INTERNATIONAL
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WEIGHT ENGINEERS, INC.

Serving the Aerospace - Shipbuilding - Land Vehicle and Allied Industries
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Weight Control Technical Requirements for Naval Surface Ships

Revision Issue No. D

Prepared by
Marine Systems
Government - Industry Workshop
of the
Society of Allied Weight Engineers

Change Record

Issue	Date	Title/Brief Description	Entered By
A	06/04/96	On Page 2, deleted reference to cancelled DOD-STD-1690 (Government document) "Maritime Metric Practice Guide," and replaced with Non-Government document, on Page 2, "Use of SI Units in Maritime Application." On Page 36 and 37, correct Figures 9 and 9A, Trim and List column titles to read TRIM (F)/(A) and LIST (P)/(S).	D. Cimino
B	05/21/97	On Page ii, Change Record Issue No. A, corrected description to read "…Page 2, …" instead of "…Page 3,…" On Page 1, modified Section 1.1, Scope. On Page 1, added Section 1.3, Units of Measurement. On Page 3, revised Section 3.2, Accepted Weight Estimate, by replacing "…centers…" with "…center…" On Page 5, Section 3.21, Electronic Media replaced previous wording "Magnetic Media" (previous Section 3.35). Replaced all references to "magnetic" with the word "electronic," and re-numbered all sections in Section 3 as appropriate. On Page 6, Section 3.34 (previous Section 3.33), Light Ship Condition (Condition A): deleted "…aviation mobile support equipment as assigned,…" from definition. On Page 14, revised Section 5.1.2.10, Magnetic Media to read "Electronic Media" and replaced all references to "magnetic" with the word "electronic."	D. Cimino

Change Record

Issue	Date	Title/Brief Description	Entered By
B	05/21/97	On Page 23, revised Section 5.3.4.6, Magnetic Media, to read "Electronic Media" and replaced all references to "magnetic" with the word "electronic."	D. Cimino
C	05/22/02	Page 1, Section 1.1, added A…and service lift…@ Page 2, Section 2.2, added AF1321-92…@ Page 4, Section 3.9, and Page 6, Section 3.26, substituted A…empty weight…@ with A…fully fueled…@. Page 7, Section 3.27, added definition of FSC. Page 8, Section 3.43, added definition of Planning Yard. Page 12, Section 4.2.8, deleted "A, The original … MIL D 5450." Page 14, Section 5.1.2.4, deleted A, The format of … provided by NAVSEA@. Page 15, Section 5.1.2.9, deleted A, and the concurrence of cognizant NAVSEA tech code @. Page 20, Section 5.3.1.5, added A, The detail data … specified in the Appendix@. Page 26, Section 5.1.2.10, and Section 5.3.4.7 was moved and relabeled Section 5.6 and 5.5 respectively. Pages 24 and 25, added Sections: 5.3.5, 5.4, 5.4.1, 5.4.2, 5.4.3, 5.4.3.1, 5.4.3.2, 5.4.3.3, 5.4.4, 5.4.5, 5.4.6, 5.4.7, 5.5, 5.6. Page 27, revised Figure 1 to include in-service phase. Renumbered figures.	D. Cimino C. Filiopoulos

Change Record

Issue	Date	Title/Brief Description	Entered By
D	3/30/08	Revised and updated text, numbering, and format throughout body of the RP and appendices to improve readability. Revised section on Government Furnished Material to address the treatment of GFM growth and improve clarity. Revised Figure 9 in Appendix A to suit. Deleted section titled “Notes” addressing data requirements, DODISS. Revised title to include “Naval” and revised applicability to Navy ships only. Reorganize by design phase. Update terms to include only terms used in the text. Added description and Figure 6., example Current Ship Summary. Added discussion of bridge phase, Section 3.3; data fidelity, Section 3.2; and weight maturity level codes, Section 3.2.	A. N. Titcomb, C. Filiopoulos, J. Burroughs

FORWARD

The technical responsibility for the content and currency of this recommended practice resides with the incumbent chairperson(s) of the Marine Systems Government/Industry Workshop of the Society of Allied Weight Engineers. Any comments or questions regarding this recommended practice should be addressed to the SAWE Executive Secretary, whose address is shown with the Title Page logo with attention to the Marine Systems Government/Industry Workshop.

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1.0 SCOPE

1.1 PURPOSE

Naval ships by nature require a rigorous and proactive approach to weight control. Their unique missions and operating environments make them markedly different from other more conventional ships. Their unique requirements for survivability, seakeeping, maneuverability, and the need to undergo significant overhauls and upgrades during their service life coupled with their high sensitivity to weight and KG makes them a special case for weight control. New or specialized hull forms may add further to the need for significant emphasis on weight control.

This recommended practice provides weight control technical requirements for all phases of naval surface ship acquisition (i.e., preliminary design through detail design and construction) and service life and also describes different types of weight estimates, reports, and weight control procedures. The purpose of this document is to promote uniformity and standardization in weight control and weight reporting. This RP describes weight control measures and requirements that are applicable to military vessels which typically require more stringent emphasis on weight control due to the need for upgrades in systems and functions throughout the life of the ship. This RP may also be invoked in whole or in part for other vessels such as commercial ships or offshore platforms as deemed appropriate. The requirements in this practice apply (either in part or in total) only as specified in a contractual agreement (e.g., contract clause, purchase order, etc.). This standard defines weight control technical requirements and describes the various different types of weight estimates and reports that may be contractually required by a ship owner. The contract will specify requirements for deliverables commensurate with the weight control program for the ship in question including data to be submitted, frequency of submission, number of copies, and recipients. Although the frequency and level of fidelity of estimating and reporting may vary, the definition of weight control products is uniform.

1.2 ORGANIZATION

This Recommended Practice is presented in two basic sections, General Requirements and detailed requirements that are presented in terms of the design phases, Preliminary /Contract Design, (Pre-award period), Detailed Design and Construction, and Post Delivery and Service Life. The General Requirements section applies to all weight control documents and deliverables prepared throughout the entire ship design and construction phases. It also includes requirements or “best practices” that apply throughout all design phases. Under each design phase, specific weight control deliverables are described that may be required by contract for a given ship as well as the recommended weight control activities for that phase of the design process. Figure 1 provides an overview of weight control technical products by design phase, and also depicts the interface of estimates vs. reports. All figures referred to in the text of this document are located in Appendix A.

2.0 DEFINITIONS

Accepted Ship Report (ASR) - The ASR is the document that demonstrates the Contractor's performance with regard to weight control. The ASR highlights the differences between the Accepted Weight Estimate (AWE) or the Allocated Baseline Weight Estimate (ABWE) and the delivered ship as inclined.

Accepted Weight Estimate (AWE) - The AWE defines the weight and center of gravity of a ship that was awarded under a specification-type contract using the information that was available at the time of contract award. It establishes contractual values for weight and KG and is the baseline for detail design and construction.

Acquisition Margins - Acquisition margins are weight and KG allowances included in the weight estimate to cover the inherent limits of precision and the undefined variations of component weight and centers of gravity that take place throughout the design phases and during the construction of a ship. In order to provide for adequate weight control and configuration control, acquisition margins are divided into five accounts: preliminary design margin, contract design margin, detail design and building margin, contract modification margin, and Government-Furnished Material (GFM) margin.

Actual Weight - Actual weight, or weighed weight, is the value obtained by a measurement of material or equipment on an accurate scale or other weighing device.

Allocated Baseline Weight Estimate (ABWE) - The ABWE is the Contractor's definition of the weight and centers of gravity of a ship that was awarded under a performance-type contract at the time of hull and propulsion configuration approval. It is the baseline for detail design and construction.

Baseline Weight Estimate (BWE) - The BWE is any designated weight estimate that is used as a starting point in a design phase for comparative analysis with subsequent weight estimates. Before contract award, the final estimate of each design phase is usually the baseline estimate for the succeeding phase. After contract award, the AWE or ABWE is usually the baseline estimate for the remainder of detail design and construction.

Bidder's Independent Weight Estimate (BIWE) - The bidders (or offeror's) independent weight estimate is prepared by each potential contractor in response to a solicitation. It is the bidder's evaluation of the ship design based on the ship specifications, drawings, and data that comprise the contract package.

Bridge Phase – Bridge phase refers to activities that occur during a gap between the end of one design phase and the start of another, usually resulting from contractual, funding, or significant design deficiencies that prevent the exiting of the current design phase.

Calculated Weight - Calculated weight is weight computed from ship construction drawings, vendor drawings, and final detailed computer models.

Capacity Load Condition (Condition E) - The capacity load condition is the ship complete and ready for service in every respect. It is light ship (Condition A) plus the following variable loads: maximum number of officers, crew, and passengers that can be accommodated and their effects; maximum stowage of ammunition in magazines and ready service spaces; full allowance of aircraft and vehicles (fully fueled with full allowance of repair parts and stores); maximum amount of provisions and stores that

can be carried in the assigned spaces; and maximum capacity of liquids in tanks. Fuel and lube oil shall be not greater than 95 percent of tank capacity, unless such tanks are compensating. Compensating tanks shall be considered filled with 95 percent fuel and 5 percent salt water. Maximum amounts of cargo and supplies, other than for ship's own use, shall be included to the full capacity of the assigned spaces. This load condition shall not be greater than the limiting drafts.

Category - Category is a fundamental unit of machinery weight classification for nuclear-propelled ships in accordance with NAVSEA 0900-LP-039-9020.

Category System - Category system is a system of machinery weight classification for nuclear-propelled ships in accordance with NAVSEA 0900-LP-039-9020

Class Accepted Weight Estimate (CAWE)- the AWE that is developed in a cooperative and integrated effort by two or more class lead contractors. The construction may be totally independent and competitive from the detail design but would still require each builder to maintain the acquisition margin stated in the CAWE

Class Quarterly Weight Report (CQWR) – The QWR that is developed in a cooperative and integrated effort by two or more lead contractors.

Class Standard Equipment – provide definition (or check with new defitions) and provide link in the text

Component - A single item of shipboard equipment or a unit of a shipboard system.

Contract Data Requirements List (CDRL) - A CDRL is a contract form (DD Form 1423) listing all data items selected from an authorized data list to be delivered under the contract. It includes the format, content, frequency, submittal and distribution requirements.

Contract Design Margin - The contract design margin is a weight and KG allowance included in the weight estimate to account for increases associated with design development during the contract design phase. This margin is included in the feasibility and preliminary design phases. No portion of this margin is consumed prior to the start of contract design.

Contract Design Weight Estimate (CDWE) - The CDWE is the weight estimate of the light ship, full load, and any other specified loading condition prepared during the contract design phase.

Contract Modification Margin - The contract modification margin is a weight and KG allowance included in the weight estimates and reports to account for increases associated with contract modifications issued during the detail design and construction phase. This margin is included in the feasibility, preliminary, and contract design phases. For performance-type contracts this margin is also included in detail design and building phase. It may also apply to other types of contracts. No portion of this margin is consumed prior to award of the detail design and construction contract.

Contract Modification Summary - The contract modification summary is a complete listing of the weight and moment effects of approved contract changes. This information is included as an appendix to the quarterly weight reports, class quarterly weight reports, the accepted ship report, and the final weight report. In the case where the detail design and construction are separate contracts, this summary is included in the CAWE and AWE.

Contractor-responsible Condition - The Contractor-responsible condition is the full load condition without the effects of contract modifications, changes in GFM, and other allowable changes after the establishment of the CAWE, AWE or ABWE. This condition is used to measure the Contractor's progress in achieving his requirement to deliver the ship within contractual values.

Current Weight - Current weight consists of the most accurate data available on the date of a given weight estimate or report. The summary of current weight is frequently a combination of estimated, calculated, and actual values.

Design Development – Design development consists of changes in ships systems or subsystems configuration or hardware resulting from improved definition and detail of the original requirements. Acquisition margin is intended to account for this type of growth. Excluded from design development is growth in characteristics that increase the design baseline and is not intended to be addressed by acquisition margin.

Design and Weight Data Sheet - The design and weight data sheet is a one page summary which includes group level weight data, hull characteristics data, displacement and stability characteristics data, load data, and machinery data.

Detail Design and Building Margin - Detail design and building margin is a weight and KG allowance included in the weight estimates and reports to account for design changes due to ship construction drawing development; growth of Contractor-furnished material; omissions and errors in the CAWE, AWE or ABWE, as well as differing shipbuilding practices, omissions and errors in the ship construction drawings; unknown mill tolerances; outfitting details; variations between the actual ship and its curves of form; and similar differences. This margin is to compensate for all Contractor-responsible differences between the CAWE, AWE or ABWE and the results of the inclining experiment, as well as tolerances for experimental variation in the inclining experiment. [contents moved to section 3.2.2]

Data Requirements List – similar to CDRL – look for exact definition

Estimated Weight - Estimated weight is based on preliminary data and is subject to revision when more accurate information is available, such as when more detailed drawings or detailed computer models are developed or when components are actually weighed.

Expanded Ship Work Breakdown Structure (ESWBS) - ESWBS is a five-digit functional classification system in accordance with Reference 1. For weight reporting purposes, only the first three digits of this system apply. The fourth and fifth single digit classification levels are used to incorporate additional classification capability that is unique to the builder's design and constructions methods.

Feasibility Study Weight Estimate - The feasibility study weight estimate is a compilation of the ship's weight and center of gravity data that result in light ship, full load, and any other specified loading conditions. This estimate is prepared during the feasibility study design phase.

Final Contract Design Weight Estimate - The final estimate produced during the contract design phase is designated as the final contract design weight estimate. May form the basis of the CAWE, AWE or ABWE.

Final Weight Report (FWR) - A FWR is a detailed final report of weight and moment data for all required loading conditions. This report accurately reflects accumulated values for estimated, calculated, and actual weight data for the detail design, including the net effect of changes to GFM and adjudicated and unadjudicated contract modifications, and inclining experiment adjustment, when applicable.

Full Load Condition (Condition D) - The full load condition is the ship complete and ready for service in every respect. It is light ship (Condition A), plus the following variable loads: authorized complement of officers, crew, and passengers, and their effects; full allowances of ammunition in magazines and ready service spaces; full allowance of aircraft , vehicles, and mission modules (fully fueled with full allowance of repair parts and stores); full supply of provisions and stores for the periods specified in the design characteristics; full potable water tanks; lube oil tanks to 95 percent of capacity; fuel tanks to 95 percent capacity, or in the case of compensating tanks 95 percent fuel and 5 percent salt water; CHT tanks to 25 percent capacity; anti-roll tanks to operating levels; and all other liquids in tanks to required capacity in accordance with characteristics and liquid loading instructions. The ammunition, stores, fuel, and other liquids referred to above are for the ship's own use. Cargo (liquid and solid) is included in the amounts normally carried or to the specified portion of the full capacity of the assigned spaces.

Full Service Contractor (FSC) - Prime Contractor who designs builds, and in many cases supports, the in-service weight control effort of the ship or classes of ships. A Full Service Contractor is synonymous with a Planning Yard within the context of weight control.

Government-Controlled Equipment – Shipboard material or equipment that the Government or Customer brings onboard prior to ship delivery and is included in the weight report for the ship. Generally, Government-controlled equipment is treated similar to, or is a part of Government-Furnished Material in weight accounting and with regard to margins. May also be termed Customer-directed equipment.
[check new definition]
Government-Directed Equipment – Shipboard material or equipment that is specified, but not directly furnished, by the Government or Customer. Because it is specified, the shipbuilder typically has no opportunity to implement any weight reduction measures on these items. Generally, Government-directed material is treated similar to, or a part of, Government-Furnished Material in weight accounting and with regard to margins. May also be termed Customer-directed equipment.
[check new definition]
Government-Furnished Material (GFM) Margin - GFM margin is a weight and KG allowance included in the weight estimates and reports to account for increases caused by the growth in GFM during the detail design and construction phase. This margin is included in the feasibility, preliminary, and contract design phases. For performance-type contracts, this margin is also included in detail design and building phase. No portion of this margin is consumed prior to award of the detail design and construction contract. May also be termed Customer or Owner-furnished material margin. [check last sentence]

Government-Furnished Material Summary - The GFM summary is a complete listing of weight and center of gravity data for material and equipment that will be provided by the Government. The baseline GFM summary, which is included as part of the CAWE, AWE or ABWE, reflects the Schedule A portion of the contract at the time of contract award. The GFM summary is continuously updated as the detail design weight estimates mature and the Schedule A is modified. Also, where the contract permits, the GFM summary can include other government-responsible equipment, such as

equipment designated as standard for the class, directed procurement, and so forth.In the case where detail design and construction are separate contracts, the summary is included in the CAWE and AWE as needed.

Group - Group is a fundamental unit of ship classification, identified by one numeric digit or an alphabetic designator. For weight estimates and reports, a group is the first character of the three-digit system. The summation of weights and moments for all of the three-digit elements that begin with the number one is the total for group one, and similarly for the other groups.

Gyradius - The gyradius for roll, pitch, or yaw is the square root of the quotient of the ship's weight moment of inertia about the roll, pitch, and yaw axes, respectively, divided by the ship's displacement.

Inch-pound Units - Inch-pound units comprise a system of units using pounds, long tons, feet, foot-pounds, and foot-tons for reporting mass properties data.

Inclining Experiment - The inclining experiment is the procedure for determining the height of the ship's center of gravity by observing the inclination produced by a known transverse moment, and for determining the displacement and longitudinal position of the ship's center of gravity by observing the drafts.

Interim Report - Any weight report produced at regular intervals after the initial weight report and before the final weight report or in response to a specific request from the customer.

KG - The height of the ship's vertical center of gravity as measured from the bottom of the keel (includes keel thickness).

Legacy Mass Properties Data – calculated carry over systems data from a previous design that applies in total to the current design. A review and evaluation of each legacy drawing for total applicability to the current design should be completed prior to incorporating legacy data into the database as calculated weight.

