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INSTITUTE FOR RESEARCH AND ENGINEERING FOR AUTOMATION AND PRODUCTIVITY IN SHIPBUILDING

I R E A P S

APPLICATION OF SHIPOPT TO PRELIMINARY DESIGN OF COMMERCIAL SHIPS

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ABSTRACT

The theory and results of applying computer-aided ship structure optimization procedures to design of a new ferry for southwestern Alaska routes is presented, and is called SHIPOPT. It has been developed by Professor Owen Hughes of the University of New South Wales, Australia, and has had recent application by Giannotti and Associates Inc, to structural design of U.S. Navy ships. Ship optimization is a rationally based, interactive procedure which recognizes prescribed design constraints and optimizes within those constraints ship structural scantlings and geometry for strength, weight, and cost. The structural constraints typically considered are allowable shear and bending stresses, buckling loads, fatigue life, weight, and ship arrangements, based on commercial or regulatory body requirements.

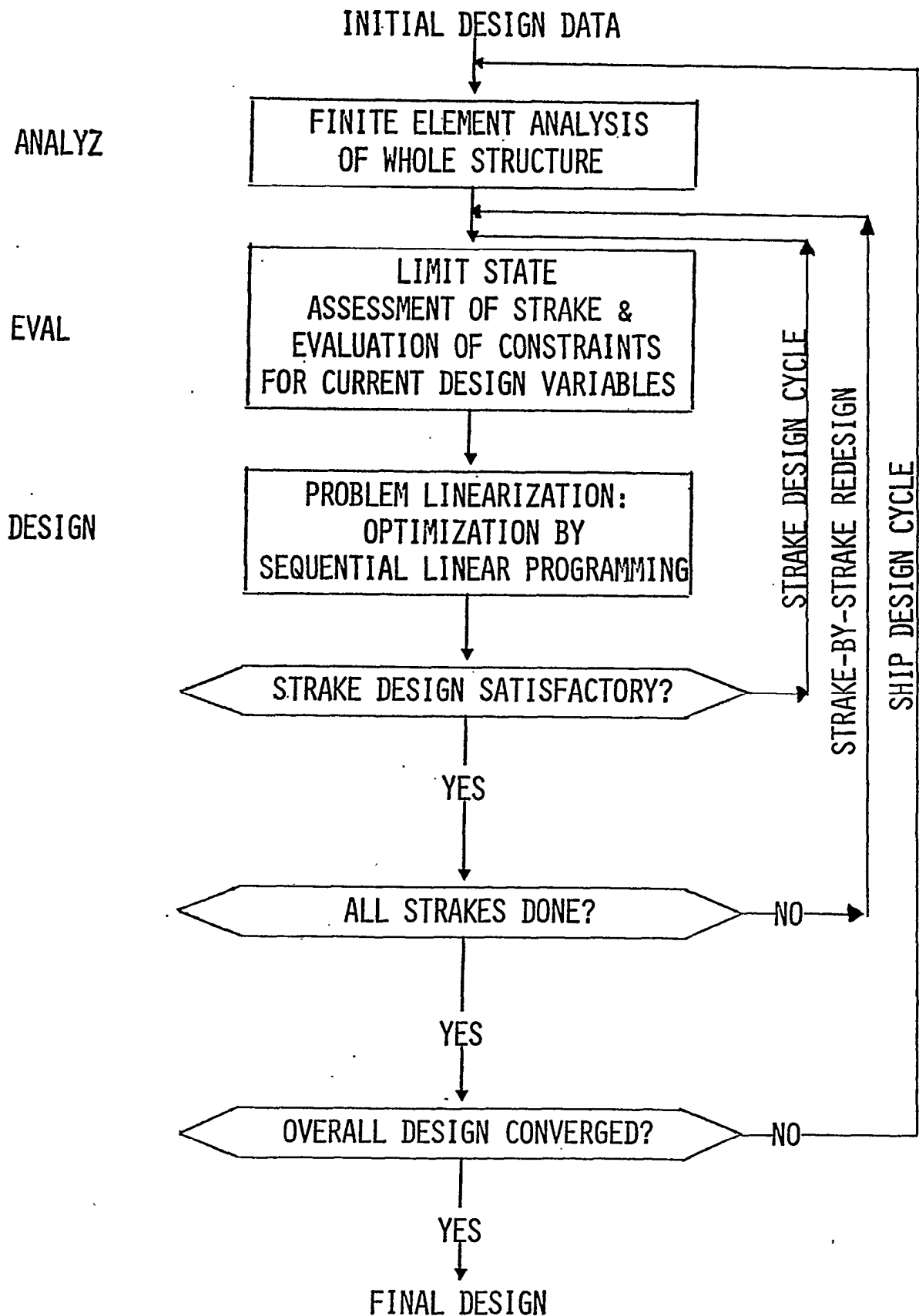
- 1) SCOPE
- 2) METHODOLOGY
- 3) APPLICATION (GENERAL) OF SHILOPT
- 4) APPLICATION (SPECIFIC) OF SHILOPT
- 5) ACCESSIBILITY/HARDWARE REQUIREMENTS

