water 60	50
Atigun Pass	Richmond	10/1/88	10/12/88	Keystone	None	0	Salt Water 60	100

Departures

Vessel Name	Destination	Depart	Arrive	Operator	Cargo	% Cargo	Ballast	% Ballast
Atigun Pass	Oakland	1/23/81	1/31/81	Keystone	None	0	Salt Water 60	100
Atigun Pass	Richmond	1/1/82	2/1/82	Keystone	Boscan	100	None	0
Atigun Pass	Annacortes	3/23/83	3/31/83	Keystone	Boscan	100	None	0
Atigun Pass	Los Angeles	4/1/84	4/10/84	Keystone	None	0	Salt Water 60	100
Atigun Pass	Annacortes	5/1/85	5/10/85	Keystone	Boscan	50	Salt Water 60	50
Atigun Pass	Richmond	6/1/87	6/10/87	Keystone	Boscan	100	None	0
Atigun Pass	Annacortes	8/1/88	8/12/88	Keystone	Boscan	50	Salt Water 60	50
Atigun Pass	Annacortes	11/1/89	11/15/89	Keystone	Brass River	100	None	0

Summary Charts | Operations Summary

Figure F-16: Port Activity Summary form

The **Summary Charts** button leads to the *Port Activity Summary Chart* form, which provides charts displaying the distribution of vessel arrivals and departures by date, and the distribution of cargo types coming in and out of the given port, over the given period (Figure F-17).

