

LR *Technical Association*

**The LR Type Approval System
and LR Quality Schemes for
Machinery, Materials and Hull
Construction**

by G. C. Harris, A. E. McLaughlin and G. W. Johnston

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Enquiries should be addressed to Lloyd's Register of Shipping, 71 Fenchurch Street, London EC3M 4BS, England.

HONORARY SECRETARY, LR TECHNICAL ASSOCIATION
A. F. McKinven
71 Fenchurch Street, London EC3M 4BS

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After graduating in Mechanical Engineering from Leicester University, Gary Harris joined the Lucas CAV Limited graduate training scheme, on completion of which he became a Machine Tool Development Engineer. He commissioned and tested machine tools for three years, eventually moving to Amot Controls Limited for three years as a Design/ Development Engineer involved in the design and environmental testing of electro-mechanical instruments for the marine industry. He then moved into the oil and gas industry, working as a Project Engineer responsible for the design, manufacture and

testing of bespoke, safety critical wellhead control systems against client specifications before becoming Project Manager in 1990, responsible for wellhead control systems on several world-wide projects including Occidental Piper Bravo.

In 1995, he joined Lloyd's Register's Type Approval Department, was promoted to Senior Surveyor in 1999, and is now responsible for type approval of mechanical engineering products and for product certification against EC Directives.



Anthony McLaughlin graduated in 1973 with a Degree in Electrical Engineering from Queens University, Belfast. His initial training was with the Northern Ireland Electricity Service. He then joined the Department of the Environment in London, initially working in the design office and was subsequently sponsored on a Post Graduate Diploma in Environmental Engineering. He then transferred to Germany, project managing NATO infrastructure works. An appointment as Area Engineer in Wales followed and then on promotion to Principal, he project managed works services for the Auxiliary Oil Refueller on the Forth. Under the transition to the privatised regime he project managed works

services for the Vanguard class submarine on the Clyde.

He joined Lloyd's Register's Type Approval Department in 1995, was promoted to Senior Surveyor in 1999, and is currently responsible for type approval of electrical and control engineering products and for certification of products for the EMC Directive and the Marine Equipment Directive. He is a member of the IEE EMC and functional safety group and the LR representative on the European Commission Association of Competent Bodies for the EMC Directive.



Graham Johnston joined Lloyd's Register as a Quality Assurance Specialist in 1992 after 27 years in industry, much of which was associated with Quality Engineering and Quality Management. Four of those years was with the British Standards Institution researching and developing BS5750:1979, the forerunner to ISO9001 Quality Management Systems. Graham, through the Quality Services Department, provided both advisory services on Quality Management Systems and assessment services to LR Group clients worldwide.

After promotion to Senior Surveyor, and a period of secondment to LRQA, he joined the Type Approval Department in 1998, with responsibility for the LR Quality Schemes. These duties include the administration of the 'schemes' world-wide, and their future development, whilst continuing to maintain practical involvement in their operation, through active participation.

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Synopsis

The LR Type Approval System was originally developed with the purpose of creating a 'benchmark' for the environmental testing of electrical and control equipment, to determine its suitability for use in shipboard applications. To this day, statutory type approval, in accordance with National Administration requirements, and the closely associated EC Marine Equipment Directive, are still largely confined to the marine sector.

Over the years, however, the LR Type Approval System has developed such that it now extends beyond the type approval of electrical and control equipment for marine applications. It now embraces the needs of other industries and will be further upgraded to cover equipment used on naval ships. LR Type Approval in accordance with the LR Rules obviates the need for plan appraisal on a ship by ship basis, provided the type approval is based on the latest LR Rule requirements.

However, the LR Quality Schemes for Machinery, Materials and Hull Construction are still currently concerned with the marine industry and LR's Rules. The LR Quality Schemes tend to shift the emphasis from the direct survey requirements of LR's Rules, placing more reliance on the manufacturer's production controls to ensure the conformity of ongoing production with the relevant Rule requirements.

The Paper explains the main features and processes of these certification systems, clarifies some of the misconceptions and highlights some of the benefits. It also examines some of the developments since the publication of LRTA Paper No. 5, Session 1990-91, which introduced the subject of type approval, and considers some possible future developments into areas closely related to the existing LR Type Approval System and LR Quality Schemes.

Introduction

The main body of the Paper is split into two parts, for ease of reference. Part I addresses the issues of LR Type Approval and Part II covers the LR Quality Schemes. The Paper then closes with some concluding remarks regarding the benefits and possible future direction of these certification systems, as self-standing entities or as parts of a package.

The term alone, 'type approval', probably does not convey to the reader the nature of the actual processes involved and can engender some confusion for individuals who are not normally involved in this field; especially for those from outside of the marine industry, where LR first focused its attention on the field of type approval.

Many of the certification systems operating within LR rely upon a set of prescribed rules which clearly define the technical requirements to be satisfied. This also applies to work undertaken for classification, with reference to the applicable LR Rules. Indeed, the same principle applies to the LR Quality Schemes for Machinery, Materials and Hull Construction which are addressed in the Paper.

However, both the LR Type Approval System and LR Quality Schemes place more emphasis on the manufacturer's control of the product. They are both 'product' specific, rather than 'project' or 'ship' specific, as is generally the case with classification. For the purposes of the Paper, the term 'product' is used in the broadest sense and includes 'systems', where relevant.

In this context, the 'type' in the term 'LR Type Approval' is the unique designation, code or part number of the product which is the subject of the type approval process. For products covered by the LR Rules, the applicable Rules generally provide the terms of reference for a type approval. Where they are to be used on LR classed ships, it is a requirement of the LR Rules that certain products are to be type approved. This includes, for example, loading instruments and programmable electronic equipment for control, alarm and safety functions.

However, there are many other products, where other applications (even marine applications) are specified, which are outside the scope of the LR Rules. For these products, the client specifies the terms of reference.

Type approval may be defined as *"the process of verifying both:*

- *the client's documented product design, ratings and/or performance characteristics with respect to a recognised standard (defined reference point) by design appraisal and/or testing;*
- *the manufacturer's capability of maintaining production in compliance with the type tested specimen".*

Part I

LR Type Approval

1 Background to LR Type Approval

1.1 Historical Development

LR first became involved in the concept of type approval in the early 1960's. The need for such a system in the marine industry was driven by the shipping industry, and shipowners in particular. It was a period when the marine industry attempted to benefit from developments of increasingly sophisticated control equipment with proven success in land-based industry. The incentive for those in the marine industry was to increase functionality, enhance operation and to reduce costs. However, high failure rates resulted in unacceptable operational difficulties, demonstrating that equipment, previously well tried and tested in relatively benign environments, was significantly less successful in the more onerous marine environment. A particular example concerned the use of data-loggers in shipboard applications. The performance of the early models was significantly impaired by a ship's rolling motion.

Following much investigation into the failures, national authorities and LR developed guidelines for the design and 'type' testing of the equipment with the purpose of ensuring greater reliability and instilling greater confidence in the end user. The concept of type approval was thus created. During this period, there was much consultation between the national authorities, LR, various standards bodies, manufacturers and shipowners.

An account of how LR developed its own procedures and generated its own test specifications is provided in LRTA Paper No. 5, Session 1990/91 [1]. The control of production to ensure conformity with type tested sample(s) has also

been addressed by developments in the LR Type Approval System. To this day, LR continues to keep abreast of developments and take account of experience gained in the field.

1.2 The 1996 LR Type Approval System

The early LR Type Approval System related to control and electrical equipment and it was a requirement that type approved equipment should comply with LR's Rules. Major units of control equipment were also to be surveyed at the manufacturer's works. However, the scope of the LR Type Approval System expanded over time to cover a vast range of products, both electrical and mechanical, and for many applications outside the scope of LR's Rules. Satisfactory evidence of the manufacturer's control of production [2(a)] was acceptable for the type approval of products which were not required to comply with LR Rules. The LR Type Approval System now requires local office confirmation, in this respect [2(b)].

Figure 1 illustrates that LR Type Approval now applies to products that are not type approved against LR Rules, as well as those that are. The block diagram also demonstrates that the LR Quality Schemes could be used as alternatives to direct survey, where the products are covered by an applicable Scheme.

LR Type Approval is a process that includes appraisal of the client's documentation, testing of representative samples of the product, and verification of satisfactory control of production. Documentation may be reviewed under LR Plan Appraisal, where LR Rules are applicable, or design appraisal to other normative standards, if LR Rules do not apply. Consequently, where a product is required to comply with LR Rules, LR Plan Appraisal can form part of the type approval process. Upon satisfactory completion of the type approval process, the product would not require LR Plan Appraisal for use on other LR classed ships, providing the type approval addresses the latest Rules.

The particular benefits of LR Type Approval, therefore, are that:

- it removes the need for additional LR Plan Appraisal to approve the equipment for use on other LR

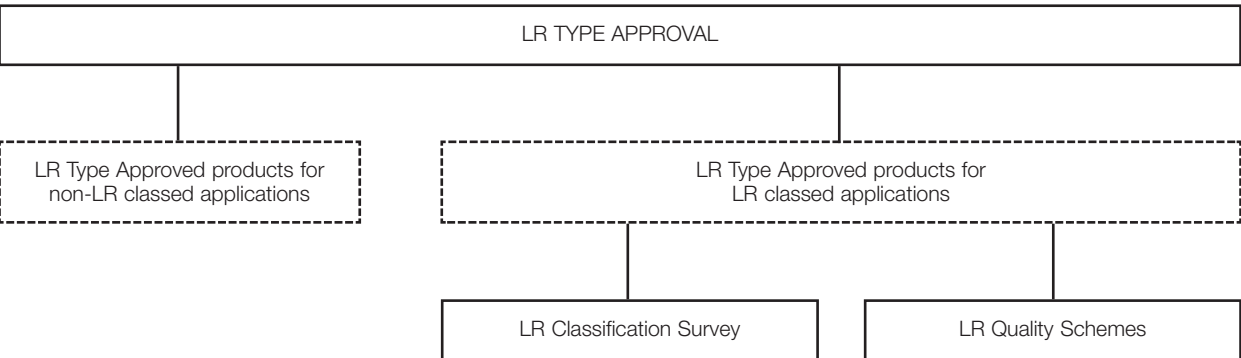


Figure 1: Block Diagram – The relationship between LR Type Approval and LR Rules

The design appraisal will also include a review of the client's test proposals, where submitted, to confirm that they will adequately demonstrate compliance of the product(s) with the Rules, codes or standards referenced by the client in the request form; any comments will be advised through the local office. For this reason, the type testing should not proceed without the agreement of the designated Type Approval Office.

2.3 Type Testing (and local office involvement)

The basis for sampling must ensure that the samples are representative of production of the entire range which is to be type approved. The procedures for marking, inspecting and testing the samples and reporting on the findings must adhere to the appropriate procedures [2(d)]. Except where the samples to be tested are prototypes, samples are to be agreed by the local Surveyor and selected at random from a production line used for the normal production runs. The samples should be positively identified in a tamperproof way by means such as hard stamping, tagging with a seal, or, in the case of castings for example, tags may be placed in a mould so that the identification mark becomes an integral part of the mould.

The basis for determining that the sample(s) selected are representative of the entire range will depend on the size of the range. However, specific testing on a sample considered to represent a 'worst case scenario' may satisfy the requirements.

Testing must be performed in accordance with the LR agreed test schedule and the acceptance criteria defined therein. The testing must either be witnessed by an LR Surveyor or conducted at a test house which is acceptable to LR, normally a nationally accredited test house.

When the tests have been completed, a test report is to be submitted to the designated Type Approval Office. If submitted by a local office, the test report must be in accordance with LR Type Approval requirements [2(e)]. The test results must be stated clearly and unambiguously, in the English language, or a language acceptable to LR. The test report must contain all of the relevant details, including any codes or standards referencing the actual tests completed. LR may recognise valid certificates and reports issued by another certification body or accredited laboratory.

The local Surveyor must take care that any test reports or certificates issued do not give the impression that the test results are acceptable. Reports or certificates should be endorsed with the wording:

This report does not constitute LR Type Approval nor signifies entry into the List of LR Type Approved Products which will be subject to satisfactory review and issue of a Type Approval Certificate

It is also recommended, when signing a manufacturer's test report, that the following wording is used before the document is signed and dated:

Verified as a true record of the test(s) witnessed

2.4 Factory Inspection (and local office involvement)

The manufacturer has certain obligations to control production [2(a)], ensuring that it is in strict conformity with that certified by LR, as detailed in Part I, Section 1.2. However, this does not preclude the normal survey requirements of LR Rules, if applicable. There is also a requirement for the local office Surveyor to establish, and confirm, that the procedures controlling incoming materials, manufacture, assembly, in-house inspection, testing and handling of complaints are adequate to ensure conformity of ongoing production with the approval documentation associated with the type approval. This requirement must be complied with, both for new type approvals and for extension certificates

2.5 Production Surveillance (at present)

In addition to the factory inspection for the initial type approval and for subsequent extensions, the current LR Type Approval System requires that surveillance activities be carried out in accordance with Figure 1, for products type approved against LR Rules. For products subject to direct survey in accordance with LR Rules, details would normally be included within the type approval certification, e.g. the type approval of diesel engines does not obviate the need for hydrostatic pressure testing of certain components such as fuel injection systems and cylinder jackets as required by LR Rules.

The manufacturer is required to ensure adequate controls over production to maintain the validity of any Type Approval Certificates held [2(a)].

2.6 Certification

Only when the product complies with the LR Rules, codes or standards against which type approval is sought, and when the manufacturer has demonstrated adequate control of production, will an LR Type Approval Certificate be issued. A sample LR Type Approval Certificate is given in Appendix B.

The certificate number takes the format:

AA/BCCCC

where 'AA' denotes the last two digits of the year that the original certificate is issued, 'B' denotes the Type Approval Office which issued the certificate and 'CCCC' is simply the number specific to that certificate, taken from a numerical sequence beginning 0001. Each certificate, therefore, has a unique number.

The certificate itself includes specific details taken from the initial request form such as the manufacturer's name and address and, where different, the address of the production facility. This denotes that the certificate is only valid for that manufacturer and production facility.

