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Requirements for the effective Planning, Scheduling, Reporting and Storage applied to the underwater inspection of offshore installation, pipelines and subsea systems.

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SECTION 1.0

INTRODUCTION

1.0 INTRODUCTION

1.1 General

The underwater inspection of offshore installations, pipelines and sub-sea systems is a sophisticated, onerous and expensive process. The success of this undertaking is wholly dependent upon the establishment of an inspection philosophy that recognises the constraints imposed both by the environment and the available technology. This philosophy must encompass those aspects of the process involving the identification of the criteria that will define the inspection requirement, the methodology to undertake the particular task and the techniques to be employed in the analysis of the survey results.

This report addresses the components of the inspection process fundemental to the control and co-ordination of the operation. The particular needs of the planning, scheduling, reporting and storage activities are discussed and the information requirements for each activity outlined.

1.2 Background

The requirement to undertake inspection and maintenance of offshore installations must, of course, be analysed to ensure that the organisation benefits from these activities. The activities can be assessed against the following parameters;

1. Confirmation of the continued structural and mechanical integrity of the installation.

2. Identification of potential problem areas.

3. Avoidance of structural or mechanical collapse.

4. Avoidance of production shut-down.

5. Avoidance of pollution.

6. Compliance with local legislation.

7. Ability to extend the design life of the installation.

8. Provide design criteria for any additional construction or repair work.

This report is based on the presumption that the requirement to inspect has been established. This requirement being the result of the need to ensure continued, safe production from or through the particular offshore installation.

1.3 Overview

The Inspection Management Group (IMG) of the organisation responsible for the particular installation is charged with the duty of developing the basic philosophy, co-ordinating and directing the actual work and reporting on the findings of the work. This necessitates the effective management of the committed resources including human, financial material and data. The recognition that data is indeed a resource requiring management is a recent development.

In fact, the value of data is unique in that the entire organisation depends on its availability for the management of other resources. Any organisation that fails to treat data as a resource and to manage it effectively will be handicapped in how it manages its human, material and financial resources.

The contention of this report is that the formation of inspection policy and the management and control of the operation are wholly dependant upon the development and implementation of an effective information system.

This report identifies the fundemental information that should be addressed in the development of an overall inspection strategy. The source of the information and its use within the IMG are discussed and the concept of data management introduced.

1.4 Definitions

For the purposes of this report the following definitions shall apply:

Planning	The high level preparation of inspection policy and budget estimates for undertaking the work.
Scheduling	The detailed organisation of the individual inspection tasks into coherent and logical units and sequences.
Reporting	The preparation of information that details the progress of the work and the performance of the operatives.
Storage	The containment of relevant information and the entry and retrieval mechanisms for the information.

1.5 Document Structure

Section 2.0 outlines the requirements for effective data management techniques to provide a framework within which control can be exerted over the operation. The relationship between data management and the organisational structure it must service is developed. Section 3.0 considers the data sources that must be addressed in the formation of inspection policy. This looks at the criteria that define inspection requirements, the available technology and the management skills associated with underwater inspection and maintenance.

The final section outlines the use of computers by the various parties involved in inspection and identifies particular features and facilities that are regarded as essential to the success of these systems.

SECTION 2.0

DATA MANAGEMENT

2.0 DATA MANAGEMENT

2.1 Introduction

The development of inspection policy requires a careful consideration of the information generated during the design, construction, installation and previous inspection phases of the installation.

In a perfect world a reasoned analysis of the information would yield an inspection policy that would command the respect and acceptance of all interested parties. However, the scale of such a task is enormous. The volume of information generated in each of these phases can be massive and figures for some North Sea developments would indicate that this involves many thousands of drawings and many hundreds of yards of shelf space of documentation [1]. This massive amount of information together with the fact that it is unlikely to be structured to facilitate the needs of the IMG makes a rigorous inspection analysis almost impossible. Faced with such a task the development of inspection policy is generally intutitive in nature.

Consequently in order to enable a reasoned analysis to be undertaken it is essential that not only the key information is identified but also it is organised in a manner to facilitate analysis. These two criteria form the basis of data management.

2.1.2 Key information is not a consistent commodity across different organisations. The organisational and accounting procedures of individual companies will combine to create criteria unique in the majority of instances. However, some recognition of inherent similarity is obviously sensible and the following data areas would require addressing.

1. Design Criteria

2. Design Configuration

3. Design stress regimes (static and fatigue)

4. As-built Configuration

5. As-built QA/QC Records

6. As-installed Configuration

7. In-service Environmental Records

8. In-service Inspection Reports

9. In-service Construction Records

10. Re-analysis Results

2.1.3 Data Structure

A mechanism is obviously required to store this data and provide a means for easy retieval and analysis. An array of methodologies have been tried with varying degrees of success. Manual file systems, microfilming and of course computer systems have all been employed and each has its advocates. However, it is generally the case that a comprehensive information regime would employ all three in some capacity. Whereas manual file systems and microfilming may be suitable for static data operating in a well defined business environment the computer offers greater flexibility and performance.

Which ever system is chosen, great care and attention is required at the design stage to identify the information needs of the organisation. Those areas that are defined as fundemental to the success of the operation must be positioned to facilitate rapid and straight forward access. The constituent information for standard reports must be logically linked to enable the compilation of these reports to be undertaken.

Data management therefore requires that;

1. Information needs of the organisation are defined and understood.

2. Storage and access mechanisms are designed to reflect the organisation's needs.

2.2 Information Needs

To benefit from the data management approach the organisation must analyse its information needs and plan its data management system accordingly. Without such planning the results may well be disasterous. The resulting system may provide for limited applications but will not provide a resource that can be shared by engineers throughout the organisation. It would, in short, become an expensive storage method.

A major objective of data management planning is to develop a strategic data model. This data model should be a model of the information needs of the various levels of management within an organisation.

There are, generally, three recognised levels of management planning and control in an organisation:

1. Strategic
2. Tactical
3. Operational

The relationship between the management levels is depicted in Figure 2.1. The particular areas of responsibility are outlined in the following sections and graphically described in Figure 2.2.

2.2.1 Strategic Management

Strategic managers are responsible for the overall performance of the enterprise and will rely on data presented in highly summarised form. A manager at this level requires a decision support system that can respond to ad-hoc queries for information and simulate various planning alternatives.

This level of management is responsible for the definition of inspection policy. A first decision is, of course, to choose between either a breakdown or preventive maintenance approach. The selection criteria would include:

1. Safety Considerations
2. Pollution
3. Availability of replacement installation
4. Cost of replacement versus cost of maintenance
5. Projected installation life.

For the majority of areas of offshore operation preventive maintenance provides the only real alternative. The potential cost in terms of human life, pollution and ultimate replacement of a major installation failure would be far too great to countenance.

Areas to be addressed by strategic managers for which a decision support system must supply the relevant information are:

1. Technical summary of inspection design criteria, i.e. critical stress ratios, fatigue lives and geometric configurations.

2. Technical summary of scope of work, i.e. number of MPI, visual, CP etc inspections to be performed and at what frequency.

INFORMATION REQUIREMENTS BY MANAGERIAL LEVEL

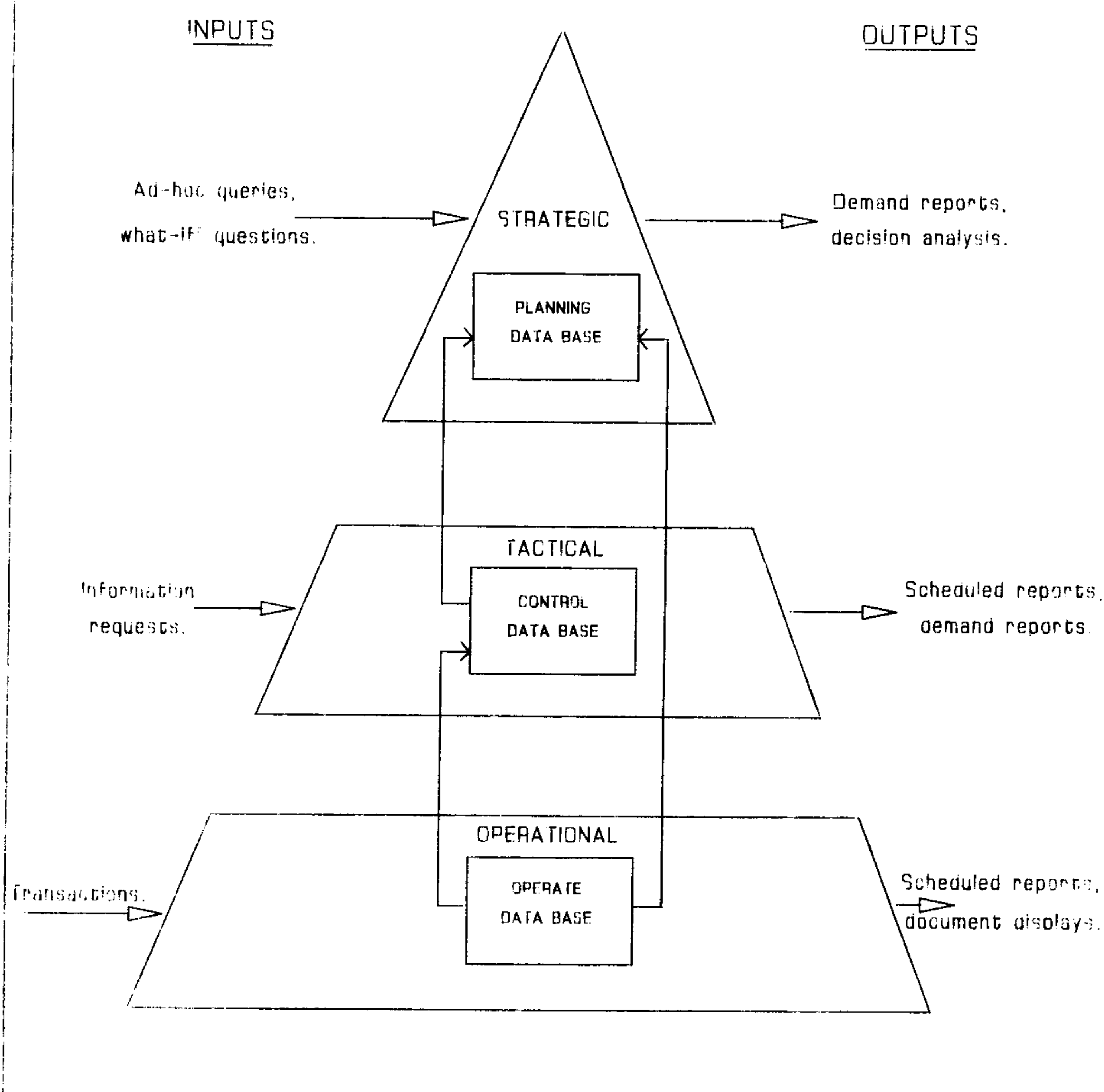
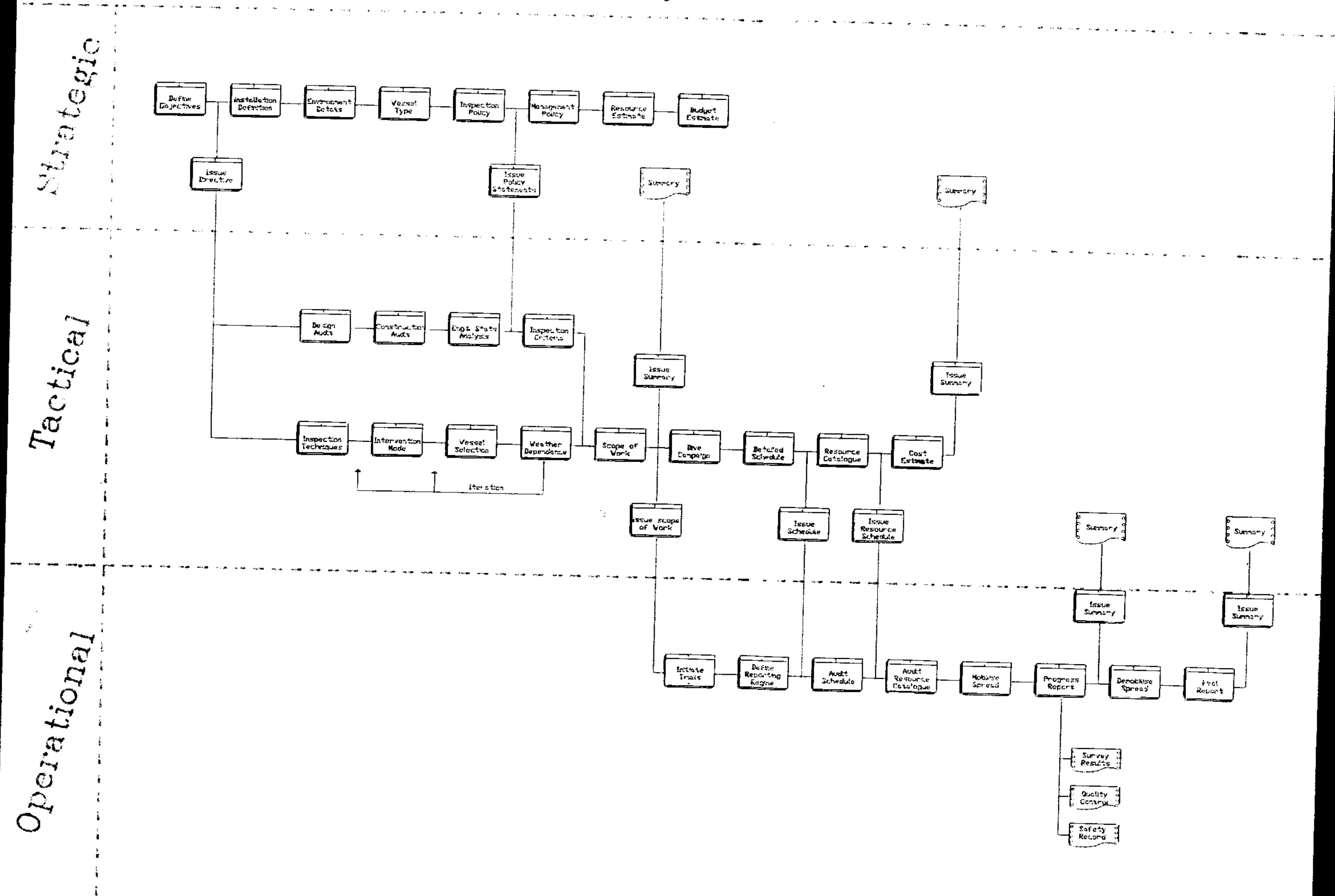


FIGURE 2.1

Underwater Inspection Activity Chart



Thalassa	System Overview	U.E.G. Project 72 Study 5	Figure No. 2.2
			Date: 10th Sept, 1986

3. Major resource schedule, i.e. air, sat, and ROV spread complements together with durations.

4. Vessel characteristics versus envisaged environmental conditions.

5. Internal management structure, i.e. division between operations, engineering and document control.

6. Manpower, i.e. numbers of staff and breakdown of permanent and contract personnel.

7. Liaison with other departments, drilling, production etc.

Decisions relating to any one of these areas will obviously have an effect on many of the other areas. The development of a coherent policy is, therefore, iterative in nature. Attempts have been made to formulate mathematical models of the subsea inspection process to assist the decision maker. As yet, however, these models have not achieved general acceptance [2,3].

Of potentially more benefit is the application of knowledge based engineering skills and artificial intelligence techniques. These dependent areas of research hold out great promise of being able to provide a true "Expert System" to assist the decision making process. Such systems will be capable of assimulating operational data and modifying the model accordingly. The advantage with these particular areas of research is that problems with a large number of ill-defined dependencies can be accommodated. The relevance of this capability to subsea inspection is obvious [4].

2.2.2 Tactical Management

Tactical management is concerned largely with the process by which resources are obtained and used effectively and efficiently. Management control is concerned with balancing the use of resources, measuring progress against plans, and taking corrective action when necessary.

As shown in Figure 2.1 tactical managers require information in the form of summaries of operational data and management control reports such as budget summaries. This information must be made available in response to ad-hoc requests as well as in the form of periodic reports.

The tactical manager is responsible for the detail scheduling of the inspection activities. Choices as to the work methodologies and resources to be deployed are made at this level. The particular areas to be addressed by tactical managers include,

1. Detailed technical audit of design and fabrication information.

2. Identification of inspection design criteria based on sound engineering practice.

3. Detailed evaluation of inspection techniques and selection of most appropriate.

4. Detailed evaluation of available intervention modes and selection of the most approriate.

5. Technical appraisal of contractor tender submissions.

6. Appointment of client representative for offshore operations.

7. Detail scheduling and resource allocation for all activities.

8. Monitor progress and where appropriate formulate alternative schedule or research substitute resource availability.

9. Review submitted dive reports with regard to satisfactory completion of the work and requirements for additional works.

10. Analyse submitted survey results to verify the integrity of the installation.

11. Review overall inspection policy as a result of analysis performed in 10.

The tactical manager has a large amount of choice in terms of computer systems to provide analysis and scheduling assistance. The most widely used is probably the ARTEMIS project management system developed by Metier.

2.2.3 Operational Management

Operational control focuses on the execution of specific tasks and activities. It is concerned with scheduling and controlling individual jobs, procuring materials, and taking specific personnel actions.

Data required for operational control is detailed and frequently non-monetary. It is based on transactions such as with requests, dive logs and procedures details. The operational control system must produce operating documents and displays that are immediately useful for operational decision making.

This facet of management is concerned with workface activities ensuring that the resources are utilised in the most effective manner. In addition the quality of the work and inspection survey results are monitored to provide reliable data for analysis and interpretation. Areas of responsibility would generally include:

1. The relevant standards of safety and working practices are adhered to at all times.

2. The work is progressed in a professional manner.

3. The results of the survey are logged in a competant and verifiable way.

4. Technical acceptance of the work.

5. The logging of all durations and resource utilisations associated with the performance of the work.

6. Recommendations with regard to additional works as a consequence of the inspection survey.

A number of companies have developed bespoke computer systems to assist the recording of survey results. Generally these are based on single-user desk-top computers employing a proprietory data base management system.

2.3 System Structure

The various levels of management involved in underwater inspection require access to, essentially, the same data. The view and presentation of the data however varies from one group to another. The information system that supports the planning, scheduling, reporting and storage activities of the management groups must, therefore, reflect these differing views and uses.

The most common method of archiving drawings and documentation is by the use of microfilming or microfiching techniques. A manual or computer driven index system provides a record of the physical location of an individual item. The major drawback of such an approach is that cross-referencing modifications to drawings or documents quickly becomes very complex. Direct computer based storage systems will overcome this problem at a cost. Depending upon the nature of the installation and the inspection policy some compromise between these two options will serve the needs of individual operators.

The improved cost and performance characteristics of optical storage systems has added a third option. Currently this technique most closely resembles the microfilm/fiching option but the improving robustness, performance and space utilisiation must make this form of storage the most economic for future developments.

To manage their key data more effectively, many organisations are formally defining this data and placing them onto computer systems. The preferred methodology is to utilise some form of data base management system. A data base is a shared collection of inter-related data designed to meet the varied information needs of the organisation. A data base has two important properties: it is integrated and it is shared.

By integrated it is meant that previously distinct data files have been logically organised to reduce (or hopefully eliminate) redundancy and to facilitate data access. By shared it is meant that all qualified users in the organisation have access to the same data, for use in a variety of activities.

Implementing the database approach requires a large investment of organisational resources. An investment in new software products, additional hardware and new personnel skills are normally required. Management committment and time are also needed. Other costs include education and training, conversion and documentation. To justify the conversion to data base, an organisation should perform an extended analysis of benefits and costs.

A quick indication of whether data base is justified can often be obtained by considering the information systems context in a company. The following factors favour the database approach in an organisation.