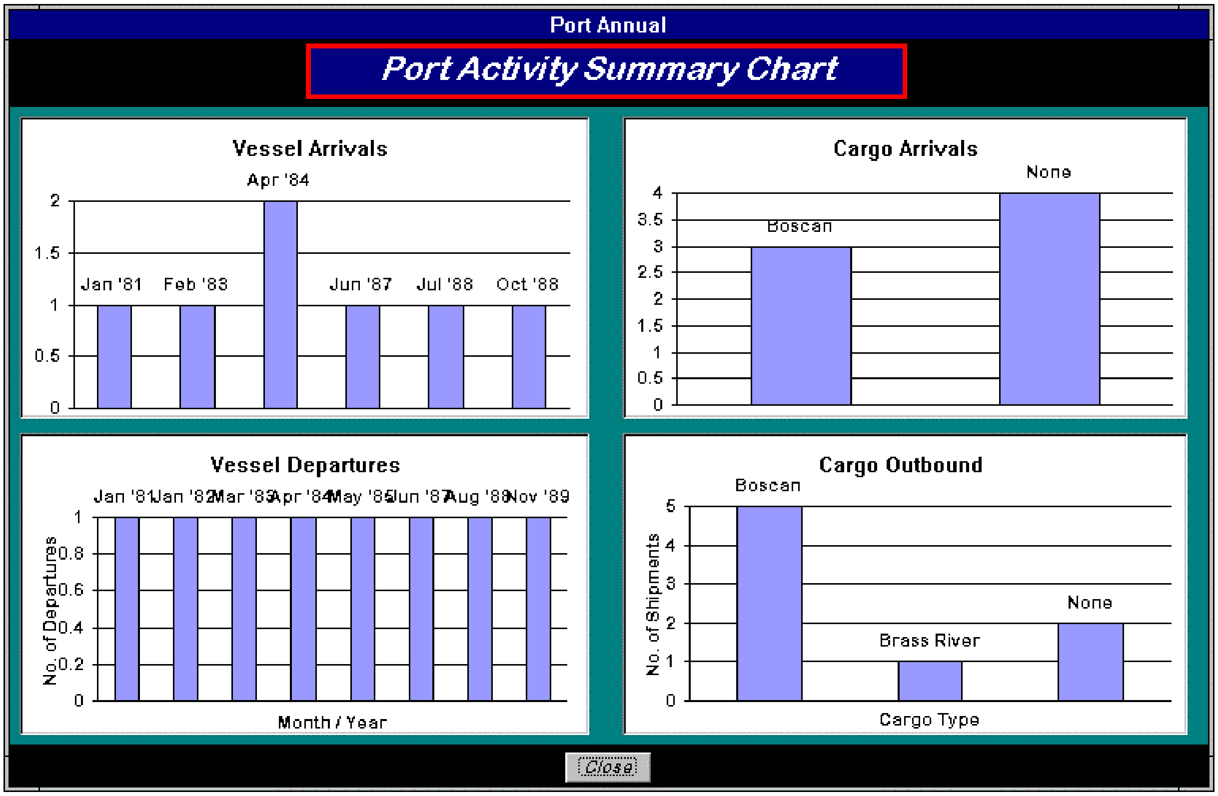


Figure F-17: Port Activity Summary Charts form

Route Activity Summary

The *Route Activity Summary* form displays the activity between a selected pair of ports, over a selected range of dates. The user selects the ports of origin and destination from lists, and sets the date range in the **Date From** and **Date To** fields. The form shows the vessels that transited that route, the operator, voyage dates, and weather and seas information (Figure F-18). The same information, along with a monthly activity summary is displayed graphically on the *Route Activity Summary Charts* form, accessed through the **Summary Charts** button (Figure F-19).