The certificate also includes a description of the type approved product and its specific type designation, together with references to the Rules, codes, standards or specifications against which the product was type approved, details of ratings which have been verified by the type approval process and any conditions or limitations which apply to its use. The certificate also includes the statement:

"This certificate is not valid for equipment, the design, ratings or operating parameters of which have been varied from the specimen tested. The manufacturer should notify LR of any modification or changes to the equipment in order to obtain a valid certificate".

A Design Appraisal Document forms part of the certificate and details or cross-references the approval documentation on which the type approval is based. By implication, the type approval is valid only for products which comply with the listed approval documents. A sample Design Appraisal Document appears in Appendix C.

Finally, details of the type approval will be entered onto the Type Approval Department database, defining the product as it will appear in one of LR's Lists of Type Approved Products. It contains the pertinent details shown on the certificate.

2.7 Validity

The LR Type Approval Certificate is valid for five years from the date of issue, provided:

- the product conforms to the approval documentation referenced in the Design Appraisal Document;
- the manufacturer complies with the LR Type Approval System requirements [2] and the Terms and Conditions stated on the certificate.

LR must be advised of any changes to the company name or production facilities or to the product itself. If production moves to a new facility, a factory inspection of the new facility will be required in accordance with Part I, Section 2.5 of the Paper. If the product itself has changed, or if the applicable Rules, codes, standards or specifications have changed, further design appraisal and/or testing may be required and an extension certificate will be issued upon satisfactory completion.

LR's Type Approval System Procedures [2] reserve LR's right to cancel a Type Approval Certificate if:

- any subsequent design changes are deemed to adversely affect the provisions under which LR Type Approval was issued;
- safety or any other feature of the product is found to be unsatisfactory in service;
- improper use is made of the certificate, or of LR's name, in marketing the product;
- LR's fees are not duly settled;
- the address of the production facility changes, without LR being notified.

In addition, a Type Approval Certificate may be withdrawn if:

- the manufacturer does not wish to renew the certificate;
- the product is no longer produced;
- the specific relationship between a producer and a licensor no longer applies.

2.8 The Type Approval Logo

When LR Type Approval has been satisfactorily completed, and a certificate has been issued, and whilst it remains valid, the manufacturer is authorised to use the LR Type Approval Mark. The Type Approval Logo, at the time of going to print, is depicted in Figure 2.

The logo may be applied to the packaging of the type approved product, to promotional literature or to the product itself, but it must comply with the LR specification which governs its design [3].

2.9 Extension Type Approval Certificates

For extension certificates, a completed Request for LR Type Approval form must be submitted. No additional documentation is required if the product and the place of production are unchanged from those specified in the original type approval. If changes have been made, however, details of the changes are to be submitted, together with a client statement regarding any impact that the changes have on the ratings, conditions or any other details specified in the original type approval.

The LR Terms and Conditions governing LR Type Approval include a statement that a Type Approval Certificate does not mean or imply approval for any use other than the



Figure 2: The Type Approval Logo

use(s) specified, nor approval of any product(s) which are not in strict conformity with the type tested sample(s). It is also incumbent on the manufacturer to ensure that the certificate remains valid by notifying LR of any changes which affect it.

If there have been no changes to the product details or operating parameters or, indeed, to the place of production, then it would only be necessary to check compliance of the product with the latest revisions of Rules, codes or standards. LR would also require confirmation that the procedures used to control ongoing production are adequate to ensure its conformity with the previous certificate details.

The extension certificate number will take the format:

AA/BCCCC E(X)

This is identical to the format for a new certificate, except for the addition of the designation E(X), which infers that the certificate is an extension certificate; the 'X' denotes the number of times that the certificate has been extended.

3 Issues Affecting LR Type Approval

3.1 The Impact of EC Directives

The EC Marine Equipment Directive has probably had the most impact on the work carried out by the Type Approval Department. To a lesser extent, EC Directives covering Recreational Craft, Electro-Magnetic Compatibility and Machinery have also had some effect.

Manufacturers of equipment covered by any of the above Directives will be required, by law, to comply with those Directives to the extent that, for the items concerned, the manufacturer may perceive little merit in obtaining LR Type Approval. However, LR Type Approval is applicable worldwide, whereas EC Certification is only required for European Community countries. For products which are not presently covered by EC Directives but which may be covered by an EC Directive in future, it is possible to certify the product through LR Type Approval. This can assist the demonstration of compliance with an EC Directive when it does come into force, even if LR does not become a notified body for the EC Directive concerned.

The nature of certain products, within the equipment categories listed below, is such that they previously required statutory type approval by a National Administration. In the case of the UK, the Maritime Coastguard Agency (MCA) enforce this requirement. LR has completed work on behalf of the MCA for many years and is also authorised to conduct type approval on behalf of other flag states or governments. On 1 March, 1996, however, the MCA delegated statutory type approval work for these products to LR and five other IACS members, by means of the Merchant Shipping Notice No. M.1645 [4]. This gave LR the authority to type approve products within these equipment categories, as defined by the Merchant Shipping Notice, on behalf of the MCA, in accordance with the associated MCA Specification Sheets:

- fire appliances;
- structural fire protection;
- life-saving appliances;
- marine engineering;
- load line equipment;
- crew accommodation;
- MARPOL equipment;
- group 1 navigation equipment.

However, the EC Marine Equipment Directive [5], which applies to all EC Member States, supersedes the above Merchant Shipping Notice for those products which feature in both documents. LR is now a notified body for the EC Marine Equipment Directive and is therefore appointed, on behalf of the MCA, to certify products under the Directive for use on any 'Community' ship.

4 Test Laboratories

4.1 Introduction

Equipment is to be tested in a laboratory with an acceptable national accreditation or in a test laboratory that is satisfactory to LR. The following notes give guidance on the assessment of a test laboratory. The assessment includes the test laboratory's quality system, standards and working procedures. The assessment also includes the premises and environment, equipment and calibration and a demonstration of procedure, that is the physical means to carry out the tests. Management and organisation, personnel, qualifications and training are also assessed. Test reports, records and uncertainty of measurement are considered. The process is summarised in Figure 3.

4.2 Standards

Guidance on inspection and assessment requirements for laboratories is given in ISO/IEC Guide 25 [6]. The equivalent British and European Standard is BS7501 (1989) EN45001 (1989) [7].

4.3 The Approval Process

The approval process, as indicated in the standards, shall include:

- collection of information;
- appointment of assessors;
- on site assessment;
- review;
- decision on approval and definition of scope.

4.4 Assessment

The assessment will include technical competence and working methods, and will be assessed under the following topic headings.

Quality System: A Quality System is to be operated by the test laboratory. The Quality Manual is to comprise, as a minimum:

- quality policy statement;
- organisation chart;
- responsibility descriptions and delegations;
- QA procedures;
- references to test procedures;
- references to proficiency testing and reference material;
- procedures for corrective action when discrepancies are detected;
- complaints procedure.

Standards: A full listing of standards for which the test laboratory requires approval is to be made available.

Standards, for example IEC, ISO, shall be inspected against a master schedule to check that the edition and date are correct.

Working Procedures: The test laboratory shall have adequate documented instructions on the use and operation of all relevant equipment, on the handling and preparation of test items and on standard testing techniques. Standards, for example IEC, ISO, shall be inspected against a master schedule to check that the edition and date are correct.

Where non-standard test methods and procedures are used, these shall be fully documented.

Premises and Environment: Premises and environment are to be suitable for the scope of testing undertaken on-site. Test premises are to be protected from excessive heat, dust, moisture, steam, noise, vibration and electromagnetic disturbance or interference. They shall be sufficiently spacious to limit the risk of personal injury or damage to property and to allow operators to make practical and precise movements.

Equipment and Calibration: Equipment shall be properly maintained in accordance with the manufacturer's instructions. Defective equipment shall be quarantined with labelling and storage and shall not be returned to service until it has been repaired, tested and calibrated.

Records shall be maintained for each major item of test and measurement equipment.

Measuring and testing equipment shall be calibrated before service and subsequently to a programme.

Reference standards of measurement held by the laboratory shall be used for calibration only and for no other purpose. Such standards will be traceable to a national or international standard of measurement.

Management and Organisation: The organisation chart is required to indicate the responsibilities of the testing laboratory. Each member of personnel is to be aware of the extent and limitation of his area of responsibility. Authorisations are to be checked at regular intervals.

Personnel: Qualification and Training Records are to be made available. These records are to be up to date and relevant for the scope of work of the test laboratory.

Authorisation: Authorisations of responsibility for each member of personnel should be in writing and made available for checking.

Test Reports: Each test report shall include as a minimum:

- name and address of testing laboratory, and location where the test was carried out at a different address to that of the testing laboratory;
- unique identification of report (for example serial number) and of each page, and total number of pages of the report;
- name and address of the client;
- description and identification of the test item;

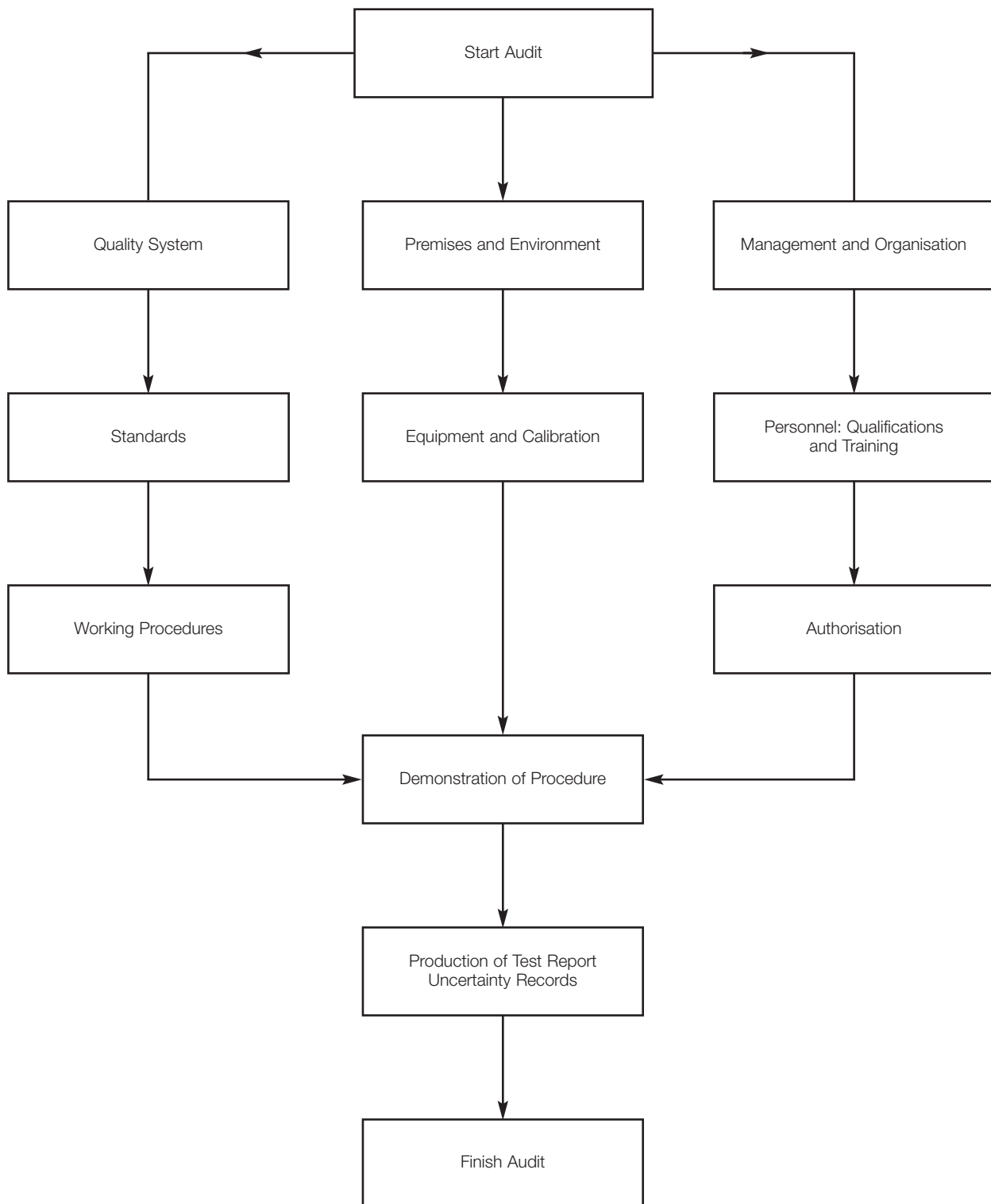


Figure 3: Audit trail for the assessment of a test laboratory

- date of receipt of test item and date of performance of test;
- identification of the test specification or description of the method or procedure;
- description of sampling procedure;
- deviations, additions to, or exclusions from the test specification;
- reference to non-standard test method or procedure;
- measurements, examination and derived results, supported by tables, graphs, sketches and photographs as appropriate, and identification of any failures;
- a statement on measurement uncertainty;
- signature and title of person accepting technical responsibility for the test report;
- a statement that test results relate only to the items tested;
- a statement that the report shall not be reproduced except in full without the written approval of the testing laboratory.

Records: The laboratory shall retain on record all original observations, calculations and derived data, calibration records and the final test report for an appropriate period. The records for each test shall contain sufficient information to permit repetition of the test.

Uncertainty: In common usage "uncertainty" means "not able to be accurately known or predicted". The term "uncertainty" when applied to measurement in a test or calibration laboratory is a quantifiable term.

Example:

For a particular measurement of distance, there is a 95% confidence level that the measurement uncertainty is $\pm 10\%$.

It is recognised that when all of the known or suspected components of error have been evaluated and the appropriate corrections have been applied, there still remains an uncertainty about the correctness of the stated result.

Any measurement is subject to random effects, such as short term fluctuations in temperature, humidity and air pressure and human factors such as variability associated with the actions of the test engineer. The calibration of the measuring instrument and the type of instrument used are also factors.

Example (Measurement of distance with a tape):

Consider two fixed points marked on a metal plate. An individual carries out repeated measurements of the distance with the tape and records the result to the nearest millimetre. Then the individual selects a further tape and carries out a further series of measurements. Ten other individuals then repeat the exercise. The exercise is carried out in the winter and again in the summer. When all the results of this highly tedious exercise are recorded there will be a variation or uncertainty due to the many random effects identified in the previous paragraph.

If the uncertainty components are quantified by repeated measurement results then the bell shaped curve or Gaussian distribution, as depicted in Figure 4, will result.