1. Application needs are constantly changing, with considerable uncertainty as to the important data elements, expected update or processing functions, and expected volumes to be handled.

2. Rapid access is frequently required to answer ad-hoc questions.

3. There is a need to reduce long lead times and high development costs in developing new applications systems.

4. Many data elements must be shared by users throughout the organisation.

5. There is a need to communicate and relate data across functional and departmental boundaries.

6. There is a need to improve the quality and consistency of the data resource and to control access to that resource.

7. Substantial dedicated programming assistance is not normally available.

The implications, advantages and disadvantages of employing computer based inspection information systems are discussed in Section 4.0

2.4 Conclusions

The implementation of effective data management techniques requires the commitment of all involved in the enterprise to secure the benefits of improved information flow and accessibility. The existing management structure and individual personnel skills may well require review and enhancement in order to maximise the potential benefits.

An educational process involving not only the manipulation and operation of the system but also the implications of the availability of information and level of detail of this information will be required. This could very well result in the re-definition of the responsibilities and duties of individual members of the management team. The operation of the information system must involve an assessment of the benefits achieved compared to these envisaged. The system should be subject to detailed post-evaluation studies to ensure maximum advantage is made of the system and to highlight areas of inprovement. In short the adoption of an information system to facilitate the needs of data management require the imposition of product management techniques to that system.

SECTION 3.0

THE INSPECTION PROCESS

3.1 INTRODUCTION

It is conceivably true that the inspection process can be described as attempting to predict the future utilising historical data and current analytical techniques. The application of such a supposition to the subsea inspection work associated with offshore installations sharply exposes current problem areas. The accessability and usefullness of historical data can generally be described as difficult while survey result and defect evaluation techniques are still recognised as being formative. Against this background the definition, organisation and performance of subsea inspection must be undertaken by the responsible management group.

This group must assess the work scope, validate the survey results and subsequently satisfy all interested parties as to the continued safe performance of the installation.

The identifiable areas of responsibility can therefore be defined as:

1. Inspection Requirements.
2. Inspection Techniques.
3. Intervention Modes.
4. Inspection Implementation.
5. Inspection Survey Results Analysis.

This section shall define the parameters that are fundemental to the formulation of management policy with regard to the above five areas. In particular the inter-relationships shall be highlighted as these five areas cannot, in reality, be considered as totally separate entities.

The information pertinent to each of the described areas is graphically represented in figures 3.1, 3.2, 3.3 and 3.4. This information is supplied in a variety of formats including free text, standard forms, computer output, photographs drawings, microfilm and in some instances magnetic tape. The data management system must be capable of coping with each of these mediums.

The scope and methodology for introducing computers to this environment was discussed in the previous section. The development of computer systems to provide ready access to historical data, undertake trend analyses of this data or provide monitoring facilities of work is progress can yield benefits not only of quality of information but also costs of data collection and reporting. This section shall outline those areas of the inspection process that must be addressed in the development of a comprehensive information system for sub-sea inspection and maintenance.

3.2 INSPECTION REQUIREMENTS

The formulation of the inspection programme is wholly dependant on a definition of the criteria that will determine the inspection requirements of individual components. These criteria are based, in the first instance, on the results of the original design analyses. These analyses will identify those areas of the installation that experience high stress levels, are subject to low fatigue lives or are suseptible to scouring. As important is the definition of criteria upon which the design was based, this will enable the validity of these parameters to be monitored in service.

The inspection programme should not be viewed as a static, inert object. The collection of survey data will facilitate the review of the programme based on the analysis of the results. Experience of the performance of the installation together with any change of use resulting in differing loading conditions will contribute to periodic re-appraisal of the relevance and limitations of the adopted inspection programme.

3.2.1 STRUCTURAL DESIGN

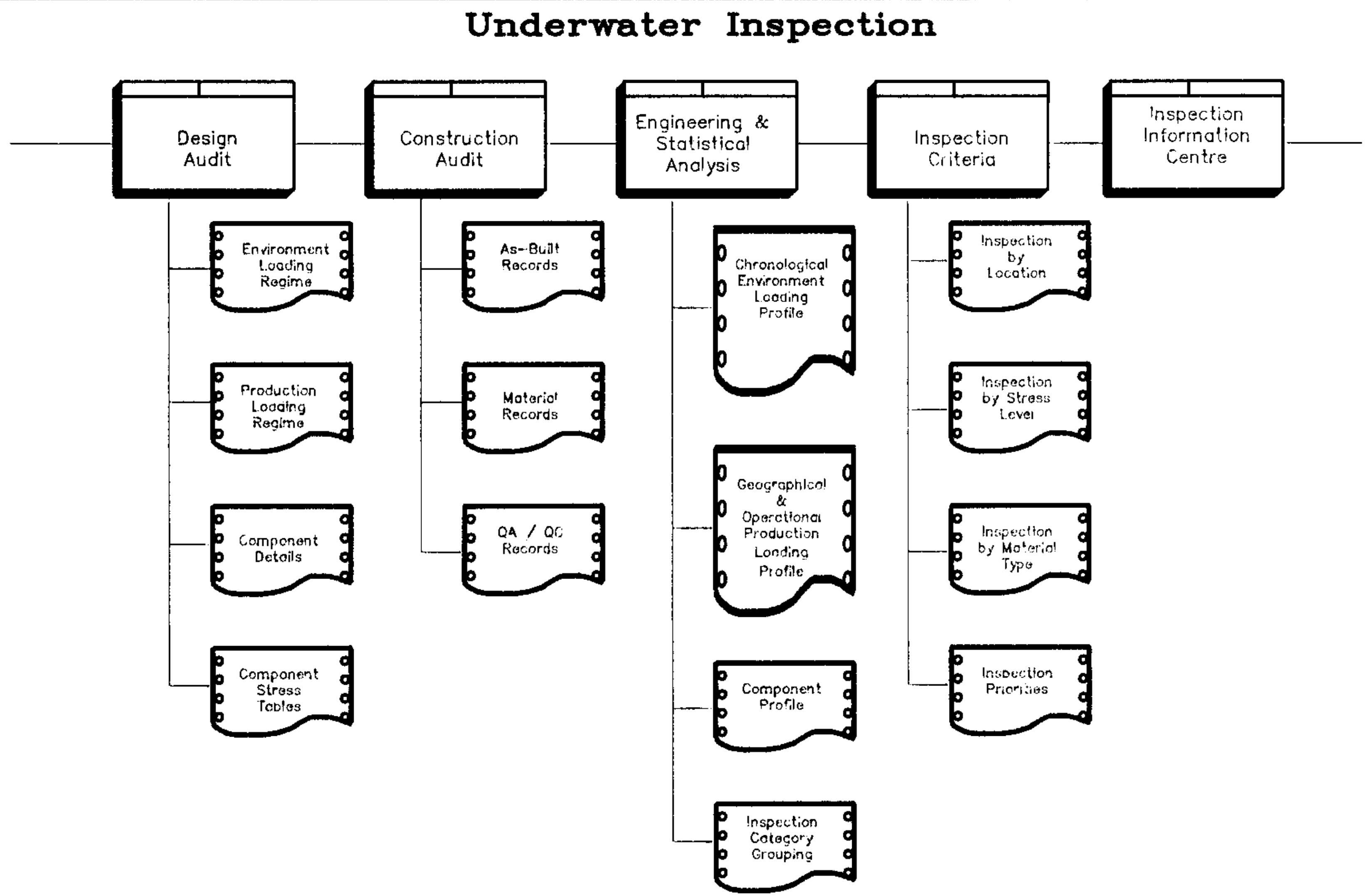
The environment for which offshore installations are intended is recognised as both hostile and severe. The complex loading patterns and regimes induced by the environment while appreciated are not completely understood. The design process is, therefore, necessarily onerous.

Such a situation only benefits the Inspection Management Group (IMG). To fulfill their role the Design Engineering Group (DEG) must collate detailed information with regard to the following:

1. Environmental Loadings.
2. Production Loadings.
3. Individual Component Descriptions.
4. Individual Component Stress Levels.
5. Individual Component Fatigue Lives.

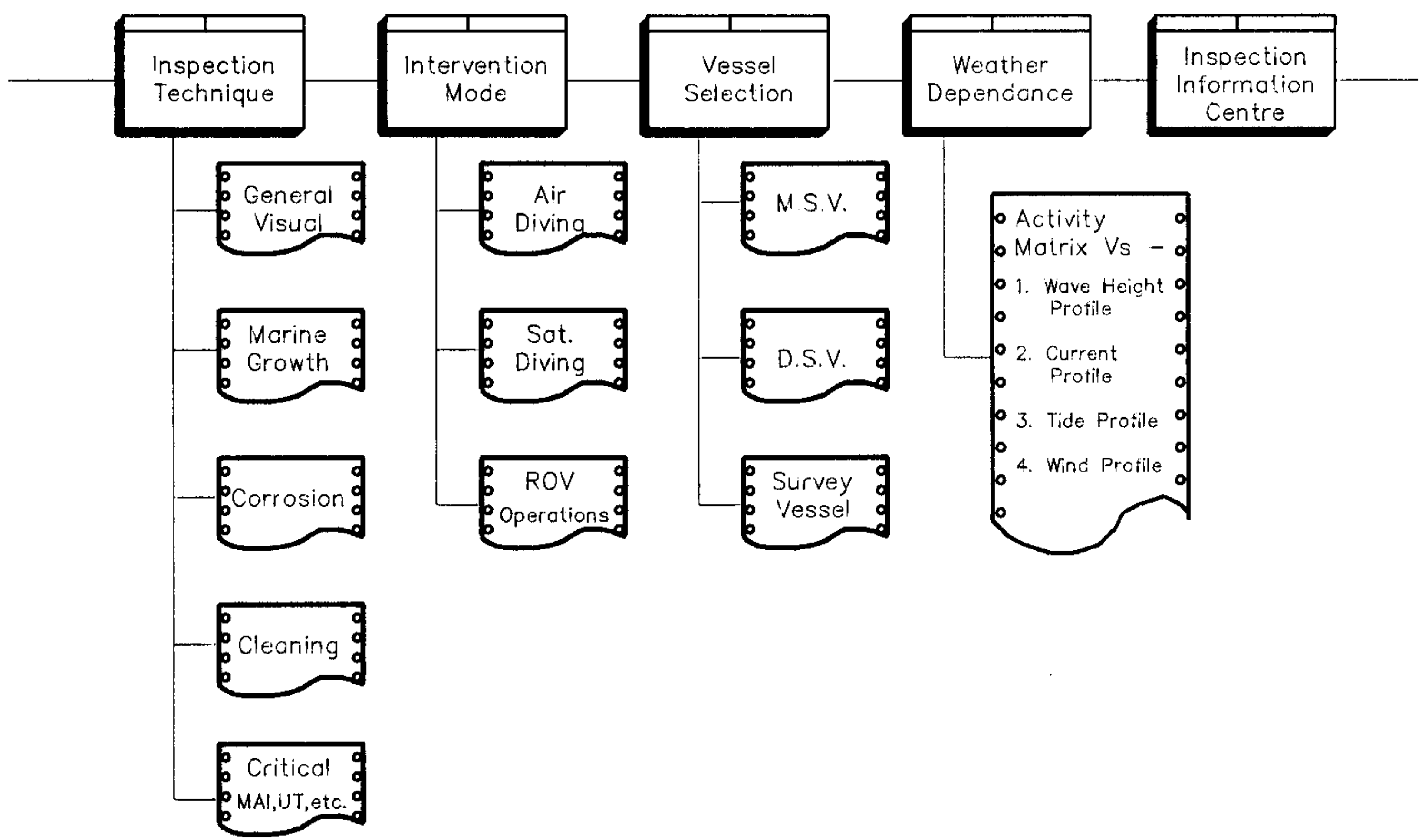
Environmental Loadings

These loadings are defined as all loadings that are induced as a consequence other than that of man.



Thalassa | Inspection Requirements | U.E.G. Project 72 Study 5 | Figure No.3.1 | Date: 11th Sept,1986

Underwater Inspection



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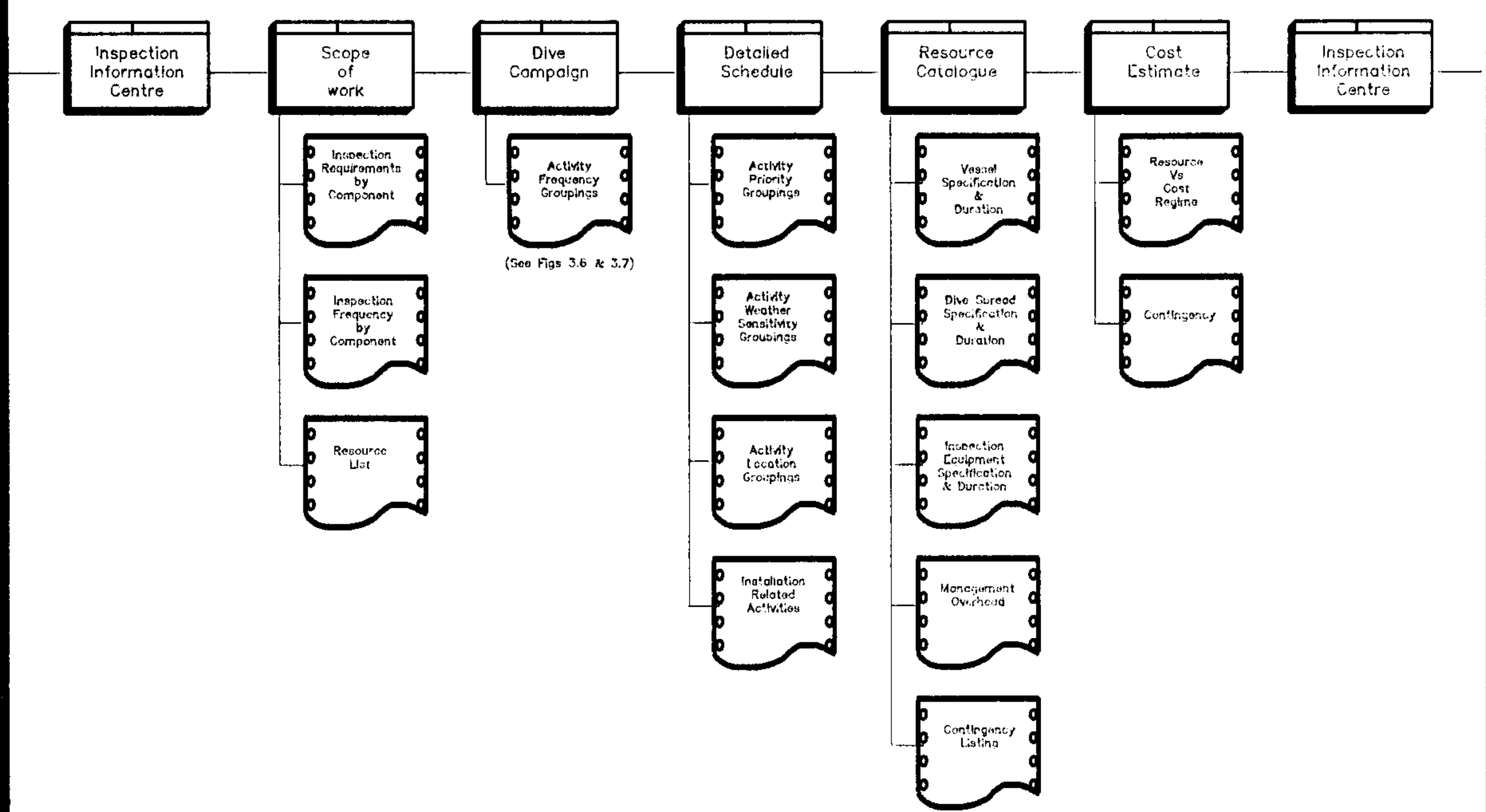
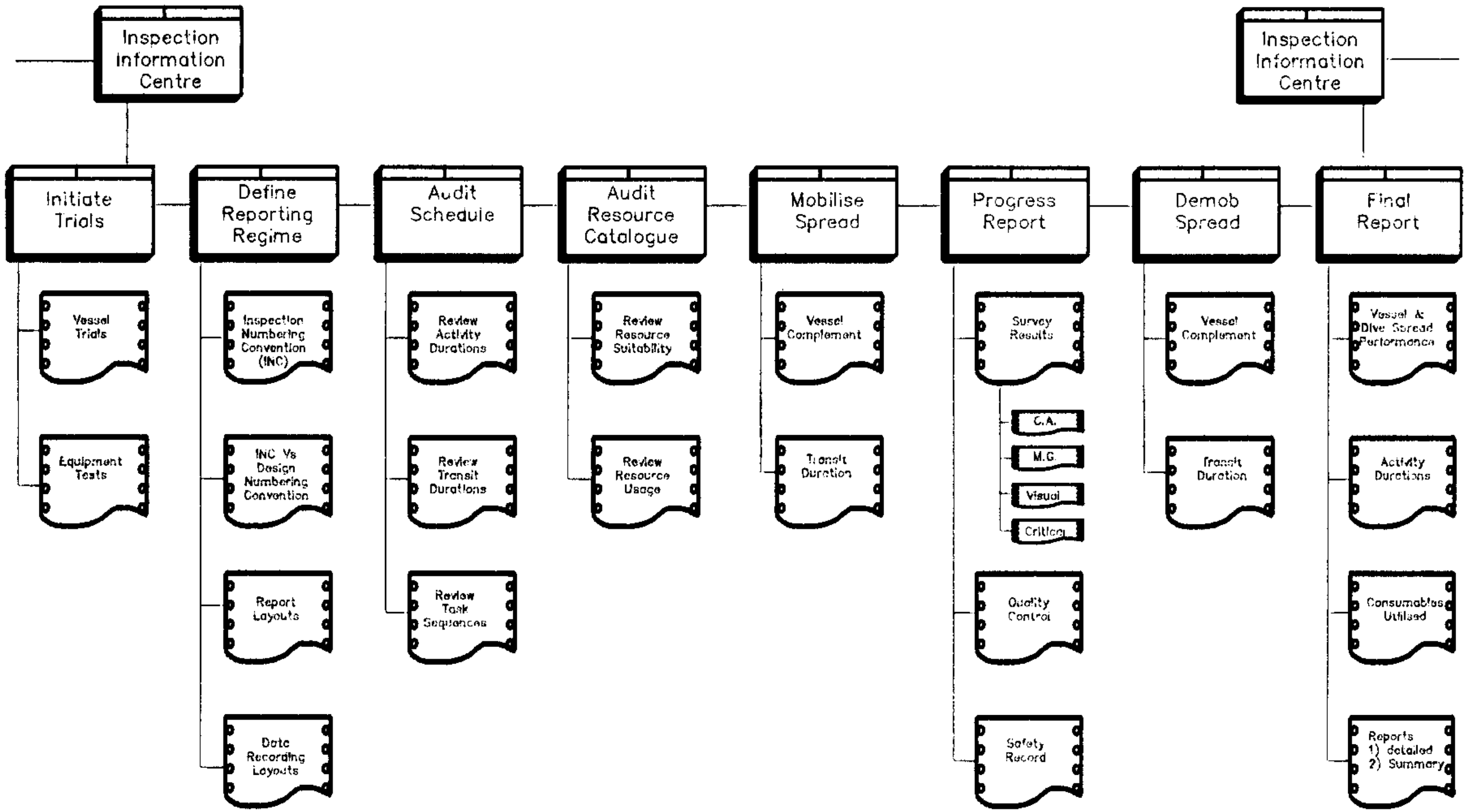
Underwater Inspection



Thalassa	**Inspection Planning**	**U.E.G. Project 72 Study 5**	**Figure No.3.3**
			Date: 11th Sept,1986

Underwater Inspection



Thalassa	Inspection Operations	U.E.G. Project 72 Study 5	Figure No.3.4
			Date: 11th Sept,1986

Of interest to the Design Engineering Group are the extremes of wave, wind, current and tide for both the unique storm case, which is dependent upon the installation design life, and the operational case, which is generally the maximum conditions associated with full production. The matrix of these parameters is compiled from data produced by meteorological consultancies. For the Inspection Management Group these parameters represent boundaries which, should they be exceeded may necessitate additional emergency inspection work.