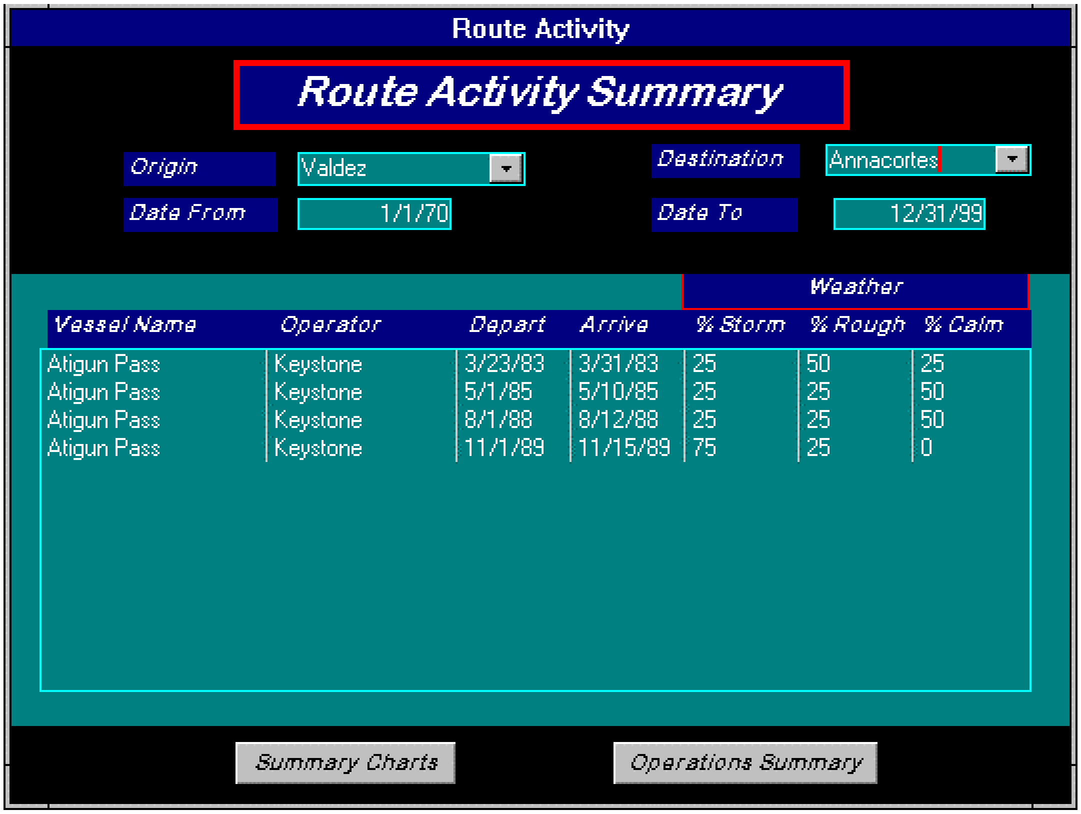


Figure F-18: Route Activity Summary form

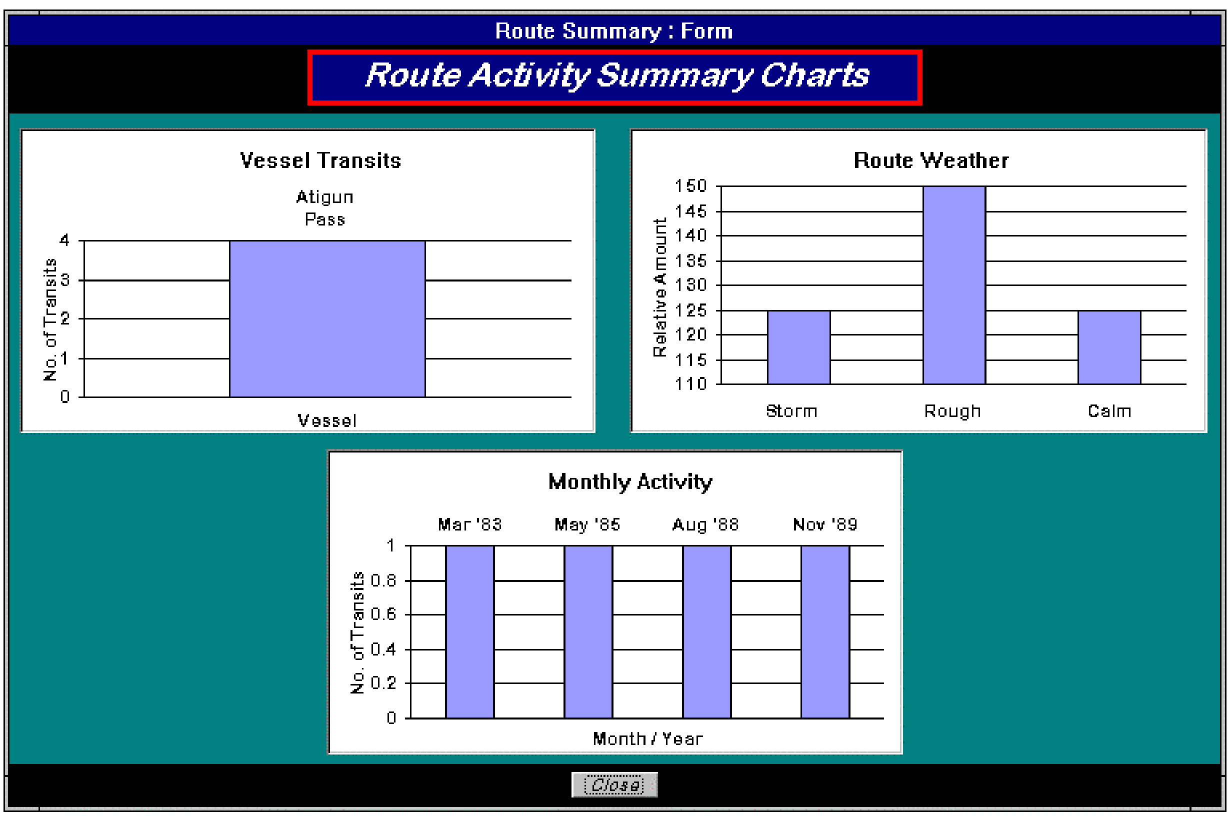


Figure 19: Route Activity Summary Charts form

F.7 Reports

The only report available in the SQIS Prototype is the *Vessel Summary Report* which is accessed from the *SQIS Switchboard* by clicking the **Vessel Summary** button in the “Reports” column. This opens the *Vessel Summary Report* form, in which the user chooses a **Vessel** from a list of all vessels in the SQIS database (Figure F-20). The user may then click the **Preview Report** button to view the report in print preview, or **Print Report** to print the report to the Windows default printer.