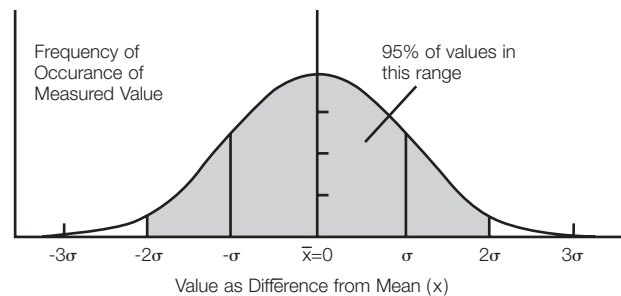


Figure 4: Gaussian Distribution

The result can be expressed in terms of standard deviations, as in the example 'a 95% confidence level that the measurement uncertainty is $\pm 10\%$ '. 95% is equivalent to two standard deviations (in precise terms $1.96 \times$ standard deviation).

If it is considered that the performance of equipment under test should be reproducible, then the importance of knowing the "uncertainty of measurement" becomes apparent.

Equally, when a result is near a specification limit or within the uncertainty band then it is important that the measurement uncertainty is reported.

The following guidance applies to the majority of cases.

If the limit values (upper/lower) for the particular test given in a standard falls outside of the range of values calculated from the test data plus/minus the uncertainty 'U' of measurement, then the result shall be deemed to be a straightforward pass or fail (Figure 5: (a) and (b)).

If the limit value for the particular test given in a standard falls within the range of values calculated from the test data plus/minus the uncertainty 'U' of measurement, then the assessment of pass or fail shall be determined on the basis of safety, that is considering the safest conditions (Figure 5 (c)).

There are exceptions to the above guidance, for example, for EMC tests it is normally accepted that the EMC limits have already taken into account the measurement uncertainties provided that the measurements are conducted according to good laboratory practice.

Laboratories that operate in accordance with EN45001 are required to report with a statement of uncertainty. Accreditation bodies are responsible for ensuring that accredited laboratories meet the requirements of EN45001. Accreditation bodies normally produce their own guidance based on the ISO PD 6461, Part 3 [8]. This document offers a comprehensive treatment of the subject. For the LR Surveyor attending a test, the basics are:

- It is the job of the test laboratory to carry out the evaluation of uncertainty;
- Laboratories that are accredited or working towards accreditation should have records showing the assumptions made and the sources of information for the estimation of component uncertainty values, for example calibration certificates, previous data, experience of the behaviour of equipment under test;
- Uncertainty of measurement should be reported in the test report.

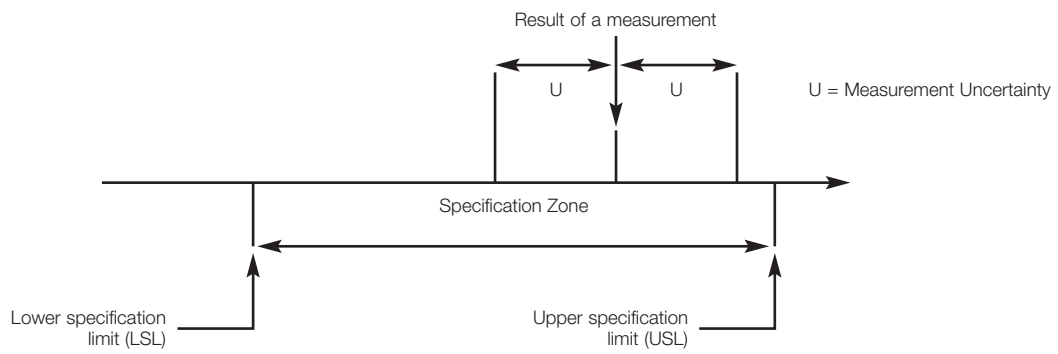


Figure 5(a): Result Pass

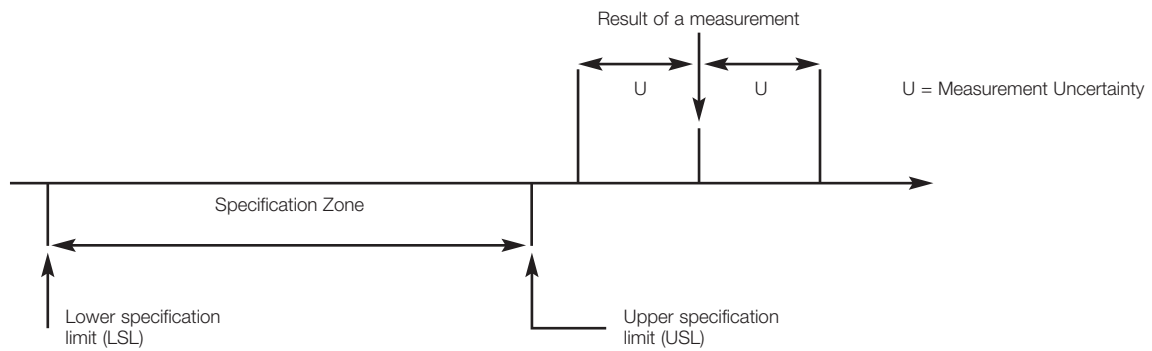


Figure 5(b): Result Fail

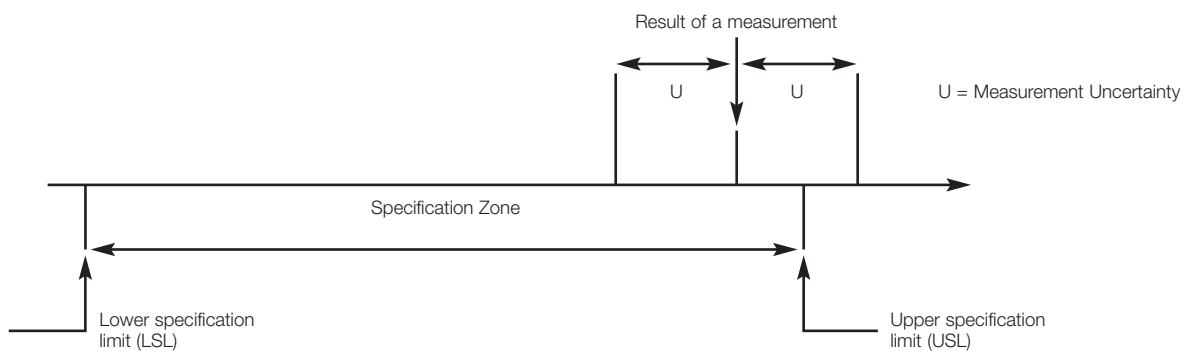


Figure 5(c): Result Fail

Figure 5: Measurement Uncertainty – Pass/Fail Criteria

4.5 Audit

Where test laboratories are accredited, the accreditation body will carry out audits.

Guidance notes [9] for organisations working towards accreditation and for LR approval of a test laboratory are available from the Type Approval Department.

For one-off audits for particular jobs the above notes should be suitable and Figure 3 may be used as the basis of an audit trail.

5 Type Approval Certification Issues

Manufacturers often wish to have a complete range of equipment approved. The apparently straightforward task of reporting the range on a certificate has identified a number of challenges.

A certificate listing, SWITCH TYP *** is not acceptable unless the asterisks are fully explained. The listing is to be sufficiently detailed to allow identification of the tested components. This is of importance when modifications are requested or when system problems occur. Examples are given for a float switch and an oxygen sensor in Figures 6 and 7 respectively.

The particular choice of items is not significant and the technical information given is not intended to be definitive. The main point of giving these examples is to illustrate the importance of clarifying all the options. The visual presentation of the information to suit the manufacturer and product can be varied but all the information required is to be provided.

Programmable Logic Controller (PLC) based products appear in many different versions and can build up to an extensive range. An example of part of a listing is provided in Figure 8. A comprehensive listing may extend to many pages, if that is necessary to fully describe the product.

There is no merit in reducing the amount of paper, and hence information, if clarity is lost as a result. If a problem arises when the product is incorporated in an installation then a clear definition allows LR and the manufacturer to look at the problem together. Equally, when the manufacturer carries out a modification on a particular module, the modification can be assessed against the initial design appraisal and test report. Modifications are to be formally advised to the Type Approval Centre as appropriate for appraisal.

SWITCH – PRESSURE

Producer/Licence No.	Item Description	Technical Details	Cat
Acme Alarm Inc. Unit 5, Chipping Flugga Wessex	Switch range SNxxxJ3xX/F/C (see below for detail)	Power supply (V): 220 240 (Hz): 50/60	ENV1 ENV2 ENV3

ACME ALARM INC

SN	***	J3	*	X	/F/	C	Customisation
							Float unit as required
							Denotes – 25°C/+70°C ambient temperature range
							Enclosure body material B = Aluminium Bronze S = Stainless Steel
							Sealed switch contacts
							Denotes flange size, configuration, material and pressure rating
							Denotes level switch head

Figure 6: Sample extract from a certificate for a Float Switch

TRANSMITTERS/TRANSDUCERS

Producer/Licence No.	Item Description	Technical Details	Cat
LOX Specialities Technopole Millenaire Carrefour Languedoc	HIALT Oxygen Sensor (see below for detail)	See Manufacturer's Specification	ENV1 ENV2

TYPE

HIALT Oxygen Sensor				
	Package: 1 – Weatherproof enclosure IP65 X – Without enclosure (spare)			
		Instrument Range: H – High M – Medium L – Low		
			Material: 1 – Stainless Steel 2 – Aluminium Bronze	
				Options: M – Marine Version F – Flameproof
HIALT				

Figure 7: Sample extract from a certificate for an Oxygen Sensor

CONTROL SYSTEMS

Producer/Licence No.	Item Description	Technical Details	Cat
Bach Industrie GmbH Landstrasse Oberdorf Mitteleuropa	ASAPAC Control and Alarm System (see below)	See Manufacturer's Specification	ENV1 ENV2

DESCRIPTION	ASAPAC Control and Alarm System	
TYPE	Epoch 2000	
Type Designation	Article No.	Description
AIM 101	2000-XYZ10	Analogue Input Module
AOM 101	2000-XYZ20	Analogue Output Module
RACK SS1	2000-XYZ30	Screening Kit
DIM 110	2000-XYZ40	Digital Input Module
DOM 110	2000-XYZ50	Digital Output Module
MEM 200	2000-XYZ60	Memory Board
MEM 300	2000-XYZ70	PROM

Figure 8: Sample extract from a certificate for a PLC based system

6 Future Developments in LR Type Approval

Discussions within LR concerning the future of type approval have centred on a number of areas where the current LR Type Approval System may be modified, or adapted to products it cannot readily accommodate at present, or where it may be more finely tuned. Five specific areas have been discussed and these are briefly described below.

6.1 Production Surveillance (in the future)

Primarily, production surveillance would apply to products which are not required to comply with LR Rules. For those products, it is envisaged that annual inspections would be carried out by the local Surveyor to ensure that:

- the product still complies with the approval documentation associated with the type approval;
- the procedures controlling production will ensure that it continues to do so for the following year;
- the firm has not changed its identity.

Forms (refer to Appendix D) and guidance notes have been prepared to define the requirements. Currently, these inspections of production controls only occur at the initial approval stage or when the client:

- advises that the product or documentation has changed;
- advises that the production facility has changed;
- applies for an extension certificate after five years.

The proposed new procedures will call for annual inspections to confirm the status of the above. It is intended that these will be formalised at a later date and communicated to other offices via appropriate channels.

6.2 Emphasising Standards rather than Product Applications

In the past, significant emphasis has been placed on the fields of application for which products are type approved. At times, this approach has been shown to be a constraining one, or open to misinterpretation. There have also been occasions where conflicts have arisen between the stated fields of application and the Rules, codes or standards against which the product was type approved.

Against this background, future type approval cases will place emphasis on the reference point against which the product is type approved, not the fields of application in which it may be used and which, in some cases, are too broad and expansive, e.g. marine, offshore and industrial.

The product will always be type approved against Rules, codes or standards, as defined by the Applicant. This will

enable the end user to determine the suitability of the product for use in any given application, by making appropriate cross-reference to the specified standard(s).

The Applicant should always be clear about the basis on which type approval is required. Where no recognised standards exist, the Applicant should be encouraged to generate a specification for the product. The specification would constitute the reference point for the type approval and should define the operating parameters and ratings which are to be verified, including test proposals for doing so.

6.3 Product Verification

Product verification is a form of certification that has been proposed as an alternative to full LR Type Approval. The process is being developed as a direct response to enquiries from clients who have requested type approval for products that the LR Type Approval System is not suited to. LR Product Verification (to be formalised) would probably be more appropriate to products whose performance cannot be readily evaluated through testing, e.g. products such as lubricants, paints or corrosion inhibitors. Type approval is not applicable to such products, primarily because of the problems associated with measuring and defining performance or operational parameters in the context of applications over which the manufacturer has no control.

The process of product verification, therefore, would involve LR verification of the product's claimed physical properties against a Product Data Sheet provided by the manufacturer. The process would also include some verification of the production controls, using an LR Quality Scheme approach with auditing and surveillance aspects.

Implementation of a product verification programme will necessitate the reassessment of current request forms. The existing form [10] will only be appropriate to full type approval. It will, in any case, be necessary to develop a new form which enables the client to simply specify his requirements without committing himself to the process, whether it be product verification or type approval. LR would then quote against these specified requirements and define the scope of work.

6.4 Type Approval Department Specifications

The following formal LR Test Specifications are currently available:

- LR Test Specification No. 1:1996, which is a performance and environmental test specification for control and electrical products;
- LR Test Specification No. 2:1999, for piping system components (limited to flexible hoses at this time);
- LR Test Specification No. 3:1996, for electric cables, circuit breakers, fuses, submersible penetrators, subsea cable connectors and electric motors;
- LR Test Specification No. 4:1996, for internal combustion engines;

- LR Test Specification GT98:1998, for gas turbines;
- LR Software Conformity Assessment System – Assessment Module GEN1:1994.

In due course, additional Specifications will become available, for example, for special service craft fittings and components.

The current view is that the future approach with these specifications should be to compile them in more general terms, specifying LR's core requirements, possibly with references to additional or optional requirements that might apply to products of a specific design or type.

The Specifications could relate to either of the following areas:

- Product Verification (e.g. for lubricants);
- Type Approval.