While the above information is primarily utilised for the in-place static analysis, the dynamic and fatigue analyses require a statistical interpretation of wave formation occurances within set bounds. This information will not provide details of seasonal variations but represents the anticipated wave load versus time regime. Again meteorological monitoring will inform the Inspection Management Group as to the correctness of the predicted regime.

At the design stage assumptions are made as to the build-up of marine growth. Generally the local geometry of the structural model is modified to reflect the increased dynamic loading that accrues with marine fouling. Details of this predicted growth are obviously important so that they can be compared to the in service condition.

The environmental influences that combine to cause scouring should form part of the design process. Predictions of the likely occurances and their effects should be available for review by the Inspection Management Group to assist with Survey Programme development.

Corrosion protection schemes are all affected by the varying salinity and temparature of sea water. Again the design limitations should be available such that meaningful monitoring can be undertaken.

Production Loadings

These loadings are defined as those loads that impinge on the installation as a result of man's influence.

In the case of structures this relates to the weight and distribution of the production, drilling and accommodation modules. For pipelines and risers the important factors are the hydrodynamic and thermodynamic loadings induced by product flow.

Again the design process demands that these loadings are well defined prior to undertaking any analysis work. The Inspection Management Group requires access to this information so that, once again, effective monitoring can take place. Equally important in this respect are the design contingencies that are applied to the design loading capacities and positions. In the case of module loadings this relates to not only the weight of the particular module but also its centre of gravity.

In the first instance it is unlikely that the Inspection Management Group would exert any influence on the variation in the described design loadings. However, substantial changes would no doubt result in re-analysis causing a shift in the priorities of inspection. The consequent impact on the inspection programme will require evaluation and the adequacy of the deployed resources assessed.

Early warning of any impending changes and the likely consequences offers obvious managerial advantages. Information regarding the performance of an installation resides with the IMG and the benefit of this experience should be made available to senior management when evaluating any potential adjustments to installation loading.

Individual Component Descriptions

The general case is that the source of information for individual components within an installation is the "as-built" drawing. While such description that is afforded by these drawings is essential it is equally important to be aware of the sizing and specification utilised in the development of the design. Variations from the design parameters may well effect the inspection requirements. As a general rule substitutions made during the construction process result in a more conservative design. This in turn provides an opportunity to reduce the inspection requirements.

During the design process the detailed specification of individual components is undertaken. The base information is therefore available, however, the transfer mechanism may not facilitate the needs of the IMG.

Individual Component Stress Levels

The Design Engineering Group, having collated the various environmental and production loadings and specified individual components undertakes, among others, a rigorous in-place analysis. The resulting forces and moments calculated for each load case for each member or component are checked for compliance against recognised guides or codes of practice. For each component, therefore, a catalogue of information is generated detailing its response to the design load conditions.

This catalogue forms the basic building block of the inspection programme. By identifying the most highly stressed areas of the installation those areas most suseptible to failure are similarly identified. Consequently, these areas are most worthy of inspection on a regular basis. Failure as a result of static loading would be a consequence of inadequate design or an unforseen environmental occurance. Regular surveys would hopefully, identify the former whereas the latter should initiate an emergency survey.

Individual Component Fatigue Lives

Fatigue failure is both time and load dependent. It should, therefore, be possible to monitor and predict failure patterns.

Again the Design Engineering Group will compile a catalogue of fatigue lives for individual elements within the installation. These will result from an analysis of the natural spectrum associated with significant wave patterns and the geometric configurations employed.

Low fatigue life components are obvious candidates for early inspection. The point at which inspection should be undertaken is open to interpretation. However, good practice would generally indicate that a point at one third of the predicted life would appear appropriate [5].

3.2.2 CONSTRUCTION

Completion of the design phase of a project sets in motion the processes of purchasing, manufacturing, logistics and fabrication. In all cases agreement between the design drawings, specifications and procedures is required and this agreement, or quality control, is monitored by the Construction Engineering Group (CEG). This group must, in the course of its duties compile all necessary documentation to satisfy the relevant authorities that the construction process has been performed in accordance with the design parameters and good working practice. Once again information pertinent to the IMG is compiled, however, it is unlikely that this data will be readily available to the IMG. Generally this information is produced in the form of detailed "as- built" drawings and extensive volumes of paper documetnation.

a. <u>Purchasing</u>

The CEG is presented with a material list detailing quantities and specifications for purchase. It is their responsibility to place contracts for the supply and to co-ordinate the delivery of these items. Such a process demands that details of supplier, materials, delivery times and cost are collated. Access to this information is of obvious benefit to the IMG when undertaking trend analysis. Identification of critical areas exposed during inspection could be related to other possible critical areas sharing some characteristic. Equally, when formulating repair or new construction work access to material availability, costings and suppliers may be of benefit.

b. <u>Manufacturing</u>

The use of specialist manufacturing processes such as casting, coating or forging requires the detailed specification of the process and the recording of chemical and mechanical testing. For the reasons espoused above the availability of this information will greatly assist the IMG.

c. <u>Fabrication</u>

The fabrication process instigates a complex procedure of controlling the flow of material and equipment to specific areas in the structure. The identification of individual components and the mechanisms involved in joining these components are monitored and recorded to facilitate the QA/QC procedures of the particular fabricator and client. While such information is of value to the IMG the areas of interest for the CMG may be different. Anomolies which may cause confusion and delay during inspection may be of no interest to the CMG. These include apparently unimportant details such as variations of coating colour, rolling defects or abraisions on members, peculiarities in the appearance of a weld and other features which are rightly of no importance to the construction inspectors and would not be recorded by them [6].

There may, therefore, be great benefit in the IMG undertaking a detailed survey of the structure prior to load-out. Such a survey should involve the preparation of a comprehensive photographic record.

3.2.3 CONCLUSION

The design and construction processes produce a vast amount of information regarding the composition of the offshore installation and its predicted responce to the imposed loading. From this information the key inspection areas can be identified and the nature of their criticality highlighted. However, the sheer bulk of the data produced may obscure this identification. The management and manipulation of this data are, consequently, of fundemental importance to the effective use of the information. Initially it may be sufficient for members of the IMG to communicate with the DEG and CEG to assess the relevant information. However, following the dispersal of these Groups such a process will not be available.

It is therefore important for the collation and storage of the information to take account of the needs and requirements of the IMG. Consequently the involvement of the IMG at all stages of development is crucial.

Analytical techniques to define the relationship between the collated design and construction information and the inspection requirements are generally heuristic in nature. With regard to static stress ratios it is probably sufficient to undertake a statistical interpretation of the figures and relate the differing bandings to differing inspection frequencies and requirements. As already indicated working practise would dictate that fatigue sensitive elements should be investigated before to one third of the design fatigue life expires.

3.3 INSPECTION TECHNIQUES

The definition of the inspection areas and priorities having been established from considerations of the design and construction information, the available inspection techniques must be evaluated for their suitabilities. A formal description and assessment of the techniques is undertaken elsewhere, however, it is doubtless worthwhile to list the options available to the IMG.

1. General Visual Inspection.
2. Marine Growth Survey.
3. Corrosion Inspection.
4. Cleaning.
5. Critical Inspection.

3.3.1 GENERAL VISUAL INSPECTION

1. Purpose of Inspection

   a) Mechanical Damage - to detect obvious physical deterioration resulting in reduced structural redundancy.

   b) Debris Survey - to locate and identify all extraneous items that may prove dangerous to the operation of the installation.

   c) Abrasion and Scour Survey - to assess variations in sea bed conditions with regard to possible movement and instability of the installation.

2. Areas to be Inspected

   a) All structural components, including legs, braces and nodes.

   b) All risers, cassions and their associated support details.

   c) Surface condition of anodes and non-structural items.

   d) Mud line components including piles, skirts etc, and surrounding sea-bed.

3. Methods Available

a) Diver Intervention - Applicable only to close up detailed survey.

b) ROV Intervention - Applicable to general surveys over wide areas.

3.3.2 MARINE GROWTH SURVEY

1. Purpose of Inspection

a) Thickness Measurement - determine the build up rate and profile of the marine growth to facilitate monitoring of induced loadings, both dead weight and wave induced.

b) Sample Removal - ascertain nature and characteristics of marine growth for possible harmful effects for divers.

2. Areas to be Inspected

a) Generally all splashzone items i.e. those that exist between the +10 metres and -20 metres levels.

b) Other areas of significance resulting from previous general inspections, particular waste products emmissions or temperature and salinity profiles.

3. Methods Available

a) Diver Intervention - direct physical measurement or sampling and photographic records. Applicable to particular areas of interest.

b) ROV Intervention - Photogrammetric surveys to ascertain detailed information, general video survey for general information.

3.3.3 CORROSION INSPECTION

1. Purpose of Inspection

a)	Anode dimensions measurement	- determine rate of loss of material.
b)	C.P. potential readings	- ascertain the level of protection afforded the installation.
c)	Wall thickness check	- ensure corrosion losses do not exceed design.
d)	Corrosion pit measurement	- assess local corrosion damage.

2. Areas to be Inspected

   a) Selected areas of installation or anodes based on previous experience and design details.

   b) Random areas of anodes in association with other inspection works.

   c) Particular points of interest - legs (at node levels)
   - Risers/Conductors.

   d) Areas of pitting highlighted from previous inspections.

3. Methods available

a)	Diver Intervention	- direct physical or photogramme tric measurements of anodes. Use of pit gauges for pitting and ultrasonic test equipment for wall thickness checks.
b)	ROV Intervention	- photogrammetric and video condition monitoring. Proximity and contact probes for C.P. readings.

3.3.4 CLEANING

1. Purpose of Intervention

a) Removal of marine growth fouling - to prevent the build up of excess loadings.

b) Cleaning to bright metal - to remove all matter to facilitate close and NDT inspection.

2. Areas to be Inspected

a) All elements in the splashzone region.

b) All welded joints and areas of particular importance.

3. Methods Available

a) Diver Intervention - use of handheld tools from wire brushes to power tools. Additional options include the use of high pressure water-jets with or without sand entrainment.

b) ROV Intervention - none available.

3.3.5 CRITICAL INSPECTION

1. Purpose of Inspection

a) Close Visual - to ascertain evidence of serious surface defects visible to the human eye. Such defects may result in reduced structural redundancy.

b) NDT Inspection - to ascertain evidence of defects not visible to the human eye. Again such defects may result in reduced structural redundancy.

2. <u>Areas to be Inspected</u>

a) Identified areas of high stress or low fatigue expectancy.

b) Areas subject to mechanical damage from physical impact.

3. <u>Methods Available</u>

a) Diver Intervention
- close visual with naked eye or close-up video and photography.
- NDT techniques such as magnetic particle inspection, ultrasonic inspection, crack depth microgauge radiography.

b) ROV Intervention
- close-up and photography where local geometry permits.

3.4 INTERVENTION MODES

3.4.1 SUB SEA ACTIVITIES

Against each of the inspection techniques described in the previous section, modes of intervention have been identified. The selection of the appropriate method is obviously related to the work site conditions and relative costs.

It is apparent that a great deal of sub-sea related inspection work depends upon the available visual inspection techniques. Where the intention is to establish that there are no major defects present in a large designated area the use of a remotely operated vehicle (ROV) is generally regarded as the most economic alternative. It is now possible to equip ROV's with sophisticated close circuit television units (CCTV) to facilitate progress monitoring by the client's representative. Additionally photographic and photogrammetric equipment can be mounted on the ROV to enable more detailed information to be processed. Generally the smaller sub-sea launced, ROV's are utilised in platform inspection whereas for pipeline surveys the larger ROV's capable of supporting the full range of survey equipment, including photographic, video and CP measurement devices, are employed [8].

The pursuit of more detailed information and interpretation requires human intervention at the work-site. This involves the use of trained divers to undertake close visual inspection, provide photographic records and perform the various Non-Destructive Testing (NDT) techniques on appropriate areas.

Validation of the inspection work undertaken by divers is obviously not feasible given the obvious cost ramifications. Consequently, it is important that the inspection divers are qualified to a recoginised standard so that confidence in the results can be established. The current practice is for inspection divers to be trained and qualified through the Certification Scheme for Weldment Inspection Personnel (C.S.W.I.P.). This calls for a two level examination defined as 3.1.U and 3.2.U.

3.1.U

Underwater Inspection Grade 1.

This section of the qualification includes visual inspection, photography, the use of CCTV and ultrasonic digital thickness meters and the measurement of cathodic potentials.

3.2.U

Underwater Inspection Grade 2.

This section of the qualification, in addition to the requirements of 3.1.U, includes magnetic particle examination and the use of A-Scan flow detectors for ultrasonic thickness measurements of corroded and uncorroded ferritic steel structures.

The deployment of divers is further complicated by the two methods available.

1. Air Diving

Sometimes referred to as surface diving this involves the diver using compressed air and decompressing immediately after each dive. The depth limitation of air diving is generally recognised as being approximately 50 metres.

Divers are deployed from the surface, sometimes using a cage or wet bell, with the relevant air, power and communication services provided via an umbilical from the dive station. Post dive decompression is generally afforded by a small deck decompression chamber. The decompression requirement varies with both depth and duration of dive. This effect and the natural physiological limits of a man working in the water would suggest a limit of 3 hours per dive per 24 hours period for an individual diver as a reasonable working practice [7].

2. Mixed Gas Diving

Also referred to as saturation diving this involves keeping the divers in a pressurised environment for protracted periods utilising heliox or similar mixtures. Living chambers, transfer locks and a deployment system capable of positioning the divers at working depths of the appropriate pressurisation are all required. In this way divers can work to depths of approximately 400 metres.

Deployment is generally achieved using a diving bell through which the gas, power and communications umbilical is passed. Good practice would dictate that for a diver working outside the bell a standby diver should be retained inside the bell to administer the support services and provide emergency cover. Bell run times of approximately 8 hours are advised with each diver undertaking a maximum or 3 hours outside the bell [7].

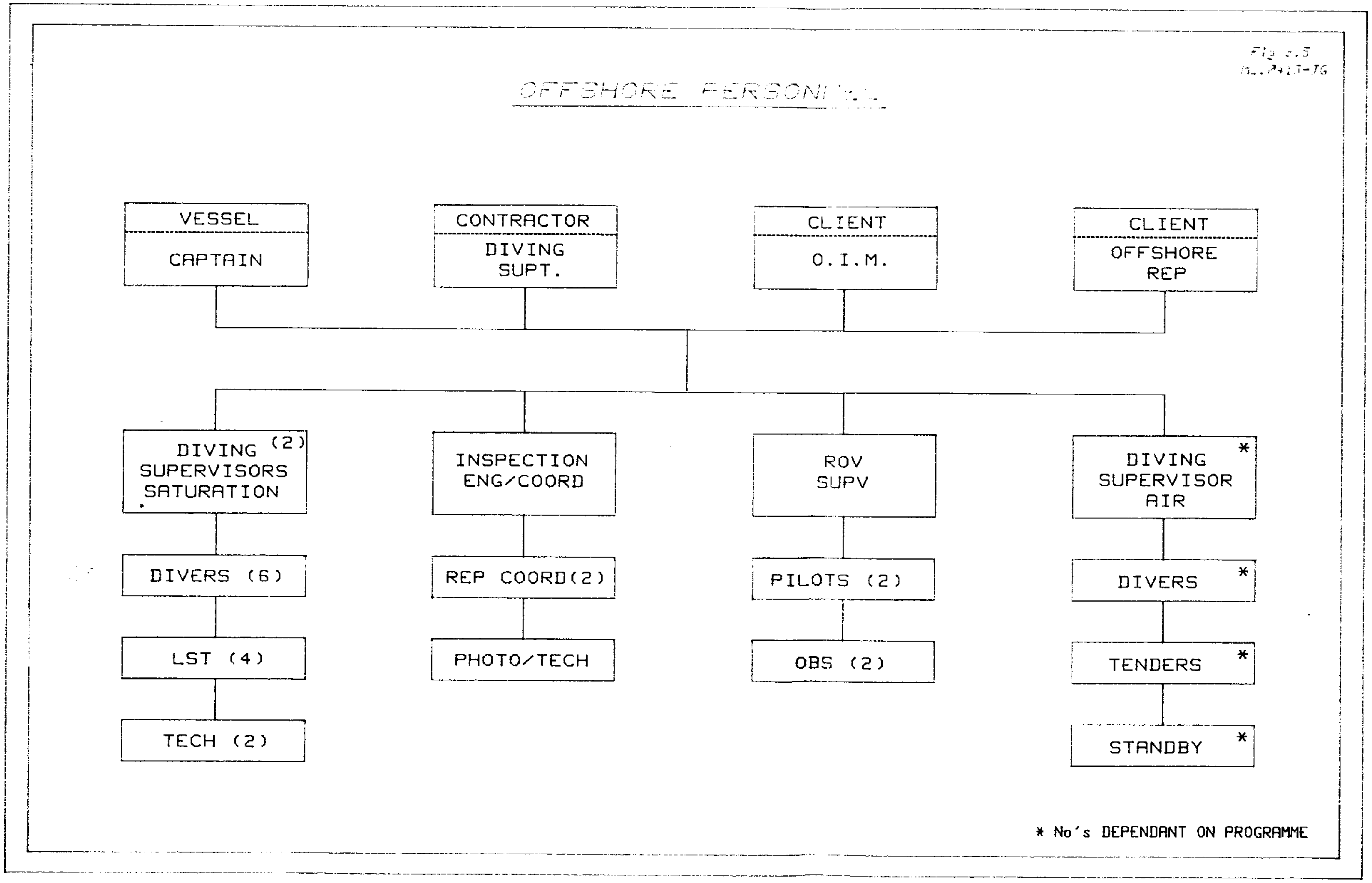
In assessing crew complements it should be remembered that approximately ten percent of a pressurisation period is necessary for decompression.

The break-over point between air and mixed gas diving is subject to particular site conditions and work scope requirements. Many diving contractors advocate using saturation techniques from depths as low as 10 metres. The rationale being that the productivity gains outweigh the increased costs. However, the individual requirements of particular inspection programmes should be evaluated to determine the most efficient diving spread.