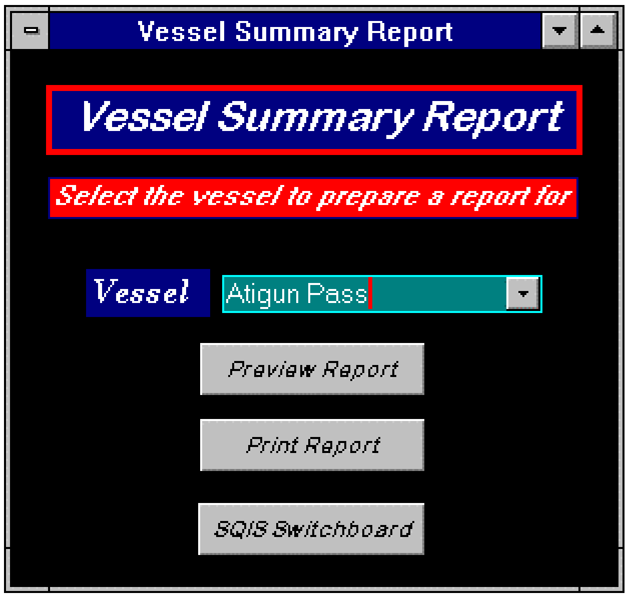


Figure F-20: Vessel Summary Report form

The *Vessel Summary Report* displays key administration information, corrosion and crack trends, and summarizes operations related information (Figure F-21). This form displays the wealth of information that the SQIS database holds on each vessel. The combination of this information, on a fleet-wide basis, which is the goal of the Industry-Wide SQIS, would provide a whole host of new ways of looking at the data. Unfortunately, such a task is beyond the capabilities of Access™.