Light Ship Condition (Condition A) - The light ship condition is the ship complete, ready for service in every respect, including permanent solid and liquid ballast, onboard repair parts, and liquids in machinery at operating levels, without any items of variable load.

Longitudinal Lever - The longitudinal lever is the perpendicular distance from a transverse plane through the ship's longitudinal reference to the center of gravity of an item. The longitudinal reference is located at the forward perpendicular, unless otherwise specified by the design contract or Ship Specifications.

. [use correct definition]

Maturity Index - A relative index based on the fidelity of the engineering documents used for weight determination, the technological maturity of the item in question, the magnitude of the weight involved, and the potential shipboard impact. The maturity index is an indication of the risk associated with a given shipboard item or system.[check if we need this definition]

Mass Properties Data - Mass properties data are those physical characteristics which define the magnitude, location, and distribution of weight in the ship. They include weight, centers of gravity

location, moments, and weight moments of inertia.

Moment - A moment is the product of a weight and its lever. For example, the longitudinal moment of an item is the product of the weight of the item multiplied by its longitudinal lever.

Not –to- Exceed (NTE) - Contractually established values for weight and KG/ to protect the service life allowances for weight and KG. Liquidated damages may be associated with NTE requirements.

Percent completion –insert definition

Performance-type Contract - A performance-type contract is the vehicle for ship acquisition resulting from a description of operational and mission requirements. Since the shipbuilder usually has substantial latitude in determining ship size and configuration, a PABWE or ABWE is used in this situation.

Pitch Moment of Inertia - Moment of inertia about the transverse axis through the ship's center of gravity.

Planning Yard - Ship Class Design Agent that has life cycle design responsibility for assigned ships. The Planning Yard establishes list of programmed ship alterations (ShipAlts) with their associated weight and moments effects, and identifies removals and ballasting requirements. Private shipyards or contractors possessing special knowledge of a class of ships may also be designated as planning yards.

Pre-award Period – Ship design development period in which engineering findings and decisions from preliminary design are translated into solid technical requirements which form the basis of a detail design and construction contract.[confusing definiton- not a design phase as defined in SECNAV 5000.2D]

Preliminary Allocated Baseline Weight Estimate (PABWE) - The PABWE is the potential bidder's (or offeror's) estimate of the weight and center of gravity of the ship in response to a solicitation for a performance-type contract.

Preliminary Design Margin - Preliminary design margin is a weight and KG allowance included in the weight estimates to account for increases associated with design development during the preliminary design phase. This margin is included in the feasibility design phase. No portion of this margin is consumed prior to the start of preliminary design.

Preliminary Design Weight Estimate - Preliminary design weight estimate is the weight estimate of the light ship, full load, and any other specified load condition prepared during the preliminary design phase.

Quarterly Weight Report (QWR) - An interim weight report produced in response to a customer requirement for weight reports every three months. A QWR provides a periodic assessment of displacement, drafts, trim, list, GM, and KG as the weight estimate matures during detail design and construction. In the case where the detail design is a separate contract from construction the QWRs are CQWRs.

Roll Moment of Inertia - Moment of inertia about the longitudinal axis through the ship's center of gravity.

Space and Weight Items- An (space and weight) allocation for future equipment. Items designated as such should be included in weight estimates and reports accordingly.

Service Life Allowances - Service life allowances are weight and KG budgets included in the design to accommodate changes due to both authorized (for example, ship alterations), and unplanned growth (for example, paint, personal belongings, and so forth) during the ship's operational lifetime, which tends to increase displacement and impact stability.

SI Units - SI units refers to an international system of units using kilograms, metric tons, meters, kilogram-meters, and metric ton-meters for reporting mass properties data.

Specification-type Contract - A specification-type contract is the vehicle for ship acquisition resulting from a Navy controlled contract design. The products of the contract design, which usually become part of the shipbuilding contract and therefore the basis for the BIWE, include items such as: midship section drawing, lines drawing, table of offsets, general arrangement drawings, the shipbuilding specifications, and special requirements like not-to-exceed weight and KG values.
Standard Longitudinal Station Breakdown - The standard longitudinal station breakdown is a system consisting of 22 stations designated by the letters A through X (excluding I and O). Station A is the only station forward of the forward perpendicular (FP). Station X is the only station aft of the aft perpendicular (AP). Stations B through W extend from the FP to the AP, and each comprises 1/20 of the length between perpendiculars.

Three-digit System - The three-digit system is a means of classifying mass properties data in a structured order. Every item that comprises the completed ship is included in the weight estimates and reports grouped in accordance with the three-digit system. Unless otherwise specified, the three-digit system for weight estimates and reports is the same as the first three digits of the ESWBS.

Transverse Lever. Transverse lever is the perpendicular distance from the vertical centerline plane of the ship to the center of gravity of an item.

Unit Weight – The elemental weight of a material or equipment as is recognizable in material or equipment catalogs. The unit weight is typically defined on a dimensional basis such as area, length, or other dimensional parameters. Assemblies or sub-assemblies should not be considered unit weights.

Vertical Lever. Vertical lever is the perpendicular distance from a horizontal plane through the molded baseline of the ship to the center of gravity of an item.

Weight Control - Weight control is comprised of all the necessary actions such as predicting, estimating, calculating, weighing, reporting, analyzing, evaluating, and reversing adverse trends to ensure that a ship's weight and moments are consistent with its naval architectural limits for displacement, strength, stability, list, trim, and performance (such as speed, endurance, and seakeeping).

Weight Control Plan - A weight control plan outlines the approach, practices, and procedures that will be followed to meet contractual weight control responsibilities.

Weight Distribution - A weight distribution is a weight summary by the standard longitudinal station breakdown and is used to develop shear forces and bending moments.

Weight Moment of Inertia - Weight moment of inertia about any reference axis through the ship's center of gravity is the summation of the moment of inertia of each item about its own axis (parallel to the reference inertia axis), plus the products obtained by multiplying the weight of each item by the square of its distance from the reference inertia axis.

Weight Reporting - Weight reporting is the preparation and submission of the most accurate and current weight and moment data available at designated intervals throughout the design and construction phases.

Yaw moment of inertia – Moment of inertia about the vertical axis through the ship's center of gravity.

3.0 GENERAL REQUIREMENTS

3.1 DETERMINATION OF MASS PROPERTIES DATA

The weight and moment data for all components and material and their overall effect on the ship's displacement, center of gravity, list, and trim shall be determined by estimation or calculation methods as appropriate for the design phase at hand. As ship design proceeds or ship construction drawings are prepared and as material is selected, acquired, or received, the weight, centers of gravity, and (where appropriate) the weight moment of inertia of all items that comprise the ship shall be determined, updated, and reported in the weight estimates and reports. These data may be obtained by estimation or calculation during preliminary and contract design, by calculation of ship construction drawings or CAD product models, and by actual weight determination of items during detail design and construction. The data determination methods depend on the design phase and the quality of the available data. During preliminary and contract design, data may be obtained by a combination of estimation, calculations from preliminary schematics, all available drawings and products including direct transfer of legacy data. As preliminary design drawings are refined, and additional drawings are developed during contract design, a similar re-estimation of these drawings should be done soon thereafter. Also vendor equipment should be kept refreshed by similar methods. During detail design and construction, data is primarily obtained from calculations of ship detail design and construction drawings, and by actual weight determination of items. The data is maintained current by continuous monitoring and incorporations of available drawings and revisions. Weights extractions from CAD construction models may be utilized for verification or direct input into the weights database. In this case, the data item descriptions should be understandable(not CAD internal nomenclature or number), and logically structured with linkage to drawings and ESWBS elements.A weight estimate or report shall reflect the latest iteration of engineering products available prior to the cut-off date for a given estimate or report. Key engineering products include the general arrangements; structural, electrical, and piping drawings or diagrams, and the Master Equipment List.

3.2 STRUCTURE AND FORMAT

Weight estimate and reports shall be prepared using the ESWBS classification structure. The detail line items may be prepared by expanding ESWBS up to five digits, in order to be able to sub-total sub-assemblies, assemblies, and other groupings – only three digits should adhere to ESWBS classification, the last digits two are discretionary. The details should be summarized to the three and one digit level of definition.

3.3 GENERAL REPORT REQUIREMENTS

The contract will invoke this standard and will specify technical data to be prepared, including modifications and exceptions. The CDRL/DRL will specify requirements for deliverables, such as data to be submitted, frequency of submission, number of copies, and recipients. Reports shall be submitted accordingly, even if there is no change since the previous reporting period. The following general weight report requirements are applicable to all weight reports described within this Recommended Practice:

—3.4 Loading Conditions

Weight estimates and reports shall contain loading conditions for light ship, full load, Contractor responsible, and additional loading conditions specified by the contract, or the specifications. These

loading conditions should be shown with and without margins. Also, where applicable, during detail design, an additional summation labeled "Pending Future Changes" should be included to account for substantial changes that have not been engineered- therefore do not have a weight estimate yet-but they have been contractually incorporated in the design. Additional detail comprising these conditions are specified in Section X. In addition to the total weight, centers of gravity, and associated moments, each loading condition shall also display KG, metacentric height (uncorrected and corrected for the free surface effect of liquids in tanks), list, trim, and drafts above the bottom of the keel at the perpendiculars and midship. Figures 2 through 4 provide examples of typical loading conditions.

3.4.1. Light ship condition

The lightship condition should be developed from data discussed in Section 3.1 and include full details according to the appendix A. The light ship condition should be summarized into a three digit and one digit summary. The one-digit summary includes the remaining acquisition margin. An example is shown in Figure XX.

3.4.2 Full Load Condition

The Full Load Condition is defined by adding specified variable loads (see definition for details) to the lightship condition and reflects the actual ship that is planned for delivery. Other loading conditions are defined similarly by adding mission loads to lightship and reflect the mission operational condition. An example of the summary page is shown in Figure X.

3.4.3 Contractor Responsible Full Load Condition

The Contractor-responsible full load condition is the full load condition without the effect of contract modifications, both adjudicated and unadjudicated, the net weight change and associated moment changes from baseline values of current GFM items that were included in the original Schedule A or were subsequently added to Schedule A through a change in acquisition responsibility, and other allowable changes beyond the control of the Contractor (see 6.2.6). This condition is used to assess contractual performance. An example is shown in Figure X. In the case where the Government margins are included in the contract, the Contractor responsible full load condition is the full load condition without the effect of the contact modifications, changes in GFM, other allowable changes, that exceed the specified Government margins.

3.5 Margins

All weight estimates and reports shall include acquisition margins tailored to the acquisition design phases and procurement strategy. Typically , margin is allocated for preliminary design, contract design, detail design and construction, contract modifications, and GFM. If the preliminary design phase is excluded or combined with contract design phase, as a single design phase, margin has to be tailored accordingly. If the ship construction will be competed to other Bidders, besides the detail design agent, it will be necessary to separate the construction margin from the detail design margin Although margin values for detail design and construction are selected by the offeror and included along with rationale for their basis in the BIWEs or PABWEs, the final margin values are subject to negotiation and acceptance between the Government and the contractor selected for detail design and construction. Throughout the design cycle, the appropriate margin account shall be adjusted concurrently to compensate for departures from the original estimates due to design development. Design characteristics growth should not be compensated from the acquisition margin; it is considered

as growth to the ship's baseline. Acquisition margins from the current design phase may only be consumed, all other future margins should remain intact until that design phase has started This allows for the maintenance of a constant design baseline until the budgeted margin account is exceeded. Weight margins shall be located at the same centers of gravity as the ESWBS current one-digit totals. Figure 5 provides a typical example.

3.6 Reasons for Change

Weight estimates and reports shall include an addendum that explains each cause of significant change in weight or moment within every three-digit element. Unless otherwise specified, the definition of significant change is one percent or greater difference from an element's previous estimate. A brief narrative of the ship's condition relative to its naval architectural or contractual limits shall be included in this section. If any of these limits is in jeopardy, recommendations for reversing the adverse trend are also required.

3.7 Additional details

3.7.1 Table of Contents - The estimates and reports shall contain a table of contents.

3.7.2 Special Coding - An explanatory note and remarks section shall be included to define special coding symbols, such as material codes, GFM indicators, and reasons for change indicators.

3.7.3 Lever Symbol - Vertical levers shall be indicated by a "-" for below the baseline, and a "+" or a blank for above the baseline. Longitudinal levers shall be indicated by an "F" or a "-" for forward of the reference plane, and an "A", a "+", or a blank for aft of the reference plane. Transverse levers shall be indicated by a "P", a "+", or a blank for port, and an "S" or a "-" for starboard.

3.7.4 Reporting system units. Estimates, reports, and other specified mass properties documentation and data shall be in either English or metric (inch-pound units or kilogram-meter) units, as specified in the specifications. -

3.7.5 Supporting Documents – Background information, studies, directives, correspondence, and all detail calculations pertaining to weight and moment data, including density factors, shall be made available to the Customer upon request.

3.7.6 Ship Conditions – Weight reports shall contain ship conditions for light ship, full load, contractor-responsible full load, and other loading conditions as specified in the Ship Specifications or other contract documents. Each condition shall be reported with and without remaining margins, and all condition should include associated hydrostatics.

3.7.7 Reporting Accuracy – When using SI units, all levers shall be carried to the nearest one-hundredth of a meter. The weight and moment data shall be carried to the nearest kilogram and kilogram-meter at all detail levels. In addition, summaries are to be converted and reported to the nearest one-hundredth of a metric ton and to the nearest metric ton-meter. When using the inch-pound system, or Imperial System, weight and moment data shall be carried to the nearest pound and foot-pound at all detail levels. Summaries are to be converted and reported to the nearest one-hundredth of a long ton and to the nearest foot-ton. All levers shall be reported to the nearest one-hundredth of a foot.

3.7.8 Weight History – A report number or a date stamp shall be included with each weight item element that will indicate the specific weight report when a change to this element was last incorporated.

3.7.9 Data Grouping – All items of significant weight should be listed in weight estimates and reports as separate line items. However, if there are large quantities of very small items of insignificant weight they may be grouped into a single line and expressed as a single total.

3.7.1 Weight Maturity Level Codes – Each line item in the weight estimate and report should contain a code to indicate its weight maturity level. The maturity levels are summed to the three and one digits and is used to correlate design maturity with management of the remaining margin. Weight maturity refers to the degree of risk inherent in a given element at the reported time. Weight maturity, for example, of a shipboard component that has never been used on a naval ship would be very low. Conversely, a common non-developmental naval ship component would be considered a high maturity level. It is typical for an item to have a low weight maturity early in the design and progress to high maturity as more information is available and the design progresses in detail. Typical maturity levels are shown in Figure XYZ. Additional level maybe be use as necessary to further refine design maturity as long as they correlate and sum up to the basic definitions of Figure XYZ. The maturity levels are single character designations and are included in column 78 of Appendix A.)

3.8 CLASSIFIED REPORTS

Weight reports containing classified data shall be marked in accordance with the security requirements contained in the contract. Whenever possible, classified or proprietary material shall be downgraded by deleting classified or proprietary portions that do not impair the usefulness of the document. Weight reports may also be considered technical data that is governed by export control regulations of the Departments of State and/or Commerce.

3.9 VENDOR WEIGHT CONTROL

In order to effectively comply with the requirements of this Recommended Practice, the primary contractor may need to impose some level of weight control on vendors that contribute material, equipment, and complete systems to the ship. Generally, the party who is directly contracting with the vendor is in the best position to invoke weight control requirements on vendors. In the case of Government-Furnished equipment or material, it is the responsibility of the contracting party to impose the appropriate weight control measures in order to effectively apply the same level of weight control to the ship as a whole. Reference 4 provides guidance on how to implement a weight control program for vendors.

3.10 DESIGN NOTEBOOK

Although not a mandatory requirement or specific deliverable to the customer, it is strongly recommended that a design notebook be initiated as early as possible and maintained throughout ship design. The design notebook shall include a completed set of weight data collection sheets. For each system, these sheets describe the composition of the system, the source of the mass properties data, the latitudes in the system definition that could cause weight variations, and the parameters and assumptions that were used to generate the mass properties data. In addition to the weight data collection sheets, the design notebook shall include a record of the information that was used in the development of the estimates and reports. This information typically consists of engineers' notes, memoranda, records of telephone conversations, margin determination/rationale, interim reports, material equipment lists, and an index of drawings, sketches, and reports that were translated into mass properties data. Separate notebooks are required for preliminary design and contract design. Part of the Design Notebook should address design history. The design history is a combination of narrative and tabular data that summarizes in chronological order the mass properties evolution of the ship

design. The text highlights the major problem areas and their resolutions during the design phase, significant issues and decisions which had an impact on mass properties, and a discussion of margin usage. The narrative is interspersed with summary data from the weight estimates and reports. Separate histories are required for preliminary design and contract design. The design notebook can prove to a valuable resource to the mass properties engineer especially for weight-critical ships. The design notebook is most critical during the concept and preliminary design when traditional engineering documentation methods may not yet be in place.

3.11 WEIGHT AND MOMENT TRADE-OFF STUDIES

At some point in time, a weight and moment trade-off study may need to be conducted. Such studies are typically not a contractual requirement, but rather provide support for weight control activities and occur on an as-needed basis during any phase of ship design. Trade-off studies comprise various engineering and technical studies directed toward determining detail weight data. These analytical studies are used to support design change proposals and to support recommendations for reversing trends toward exceeding established margins or limits. These studies are conducted on an "as requested" basis, and contain detailed weight calculations reflecting the impact of the study on ship displacement, KG, list and trim. There is no fixed format for the weight calculations, but each submittal shall use the ESWBS classification system or other accepted work breakdown structure to summarize the data.