Dive Complements

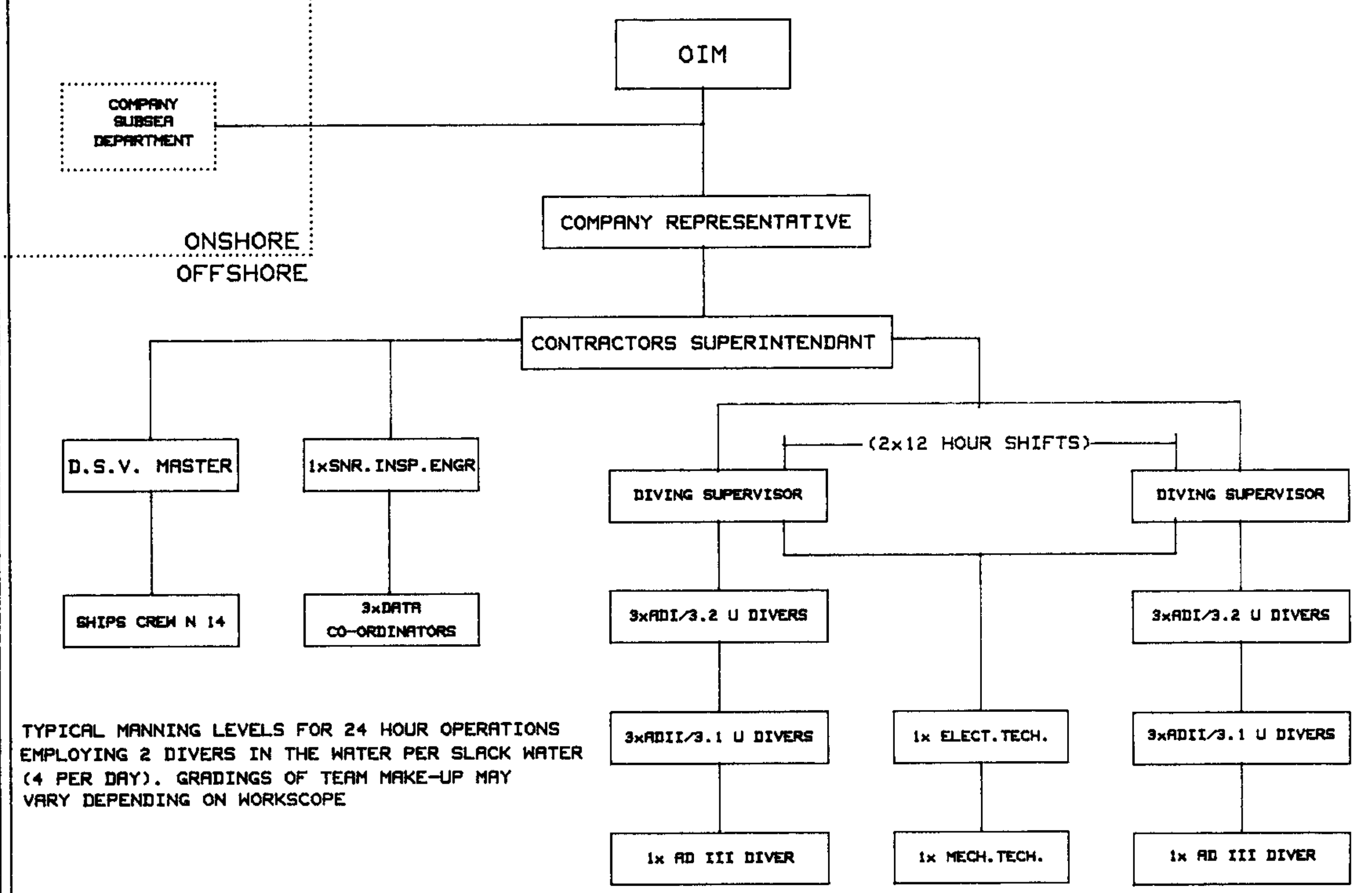
The establishment of a dive complement of personnel will obviously be dependant upon the range of activities to be attempted. Equiping a vessel with air and mixed gas diving together with ROV capability will yield limited opportunites to improve personnel utilisation in that each requires dedicated specialists. A typical complement for an air diving spread would involve some eight divers, to ensure 24 hour operation, two dive supervisors and one superintendent. A mixed gas spread would require a minimum of six divers, four chamber operators, two technicians, two supervisors and one superintendent. The ROV spread would require a minimum of two pilots, two observers and a supervisor.

In addition the necessary support staff, including the marine crew, data recorders etc, are required at the offshore site. It is unlikely that simultaneous operations will be permitted for all three activities but the likely crew complement to support, at best, two operatives will be aproximately fifty. This obviously makes no allowance for onshore based staff or crew rotation. A typical manning chart for a full underwater inspection is shown in figure 3.5. Figure 3.6 shows the organisation chart of a typical air diving spread employed by a major, UK based operator. This shows the requirements for 24 personnel to directly support the diving operator.



OFFSHORE
VESSEL
CAPTAIN
CONTRACTOR
DIVING SUPT.
CLIENT
O.I.M.
CLIENT
OFFSHORE REP
DIVING SUPERVISORS SATURATION (2)
DIVERS (6)
LST (4)
TECH (2)
INSPECTION ENG/COORD
REP COORD(2)
PHOTO/TECH
ROV SUPV
PILOTS (2)
OBS (2)
DIVING SUPERVISOR AIR *
DIVERS *
TENDERS *
STANDBY *
* No's DEPENDANT ON PROGRAMME

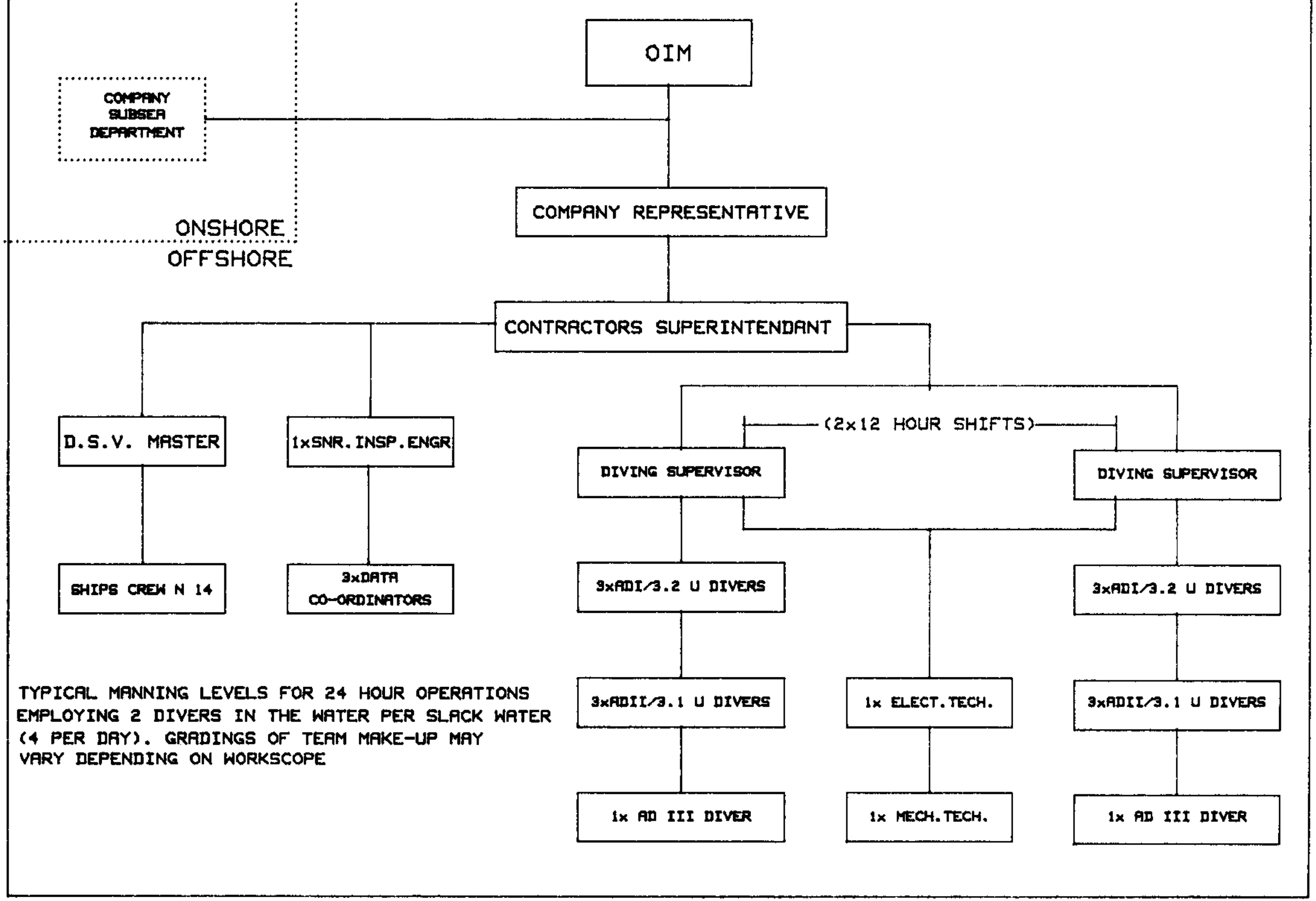
OFFSHORE OPERATIONAL DIVING ORGANIGRAM Fig No 3.6



TYPICAL MANNING LEVELS FOR 24 HOUR OPERATIONS EMPLOYING 2 DIVERS IN THE WATER PER SLACK WATER (4 PER DAY). GRADINGS OF TEAM MAKE-UP MAY VARY DEPENDING ON WORKSCOPE

OFFSHORE OPERATIONAL DIVING ORGANIGRAM

Fig No 3.6



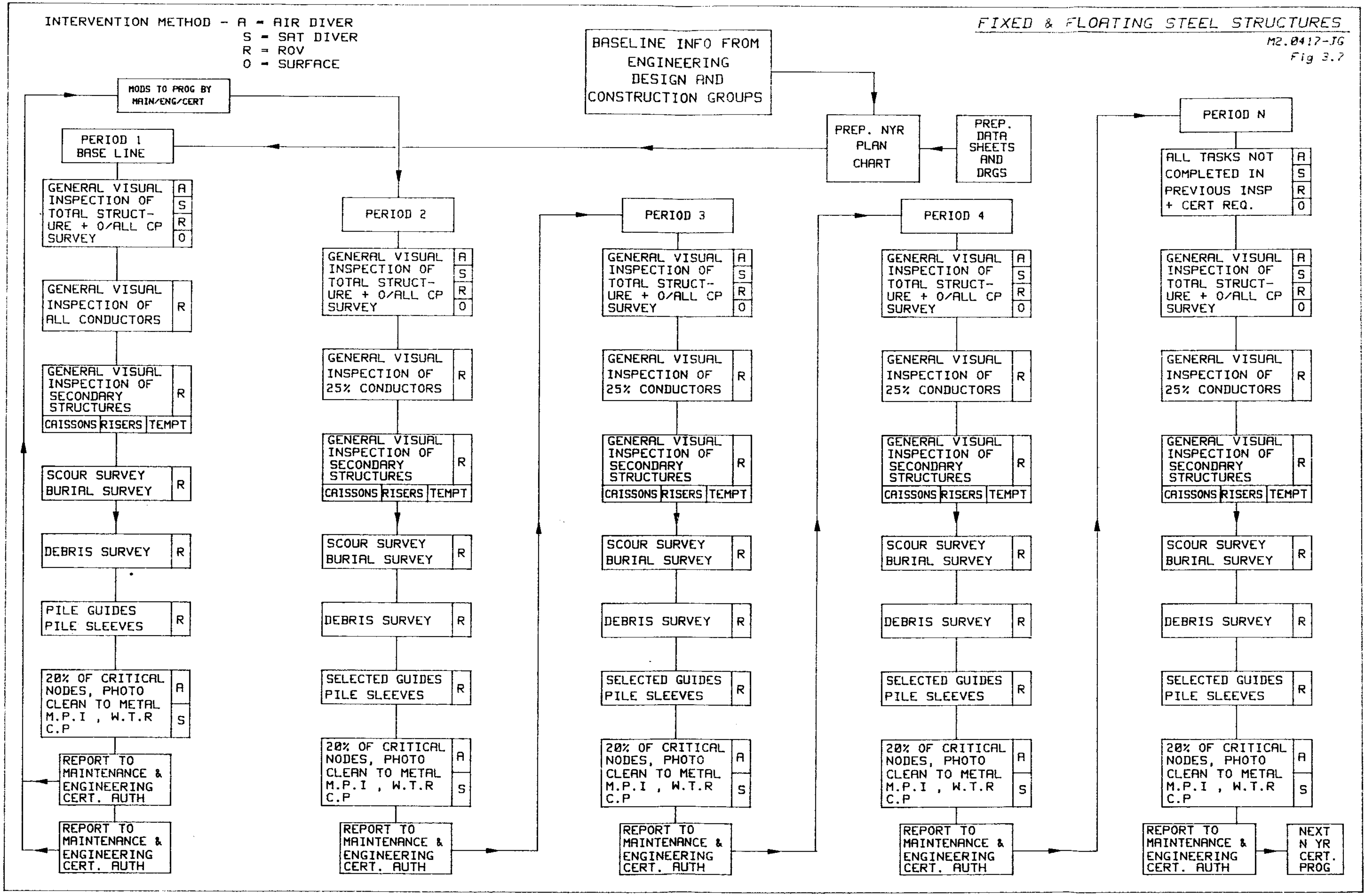
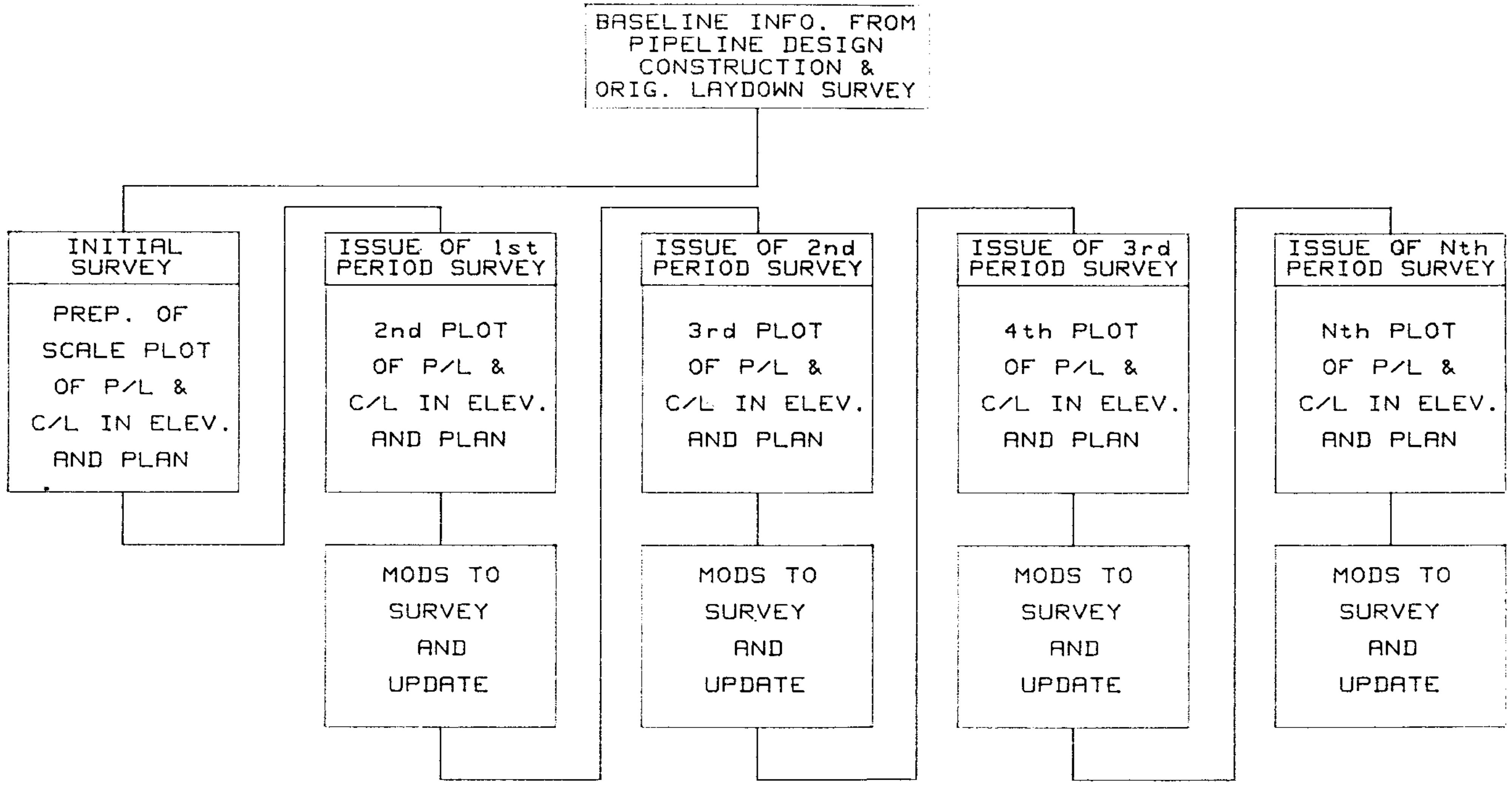

FIXED & FLOATING STEEL STRUCTURES
M2.0417-JG
Fig 3.7
INTERVENTION METHOD - A = AIR DIVER
S = SAT DIVER
R = ROV
O = SURFACE
BASELINE INFO FROM ENGINEERING DESIGN AND CONSTRUCTION GROUPS
PREP. NYR PLAN CHART
PREP. DATA SHEETS AND DRGS
MODS TO PROG BY MAIN/ENG/CERT
PERIOD 1 BASE LINE
GENERAL VISUAL INSPECTION OF TOTAL STRUCTURE + O/ALL CP SURVEY
A S R O
GENERAL VISUAL INSPECTION OF ALL CONDUCTORS
R
GENERAL VISUAL INSPECTION OF SECONDARY STRUCTURES
R
CAISSONS RISERS TEMPT
SCOUR SURVEY BURIAL SURVEY
R
DEBRIS SURVEY
R
PILE GUIDES PILE SLEEVES
R
20% OF CRITICAL NODES, PHOTO CLEAN TO METAL M.P.I , W.T.R C.P
A S
REPORT TO MAINTENANCE & ENGINEERING CERT. AUTH
REPORT TO MAINTENANCE & ENGINEERING CERT. AUTH
PERIOD 2
PERIOD 3
PERIOD 4
GENERAL VISUAL INSPECTION OF TOTAL STRUCTURE + O/ALL CP SURVEY
A S R O
GENERAL VISUAL INSPECTION OF 25% CONDUCTORS
R
GENERAL VISUAL INSPECTION OF SECONDARY STRUCTURES
R
CAISSONS RISERS TEMPT
SCOUR SURVEY BURIAL SURVEY
R
DEBRIS SURVEY
R
SELECTED GUIDES PILE SLEEVES
R
20% OF CRITICAL NODES, PHOTO CLEAN TO METAL M.P.I , W.T.R C.P
A S
REPORT TO MAINTENANCE & ENGINEERING CERT. AUTH
PERIOD N
ALL TASKS NOT COMPLETED IN PREVIOUS INSP + CERT REQ.
A S R O
NEXT N YR CERT. PROG

Fig 3.8
M3.2386-R3

SUBSEA PIPELINE INSPECTION



3.4.2. SUPPORT PLATFORMS

The Sub-sea inspection systems require the provision of support facilities from some surface mounted vehicle. The available options include the using of some form of vessel based station or in the instance of structure inspection an installation mounted station.

While the use of platform based diving or ROV spreads is not unknown the economic justification is generally onerous. Deck space is at a premium and the deployment system will need to access a number of cellar deck areas to ensure that the entire structure can be reached. Particularly in the case of mixed gas diving spreads the space demands this would place on the cellar deck may be prohibitive. However, where the inspection requirement is for frequent sub sea surveys this option should be investigated. The increase in productivity related to reduced weather dependance should also be considered.

The more usual procedure is to place the diving or ROV spread on a specialist floating platform or vessel. The range of options spans the use of very large semi-submersible multiple support vessels (MSV), purpose designed mono-hulled diving support vessels (DSV) and generally available support and survey vessels.

The major disadvantage of siting the spread on a vessel is that it becomes exposed, to a much greater extent, to the disruptive influences of the environment. The degree of disturbance is obviously related to the characteristics of the selected vessel. While the MSV will exhibit a far greater tolerance to the environment than a survey vessel the cost will be much higher. Consequently the nature of the work needs to be considered in relation to the scheduling of the work and the likely environmental conditions that will be encountered.

The major advantage of siting the diving or ROV spread on a vessel is the increased mobility afforded. Additionally the specialist, and expensive equipment can be utilised for the duration of the inspection programme and then be demobilised.

It is generally the case that the sophisticated mixed gas diving spreads are mounted on dedicated DSV's or MSV's. These vessels are equiped with central "moon pools" to facilitate the easy deployment of the diving bells. While air diving or ROV operations may be carried out from these vessels, less sophisticated survey vessels may also be employed.

The ability to hold station, that is to say the degree of accuracy to which a vessel can remain in a pre-defined position is of obvious importance to the efficiency of the sub-sea operations. The usual methods employed involve either some form of anchoring or dynamic positioning (DP) system. The latter are generally computer controlled with a high degree of redundancy to improve safety factors.