SHILOPT PROVIDES:

- A RATIONALLY BASED TOOL FOR PRELIMINARY SHIP DESIGN THROUGH;
- A FAST, EFFICIENT, LOW COST, STRUCTURAL ANALYSIS AND OPTIMIZATION PROGRAM WHICH;
- ALLOWS DESIGNER INPUT OF SAFETY AND FUNCTIONAL CONSTRAINTS AND OPTIMIZATION MEASURES OF MERIT,

RATIONALLY BASED PRELIMINARY
STRUCTURAL DESIGN

- 1) RESPONSE ANALYSIS
- 2) CAPABILITY (OR LIMIT STATE) ANALYSIS
- 3) RELIABILITY BASED STRENGTH CRITERIA
- 4) NONSTRUCTURAL CRITERIA
- 5) OPTIMIZATION
- 6) INTERACTIVE MODE OF OPERATION



APPLICATION (GENERAL) OF SHIPOPT

- BENEFITS
- LIMITATIONS
- STARTING POINT
- RESULTS

BENEFITS (OF STRUCTURAL ANALYSIS>

- STRUCTURAL ASSESSMENT AND DESIGN REVIEW
- INVESTIGATION OF SAFETY FACTORS
- INVESTIGATION OF ALTERNATIVE DESIGN LOADS
- ASSESSMENT OF STRUCTURAL DAMAGE OR CORROSION

BENEFITS (OF OPTIMIZATION)