3.12 SHIP SUMMARY SHEETS

A Ship Summary Sheet is a weight summary that is produced for management and customer reviews. The Summary highlights current ship conditions, trends, significant contributors to weight and center of gravity changes, and the breakdown of the weight estimate into the various levels of weight maturity index. A sample Ship Summary Sheet for a large complex vessel is shown in Figure 6. The summary is easily simplified for smaller or simpler vessels by reducing the levels of gradation of calculated and estimated weight. Regardless of platform size and complexity, the 1-digit weight groups or ESWBS groups should be used in tracking changes to the weight estimate, as well as for the process of attributing those changes to the responsible parties.

4. 0 PRELIMINARY/CONTRACT DESIGN PHASE

4.1 WEIGHT CONTROL PRACTICE FOR PRELIMINARY/CONTRACT DESIGN PHASE

4.1.1 Weight Control Activities

Weight control activities for this phase consist of the development of weight and KG estimates based on parametric data or historical information derived from past ships similar to the subject ship. The preliminary design baseline weight estimate estimate should be developed to at least the 3-digit ESWBS level. Interim weight reports should reflect the currently available drawings and other data. Structural weight should be estimated by extending available sectional cuts from structural drawings, along with ratiocination and parametric methods. T Major equipment tshould be identified and integrated in the design via preliminary general arrangement drawings, sketches and schematics. Also, various estimation methods should be used to complete the remaining estimates ship. Acquisition margins (for all design phases) should also be established during the preliminary phase. Since preliminary design has the most design fluctuation, assigned acquisition margin should be constantly evaluated and balanced against design characteristics or design trade-off and consequently margin would be consumed or the baseline be adjusted. Refinement of the final preliminary weight estimate continues into contract design and the first estimate is labeled as the contract design baseline weight estimate. Available contract design acquisition margin is assessed based on this weight estimate, and also depleted from this estimate, as well. Interim weight estimates are refined to reflect the continuously developing design products. The mass properties data included in these estimates and reports are based on the engineering products available prior to the date of the document. The weight engineering function should aim to estimate as great a percentage of the ship as possible. It is important for the weight engineer to stay abreast of the design as it progresses as there exists a strong potential for major design and major systems changes to occur during the preliminary and contract design phases. Budgets for weight and/or KG should be developed for functional design areas or ESWBS areas that will allow for the tracking of progress towards meeting ship objectives..

4.2 WEIGHT CONTROL DELIVERABLES (note: deleted “requirements” for clarity ie., it implied the above text was optional and not a requirement)

4.2.1 Weight Estimates and Reports

Weight estimates, reports, and supplemental documents prepared during these phases consist of baseline weight estimates, interim reports, and final design weight estimates. They shall be prepared in accordance with section 3.

4.2.2 Baseline Weight Estimates

The initial estimate for a given design phase is designated the baseline weight estimate. The baseline weight estimate consists of the light ship, full load, and any other specified loading condition. The estimate shall be titled Baseline Preliminary or Baseline Contract Design Weight Estimate. The requirements for the estimate are as specified in 3.

4.2.3 Interim Reports

Weight estimates produced at specified intervals during a given design phase are designated interim weight reports. The interim report summarizes the current weight and moment status of the design and highlights any changes that occurred during the reporting period. The report shall contain the light ship, full load, and any other specified loading condition. It shall also reflect the appropriate title, such as Preliminary Design Interim Report No. 2. The interim report summarizes the current weight and moment status of the design and highlights any change that occurred during the reporting period. Figure 7 and 8 (check numbers) provides typical margin status examples. In addition to the requirements specified in the report shall contain the following:

a) Previous design phase group level summary.
b) Previous report group level summary.
c) Current group level estimate and, when required, the element level estimate and longitudinal weight distribution data.
d) Net change, by group and total, between a. and c. above.
e) Net change, by group and total, between b. and c. above.
f) The current status of margins, loads, full load displacement, KG, list, and trim. The changes corresponding to the total net change calculated for d. and e. above shall be shown for margins, loads, and full load displacement
g) A brief narrative providing rationale for any significant changes since the previous report and classified by the groups in which the changes occurred, the system which changed, and the authority for the change
h) A breakdown of weight maturity of the ship's weight determination

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4.2.4 Final Design Weight Estimate

The final estimate produced during a design phase is designated as the final design weight estimate and is titled Final preliminary or Contract Design Weight Estimate This estimate will reflect the final weight and moment data for the design phase. The requirements for the estimate are specified insection 4.

4.2.5 Weight Distribution Report

A longitudinal weight distribution shall be provided in a tabulated format in accordance with the standard longitudinal station breakdown. Weight and longitudinal center of gravity shall be determined for each ship station for both light ship and full load condition as well as other conditions appropriate for the ship's intended service. The weight distribution for each condition shall include all margins.

The resultant total weight and longitudinal center of gravity for the weight distribution report for each condition shall equal the values reflected in the weight estimate or report for the same condition in that reporting period.

4.2.6 Weight Moment of Inertia

When specifically required by the contract, weight moment of inertia data shall be included for the full load condition, typically at the end of contract design. Current weights, centers of gravity, and engineering information describing the shape and orientation of each data element shall be used to develop weight moment of inertia data or accepted alternative methods may be employed. The minimum data required are as follows:

a) Ship oriented roll, pitch, and yaw weight moments of inertia about each individual data element's centroidal axes.

b) Ship oriented roll, pitch, and yaw weight moments of inertia about the ship's centroid in the full load condition.

Other accepted alternative methods may be employed. If so, item (a) above might not be required, and instead a different reference point may be used.

4.2.7 Design History

The design history is a combination of narrative and tabular data that summarizes in chronological order the mass properties evolution of the ship design. The text highlights the major problem areas and their resolutions during the design phase, significant issues and decisions which had an impact on mass properties, and a discussion of margin usage. The narrative is interspersed with the summary data from the weight estimates and reports. Separate histories are required for preliminary design and contract design.

4.2.8 Design notebook (optional)

4.2.9 Ship Specification Sections

Ship specification sections shall define the requirements of the weight control program and any range of acceptable trim and list limit values that are to be invoked upon the shipbuilder. Deviations from this standard, such as special loading conditions, reporting units, or margins, shall be clearly defined.

4.2.10 Circular of Requirements Sections

For ships built under a performance-type contract, a Circular of Requirements (COR) may be used to provide the weight control requirements of the Customer. The content of these sections shall be similar to 4.2.5.3, with the addition of service life allowance quantities.

4.2.11 Contract Data Requirements List (CDRL)

A CDRL will be developed by the shipowner to itemize the data deliverables that shall be required by the ship acquisition contract. The portion of the CDRL that contains weight estimates, reports, and supplemental documents may be generated during the contract design phase by the customer.

4.2.12 Solicitation Input

A request for proposals or similar document shall be prepared that describes the ship design to potential shipbuilders and defines the format for submitting a bid or making an offer. The following portions of the solicitation package that pertain to weight control shall be generated during contract design:

Instructions to Offerors - This section describes the content of the weight control material that will be submitted for source selection consideration. The Bidder's Independent Weight Estimate or Preliminary Allocated Baseline Weight Estimate, Preliminary Weight Control Plan.

Factors for Determining Loads - These are allowances, densities, and stowage factors that are used in the variable load portion of the full load condition are included in the solicitation to permit a consistent calculation of load items by the bidders (or offerors). Additional loading conditions may be defined as required

Weights for Schedule A Items - This listing establishes the baseline GFM weight that will be required in the AWE/ABWE.

4.2.12.1Weight Control Contract Clause

The contract clause for weight control shall be provided for inclusion in the shipbuilding contract. The clause shall contain Not-To-Exceed (NTE) displacement and KG values, when applicable, a requirement for adjudicating the weight and moment effect of contract changes, a requirement that GFM growth is to be agreed upon prior to the inclining experiment, an explanation of the Contractor-responsible condition, the method of incorporating changes that are proposed solely to achieve satisfactory naval architectural characteristics, and the amount of liquidated damages that apply.

5. 0 BRIDGE PERIOD (OPTIONAL)

Occasionally, it is necessary to create an interim design period in the overall design process between the end of one design phase and the start of another. This situation occurs primarily to provide additional time to address and resolve remaining design issues that are major and prevent exiting the current design phase. This is a very condensed and intense period of design development and weight estimating and reporting is critical. Estimates are defined on a case-basis, and shall adhere to Section 3. Also, this situation could arise from contractual or funding issues that occur at the ship program level and may last anywhere from a couple of weeks to months. During a bridge period, funding is often provided to maintain some degree of design momentum, minimize manpower availability problems, and to minimize restart costs. At a minimum, weight control activities should be commensurate with the level of design development underway during any gap between design phases.

6.0 PRE-AWARD Period [I called it period because there is not pre-award Phase defined in OPNAVINST 5200.?]

6.1 WEIGHT CONTROL PRACTICE FOR PRE-AWARD PROCESS

6.1.1 Weight Control Activities

During Pre-award, the period between the release of the request for proposals (RFP) or request for bids and the award of the contract, weight control consists of ensuring that the weight estimate upon which the contract is signed is the most accurate and complete estimate possible. At this time, it is important to accurately define exactly which components are GFM or otherwise directed or dictated by the customer. During this time, engineering diagrams, drawings, or computer models should continue to be estimated or calculated so that the most accurate data forms the basis of the detailed design and construction contract. The weight-related clauses and requirements, such as weighing of equipment and the requirement for vendor weight reports that will become part of the purchase or other contractual agreements should be determined during this period so that contracts can be initiated with equipment and material vendors as soon as possible after contract signing.

6.2 WEIGHT CONTROL REQUIREMENTS AND DELIVERABLES

6.2.1 Weight Estimates

The BIWE or the PABWE is prepared during this process. The estimate shall contain detailed information appropriate to the design phase, loading conditions for light ship and full load, and shall be summarized in tabular form as follows:

a) Three-digit System Number and Title
b) Current Weight
c) Current Vertical Lever
d) Current Vertical Moment
e) Current Longitudinal Lever
f) Current Longitudinal Moment
g) Current Transverse Lever
h) Current Transverse Moment

When a technical evaluation is conducted during source selection, the estimate is reviewed for appropriate content and scored against the requirements. After contract award, the successful bidder's (or offeror's) estimate becomes the basis for the AWE or ABWE.

6.2.2 Bidder's Independent Weight Estimate (BIWE)

The BIWE establishes the potential contractor's estimate of the ship design prior to contract award. It is based on the contract, ship specifications; all of the documents referenced therein, the factors for determining loads, and the weights for GFM. The BIWE shall conform to the content and format requirements of 5.2.1, include estimated values for design and building margin, contract modifications and GFM margins if specified,and contain loading conditions for light ship and full load. The variable loads shall be realistically distributed throughout the ship in their appropriate spaces. The bidder (or offeror) shall include in appendices the following information:

a) Historical back-up data for estimating factors that were used in the development of the BIWE, such as mill tolerance, paint, weld material, insulation, and so forth.
b) The technical analysis that substantiates the values selected for design and building margin.
c) A summary of GFM as reported in the details of the BIWE (see 6.2.8).

When NTE displacement and KG values are defined in the contract, the bidder (or offeror) shall take the appropriate measures to reflect the design solutions and building practices that ensure delivery of a satisfactory ship.

6.2.3 Preliminary Allocated Baseline Weight Estimate (PABWE)

The PABWE establishes the potential contractor's estimate of the ship design prior to the award of a performance-type contract. It is based on the contract, Circular of Requirements, all the documents referenced therein, and the bidders (or offeror's) proposed hull and propulsion configurations. The report shall conform to the requirements of 5.2.1, include estimated values for design and building margin, and contain contract modification and GFM margins as specified. Variable loads shall be realistically distributed throughout the ship in their appropriate spaces. The bidder (or offeror) shall include in appendices the following information:

a) Historical back-up data for estimating factors that were used in the development of the PABWE, such as mill tolerance, paint, weld material, insulation, and so forth.
b) The technical analysis that substantiates the values proposed for design and building margin.
c) A summary of GFM as reported in the details of the PABWE (see 6.2.8).

After contract award, the PABWE of the successful bidder (or offeror) becomes the basis for the ABWE, which is used to measure contractor responsibility.

6.2.4 Preliminary Weight Control Plan

A preliminary weight control plan shall be submitted with detail design and construction proposals that outline the procedures that shall be followed to meet contractual weight control responsibilities. The plan shall include, but is not limited to, the following topics::

a) A discussion of design risk as it relates to the selected acquisition margins vs. decisions regarding the purchase of equipment and components.
b) A discussion of design risk with respect to the ship's naval architectural characteristics, including special weight control problems and the areas that will receive weight control emphasis.
c) A discussion of the methodology to be used in adjusting margin accounts.
d) A discussion of the method by which margin will be determined based on the status (weighed, estimated, or calculated) of the weight of each item or system. –delete this BS
e) The frequency of briefings to top management concerning the ship's naval architectural condition throughout the detail design and construction phase. The individual who will give the briefings shall be identified.
f) A description of software that will be utilized in the weight control effort. Particular emphasis should be placed on the usage and procedures of CAD.
g) A listing of equipment that will be used to perform actual weight measurements. The listing shall include equipment capacity, accuracy tolerance, and calibration frequency.
h) A discussion that conveys an understanding of the actual weight determination requirements of the contract.
i) A detailed discussion of how many times or how often and when specifically the design and construction CAD models or drawings will be calculated during preliminary, contract, and detail design and construction.
j) The reporting schedule and cut-off dates for weight calculations.
k) The planned action for verification of mill tolerances, welding, and paint factors.
l) The management and technical authority of the weight control coordinator relative to the overall design effort anticipated.
m) The method of communicating the condition of the ship to line personnel.
n) The management actions which will be taken upon detection of weight and margin trends tending to cause contractual values to be exceeded.
o) The method and degree of weight control that will be required of subcontractors and vendors.
p) A discussion of construction monitoring techniques that will be used to ensure that the ship, as constructed, is accurately reflected in the weight reports.
q) A discussion of weight control training to be administered to personnel involved in the design and construction of the ship.

7.0 DETAIL DESIGN AND CONSTRUCTION PHASE

7.1 WEIGHT CONTROL PRACTICE AND REQUIREMENTS FOR DETAIL DESIGN AND CONSTRUCTION PHASE

7.1.1 Weight Control Activities

Detail Design and Construction is a very active period for the Weight Engineering function. The requirements of the Preliminary Weight Control Plan are reviewed for final implementation details and the Weight Control Plan is submitted. The Weight Control Plan defines the weight control approach to the design via detailed information concerning operating methods, plans, schedules, and internal operating instructions for its execution

Weight calculating and reporting is the dominant responsibility. Mass properties data should be obtained by a combination of estimation, calculation, incorporation of legacy data, CAD, scale weighing, and field sampling. As the detailed engineering products are issued, the calculation of weight and centers from drawings or CAD models, according to the schedule, becomes a major effort. The ship designer/builder should make every effort to replace estimates with calculations that reflect the current revisions of drawings with the objective of achieving a calculation/actual percentage of 90 to 100% of the ship. Refreshment of these calculations should be accomplished on a frequent basis as the design is revised to ensure that the weight estimate remains accurate. Weighing should occur for all items over 500 lbs. Vendor-reported weights should also be sought from vendors of all equipment over 500 lbs. As the weights are reported, this information should be inputed to the weight database for the ship. Weight reporting occurs on a regular basis, typically quarterly, and weight trends should be carefully analyzed to determine adverse trends that require attention. Weight and/or KG growth should be carefully tracked to ensure ship objectives can be achieved. If individual budgets were allotted for systems or functional areas, the status of each budget should be tracked and reported. An Accepted Weight Estimate is established with the customer , per contract requirements, and serves as the basis for measurement of margin consumption and progress toward the satisfaction of contractual requirements. Once a contract is signed, contract modifications or change orders should be analyzed for their weight and moment impact. Weight calculations for ship construction units to support production are needed to ensure successful lifts and to properly locate lifting pads. At delivery, an inclining experiment should be conducted to determine the actual ship weight and vertical cenThe final action involves reconciling the weight and KG differences between the inclining experiment and the calculated values

7.1.1.1 Calculations of drawings

Estimates and reports shall contain calculated detailed information reflective of the current revision of the design at the time of submittal. The normal development of detail drawings usually involves several revisions. A drawings calculations schedule is developed, that includes expected revisions, review of legacy data, weighing of items, and extracting/verifying data from CAD. The drawings calculation schedule should lead the construction schedule. When design development has occurred for a component, system, or portion of structure, a reevaluation of the original weight estimate shall be made to obtain the most accurate current weight. Refreshment of these calculations should be accomplished as the design is revised to ensure that the weight estimate remains accurate. In order for the data to be useful in a variety of applications, the details shall contain an accurate and logical description that links each listed item to a recognizable component. For example, a long listing of plates, tees, angles, beams, chocks, and so forth, with precise weight and center of gravity data does not comprise a satisfactory estimate, unless those pieces of structure can be readily identified with a specific bulkhead, deck,

foundation, or other structure. Similarly, the descriptions for distributive systems shall indicate the major components that are being connected followed by the detailed connector items such as piping and fittings, followed by auxiliary supported items such as hangers. Major component descriptions shall include identifiers, such as type, size, rating, capacity, and so forth. The details of a system or subsystem should be summed up by the fourth or fifth ESWBS digit, which are summed up to the three digit ESWBS element. The last ESWBS element is advanced to the next element until the total ship has been calculated. An example of adequate detail and proper numerical ordering is shown on Figure 8. Calculations and actual weight determinations shall be terminated in advance of report preparation to ensure timely submittals.

7.1.1.2 CAD data processing and incorporation into reports

CAD drawings proceed through a development stage as well, with various levels of detail data and maturity. The weight control plan should take advantage of this source of data, initially as a check of calculated data, and eventually replacement, if necessary. However, weight engineers should be aware that CAD development generally lags the weight estimate, and the final verification from CAD models comes at the very late stages of detail design and start of construction.
When weights and centers are replaced with CAD model data, external processing of the data is necessary to conform to the existing data. CAD data should be deducted appropriately from the total data of each ESWBS element produced by other manual methods. The following requirements apply to CAD data:

1) The "posting" or creation of CAD produced weight line entries should be formulated as a complete and logical record that consists among other details a standard and commonly understood description, unit weight, number of units and consistent centers with the remaining data.