Whichever support platform option is chosen physical accommodation space will always provide a problem areas. Given the remoteness of many offshore locations and the pressure to keep to a minimum the personnel required to undertake the task, the provision of "bed space" and logistics will require careful and detailed evaluation.

3.5 INSPECTION IMPLEMENTATION

3.5.1 INSPECTION PLANNING

The scale of the inspection process for sub-sea installations and the attendent cost and resource requirements precludes the "Forth Road Bridge" approach. This would involve employing a group of individuals to proceed from one component to the next and once having completed one cycle would commence the next. Additonally such an approach would not facilitate any method of prioritising key components.

The adoption of a cyclical approach based on individual components is obviously more relevant to offshore installations. The precise cycle would be dictated by a consideration of the engineering design parameters, previous inspection results and, where appropriate, any statutory requirements imposed on the operator. In general, where such requirements exist the demands of the engineering and inspection departments within the operator are more onerous.

The selection of the inspection frequencies for individual components must conform to some related logic. That is to say for some discrete time frame, generally measured in years, an inspection plan exists with identifiable beginning and end points. The duration of the plan is dictated by inspection frequency for the least sensitive components of the installation. In other words the time frame, during which these components require inspection only once. The inspection requirements for many components will be much more exhaustive and may require several surveys of differing natures during this period.

Subsequent inspection plans must recognise the results of previous surveys. Many operators have been able to reduce the inspection intensity as a consequence of monitoring the survey results. However, as the design life is approached it is generally anticipated that an increase in this activity will be required.

Having assembled the inspection requirements, frequencies and priorities for individual components a framework can be created within which the work can be allocated to survey campaigns. These campaigns may be constrained by environmental considerations, the sensitivity of individual components demanding that inspection is required at a certain freqency and the sheer volume of work required.

Management decisions are obviously required at this stage to commit resources over a protracted period to undertake a recognised campaign of work. Considerations of the work required, the techniques to be employed and the deployment systems to be used will impinge on these decisions. Figures 3.7 and 3.8 set out typical global plans for the inspection for fixed and floating structures and pipelines.

3.5.2 SCHEDULING CRITERIA

The previous section outlined the sources of information that will facilitate the identification of the components that require inspection and the nature of that inspection. Additionally the tools available to undertake this work were summarised in the previous section. The deployment of the resources necessary to complete the sub-sea inspection tasks is obviously an highly expensive operation. Consequently the development of discrete, effective work schedules that provide for the efficient sequencing of individual tasks offers obvious advantages. The purpose of such a planned approach is to provide the following:

1. An estimate of the resources necessary to undertake individual programmes of work.

2. An indication to other departments of possible constraints due to the proposed schedule.

3. A method for measuring the progress of the work.

The complications associated with applying rigorous resource scheduling techniques to sub-sea inspection programmes are the numerous uncertainties that affect the progress of the work. The major concern is obviously the weather. However, other influences would include uncertainties with regard to the timing and necessary resources for individual tasks and the interruptions that result from other operational problems or other installation related activities.

A consideration of these influences would indicate that experience is essential in the formulation of the proposed schedule. What would, no doubt, be beneficial would be access to information gathered from previous inspections detailing the impacts of the various influences. That such information is currently gathered is not in question, however, it is generally in a form that restricts detailed analysis.

Weather Dependance

The impact of the environmental conditions on the progress of inspection work is varied and complex. The possible permutations of wind, current and wave regime will each effect different aspects of the inspection programme in different ways. The work may simply be slowed down or it may be halted altogether. The characteristics of the selected support platform will further complicate the effect of the weather on the inspection process.

Statistical interpretation of the expected weather pattern and the sensitivity of the scheduled activities will yield some indication of the probable effects of the environment. It must be recognised, however, that whatever is detailed in such a schedule operational decisions will be required, based on the prevailing conditions, which will necessitate variation to this schedule.

Task Duration Dependancy

The procedure for allocating time to a particular sub-sea task requires careful consideration. The physical restraints with regard to the chosen deployment system have already been described. In addition, constraints not experienced in traditional areas of inspection are in operation.

It is a valid assumption that a sub-sea inspector will take considerably longer to complete a task than his atmospheric equivalent. Such a situation is understandable as each action by the diver is evaluated for its potential danger to his very existance. The key to effective evaluation of individual task durations is by examining previous dive records based on a conscientious logging of underwater operations.

In many instances this avenue will not be available. The development of timescales will be dependant upon the experience of the individual formulating the plan. Areas to be considered in formulating individual timescales can be summarised as:

1. Surface preparation of equipment.
2. Surface briefing of diver.
3. Deployment of dive system to work site.
4. Erection of staging at work site.
5. Erection of lighting at work site.
6. Deployment of specialist equipment.
7. Performance of work.
8. Removal from work site of equipment, lighting and staging.
9. Return diver to surface, possibly for de-compression.
10. De-brief diver.

Consequently the time spent in performance of the work, at the work site, may form an apparently, disproportiately low per-centage of the total time required to effect a particular task. As a general rule the "non-productive" element of the work, for mixed gas diving, will account for some forty (40) per-cent of the total time [7]. The overhead, associated with air diving and ROV operations is much more difficult to predict and will vary according to working depth and shift duration.

Unplanned Events and Offshore Activities

The failure of equipment, while not forseeable, must be accounted for in the overall schedule. The problems associated with equipment failure in the field of sub-sea inspection are not only related to the potential hazards to life but the delays and consequent costs of operational delay. Mal-function of facilities such as with the gas, heating and communications supplies or the umbilical and winching systems will effectively halt operations. The capability to effect repairs, particularly when operating at remote locations, is of obvious benefit. While the breakdown of inspection aids, such as cameras, may not be of such crucial importance such occurances will inevitably lead to delays.

Installation initiated delays generally result from the access demands of supply boats, cellar deck activities and drilling operations such as perforation and the dumping of drilling wastes. It is arguable that such activities could be pre-planned and consequently delays resulting from them avoided. Such an argument fails to understand the working environment and contingencies of up to ten (10) per-cent should be allowed for to cover these possible causes of delay.

Job Pack Preparation

Having established the work content and associated overhead, the equipment requirements and location for individual tasks, groups of tasks should be organised to form logically linked units or job packs. The intention would be to group geographical and equipment dependancies so as to provide effective utilisation of resources. These groups would be further assembled in relation to their ascribed durations with regard to the envisaged dive scheduling. This process would produce discrete entities of work which could be allocated within individual inspection campaigns.

For the various reasons already described a key consideration in compiling individual dive campaigns is to facilitate a degree of flexibility. The operations supervisor should, as far as practically possible, always be provided with a number of work faces. The definition of the work required at each site will obviously have to be available to the operations supervisor in a format to permit rapid dissemination so as to facilitate the decision making process.

The ability to organise the work into discrete inspection campaigns is obviously a reflection of layout of the installation and the survey requirements. The clustering of such items as risers and caissons, in many instances, will greatly assist in providing concentrated work packs. However, the positioning of water intake and exhaust ducts could disrupt the envisaged work. The dispersed requirement for detailed NDT necessitating Vessel movement for deployment will obviously greatly reduce utilisation and efficiency. Consequently, priorities should be assigned to individual tasks detailing the time frame during which a particular inspection must be performed.

Where data recording has been undertaken over a number of survey campaigns a profile of task durations can be assembled. This not only assists the scheduling of the activities but provides a mechanism for measuring procedure and operative productivity.

3.5.3 SURVEY CONTRACTOR SELECTION

The specialist and seasonal nature of sub-sea inspection work has led to the development of a number of contractors capable of supplying the necessary services on an "as-required" basis to a number of operators. This situation not only benefits the operators in that the required equipment and personnel can, effectively, be shared but also in that a highly efficient and competitive industry has evolved.

Prior to issuing invitations to tender for either the individual dive campaigns or the entire program it is normal practise to vet all the interested contractors. All the major contractors would understand this requirement and welcome this opportunity to discuss the proposed scope of work and envisaged techniques to be employed. In this way the competance of these companies can be assessed, taking into account the past and present performance of the particular contractors. The bid list would, consequently, be assembled from a consideration of the competance, performance and suitability of equipment of the various contractors.

In seeking proposals to undertake the required inspection works the greater the level of information available to the selected contractors the greater the confidence that can be achieved in the submitted proposals. Comparability of submissions in also enhanced by detailed description of the required services. Typically this would involve "as-built" drawings of the relevant areas, task and data sheets indicating the work methodology and expected level of data recording and the proposed period for the execution of work together with details of installation related activities that may effect the schedule.

To effect comprehensive and meaningful proposals from responsible contractors it is necessary to allow realistic timescales for the preparation of these proposals. Vessel, equipment and personnel availabilities must be researched and where appropriate, subsitiutions offered as alternatives. The importance of producing minimum specifications for all marine and diving equipment and procedures cannot be stressed too highly. These specifications should form part of the contractural agreement. Detailed schedules must be prepared that will facilitate the necessary operational flexiblility and provide for any envisaged interference from other installation related activities. As a general rule some 4 - 8 weeks should be allocated for the contractors to prepare and present their proposals.

The evaluation process must be, and must be seen to be, fair and equitable. It may, therefore, be appropriate to produce a points system whereby critical success factors are allocated a number of points based on the submitted proposals. These factors are weighted according to their relative importance facilitating the production of a league table of bidders.

Such an approach while of obvious use to the management group should not be construed as the total decision making tool. The management group must use this information together with other assembled data to justify the final decision.

The points system should cater for both commercial and technical components of a proposal. It would, no doubt, be useful to the bidders for the areas of importance of the system to be included in the bid documents. This would ensure that these particular areas would be adequately covered by the bidder.

These are essentially two methods for commercial consideration namely lump sum and day rate. The fundemental difference is in the area of who accepts the risk for interuption to the work. In the case of lump sum contracts the risk is bourne by the contractor. He submits a fixed price for the completion of a described scope of work. The effect of environmental factors must be accounted for in the proposal. The use of a day rate contract shifts the burden of risk to the operator.

These are undoutably instances when either approach offers advantages over the offer. In general terms where the scope of work is well defined and the influence of the environment well understood the lump sum approach provides for ease of accounting. However, where these areas are neither well defined or understood the day rate approach provides the most equitable solution.

Neither option reduces the need for comprehensive data gathering and reporting on the operation. In the case of lump sum contracts the onus falls more heavily upon the contractor, whereas with day rate contracts the onus shifts somewhat to the operator.

3.5.4 CLIENT REPRESENTATION

Much of the argument detailed above is applicable to the use of third party inspection personnel for supervision of the work. A number of specialist companies can provide individuals with the necessary expertise for the duration of inspection campaigns. This approach enhances staff utilisation and provides the operator with greater flexibility. There is also benefit in that the individual will bring experience of operations from differing environments.

Against these advantages must be weighed the lack continuity of utilising different staff during each campaign. Familiarity with the installation, management structure, data gathering and reporting requirements and the overall inspection programme all contribute to a successful survey programme.

The role of the company representative is crucial to the satisfactory performance of the work. Prior to mobilisation, it is his function to become totaly familiar with the proposed scope of work and the various equipment and location dependancies. In this way he can instigate a full, pre-contract function test of the proposed vessel and equipment to ensure its suitability. His role in monitoring and recording the work is essential to the resolution of any claims that may arise during the inspection period. The nature of the work and the environment makes some variation to the scope of work almost inevitable. In order to facilitate such variations the contract administration procedures must be understood and adhered to by the company representative.

His role, however, is not solely to review and collate contract administration. The primary function is that of technical arbitor. The quality of the inspection work from the photographs to the NDT results must be approved by the company representative prior to their inclusion in any reports. Such work that is unacceptable must be repeated. Should the results of any part of the inspection programme give the company representative any cause for concern he has the authority to request additional work to investigate further his concern. The formation of opinion by the company representative will obviously be helped should access to relevant historical data be available. The development of any trends and the comparison with previous results will assist in the decision to commit to additional work.

It is ultimately the decision of the company representative to accept that the work has been satisfactorily completed and that the quality of documentation and the recording of results is of a high standard. This latter areas is of obvious importance during the analysis phase of the inspection process and in many instances it is preferable to utilise the company representatives specialist knowledge in this phase of the work.

The volume of pre-mobilisation and post demobilisation work for the company representative will obviously impinge upon the decision for either a full-time member of staff or seasonally employed individual. In many instances both options are available to an operator in that the company representative can be drawn from his own members of staff or should that not be possible an individual from a third party can be arranged.

3.5.5 DATA COLLECTION

All offshore installations involved in the oil and gas production industries can be described in one of three categories:

1. Concrete Structures.
2. Steel Structures.
3. Sub-Sea Pipelines.

An operational problem encountered in the inspection of all three categories is that of orientation. The sheer expance of typical concrete structures with surface areas of the order of 40,000 square meters presents enormous problems of identifying a feature's location. Steel structures provide a matrix of elements that, without adequate markings, can be confusing, particularly as many areas of similarity will occur on any one structure. The survey techniques available to pipeline survey contractors provide accuracies of only ± 30 metres. Consequently, re-locating specific features, particularly in areas of congestion, can be very difficult.

Some form of zonal notation to identify individual areas of the installation is therefore useful. Figures 3.9 and 3.10 provide a method of notation that may be applicable in the case of steel jacket structures. Whatever methodology is adopted it is essential that all interested parties adhere to the conventions.

It is important that the data collection process does not impose a restrictive regime of feature identification and location during the survey process. Rationalisation of the collected data with expected data should not form part of the critical path. Data collection should, therefore, facilitate the recording, and retrieval of the following information:

1. Reporting of ALL information - previous knowledge should be ignored.

2. The reasons particular methodologies or techniques were employed.

3. The orientation and scale of recorded features.

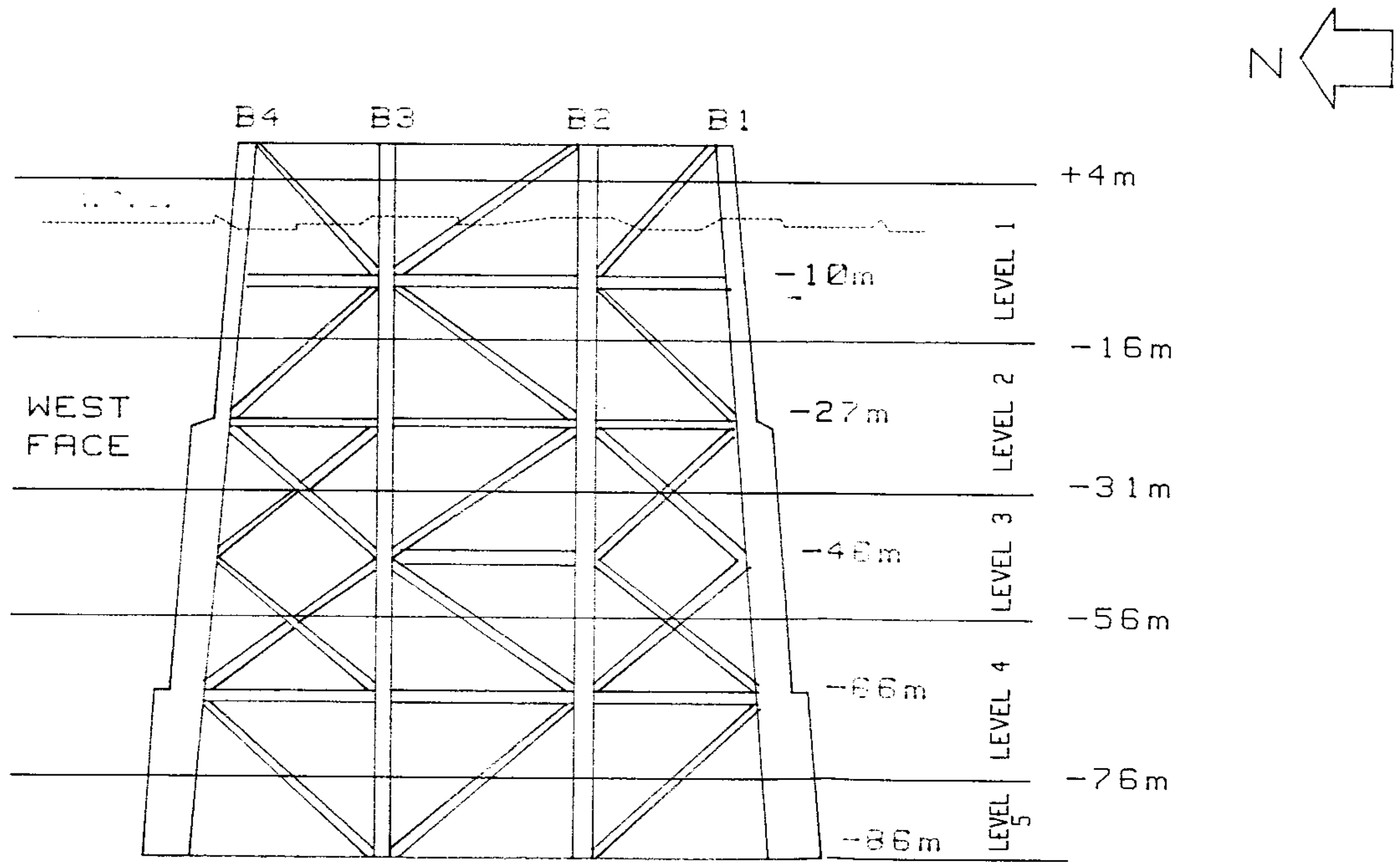
4. Video record and still photography camera orientations together with scale markers.

The usual method employed is to provide the operatives with pre-printed forms, relevant to the envisaged scope of work. These forms are completed during the inspection survey noting all necessary information. The layout and composition of the form should embody front line quality assurance requirements in addition to providing a concise reporting format.

44-45

Fig 3.9

EXAMPLE OF POSSIBLE METHOD OF DETERMINING INSPECTION LOCATIONS ON A JACKET FACE

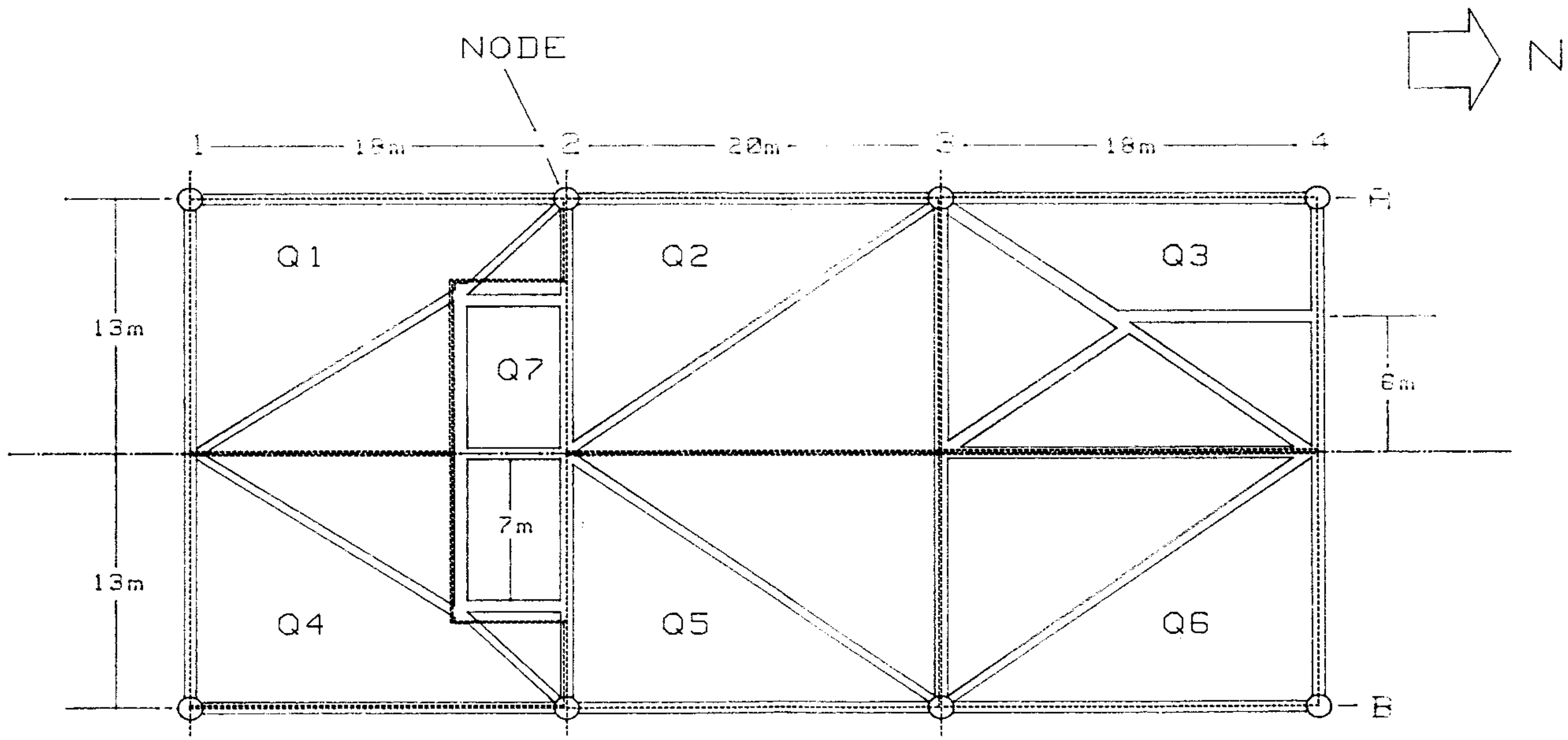


FRAME 'B'

M2.0387-RS

Fig 3.10

EXAMPLE OF POSSIBLE METHOD OF DETERMINING INSPECTION LOCATIONS ON A JACKET PLAN.



