NOTE: DOD-STD-2143 has been redesignated as a Design Criteria Standard. The cover page has been changed for Administrative reasons. There are no other changes to this Document.

METRIC

DOD-STD-2143 (SH)
1 June 1983

DEPARTMENT OF DEFENSE
DESIGN CRITERIA

MAGNETIC SILENCING REQUIREMENTS FOR THE CONSTRUCTION OF NONMAGNETIC SHIPS AND CRAFT (METRIC)

AMSC N/A FSC 1905

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DEPARTMENT OF THE NAVY
NAVAL SEA SYSTEMS COMMAND

Washington, DC 20362

Magnetic Silencing Requirements for the Construction of Nonmagnetic Ships and Craft (Metric).

DOD-STD-2143 (SH)

1. This Military Standard is approved for use by the Naval Sea Systems Command, Department of the Navy, and is available for use by all Departments and Agencies of the Department of Defense.

2. Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Commander, Naval Sea Systems Command, SEA 55Z3, Department of the Navy, Washington, DC 20362 by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

FOREWORD

1. This standard establishes uniform criteria for materials and equipment which, when implemented, will reduce the magnitude of the magnetic field of nomagnetic mine warfare ships and craft. It also provides for the tagging of material and equipment complying with the requirements of this standard and standardized documentation of magnetic information which will facilitate the evaluation of the effects on the magnetic field of nonmagnetic mine warfare ships and craft from materials l nd equipment installed on or in the ship or craft.

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1. SCOPE

1.1 Scope. This standard covers the requirements that are imposed on materials and equipment which are to be installed on and that are pertinent to the magnetic silencing characteristics of nonmagnetic mine warfare ships and craft.

1.1.1 Application. Adherence to this standard is required in the design of items, equipment, parts of equipment, parts of equipment and systems which are to be installed on nonmagnetic mine warfare ships and craft. Adherene to this standard also required in the development of installation practices for nonmagnetic mine warfare ships and craft. This standard is not mandatory in the design of items, equipment, parts of equipment and systems or in the development of installation practices for ships and craft with magnetic steel hulls.

1.2 Classification. Classification is applicable to the magnetic field sources upon which the requirements of this standard are imposed and types of magnetic information drawings.

1.2.1 Magnetic field sources. Magnetic field sources are classified as follows:

Class 1. Ferrous field source.

Class 2. Eddy current field source.

Class 3 l Stray field source.

2. REFERENCED DOCUMENTS.

2.1 Issues of documents. The following documents, of the issue in *effect* on date of invitation for bids or request for proposal, form a part of this specification to the extent specified herein.

SPECIFICATIONS

MILITARY

MIL-P-15024 - Plates, Tags, and Bands for Identification of Equipment l

MIL-P-15024/5 - Plates, Identification.

STANDARDS

MILITARY

MIL-STD-1310 - Shipboard Bonding, Grounding, and Other Techniques for Electromagnetic Compatibility *and Safety* l

DOD-STD-1399, Section 070, Part 1 - Interface Standard for Shipboard Systems, D.C. Magnetic Field Environment (Metric).

DOD-STD-2133 - Cable Arrangement for Minimum Stray Magnetic Field (Metric).
DOD-STD-2134 - Storage Battery Arrangement for Minimum Stray Magnetic Field (Metric).
DOD-STD-2141 - Definitions and Systems of Units, Magnetic Silencing (Metric).
DOD-STD-2142 - Magnetic Silencing Characteristics, Measurement of (Metric).
DOD-STD-2144 - Induction Clutches, Low Magnetic Field Design of (Metric).
DOD-STD-2145 - Disconnect Switch Boxes- Contactor Panels and Switchboards, Low Magnetic Field Design of (Metric).
DOD-STD-2146 - Direct Current Generators and Motors, Low Stray Magnetic Field Design of (Metric).

HANDBOOK

MILITARY

DOD-HDBK-270 - Metallic Materials, Magnetic Permeability y and Electrical Conductivity, Characteristics of (Metric).

(Copies of specifications, standards, drawings, and publications required by contractors in connection with specific acquisition functions should be obtained from the contracting activity or as directed by the contracting of ficer.)

3. DEFINITIONS

3.1 General magnetic silencing terms. The meanings of general magnetic silencing terms used in this standard are in accordance with DOD-STD-2141.