2) Data should be arranged in a logical precedence, such as the predominant weight or equipment first, distributors or connectors such as piping or cable second, followed by support items such as hangers, chocks, steel mill tolerance or miscellaneous items last.

3) Method of increasing the quantity of small like weights to more than one in a single entry thus decreasing and managing file size

4) If the difference between the previously calculated weight and the CAD exported weight is greater than ½ percent of the compared system, the system's estimate or calculations shall be reviewed and revised to properly identify and include the difference; differences less than ½ percent may be entered in the weight report as a single four-digit entry titled "CAD difference" for the system under consideration. If the KG differs by xx percent (establish this value) a similar analysis should occur.

7.1.1.3 Actual weights data

The actual weight of all components and equipments, greater than 500 pounds (unless otherwise specified), both Contractor and Government-furnished, shall be determined through accurate scale weighing along with the estimation or calculation of centers of gravity. The actual weights for materials, components, and equipment, less than 500 pounds, shall be determined on a selective or sampling basis, as determined by the Contractor, to provide unit weight data.
In addition, to minimize the amount of actual weight determination at the shipbuilding site, the contractor shall require, through acquisition documents, subcontractors or vendors to submit information on the current weight and center of gravity of all major assemblies, equipment, fittings, or components to be installed on the ship. SAWE Recommended practice reference defines a structured vendor weight control It is suggested that information be submitted by subcontractors or

vendors in the following sequence:

a) An estimate of weight and center of gravity in the proposal.
b) The calculated weight and center of gravity when the design is completed.
c) The actual weight and calculated center of gravity when the fabrication or assembly is completed

7.1.1.4 Field sampling to establish unit weights

Since density and thickness tolerances vary for a lot of material, reliable units weight can only be established by field measurements. Potential candidates for actual weight determination on a selective basis include such items as insulation, structural plates and shapes, sheathing, piping, and the components and equipments less than 500 pounds. Where factors or percentages are utilized, such as for estimating and calculating paint, mill tolerance, and welding, the Contractor shall substantiate these values by supplying background information (current and historical). Historical background information on paint, mill tolerance, and welding factors shall be forwarded with the BIWE or PABWE. Occasional validation of such unit weight is necessary since the fabrication and applications methods could impact the unit weight drastically. Final values for paint, mill tolerance, and welding factors based on current ship information shall be forwarded with the FWR is completed.

7.1.1.5 Evaluation of remaining acquisition margins

Baseline, interims, and the final weight report shall contain a maturity index with a structure similar to Figure X (see Nnews curve) that indicates how the fidelity of the data is maturing during the design phase, and a risk curve characterizing the risk of delivering the ship within the remaining margins. Each weight item line shall contain an appropriate code which may be summed up for each three-digit and one-digit ESWBS elements and shall be included in the one-digit summary of the weight report.

7.1.2.5 Reconcilling the differences between the weight report and the inclining experiment [?}

7.2 Multiple Ships in a Class

When the mass properties data for two or more ships under the same contract are identical, the estimates, reports, and supplemental documents can apply to more than one hull number. If deviations in design or construction or the addition of contract modifications create unique mass properties data, then separate detail reports, summaries and condition sheets shall be included with QWRs. Separate FWRs shall be submitted to reflect the unique changes and inclining variations

7.3 WEIGHT CONTROL DELIVERABLES – ESTIMATES AND REPORTS

7.3.1 Accepted Weight Estimate (AWE)

After contract award, the Contractor and Customer shall agree on AWE values for displacement and KG. To expedite this agreement, the Contractor shall, upon request, visit the Customer not less than one month prior to the required submittal date of the AWE. The estimate shall consist of the Contractor's BIWE that was submitted during the solicitation process, adjusted as necessary to reflect corrections, and negotiated changes, such as reclassification of data. The AWE shall include loading conditions, summaries, supporting details for each three-digit element, appropriate margins, including Contract Modifications and GFM margin, if stated in the specifications, and an appendix that

establishes the baseline for measuring detail design changes in GFM. The estimate shall conform to the content and format of the general requirements of Section 3. An AWE is required for all ships.

7.3.2 Allocated Baseline Weight Estimate (ABWE) for performance-type specifications

The ABWE establishes the Contractor's estimate of the ship design when the hull and propulsion configurations are defined. The ABWE shall reflect a design that meets all of the required performance criteria, satisfies the required service life allowances, and includes the appropriate margins, including Contract Modifications and GFM margin, if stated in the specifications The basis for the estimate shall be the Contractor's PABWE that was submitted during the solicitation process, adjusted as necessary to reflect design changes and corrections. The ABWE shall include loading conditions, summaries, margins, and an appendix that establishes the baseline for measuring detail design changes in GFM. The estimate shall conform to the content and format of the general requirements of Section 3.

7.3.3 Weight Control Plan [moved it from the supplemental documents section to emphasize its importance]

A weight control plan shall be submitted for each ship that outlines the procedures to be followed in meeting the contractual weight control responsibilities. The plan shall address, but is not limited to, the topics listed in 6.2.4. In the event a preliminary weight control plan was submitted during the solicitation process, the post-award plan described herein shall not differ from the preliminary plan in basic content, intent, or significance; however, it shall address the weight control issues and practices in greater detail.

7.3.4 Quarterly Weight Reports

Quarterly weight reports shall document the current mass properties status and progress of the ship design and construction effort on a periodic basis. Unless otherwise specified, weight reports shall be prepared and submitted to the customer on a quarterly basis on a schedule to be agreed upon between the builder and customer. The light ship and full load conditions shall reflect the ship that is projected for delivery, including the current mass properties values for GFM and contract modifications, both adjudicated and unadjudicated. The Contractor-responsible condition shall be used to adjust the current full load to account for changes that occur after the establishment of the contractual baseline and are not within the control of the shipbuilder. Examples of these types of changes are as follows:

a) Changes in weight of GFM and the moment changes associated with those weight changes.
b) The net effect of contract modifications.
c) Changes in weight of equipment designated as standard for the class and the moment changes associated with those weight changes.
d) Changes that result from the required use of warranted documentation.
e) Growth resulting from directed acquisitions.

Separate summaries for each type of change listed above shall be provided as appendices to the periodic weight reports. A GFM summary (see 6.2.8) and a contract modification summary (see 6.2.9) are required with every submittal of a QWR. Other summaries may be submitted at the option of the Contractor in order to substantiate growth beyond his control. If an optional summary is submitted, it shall document all of the activity for that particular type of change, weight increases and decreases, and modified locations. The ship's displacement, KG, list, and trim from the Contractor-responsible condition shall be compared to the AWE or ABWE values for displacement and KG and the specified

allowable ranges for list and trim. Report details shall be grouped in accordance with the three-digit system and each item shall indicate whether the information shown is estimated, calculated, or based on actual weight determination. The report shall conform to the content and format requirements of 6.2.2. In addition, the report shall contain reasons for changes, recommendations to correct any adverse trends, and a listing of all the equipment for which an actual weight determination was performed during the reporting period.

7.3.5 Final Weight Report (FWR)

The FWR shall reflect the final status of the ship design and construction effort that resulted in a delivered product and is normally based on an inclining experiment. All of the reporting requirements of a periodic weight report also apply to a FWR. In addition, when inclining experiment full load displacement and KG values differ from the weight estimate without margin predictions by greater than 1/2 percent, an analysis of the data shall be conducted to reconcile the differences. Findings which result in correction of inaccuracies, reevaluation of factors, etc., shall be incorporated in the FWR. The light ship condition shall be adjusted to correlate with the inclining experiment data. Building margin is used to account for irreconsilable differences between the FWR and inclining experiment and is the only acquisition margin that may appear in the FWR. If remainders of other margins exist, they shall be deleted. The FWR shall contain a narrative that describes the portions of the weight data that are still based on factors, such as paint, weld material, mill tolerance, etc., and the criteria which comprise the factors. The detail data comprising the FWR shall be submitted via an electronic media and complying to the format specified in the Appendix B for US Navy Ships. An FWR is required for all ships.

7.3.6 The GFM Summary Report

The purpose of the GFM Summary Report is to show the weight and location data for all GFM, and to identify the Government-responsible net weight and moment change that occurs to GFM during detail design.

In order to determine the Contractor-responsible portion of the current full load condition, the government-responsible weight and moment changes to GFM must be subtracted from the full load condition ship. Additionally, the weight and moment of contract modifications and other items beyond the control of the contractor must also be subtracted. Since contract modifications that contain GFM overlap a simple accounting of GFM, GFM contained in contract modifications must first be tabulated and subtracted from the total weight and moment value of the current GFM to eliminate double accounting of GFM. This process is shown in Figure 9.

GFM reports shall accurately reflect the Schedule A portion of the contract, conform to the requirements of 6.2.8.6, and be included as an appendix to the BIWE or PABWE, AWE or ABWE, each QWR, and the FWR. It may be appropriate on some contracts to also include Government Directed Material and Government Controlled Material in the GFM report. These will be handled in the same manner as GFM.

7.3.6.1 Adjustment to Baseline GFM

The baseline for measuring detail design changes is established in the BIWE or PABWE or AWE or ABWE. Weight and moment totals for the baseline GFM will form the basis for measuring all subsequent GFM changes.

Once accepted, the baseline is only adjusted to correct data that was available to the Contractor prior to the AWE or ABWE, but was inaccurately reported. In cases where inaccuracies are discovered, the current weight report details shall be modified to reflect the correct information. The baseline GFM weight and moments are shown on Line 1 of Figure 9.

The weight and moment impacts for the corrections, along with their margins are the responsibility of the shipbuilder, or contractor. They are not part of the government responsible weight that is deducted to arrive at the Contractor-responsible condition. These adjustments are shown in Line 2 of Figure 9.

7.3.6.2 Design Development to Baseline GFM

Government responsible changes to GFM can result from:

- a better definition of the baseline items as the design matures
- the addition, deletion or modification of items by a revision to Schedule A
- a transfer of acquisition responsibility
- weighing

Revisions to Schedule A and transfers of acquisition responsibility are typically accomplished by contract modifications.

When design development occurs to items of baseline GFM, the weight report details will be updated to record current weight and moment data. The Government is responsible for the weight and moment impact of weight changes to baseline items that occur after establishment of the baseline. Weight changes usually happen as a result of weighing. These kinds of changes are referred to as "GFM Growth" and are included in the values shown on Line 7 in Figure 9. **NOTE:** The Government is not responsible for moment changes resulting from the relocation of GFM by the Contractor (shipbuilder) to ease design development. The contractor is responsible for the impacts of these types of changes. This adjustment is shown on Line 2 of Figure 9.

7.3.6.3 Revision to Schedule A

When Schedule A is revised to add, delete, or modify GFM, the weight report shall be updated accordingly. The changes will be also reflected in the GFM Summary Report. Since these types of changes will usually be implemented by a contract modification, the contractor shall ensure that the weight and moment changes are also reflected in the Contract Modification Report.

When determining Contractor responsibility, the weight and moment impact of contract modifications on GFM should not be included with the GFM values, since it is already included with the net weight of contract modifications. Line 5 of Figure 9 shows the deletion of the contract modification GFM from the current GFM values. Line 5 may include both adjudicated and unadjudicated changes.

The Government is responsible for changes to GFM in contract modifications even after the contract modification has been adjudicated. Once a contract modification has been adjudicated, the GFM portion of the change shall be entered in a second section of the GFM Summary Report with the GFM weight and moment values as adjudicated in the "Baseline Weight" data field and in the "Current Weight" data field. This section will be used to monitor weight changes to GFM after the contract modification has been adjudicated.

Weight changes after adjudication typically occur as a result of weighing. When a weight or moment

change occurs in an adjudicated GFM item, the weight database and the second section of the GFM weight report will be updated to reflect the new weight. The new weight will be reflected in the current weight column of the GFM Summary Report and in the weight database. The weight in the baseline weight column will not change. The net weight and moment change will be included with the weight and moment changes that are deducted from the current full load condition when determining the Contractor-responsible condition. These changes are referred to as "GFM Growth." The calculation of GFM Growth is shown on Line 7 of Figure 9.

7.3.6.4 Acquisition Responsibility Changes from Government to Contractor

When acquisition responsibility passes from the Government to the Contractor, the item will be removed from the GFM report. Since these types of changes will usually be implemented by a contract modification, the Contractor shall ensure that the change in acquisition responsibility is also reflected in the contract modification report. The weight database should also be reflected to reflect the change in ownership.

If the current weight differs from the baseline weight, the contract modification will reflect the weight difference. Any subsequent weight and moment change becomes the responsibility of the Contractor.

Reallocation of margin to account for newly assumed risk associated with the responsibility changes for large systems may be subject to negotiation between the Government and the Contractor.

7.3.6.5 Acquisition Responsibility Changes from Contractor to Government

When acquisition responsibility passes from the Contractor to the Government, current weight and moment values for the item that appear in the most recently submitted weight report shall be added to the baseline weight and current weight columns of the GFM Summary Report. Since these types of changes will usually be implemented by a contract modification, the Contractor shall ensure that the change in acquisition responsibility is also reflected in the Contract Modification Report. The weight database should also be updated to reflect the change in ownership.

If the current weight differs from the baseline weight, the contract modification shall reflect the weight difference. Any subsequent weight and moment change becomes the responsibility of the Government. Reallocation of margin to account for newly assumed risk associated with responsibility changes for large systems may be subject to negotiation between the Government and the Contractor.

7.3.6.6 GFM Report Format

The GFM Summary Report shall be in tabular form with subtotals by three-digit system, grand totals for current values, and shall include columns containing the following information for each item:

Three-digit System Number in accordance with Reference 1.
Schedule A Item Number
Contract Modification or Other Type of Change Number (if applicable)
Description of the Item
Baseline Weight
Current, Estimated, Calculated, or Actual Weight
Current Vertical Lever
Current Vertical Moment

Current Longitudinal Lever
Current Longitudinal Moment
Current Transverse Lever
Current Transverse Moment

7.3.7 Contract Modification Summary

Prior to each claim for equitable adjustment in price and/or delivery asserted pursuant to the Changes Clause of the contract, an estimate of the net weight and moment change resulting from the contract modification shall be prepared and submitted to the designated Ctomer point of contact. The contract modification summary shall reflect these weight and moment impacts as they appear in the details of the weight estimate, for both adjudicated and unadjudicated changes (including field changes). The summary shall consist of all approved changes listed numerically by Customer number and shall include the title, net weight and moment impact of each change, an identifier that indicates whether the data is adjudicated or unadjudicated, and a grand total representing the net effect of all approved contract modifications. The contract modification summary shall be submitted as an appendix to the periodic weight reports, the ASR, and the FWR. Supporting details for each contract modification shall be incorporated into the body of the weight estimate as soon as the change is approved. Prior to adjudication of the contract modification, the weight and moment effect of the change as reported in the contract modification summary shall reflect the current values of the supporting details. After the contract modification has been adjudicated, the supporting details are treated as any other line items in the weight estimate, but the weight and moment effect of the change as reported in the contract modification summary remains at the adjudicated values. The weight and moment impact of the addition, deletion, or modification of GFM to the Schedule A is implemented by a contract modification summary. If acquisition responsibility passes from the government to the Contractor, the contract modification summary shall reflect any difference in weight between the current and baseline weight values. Moment changes associated with the weight difference may be computed by using the baseline centers of gravity for the item that was transferred. Changes in weight are the responsibility of the Contractor after the contract modification has been adjudicated. Contract modifications that change acquisition responsibility from the Contractor to the Government shall reflect no weight or moment impact in the contract modification summary.

7.3.8 Supplemental Weight Report

The following supplemental weight report, specified below, provides additional information and background data during the detail design phase.

7.3.8.1 Machinery Weight Report (Nuclear)

A machinery weight report for a nuclear ship design shall be submitted in the category system in accordance with Reference 6. The report shall be divided into two sections. Section I shall contain nuclear machinery items; section II shall contain the remaining items of the category system. The following summary sheets shall be included:

a) A listing of a total for each three-digit group within each of the categories A through M (excluding I). Subtotals shall be listed for each category, and a grand total for nuclear propulsion machinery.
b) Same as a., except that sections I and II shall be listed separately with a subtotal for each section, and a grand total for nuclear propulsion machinery.

c) A listing of a total of categories A through M (excluding I) for each three-digit group to make a grand total for nuclear propulsion machinery.

The totals for all summaries shall be the same.

The report shall include the following information in tabular form:

a) Original Weight Values from the AWE or ABWE for Each Item
b) Current Weight of Each Item
c) Current Vertical Levers
d) Current Vertical Moments
e) Current Longitudinal Levers
f) Current Longitudinal Moments
g) Current Transverse Levers
h) Current Transverse Moments

When this report is submitted concurrently with the AWE , CAWE or ABWE, the QWR, and the FWR, it shall reflect the details of the report it accompanies.

7.3.9 Accepted Ship Report (ASR)

The ASR is the document that demonstrates the Contractor's performance with regard to weight control. It constructs Contractor responsibility by reporting the light ship values for displacement, KG, trim, and list from the inclining experiment, and the current loads from the most recent QWR. The net weight and moment effect of the following categories of changes are then algebraically subtracted:

a) Adjudicated and unadjudicated contract modifications that were included in the inclining experiment data.
b) Other directed modifications to loads.
c) Modifications to GFM since the AWE.
d) Other allowable categories (see 6.2.6).

