The Symbols and Terminology Group

Final Report and Recommendations to the 20th ITTC

1 GENERAL

1.1 Membership

The membership of the Symbols and Terminology (S&T) Group is as follows:

Prof. Bruce Johnson (Chairman)
U.S. Naval Academy,
Annapolis (USA)
Dr. David Clarke
University of Newcastle upon Tyne,
Newcastle (GB)
Prof. Michio Nakato
University of Hiroshima (J)
Prof. Carlo Podenzana-Bonvino (Secretary)
University of Genova (I)
Prof. Michael Schmiechen
V.W.S., Berlin (D)
Dr. Kostadin Yossifov
B.S.H.C., Varna (BG)

1.2 Meetings

A first informal meeting was held at Madrid, September 1990, immediately after the closing of the 19th Conference.

Three further Group meetings have been held as follows:

24 to 25 June, 1991, at Berlin

16 to 17 May 1992, at Newcastle upon Tyne

4 to 6 January, 1993, at Genova.

1.3 Recommendations of the 19th ITTC

1) Recommendations to the Conference

Symbols. The 1990 Version of the List of Standard Symbols should be used as a working document without the formal approval of the Conference.

Formats. The Conference should discuss the need for the introduction of standard formats for the exchange of data.

2) Recommendations for the future work of the Group

Symbols. The Symbols and Terminology Group to put the Computer Compatible Symbols on a more rational basis in order to make them useful for data exchange purposes.

Formats. The Symbols and Terminology Group to develop standard formats for the exchange of data defined in the List of Standard Symbols and hull form, propeller and appendage data on the basis of international standards.

2 GROUP ACTIVITIES

2.1 Introduction

The Symbols and Terminology Group, formed in October 1985, has produced three versions of the Standard Symbols and Terminology List. The first one was distributed to all ITTC members during the Kobe Conference (October 1987); the second version was distributed during the Madrid Conference (September 1990), while the third one has been prepared for distribution before the 20th Conference.

In the first period (1985/87) the attention of the Group has been mainly paid to the development of a list of Standard Symbols, comprising also the corresponding Computer Compatible Symbols, together with a short definition or explanation, when necessary.

In the second period (1987/90) the Group continued to rationalize and to update the List, but more attention has been devoted to the Computer Compatible Symbols, in view of the possibility of basing on these symbols the planning of neutral formats for data exchange among ITTC organizations.

The work accomplished in the third period (1990/93) resulted in the 1993 Version of the ITTC Symbols and Terminology List. The introduction to the 1993 Version describes in detail the philosophy and the practice which directed the Group activities concerned with Symbols and Terminology. In this report only the main topics are summarized.

2.2 Symbols and Terminology

It is important to state beforehand that, in view of the increasing demands concerning quality assurance systems, the ITTC Symbols, in S&T Group opinion, should no longer be called Standard Symbols, as this name could imply legal obligations, which are of course non-existent. The International Standard Organization (ISO) and various national institutions may, at a later stage, decide to adopt ITTC Symbols as a standard, as already intended with the earlier version of the List (ISO/DIS 7463 Shipbuilding, Symbols for Computer Applications, based on 1975 ITTC List and 1974 ISSC List).

The S&T Group also discussed the opinion, expressed by some Japanese and Korean member organizations, that the number of Symbols in the List may be too large and many of these are used only by specialists in a specific field; this could be confusing for the ITTC community. It was then suggested to distinguish the symbols in two levels of importance: the first for the symbols to be used by the entire community, the second for the symbols needed by specialized applications.

Although this proposal seemed very interesting to the Group, its application was judged difficult to do in time for the 1993 Version to be distributed at the present Conference; it could be considered suitable for the future work of the Group.

During the Newcastle meeting, the Group contacted several people belonging to ISSC community and many others attending PRADS'92, and the proposal of developing a common Master List of Symbols was discussed.

As pointed up in the 19th ITTC Report, during the 1987/90 period, the members realized that the automatic handling of Standard Symbols, in data bases and in validation work, requires a more rigorous organization than previously envisaged. It became clear that the adopted word-processing program used to produce the Kobe 1987 Draft was inadequate from an efficiency and availability point of view. Therefore, immediately before theä Madrid Conference, the List was converted into the more popular WordPerfect 5.1 format, as this software appeared to be the most widely used package at that time. The first WordPerfect version, regrettably containing some mistakes, was distributed during the Madrid Conference.