1 FIRST ORDER

- REDUCED COST AND WEIGHT
- INCREASED PERFORMANCE (E.G., LOWER VCG)
- COST VS. WEIGHT

1 SECOND ORDER

- REDUCED WEIGHT IMPLIES LOWER RESISTANCE
THUS LOWER MACHINERY WEIGHTS

1 THIRD ORDER

- REDUCED MACHINERY WEIGHT IMPLIES FURTHER
REDUCTION IN LOCAL SCANTLINGS, OVERALL
WEIGHT, RESISTANCE AND COST

SHIPOPT ABILITIES

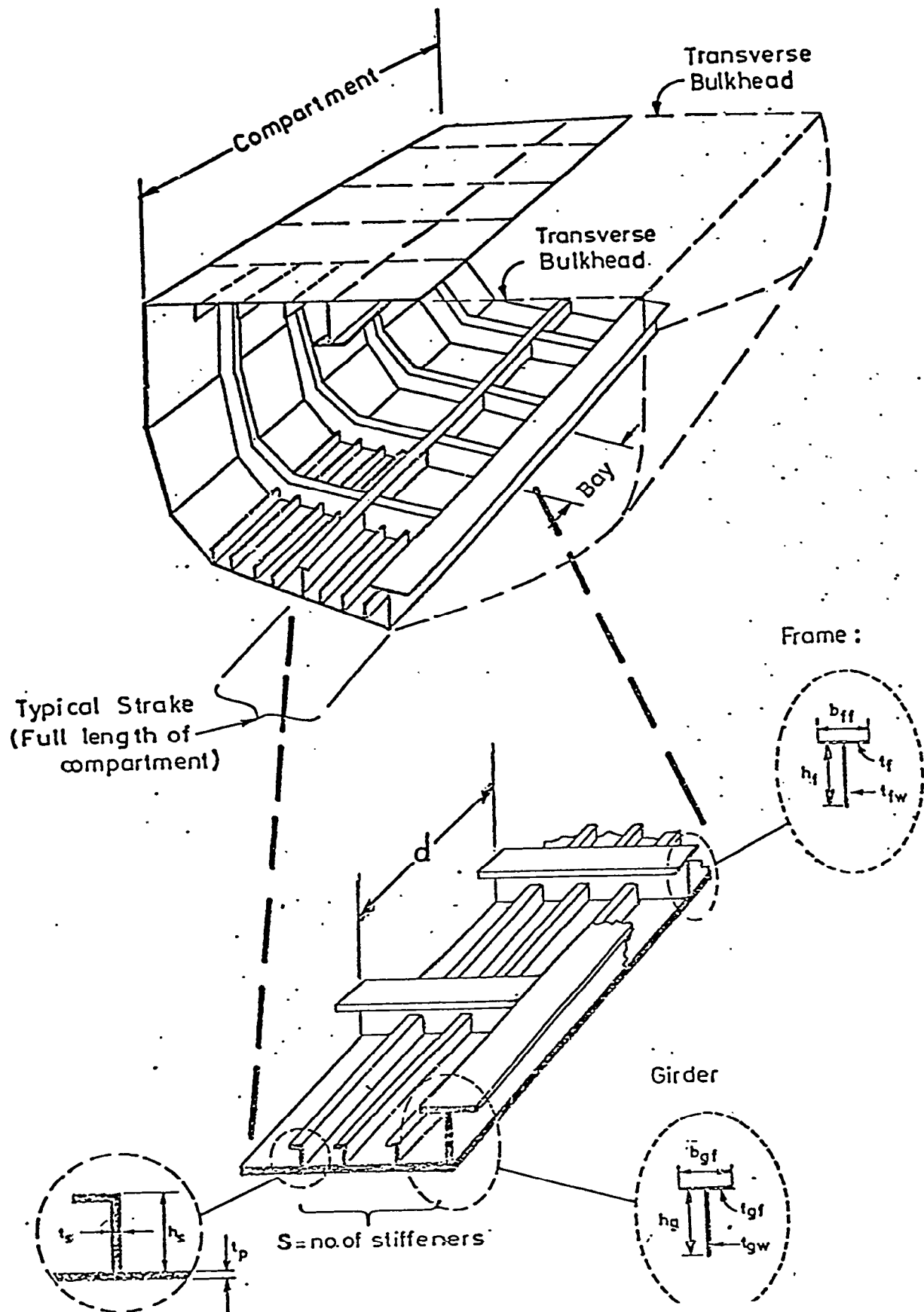
- COMPREHENSIVE 3-D STRUCTURAL ANALYSIS AT EACH STAGE
- EXPLICIT CALCULATION OF ULTIMATE STRENGTH OF ALL PRINCIPAL MEMBERS
- FAST CYCLE TIME
- ABILITY TO REPEAT A PRELIMINARY DESIGN
- ALTERNATIVE STRUCTURAL CONFIGURATIONS
- STANDARD SECTIONS
- USER DEFINED MEASURE OF MERIT; CONSTRAINTS

LIMITATIONS

- PRISMATIC MODEL
- SYMMETRIC ABOUT ζ
- STATIC OR QUASI-STATIC LOADING ONLY

STARTING POINT

- LOADS
- STRUCTURAL DEFINITION
 - STIFFENERS AND PLATES
 - STRAKES
 - BHDS,
 - MODULE
- CONSTRAINTS
- PARTIAL SAFETY FACTORS



RESULTS

- ANALYSIS
 - NODAL DEFLECTIONS
 - STRESSES
 - MINIMUM CONSTRAINTS FUNCTION
LOCATION IN STRAKE
 - STATISTICAL FEASIBILITY SUMMARY