3.1.1 B. See flux density (3.1.5).

3.1.2 Center. As used in this standard, center refers to the geometric center of the item (that is, center of a battery arrangement).

3.1.3 Enclosure. Enclosure refers to any structure that envelops a space or quantity within itself, such as boxes, lockers, switchboards, electrical cabinets, storage containers, and tanks.

3.1.4 Face area. Face area refers to the side of an enclosure which has the greatest surface area, whether it is the side, top, or bottom of the enclosure.

3.1.5 Flux density. Flux density is the magnetic flux per unit area denoted as B. This quantity is often specified or referred to in lieu of magnetic field intensity, H (valid in air or vacuum environment only).

3.1.6 Grounding wire. Grounding wire is a ground connection of equipment and items at the level of the branch ground in the ship’s or craft’s grounding system (see MIL-STD-1310).

3.1.7 Loop. A loop is any structure that forms an electrically continuous path, such as piping loops, subbaseo, foundations, and non-synmetrical structures.

3.1.8 Magnetic documentation. Magnetic documentation refers to magnetic information drawings and aperture cards of magnetic information drawings (see 5.8).

3.1.9 Piping system . As used in this standard, piping system is -a structure which, as a system, transfers a fluid from one point to another point.

3.1.10 Plate. A plate is a flat, continuous surface of material.

4. GENERAL REQUIREMENTS.

4.1 Material. In general, material, to be installed, on nonmagnetic mine warfare ships and craft shall be nonmagnetic and shall not exceed the applicable size limitations of 5.3. Magnetic materials may be used when required by an electrical function (see 5.2.1.1) or when required for mechanical strength (see 5.2.1.2).

4.1.1 Selection of material. DOD-HDBK-270 my be used as a guide in the selection of material to be installed on nonmagnetic mine warfare ships and craft. Regardless of how the material selection is made, the material shall conform to the requirements of this standard.

4.2 Direct current (d.c.) electrical circuits. D.c. electrical circuit(s) which will be operated on any nonmagnetic mine warfare ship or craft shall be designed in accordance with the requirements of 5.4, to minimize the stray magnetic field produced by the circuit(s).

4.3 Provision of Identification plates. Material and equipment that have met the requirements of this standard shall be provided with a separate identification plate, which shall be permanently attached to the material and equipment. The identification plate inscription shall be as follows, with the appropriate test method identification inserted:

(a) FOR MATERIAL: This material conforms to DOD-STD-2143 and has passed test method _____ as specified in _____.

(b) FOR EQUIPMENT: This equipment conform to DOD-STD-2143 and has passed test method _____ as specified in _____.

This information shall not be combined on the general equipment identification plate.

4.3.1 Materials and physical characteristics of identification plates. Identification plates shall be in accordance with MIL-P-15024, type A, B, C, D, E, or F, and MIL-P-15024/5 except that class 302 corrosion-resisting steel material shall not be used.

4.4 Magnetic documentation. Magnetic documentation shall be provided in accordance with 5.8 for all class 1 and 2 field sources that are to be installed on nonmagnetic mine warfare ships and craft.

5 . DETAILED REQUIREMENTS

5.1 Minimization of magnetic field. It is essential that every effort be-made -to minimize the magnetic field of a nonmagnetic mine warfare ship-or craft. The magnetic field contribution-of individual components of a ship or craft to the total magnetic field of the ship or craft is dependent significantly upon the following:

(a) The magnetic characteristics of the component's material - whether it is magnetic or nonmagnetic is a function of its magnetic, permeability and its fabrication (see 5.2).
(b) The electrical conductivity of the component's material and the construction of the component (see 5.3).
(c} The d.c. circuits of the component (see 5.4).
(d) The orientation and location of the component on the chip or craft (see 5.5)₀
(e) The degaussing system installed on the ship or craft (see 5.6).

5.2 Magnetic characteristics (class 1).

5.2.1 Magnetic and nonmagnetic material requirements. In general, material to be installed as part of or on a nonmagnetic mine warfare chip or craft shall be nonmagnetic. Materials which serve an electrical function or require mechanical strength may be magnetic in accordance with 5.2.1.1 and 5.2.1.2, respectively .

5.2.1.1 Material serving an electrical function. Material, of which electrical function in equipment requires the material to be magnetic for normal operation, may be magnetic. However, equipment shall be designed to minimize the volume of magnetic material required. Upon the request of the contracting activity, the contractor shall prove to the satisfaction of the contracting activity that a nonmetallic or a nonmagnetic material cannot be used.