Vessel Summary Report

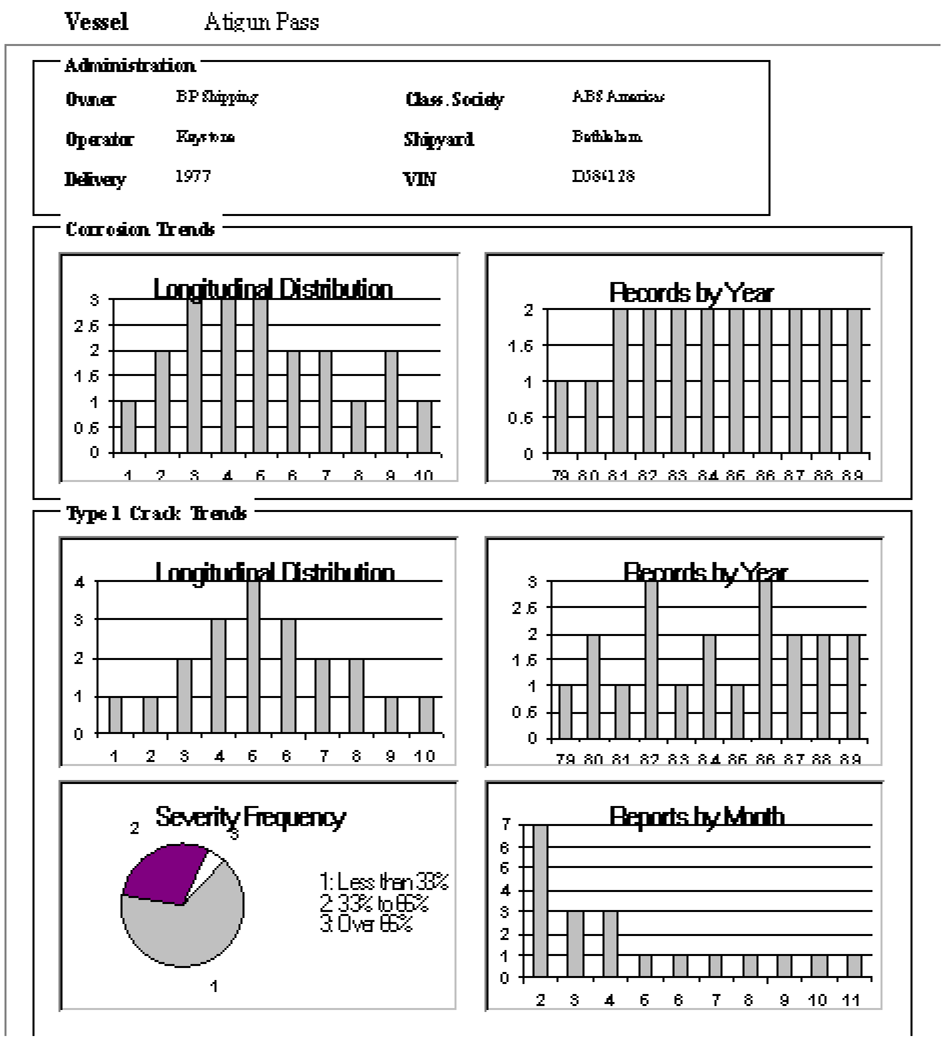


Figure F-21: Vessel Summary Report

Vessel Summary Report

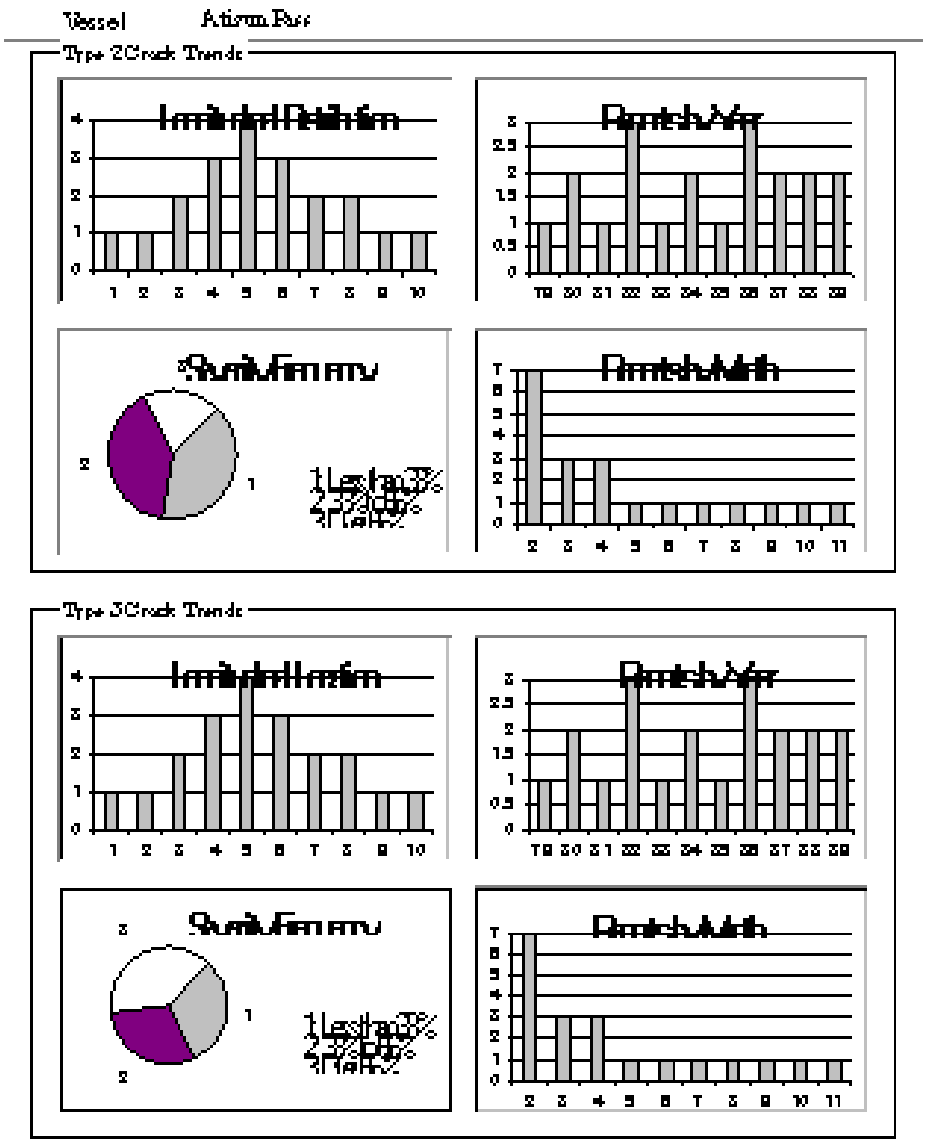


Figure F-21: Vessel Summary Report (continued)

Vessel Summary Report

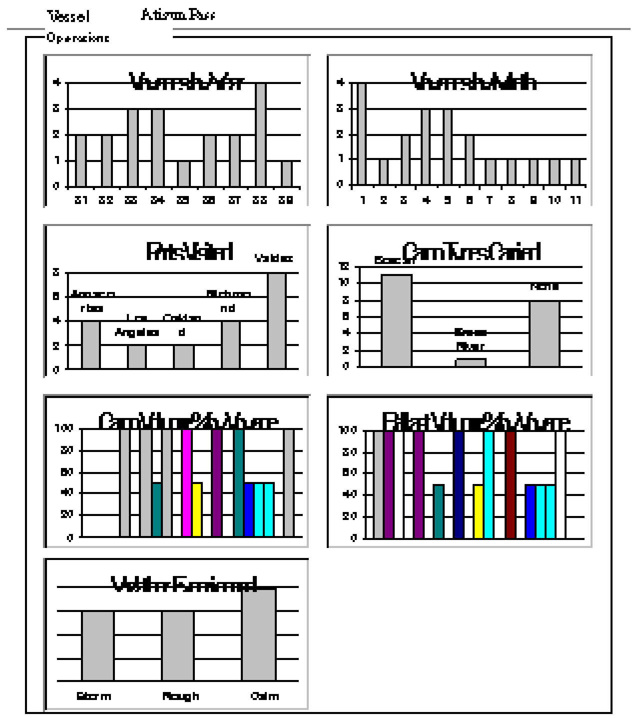


Figure F-21: Vessel Summary Report (continued)