The 1993 Version of the ITTC List of Symbols and Terminology, as printed in the distributed volume, is now available on floppy diskettes in WordPerfect 5.1/5.2 format from the S&T Group.

With a better tool now available and effective, the main tasks accomplished by members in the 1990/93 period were the following:

- correcting the misprints and implementing improvements suggested by Group members, by Technical Committees and by member organizations;
- putting Computer Compatible Symbols on a more rational basis, as recommended by the Madrid Conference.

For the first action the Group is indebted to Dr. Stanley S.S. Yuan of Shanghai, who supplied many suitable suggestions and observations. On the contrary, inputs from Technical Committees relative to the organization and contents of the List of Symbols were received from only a few committees; accordingly, some of the basic chapters are not adequately reviewed.

The accomplishment of the second task can only be achieved by rigorously following the "object-oriented paradigms" already used in restructuring the Symbols List and in designing the Chapter on General Mechanics. In many cases, the previously inconsistent "standard" symbols have been maintained as widely accepted interim standards, and new consistent symbols are suggested as an alternative. However, the efficiency of the latter ones makes it easy to foresee in the future a complete replacement of some of the previously used symbols.

Basic principles and rules for the generation of the proposed Computer Compatible Symbols are outlined in the Introduction to the 1993 Version of ITTC Symbols and Terminology List.

An area of continuing investigation by the S&T Group concerns the problem of sorting and searching for ship characteristics represented by ITTC Symbols including Greek letters, subscripts and superscripts in both documents and databases. The need to use either ASCII-based Computer Compatible Symbols or an ITTC Symbol primary key numbering system, such as that mentioned here below, for most neutral format sorts and searches is not expected to be overcome in the near future. Thus it is important that the S&T Group continue to organize the Computer Compatible Symbols on a rational basis for ease of use. Progress has been made in completing a Computer Symbol index for the 1993 Version of the Symbols List, but interpretation of the Computer Symbol definition is not yet possible from this alphabetical listing, due to the still existing compromises.

What is necessary for the future is the ability to sort and select, based on either the ITTC Symbol primary key or the Computer Compatible Symbols. The Group is indebted to Mr. Robert Aiken who, to help with the above mentioned problem, has developed a sample terminological database by exporting a comma-delimited word processor file into one of the new Windows-based databases which can handle Greek letters, subscripts, superscripts and equations with ease. In the process of successfully demonstrating that this is possible, Mr. Aiken also generated a primary key numbering system based on the Symbols and Terminology List numbering system, sort/choice codes and a data entry form for each Symbol in the List.

It was hoped that a new expanded version of the Standard Query Language SQL'92, approved by ANSI BSR in October of 1992 (FIPS PUB 127-2, 1992) would enable the Symbols List to be accessed from a database without the need for a numeric primary key (in the United States this standard is known as ANSI X3.135-1992, Database Language SQL (Gallagher 1992) and the equivalent ISO specification is ISO/IEC 9075:1992 Database Language SQL). Character set support has been expanded to include SQL CHARACTERS, ASCII GRAPHIC (all keyboard characters) and LATIN 1, which consists of all characters commonly used in the following languages: Danish, Dutch, English, Faeroese, Finnish, French, German, Icelandic, Irish, Italian, Norwegian, Portuguese, Spanish and Swedish, and includes the Yen sign and some superscript support. However, Greek letters and subscripts are still not included as a SQL character set, so the ITTC Computer Compatible Symbols will be necessary for querying most databases which are organized in the proposed neutral standard format.

During work on the Group's task to rationalize the Computer Compatible Symbols for use in databases etc., the S&T Group became aware of a number of related efforts on an even more general level, which need to be taken into account in the further development of the ITTC Symbols and Terminology. The S&T Group did not have adequate time to discuss Appendix 1 entitled "Development and application of terminological databases", but it is included to indicate that activities in these fields are dramatically increasing and have led to a number of specialized symposia and workshops. In the broadest sense, terminological databases are basic to information technology and knowledge engineering and they are being developed at a breathtaking pace. In order to meet the forthcoming requirements, the ITTC Symbols and Terminology List will have to be further rationalized. Compared to this still formidable task, which has only been started with the new object-oriented structure of the List of Symbols, the transformation from the present table format into any of the rapidly developing terminological database formats appears to be a feasible task. As has been mentioned, the word-processing systems presently available still do not meet basic formalized requirements. While the problem of producing customized lists of symbols may now be solved rather easily, the much more pertinent problem of generating consistent sub-models still needs much more development work.