RESULTS

1 OPTIMIZATION

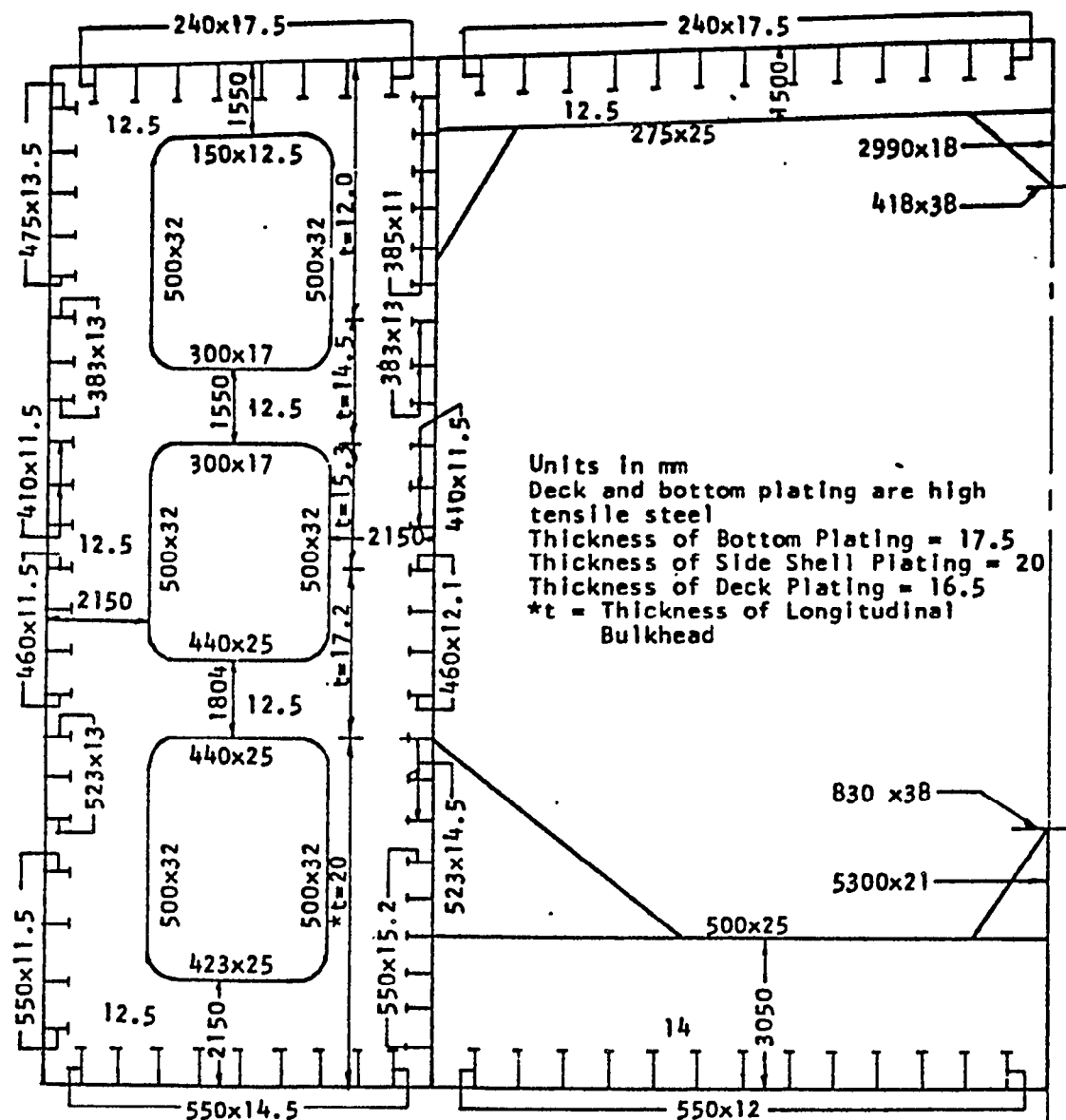
- CONSTRAINT FUNCTION VALUES
- ACTIVE CONSTRAINTS
- STATISTICAL FEASIBILITY SUMMARY

APPLICATION (SPECIFIC)

1 TEST CASES

1 ALASKA FERRY

- **HULL CUTOUTS**
- **VEHICLE DECK**
- **SUPERSTRUCTURE**
- **EXTREME HEAVY WEATHER**



NOTE: Stiffener scantlings are for web only. For each group of stiffeners, user defines ratio of flange area to web area.