PLAN EL −10m

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Following completion of a particular operation the report information should be collated and presented to the company representative. This would be the first level of quality assurance. The data would be checked for its sense and the implications of the reported data assessed with regard to additional works. The level of interpretation is a function of the management organisation and the available information offshore. In some instances the information held offshore is a duplicate of that onshore facilitating review on-site. Discussion between office and site is enhanced by the availablity of the same information at both locations. Such a situation requires good communications between the locations to ensure the information remains consistent. Some organisations prefer that data interpretation and analysis be performed following completion of individual dive campaigns. Here the emphasis is solely on producing sensible, correct information for review by others.

3.6 INSPECTION SURVEY RESULTS ANALYSIS

The supposition that data are indeed a resource would suggest that by the careful control and administration of relevant sub-sea inspection data benefit will accrue to the organisation. To achieve these benefits detailed analysis of the survey results is necessary.

Trend analysis of individual locations or related locations over some time frame will provide useful indicators as to the performance of the installations. It will be possible to concentrate initially on those areas where deterioration is apparent and assess the potential consequences. In addition those areas where the condition of particular areas remains unaffected by the passage of time can be isolated and the inspection requirements reviewed. This performance monitoring approach ensures that the inspection resources are directed to the critical areas and excessive inspection works are avoided. Typically where a small surface crack or marine growth presence is noted at some constant level over a period of years the inspection frequencies can be reduced. However, the importance of the features may increase with some change in use or operation of the installation consequently the rationale for the reduced inspection frequency must be logged.

From an operational standpoint the durations, equipment requirements and problems associated with individual tasks are of interest. A consideration of these aspects of the work will enable the process to be refined with consequent savings in time and resources. The effectiveness of the schedule with regard to the task sequencing and the implications of installation related stoppages can be addressed. In addition a data bank of encountered environmental conditions and their effect on the work will be available.

A considered analysis utilising both engineering and statistical models of the inspection programme and its results is essential to the operation of an effective underwater inspection and maintenenace regime. The necessary analysis tools are being developed as indicated by other areas of this major report prepared by UEG. However to utilise these tools the base information must be available.

PRO'S	CON'S
Only collect information required and reduce time spent in gathering redundant information.	
Planning of work during inspection programme.	

4.2 FUNCTIONS TO BE FOUND IN AN INSPECTION SYSTEM

Both small and large systems tend to use similar functions. However, in practical terms small systems are unable to handle (h), (i) and (j).

(a) Data Base

This is where the inspection information is held.

(b) Drawing Package

This allows the input of mainly 2D drawings, some have a small 3D capability, but none have a full 3D system.

(c) Menus

Lets the user select the different programs to run, without having to know how.

(d) Input Screens

Allows the user to input the inspection information.

(e) Reports

Produces ad-hoc or pre-formatted reports on the information in the data base.

(f) Management Graphics

Produces bar, pie, scattergram and line charts on information held in the data base.

(g) Word Processor

This allows input of large volumes of text for reports, work procedures etc.

(h) Statistics and Analysis

Complicated software which uses design, as-built and operational data to predict or indicate problem areas.

(i) Graphics and Data Mix

A general Fast program which can blend (a), (b), (d) and (e) on a single screen or piece of paper.

2. PROGRAMMER-DBA INTERFACE. The DBA controls all data definitions and establishes standards for all application programs that access the database. The DBA also trains programmers in using the DBMS.

3. DBA-DBMS INTERFACE. The DBA monitors operational performance of the DBMS and initiates changes that may be necessary to improve response time or other operational characteristics.

In summary, the DBMS oeprational environment shown in Figure 4.2.1 is an integrated system of hardware, software and people that is designed to facilitate the storage, retrieval and control of the information resource.

4.2.2 DRAWING PACKAGE

Having a drawing package on your system allows the user to access component drawings, inspection drawings, etc.

Most facilities are common for each package, such as:-

(a) Line drawing
(b) Circle, arcs and ellipses
(c) Text with different font types
(d) Variable line types
(e) Variable colours
(f) Isometric grids
(g) Zoom
(h) Edit drawing - move, delete, modify and copy
(i) Symbols
(j) Variable drawing sizes
(k) Output to plotter, printer, laserjet and inkjet

The major way each package varies is by the quality of drawing produced and its speed.

DATA BASE ENVIRONMENT

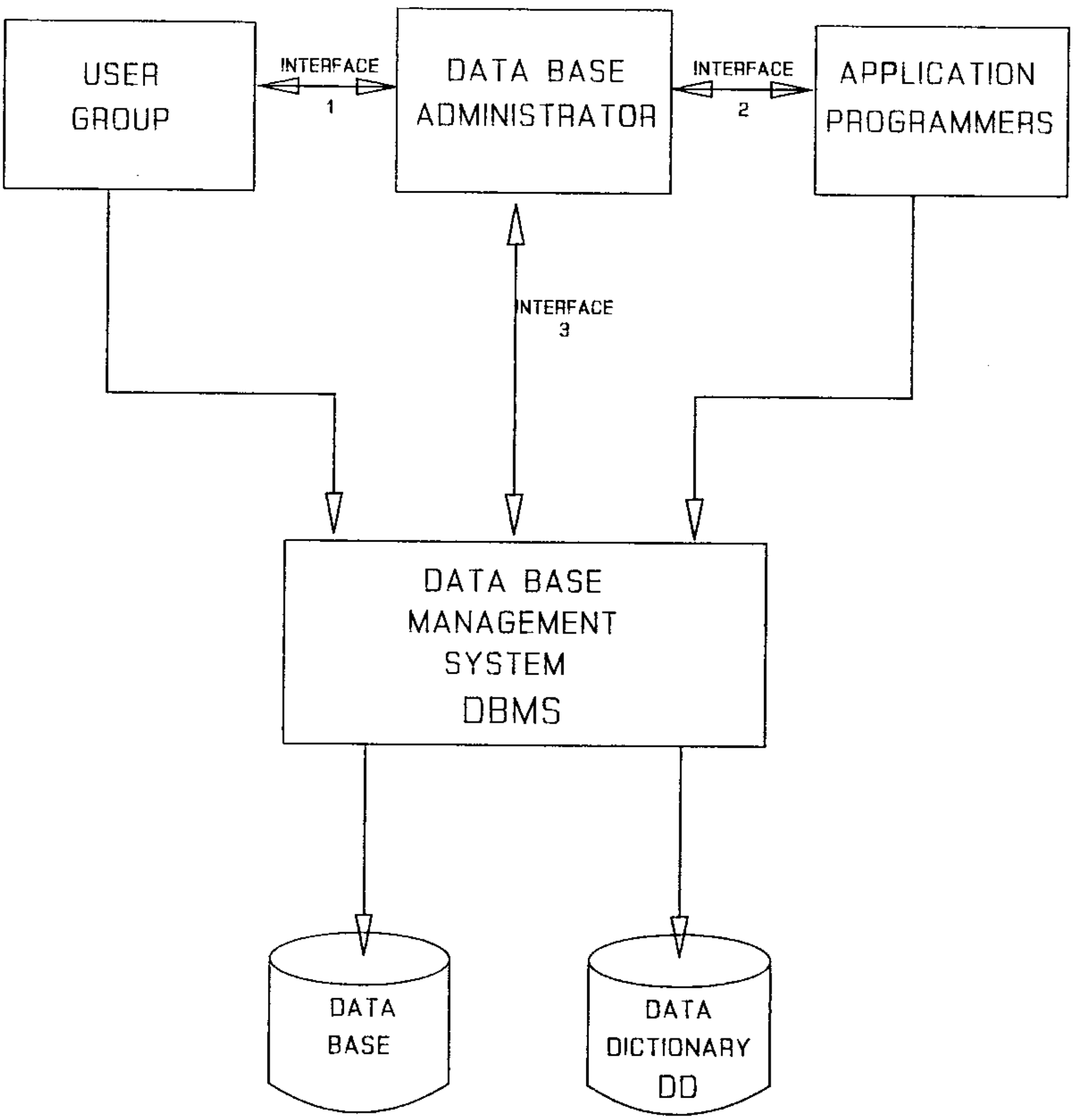


FIGURE 4.2.1

4.2.3 MENUS

A menu is a facilily for a non-computing person to use the system without having extensive training.

The way this is normally achieved is by leading the user through a set of options until the process to be carried out is completely specified. Sometimes there is a fast access utility to allow experienced users to specify the process without going through the options.

4.2.4 INPUT SCREENS

The input screen or forms for this type of application is one of the most important parts of the computer system. A bad forms package could:-

(a) Create more work for the user.
(b) Allow obvious errors in the data to be input.
(c) Not represent the desired system because "the forms package will not do it".
(d) Mean updating software to accommodate the least change.

A good forms package would:-

(a) Imitate many of the manual forms currently in use.
(b) Validate information based on known ranges and associated criteria.
(c) Have a great deal of flexibility in the design and operation of a form.
(d) Integrate with the data dictionary which will allow minor changes to be made, without any changes to the software.

4.2.5 <u>REPORTS</u>

This type of package allows the user to produce ad-hoc reports from the information within the data base. The types of facilities available in such a package are as follows:-

(a) SEARCH : Examine the data base for any information which meets the search criteria.

(b) SORT : Order the information for readability.

(c) REPORT : Output the information with headings, titles, etc.

(d) BATCH COMMAND : Allow any combination of the above to be specified in a file which would be run without any user interaction. For monthly reports, etc.

(e) INTERACTIVE : Allow the user to specify any of the above step-by-step with menu's and help facilities.

As with the input forms, a good report package is one that integrates well with the rest of the system.

4.2.6 MANAGEMENT GRAPHICS

The following are all examples of management graphics:-

(a) Bar Chart
(b) Pie Chart
(c) Line Graph
(d) Scattergram

All these would normally be expected in a reasonable package. One of the most important points is how does the management graphics product retrieve its information from the data base?. By the nature of the system the user would want to graph any information from the data base with meaningful titles and headings. One of the ways to achieve this is to produce the graph with the result coming from the report package and the titles, headings and ranges coming from the data dictionary.

Some graphics packages allow the user to have many management graphs on the same output device (screen, etc), therefore allowing the user to represent the information in different styles for comparison purposes, e.g. a bar graph of vessel hours compared with a pie chart of vessel hours, etc.

4.2.7 WORD PROCESSOR

A package such as this allows manuals, procedures and inspection summaries to be readily at hand. Typical facilities within such a package would be:-

(a) Insert/delete characters
(b) Insert/delete lines
(c) Copy/Move blocks of text
(d) Insert pages of text
(e) Merge files

The main differences between word processing packages are listed below:-

(a) Some need specialist computer hardware
(b) Search facilities within a document
(c) Automatic page numbering
(d) Audit trail of document updates
(e) List processing for mail shots

4.2.8 WHAT IF FUNCTIONS

A "what if function" is a process which allows the user to change a constant that is in a calculation or analysis. Different results for various scenarios can, therefore, be gathered.

Example:

Given loadings on nodes and previous inspection results of cracks, the analysis program then calculates the predicted life of all welds. An example "what if" would be:-

What would the new predicted life of the welds with cracks be if the loading was:-

(a) increased
(b) decreased
(c) moved
(d) any combination of the above

This would then aid the engineer to decide on any repairs required if the loading varied, or move/vary the load so repairs do not have to be made, i.e. the welds with serious cracks are no longer the critical ones.

4.2.9 STATISTICS AND ANALYSIS

The following techniques mentioned will produce a result, but the usefulness of such is dependent on the following factors:-

(a) Errors introduced by equipment used are insignificant.
(b) Qualified personnel collect the inspection data.
(c) When trending - ensure that the readings are taken from exactly the same place.
(d) Errors introduced by the computer system are insignificant.

Without ensuring the above are met, the result produced will be highly misleading, which could mean work being carried out unnecessarily, or even worse, hiding a real problem that needs immediate action.

With the above being met, some very useful information can be realised, by highlighting not only problem areas but also areas that do not need inspecting. Therefore the inspection can become directly related to the number of problem areas.

The types of trending techniques are all based on fitting a line to the data. This can be achieved in two ways.

(a) Linear fit
(b) Curve fit

There are many mathematical functions to do this. Some trending techniques would be used to forecast or predict future inspection results at specific locations on a structure.

Also analysis or modelling techniques could be used to show general trends in the results obtained to highlight key areas of interest.

EXAMPLE OF TRENDING

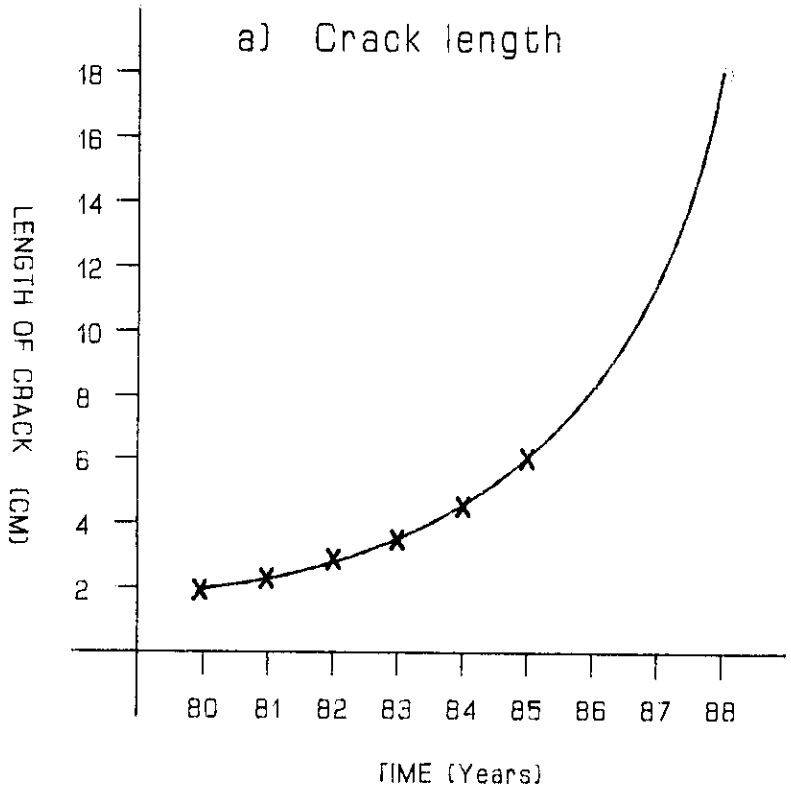
This example shows two benefits that could be achieved by trending inspection results.

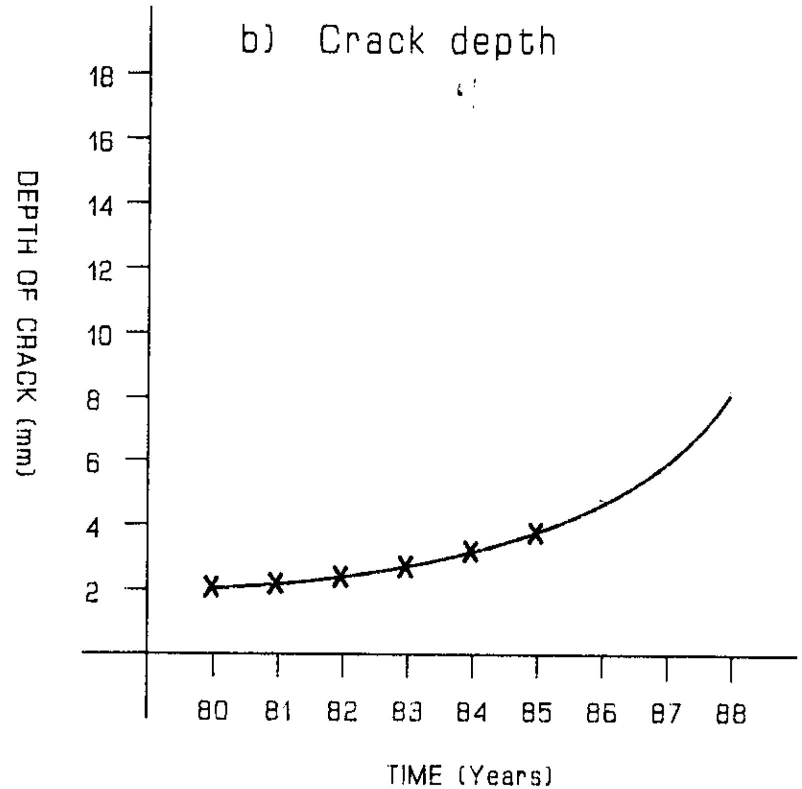
Over a six year period of inspection many cracks have been examined and measured. The engineers are interested in their overall length and depth but cannot be offshore to examine the results as they are taken:

Benefit One:- The engineer can produce crack propagation graphs to show what is happening and also help him make a decision or whether it needs repairing, inspection each year or forgetting about.

Benefit Two:- If in 1986 the inspection of the crack showed that the length of the crack was grossly different from the prediction and the engineers believe that their model of crack propagation is correct, they would not be able to re-inspect until the next diving program. A computer system could highlight the problem much quicker and therefore allow the readings to be taken again during the same diving progam.

Trending & Analysis example





X => **Actual reading**

○ => Predicted reading

WELD CRACK TRENDING		
DATE	WELD No.	CRACK No.
10th JUNE 1985	A029	0001

EXAMPLE OF DATA ANALYSIS

This example shows that general data at many different locations on a structure can be analysed and displayed in a meaningful manner. The following diagram shows C.P. readings taken during a general survey.

4.2.10 GRAPHICS DATA MIX

This type of program is normally only found in well integrated systems, because it uses input screens, database, reports and graphics package to allow the user to input and output the data in a format which would normally be prohibitive in time and cost using manual methods.