The results are then compared to the corresponding values in the AWE. The report shall be submitted in summary form similar to the example formats shown on Figure 10, as required by the CDRL. The procedure to compute Contractor-responsibility for performance-type contracts shall be submitted in summary form similar to the example format shown on Figure 11, as required by the CDRL. If the final inclining experiment data differs significantly from the preliminary report of the inclining, or if it would alter the conclusions drawn from the ASR, the report shall be corrected by the Contractor to reflect these differences and resubmitted.

7.3.10 Design and Weight Data Sheet

The design and weight data sheet shall contain the information, and shall be of the format, indicated on Figure 12, which is an example for a gas turbine powered ship. Major load and machinery items, as appropriate to the applicable ship, shall be listed. This document shall be submitted with a note indicating whether the units are in the SI system or inch-pound system.

7.3.11 Weight Moment of Inertia Report

A weight moment of inertia report shall be submitted for the full load condition for all vessels. Current weights, centers of gravity, and engineering information describing the shape and orientation of each data element shall be used to develop weight moments of inertia. The minimum required data shall be tabulated as follows:

a) Ship oriented roll, pitch, and yaw weight moments of inertia about the ship's centroid in the full load condition and each individual data element's centroidal axes summarized by the three digit group.
b) Ship oriented roll, pitch, and yaw weight moment of inertia about the ship's centroid in the full load condition and each individual data element's centroidal axes summarized by three digit group.
c) Ship oriented roll, pitch, and yaw weight moments of inertia about the ship's centroid in the full load condition and each individual data element's centroidal axes for the total ship.
d) The gyradius for roll, pitch, and yaw.

7.3.12 Weight Distribution Report

A longitudinal weight distribution shall be submitted in a tabulated format in accordance with the standard longitudinal station breakdown as described in 4.2.5.1

7.3.13 Launch Weight Report

For U.S. Navy ships, a Launch Weight Report that indicates the light ship launch condition of the vessel and critical drydock clearances is required to be submitted in Contractor format that is acceptable to the Navy prior to launch.

7.3.14 Ship Delivery Inclining Experiment

An inclining experiment to determine ship weight and center of gravity in accordance with Reference 7 shall be conducted. Reporting shall be in accordance with Reference 9.

8.0 POST-DELIVERY AND IN-SERVICE

8.1 WEIGHT CONTROL PRACTICE FOR POST DELIVERY AND IN-SERVICE PHASES

8.1.1 Weight Control Activities

The Navy Planning Yard or Full Service Contractor shall continue to implement weight control methods and procedures that will incorporate planned and documented as well as unplanned post-delivery weight and KG growth. This will be accomplished by a combination of determination of effected weight, issuance of appropriate weight reports, and performing inclining experiments to verify that the actual stability baseline of the ship is consistent with its naval architectural limits. It is important during the ship's service for the Customer or shipboard personnel to update the final weight report and appropriate ships drawings to serve as an accurate baseline from which to measure the impact of alterations. The Navy Planning Yard or FSC that establishes the ship's planned alterations list will ensure that each alteration contains a weight and moment impact, identification of any weight and or moment compensation if necessary, and other weight control actions needed to maintain the ship within its naval architectural and operational limits. The required amount of detail for each alteration shall include the following: weight installed, removed, and relocated; vertical, longitudinal, and transverse levers, and resulting moments. Weight shall be classified using the same classification system to which the ship was designed and constructed. The calculation level-of-detail will mirror the design and construction phase. Each three-digit element will be separated into installed and removed weights. Relocated weight shall be reported as both a removal and an installation. Alteration packages will be subtotaled to provide total weight and moment changes under Conditions A, D, and others, as required.

As ship alteration and installation drawings are prepared and material procured or received, weights and centers of gravity of items being added, removed, or relocated shall be determined. These weights may be calculated from a drawing or weighed, or a combination of both.

8.2 WEIGHT CONTROL REQUIREMENTS AND DELIVERABLES

8.2.1 Post Shakedown Availability Weight and Moment Report

This weight and moment report will be prepared to document all post delivery inclining changes that are initiated prior to custody transfer and up to the development of the initial Service Life Weight and Moment Reporting. The report will contain all work items, Alterations Equivalent to Repairs (AERs), and SHIPALTs, etc., which will be summarized and listed by their designated number, and title and will establish the initial stability baseline. This information will be derived by obtaining weight and moment estimates from the best available information, such as: previous weight and moment reports of ships of the class, historical reports, ship alteration records, inclining reports, or if available, from actual drawings/3D models completed for the ship.

8.2.2 Service Life Weight and Moment Reporting

The Planning Yard or FSC will document post delivery weight growth via various reports and

special studies. They are as follows:

8.2.2.1 Preliminary Service Life Weight and Moment Report

This report is the first weight and moment report prepared for shipyard availability. The weight and moment data for each SHIPALT and work item will be summarized and listed by their designated number and title. This information will be derived by obtaining weight and moment estimates from the best available information such as weight reports of ships of class, historical reports, ship alteration records, preliminary drawings/3D models, or if available, from actual drawings/3D models completed for the ship.

8.2.2.2 Estimated Service Life Weight and Moment Report

This weight and moment report will be prepared in detail to include weight and moment changes of authorized SHIPALTs and work items. It will include the weight and moment changes for each drawing/3D model, attributed to each SHIPALT and work item. The SHIPALT and work item weight and moment data will be summarized and listed by their designated number and title. As drawings and/or 3D models are prepared and material procured or received, weights and centers of gravity of items being added, removed, or relocated shall be determined. These weights may be imported from the model, calculated from a drawing or weighed, or a combination of all. If changes occur in any previously reported components, systems, fittings, or furniture, a revised computation or scale weighing of the item shall be made to obtain the more accurate weight and moment data.

8.2.2.3 Actual Service Life Weight and Moment Report

This weight and moment report will be prepared in detail to include actual weight and moment changes of completed SHIPALTs and work items. It will include each issued drawing/3D model's weight and moment changes attributed to each SHIPALT and work item. Estimated weight and moment data will be replaced with calculated or scale weighed weight and moment data. Weight data from drawings and /or 3D models will be entered into the weights database. The following items will be provided SHIPALTs and work items listed in the Estimated Weight and Moment Report that were deleted or deferred will be identified with their status. The SHIPALT and work item weight and moment data will be summarized and listed by the designed number and title.

8.2.3 Service Life Stability Study

A stability study will be included as an enclosure to preliminary, estimated and actual weight and moment reports. Each study will contain alternative ways to provide the ship with at least the same stability condition that existed prior to the overhaul or to a specified post overhaul condition specified. The basic stability study shall include the latest inclining experiment or Part IIA Stability and Loading Data of the Damage Control Book, updated with the previous overhauls's Actual Weight and Moment Reports to achieve an up-to-date Condition D baseline or other required baseline condition.

8.2.4 Ballast Study

The above reports will be supplemented by a ballast study if required. The ballast study will address the following:

a) Amount of ballast required to compensate for changes in stability, list, or trim due to overhaul or the amount of ballast required to bring the ship to a post overhaul condition required by the Government.
b) Cost estimate for the installation or relocation of the ballast.
c) The total effect of the ballast will have on the ship's stability, list, trim and Condition D drafts.

8.2.5 Service Life Weight and Moment Compensation Report

The above reports may be supplemented by a Weight and Moment Compensation Report if required. This report shall contain obsolete and unused items no longer required for the operation or mission of the ship which are proposed for removal, relocation, or replacement to reduce the ship's displacement or lower the ship's vertical center of gravity. The report shall be of the same level of definition as the reports that it supplements. In addition, a ship check will be performed to verify the proposed items in the report.

8.2.6 Service Life Inclining Experiments

Service Life Inclining Experiments shall be conducted during regular established intervals of the ships service life, and or at critical points during the ships service life such as major overhauls or at the conclusion of a FSC support, or at any point for which the stability of the ship is in question. The inclining experiment will be conducted according to the requirements of Reference 7. Reports shall be in accordance with Reference 9.

9.0 REFERENCES

The following Government and non-government standards, publications, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the Department of Defense Index of Specifications and Standards (DODISS) and supplements thereto cited in a Government solicitation. For those documents not cited in DODISS, the issue is as cited in the applicable solicitation or the latest revision as issued by the authorized agency or organization unless otherwise specified herein.

1. "Expanded Ship Work Breakdown Structure for all Ships and Ship/Combat Systems" NAVSEA, S9040-AA-IDX- 010/SWBS 5D and S9040-AA-IDX-SWBS 5D (Volumes I and II), Feb. 1985.
2. NAVSEA. NAVSEA INST 9096.3E "Weight and Moment compensation and Limiting Drafts for Naval Surface Ships", February 2005
3. American Society for Testing and Materials. ASTM 13332 93 "Standard Practice for Use of SI (Metric) Units in Maritime Applications.
4. Society of Allied Weight Engineers. "Vendor Weight Control for the Marine Industry," SAWE Recommended Practice 15.
5. Marine Vehicle Weight Engineering, Cimino, Dominick and Tellet, David, Editors, Society of Allied Weight Engineers, June 2007.
6. "Ship Work Breakdown for Nuclear Propulsion Plants (U), CONFIDENTIAL – NORFORN", NAVSEA 0900-LP- 039-9020, August 1977.
7. American Society for Testing and Materials. "Standard Guide for Conducting a Stability Test (Lightweight Survey and Inclining Experiment) to Determine Lightship Displacement and Centers of Gravity" ASTM F1321-92, Feb. 1993.
8. MARAD, Department of Transportation Maritime Administration "Classification of Merchant Ship Weight", January 1985.
9. Naval Ships Technical Manual S9086-C6-STM-000 Chapter 096 "Weights and Stability" Revision 3, March 2007.

See also:
Lamb, Thomas, Ship Design and Construction Volume 1, Society of Naval Architects and Marine Engineers, 2003. Chapter 12 – Mass Properties, W. Boze.

NAVSEA. NAVSEA Instruction 9096.6B "Policy for Weight and Vertical Center of Gravity Above Bottom of Keel (KG) Margin for Surface Ships".

Society of Allied Weight Engineers "Standard coordinate System for Reporting Mass Properties of Surface Ships and Submarines", SAWE Recommended Practice 13, June 1996.

Society of Allied Weight Engineers "Weight Estimating and Margin Manual for Marine Vehicles", SAWE Recommended Practice 14.

"Weight Engineers Handbook", Society of Allied Weight Engineers May 2002.

10. ORDER OF PRECEDENCE

In the event of a conflict between the text of this document and references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

APPENDIX A

FIGURES 1 - 12

Add: maturity table –example
Modify several tables

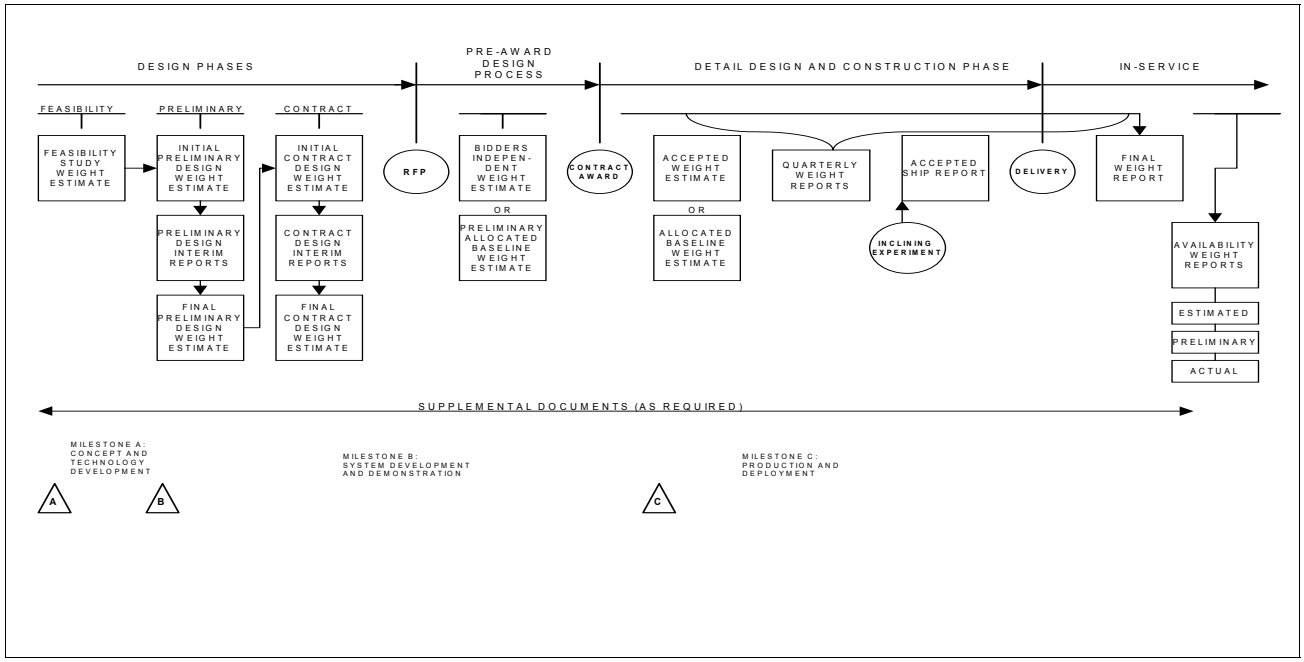
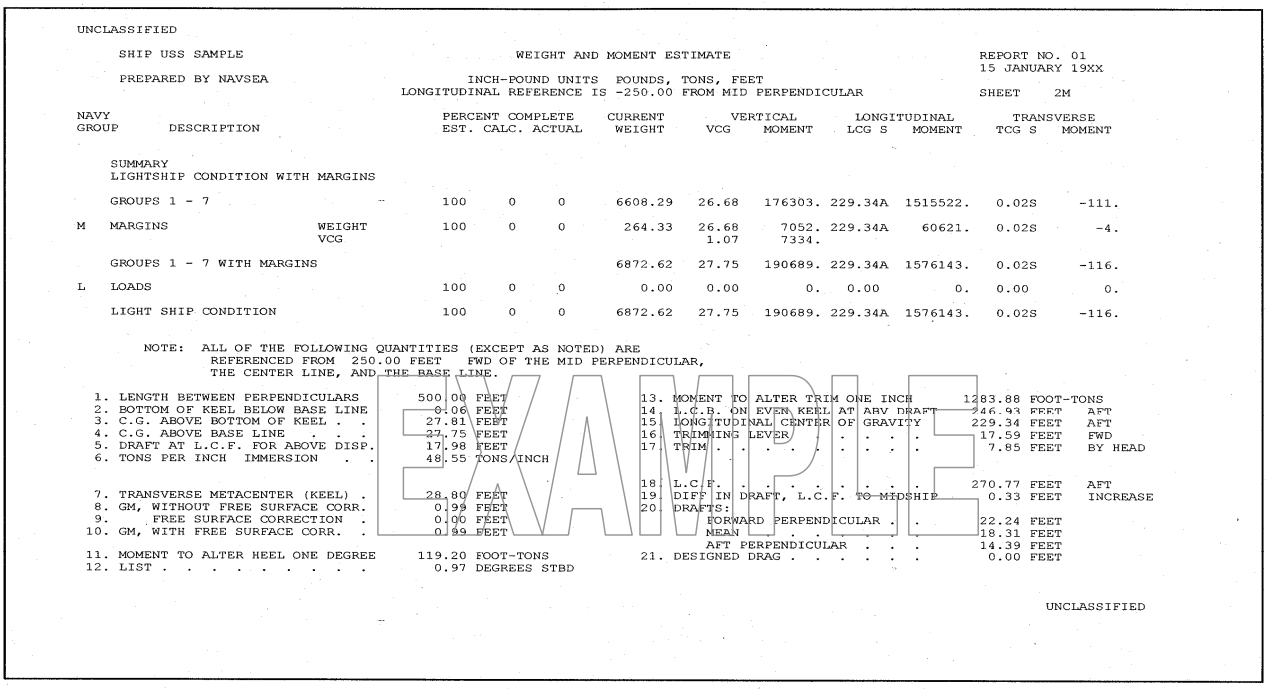


Figure 1 – Weight Reporting Interface Flowchart



UNCLASSIFIED

SHIP USS SAMPLE — WEIGHT AND MOMENT ESTIMATE — REPORT NO. 01
PREPARED BY NAVSEA — INCH-POUND UNITS POUNDS, TONS, FEET — 15 JANUARY 19XX
LONGITUDINAL REFERENCE IS -250.00 FROM MID PERPENDICULAR — SHEET 2M

NAVY GROUP	DESCRIPTION	PERCENT COMPLETE EST.	CALC.	ACTUAL	CURRENT WEIGHT	VERTICAL VCG	VERTICAL MOMENT	LONGITUDINAL LCG S	LONGITUDINAL MOMENT	TRANSVERSE TCG S	TRANSVERSE MOMENT
	SUMMARY LIGHTSHIP CONDITION WITH MARGINS										
	GROUPS 1 - 7	100	0	0	6608.29	26.68	176303.	229.34A	1515522.	0.02S	-111.
M	MARGINS WEIGHT VCG	100	0	0	264.33	26.68 1.07	7052. 7334.	229.34A	60621.	0.02S	-4.
	GROUPS 1 - 7 WITH MARGINS				6872.62	27.75	190689.	229.34A	1576143.	0.02S	-116.
L	LOADS	100	0	0	0.00	0.00	0.	0.00	0.	0.00	0.
	LIGHT SHIP CONDITION	100	0	0	6872.62	27.75	190689.	229.34A	1576143.	0.02S	-116.

NOTE: ALL OF THE FOLLOWING QUANTITIES (EXCEPT AS NOTED) ARE REFERENCED FROM 250.00 FEET FWD OF THE MID PERPENDICULAR, THE CENTER LINE, AND THE BASE LINE.