Ultimately, a range of Specifications would be available and would be maintained in a controlled manner with close liaison between the Type Approval Department and any LR specialists involved in their compilation. This would enable LR's requirements to be specified in a clear and consistent manner at an early stage of an enquiry, thus reducing delays, whilst ensuring consistency within LR.

6.5 Type Approval under LR's Rules and Regulations for the Classification of Naval Ships

With the advent of LR's Rules and Regulations for the Classification of Naval Ships, the scope for type approval has extended. This is another area where LR Type Approval could benefit clients because current naval requirements tend to specify that equipment, such as gas turbines, are type approved against defined specifications. In this respect, LR Type Approval against the Naval Rules could complement naval requirements for Upkeep by Exchange [11] and Through Life Survey Schemes.

The existing type approval procedure will be the basis for the type approval of equipment used on naval ships. However, requirements which are additional to those for merchant ships will apply to naval ships. These requirements will depend on the navy for which the equipment is intended.

For example, type testing of diesel engines and gas turbines for naval ships is likely to be more onerous with regard to inclination tests, and the examination of the resistance to impact and blasts is likely to be more extensive.

Applications for LR Type Approval under LR's Rules and Regulations for the Classification of Naval Ships should include declarations concerning the following environmental criteria which may be in excess of those specified for merchant ships:

- Ambient sea, air and machinery space conditions:
The range of climatic conditions under which the equipment is capable of the full specified performance such as those associated with closedown situations.
- Temperature and humidity:
Ambient temperature and humidity conditions from sub-arctic to extreme tropical conditions (air and sea water temperatures).
- Pressure:
Ambient atmospheric pressure range at which the equipment is capable of full specified performance.
- Ship motion:
Conditions of ship motion under which equipment is capable of efficient operation and any performance relaxations under those conditions.
- Static tilt conditions:
Permanent and damage conditions of heel and trim.
- Habitability:
*Heat insulation;
Emission of noxious substances;
Noise levels.*
- Vibration environment (externally generated):
Limitations.
- Noise and vibration (self generated):
Levels of machinery derived noise and vibration signatures.
- Shock:
Mounting performance requirements.
- Submersion:
Capability of operation under flooding to a specified level.
- Electro-magnetic pulse:
Effects from airborne nuclear explosion.
- Electro-magnetic engineering:
RADHAZ (Radio Hazards) and EMC (Electro-Magnetic Compatibility).

The foregoing list is not exhaustive and additional aspects may be included where specified by a Naval Authority. The responsibility for defining the military requirements relating to design and performance capability of equipment and systems required for naval operations rests with the Naval Authority. It is important that producers of equipment intended for supply to naval ships are fully aware of the potential military capability requirements that may be specified before embarking on an extensive test programme. LR is able to provide guidance on design and testing of equipment and systems and it is intended that supplements to existing type approval procedures will be developed in the future.

Part II

The LR Quality Schemes for Machinery, Materials and Hull Construction

1 Background to the LR Quality Schemes

1.1 History

The LR Rules and Regulations, and subsequently the Marine Division Survey Procedures Manual, have evolved by utilising for example, available data concerning ship losses, survey data, surveyor personal experience, industry best practice, customer requirements and relevant legislation.

The requirements of the LR Quality Assurance Schemes for Machinery, Materials and Hull Construction, hereafter referred to as the Schemes, evolved in a similar way. They began as the Batch and Line Scheme (Quality Control biased) and, as quality management system standards became a measure of additional confidence in contractual situations, developed into Schemes that recognised the principles of Quality Assurance.

Initially, the only method of assuring compliance with the LR Rules and Regulations was by direct survey. However, as production levels increased and companies started to mass produce machinery, it became necessary to develop a survey system which did not disrupt production lines but which allowed the Surveyor to conduct the required stage inspections. As a result, in the late 1950's, the Batch and Line Scheme for machinery was developed.

In the early 1970's, large numbers of oil tankers were constructed, particularly in Japan, which required vast quantities of steel plate, sections and bars to be surveyed. In order not to disrupt material production and deliveries, and to facilitate survey of shipbuilding, the Quality Assurance Schemes for Materials and Hull Construction of Steel Ships were developed. At the same time, the Batch and Line System was upgraded to the Quality Assurance Scheme for Machinery.

In these Schemes mentioned above, the quality of product is assessed by surveyors through a combination of regular auditing of procedures and processes, with regular monitoring of inspection, process control points and

testing, i.e. the emphasis is on the Surveyors monitoring the entire system controlling the product, allowing the product to be certified by the manufacturer.

For the benefit of the reader, the term 'Assurance' has been removed from the titles of the Schemes. This has been necessary since the founding of Lloyd's Register Quality Assurance Ltd. (LRQA) began to create some confusion when referencing the Quality Assurance Schemes or, abbreviating the title for example, LR QA Scheme for Machinery. Any new Schemes publication will not reference 'Assurance' in the title.

1.2 The Schemes – What are they?

The Schemes are product related and can be used to complement or, enhance traditional survey activities.

Most companies have some form of quality system control implemented, however simple, that control the manufacturing processes. Although the control measures are not always formally documented, they nevertheless tend to be present. Such quality systems alone do not normally address the product specific relationships between LR and its clients, and are likely to require some form of modification to bring them into line with the requirements of the relevant Scheme and thus, provide the overall system confidence required by LR.

The majority of quality management systems in industry today, are based upon the requirements of ISO 9000 [12]. However, ISO 9000 being generic is in many instances too general for the more product and industry orientated Schemes. For example, ISO 9001 Clause 4.6 requires that:

"subcontractors shall be selected on the basis of their ability to meet subcontract requirements including the quality system and any specific quality assurance requirements".

However, LR requires specific products to be sourced from LR approved manufacturers, e.g. plate, sections, castings, coatings, electrodes, fluxes, switchgear, etc. Furthermore, LR requires control of product design through plan approval/appraisal, and identification and control of authorised signatories for the issue of certification for the product, i.e. those who will certify the release of approved product under Scheme operation on behalf of the manufacturer and LR. There are other examples of obvious differences depending upon the particular Scheme under consideration, e.g. certification of products for compliance with LR's Rules.

The Schemes are designed as an alternative to direct survey, or to provide a reduction in the degree of survey required. Accordingly, it is imperative that those clients wishing to participate in the Schemes have a verifiable record of commitment to quality and the Scheme philosophy. Otherwise, LR would not be able to establish the necessary confidence to allow a reduction in or to eliminate direct survey activities.

1.3 Location of the Scheme Specifications

The Scheme's specifications for Materials, Hull Construction of Ships and Machinery can be found in LR's Rules and Regulations for the Classification of Ships [13(a-c)], respectively.

Additional guidance notes for Surveyors on the above specifications are provided in the Marine Division Survey Procedures Manual (MDSPM) [14(a-c)].

A Quality Scheme for Special Service Craft is currently being considered which will cover the manufacturing process from hull construction through to delivery of the craft, including outfitting, inspection and testing. These later aspects may be included in requirements when the Hull Scheme is redeveloped in 2000.

2 The Processes within the LR Quality Schemes

The Schemes are there to assist manufacturers who have established and actively operate a quality system for manufacturing their approved products and wish to streamline the certification process by reducing the degree of intervention by the Surveyor. The process is depicted in the Flowchart in Appendix E. A Case Study, reflecting a recent case, appears in Appendix H.

2.1 Application for a Scheme

When a manufacturer requests to join a Scheme, the local attending Surveyor discusses the specific Scheme requirements, and the role of LR and the manufacturer during the operation of the Scheme. To reduce problems at the subsequent stages of the process, it is essential that the manufacturer be encouraged and educated into the role as a Scheme participant, and be made aware of the associated responsibilities. Once the Surveyor is satisfied that the manufacturer can fulfil the requirements for implementation of the Scheme, a request along with the manufacturer's details will be forwarded to the Type Approval Department (the Scheme's Administrators).

General liaison between the local office and the Scheme Administrators will take place in order to assess the client's experience and general suitability as a Scheme participant. A quotation may also be provided to the manufacturer at this time.

Once it is agreed to proceed, details of the manufacturer's documented quality system, manufacturing and quality controls, products, equipment, staff, etc. are obtained. This documentation and data are submitted to the Administrators for review. Where other departments in HQ are involved with the approved or appraised product, they will be advised of the situation.

It is at this stage that LR would expect to see evidence that a quality assurance philosophy prevails at the manufacturer's works, not simply one based upon the principles of quality control. LR encourages manufacturers to operate the Scheme in such a way as to PREVENT the occurrence of non-conformance in their products and procedures, not just to adopt a DETECT and CORRECT approach.

After the preliminary review of the submitted information and documentation, a response will be forwarded to the local office. The response is considered by the local office and adjusted as necessary giving due regard to culture and local knowledge of the manufacturer. This allows the manufacturer to implement any corrective measures considered necessary prior to the formal assessment of the quality system and controls.

Subsequent to the preliminary review, a contract for LR to conduct an assessment of the quality system controls for compliance with the relevant Scheme requirements will be submitted to the manufacturer for signature.

After acceptance of the contract, the local or regional LR offices, or the Administrators themselves, will arrange for the initial assessment of the manufacturer's quality system. This may involve a visit to plan the assessment and to review further documentation. The result of this should be a programme scheduling the assessment, dates and durations, and the names of qualified LR personnel nominated to attend. These details are to be submitted to the Administrators for review and approval prior to finalising arrangements for the initial assessment of the manufacturer's quality system.

The initial assessment of the client's quality system utilises the results of the preliminary review, the requirements of the relevant Scheme and the client's own documented system. These are then compared with the actual practice observed in the various areas visited, as defined by the programme.

An initial assessment is a mandatory requirement and must be successfully completed prior to acceptance onto the Scheme.

The results of the assessment will be recorded and reported as required by the relevant Scheme Rules and MDSPM. The report should include the following extract from the MDSPM:

- Title page;
- Distribution;
- Introduction;
- Standards applied;
- Limits of the assessment;
- Disclaimer;
- LR limited liability clause;
- Assessment programme;
- Findings;
- Conclusions;
- Recommendations;
- Attachments (Non-compliances/observations raised).

A copy will be supplied to the Administrators for subsequent review/approval.

Following satisfactory review and approval, a certificate will be issued to the client via the local office. Under the Machinery and Materials Schemes, where it is a requirement to identify the LR approved product, metal stamps of interlaced LR logo will be issued to the manufacturer for hard stamping of the product(s) prior to release.

However, if the results are unfavourable, it may be necessary to arrange follow-up visits to confirm that adequate corrective actions have been implemented for the problems encountered. Once these matters have been resolved a Scheme certificate will be issued.

2.2 Maintenance of the Scheme

The Schemes are maintained in two phases:

- (i) regular visits by the attending surveyor, who monitors the production, inspection and testing procedures implemented by the manufacturer;
- (ii) intermediate surveillance visits by surveyor/assessors, where the management quality procedures relating to the products are audited.

The choice of title for the two types of visit was by design, to emphasise the difference between them, regarding purpose, content, structure, frequency, basis, reporting and LR attendees, etc.

2.2.1 Regular Surveillance

The local office will establish a monitoring programme based on the quantities and production schedule for the approved product. Depending on production levels and the Scheme type, the monitoring may be conducted on a daily, weekly, bi-weekly, monthly, etc. basis. If the client is experiencing periods where production ceases or is irregular, then the period between monitoring visits may be extended to a maximum of three months.

These visits will be product and manufacturing process related and termed 'regular and systematic' visits. They will typically involve witnessing tests, observing the manufacturer's inspection and quality control activities, reviewing records and observing the production processes. What is to be performed during these visits is defined in the guidance notes. These are produced by local office personnel for use by the attending Surveyor. They are reviewed and agreed by the Administrators prior to use.

The feedback from these activities will assist the clients to maintain and improve their systems whilst also identifying potential areas for possible development. The same activities will provide LR with evidence that the Schemes are being maintained. Each visit is reported to the Administrators in an agreed format, an example of which can be found in the MDSPM.

The key features of the Schemes are that:

- the Schemes are an alternative to direct survey;
- the client is accepting and certifying the products on behalf of LR;
- the client issues and signs the certificates, which are verified by the local LR office at a later date;
- there is no Surveyor on site witnessing every product;
- the Surveyor's confidence in the client's procedures and capability to maintain product quality is through regular attendance.

Accordingly, the attending Surveyors must have the product knowledge, an understanding of the processes involved in producing the product and, be familiar with the respective Scheme requirements.

2.2.2 Audit Surveillance

Surveillance visits are conducted once every six months, which is a mandatory requirement, and are not dependent

on the manufacturing output. The visits are system related and termed 'intermediate' visits. They would typically involve, reviewing results of internal audits, internal or external non-conformances, results of management review, customer complaints, certification process, corrective/preventive actions taken, changes to the system, and assessment of selected areas of the client's quality system. Each visit is reported to the Administrators and if successful, the reverse side of the Scheme certificate is endorsed by the Assessor/Surveyor.

What is to be assessed at each surveillance visit is dictated by entries in an audit plan for the client. This document is produced by the Lead Assessor/Surveyor at, or immediately after, the initial assessment.

Sometimes, these audits involve certain product related aspects which result from the previous 'regular and systematic' monitoring visits. Indeed, the audits are planned such that over the certification period (usually 3 years), the whole of the client's quality system is audited.

The Assessor/Surveyor(s) must be qualified as for 'regular and systematic' visits and have a recognised assessment qualification, i.e. registered with International Register of Certified Auditors (IRCA) as an auditor/lead auditor, or a suitable equivalent.

2.3 Triennial Assessment

The normal Scheme period of operation is three years.

Providing LR's experience of the performance of the client in operating and maintaining the Scheme has proved successful, a triennial re-assessment of the client's entire quality system will be scheduled. The arrangements for the triennial will be as for the initial assessment mentioned in Part II, Section 2.1 above.

The client is required to successfully complete the mandatory triennial process in order to maintain certification under the relevant Scheme. The report of the visit will however take a slightly different form, due to LR's experience of Scheme operation at the client but, is generally as for the initial assessment. The Administrators will issue a certificate for a further three years on satisfactory completion of the visit

2.4 Recognised Supplier

Scheme participants have options regarding the control of their suppliers of materials and components requiring classification certificates. They are:

- (a) direct survey by LR surveyors, or
- (b) agreed inspection procedures between the two parties combined with documented evidence of assessments by the Scheme participant, and annual surveillance visits by LR, or

- (c) recognition of quality agreements between the two parties, which include initial assessment by the Scheme participant and regular surveillance visits by LR (minimum four per year), or
- (d) the supplier becoming a Scheme participant.