INPUT

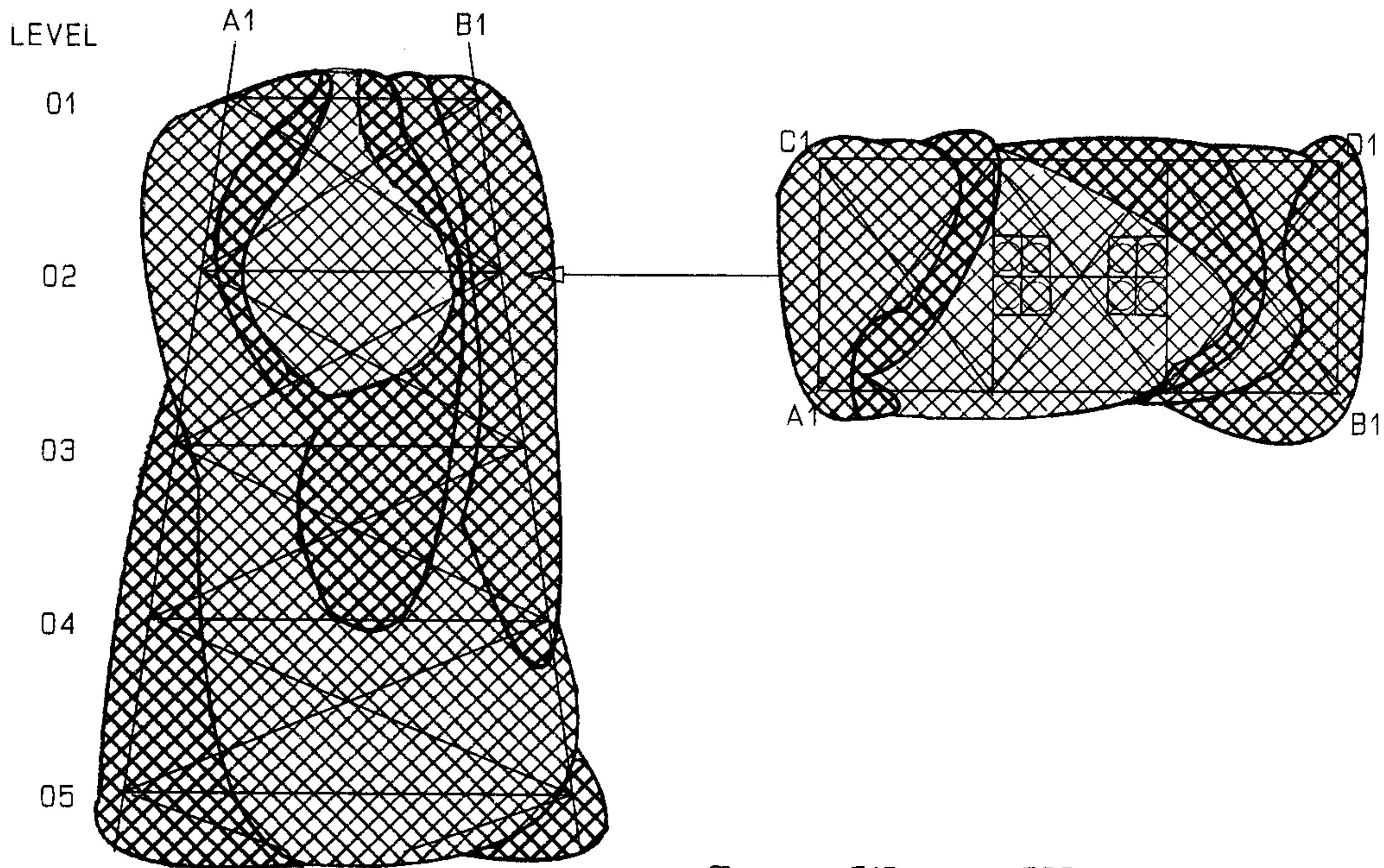
Allows the user to have displayed a drawing of the component or area of inspection being examined. He can then with a single key stroke, put the results into the input screen using flip or split screen techniques. The input screen would have all the functions already discussed previously. When the results are typed in, the drawing automatically displays a symbol of where the readings are taken and what they were.

Example: The following diagram is of a Pipeline survey. Also the data from which this drawing was produced can be displayed by placing the cursor on a result and pressing a single key. This could display the inspection report form. Listed below are some reports that could be displayed:

a. C.P.
b. Span
c. Debris
d. Wall Thickness
e. MPI
f. Damage

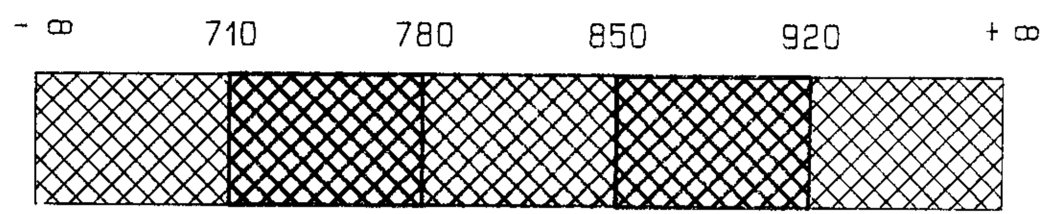
THALASSA A.T.LTD Fri Apr 1, 1983 1:09:59 pm User: SHL Drawing Name: /STSDRAWING/DRAWINGS/UEG_ANALYSIS

Trending & Analysis example



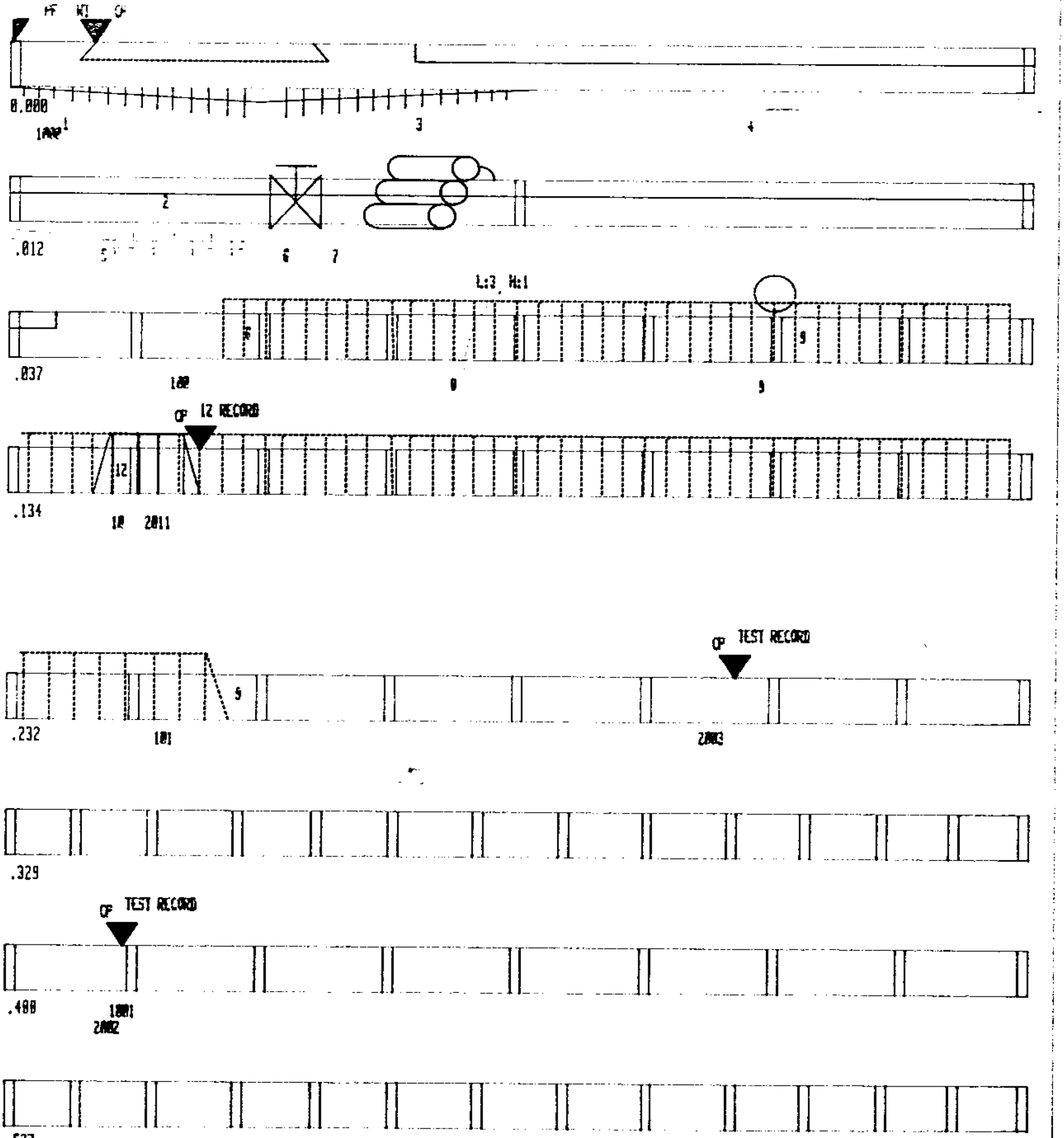
DATE: 10th june 1985

CATHODIC POTENTIAL SURVEY



CATHODIC POTENTIAL COLOUR BAND INDEX (-mV)

THALASSA	PIPELINE CODE : TRI-34-A	PAGE 1 OF 3
	START DATE : Nov -4713	START KP : 0.000
	END DATE : 24 Nov -4713	END KP : 2.000



Note: FJ lines diagrammatic only

Drg No. M2.0410-JG

OUTPUT

A graphics drawing is displayed and component locations are specified on it. This would then allow the user to produce drawings with all the components numbered or carry out an ad-hoc search of the database and display all findings on it.

Example:

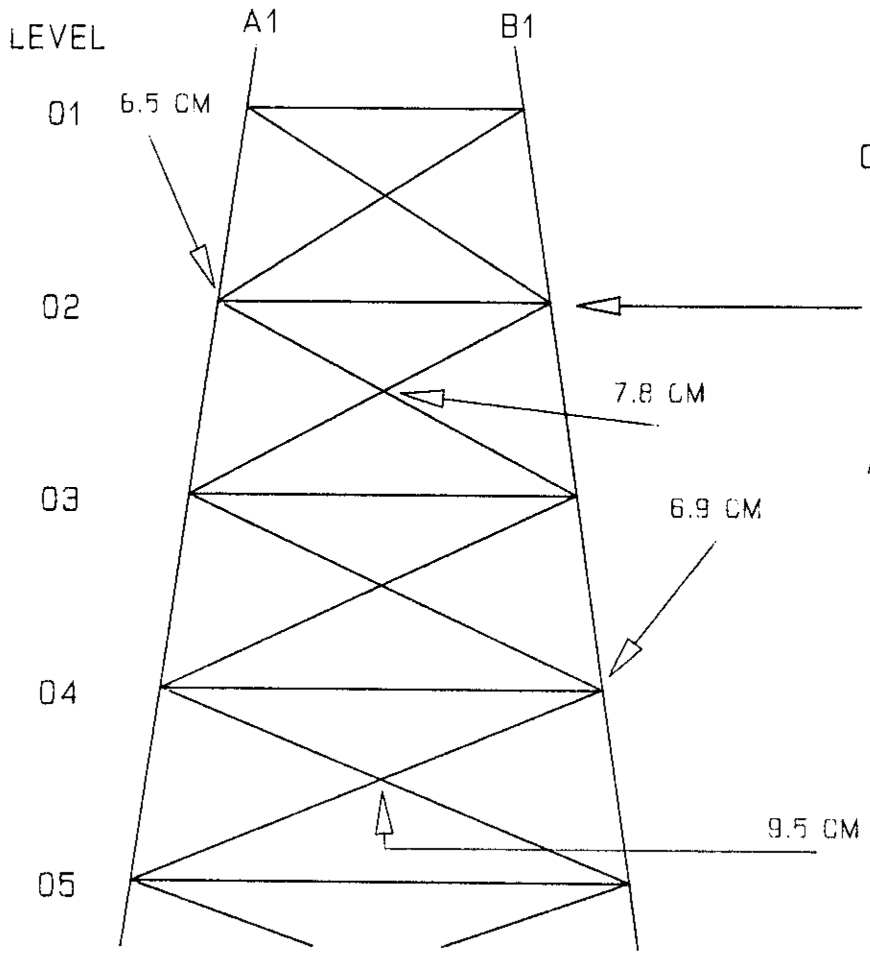
Display all crack length measurements that are greater than 5 cm:

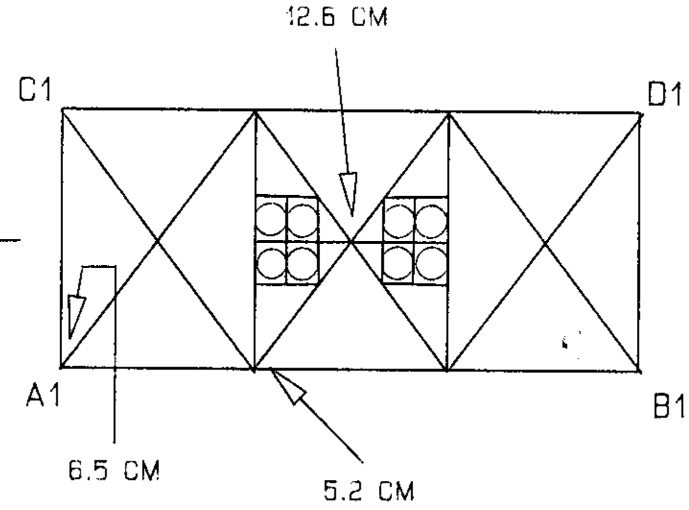
4.3 THE USE OF COMPUTERS IN STRUCTURAL INSPECTION REPORTING

THALASSA A.T.LTD Fri Apr 1. 1983 1: 20: 18 pm User: SHL Drawing Name: /STSDRAWING/DRAWINGS/UEG_CRACKS

ALL CRACKS WITH A LENGTH MEASUREMENT GREATER THAN 5cm

10th JUNE 1985





4.3.1 INTRODUCTION

There are three methods at the moment employed in this field of computerisation.

1. Manual

   Where operators/service companies do not utilise computers directly for any of the applications.

2. Hybrid

   Where only part of the application is computerised e.g.

   a. Manual system onshore - computer system offshore.
   b. Computer system onshore - manual system offshore.

3. Advanced

   This only applies to the most recent systems introduced by operators where there is a system onshore as well as a system offshore.

Where all or part of the method is manual, this is only a temporary situation and computer systems are or will be developed.

Even though the application area is constant, the types of system in use are not. This is due to the benefits needed from the system and inspection philosophy all being different.

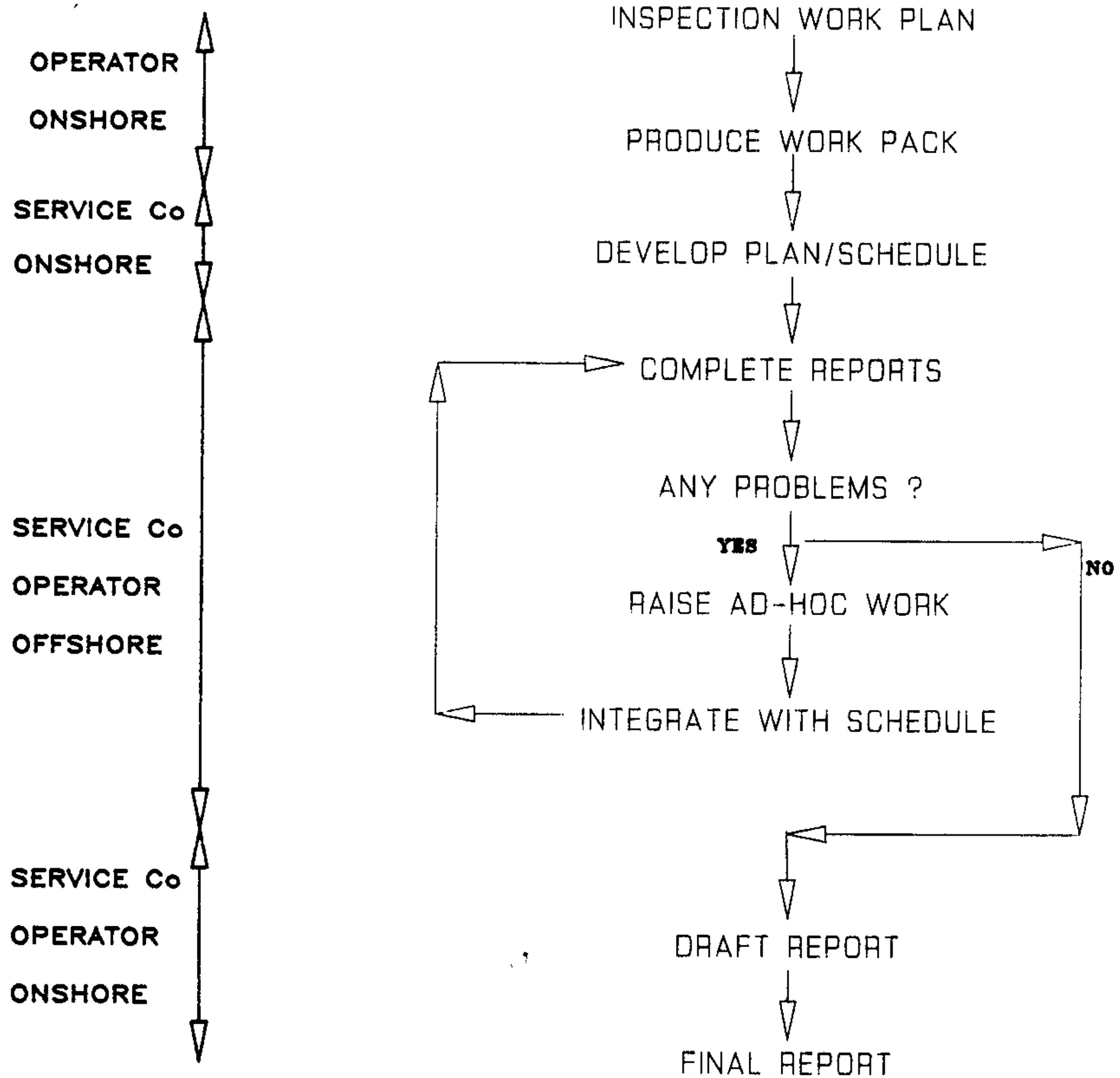
It is well known that differing inspection philosophy exists. The benefits however, are a little more obscure. Here is a list of some of them:-

(i) Production of inspection report quicker and cheaper.
(ii) Standardisation.
(iii) Reduction of space used.
(iv) Tight control on work being carried out offshore.
(v) Free access of data for many departments.
(vi) To sell other services.

Each company will regard some of the above a constraint rather than a benefit. Therefore, it is not surprising to find that every system in use is slightly different.

The following list contains some of the main differences between Operator and Service Companies:-

OPERATOR	SERVICE COMPANY (Internal)
All historic information held on-line.	Only holds data that is compatible with their system.
Multi-User.	Single-User.
Potentially large computer system.	Small portables potentially networked.
Non inspection data (design specs etc).	