1. LENGTH BETWEEN PERPENDICULARS	500.00	FEET	13. MOMENT TO ALTER TRIM ONE INCH	1283.88	FOOT-TONS
2. BOTTOM OF KEEL BELOW BASE LINE	0.06	FEET	14. L.C.B. ON EVEN KEEL AT ARV DRAFT	246.93	FEET AFT
3. C.G. ABOVE BOTTOM OF KEEL	27.81	FEET	15. LONGITUDINAL CENTER OF GRAVITY	229.34	FEET AFT
4. C.G. ABOVE BASE LINE	27.75	FEET	16. TRIMMING LEVER	17.59	FEET FWD
5. DRAFT AT L.C.F. FOR ABOVE DISP.	17.98	FEET	17. TRIM	7.85	FEET BY HEAD
6. TONS PER INCH IMMERSION	48.55	TONS/INCH			
			18. L.C.F.	270.77	FEET AFT
7. TRANSVERSE METACENTER (KEEL)	28.80	FEET	19. DIFF IN DRAFT, L.C.F. TO MIDSHIP	0.33	FEET INCREASE
8. GM, WITHOUT FREE SURFACE CORR.	0.99	FEET	20. DRAFTS:		
9. FREE SURFACE CORRECTION	0.00	FEET	FORWARD PERPENDICULAR	22.24	FEET
10. GM, WITH FREE SURFACE CORR.	0.99	FEET	MEAN	18.31	FEET
			AFT PERPENDICULAR	14.39	FEET
11. MOMENT TO ALTER HEEL ONE DEGREE	119.20	FOOT-TONS	21. DESIGNED DRAG	0.00	FEET
12. LIST	0.97	DEGREES STBD			

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Figure 2 – Example of Light Ship Condition Format

UNCLASSIFIED

SHIP USS SAMPLE — WEIGHT AND MOMENT ESTIMATE — REPORT NO. 01
PREPARED BY NAVSEA — 15 JANUARY 19XX
INCH-POUND UNITS POUNDS, TONS, FEET
LONGITUDINAL REFERENCE IS -250.00 FROM MID PERPENDICULAR — SHEET 1M

NAVY GROUP	DESCRIPTION	PERCENT COMPLETE EST.	CALC.	ACTUAL	CURRENT WEIGHT	VERTICAL VCG	VERTICAL MOMENT	LONGITUDINAL LCG	S	LONGITUDINAL MOMENT	TRANSVERSE TCG	S	TRANSVERSE MOMENT
	SUMMARY FULL LOAD CONDITION WITH MARGINS												
	GROUPS 1 - 7	100	0	0	6608.29	26.68	176303.	229.34	A	1515522.	0.02	S	-111.
M	MARGINS WEIGHT	100	0	0	264.33	26.68	7052.	229.34	A	60621.	0.02	S	-4.
	VCG					1.07	7334.						
	GROUPS 1 - 7 WITH MARGINS				6872.62	27.75	190689.	229.34	A	1576143.	0.02	S	-116.
F	LOADS, FULL	100	0	0	1674.07	11.33	18973.	258.54	A	432809.	0.16	P	264.
	FULL LOAD CONDITION WITH MARGINS	100	0	0	8546.69	24.53	209662.	235.06	A	2008952.	0.02	P	148.

NOTE: ALL OF THE FOLLOWING QUANTITIES (EXCEPT AS NOTED) ARE REFERENCED FROM 250.00 FEET FWD OF THE MID PERPENDICULAR, THE CENTER LINE, AND THE BASE LINE.

1. LENGTH BETWEEN PERPENDICULARS	500.00 FEET	13. MOMENT TO ALTER TRIM ONE INCH	1453.19 FOOT-TONS	
2. BOTTOM OF KEEL BELOW BASE LINE	0.06 FEET	14. L.C.B. ON EVEN KEEL AT ABV DRAFT	251.96 FEET	AFT
3. C.G. ABOVE BOTTOM OF KEEL	24.59 FEET	15. LONGITUDINAL CENTER OF GRAVITY	235.06 FEET	AFT
4. C.G. ABOVE BASE LINE	24.53 FEET	16. TRIMMING LEVER	16.90 FEET	FWD
5. DRAFT AT L.C.F. FOR ABOVE DISP.	20.75 FEET	17. TRIM	8.28 FEET	BY HEAD
6. TONS PER INCH IMMERSION	51.68 TONS/INCH			
		18. L.C.F.	273.31 FEET	AFT
7. TRANSVERSE METACENTER (KEEL)	29.00 FEET	19. DIFF IN DRAFT, L.C.F. TO MIDSHIP	0.39 FEET	INCREASE
8. GM, WITHOUT FREE SURFACE CORR.	4.41 FEET	20. DRAFTS:		
9. FREE SURFACE CORRECTION	0.16 FEET	FORWARD PERPENDICULAR	25.28 FEET	
10. GM, WITH FREE SURFACE CORR.	4.25 FEET	MEAN	21.14 FEET	
		AFT PERPENDICULAR	17.00 FEET	
11. MOMENT TO ALTER HEEL ONE DEGREE	633.76 FOOT-TONS	21. DESIGNED DRAG	0.00 FEET	
12. LIST	0.23 DEGREES PORT			

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Figure 3 - Example of Full Load Condition Format

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SHIP USS SAMPLE — WEIGHT AND MOMENT ESTIMATE — REPORT NO. 01
PREPARED BY NAVSEA — 15 JANUARY 19XX
INCH-POUND UNITS POUNDS, TONS, FEET — SHEET 1M
LONGITUDINAL REFERENCE IS -250.00 FROM MID PERPENDICULAR

NAVY GROUP	DESCRIPTION	PERCENT COMPLETE EST.	CALC.	ACTUAL	CURRENT WEIGHT	VERTICAL VCG	VERTICAL MOMENT	LONGITUDINAL LCG S	LONGITUDINAL MOMENT	TRANSVERSE TCG S	TRANSVERSE MOMENT
	SUMMARY										
	CONTRACTOR RESPONSIBLE CONDITION										
	FULL LOAD	100	0	0	8546.69	24.53	209662.	235.06A	2008952.	0.02P	148.
	EFFECT OF CON MODS	100	0	0	-15.00	30.13	-452.	265.98A	-3990.	2.37S	36.
	EFFECT OF GFM WEIGHT CHANGES	100	0	0	-6.25	23.04	-144.	135.36A	-846.	0.80P	-5.
	EFFECT OF CLASS-STANDARD EQPT	100	0	0	-20.00	18.28	-366.	295.74A	-5915.	0.18P	-4.
	CONTRACTOR RESPONSIBLE CONDITION	100	0	0	8503.79	24.53	208623.	234.93A	1997772.	0.02P	176.

NOTE: ALL OF THE FOLLOWING QUANTITIES (EXCEPT AS NOTED) ARE REFERENCED FROM 250.00 FEET FWD OF THE MID PERPENDICULAR, THE CENTER LINE, AND THE BASE LINE.

1.	LENGTH BETWEEN PERPENDICULARS	500.00 FEET	13.	MOMENT TO ALTER TRIM ONE INCH	1450.17 FOOT-TONS
2.	BOTTOM OF KEEL BELOW BASE LINE	0.06 FEET	14.	L.C.B. ON EVEN KEEL AT ABV DRAFT	251.85 FEET AFT
3.	C.G. ABOVE BOTTOM OF KEEL	24.59 FEET	15.	LONGITUDINAL CENTER OF GRAVITY	234.93 FEET AFT
4.	C.G. ABOVE BASE LINE	24.53 FEET	16.	TRIMMING LEVER	16.92 FEET FWD
5.	DRAFT AT L.C.F. FOR ABOVE DISP.	20.69 FEET	17.	TRIM	8.27 FEET BY HEAD
6.	TONS PER INCH IMMERSION	51.62 TONS/INCH			
			18.	L.C.F.	273.30 FEET AFT
7.	TRANSVERSE METACENTER (KEEL)	29.00 FEET	19.	DIFF IN DRAFT, L.C.F. TO MIDSHIP	0.39 FEET INCREASE
8.	GM, WITHOUT FREE SURFACE CORR.	4.41 FEET	20.	DRAFTS:	
9.	FREE SURFACE CORRECTION	0.16 FEET		FORWARD PERPENDICULAR	25.22 FEET
10.	GM, WITH FREE SURFACE CORR.	4.25 FEET		MEAN	21.08 FEET
				AFT PERPENDICULAR	16.95 FEET
11.	MOMENT TO ALTER HEEL ONE DEGREE	630.34 FOOT-TONS	21.	DESIGNED DRAG	0.00 FEET
12.	LIST	0.28 DEGREES PORT			

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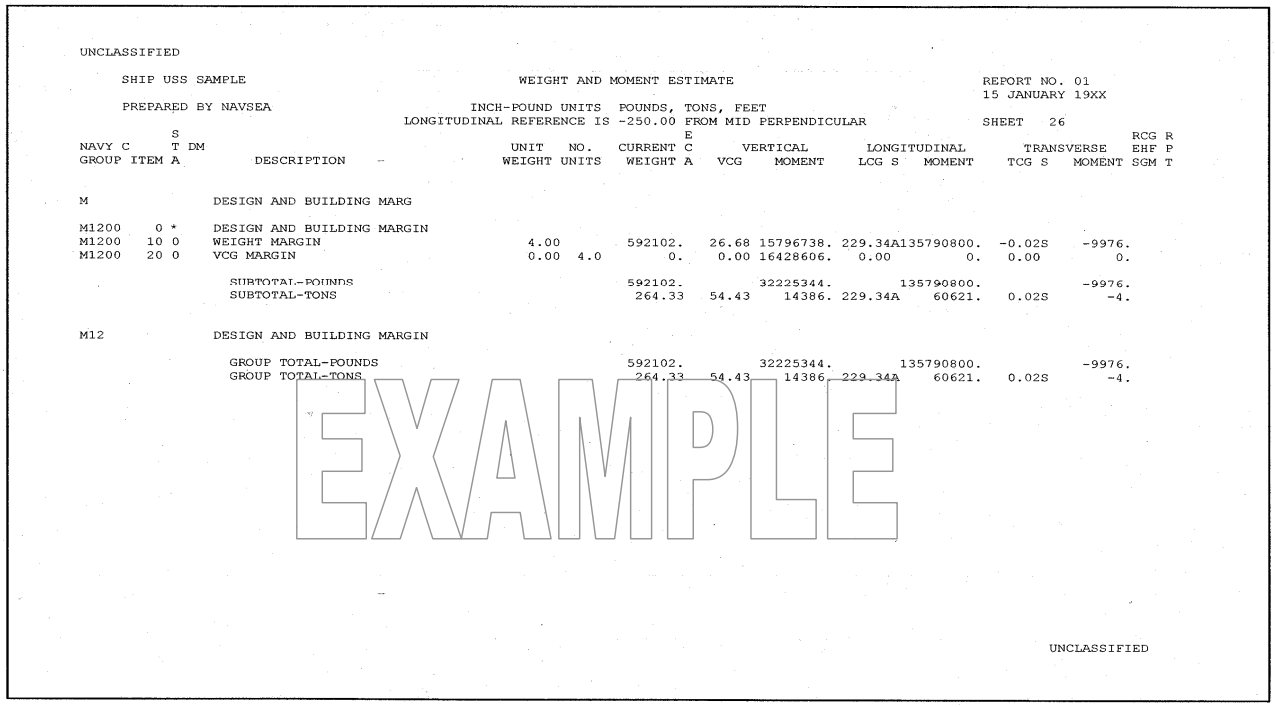
Figure 4 - Example of Contractor-responsible Condition Format



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SHIP USS SAMPLE — WEIGHT AND MOMENT ESTIMATE — REPORT NO. 01
15 JANUARY 19XX

PREPARED BY NAVSEA — INCH-POUND UNITS POUNDS, TONS, FEET
LONGITUDINAL REFERENCE IS -250.00 FROM MID PERPENDICULAR — SHEET 26

NAVY GROUP	ITEM	S A T	DM	DESCRIPTION	UNIT WEIGHT	NO. UNITS	CURRENT WEIGHT	E C A	VERTICAL VCG	VERTICAL MOMENT	LONGITUDINAL LCG	S	LONGITUDINAL MOMENT	TRANSVERSE TCG	S	TRANSVERSE MOMENT	RCG EHF SGM	R P T
M				DESIGN AND BUILDING MARG														
M1200	0	*		DESIGN AND BUILDING MARGIN														
M1200	10	0		WEIGHT MARGIN	4.00		592102.		26.68	15796738.	229.34	A	135790800.	-0.02	S	-9976.		
M1200	20	0		VCG MARGIN	0.00	4.0	0.		0.00	16428606.	0.00		0.	0.00		0.		
				SUBTOTAL-POUNDS			592102.			32225344.			135790800.			-9976.		
				SUBTOTAL-TONS			264.33		54.43	14386.	229.34	A	60621.	0.02	S	-4.		
M12				DESIGN AND BUILDING MARGIN														
				GROUP TOTAL-POUNDS			592102.			32225344.			135790800.			-9976.		
				GROUP TOTAL-TONS			264.33		54.43	14386.	229.34	A	60621.	0.02	S	-4.		

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Figure 5 - Example of Margins Format

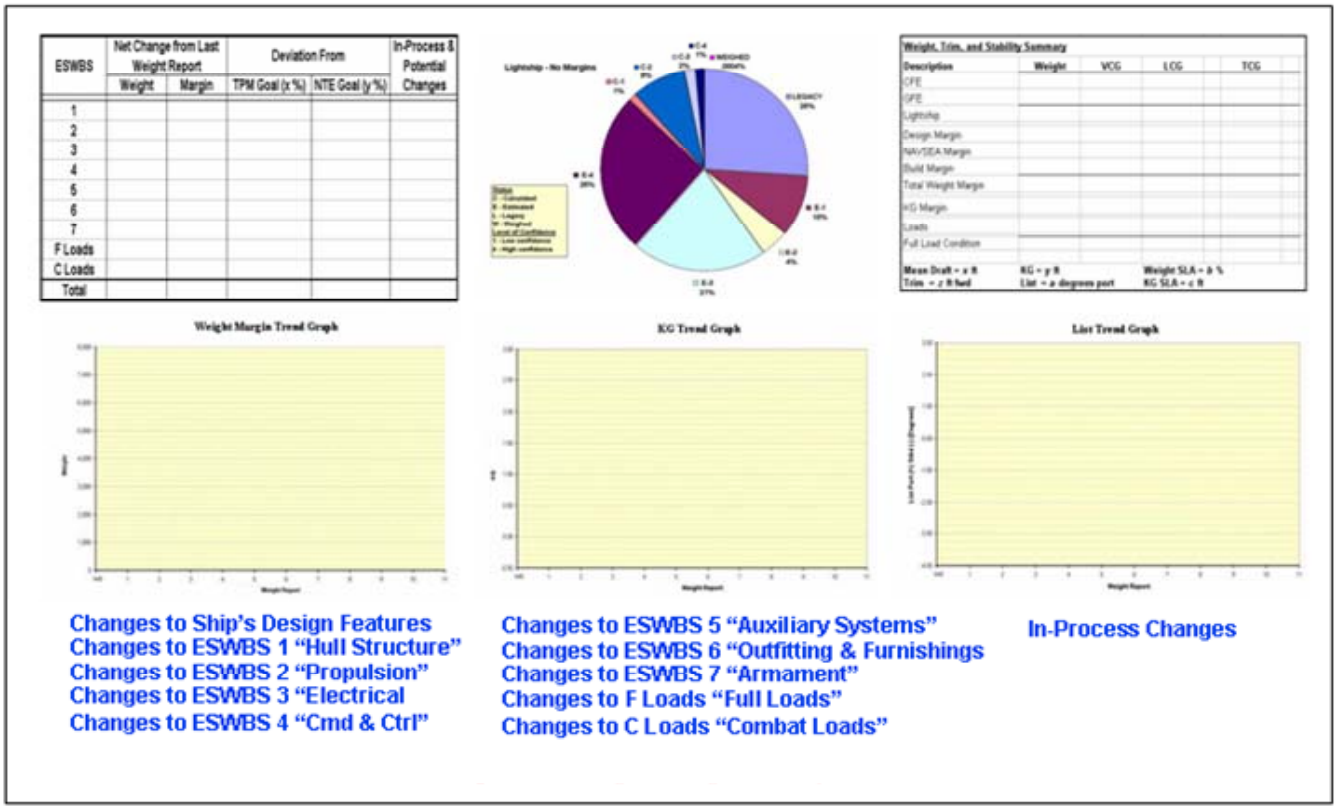

Figure 6 - Ship Summary Sheet

USS SAMPLE WEIGHT AND C.G. DESIGN MARGIN STATUS
PRELIMINARY/CONTRACT DESIGN - INTERIM REPORT

A. WEIGHT:

	Item	Contract Design Baseline 10/7/88	Last Report 12/2/88	Current Report	Change From BL	Change From Last Report
1.	GROUPS 1-7	6084.9	6123.1	6148.4	(+) 63.5	(+) 25.3
2.	a. P.D. Margin	0.0	0.0	0.0	0.0	0.0
	b. C.D. Margin	76.9	46.4	35.6	(-) 41.3	(-) 10.8
3.	D & B Margins	392.1	392.1	392.1	0.0	0.0
4.	Loads	1874.4	1870.9	1839.2	(-) 35.2	(-) 31.7
5.	Projected Delivery	8428.3	8432.5	8415.3	(-) 13.0	(-) 17.2
6.	Limits:					
	Speed			9400		
	Strength			9370		
	Subdivision			9426		
	"V" Lines			9500		

SERVICE LIFE DISPLACEMENT ALLOWANCE:

7.	Required	841
8.	Available at Projected Delivery	955

B. CENTER OF GRAVITY - CURRENT STATUS:

			KG	List	Trim
1.	GROUPS 1-7	26.26	26.24	2.95° (P)	0.33′ (A)
2.	a. P.D. Margin	0.00	0.00		
	b. C.D. Margin	0.28	0.30		
3.	D & B Margins	1.00	1.00		
4.	Projected Delivery (Light Ship)		27.54		
5.	Projected Delivery (Full Load)		23.96	0.37° (P)	0.77′ (A)