CL

Fig. 6 Initial tanker scantlings

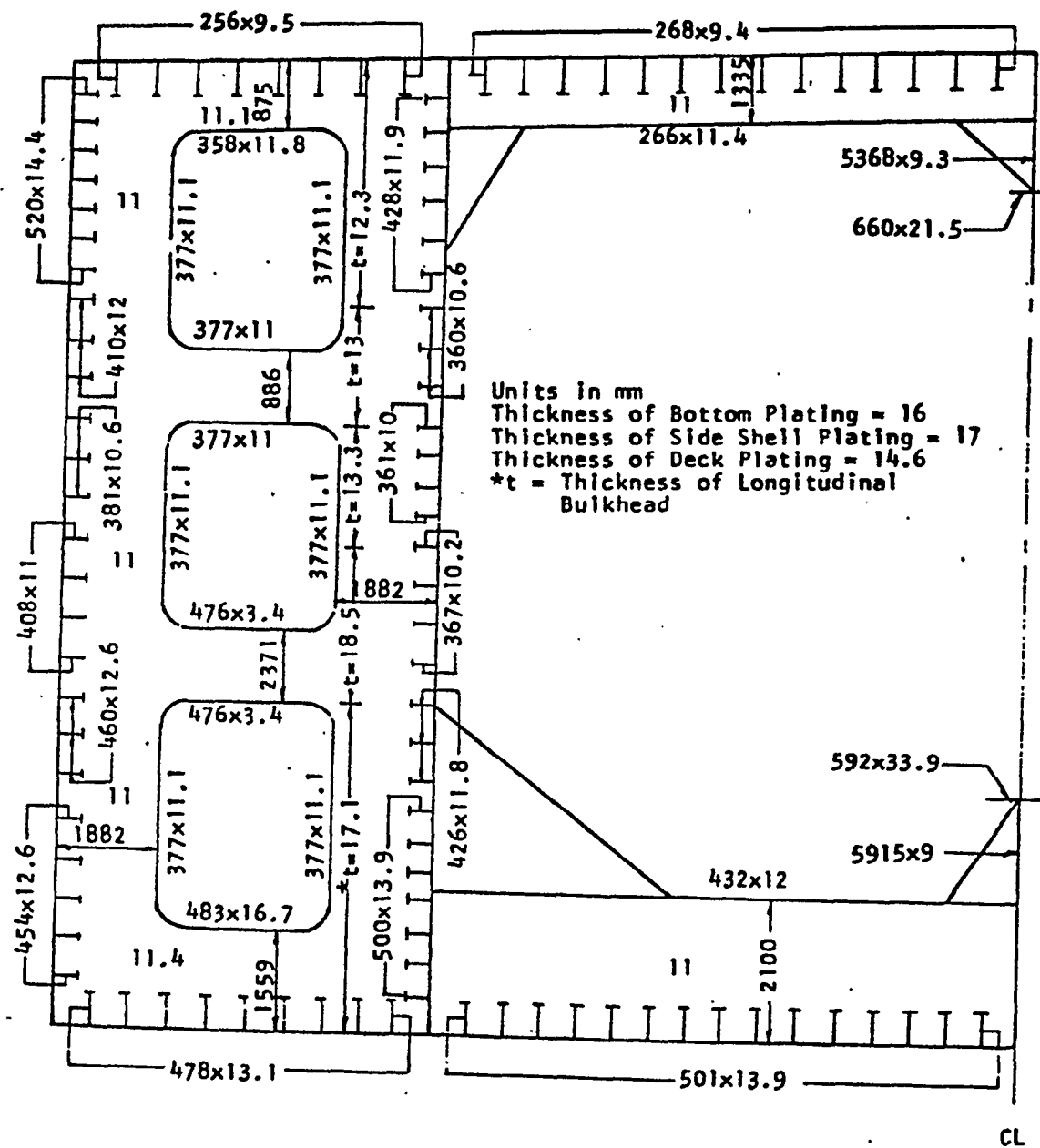


Fig. 7 Final tanker scantlings