5.2.1.2 Material requiring mechanical strength. The material of an equipment or equipment part which must exhibit a mechanical strength that cannot be attained with nonmagnetic material may be magnetic. However, the equipment or equipment part shall be designed to minimize the volume of magnetic material required. Upon the request of the contracting activity, parts subject to usage under high stress, where the maximum dimension of the equipment or equipment part exceeds 5 centimeters (cm) and where the sun of the maximum dimension of all parts having a similar function in a 9 meter section of the ship exceeds 1.5 meters, shall be reported to the contracting activity. The contractor, upon the request of the contracting activity, shall prove to the satisfaction of the coatracting activity that a nonmetallic or a nonmagnetic material cannot be used.

5.2.1.3 Location of mandatory magnetic material. Components containing magnetic material shall be located as high in the ship or craft as practicable and shall be widely dispersed through the ship or craft as is practicable, to avoid producing peaks in the curve of the ship's or craft's magnetic signature.

5.2.2 Permeability of material.DOD-HDBK-270 may be used. as guidance relating -to the effects of fabrication methods on the magnetic permeability of materials. However, regardless of materials selected because of conclusions drawn from DOD-HDBK-270, the relative magnetic permeability af ter fabrication , of all materials shall not exceed 2.0, subject to the exceptions of 5.2.1.1. or 5.2.1.2.

5.2.3 Welding.. Welds shall have a relative magnetic permeability of 2.0 or less in their finished comdition.

5.2.4 Magnetic components l Unless otherwise approved by the contracting activity prior to installation, items, equipment, or systems which contain magnetic components in accordance with 5.2.1.1 or 5.2.1.2 shall not emanate a ferrous magnetic field greater than 0.15 ampere per meter (A/m) (B - 188 nT) at any point 2 meters from the center of the item, equipment or system.

5.3 Electricity conductivity of material (class 2). Any material to be installed as part of or on a nonmagnetic mine warfare ship or craft shall conform to the requirements of 5.3.1 and 5.3.2, and to the size limitation specified in 5.3.3 through 5.3.11.

5.3.1 Electrical conductors. Except for ground conductors and cable armor, electrical conductors specifically designed to carry an electric current (alternating or direct) shall not be required to conform to the size limitation specified in 5.3.4. However, electrical conductors designed to carry d.c. shall conform to the requirements of 5.4. Ground conductors shall conform to the requirements of 5.3.2.

5.3.2 Grounding The ship’s or craft’s ground system shall be in accordance with MIL-STD-1310 for nonmetallic hull ships. In addition, grounding wires shall be insulated and shall have a cross-sectional area equal to or less than 5.27 mm2 (10,400 circular roils) and shall have a minimum length of 2 meters or shall be wires which have the equivalent resistance. Only one wire shall be used to ground an equipment or item. No electrically continuous loops shall be formed by the grounding wire.

5.3.3 Piping systems. The electrically continuous paths of any piping system to be installed on nonmagnetic mine warfare ships or craft shall not enclose an area exceeding the applicable limiting area of figure 1 for ships and figure 5 for craft.

5.3.4 Loops other than in piping systems. The electrically continuous paths of any loops, other than the ones constituting a piping system (see 5.3.3), to be installed on nonmagnetic mine warfare ships or craft shall not enclose an area exceeding the applicable limiting area of figure 2 for ships and figure 6 for craft.

5.3.5 Plates. Plates constructed of electrically continuous material to be installed on nonmagnetic mine warfare ships or craft shall not have an area exceeding the applicable limiting area of figure 3 for ships and figure 7 for craft.

5.3.6 Enclosures. Enclosures constructed of electrically continuous material to be installed on nonmagnetic sine. warfare ships or craft shall not have face areas exceeding the applicable limiting area of figure 4 for ships and figure 8 for craft.

5.3.7 Parameters for loops, plates and enclosures. The significant parameters associated with, finding the enclosed areas of hops. (see 5.3.3 and 5.3 .4), the areas of plates (see 5 .3.5), and the limiting, face area of enclosures (see 5.3 .6) are included on figures 9 (loops constituting piping systems), 10 (loops other than loops constituting piping systems), 11 (plates), and 12 (enclosures).