Conversion to an object-oriented database format will also enable explanatory diagrams and sketches to be included as linked objects. Past suggestions from Technical Committees concerning the inclusion of illustrations of complex concepts, such as skew induced rake for propellers, various wave height parameters, etc. could then be accommodated. The present word-processing format does not have enough graphic detail to include useful illustrations except by using paste-up methods.

2.3 Standard Formats

The amount of information to be stored in future hydrodynamic hull form design databases will be very large, especially if CFD analysis, code validation, data and comparative model test data are to be shared between various hull form design support organizations. The quantity of possible attributes (columns) and individual tests (rows) in these tables numbers in the thousands. This is a situation where the development of neutral standard formats could make data exchanges between multiple organizations more economically feasible. In addition, neutral formats are cost-effective for building expert systems which use knowledge bases located across a variety of computers and languages.

Responding to the need for data exchange standards expressed by various organizations associated with the International Towing Tank Conference, the ITTC Symbols and Terminology Group proposed to undertake the following tasks during the 1990 to 1993 period:

- to develop a standard neutral format for the efficient exchange of hydrodynamic performance data defined in the ITTC Symbols and Terminology List;
- to utilize the format specifications being developed by ISO/STEP (STandard for the Exchange of Product model data) as the basis for an interim standard neutral format for the efficient exchange of data concerned with the definition of hull form, propeller and appendage geometry.

With regard to the first task, the 1990 Version of the Symbols and Terminology List has been updated for the 1993 Conference and now includes Computer Symbols for hull and appendage attributes. Although the list is not yet complete, the Computer Compatible Symbols contained in the 1993 Version can be used as the basis for defining standard attribute names for a neutral control file format. As soon as the few remaining duplicate symbols are eliminated, the existing List will be considered complete. The problem of reducing the 1993 Version to customized lists for data exchange is addressed elsewhere in this report. A possible database table structure for the data exchange format is addressed in Appendix 2 of this report, but this structure may need to be modified by the STEP application protocols (King and Norman 1992a) and the data definition language EXPRESS.

With regard to the second task, there is considerable activity within the ISO/STEP-/NEUTRABAS efforts (King and Norman 1992a and 1992b). In the absence of specific ISO-standards for ship hull and appendage geometric representations, however, the S&T Group urged the International Marine Software Associates (IMSA) to develop an interim non-proprietary neutral file format based on the IGES NURBS. The IMSA Definition File (IDF) format (Hays, et al., 1991) has been successfully used to transfer geometric data between different hardware and software systems located in the United States and Europe. Until such time as the STEP file formats are standardized, the S&T Group recommends theuse of the IDF file format on an interim basis. Since the IDF format is based on human readable ASCII text formats, it will be compatible with any future STEP formats which are also based on ASCII text formats (King and Norman, 1992a).

2.4 Future Work

A combined Master List of Symbols and Terminology, common for the ITTC, the ISSC and the PRADS communities, appears to be desirable; it would provide a common basis from which to develop standard neutral formats for data exchange and retrieval between various ship design systems. The current List should be converted from word-processing formats to text-and-graphics-based or database formats, in order to enable users to perform custom searches and prepare various outputs, both in diskette and in hardcopy formats.

Also, according to the suggestion of distinguishing the symbols in two levels of importance, the first for the symbols used by the entire community and the second for those needed for specialized applications only, the present 1993 Version of the List of Symbols and Terminology could be reorganized in the future as follows.

- Master List: the complete list of symbols;
- Concise List: a subset of commonly and widely used symbols;
- Customized Lists: specialized subsets of symbols.

In addition, standard data field names for use in the development of neutral format data exchanges during concept and preliminary design should be produced.

The S&T Group intends to continue exchanging ideas with communities outside the ship design field, in order to explore possible solutions to the mentioned problems.

3 CONCLUSIONS AND RECOMMENDATIONS

3.1 Conclusions of the Group

Symbols. The Symbols and Terminology Group has completed the List of ITTC Symbols and Terminology in tabular word processor format, which may be further developed into an object-oriented database format, in order to prepare Concise Lists of the most commonly used symbols within particular specialist areas.