Scheme participants whose product includes materials or components that feature in the above scenario must have procedures and controls over their suppliers which are based on one of the above. This aspect is verified during the initial assessment of the Scheme participant.

Should the LR visit(s) in options (b) or (c) prove successful the manufacturer will receive the status of 'recognised supplier' to the Scheme. A report of the visit(s) is submitted by the Surveyor to the supplier in order to support the release of product to the Scheme participant, and copied to the Scheme administrators.

3 The Role of LR

3.1 The Local Surveyor's Role

Surveyors may be requested to attend either regular monitoring visits described in Part II, Section 2.2.1 or, surveillance visits in Part II, Section 2.2.2 at Scheme participant's works or, at 'recognised suppliers' works. This will depend upon their product and process knowledge or background, qualifications and where relevant, auditor training. It is important for the Surveyor to be familiar with the Scheme requirements and guidance material regardless of the role undertaken.

Surveyors who have been trained within LR for quality system auditing may be requested to attend initial or, triennial assessments for the Schemes or, surveillance visits. This also requires knowledge of the Scheme's requirements.

Those who attend visits relating to Scheme requirements should ensure that the client's do not compromise the trust placed in them by LR. There is by the very nature of the process involved a need for a special relationship between LR and the Scheme participants. If a product released under Scheme operations is subsequently found to be non-compliant, this could have significant legal and financial implications for LR.

3.2 The Scheme Administrator's Role

The Administrator's role, as undertaken by Type Approval Department, is to ensure that the Schemes are operated in accordance with the relevant requirements and are conducted in a uniform manner worldwide. They are to ensure that the interests of all parties are satisfied:

- (i) the LR Committee;
- (ii) Scheme participants;
- (iii) customers of Scheme participants;
- (iv) LR surveyors who receive the product under Scheme operations;
- (v) purchasers who specifically buy from Scheme participants;
- (vi) IACS as an alternative to direct survey activities;
- (vii) LR internal Auditors; and
- (viii) society at large;

all of whom expect LR to operate the Schemes effectively, efficiently, consistently and in accordance with the LR Rules and Regulations.

Type Approval Department achieves the above by monitoring documents produced by clients and LR staff, and by participation in the Scheme's operational processes. These methods of control and the subsequent records produced, enable the Administrators to demonstrate that a

consistent approach has been adopted on a worldwide basis.

It is recognised that in order to maintain high standards of quality assurance approvals, it is essential for Surveyors to effectively check or audit the approved manufacturing and quality control procedures at the frequencies specified. Performing these duties will not only communicate LR's commitment to the Schemes but also maintain the client's confidence in the approach, which remains an alternative to the traditional survey.

In addition to performing the leading, authoritative and regulatory role of Administrator, the Type Approval Department retains both the current and historical data associated with the Schemes. Furthermore, the department is responsible for monitoring the implementation and assisting with the marketing of the Schemes on a worldwide basis. As a result of administering the Schemes, regular contact is made with other departments who are involved in the plan approval, or appraisal aspects of the products covered by the Schemes. Therefore, the management and operation of these Schemes relies heavily upon a team based approach, which involves local, regional and HQ personnel.

The Administrators also offer a technical help function on Scheme requirements to local offices, existing clients, and to those clients who have expressed an interest in participating in the Schemes. Therefore, where local or regional LR personnel have problems in operating or understanding a Scheme's requirements, assistance should be sought from the Scheme Administrators.

4 Benefits to LR and Clients

The Schemes offer various benefits, some of which have been identified below:

- the manufacturer can control his production and delivery without the need for a Surveyor to attend at hold points or final inspections. This allows better use of manpower;
- regular monitoring and audit allows all manufacturing areas to be kept under surveillance on a regular basis. This allows earlier identification of problems and implementation of corrective actions, to everyone's advantage;
- LR local office, via Scheme compliance, has sufficient confidence in the client and the production quality to allow the client to endorse certificates on LR's behalf;
- clients can utilise the additional confidence placed in them by LR in their marketing;
- the Schemes require regular client contact, thus improving client relations;
- the Scheme requirements are product and process orientated, and providing the client is committed to compliance, the Scheme certificate provides additional support to product integrity, i.e. the product is in conformance with the specification;
- whilst ISO 9000 is an internationally recognised standard for quality management systems, when complemented by a certificate for compliance with the requirements of LR's Scheme, an additional level of confidence relating to the product's quality will inevitably result;
- those certified for compliance with an LR Scheme have their name and scope listed in LR's publications, e.g. List of Approved Manufacturers of Materials, which form part of the Rules. This provides a marketing outlet since it is used by industry as a source of potential suppliers.

Where a client already operates, or wishes to operate, a quality management system certified to ISO 9000 by LRQA, it may be possible using suitably qualified LR surveyors to carry out a combined ISO 9000 and LR Scheme assessment and surveillance visits, resulting in considerable cost reductions to the client.

5 The Future for the LR Quality Schemes

The subject of specifications is ever changing which inevitably affect LR and its clients.

The changes expected in internationally recognised quality management system standards such as ISO9000: 2000 will involve business objectives and customer focus issues. This evolution plus the quality assurance modules specified in the EC Directives and MARPOL Annex VI requirements regarding nitrogen oxide emissions (NOx), for example, will present a greater opportunity for product related Schemes such as those offered by LR. This is due mainly to customers recognising that quality management system certification alone, does not necessarily increase confidence of eventual product conformance.

As explained in Part II, Section 1.1 of the Paper, the Schemes are a development based upon market needs and as such will continue to evolve to meet these demands. This development process has begun again, utilising the positive comments received from Surveyors and clients on present Schemes' operation. The proliferation of Schemes for other types of products, e.g. Fixed Offshore Installations, Mobile Offshore Units, etc. based upon the requirements of the existing Schemes, has also contributed to the identification of the need to change.

Also, more can be made of 'recognised supplier' status in the supply chain.

It is intended that the Schemes will be sufficiently adaptable to be applicable to components and assemblies, through to the finished product. They will have sufficient flexibility to be utilised throughout the supply chain, enabling a greater degree of confidence to be gained by all concerned through consistently applied LR resources. They will accommodate sector specific requirements, e.g. Naval, through appendices. Only by this approach can the true benefit over direct survey of either being a Scheme participant or, as a 'recognised supplier' to a Scheme participant, be appreciated.

All of the Schemes' requirements will be contained within one document including those for specific topics such as crankshafts or GRP Hulls, etc. The guidance material will then follow in a similar format.

It is recognised that the MDSPM will need to accommodate a more varied approach to demonstrating compliance with the requirements of the Schemes. Alternatives to existing methods have been agreed with the Schemes' Administrators and are at present under trial. Examples of these are:

- combination of visit types, i.e. regular monitoring and audit, described in Part II, Sections 2.2.1 and 2.2.2;

- variation to visit frequencies, duration and content based upon LR experience of client system performance;
- variation of visit reporting methods and formats;
- variation to the qualifications required for surveyors to attend for Scheme duties;
- some recognition of client certification at specific stages of Scheme operation, e.g. ISO9000 at initial assessment;

Finally, as with current Rules, it is envisaged that the new Scheme requirements will be available in electronic format via the internet.

Concluding Remarks

The Paper demonstrates that the LR Type Approval System and the LR Quality Schemes provide the client with greater flexibility and more options with respect to the certification of products for classification purposes. Both of these certification systems are product specific and can be used separately, or in conjunction with one another, to satisfy the applicable LR Rule requirements. Furthermore, both the LR Type Approval System and the LR Quality Schemes are in tune with current trends, within industry as a whole, where end users are requiring type approved products and where the manufacturer is demonstrating more control of production, through LR Type Approval or the LR Quality Schemes.

LR Type Approval can benefit the client by:

- removing the need for additional LR Plan Appraisal for use on LR classed ships, if the type approval covers the latest LR Rule requirements;
- providing a basis on which a client may have a product independently certified against other standards, where no LR Rules apply;
- satisfying future requirements such as those for naval ships which place more emphasis on type approval;
- providing a useful marketing tool because of the confidence which it instils in the end user of the product.

Type approval is gaining wider recognition as a certification process as a result of the many EC Directives that use a similar process. By the same token, the LR Quality Schemes are similar to production control modules used in some EC Directives. In this respect, LR Type Approval and the LR Quality Schemes both represent systematic approaches that can also be used together as a package.

The LR Quality Schemes can benefit clients by:

- providing a cost effective alternative to the direct survey requirements within the Rules;
- relying on the manufacturer, rather than a resident inspector, providing sufficient evidence of product compliance;
- minimising hold points which create production delays.

The LR Quality Schemes' philosophy is a viable way forward for future survey work. Greater reliance is being placed upon quality processes which give verification and confidence in the manufactured product. The newly developed Naval Rules illustrate this point.

It is essential that LR can offer an alternative approach to accommodate these trends. The LR Type Approval and Quality Schemes provide such mechanisms and future developments of these certification systems can open up further possibilities.

Wherever possible, the Type Approval Department will

give due consideration to alternative certification systems. The example of product verification was touched on within the Paper. The Type Approval Department will seek to develop and provide further routes to independent certification and/or verification of clients' products, where those products cannot be readily accommodated by the LR Type Approval System. The intention is to develop certification systems which provide greater flexibility to LR's clients over a wider product range and to enhance those systems where areas of possible improvement become evident.

Acknowledgements

The Authors gratefully acknowledge the valued assistance and co-operation extended to them by Lloyd's Register colleagues and would like to extend their thanks accordingly.

References

- [1] Knights, J.W., and Malone, M.; Type Approval. Lloyd's Register Technical Association, Paper No. 5, Session 1990-91.
- [2] LR Type Approval System – Procedure TA96: 1996:
 - (a) Section 6;
 - (b) Section 3.4.2;
 - (c) Section 3.2;
 - (d) Section 3.4;
 - (e) Section 3.4.4.
- [3] The Type Approval Mark Specification No. 1990/1.
- [4] MCA Merchant Shipping Notice No. M.1645.
- [5] EC Marine Equipment Directive 96/98/EC, as amended by 98/85/EC.
- [6] ISO/IEC Guide 25: 1990, "General Requirements for the Calibration and Testing of Laboratories".
- [7] BS7501: 1989, EN45001: 1989, "General Criteria for the Operation of Testing Laboratories".
- [8] ISO PD6461: Part 3: 1995, "Vocabulary of Metrology Part 3. Guide to the Expression of Uncertainty in Measurement".
- [9] LR Product Certification System – PC93 Accreditation Guidance Notes.
- [10] Request for LR Type Approval form no. 2571.
- [11] LR Rules and Regulations for the Classification of Naval Ships, Volume 1, Part 1, Chapter 2, Section 4 and Volume 2, Part 1, Chapter 2, Sections 4 and 6.
- [12] ISO 9000 Series Standards.
- [13] LR Rules and Regulations for the Classification of Ships:
 - (a) Part 2, Chapter 1 – Scheme for Materials;
 - (b) Part 3, Chapter 15 – Scheme for Hull Construction of Ships;
 - (c) Part 5, Chapter 1 – Scheme for Machinery.
- [14] Marine Division Survey Procedures Manual:
 - (a) Part B, Chapter 1, Section 2 – Scheme for Materials (see also Attachment 1 to Marine Division Technical Notice No. 99/014/C);
 - (b) Part D, Chapter 2, Section 8 – Scheme for Hull Construction of Ships (see also Attachment 1 to Marine Division Technical Notice No. 99/007/C);
- (c) Part D, Chapter 3, Section 7 – Scheme for Machinery (see also Attachment 2 to Marine Division Technical Notice No. 99/007/C).
- [15] "Guidelines for Emergency Towing Arrangements on Tankers", International Maritime Organisation Resolution MSC 35(63).
- [16] Crockett, V.A., "Emergency Towing Arrangements, the Plan Approval Experience". Lloyd's Register Technical Association, Paper No. 3, Session 1997-98.
- [17] "Recommendation on Emergency Towing Requirements for Tankers", International Maritime Organisation Resolution A.535(13).
- [18] Lloyd's Register's Rules and Regulations for the Classification of Ships, Part 3, Ship Structures Chapter 4, Section 8.3, Loading Instrument.
- [19] IMO MSC/Circ. 836, 6th February 1998, "Recommendation on Loading Instruments".
- [20] LR Type Approval System, Test Specification Number 1: Performance and Environmental Test Specification for Control and Electrical Products (environmentally tested) to be used in marine and offshore applications.
- [21] IEC60945 (1996-11), "Maritime Navigation and Radio-communication Equipment and Systems – General Requirements – Methods of Testing and Required Test Results".