5.3.8 Resistive joints. The electrical continuity of an electrically continuous path or surface covered by 5.3.3 through 5.3.6, whose enclosed area exceeds the limiting area of figures 1 through 8, as applicable, shall be broken by the installation of a resistive element having l resistence of at least 1 ohm. Each electrically continuous path that exceeds the limiting area shall be broken in two places approximately 180 degrees apart. The parts shall be rejoined by resistive elements. Each electrically continuous surface shall be broken such that the sum of any two resulting enclosed areas is less than or equal to the limiting area. The parts shall be rejoined by resistive elements.

5.3.9 Compensating coils- If it is absolutely imperative that the path or surface covered by 5.3.3 through 5.3.6, whose enclosed areas exceeds the limiting area of figures 1 through 8, as applicable, not be broken, and an alternative material cannot be used, then special eddy current compensating coils shall be designed and utilized to compensate the resultant eddy current magnetic field.

5.3.10 Limitations for groups of boxes on any 6 by 6 meter section of a deck. Groups of boxes on any 6 by 6 meter section of a deck shall meet the following limitation:

$$\left[\sum_i (a_i \times A_i^{1.5})\right] + \left[0.1 \times \sum_j (a_j \times A_j^{1.5})\right] \leq 440$$

where "a" is the cross-sectional area in square cm of the box, as determined by the product of the thickness of the material and the dimension of the box which is perpendicular to the face area of the box; and "A" is the face area in square meters. If the conductivity (°) of the material of a specific box is greater than 10 percent of the conductivity of copper, the first term of the equation is used; if the conductivity of the material of a specific box is less than or equal to 10 percent of the conductivity of copper, the second term of the equation is used. For an example of these calculations, see appendix A.

5.3.11 Rotating sources. Plans and dimensions of items of electrically continuous material, which rotate at a rate exceeding 1 revolution per minute, shall be submitted to the contracting activity for approval prior to installation.

5.4 Stray field sources (class 3) "in' d.c. circuits. D.c electric circuits (except degaussing coils) shall be in accordance with the" requirements of 5.4.1 through 5.4.6, in so far as practicable.

5.4.1. Cables. Cables shall be arranged in accordance with DOD-STD-2133. Limitations on stray aagnetic field emanations frti cables shall be in accordance with 5.4.2 through 5.4.6.

5.4.2 Batteries. Batteries shall be arranged in accordance with DOD-STD-2134 by battery arrangement of which the center is separated from its associated equipmet by 1.5 meters or more shall be considered a separate stray field source and not as part of its associated equipment. Any battery arrangement of which the center is within 30 cm of its associated equipment shall be considered part of the equipment as a stray field source.

5.4.3 Meters and generators other than magnetic minesweeping generators. Design of motors and generators shall conform to the requirements of DOD-STD-2146 in order to minimize thdr stray magnetic field.

5.4.4 Magnetic minesweeping generator. Each magnetic minesweeping generator and associated circuitry shall be designed to emanate low stray magnetic fields according to the following requirements:

(a) Minesweeping generator and motor-generator exciter set combined. The generator and exciter shall be designed in accordance with DOD-STD-2146.
(b) Contactor panel and switchboards. Contactor panels and switchboards shall be designed in accordance with DOD-STD-2145.
(c) Magnetic minesweep cable. The arrangement of the magnetic minesweep cable shall be in accordance with DOD-STD-2133.
(d) Associated circuitry not included in (a), (b), or (c) above shall be designed in accordance with the requirements of DOD-STD-2134, DOD-STD-2134, and DOD-STD-2145.

5.4.5 Induction clutches. When used, induction clutches shall be designed in accordance with DOD-STD-2144

5.4.6 Other circuitry. All other d.c. electric circuitry (except degaussing coils) not Included in 5.4.1 through 5.4.5 shall be designed in accordance with the requirements of DOD-STD-2133 and DOD-STD-2145

5.5 Orientation and location. Any items, equipment, or system designed In accordance with this standard shall be designed so that when installed or stored aboard ship, its orientation and location aboard ship will not change.

5.6 Degaussing system. A degaussing system shall be installed as specified by the contracting activity.

5.7 Susceptibility. All systems and equipment designed in accordance with this standard shall comply with the d.c. magnetic field environment interface requirements of DOD-STD-1399, Section 070, Part 1.

5.8 Documentation of magnetic information. Docmentation of magnetic information in accordance with 5.8.1 and 5.8.2 shall be provided to the contracting activity for items, equipment, parts of equipment, and systems that are class 1 or 2 field sources.