The Symbols and Terminology Group feels that the ITTC Symbols should no longer be called Standard Symbols, in order to avoid legal problems which may occur in connection with litigation or quality assurance.

Formats for Data Exchange. In view of the international activity in the development of neutral data exchange formats, the Symbols and Terminology Group feels it unwise to develop unilaterally such formats. Concerning the exchange of hull form, propeller and appendage data, the Symbols and Terminology Group approached International Marine Software Associates (IMSA) to develop an interim non-proprietary format based on IGES NURBS (Non-uniform rational B-spline data exchange standard). Until STEP file formats are standardized, the Symbols and Terminology Group suggests the use of IDF file formats on an interim basis. Concerning the exchange of data defined in the ITTC Symbols and Terminology List, the Appendix to the Group report contains a possible relational database table structure to be used with the Computer Compatible Symbols.

3.2 Draft Recommendations to the Conference

The Conference should approve, as a reference document, the 1993 Version of the ITTC Symbols and Terminology List.

3.3 Draft Recommendations for the Future Work of the Group

Symbols. The Symbols and Terminology Group to make needed corrections to the 1993 Version of the ITTC Symbols and

Terminology List and additions to the document which may include specialized topics and illustrative sketches. Additions should include sections on measurement uncertainty, wave cut analysis and other suggestions from the Technical Committees.

The Symbols and Terminology Group to pursue the conversion of the 1993 Version of the ITTC Symbols and Terminology List from word-processor format to object-oriented database format. This will enable users to prepare subsets of the ITTC Symbols and Terminology List more readily.

Formats. The Symbols and Terminology Group to continue to monitor the international efforts in this field and to coordinate the development of neutral formats for the exchange of information between ITTC member organizations and their clients.

4 APPENDICES

4.1 Development and Application of Terminological Databases

In the Resolutions of UNESCO General Conference, 26th Session, Paris, 15 October to 7 November 1991, it is stated under 11 Transverse Themes and Programmes: 11.34 Co-operation on terminological matters.

Referring to 26 C/Resolution 11.31 on the General Information Programme,

Convinced that unambiguous and appropriate terminologies based on the principles and methods of terminology work are indispensable for the transfer of knowledge, unimpeded access to information and knowledge, the further development of science and technology, quality control in production and service industries, communication among subject specialists and non-specialists, and the protection of intellectual property,

Noting the exponential increase of the terminologies emerging in the course of scientific-technical and economic-industrial development, which creates communication barriers,

Invites Member States:

a) to intensify co-operation on terminological matters:

1) at national level;

2) among themselves at regional and international levels;

3) with international organizations active in terminology work, in particular with the International Information Center for Terminology (INFOTERM), operating in collaboration with UNESCO's General Information Programme;

b) to promote and support - morally and, if possible, financially - all the various kinds of terminological activities undertaken by universities, public authorities, business enterprises and other institutions.

In accordance with this fundamental resolution, on a more pragmatic level, a number of symposia have been and are being organized. The following is of particular interest:

TAMA '92, the 2nd TermNet Symposium on "Terminology in Advanced Microcomputer Applications", Avignon, June 5 to 6, in conjunction with the 12th International Avignon Conference on "Artificial Intelligence, Expert Systems and Natural Language Processing", organized by the International Network for Terminology, with the support of International Information Center for Terminology (INFOTERM), International Institute for Terminology Research (IITF) and Association for Terminology and Knowledge Transfer (GTW).

The objectives of the symposium are summarized as follows. Concepts are the building blocks of subject-field knowledge. They can be represented by terms or other linguistic symbols or by non-linguistic symbols. Therefore, a terminology of a given subject or subfield is also the representation of its knowledge at the level of conceptual logic. Terminology data banks have been developed for many purposes. The first applications were to support translation and industrial standardization. New applications for terminology software are discovered each year. Some of these applications are more linguistic in nature, thus representing an extension of the "language industries", whereas others are not primarily linguistic and thus relate more to the "knowledge industries". Mono- and multi-lingual terminology management systems can be applied to a range of purposes such as information management, information and documentation, project management, computer-assisted conferencing, technical writing, and publishing in specialized areas where terminology does not play an essential role.

The objectives of the ITTC Symbols and Terminology set forth in the Introduction are very closely in line with these objectives.