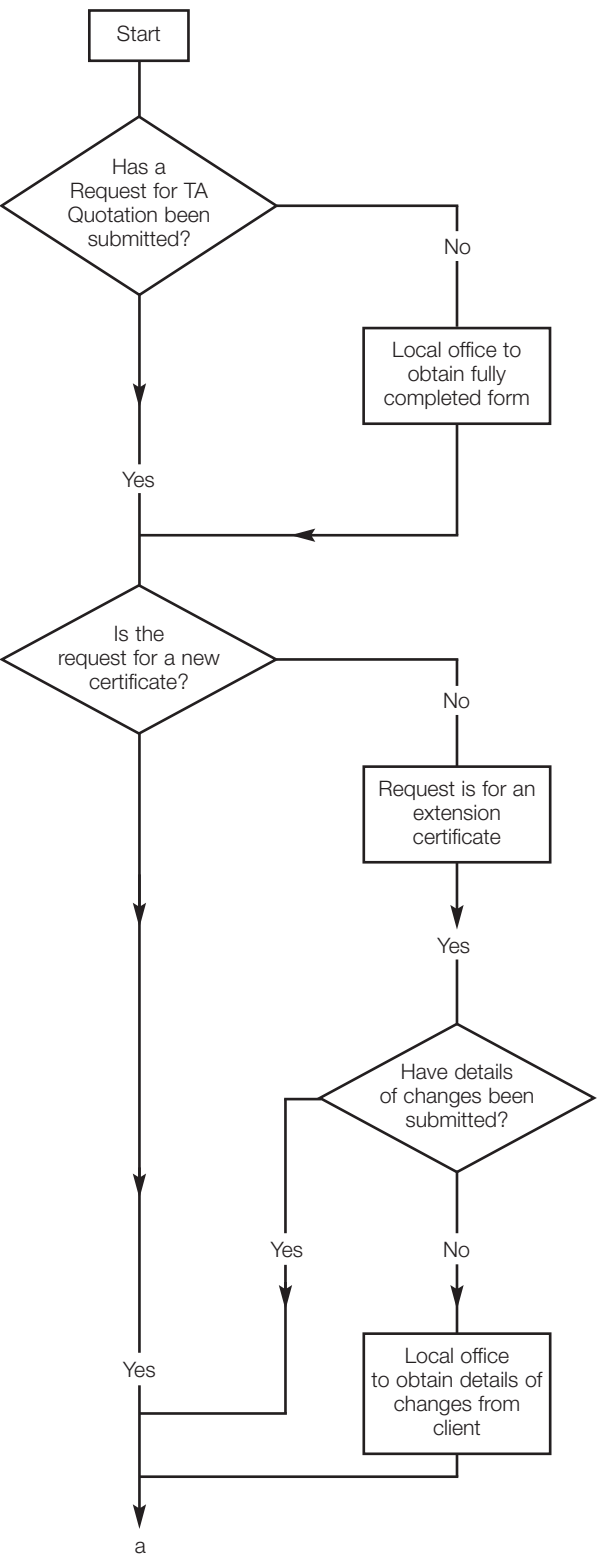
Glossary

Community Ship:	A ship for which safety certificates are issued by, or on behalf of, Member States (of the European Community) under international conventions.
Fairlead:	In the context of the Paper, a deck-mounted opening through which emergency towing chaffing gear, towing pennant or towing line runs.
Flag State:	State in which a ship is registered and which undertakes to regulate its activities under its own domestic laws and appropriate international treaties and conventions.
Reference Point:	The collective term for one, or several, codes, standards, specifications or LR Rules against which a product is type approved.
Strong Point:	In the context of the Paper, the inboard end fastening of an emergency towing arrangement.

Appendix A

LR Type Approval Procedure Flowchart

Notes

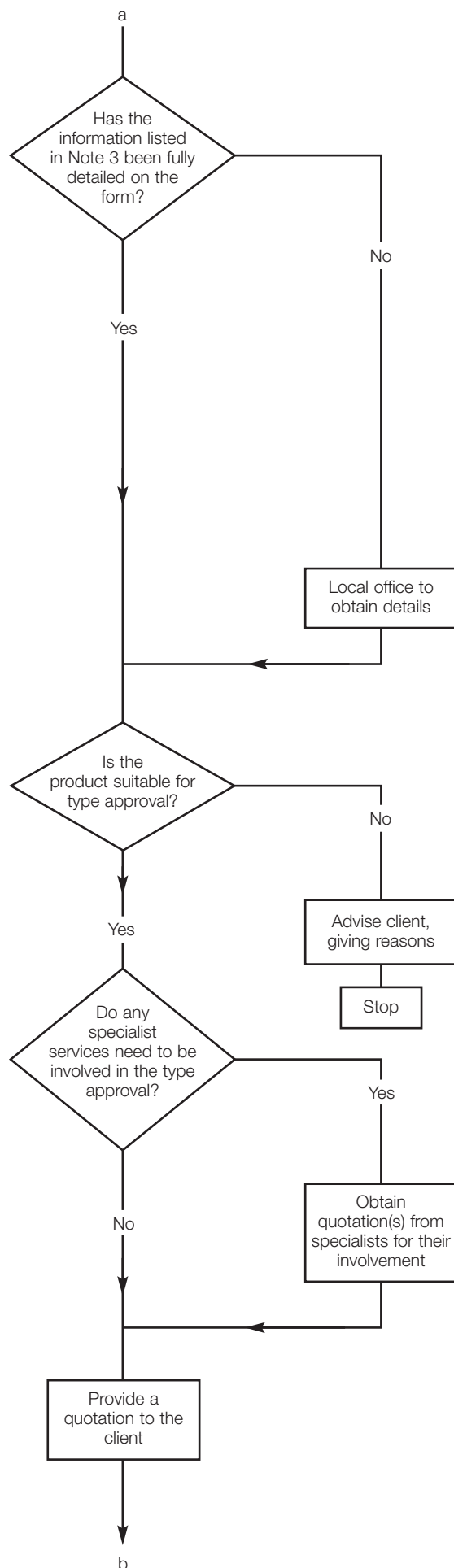


Note 1:

The Request for TA provides the Applicant with the means to define his requirements; LR's scope of work. After it is submitted, a quotation to meet the requirements can be prepared.

Note 2:

If for an extension certificate, details of any changes should be provided along with supporting documentation.



Note 3:

Applicant must confirm:

- his name and address;
- Producer's name and address, if different;
- address(es) of production facility;
- whether the request is for a new or extension certificate (if for an extension, the existing Certificate No. should be advised and it should be confirmed whether there have been any changes);
- his relationship with the Producer(s) if he is not the (only) Producer;
- the product description;
- the 'type designation';
- the relevant codes, standards or specifications;
- the environmental test category, if applicable;
- the claimed product ratings.

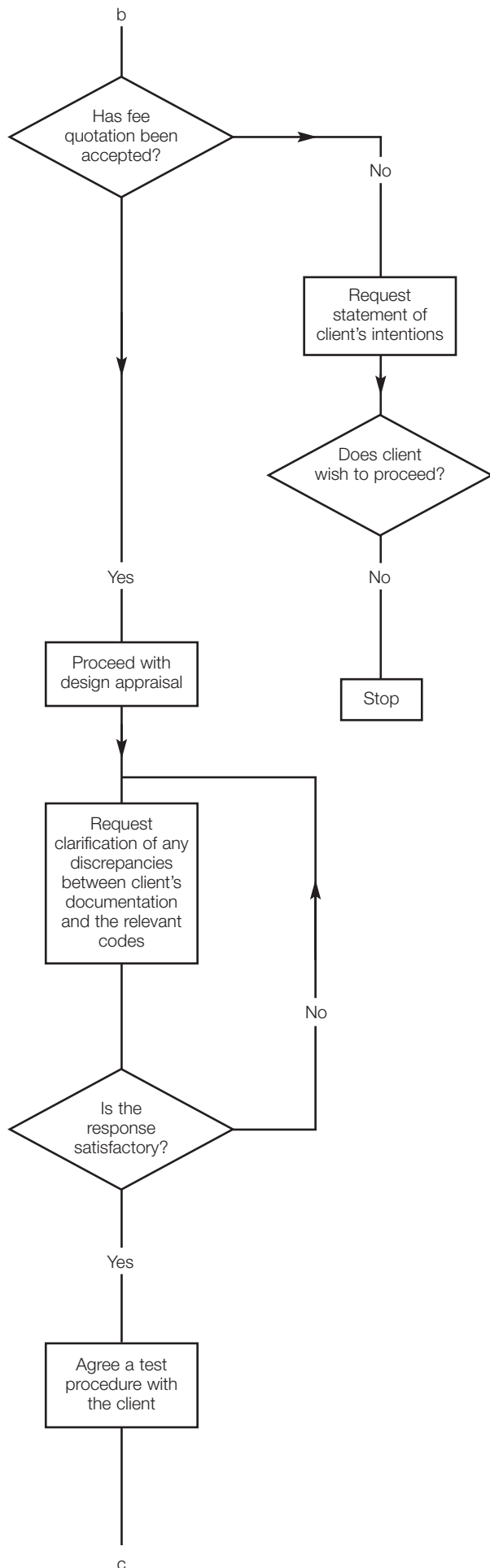
For extension certificates, not all of the above is necessary (refer to form).

Note 4:

Certain products may not be suitable for type approval. LR may not have the required expertise or authority, or the nature of the product (certain 'repair systems', for example) may not lend itself to the type approval process.

Note 5:

The quotation will state the product(s) to be covered, the reference point against which type approval will be conducted and the scope of the work, along with details of any further documentation which is required.



Note 6:

Work will not proceed until quoted fees are formally accepted, when LR Terms and Conditions will be applicable to the type approval work.

Note 7:

If, when using the TAD diary system, no response is received within 6 months the client will be advised that the case is to be closed.

Note 8:

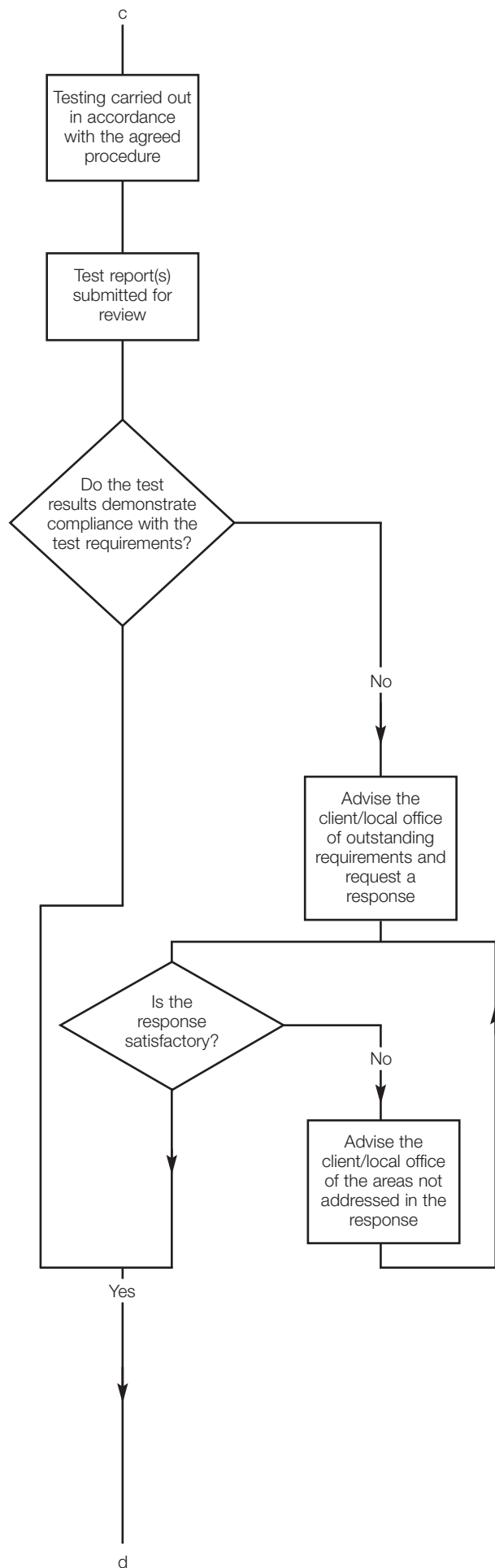
This is the first stage of the type approval process which involves a review of the client's documentation against the design requirements of the Rules/codes/standards/specifications against which the type approval is being conducted.

Note 9:

Type approval cannot proceed if the client does not provide satisfactory evidence of compliance with the design requirements of the relevant reference point.

Note 10:

This is the second stage of the type approval process. The tests are chosen to demonstrate compliance with the relevant reference point. Acceptance criteria should be defined at the start, wherever possible.



Note 11:

Type testing must always be witnessed by an LR Surveyor *or* be conducted at an acceptable accredited Test House whose scope of accreditation includes the testing concerned.

Note 12:

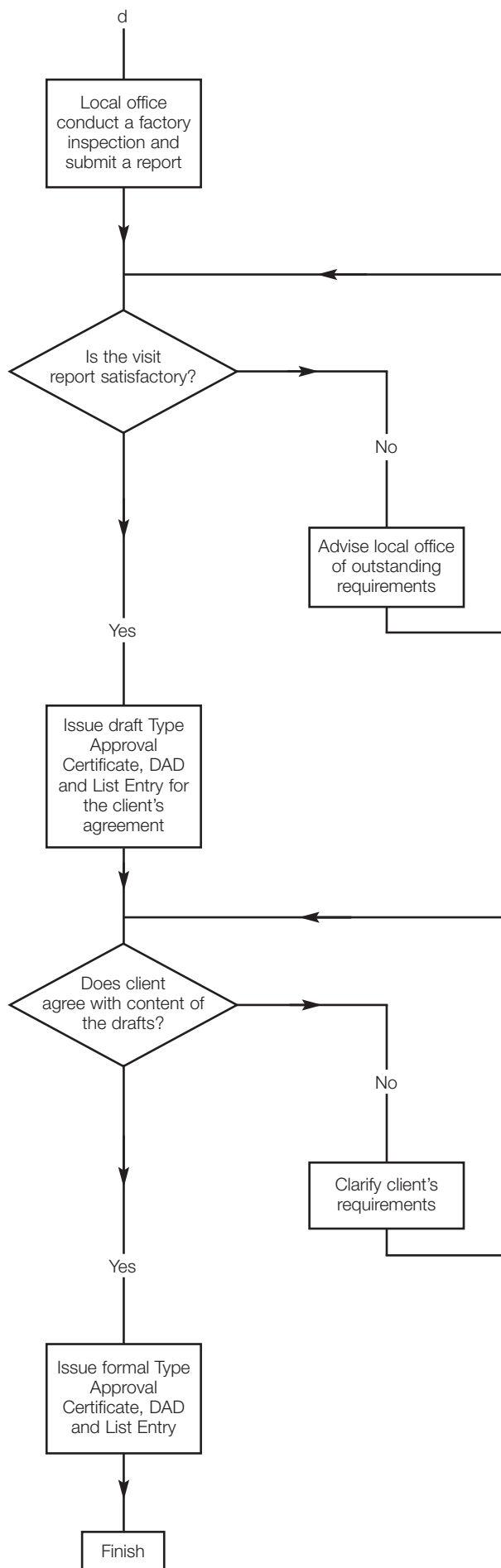
The test report(s) must originate from an accredited Test House *or* local office *or* the client and be endorsed by the LR Surveyor.

Note 13:

Type approval cannot proceed until evidence of full compliance with the testing requirements is provided. This is to be discussed and resolved with the client.

Note 14:

If other specialists are involved in the design appraisal, their DAD is to be submitted to TAD.



Note 15:

This is the third stage of the type approval process. The factory inspection report is to confirm that:

- product is manufactured there;
- production facilities are adequate;
- control procedures will ensure conformity of the products with the type approved sample(s).

The Surveyor submits a visit report (see sample report in Appendix D).