5.8.1 Magnetic information drawing. Magnetic information drawings shall be prepared for the items, equipment, parts of equipment, and systems being acquired. These drawings shall be in accordance with the data ordering document included in the contract or order (see appendix B). Only significant magnetic parameters of an item, equipment, parts of equipment, and system need to be shown in detail. The significant magnetic parameter shall include as a minimum, identification of magnetic material, nonmagnetic metallic material and nonmetallic material, dimensions, orientation with respect to the vertical, the magnetic permeability of materials, the electrical conductivity of materials, and d.c. circuits.

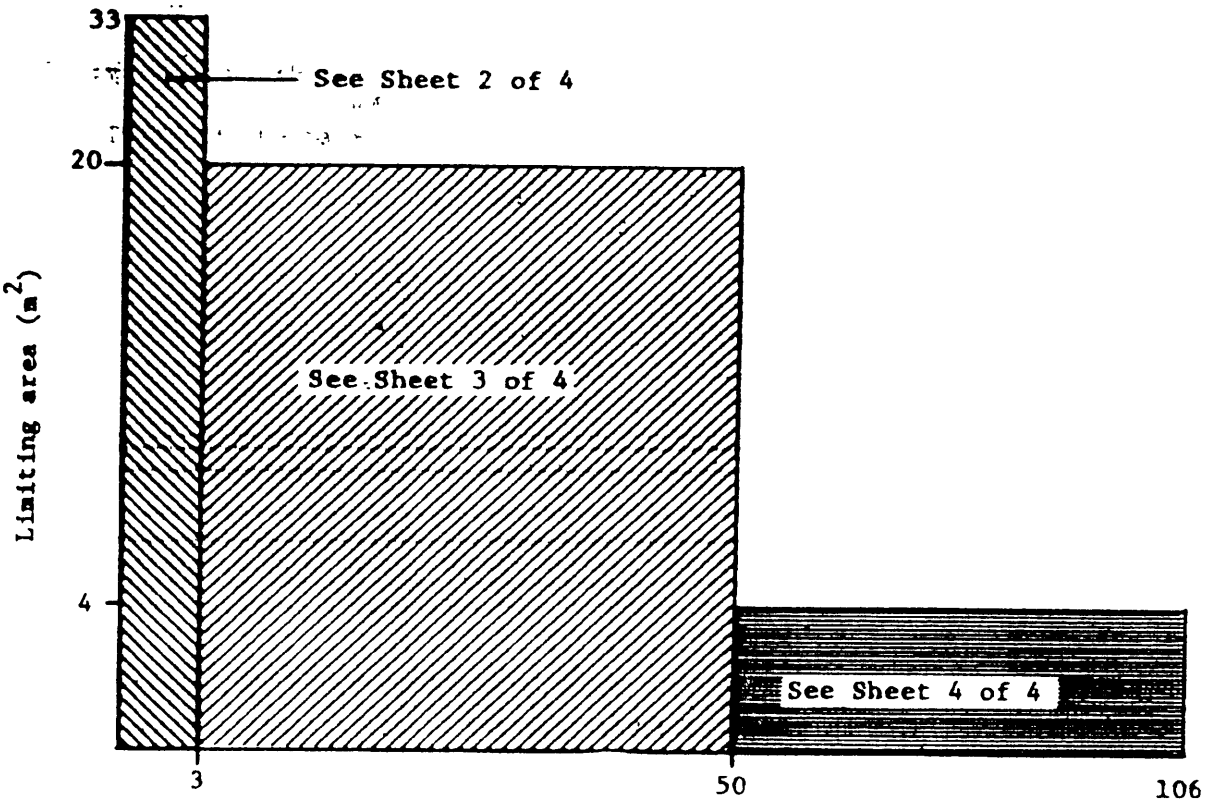
5.8.1.1 Details of drawing contents. Types of materials shall be identified by using the symbols indicated on figure 13, unless the symbols are already used on the drawing. In that case, appropriate distinct symbols shall be used and identified by notes on the drawings. If the dimensions of a material item, equipmeht, part of equipment, or system cover less than a 20 millimeter (mm) square area, an exploded view of the material item, equipment, part of equipment, or system shall be included in the drawing. The drawing shall include a material identification list which identifies the type of material in accordance with DOD-HDBK-270, if included in the handbook. In addition to the general magnetic information listed in 5.8.1, the magnetic information drawing shall include the following specific items for items, equipment, parts of equipment, and systems that are class 1 or 2 field sources:

Class 1 - Dimensions of enclosure, if enclosure is magnetic.
If the enclosure is nonmagnetic, then the dimensions of magnetic items in the enclosure.