A tutorial on "Terminology in Knowledge Bases" covered the following problems:

- many problems encountered in the construction of knowledge bases for expert systems or complex information systems arise from terminological issues;
- objects are inadequately or ambiguously represented by symbols or terms, definitions may be missing or even wrong etc.; such errors rapidly lead to faulty operation of the inference component and invalid results of the whole of the systems definitions;
- in order to avoid such problems, terminological methods should be introduced, thus enhancing the quality of the knowledge base and, therefore, of the whole system.

Further symposia of interest are:

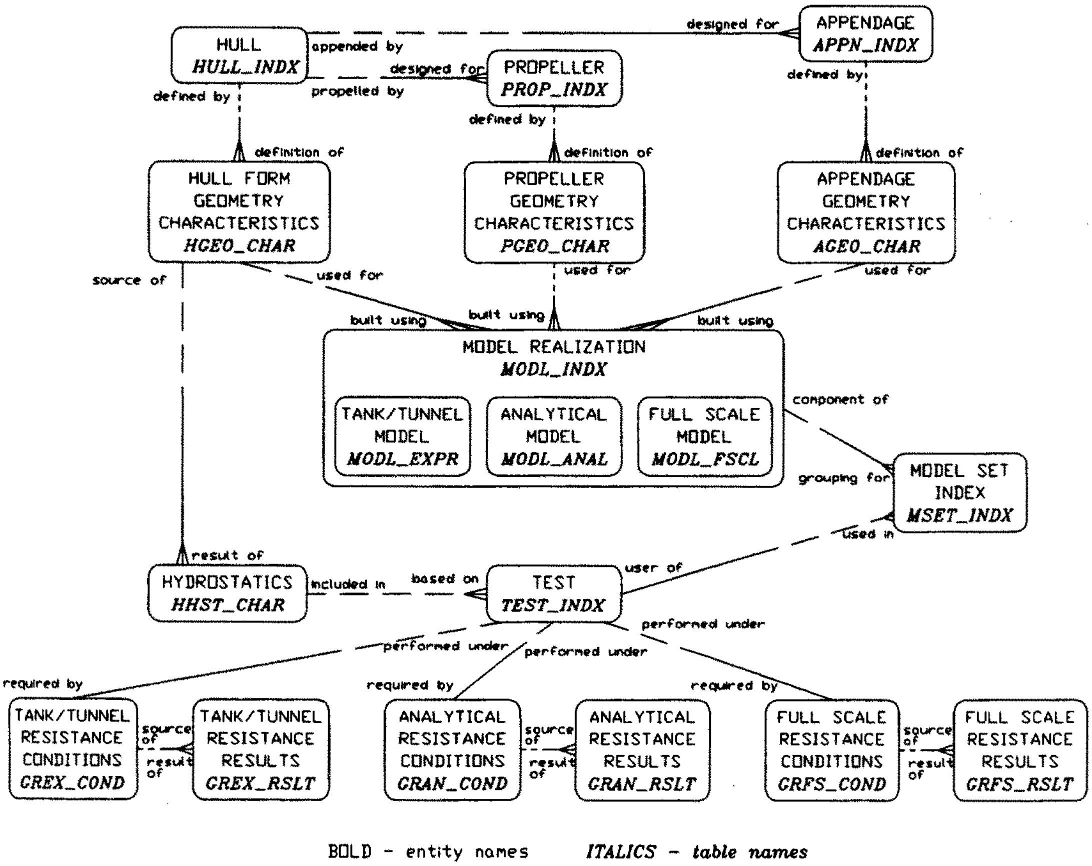

Figure 1. Entity-Relationships Diagram for Proposed ITTC Standard Data Exchange Format

International Symposium on Terminology Science and Terminology Planning at the Academy of Sciences of Latvia, Jurmala near Riga, August 17 to 19, 1992, organized among others by the International Institute for Terminology Research (IITF) and the International Information Center for Terminology (INFOTERM).

TKE '93, 3rd International Congress on Terminology and Knowledge Engineering, to be held in Summer 1993, organized by the Association for Terminology and Knowledge Transfer (GTW) and INFOTERM.

4.2 Entities and Possible Table Structure for Data Exchange (from Johnson, et.al., 1990)

A major step in the design of data exchange formats is the creation of an information model of the database relationships.