Note 16:

Drafts are issued for confirmation, by the client, that the type approval covers all his requirements and that the information is accurate.

Note 17:

Client's requirements may be considered if they do not contravene the TA Procedure or LR Terms and Conditions.

Note 18:

This remains valid for five years from the date of issue, provided the client complies with the Terms and Conditions of the Type Approval System. When the expiry date is approaching, LR will endeavour to issue a reminder in case the client has overlooked this point.

The certificate may then be extended if the client submits an application.

Appendix B

LR Type Approval Certificate (Sample)

This is to certify that the undernoted product(s) has/have been tested with satisfactory results in accordance with the relevant requirements of the LR Type Approval System.

This certificate is issued to:

PRODUCER	ANYCO Ltd		
PLACE OF PRODUCTION	Main Road London England		
DESCRIPTION	Automatic level gauge transmitter incorporating power supply		
TYPES	Level gauge transmitter	LGT01/94	
	Power supply	PS01/94	
SPECIFIED STANDARDS	LR Test Specification No. 1:1990		
APPLICATION	LNG, LPG chemical level measurement in marine applications. The components of the above system are suitable for use in the environmental categories detailed below, as defined in LR Test Specification No. 1:1990:		
	Level gauge transmitter LGT01/94	ENV1, ENV2, ENV3, ENV4 & ENV5	
	Power supply PS01/94	ENV1 & ENV2	
	The LGT01/94 level gauge transmitter is suitable for use in intrinsically safe circuits in EEx i(a) IIB T5 class hazardous areas in accordance with EN50014		
	The PS01/94 power supply is suitable for use in intrinsically safe circuits in EE x i(a) IIB class hazardous areas in accordance with EN50014		
Certificate No.	99/0XXXX		
Issue Date	19 November 1999		
Expiry Date	18 November 2004		
Sheet	1 of 2		G.C. Harris G.C. Harris

Sheet 2 of 2

RATINGS The housing of the level gauge transmitter is ingress protected to IP67 in accordance with IEC529

The voltage from the PS01/94 power supply is 10 to 16Vdc and the maximum current is 120mA (20mA/transmitter)

"This Certificate is not valid for equipment, the design, ratings or operating parameters of which have been varied from the specimen tested. The manufacturer should notify LR of any modification or changes to the equipment in order to obtain a valid certificate."

The attached Design Appraisal Document No. 99/0XXXX forms a part of this Certificate.

Certificate No. 99/0XXXX

Issue Date 19 November 1999

Expiry Date 18 November 2004

G.C. Harris
G.C. Harris

Appendix C

LR Design Appraisal Document (Sample)



MARINE DIVISION

Page 1 of 1
Document number 99/X0000
Issue number 1

DESIGN APPRAISAL DOCUMENT (Sample)

Date 19 November 1999	Quote this reference on all future communications TAD/XXXXX/O-17777/99/GCH
--------------------------	---

LR Design Appraisal Document (Sample)

LLOYD'S REGISTER'S TYPE APPROVAL SYSTEM, 1996.

Issued to: ANYCO LTD.

for: AUTOMATIC LEVEL GAUGE TRANSMITTER

INCORPORATING POWER SUPPLY

TYPE APPROVAL CERTIFICATE No. 99/0XXXX

The undernoted documents have been reviewed for compliance with the requirements of Lloyd's Register's Type Approval System, 1996 and this Design Appraisal Document is a supplement to the Certificate.

APPROVAL DOCUMENTATION

Anyco Specification No. A/LGT/0012 Rev 1	01.02.1988
Anyco Drawing No. LGT-001 Rev 2	02.03.1990
Anyco Drawing No. LGT-002 Rev 1	03.03.1990
Anyco Drawing No. PS-001 Rev 3	10.05.1990

TEST/INSPECTION REPORTS

Anyco File No. TR001, including the following Test Reports:

Performance	TR001.01	10.08.1994
Dry Heat	TR001.02	01.08.1994
Humidity - Cyclic	TR001.03	02.08.1994
Humidity - Damp Heat	TR001.04	03.08.1994
Low Temperature	TR001.05	03.08.1994
High Voltage	TR001.06	04.08.1994
Vibration	TR001.07	04.08.1994
Power Supply Fluctuation	TR001.08	05.08.1994
Power Supply Failure	TR001.09	05.08.1994
Conducted Audio	TR001.10	05.08.1994
Conducted RF	TR001.11	05.08.1994
LR Anytown Certificate No. ATN 9400636/1		10.08.1994
LR Anytown Factory Inspection Report No. ATN 9400636/2		11.08.1994

G.C. Harris

G.C. Harris

Type Approval Department, Extn. 4895

Appendix D

Production Surveillance Form

INITIAL INSPECTION / ANNUAL SURVEILLANCE *

Company's Name (confirm as indicated on the TA Certificate):

Date of Inspection:

Control No: JTAD

Full Postal Address of Company:

Contact Name:

Telephone Number:

Fax Number:

E-mail address:

Telex number:

Place of Production (confirm as indicated on the TA Certificate):

Are there any additional places of production?

Is the firm QA-approved to any standard?

If so, who has issued the QA certificate?

QA certificate number and date:
(Attach copy)

Does the firm possess an in-house QA procedure suitable for the Type Approved product(s)?

Product:

Are copies of standards listed in the Type Approval Certificate available?

Type (confirm as indicated on the TA Certificate):

We confirm that the subject manufacturing facilities have been inspected and verified that a satisfactory Quality Control System is in place to ensure each subsequent manufactured product will be in Conformity with that which was type tested.

Surveyor's name, LR stamp including office and date:

* Delete as appropriate

Page 1 of 4

COMPONENTS / MATERIAL CONTROL

Control No: JTAD

Are components/material inspected on arrival (documentation, quantities, visual, dimensions, marking, etc.) and a record kept with testing carried out, where necessary?

Are non-conforming components segregated/marked?

Is there a written procedure for non-conformity?

Is there a written procedure for storage of incoming components/materials?

Is storage of incoming components/materials carried out in accordance with these procedures?

Have there been any changes to the product, if so, have these been approved and documented? If not, details are to be submitted.

ASSEMBLY / CONSTRUCTION, INSPECTION AND TESTING

Control No: JTAD

Are there written manufacturing/assembly procedures and is production in accordance with the procedures?

Are there written inspection procedures during manufacture and for finished components and is inspection carried out in accordance with these procedures?

Is there a written procedure for non-compliance (including finished components) and can this procedure be demonstrated?

Are non-conforming components handled and identified in a suitable manner?

Are all the in-house testing instruments calibrated with traceable calibration records?

Are there written in-house test procedures?

Is the system for recording test results satisfactory and all the test reports made available to surveyors with supporting documentation, where required?

MARKING AND PACKAGING

Control No: JTAD

Are there written procedures for marking components and is marking carried out in accordance with the procedure?

Are there written procedures for storage and packaging components and is storage and packaging carried out in accordance with these procedures?

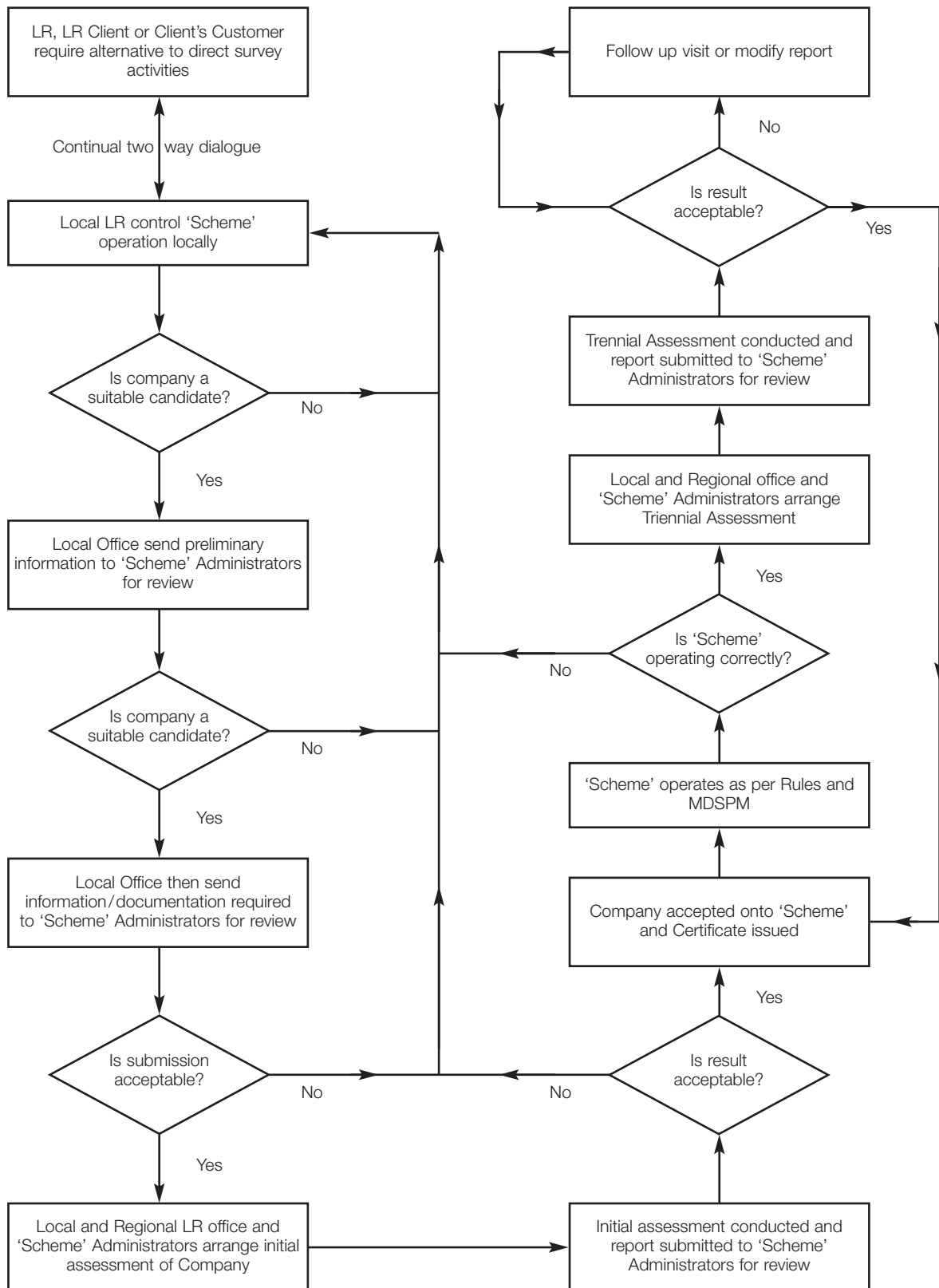
Are there production records of all Type Approved products available?

Remarks:

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Appendix E

LR Quality Schemes Flowchart



Appendix F

Case Study – Mechanical Type Approval

1 Introduction

The case study selected is representative of an actual completed case within the context of the International Maritime Organisation (IMO) requirement [15] relating to Emergency Towing Arrangements (ETAs) for tankers. This requirement was the subject of LRTA Paper No. 3, Session 1997/98 [16].

It became a requirement that all tankers of 20,000 tonnes dwt or more, constructed after 1 January, 1996, be fitted with an Emergency Towing Arrangement (ETA) at both the bow and the stern of the vessel. Tankers of 20,000 tonnes dwt, or more, constructed before this date, were required to be fitted with ETAs at the first scheduled dry docking after 1 January, 1996. Existing tankers, fitted with ETAs in accordance with an earlier IMO Resolution [17], were permitted to retain the existing forward arrangement but required to upgrade the aft arrangement to comply with the requirements of the new requirement.

The scenario was that ETAs could either be plan approved or type approved. Whereas plan approval would be necessary for each vessel on which the ETAs were used, type approval would qualify them for use on any LR classed vessel, providing the normal survey requirements were satisfied. These new IMO requirements consequently resulted in numerous requests for LR Type Approval.

2 Application

The following examines the case of a client application for LR Type Approval, caused in this instance by a market preference for the client's particular ETA system. The client had supplied approximately fifty systems during the previous two years, with ultimate tensile strengths of either 2000 or 4000kN. These systems also utilised 'off the shelf' components to some extent, namely wire ropes, fibre ropes and shackles etc.

The type approval application related to 1000kN and 2000kN Safe Working Load (SWL) ETAs. A fully completed request form, detail drawings and calculations, designed to demonstrate that the strength of the strongpoint and fairlead complied with LR and IMO requirements, and a test proposal were submitted.

The test proposal was to perform proof load tests to 1.3 times the SWLs. The purpose was to verify the acceptability of the arrangements in the 'worst case' loading condition for a line pull angle within the required operation range, as shown by calculation. The test proposal also included a load test to destruction of one test sample.

Deployment tests had previously been witnessed by LR and the deployment time was comfortably within the specified fifteen minutes.

The client's proposals were agreed and LR's fee quotation was accepted by the client, allowing the type approval to proceed.

3 Design Appraisal

Authorised LR Surveyors conducted a design appraisal of the submitted drawings, calculations and User Manual for the subject equipment, against the LR and IMO requirements in accordance with the client requested type approval.

After the review of the documentation, Design Appraisal Documents were issued for each of the two ETA systems, with the following qualifying comments in a covering memorandum:

- no fairlead was included in the type approval on the basis that another fairlead, possibly another manufacturer's, would be used. However, it was noted that another fairlead would require type approval in its own right;
- further conditions and recommendations were applied to the certification of associated equipment such as towing pennants, messengers and buoys supplied by others;
- the client was advised that the proposals for proof testing were agreed and that a draft Type Approval Certificate would be issued after receipt of a satisfactory test report.

LR approved drawings were returned to the client.

4 Type Test and Factory Inspection

Both ETA systems were satisfactorily proof tested in accordance with the LR agreed procedures, defined within the client's User Manual. The tests were witnessed by the local office. The subsequent Test Reports were reviewed and accepted by the authorised Surveyors. The Design Appraisal Documents were updated accordingly.

The Type Approval Department then requested confirmation that the production control procedures used at the manufacturing facilities were adequate to ensure conformity of ongoing production with:

- the type tested samples; and
- the approval documentation associated with the type approval.

In this case, the local office submitted a copy of an ISO 9001 certificate, issued to the client by an accredited body. This was valid for product ranges including steel wire ropes, ETAs, mooring shackles and accessories and was considered satisfactory.