LIMITS:	ALLOWABLE KG	LIST	TRIM
	25.32	0.50° P/S	1.5′(A)/0.5′(F)

SERVICE LIFE KG ALLOWANCE:

6.	Required	1.00
7.	Available at Projected Delivery	1.36

Figure 7a - Example of Interim Weight Report Format (Page 1)

USS SAMPLE WEIGHT AND C.G. DESIGN MARGIN STATUS
PRELIMINARY/CONTRACT DESIGN - INTERIM REPORT

Weight Group		Contract Design Baseline 10/7/88	Last Report 12/2/88	Current Report	Change From BL	Change From Last Report
1.	Structure	2936.2	2932.5	2941.1	(+)4.9	(+)8.6
2.	Propulsion	717.0	705.7	704.8	(-)12.2	(-)0.9
3.	Elec. Plant	392.1	393.9	401.8	(+)9.7	(+)7.9
4.	Command/Surv.	384.9	381.7	381.7	(-)3.2	---
5.	Aux. Systems	799.9	826.7	810.8	(+)10.9	(-)15.9
6.	Outfit & Furn.	554.4	583.8	609.4	(+)55.0	(+)25.6
7.	Armament	300.4	298.8	298.9	(-)1.5	(+)0.1
Total Groups 1 thru 7:		6084.9	6123.1	6148.4	(+)63.5	(+)25.3

COMMENTS:

Figure 7b - Example of Interim Weight Report Format (Page 2)

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SHIP USS SAMPLE — WEIGHT AND MOMENT ESTIMATE — REPORT NO. 01
PREPARED BY NAVSEA — INCH-POUND UNITS POUNDS, TONS, FEET — 15 JANUARY 19XX
LONGITUDINAL REFERENCE IS -250.00 FROM MID PERPENDICULAR — SHEET 15

NAVY GROUP	C ITEM	S T A	DM	DESCRIPTION	UNIT WEIGHT	NO. UNITS	CURRENT WEIGHT	E C A	VERTICAL VCG	VERTICAL MOMENT	LONGITUDINAL LCG	S	LONGITUDINAL MOMENT	TRANSVERSE TCG	S	TRANSVERSE MOMENT	RCG EHF SGM	R P T
3				ELECTRIC PLANT														
31100	0	A		SHIPS SERVICE PWR GEN. 205186														
31100	10	N		SSTG GEN 2 ENG RM 2 #81 67750	67750.00	1	67750.C		19.01	1287928.	277.47	A	18798592.	8.05	S	-545388.	E3G02	
31100	20	S		SSTG GEN 3 GEN RM #82 67750	67750.00	1	67750.C		20.83	1411233.	394.05	A	26696886.	4.12	P	279130.	E3G02	
31100	30	G		SSTG GEN 1 AMR 1 #80 67750	67750.00	1	67750.C		10.50	711375.	149.95	A	10159112.	2.30	P	155825.	E3G02	
31100	40	H		SCAVENGE PUMP & AIR SEAL AMR#1	140.00	1	140.E		11.00	1540.	150.70	A	21098.	2.30	P	322.M		01
31100	50	N		SCAVENGE PUMP & AIR SEAL ENG RM2	300.00	2	600.E		22.00	13200.	284.75	A	170850.	12.50	P	7500.M		01
31100	60	M		SPARE BATTERIES FOR NBPS	51.00	1	51.E		34.50	1760.	259.00	A	13209.	22.00	P	1122.		01
31100	70	Q		ENCLOSED BATTERY RACK	100.00	1	100.E		17.25	1725.	326.00	A	32600.	0.00		0.		01
31100	80	Q		BATTERIES	55.00	1	55.E		17.25	949.	326.00	A	17930.	0.00		0.		01
31100	90	Q		BATTERY CHARGER	90.00	1	90.E		18.25	1643.	326.00	A	29340.	0.00		0.		01
31100	100	K		MONORAIL	800.00	1	800.E		50.00	40000.	215.00	A	172000.	13.00	S	-10400.		01
31100	110	F		ENCLOSED BATTERY RACK	100.00	1	100.E		8.50	850.	103.00	A	10300.	0.00		0.		01
				SUBTOTAL-POUNDS			205186.			3472201.			56121920.			-111889.		
				SUBTOTAL-TONS			91.60		16.92	1550.	273.52	A	25054.	0.55	S	-50.		
311				SHIPS SERVICE POWER GENERATION														
				GROUP TOTAL-POUNDS			205186.			3472201.			56121920.			-111889.		
				GROUP TOTAL-TONS			91.60		16.92	1550.	273.52	A	25054.	0.55	S	-50.		

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Figure 8 – Example of Three-digit Reporting Format

Line #	Description	Weight	Vertical			Longitudinal			Transverse		
			Arm		**Mom**	**Arm**		**Mom**	**Arm**		**Mom**
1	Original Baseline Values from AWE/ABWE	355.00	31.22	A	11083	157.35	A	55859	0.17	P	60
2	Add: Adjustments to Original Values (+/-)	2.25	52.00	A	117	28.89	A	515	10.67	S	-24
3	New Basis for Measuring GFM Changes (Line 1 + Line 2)	357.25	31.35	A	11200	157.80	A	56374	0.10	P	36
4	Current Values from Quarterly #___	363.50	31.17	A	11330	157.25	A	57160	0.12	P	44
5	Less: GFM from Contract Modifications File	3.00	20.00	A	60	121.00	A	363	1.00	P	3
6	Current GFM without GFM in Contract Modifications (Line 4 - Line 5)	360.50	31.26	A	11270	157.55	A	56797	0.11	P	41
7	GFM Growth (Line 6 - Line 3)	3.25	21.54	A	70	130.15	A	423	1.54	P	5

Figure 9 - Example of GFM Summary Report Format Including GFM Growth

ACCEPTED SHIP REPORT

	WEIGHT	KG	VERTICAL MOMENTS	LCG	LONGITUDINAL MOMENTS	TCG	TRANSVERSE MOMENTS	TRIM (F) / (A)	LIST (P) / (S)
Inclining Experiment (Condition A)									
Current Loads from latest QWR (add)									
Current Full Load (Total)									
Net Effect of Contract Mods (Deduct) (note 1) Directed Modifications to Loads (Deduct) GFM Net Changes (Deduct) (note 2) Other Allowable Adjustments (note 3)									
Contractor Responsible Values (Total)									
Accepted Weight Estimate Values								(note 4)	(note 4)

NOTES:
1. Represents summation of adjudicated and unadjudicated values for all contract modifications that were included in the inclining data (including those affecting variable loads).
2. Represents values for net weight and moment changes in GFM since the AWE.
3. These adjustments can include equipment designated as standard for the class changes, changes resulting from the required use of warranteed documentation, or growth resulting from directed procurements.
4. Insert tolerances agreed to or limits in Section 070 of the Ship Specifications.

Figure 10 - Example of Accepted Ship Report

ACCEPTED SHIP REPORT
(Performance-type contract)

	WEIGHT	KG	VERTICAL MOMENTS	LCG	LONGITUDINAL MOMENTS	TCG	TRANSVERSE MOMENTS	TRIM (F) / (A)	LIST (P) / (S)
Inclining Experiment (Condition A)									
Current Loads from latest QWR (add)									
Current Full Load (Total)									
Government Margins Contract Modifications Remaining (Add) Exceeded (Deduct) GFM Remaining (Add) Exceeded (Deduct)									
Contractor Responsible Values (Total)									
ABWE/AWE Values								(note 1)	(note 1)
Governing NA Limit									
Available Service Life Allowance									
Required Service Life Allowance									

NOTE: 1. Insert tolerances agreed to or limits in Section 070 of the Ship Specifications.

Figure 11 – Example of Accepted Ship Report (Performance-type Contract)

DESIGN AND WEIGHT DATA SHEET

USS SAMPLE

General Data

Type:
Endurance: 4000 miles
Trial Speed: 29.2 knots
Complement: 300

Hull Characteristics

LOA: 563'3-13/16"
LBP: 529'0"
MP: 264'6"
Prismatic Coef: 0.560
Block Coef: 0.461
Midship Coef: 0.823
Waterplane Coef: 0.724
Volume of Superstructure: 240,860 ft^3

DWL From Baseline: 18'0"
Max. Beam Molded: 55'0"
Mean Depth at Side: 42'0"
Depth at Centerline : 42'0"
Speed to Length Ratio: 0.87
Cubic Number: 12,219.9
Volume of Hull: 953,262 ft^3

Displacement and Stability Characteristics

Limiting Drafts: 21'0"
Full Load Drafts: Fwd 19.16', Aft 19.67', Mean 19.42'
Limiting KG: 22.88 (Full Load Cond. D Basic Ship, No Margins)
Trim: 0.51 by stern

Inclining Experiment	Cond. A	Cond. D
Displacement	5929.26T	
KM	26.5'	26.2'
KG	26.0'	22.0'
GM	0.5'	4.3'
GM (corrected for free surface)	0.5'	4.2'

Weight Summary Data*

Group	Wt (Tons)	VCG	LCG**	
1. Hull Structure	3074.9	24.0	269.6	
2. Propulsion	761.9	22.7	309.4	
3. Electric Plant		284.7	28.1	298.9
4. Comm and Control	355.7	25.2	162.6	
5. Auxiliary Systems	736.2	28.4	288.6	
6. Outfit and Furnishings	478.3	32.2	280.1	
7. Armament	153.9	36.1	240.2	
Building Margin	83.7	49.0	245.7	
Total Light Ship	5929.3	26.0	271.8	

Full Loads*

	Wt (Tons)	VCG	LCG**	
Crew and Effects	29.7	29.5	300.3	
Ship Ammunition	78.4	24.7	265.0	
Aircraft (Helo)		5.3	0.0	324.0
Provisions & Stores	34.6	27.0	248.9	
General Stores		5.9	25.8	326.4
Aeronautical Stores	3.1	55.0	265.0	
Potable Water		40.9	11.2	222.1
Lube Oil (Ship)		32.1	12.9	242.7
Lube Oil (Helo)		9.5	15.7	397.4
Fuel Oil		1588.4	4.5	257.0
Unusable Liquids				
in Tanks	83.2	9.9	276.0	
JP-5	64.7	11.2	407.8	
Total Loads	1975.8	10.0	263.7	
Ship - Full Load Cond. D	7905.1	22.0	269.8	

Propulsion Characteristics

Full Power: 80,000 SHP
Cruising: 14,067 SHP

Propulsion Plant

Machinery	No./Ship	Rating	Manufacturer	Unit Weight Dry (Tons)
Gas Turbine LM2500	4	20,500 bhp	General Electric	19.9
Reduction Gear	2	300,000 lb thrust (max.)	Westinhse	71.5
Propeller, CRP	2		Bird-Johnson	21.8
Electric Plant				
SS Gas Turbine Generators	3	2,000 kw	Stewart & Stevenson	23.9
Auxiliary Plant				
	2	6,000 gal/day	Aqua-Chem	2.7
Air Conditioner Plant	3	150 Ton	York	7.7
Refrigeration Units	2	1.5 ton	York	0.8
Waste Heat Boilers	3	7,000 lb/hr	Condenser Service & Eng'r	8.0
Air Compressors	2	100 SCFM	Ingersoll Rand	2.2
Anchors	2	9,000 lb	(Navy Stockless)	4.0
Rudders	2	162 ft^2 Spade	-----	20.8

* From Final Weight Report dated 8 October 1990
** Referenced from Forward Perpendicular

(Indicate Security Classification)

Figure 12 – Example Design Weight and Data Sheet Format

APPENDIX B

STANDARD NAVY WEIGHT REPORT INPUT DATA FILE FORMAT

STANDARD NAVY WEIGHT REPORT INPUT DATA FILE FORMAT

1.0 SCOPE

1.1 Scope

This appendix contains the required format for completing the standard Navy weight report input data files. This appendix is a mandatory part of the standard. The information contained herein is intended for compliance.

2.0 APPLICABLE DOCUMENTS

This section is not applicable to this appendix.

3.0 FORMAT

3.1 Format

Input data files, when required by the design contract or Ship Specifications, shall be in accordance with the format specified in this appendix. In general, for each item in the weight estimate there shall be two lines of data in the file. The first line is mandatory and shall contain information regarding the weight and center of gravity of the item. The second line is optional, depending upon the specification requirements, and shall contain information regarding the inertia characteristics of the item. An example of the Navy Standard Weight Estimate Format is shown on Figure 14.

3.1.1 First line of Data

The format for the first line of data is as follows:

Columns 1 through 5, Classification Number - Columns 1 through 3 are based on the Expanded Ship Work Breakdown Structure (ESWBS) (see NAVSEA S9040-AA-IDX-010/SWBS 5D). Columns 4 and 5 provide for special subtotals within the classification number. Columns 4 and 5 shall contain only numeric data. Generally, two zeroes are used to designate an ESWBS element title. For example; Main Deck would be designated 13100 for ESWBS. It is noted that ESWBS subgroups ending in a zero are not to be used for input data such as 110, 120, 230, 240, and so forth.

Column 6 - Column 6 is used for functional category designation when required for nuclear powered ships. These categories are defined by NAVSEA 0900-LP-039-9020.

Columns 7 through 10, Item Number - The item number provides the means of identification of each line within any five-digit element number. The following rules apply:

Each line shall have an item number.

a) All titles representing any of the basic ESWBS titles shall include a zero in Column 10. NOTE: Titles for special subtotals within an ESWBS element may contain any item number desired

a) Care shall be taken not to repeat any item numbers within a five-digit element.

b) Do not use any leading zeroes in the item number, such as 0010.

c) Item numbers for entries should be entered in increments of ten, such as 10, 20, and 30, in lieu of 1, 2, and 3.

d) All item numbers shall be right justified.

Column 11, Station - This column is used in conjunction with the standard longitudinal weight distribution for subsequent strength calculations. For weight distribution, the ship is divided into 22 stations which are lettered A through X (excluding I and O). Station A is designated to contain all items whose longitudinal center of gravity (LCG) is forward of the forward perpendicular. Station B contains all items with an LCG between the forward perpendicular and ship station 1. Station C contains items between ship station 1 and ship station 2, and so on to station X which contains all items aft of the aft perpendicular. For each item (except titles and items with no weight), column 11 shall contain a letter from A through X (excluding I and O), unless one of the following special options is used:

a) An asterisk inserted in column 11 for any item indicates the weight will be automatically distributed in a 22-station longitudinal distribution in proportion to the basic hull structure. The basic hull structure for ESWBS consists of group 1 from 110 through 159, except 114 and 123 through 126. Items in the basic hull structure shall not use the asterisk option.

b) A digit of 2 through 9 in column 11 indicates the weight for the given item will be distributed over 2 through 9 stations centered about the item's LCG. If enough stations are not available to do a particular distribution, the distribution will be done over as many stations as are available. For instance, if a six-station distribution is required within two stations of either end of the ship, then a four-station distribution will occur.

Column 12, Special Designator - This column shall contain designators established by the Government. Where no designator is applicable, this column shall be left blank. In the event of a conflict in determining which designation is to be used, the order of precedence shall be by alphabetical order. This designator provides for dual purpose as follows:

a) Provides for extractions across the entire ship for summaries, such as plates, extruded shapes, weldments, primary, secondary, and others, as required.

b) Provides for listing within the three-digit element, such as controls, components, distribution, and others, as required.

c) The following designators are applicable:

C – D	-	Distribution items, such as ducts, pipe, wire, wireways, connectors, waveguides, propeller shafts, and propeller shaft bearings
E	-	Plating and Sheeting
F	-	Forgings, extruded shapes, rolled shapes, built-up shapes and castings.
G	-	Weldments
M	-	Major components, such as: air conditioner units, antennas, actuators, batteries, blowers, boilers, compressors,

computers, cranes, davits, distillers, transmitters, receivers, transceivers, engines, fans, generators, motors, propellers, pumps, turbines, winches, and replenishment-at-sea (RAS) equipment.

P - Secondary, peripheral, and interface components, such as hydraulic reservoirs, electrical power supplies, non-integral tanks, filters, heat exchangers (for system), and subbases.

Column 13, Special Modifier - This column shall contain a modifier established by the Government for the column 12 designator for those items in groups 1 through 7 only (that is, not including items of variable load). In the event a modifier cannot be determined, a "Z" shall be inserted. This modifier provides for dual purpose, as follows:

a) Provide for extractions across the entire ship for various material types, such as all steel, all aluminum, and others, as required.

b) Provide for special systems summaries across the entire ship or within certain elements, such as all payload, all habitability, and special systems such as hydrofoils and air cushions.

c) The following modifiers are applicable:

A - Aluminum
B - Brass and Bronze
C - Copper, copper-nickel, and nickel-copper
D - Ordinary strength steel
E - Higher strength steel
F - Habitability items, such as berthings, clothing and personal effects stowage, leisure systems, sanitary systems, messing, personal service, utility, and work systems (this modifier shall supersede any material type modifiers).
H - Habitability
J - Wood material
K - Liquids
L - Lead
M - Miscellaneous metallic material

N	-	Miscellaneous non-metallic material
P	-	Payload which includes items that are peculiar to the specific missions of a particular ship, such as minesweep gear on a minesweeper, oceanographic gear on an oceanographic ship, and so forth (this modifier shall supersede any material modifiers).
W	-	Welding, riveting, and fastening

Columns 14 through 45, Description - These 32 columns shall be used to adequately describe each item. Whatever is entered as input data is reproduced exactly on the weight estimate or report printout. Any combination of alphanumeric characters or blanks can be used. Clear and complete description is essential. However, if budget weights are being used, the description field shall be limited to 24 columns (columns 14 though 37). Columns 38 through 45 will then be used for budget weights (see the following paragraph).