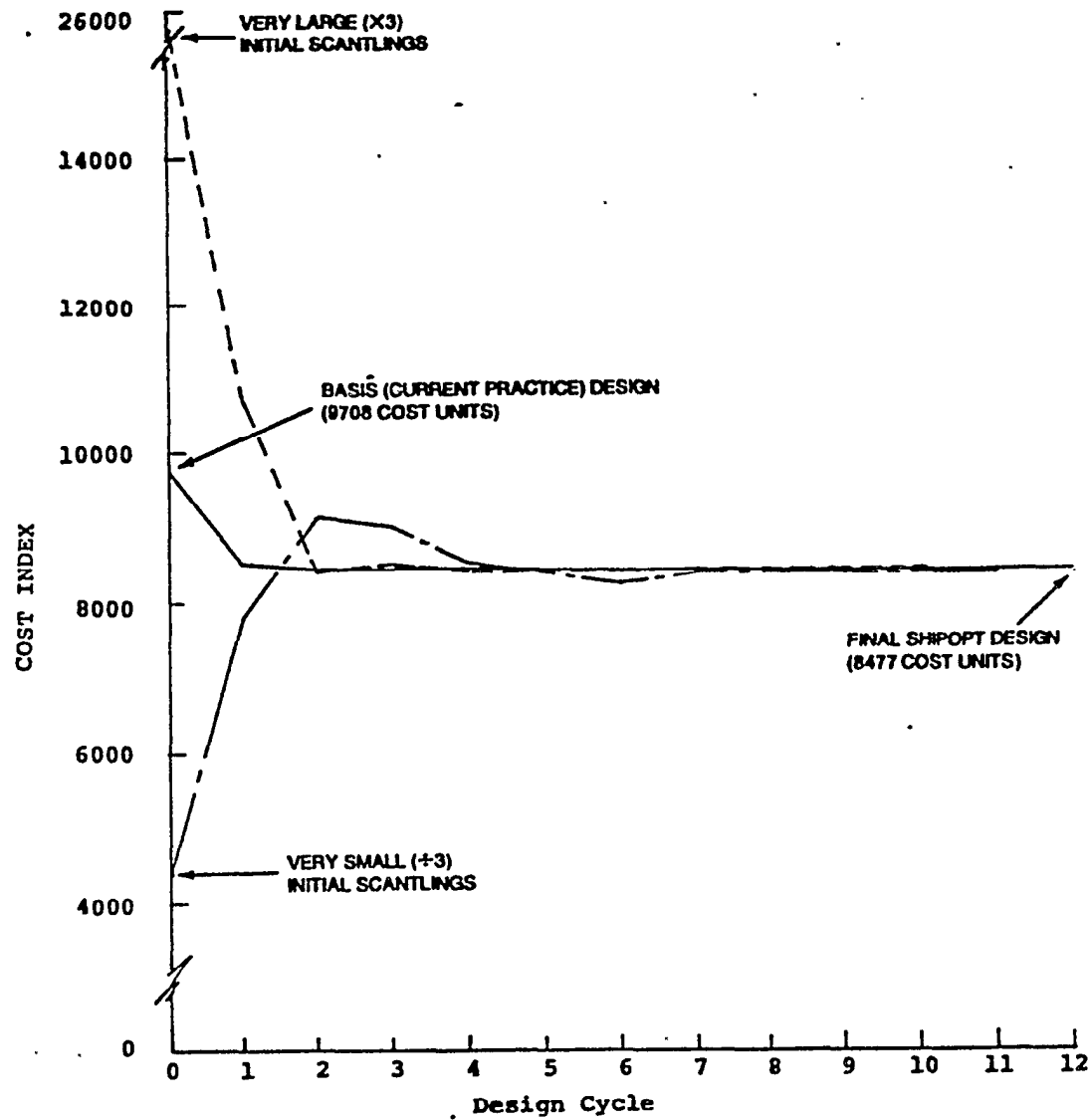


Fig. 5 Convergence and stability of SHIPOPT

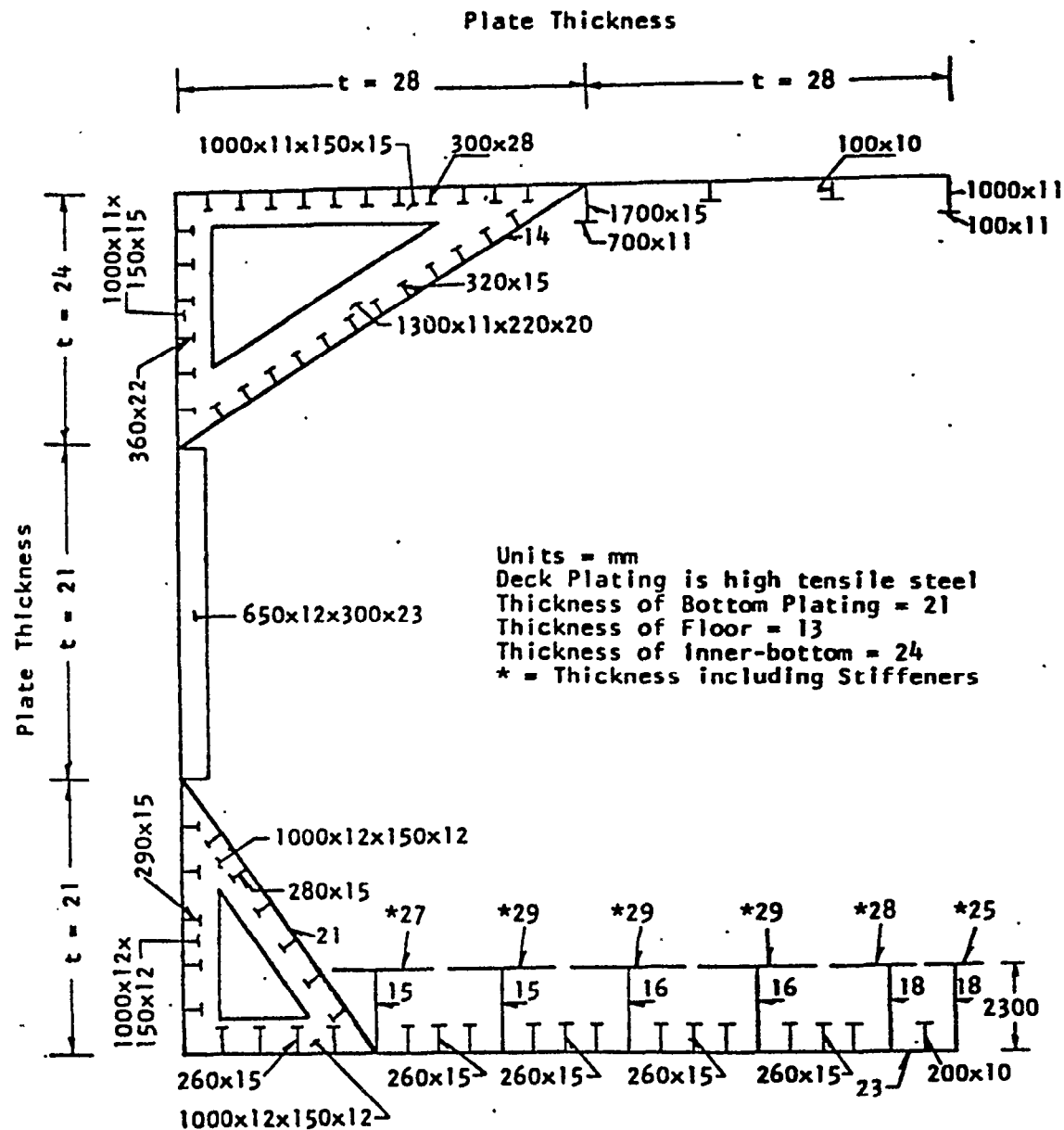


Fig. 9 Initial bulk carrier scantlings