5 Certification

On the basis of the satisfactory design appraisal, testing and factory inspection, draft Type Approval Certificates covering each of the two ETA systems were issued via the local office, to the client, for agreement.

The draft certificates contained the salient information under the standard headings:

- (i) Producer;
- (ii) Place of Production;
- (iii) Product Description;
- (iv) Type;
- (v) Specified Standards;
- (vi) Application;
- (vii) Ratings; and
- (viii) Other Conditions.

The 'Other Conditions', for the 1000kN SWL system, are listed below:

1. Towing pennants are to be supplied with separate certification demonstrating a working strength of 1000kN and an ultimate tensile strength of 2000kN in accordance with the requirements of LR Rules, Part 2, Chapter 10, for steel wire rope, and in accordance with a recognised standard for synthetic fibre rope.
2. It is recommended that the strength of the messenger is 10 – 15% of the required system safe working load, i.e. 100 – 150kN.
3. The buoys at the ends of the messenger are to be clearly marked with the safe working load of the system.

When the content of the draft certificates were agreed, the formal Type Approval Certificates were issued. The Type Approval Database was updated to include the List Entry details.

Appendix G

Case Study – Electrical Type Approval

1 Introduction

This case study covers a Personal Computer (PC). Type Approval of PC's is required for single computers used as loading instruments and when a PC is incorporated in a programmable alarm and control system [18] and [19].

The case study is generic and provides guidelines for the selection of test specimens and advice on testing.

A PC is tested for an Environmental Category in accordance with LR Type Approval System Test Specification Number 1, 1996 [20]. The minimum Environmental Category for a PC is ENV2, which relates to enclosed spaces subject to temperature, humidity and vibration, ambient temperature range 5 to 55 degrees Celsius. The listing of tests for ENV2 is as follows:

- Visual Inspection;
- Performance Test;
- Insulation Resistance Test;
- Power Supply Variation;
- Power Supply Failure;
- Inclination;
- Vibration Test 1;
- Humidity Test 1 (Cyclic);
- High Voltage;
- EMC Immunity.

Alternatively, the manufacturer may elect for testing to Environmental Category ENV3. In this instance, a further Dry Heat test is required. The additional category widens the potential scope of marine applications into enclosed spaces subject to generated heat from other equipment with a temperature range of 5 to 70 degrees Celsius.

The tests to meet the Environmental Category are described in Test Specification No 1. The application of the Vibration Test, in particular, seems to produce queries from Surveyors. The test is carried out in the X, Y and Z planes within the frequency range, displacement and acceleration figures in the Test Specification, see Figure G-1. The test takes place in two stages, a resonance search followed by an endurance test. The purpose of the resonance search is to determine resonance points with high amplification or Q factors. An endurance test is then carried out at resonant frequencies where the amplification factor is two or above. If amplification factors are less than two then an endurance test is carried out at 30 Hz. It must be remembered that the purpose of the test is to check the functional performance of the PC. It is therefore of interest if during the resonance search the circuit board or disk drives show high amplification factors. The effect typically is failed edge connectors and in extreme cases shedding of components. It is of less interest if an end panel (with no components) is resonating wildly with a high amplification factor.

2 Design Appraisal

Manufacturers often apply for approval of a range of PCs (that is a range of models) on a single certificate. The models are built around an integrated circuit. In such cases, it is necessary to appraise the elements which require testing. Guidelines for the selection of test specimens are provided on the opposite page.

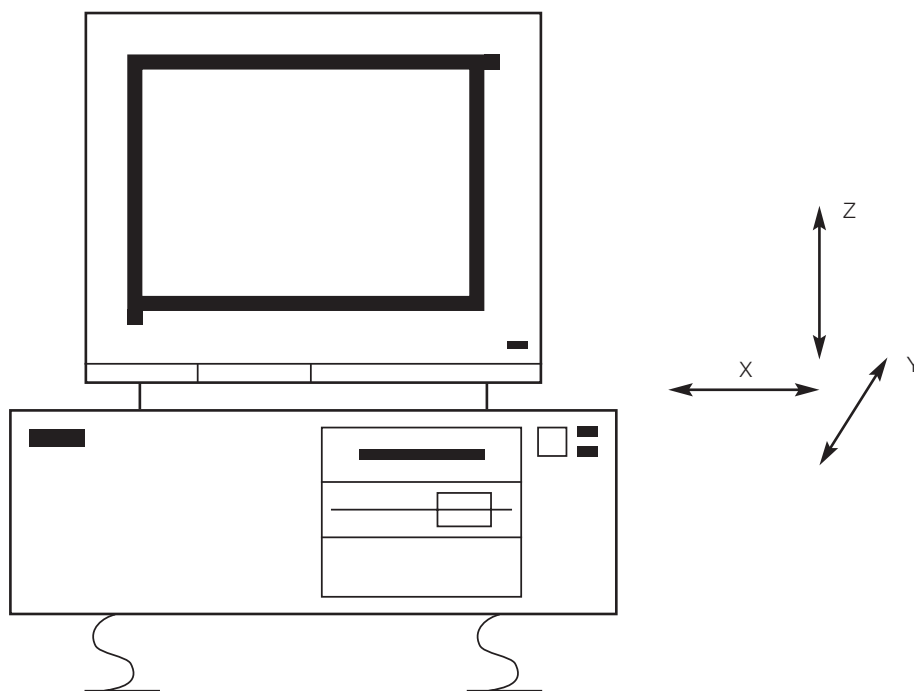


Figure G-1: Vibration Test on a PC

When a range of PC models is submitted for type approval, the test specimen should consist of the most complex configuration. Type Approval of a computer model will be considered only on the basis of test results of a representative model from the same range.

All hard disk drives must be type tested. Satisfactory tests carried out on a hard disk in one type of PC will be generally accepted when it is installed in other PCs. The above applies only to a series of drives of similar design made by the same manufacturer. The basis of this guideline is that the product specification of a tested hard disk will meet the vibration criteria of the Test Specification.

The PC model will include any anti-vibration (A/V) mountings fitted as part of the marine equipment. Normally, these A/V mountings will be required as a supplement to a standard PC to cope with the Environmental Category ENV rating for marine use.

The EMC tests are to be carried out on the fastest processor for a particular integrated circuit family. For example, for processor options 366/400/433MHz, the 433MHz processor is to be selected as the test specimen.

Accessories such as LAN cards are to be included in the test programme.

Each type and size of visual display unit is to be included in the test programme.

Manufacturers are now requesting approval to IEC60945 [21] in addition to type approval to LR requirements. This request is driven by the inclusion of IEC60945 in many product specifications for the Marine Equipment Directive. One basic difference is that IEC60945 requires emission testing, radiated and conducted. Requirements are additional to those of Test Specification No. 1 [20]. In addition a Compass safe distance test is required.

3 Information to be included with the Test Programme

The following information is to be included with the test programme:

- name and address of the proposed Test Laboratory;
- date of starting and expected completion of testing;
- a list of the proposed test specimens and sub-assemblies (for example, circuit board, processor speed, disk drives, network cards) by type number and manufacturer;
- the tests to be carried out (LR Test Specification No. 1);
- proposed tests will be carried out to a particular environmental category for example ENV1 or ENV2;
- additional tests, outwith Test Specification No. 1, that are to be credited are to be fully specified;
- any environmental specification published in the firm's datasheet which is more severe than the LR requirements is to be supported by test evidence and may require further testing;
- performance test specification. The specification is to

exercise all the functions of the product and is to have specified acceptance criteria against all the manufacturer's published technical specifications. A function test is to be specified and performed with each environmental test.

4 Liaison with the Test Laboratory

The personal computer is to be tested in a laboratory with an acceptable national accreditation or in a test laboratory that is acceptable to LR. See Part I, Section 4 of the Paper.

The test laboratory facilities are to be checked to ensure that the test equipment available covers the full range of the required tests.

Personal computers have a short product life in the market, measured sometimes in months rather than years. The manufacturer will be anxious to have a rapid approval. The critical path through the approval process includes as its longest element the test laboratory process:

- booking a slot in the laboratory programme;
- agreeing the test programme and resolving any queries;
- carrying out the testing;
- resolving anomalies and/or modification/retesting;
- production of a test report.

The turnaround time is a matter for commercial negotiation between the manufacturer and the test laboratory. However, LR can assist both parties by drawing attention to the above points on the critical path and by giving added focus to the individual tasks, the organisation of each task can be streamlined and the total time taken minimised.

5 Product Documentation

Product documentation is to include a single copy of the following items:

- Technical Specification;
- Instruction/Reference Manual;
- mechanical assembly drawings ("exploded views" with Part numbers are acceptable);
- flame retardance rating certificate/statement for plastic enclosures;
- referenced and dated Master List of part numbers and drawings of circuit boards and power supplies and the corresponding parts lists. The list of drawings is to include title, drawing number, date and revision mark;
- a short description of the salient differences between product variants of a series.

As an alternative arrangement, it may be agreed that the submission of some drawings is not practical, for example detailed circuit diagrams and printed circuit board track layouts. In this instance the drawings need not be submitted to LR. A list of drawings is to be submitted for record purposes. A signed statement is to be obtained from the manufacturer that drawings and other product

documentation will be held by the firm for the duration of the Certificate and that they will be made available to an LR Surveyor at the assembly plant on demand.

The manufacturer, type designation and technical specification of all bought in circuit boards are to be uniquely identified.

The following items are to be submitted with the test report:

- (i) A full description/drawing of any modification which may have become necessary as a result of the tests, with documentary evidence that the above has been implemented in production;
- (ii) Details and reference of any marine specific equipment such as anti-vibration damping;
- (iii) Referenced and dated drawings of the appropriate labels applicable for the product version marketed as in the certificate (for example marine, industrial).

6 Certification

On the basis of satisfactory design appraisal, testing and factory inspection a Type Approval Certificate is prepared with the following headings.

'PRODUCER'	Stating the name of the Applicant as listed on the request form.
'PLACE OF PRODUCTION'	Stating the address of the place(s) of production detailed in the request form, for which the type approval is valid.
'DESCRIPTION'	Concise description of PC.
'TYPE'	Full listing of model nos. within the family of the PC. Listing of cards with product identifier. Based on xMHz processor speed.
'APPLICATION'	Marine and offshore applications in Category ENV1, ENV2 as defined in LR Type Approval System Test Specification No. 1, 1996, where the Test Specification is satisfactory for the intended use.
'SPECIFIED STANDARD'	Manufacturer's Specification.
'ADDITIONAL TESTS'	Low temperature -25°C, 16 hours IEC 60945, 3rd Edition.
OTHER CONDITIONS'	Approved when fitted with Anti Vibration Kit 'xxx'.

Appendix H

Case Study – LR Quality Scheme

1 Introduction

This case study is an actual case where the client details have been removed to preserve confidentiality. The client has an enviable reputation, with a good history of supplying product worldwide to the marine and industrial markets. The client was well known by the local office who attended on a regular basis to survey product to Class. The client already had ISO9001 certification with another certification body.

2 Application for Scheme Participation

After provisional discussions with the client, the local office advised the Administrators of the client's requirements. The client's application was fully supported by the local office.

3 Documentation Review

Due to the lack of experience of Scheme operation in the area, it was agreed that the Administrators would conduct the document review at the client's premises. This had the added advantage of enhancing the introduction of the client and local LR personnel into Scheme operation and their respective roles.

The client actively participated in the visit and typically for this scenario, the client's documented system was ISO9001 orientated. The client was aware of the Scheme requirements and used the visit to seek guidance on how they could best accommodate LR's requirements into their documented system.

After the review of the documentation, the findings of the visit were recorded on one Lloyd's Register Non-compliance Note. Examples of the findings are as follows:

- Quality Manual does not address client commitment to compliance with the Scheme;
- Unable to establish who had the defined responsibility and authority for ensuring the quality system complied with Scheme requirements;
- Special processes are not addressed as a policy issue;
- Internal Audits did not address product related issues such as painting and stores operation;
- Recruitment is not addressed as a policy issue.

Following the review of these findings and having gained client commitment to addressing them, a tour of the plant took place to enable the assessor/surveyor to plan the initial assessment.

In planning the initial assessment, consideration was given to the client's current quality management system certification in that a reduction of assessment time would be possible in areas where there was less impact on product quality. In design for example, it was only necessary to establish that LR Rules are controlled documents and are an input to the design process, and that the status of approvals held was a controlled process. Whereas in Purchasing, more time would be required to establish the adequacy of controls over LR specified sources of supply and the transfer of information to these. Also, in production areas, more time would be required to verify process controls on the manufacture of the approved product only.

4 Initial Assessment

The plan of this visit was submitted to the client for agreement two weeks before the agreed date of the event. The resources of an Administrator and a regional assessor/surveyor were allocated for the visit and after client agreement, it took place over a three day period.

The visit went according to plan despite no LR approved product being manufactured. The client had completed effective corrective measures to the findings of the document review and with only Category 2 Non-compliances (of minor nature) being raised this visit, the client was recommended for certification to the Scheme. The client was advised of this result verbally at the close of the visit.

Examples of the findings are as follows:

- The listing of approvals held was not up to date;
- The LR list of Approved Manufacturers was not available;
- Insufficient evidence of inspection of some purchased products;
- Some process control equipment incorrectly set;
- Insufficient evidence of stock rotation of 'shelf life' items;
- Inadequate paint coverage on finished product;
- Management Review process not addressing compliance of system to Scheme requirements.

5 Review of Assessment Report

A report was prepared by the lead Assessor/Surveyor and submitted for review and approval by the Scheme Administrators. The recommendation was agreed and a Scheme certificate was issued to the client via the local office.

6 Scheme Operation

Guidance notes were prepared by the local office and reviewed and approved by the Scheme Administrators. To date, 'regular & systematic' visits are taking place at the specified frequencies and are being reported to the Scheme Administrators.

The audit plan was prepared by the lead Assessor/Surveyor immediately following the assessment and the first 'intermediate' visit has been successfully completed and reported to the Scheme Administrators.

A 'Register of Authorised Signatories' for both local LR and client personnel was prepared and a copy forwarded to the Scheme Administrators, as per the Scheme requirements in the MDSPM.

The approved product is being certified and released under the Scheme operation, and the client is realising many of the benefits associated with the Scheme participation.