Each entity, or table in the hull form database, has a set of attributes, arranged in columns. The majority of the attribute names are associated with either geometry or performance characteristics and are extracted from the ITTC Computer Compatible Symbols and Terminology List (S&T List), 1993 Version. The remainder of the attributes are the key components used to uniquely identify and define each record and its relationships to other tables.

From the entity-relationship diagram in Figure 1, an initial database design was developed, consisting of tables whose names were systematically assigned. These names will eventually constitute a proposed ITTC List of table and attribute names, modifiers and qualifiers to be added to the ITTC Symbols and Terminology List. The suggested names for the upper level tables are printed in italics. Boldface names are corresponding entities. Note that table names consist of four letter abbreviated names followed by four letter qualifiers to indicate the type of table.

For example, the HULL_INDX table, which corresponds to the HULL entity, is the top-level table and identifies all the hull forms in the database. Most tests are performed, whether they be model, analytical, or full scale, in conjunction with a particular hull form.

The APPN_INDX and PROP_INDX tables, which correspond to the APPENDAGE and PROPELLER entities, are related to the HULL_INDX table in that a hull may be appended/propelled by one or more appendages/propellers and an appendage/propeller is generally designed for one hull. These tables are very similar to the HULL_INDX table.

The HGEO_CHAR (or HREP_CHAR) table, which corresponds to the HULL FORM GEOMETRY CHARACTERISTICS entity, is related to the HULL_INDX table in that a hull may be defined by one or more hull form representations and a hull form representation must be the definition of one and only one hull. This table contains information on the characteristics which describe each unique representation of a hull. In addition, there are other attributes included in sub-tables. Most of these attributes are from the ITTC S&T List and numerically describe the geometry and some DWL characteristics of the hull as single valued quantities. The sub-tables break the hulls into categories dependent upon the typeof hull. The different categories include: GENERAL SHIPS (_GEN), ICE GOING VESSELS (_ICE), PLANING (_PLA), SEMI DISPLACEMENT VESSELS (_SDV), SWATH (_SWA), HYDROFOIL BOATS (_HYB), ACV and SES (_ACV), SUBMERSIBLE and SUBMARINE (_SUB) and SAILING VESSELS (_SAI). Each category has its own set of attributes according to the ITTC Computer Compatible Symbols List and therefore requires its own table. The various subtables may have some of the same attributes, but at this stage it is necessary to designate one table per hull category.

The PGEO_CHAR and AGEO_CHAR tables, which correspond to the PROPELLER and APPENDAGE GEOMETRY CHARACTERISTICS entities, are similar to the HGEO_CHAR table. They relate to the PROP_INDX and APPN_INDX tables as the HGEO_CHAR table relates to the HULL_INDX table. The attributes in these tables describe geometry representations of propellers and appendages. The AGEO_CHAR table may consist of several tables that are dependent upon the types of appendages which include: RUDDERS (_RUD), SKEGS (_SKG), SHAFTING (_SHT), STRUTS (_STR), BOSSINGS (_BOS), BILGE KEELS (_BIL), SAILING YACHT KEELS (_KEL), FOILS (_FOL), STABILIZERS (_STA), WEDGES (_WEG) and THRUSTERS (_THR). Each of these tables have attributes from the ITTC S&T List that describe the geometry of the particular appendage.

The HHST_CHAR table, which corresponds to the HYDROSTATICS entity (hydrostatic characteristics), relates to the HGEO_CHAR table in that a set of hydrostatic characteristics must be the result of one and only one hull form representation and a hull form representation may be the source of one or more sets of hydrostatic data. This table contains information about the hull form hydrostatics. No corresponding entities for thepropeller and appendage exist. As is the HGEO_CHAR table, the HHST_CHAR table is divided into sub-tables. The hydrostatic attributes, according to the ITTC S&T List, are placed in the appropriate sub-tables depending on the category of the hull.

The concept of a test model is central to the hull form database. All tests are performed on sets of models. A model represents how a surface corresponding to the desired hull, propeller or appendage geometry is actually realized or conceptualized, so that it can be used in either a physical or analytical test.