Class 2 - Dimensions of electrically conductive materials, including the items inside the enclosure.
Thickness of the material.
Cross-sectional area, or dimensions, of the material.
Electrical conductivity of material.
Detail of connections made to or with the material (needed to ascertain the existence of electrical loops).

5.8.2 Aperture cards. When required by the contract, 35 mm microfilm of the magnetic information drawings mounted in aperture cards shall be provided as specified in the data ordering document (see appendix B).

Preparing activity:
Navy - SH
(Project 1905-N011)



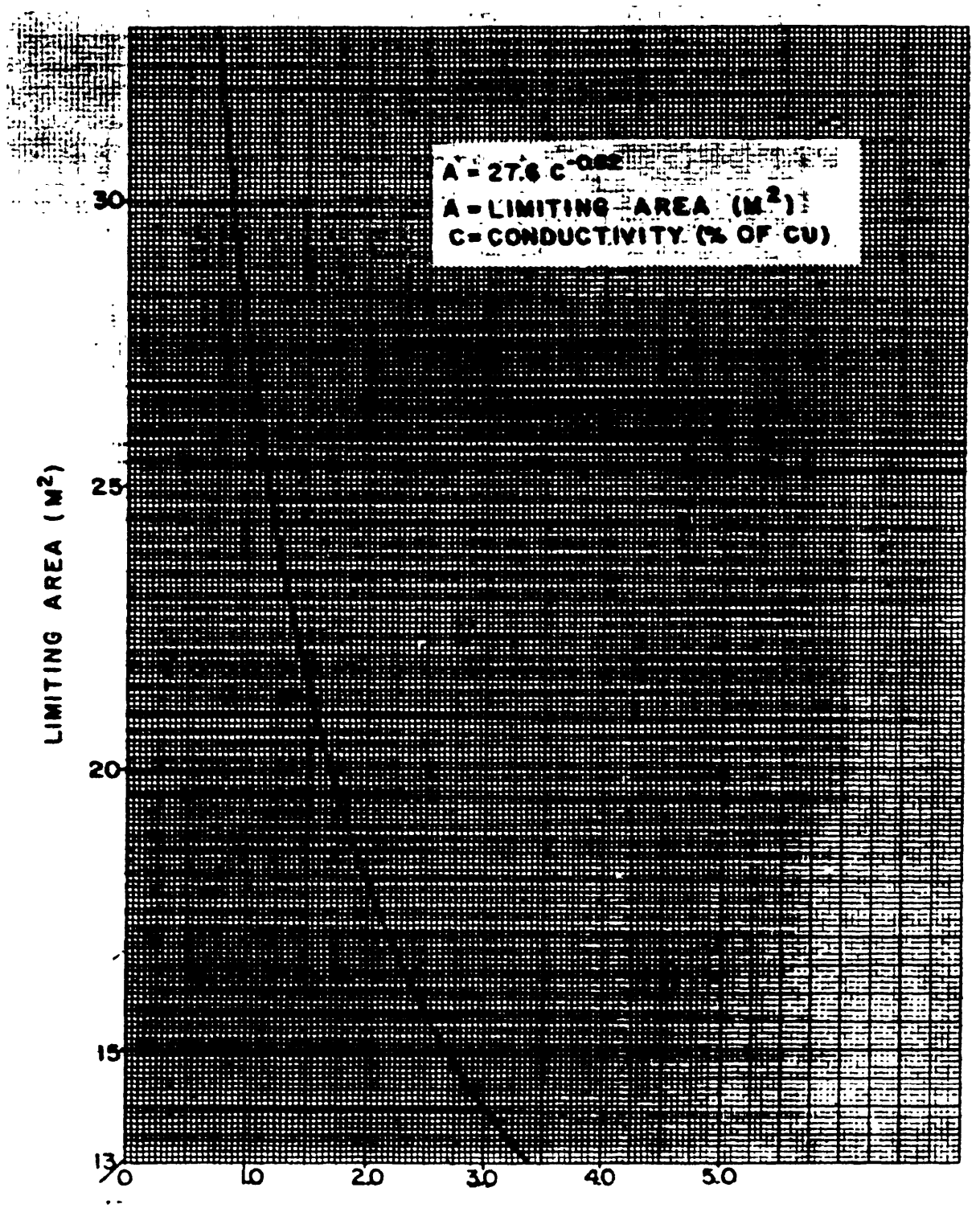
H 12212

FIGURE KEY

NOTE:

1. Percentage of conductivity refers to the electrical conductivity of materials relative to copper. Common materials having conductivity greater than 10 percent of copper are: copper, aluminum, brass and bronze. Common metals having conductivity less than 10 percent of copper are: steel (all types) and Monel.