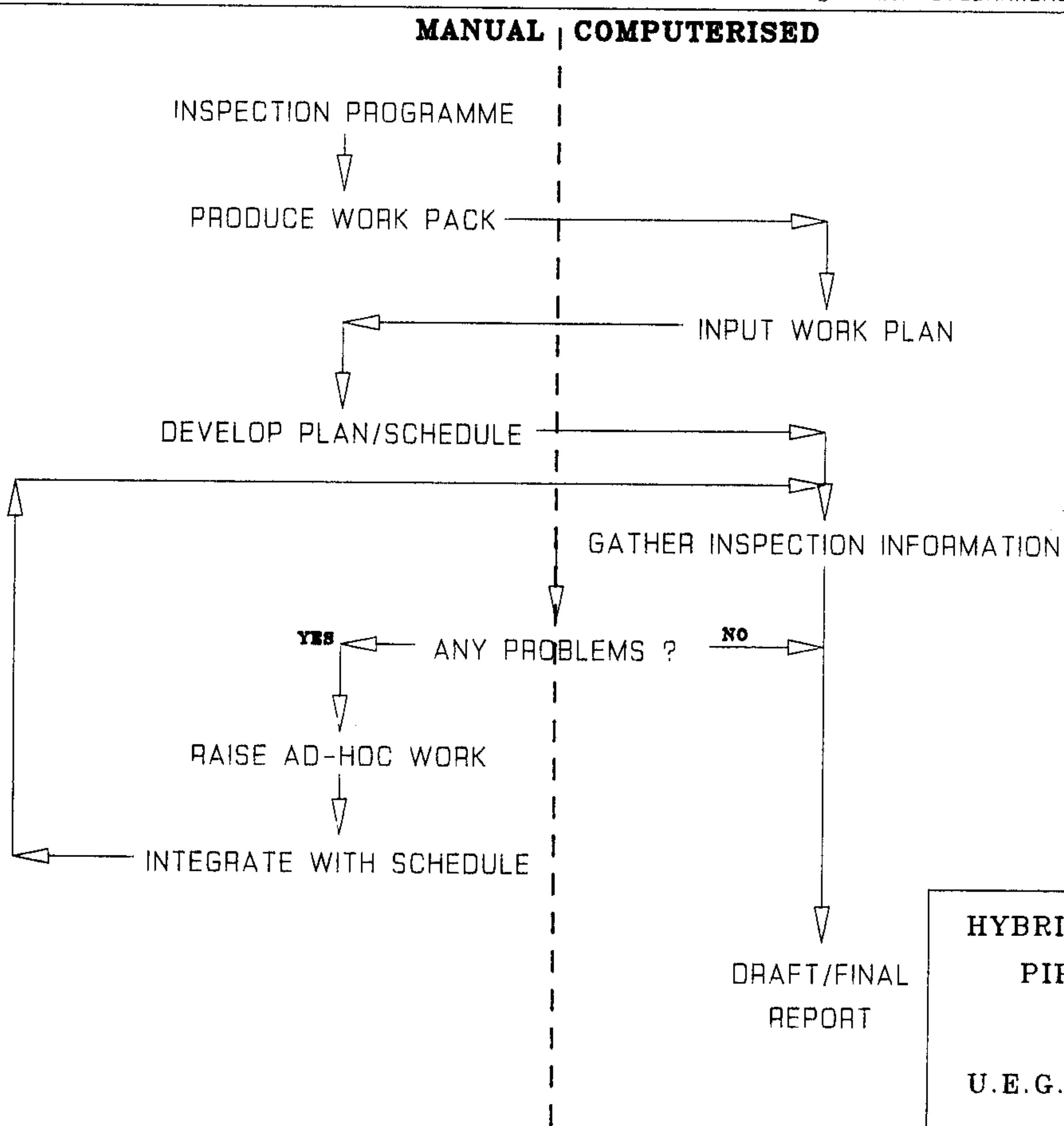
MANUAL

STRUCTURAL INSPECTION

FUNCTION FLOW.

U.E.G. PROJECT 72 STUDY 5

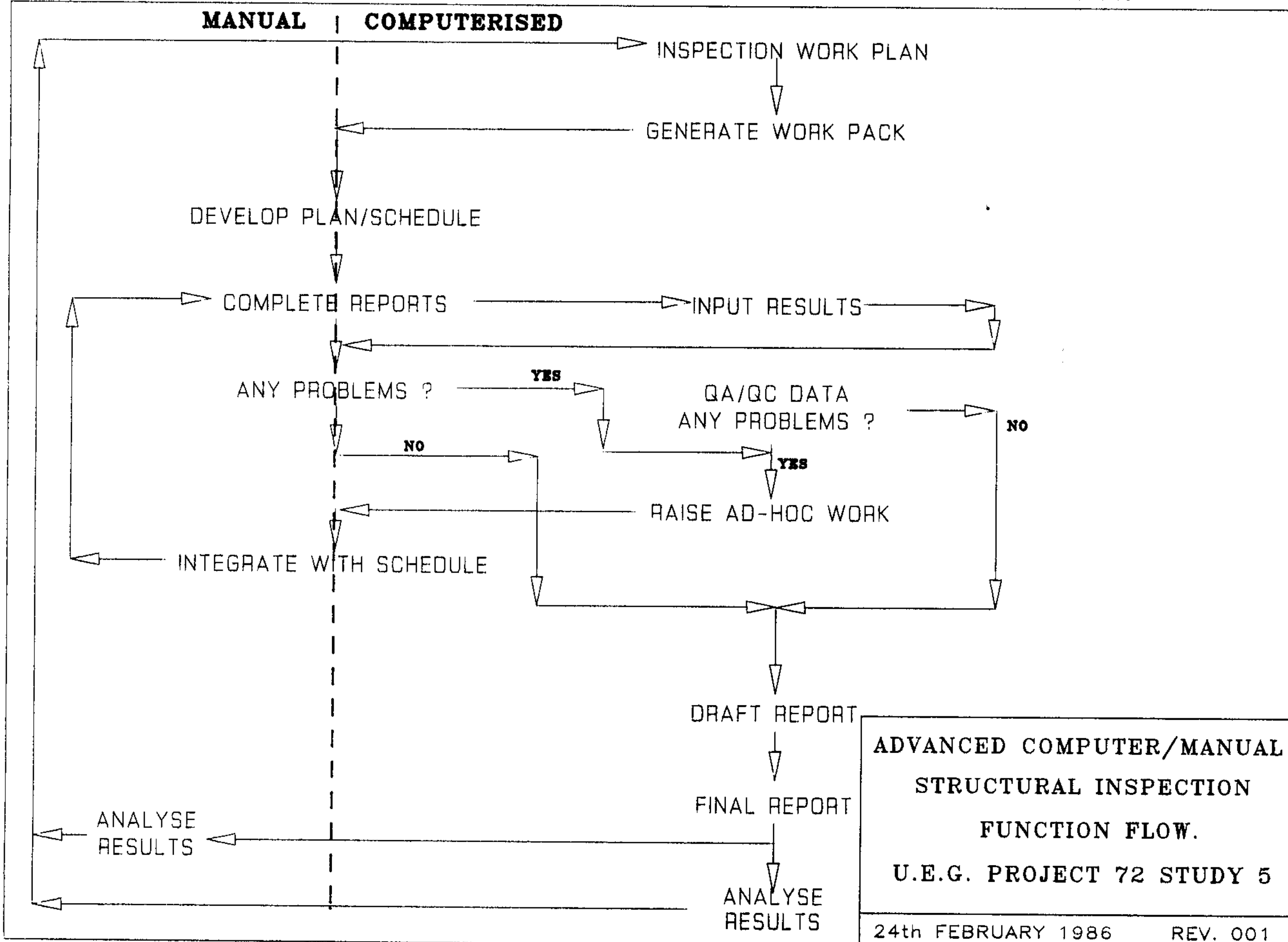
24th FEBRUARY 1986 REV. 001



HYBRID COMPUTER/MANUAL PIPELINE INSPECTION FUNCTION FLOW.

U.E.G. PROJECT 72 STUDY 5

24th FEBRUARY 1986 REV. 001



ADVANCED COMPUTER/MANUAL STRUCTURAL INSPECTION FUNCTION FLOW.

U.E.G. PROJECT 72 STUDY 5

24th FEBRUARY 1986 REV. 001

4.3.2 THE CURRENT METHODS USED IN OFFSHORE SUBSEA INSPECTION AND REPORTING

The following tables show the types of system used. As already mentioned earlier, the Manual, Hybrid and Advanced systems all functionally do the same thing and can produce the same result at the end of the day, but the timescale to do this would vary greatly.

There are some functions which could be manual or computerised. They are therefore placed on the dividing line between the two.

4.3.3 OFFSHORE COMPUTER SYSTEM

When computing systems are used offshore and there is a manual reporting system in operation between it and the Inspection Supervisor, the forms should be designed to aid them as much as possible and not aid the computer system to the detriment of the offshore operations.

When there is no manual method in operation and the Inspection Supervisor inputs the data straight into the computer system, this is sometimes referred to as a "real-time operation". This should not be mis-interpreted as a data gathering device being used (as in pipeline inspection). This type of operation requires the use of graphics and input screens mixed, using a very fast sytsem so that the Supervisor and Diver/ROV are not waiting for the computer.

An offshore computer system should conform to the following:-

It should be:

(a) Robust.
(b) Fast enough not to slow offshore operations.
(c) Reasonably compact.
(d) Able to hold historic information and perform stringent validation on all data input.
(e) Easy to use.
(f) Multi-user.
(g) Popular make, therefore easy to rent.

Many believe that a P.C. is the only item small enough, but the computer system is rarely the largest item, normally this would be the peripherals (printer, plotter, etc).

4.3.4 ONSHORE COMPUTER SYSTEM

This should be able to accept graphics as well as alpha-numeric data from the offshore system, either by tape or direct communications.

The user should be able to view the data in many different ways, from the Inspection Supervisor format to a Management Summary.

Therefore, the system should conform to the following:-

(a) Multi-user.
(b) Variable reporting methods.
(c) Allow analysis of data.
(d) Multi-system network (allow inter-computer communications).
(e) Ensure Data security.
(f) Interface with other software systems (planning, accounts etc).
(g) Transfer data to and from offshore.
(h) Not require specialist personnel.

4.4 THE USE OF COMPUTERS IN PIPELINE INSPECTION REPORTING

This area is dominated by the service companies because they supply the data capture device e.g. the ROV.

The devices on the ROV determine the information stored. Most operating companies specify similar equipment to be put on the ROV, therefore it is not surprising that this has produced very similar computer systems.

These systems produce the following which is normally shown on a single chart.

(a) Navigation Information (skew grid)
(b) Pipe Line Profiles
(c) Span and Depth of Burial Information
(d) CP Data
(e) Incident Data

A few of the operating companies specify a compatible data format so the data can be transferred into their computer using electronic methods. This then allows the operator to produce Trends, Management Summaries, etc.

4.5 THE USE OF COMPUTERS IN INSPECTION PLANNING & SCHEDULING

4.5.1 INTRODUCTION

Information available from our study suggests there are two main areas of planning and scheduling of work.

(i) Comprehensive planning package, which is used for the overall inspection program and vessel scheduling and this is being used for all different types of planning within a company.

(ii) Work package that handles detailed information about a single inspection program.

Both these systems are normally side by side, but the comprehensive planning package does not communciate with the detailed information work package to vary the work packs. This is done manually at the moment.

4.5.2 WORK PACK PLANNING

The work pack would contain:-

(a) Job Sheets:

Describing the work to be done, the procedures to be followed, etc.

(b) Inspection Sheets:

Describing the information to be collected.

(c) Graphics:

Any drawings requried for the inspection.

(d) Component sheets:

Describing the items to be inspected and any information from previous inspections.

The work pack would be split into separate jobs which could be used for bid documents and the planning of the diving programme. These jobs could come from the inspection plan or ad-hoc inspection requirements which can be created when raising unscheduled work. Also, jobs can be moved from one year's inspection to another when re-arranging the overall work plan. When a job is added or moved, all of its associated information (inspection sheets, graphics and component sheets) is automatically added or moved with it. When planning forthcoming programs, it would be very easy to use previous jobs to estimate the expected length of the programme and highlight certain areas which could be made more efficient by changing the order of the work.

4.5.3 COMPREHENSIVE PLANNING PACKAGE

This could be used in two areas:-

(i) Vessel Planning and Resource Scheduling.
(ii) Inspection programme/Diving/ROV Planning.

This would enable the user to plan and integrate the inspection programme with offshore operations/resource availability and weather/tidal conditions. The user would also be able to accurately plan the diving programme around likely resource availability (qualified divers, equipment, etc), and therefore have a greater degree of confidence when costing the work.

With all this done, different scenarios can be used to try and plan around likely events and different resource availablity to maximise profit and/or reduce costs, by using standard "what if" statements within the planning package.

The following facilities are normally found in planning packages:

(a) Planning data base.

(b) Input facilities of planning information.

(c) Ad-hoc retrieval of planning information.

(d) Project management functions to carry out critical path analysis, resource analysis, etc.

(e) Report generation:
 (i) Tabulated printed reports.
 (ii) Pie, histograms and x-y charts.
 (iii) Gantt.
 (iv) Network chart.

(f) "What if" function to vary stated constants (shutdowns, weather windows, etc).

How good the planning package is would depend on the following:-

(a) Ease of use.
(b) Speed.
(c) Integration of the facilities within the package.
(d) Quality of the output.

4.6 TYPICAL HARDWARE SPECIFICATIONS

The functionality and performance characteristics of the envisaged computer system will determine the most appropriate configuration. In many instances a PC based solution is adequate but where the user group require more sophisticated data maniplutaion features, faster response or a multi-user system with extensive help features then a mini-computer based solution will be required.

The distinction between a PC and a mini-computer is becoming somewhat ill defined. Processors available in a PC are becoming increasingly powerful and in some instance multiple processors are available greatly improving, in particular, the graphics capabilitis. Conversely, prices for mini computer are reducing to the point of comparability with these more powerful PCs.

As a general guideline, however the following configurations are included with budget cost estimates.

1. Multi-User Mini Computer System

HP 1000	A900 - processor
HP 12040	RS-232 C 8 channel multiplexor
HP 12009A	HP-IB interface card
HP 12221A	3 Megabyte memory card
HP 12222B	Mamory connector
HP 2392A	System console
HP 2397A	Graphic Terminals (x4 say)
HP 46087A	Graphic tablet (x4 say)
HP 7956A	55.5 Megabyte disc + tape drive
HP 2686BV	LaserJet printer

BUDGET COST PNDS 50,000

2. Single-User PC System

IBM AT
40 Megabyte winchester disc drive
1.2 Megabyte floppy disc drive
Laser Jet printer
Graphics tablet

BUDGET COST PNDS 15,000

The data storage requirements will obviously be dependant upon the volume of work undertaken. Again, however, certain guidelines are available based on Thalassa's previous experience. This would indicate for a single structure an initial data volume of 15 to 20 megabytes growing at approximately 10 megatbytes per dive campaign. Typically drawings would account for a major proportion of the data and a budget figure of 25 Kilobytes per drawings is a useful indicator.

4.7 EXPERT/KNOWLEDGE BASED SYSTEMS

4.7.1 INTRODUCTION

It is important that the reader understands what is meant by "Expert or knowledge based systems" in this instance, therefore the following table shows some of the difference:-

EXPERT/KNOWLEDGE	CURRENT SYSTEMS
Human Knowledge With data, facts and rules of thumb about a particular subject	Ad-hoc Searches Statistical Analysis Software
Human Experience Programmers to infer the answers using problem	What if functions using mathematical techniques

Next is to decide which areas could utilise such systems. T he following are some general areas of opportunity:-

(i) Where the expertise is scarce to interpret information quickly.

(ii) To work out a problem where many disciplined personnel need to be used.

(iii) Where work performance is inconsistent and there is a need to rationalise, standardise and remove these in consistencies.

4.7.2 POTENTIAL APPLICATION AREAS

Before two example applications are discussed, it must be pointed out that these systems need a large amount of base information (human knowledge) to carry out their functions. Also to move into this area of computing successfully, you will be unlikely to do so if you do not already use computer techniques for your inspection information.

The two applications chosen are very different in subject and complexity but both are feasible using current computer technology.

Application 1 : Interpretation of Inspection Results for Repairs and Verification

Knowledge:

Procedures of subsea inspections.
Procedures of subsea repairs.
Past cases of inspection results and repairs.
Design criteria.
Repair and inspection equipment.
All constraints, constants and performance on all the above.

Experience:

To be able to examine all knowledge and decide the following:-

(a) Verification of inspection results.
(b) If a defect is found, what should be done.

Example:

Inspection: Close visual of a weld finds a crack.

Computer system:

Is it a known problem?
Are these inspection results reasonable?
Are the results of any great significance?
Should a more accurate technique be used?
Recommendations on what to do!

Conversely, the system would also verify any problems from previous years that have not been detected this year and therefore work out why this should be so and recommend further inspections to verify the result.

Application 2 : The Scheduling and Planning of subsea Inspection

Knowledge: Design Criteria
Inspection philosophy
Inspection results
Procedures for inspection
Inspection equipment
Diving equipment
Vessel information
Weather information
Platform operations
Personnel qualifications
Past inspection programmes
All constraints, constants and performance on all the above.

Experience: To be able to examine the knowledge and decide the following:-

(a) Produce inspection for a n'year cycle.
(b) Schedule work within any one work programme.
(c) Speicify all operational parameters, e.g. type of vessel, diver qualifications, equipment, etc.
(d) Constantly update the plan on any new knowledge.
(e) Vary work programmes on changing resource availability, weather conditions, etc.

Example:

Due to operational reasons no inspection work is to be carried out this year. Produce the following answers:-

(a) A re-scheduled plan under the current inspection philosophy for the years when inspection work is to be carried out.

(b) New resource and cost implications.

(c) Potential problem areas which needed inspecting this year.

(d) Likely duration of new work programmes.

4.8 THE CONCLUSION OF CURRENT COMPUTER SYSTEMS IN USE

4.8.1 INTRODUCTION

The previous chapters list what computers are being used for, but do not detail how they are used or whether they are fulfilling the benefits set out in chapter 4.1.

4.8.2 STRUCTURES : GENERAL CONCLUSIONS

(a) At the moment many of the individual functions specified do not interact as well as could be achieved. In all fairness, most people interviewed were trying to achieve this with a single solution instead of many stand-alone systems.

(b) Most Operating companies have an ongoing development program for their computer systems, which will cover many years. The Service Companies on the other hand believe they have produced the final solution.

(c) Some companies could use the inspection data better by not restricting it to individual departments or physical sites.

(d) The data collected could provide more accurate information to departments, such as Accounts, Planning and Central Records.

(e) More base information should be integrated with the inspection data, i.e.:-

- (i) Physical measurements.
- (ii) Stress information.
- (iii) As-built drawings.
- (iv) Design parameters.
- (v) Equipment specifications and calibration results.

4.9 A GENERAL PHILOSOPHY FOR INSPECTION INFORMATION SYSTEMS

As most systems are in their infancy, below are some of the development pitfalls and a recommended approach.

4.9.1 THE PITFALLS IN DEVELOPING AN INSPECTION SYSTEM

(i) Do not develop a system around a single person's views.

(ii) Utilising hardware which is difficult to upgrade.

(iii) The need of specialist operators.

(iv) A specialised and fixed system which cannot be altered.

(v) A short-term solution for a long-term problem.

(vi) Incompatible systems to corporate computing philosophy.

4.9.2 A PROPOSED DEVELOPMENT APPROACH

(i) Select a small potential list of likely developers.

(ii) Set a test for all developers.

(iii) Let the chosen Department/Company analyse the Operator's requirements to produce a functional specification.

(iv) Within the corporate computing philosophy.

(v) During the above phase use a prototype to demonstrate the designed system before the major work takes place.

(vi) Utilise a representative from the computer department.

(vii) Develop a system with as many general/flexible software packages as possible and practicable.

(viii) Tight project control QA/QC procedures during system development.

(ix) Adhere to set operating procedures when system is in use.

4.10 COMPUTER DEVELOPMENTS WHICH COULD ENHANCE AN INSPECTION SYSTEM

There are many developments expected in the near future. These are either to be perfected or released.

(1) Optical Storage

To be able to store all visual information and photographs of documents/certificates that would allow fast access (1 second) of any item. With the more popular use of terminals with video input, this could then be used to view the optical information also.

(2) Drawing Digitisation

To input drawings into a graphics system by use of a scanning device in a format which could then be used in a graphics drawing package.

(3) Monitoring Systems

To monitor different states of the jacket (stress, CP, etc) in "real-time" and store the information in the inspection system.

(4) Real Time Data Gathering Systems

This would allow direct input of data from the instrument/equipment into the computer system, e.g. weld inspection, CP, wall thickness, etc.

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REFERENCES

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