The MODEL table, MODL_INDX, which corresponds to the MODEL REALIZATION entity, is related to the HGEO_CHAR, AGEO_CHAR and PGEO_CHAR tables in that a model must be built using one and only one hull form, appendage, or propeller geometry representation and a representation may be used in one or more models. The MODL_INDX table describes the three principal types of models:

- TOWING TANK OR WATER TUNNEL (experimental) model
- ANALYTICAL (computer) model
- FULL SCALE model

Physical models can be tested in a towing tank or water tunnel. Computer models consist of surface representations of the hull geometry used with computational fluid dynamics (CFD) flow codes. Both of these model types can be tested individually or combined with other models of the same type, which include different appendages and propellers. In either case the tests are done on sets of models. Full scale trials are made for every major shipbuilding program.

The three tables which stem from the MODL_INDX table, the MODL_EXPR, the MODL_ANAL and the MODL_FSCL tables, contain attributes which only describe the particular model type.

The Model Set Index, MSET_INDX table, which corresponds to the MODEL SET INDEX entity, is related to the MODL_INDX table in that a model realization may be a component of one of more model sets and a model set must be the grouping for unique model realizations. In short, this table groups individual model realization together in sets such as a specific hull form model, a propeller model and several appendages used for a ship powering test in a towing tank.

The TEST_INDX table, which corresponds to the TEST entity, is related to the HHST_CHAR table in that a test must be based on one and only one set of hydrostatics and a set of hydrostatic characteristics may be included in one or more tests. The TEST_INDX table is also related to the MSET_INDX table in that a test must be performed on one or more models and a model may be used in one or more tests. This tablecontains general information about the performed tests. The _COND tables, which correspond the TEST CONDITIONS entities, are related to the TEST_INDX table in that a test condition must be required by one and only one test and a test may be performed under one and only one test condition. There is a test condition table for each type of test. The information in these tables is not appended to the TEST_INDX table since each type of test requires information on different attributes. However, they could be embedded into the _RSLT tables at the expense of some space.

The _RSLT tables are related to the _COND tables in that a test result must be the result of one and only one test condition and a test condition may be the source of one or more test results. The general ship test results tables include the following tables: GENERAL SHIP (GS) RESISTANCE, GS SEAKEEPING, GS MANOEUVERING, GS PERFORMANCE and GS STABILITY. Propeller test results include the following tables: PROPULSOR PERFORMANCE and UNSTEADY PROPELLER FORCES. Although exactly which tables have to be created with what attributes has not been decided for the special ship test results, in theory each special ship will have its own set of test results tables, one for each test type. The attributes included in these tables are obtained from the ITTC Sat List. The tables and relationships for the tests not shown are configured similarly to those in Figure 1. In all cases one must distinguish between TANK, ANALYTICAL and FULL SCALE model tests, since different attributes may be measured and computed for each type of test.

The following scenario will help to illustrate a relatively simple search path for a portion of the database and the contents of the corresponding tables.

A naval architect is interested in information regarding two model tests performed on a particular ship hull form at an ITTC member organization. One is a still water performance (SHP) test of a frigate hull form with a rudder, bilge keels, shaft, bossings, struts and propeller attached. The other is an appended resistance (EHP) test using the same appended destroyer hull form, excluding the propeller. The hullä form has one entry in the HULL_INDX table, the propeller has one entry in the PROP_INDX table and the rudder, bilge keels etc. have one entry each in the APPN_INDX table. The hull is defined by three available representations and therefore has three entries in the HREP_CHAR table. The first entry corresponds to a lines plan of the hull, the second entry corresponds to a file containing the offsets and the third entry contains information on the file of B-spline net points. The propeller is defined by one available representation and the entry in the PREP_CHAR table corresponds to an offset file. The rudder and other appendages are defined by one available representation and the five entries in the AREP_CHAR table correspond to the detailed drawings of each appendage.

The MSET_INDX table contains seven entries. The first four entries correspond to the first model set. Each of these entries deals separately with an individual model in the set. The second three entries correspond to the second model set. Each of these entries deals separately with each individual model in the set. The hull, the rudder and the bilge keels are components of both sets and therefore are allocated two entries each. The TEST_INDX table contains two entries related to this example. The first entry is the EHP test, which includes a record of the model set used (hull and the appendages). The second entry is the SHP test, which includes a record of the other model set (hull, appendages and propeller). The GREX_RSLT table contains ten entries which correspond to the EHP test. Each entry corresponds to an individual tank run at a particular Froude number and its calculated results. The GREX_EXPR table contains fifteen entries which correspond to the SHP test. Each entry corresponds to an individual run as before with a different set of calculated results.

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