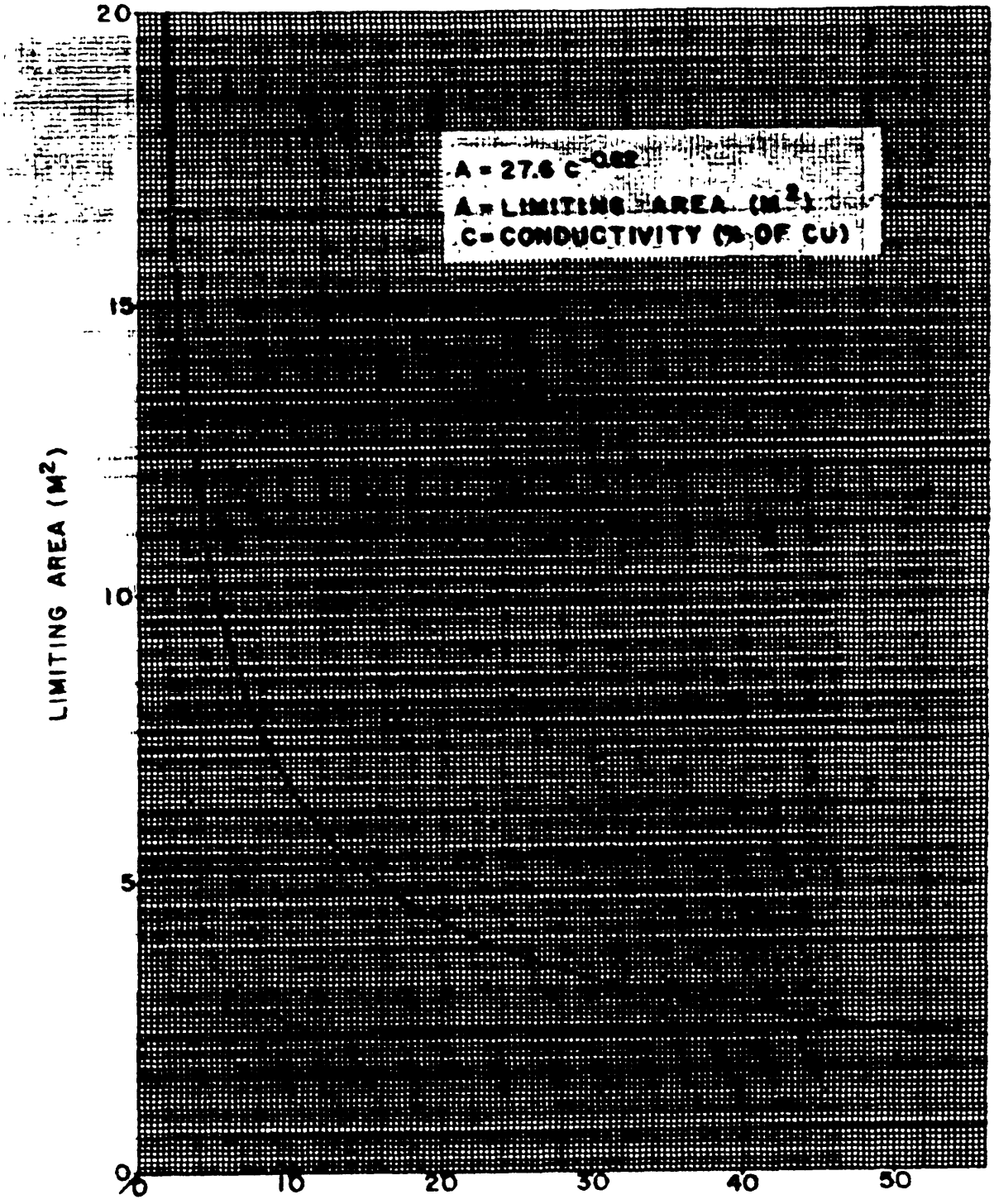
FIGURE 1. Permissible areas of electrically continuous loops constituting piping systems for ships (metric). (Sheet 1 of 4).