Columns 38 through 45, Budget Weight - Budget weight, if used, is entered in pounds on ESWBS titles only. This allows weight values from 0 to 99,999,999 pounds (to be entered 99999999).

Columns 46 through 53, Unit Weight - Always enter unit weight of any item in pounds. The broken line on the Standard Navy Transmittal Form (NAVSEA 5230/32) between columns 51 and 52 provides a decimal point, allowing a unit weight up to 999,999.99 pounds. When the unit weight is a whole number, enter two zeroes behind the implied decimal point. If the weight is a deduction, enter a minus sign (-) immediately before the unit weight number.

Columns 54 through 57, Number of Units - Values from .001 to 999 units can be entered. This number is multiplied by unit weight to produce total weight for each line item. Unit weight, number of units, and total weight are all printed in the detail output.

Columns 58 through 62, Vertical Center of Gravity (VCG) - These columns shall be used for entering the VCG of each item. VCG's shall be carried out to the hundredth decimal place. When the VCG is a whole number, two zeroes must be entered after the decimal point. If the VCG is negative (a weight below the baseline), enter a minus sign immediately before the VCG number. All VCG's are measured in feet. The VCG will be multiplied by the computed total weight, and the resultant vertical moment will be printed.

Columns 63 through 67, Longitudinal Center of Gravity (LCG) - These columns shall be used for entering the LCG of each item. LCG is measured in feet and carried out to the hundredth decimal place. Always enter a positive LCG, no sign is necessary. When the LCG is a whole number, enter two zeroes behind the implied decimal point. The LCG will be multiplied by the computed total weight, and the resultant longitudinal moment will be printed.

Column 68, LCG Sign - As mentioned above, the LCG is always entered as a positive value. Enter "F" or "A" to indicate whether the weight is located forward or aft of the longitudinal reference datum. A blank in column 68 is interpreted to mean "A" or aft.

Columns 69 through 73, Transverse Center of Gravity (TCG) - These columns shall be used for entering the TCG of each item. TCGs shall be carried out to the hundredth decimal place. When the TCG is a whole number, two zeroes must be entered after the decimal point. All TCGs are measured in feet port or starboard of the centerline, with the exception when port and starboard symmetry exists. If a line item has port and starboard symmetry, the TCG is measured in feet from the transverse center of one side (port or starboard) of the symmetrical item. This is essential in order to calculate the weight moment of inertia value of the line item. Always enter a positive TCG, no sign is necessary. If the TCG is not applicable, leave columns 69 through 73 blank. The TCG will be multiplied by the total weight, and the resultant transverse moment will be printed.

Column 74, TCG Sign - As mentioned above, the TCG is always entered as a positive value. Enter "P" or "S" to indicate whether the weight is port or starboard of the centerline. However, when a line item has port and starboard symmetry about the centerline, enter "X" to indicate the transverse center of one side (port or starboard) of the symmetrical line item. This distance will only be used to calculate the weight moment of inertia of the line item. A blank in column 74 is interpreted to mean "P" or port.

Column 75, Reservation Indicator (RES) - This column is used to indicate reservation items or design responsibility. The letter "R" shall be used to designate a reservation item. The letters "A" through "Z" (except "R") may be used, as required, to indicate design responsibility, such as:

H - Hull design
M - Machinery design
E - Electrical design

Column 76, Reason for Change - This column is used to indicate the reason for change as follows:

0	-	Nomenclature change (no weight change).
1	-	Contract modification change.
2	-	Government-Furnished Material change.
3	-	Change to class status, such as: estimated to calculated, or calculated to actual.
4 – 9 and		A – Z user assigned – The column appears “CHG” in the output.

Column 77, Material Source Indicator - The column is used to indicate the source of an item as follows:

G - Government-Furnished Material
F - Contractor-fabricated material
P - Contractor-purchased material

Column 78, Class Status - Used to indicate the confidence of the weight value entered for the line item as follows:

E - Estimated weight

C - Calculated weight
A - Actual (scale) weight
V - Vendor or catalog weight (to be changed to "A" upon actual weight determination of the item).

Columns 79 and 80, Report Number - Enter the report number where the change was first incorporated. Report number "AO" shall be used for the first submittal of input. Line items changed prior to the first periodic weight report shall carry report number "BO" for the first such change, "CO" for the second, etc. The first periodic weight report shall have column 79 blank, and a "1" in column 80, and so forth. Deletions may contain the letters "DD" in columns 79 and 80, in lieu of a report number, or the deletion line may be erased.

3.1.2 Second line of data - The second line of data for each item contains the gyradius data for the item and must immediately follow the first line of data in the file. The format for the second line of gyradius data is as follows:

Columns 1 through 5, Classification Number - These columns must contain the same five digit classification number as the line of weight data which precedes it in the file.

Column 6, I_o Designator. An asterisk (*) must be included in this field to designate the line as a second line containing inertia data for the previous line.

Columns 7 through 10, Item Number. These columns must contain the same item number as the preceding line which contains the weight data for the item.

Column 20, Shape of I_o Item. This field is used to indicate what kind shape is to be used to estimate the I_o for the weight item. The following are shapes which may be used:

0	-	The I_o calculation is to be the ratio or a percentage of a three-digit element's I_o.
1	-	The I_o data are actual inertias.
2	-	Rectangular Prism.
3	-	Hollow Frustrum of a Cone.
4	-	Hollow Right Circular Cylinder.
5	-	Right Rectangular Pyramid.
6	-	Hollow Hemisphere.
7	-	Square Diamond.

Drawings showing the geometry and orientation of shapes 2 through 7 can be found on Figure 14. If this field is blank, or contains a zero, the I_o will be calculated as a percentage of the three-digit element specified in columns 41-50.

Column 25, Orientation Of The I_o Shape. This field is used to define the relationship between the local coordinate system of the I_o item as shown on Figure 15 and the ship's coordinate system. The entries to be used are as follows:

0 - X axis of the shape as shown on Figure 15 is oriented in the ship's longitudinal direction.

1 - X axis of the shape as shown on Figure 15 is oriented in the ship's transverse direction.

2 - X axis of the shape as shown on Figure 15 is oriented in the ship's vertical direction.

Note that the orientation of the shape relative to the ship's coordinate system need not have any sign for the calculation of the inertia. For example the inertia of the pyramid (shape 5 on Figure 14) about all three axes is the same whether the point of the pyramid is pointing in the positive X (to the right) or negative X direction (to the left). Therefore, for an item which is to be modeled as a pyramid with the point oriented to the stern of the ship, the value to be entered for the orientation in column 25 would still be "0", which is the same as if it were pointing to the bow.

Columns 31-40, X-Dimension. For each of the shape definitions given in column 20 the following information must be entered. The format for this field is right justified with an implied decimal point between columns 38 and 39.

Shape (Column 20)		X-Dimension (Columns 31-40)
0 or Blank	-	Blank or zero means the ratio of current weight to the weight of the specified element (entered in the Y-Dimension field) is used to calculate the I_o and/or I_t (if 999 is entered in the Z-Dimension field) based on the specified element's I_o and/or I_t.
	-	Percentage which is used to calculate the item's I_o and/or I_t based on the specified element's (entered in the Y-Dimension field) I_o and/or I_t. For 1% enter 100, for 0.05% enter 5, etc.
1	-	I_o about the local axis oriented in the ship's longitudinal direction.
2, 3, 4, 5, 7	-	X dimension (A of Figure 15).
6	-	Blank

For the percentage option (0 or blank in column 20) there are two possible options for calculating the I_o and/or I_t terms. For the first option, the X-Dimension field is left blank and there is a three-digit element number contained in the Y-Dimension field. For this case the I_o for the data line will be calculated as a percentage of the I_o for the specified element. The percentage used will be the weight of the data line to the element weight. If 999 is entered in the Z-Dimension field, the I_t will be calculated in a similar manner. If a percentage is inserted in the X-Dimension field and an three-digit element number is in the Y-Dimension field, the I_o will be calculated as the defined percentage of the I_o for the specified element. If 999 is entered in the Z-Dimension field, the I_t will be calculated in a similar manner.

Columns 41-50, Y-Dimension. For each of the shape definitions given in column 20 the following

information must be entered. The format for this field is right justified with an implied decimal point between columns 48 and 49.

Shape (Column 20)		X-Dimension (Columns 41-50)
0 or Blank	-	Three-digit element on which I_o and/or I_t percentage calculation is based. If blank the calculation will be based on the current three-digit element.
1	-	I_o about local axis oriented in the ships transverse direction.
2, 5, 7	-	Y dimension (B of Figure 15)
3, 4, 6	-	Outer Radius (R of Figure 15)

Columns 51-60, Z-Dimension - For each of the shape definitions given in column 20 the following information must be entered. The format for this field is right justified with an implied decimal point between columns 58 and 59.

Shape (Column 20)		Z-Dimension (Columns 51 – 60)
0 or Blank	-	If blank, only the I_o calculation will be done using a ratio or an entered percentage. If 999 is entered, then both the I_o and I_t calculation will be done using a ratio or an entered percentage.
1	-	I_o about the local axis oriented in the ship's vertical direction.
2, 5	-	Z dimension (C of Figure 15).
3, 4	-	Inner Radius (r of Figure 15).
6, 7	-	Blank

Columns 61-70, T-Dimension - For each of the shape definitions given in column 20 the following information must be entered. The format for this field is right justified with an implied decimal point between columns 68 and 69.

Shape (Column 20)		T-Dimension (Columns 61-70)
0, 1, 2, 4, 5, 7 or Blank	-	Blank
3, 6	-	Thickness (t of Figure 15).

Columns 79-80, Report Number. Enter the report number where the change was first incorporated as described for the first line of data.

4.0 GENERAL INPUT DATA REQUIREMENTS

4.1 Load Titles

Line items for titles shall be prepared for each required load condition, and for each load element comprising that condition, in accordance with ESWBS in the following format:

Column 1	-	Alpha load condition designator
Columns 2 and 3	-	Load element number
Columns 4 and 5	-	Zeros
Column 10	-	Zeros
Columns 14 through 37	-	Load element title

4.2 Load Details

Loads for ESWBS are classified in much the same manner as light ship elements in groups 1 through 7, and follow the same format. Input data must be prepared for all detail load items comprising the full load condition (F in column 1). The letters "A" through "L" are used in column 1 to indicate various other loading conditions.

4.3 Margins

Margins for ESWBS are classified in accordance with ESWBS. The weight and moment of each margin will be automatically distributed over the 22 longitudinal stations in proportion to the light ship weight distribution. The margins can be either input as a total weight, or as a percentage of total light ship displacement. Line items for margins are prepared in a similar manner to light ship details. The first line item of the margin group shall be a title of the form "M0000----0---- Margins", beginning on column 1. Margin depletions are handled as negative detail weight entries, in the same manner as light ship details, and follow the same format. Margin options are as follows:

a. Option 1 - Input weight - Enter the total margin weight in pounds in columns 46 through 53, and centers of gravity as desired. All or any centers of gravity may be left blank. The margins will then be automatically positioned at the light ship centers of gravity.

b. Option 2 – Percentage - Margin may be computed as a percentage of total light ship. In the unit weight, columns 46 through 53, enter the percentage desired (for example: 4 percent = 4.00). Enter zero in column 57 of number of units. Centers of gravity may be entered or left blank. If left blank, margins will be placed at light ship centers of gravity.

4.4 Titles

Titles for groups 1 through 7 are included in the Navy program. All other titles shall be prepared by the user. A title shall be prepared for each of the ESWBS elements.

5.0 DATA TRANSFER

5.1 Data Transfer

Data files, when required by the contract or Ship Specifications, shall be transferred via electronic media such as a CD-ROM in ASCII format.

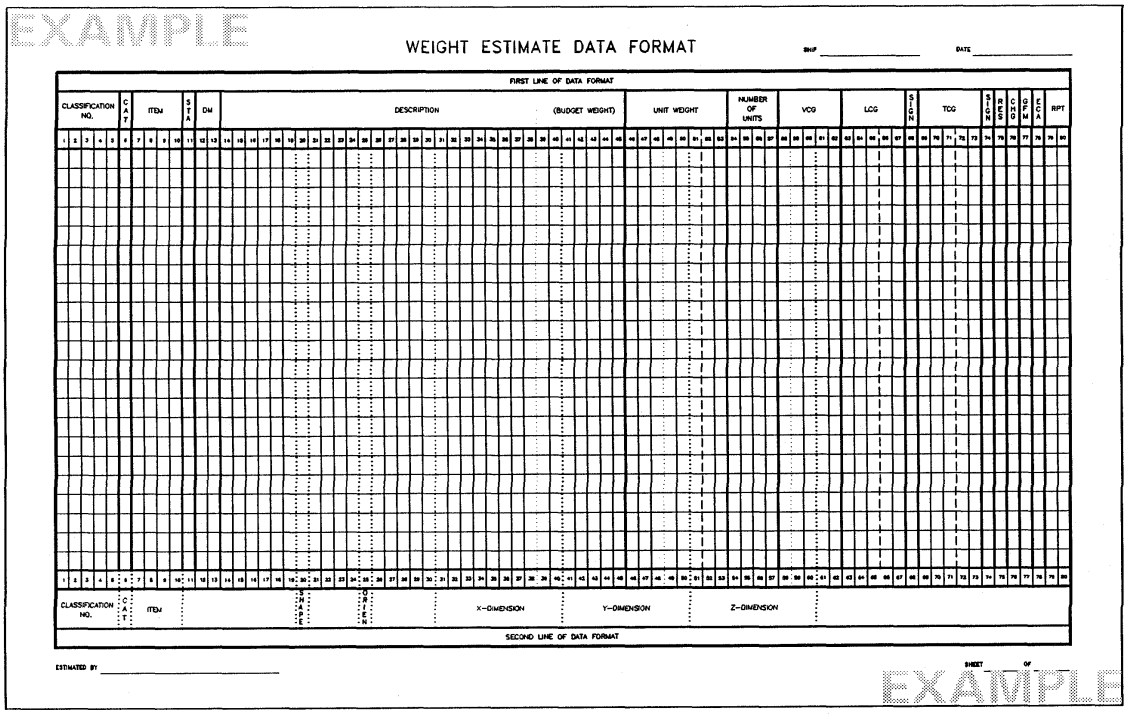

Figure 13 - Example of Navy Standard Weight Estimate Format

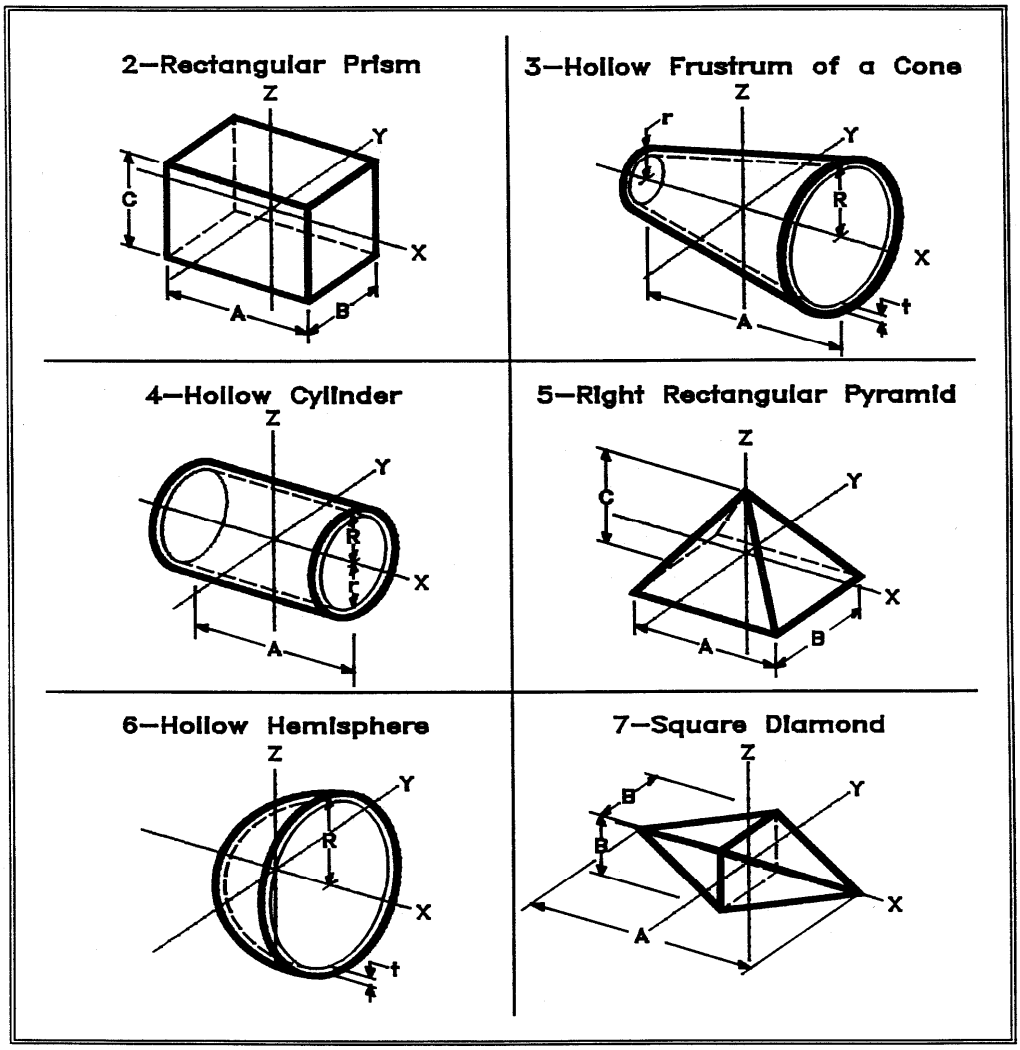

Figure 14 - Shapes for I_o Calculation