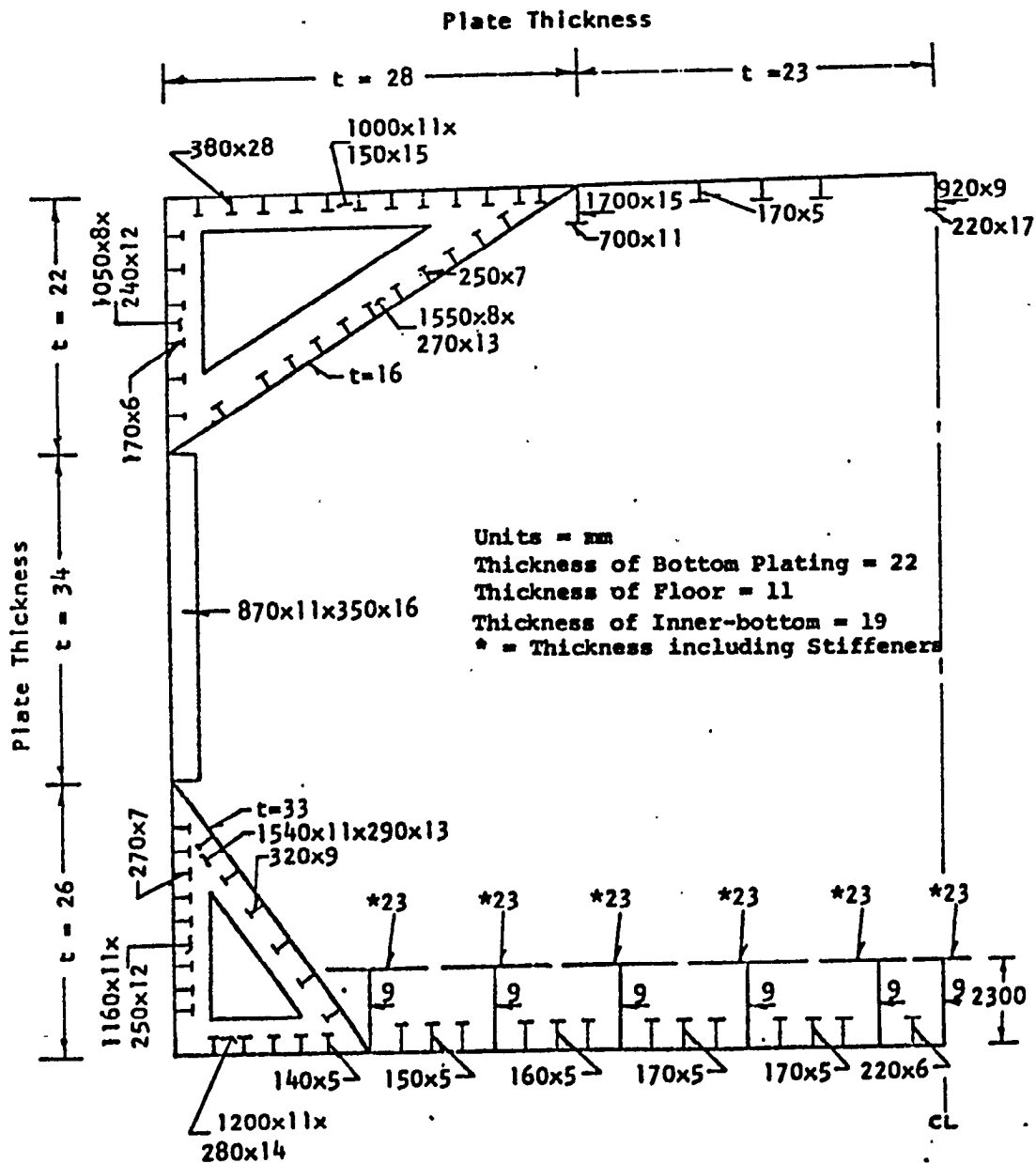


Fig. 10 Final bulk carrier scantlings

HARDWARE

- 1) MAIN FRAMES
- 2) "SUPER-MINI ,

ACCESSIBILITY

- 1) OWEN HUGHES**
- 2) GIANNOTTI & ASSOCIATES

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