F.8 Defined Table Contents

Inspection Type ID	Inspection Description
ACS	Annual Class Survey
CON	Continuous Survey
CUS	Close-up Survey
DDS	Dry-dock Survey
DIV	Diver Survey
DSS	Damage Survey
ILS	Voyage Survey
INT	Intermediate Survey
OVR	Overall Survey
SPC	Special Survey
SPS	Special Periodical Survey

Table F-1: Inspection Type Table

Member Type ID	Description
BG	BOTTOM LONGL. GIRDER
BKT	TRIPPING BRACKET
BP	BOTTOM PLATING
BT	BOTTOM TRANSVERSE
CG	CENTER LONGL GIRDER
DG	DECK LONGL. GIRDER
DL	DECK LONGITUDINAL
DP	DECK PLATING
DT	DECK TRANSVERSE
FB	FLAT BAR
HS	T-BHD HORIZ STRINGER
IBL	INNER BOTTOM LONGTDL
IBP	INNER BOTTOM PLATING
LBG	LONG-BHD LONG GIRDER
LBT	L-BHD TRANSVERSE
OTH	OTHERS
SBP	SWASH BHD PLATING
SBS	SWASH BHD STIFFENER
SG	SIDE LONGL. GIRDER
SL	SIDE LONGITUDINAL
SP	SIDE SHELL PLATING
ST	SIDESHELL TRANSVERSE
TBP	TRANSVSE BHD PLATING
TS	TRANSVERSE STRUTS
VG	T-BHD VERT GIRDER
VGS	VERTICAL GIRDER STIF
VS	VERTICAL BHD STIFF

Table F-2: Member Type Table

Repair Type	General Description
BUCI	Member Buckle - Insert
BUCR	Member Buckle - Weld
C1FI	Class 1 Fracture - Insert
C1FR	Class 1 Fracture - Weld
C2FI	Class 2 Fracture - Insert
C2FR	Class 2 Fracture - Weld
C3FI	Class 3 Fracture - Insert
C3FR	Class 3 Fracture - Weld
COWI	Corroded Weld - Insert
COWR	Corroded Weld - Weld
GECI	General Corrosion - Insert
GECR	General Corrosion - Weld
GRCI	Grooving Corrosion - Insert
GRCR	Grooving Corrosion - Weld
MIWI	Missing Weld - Insert
MIWR	Missing Weld - Weld
PICI	Pitting Corrosion - Insert
PICF	Pitting Corrosion - Filler
PICR	Pitting Corrosion - Weld
POWI	Poor Weld - Insert
POWR	Poor Weld - Weld
WEFI	Weld Fracture - Insert
WEFR	Weld Fracture - Weld
YIEI	Member Yield - Insert
YIER	Member Yield - Weld

Table F-3: Repair Type Table

Cargo Type ID	Cargo Type Name	Specific Gravity*1000	Viscosity (centistokes)	Pour Point (F)	Wax (% wt)	H2S (ppm)	Heating
1	Salt Water 60	1027					FALSE
2	Forcados Blend	874	8.00	5	7.00	0	FALSE
3	Brass River	810	3.00	-25	10.00	0	FALSE
4	Emeraude Marine	912	203.00	45		30	FALSE
5	Boscan	999		60	2.00	0	TRUE
6	Lagotreco	891	35.00	-55	6.00	0	FALSE
7	Lagocino	847	9.00	5		0	FALSE
8	Iranian Light	857	11.00	0	8.00	70	FALSE
9	Iranian Nowruz	944	917.00	-15	4.00		TRUE
10	Qatar	818	4.00	5	7.00	300	FALSE
11	Mingi	848		95	30.00	0	TRUE
12	Seria Light	830		60	8.00	0	FALSE
13	Duria	917		36	18.00	0	TRUE
14	Fresh Water 60	1000					FALSE
15	Salt Water 50	1028					FALSE
16	Fresh Water 50	1001					FALSE

Table F-4: Cargo / Ballast Type Table