SH 12212

A. Conductivity between 0 percent and 3 percent of copper.

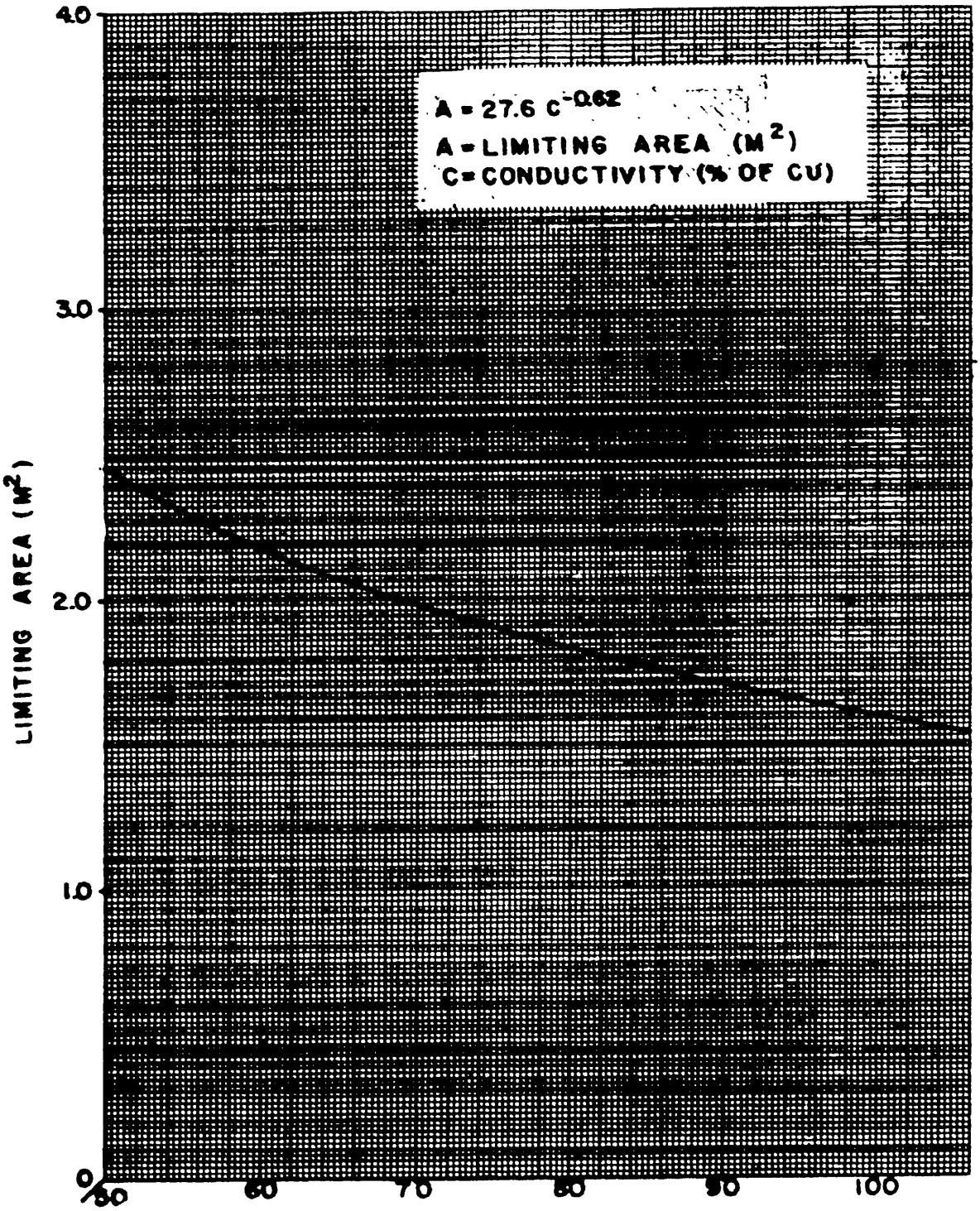
FIGURE 1. Permissible areas of electrically continuous loops constituting piping systems for ships (metric). (Sheet 2 of 4).



SH 12212

B. Conductivity between 3 percent and 50 percent of copper.

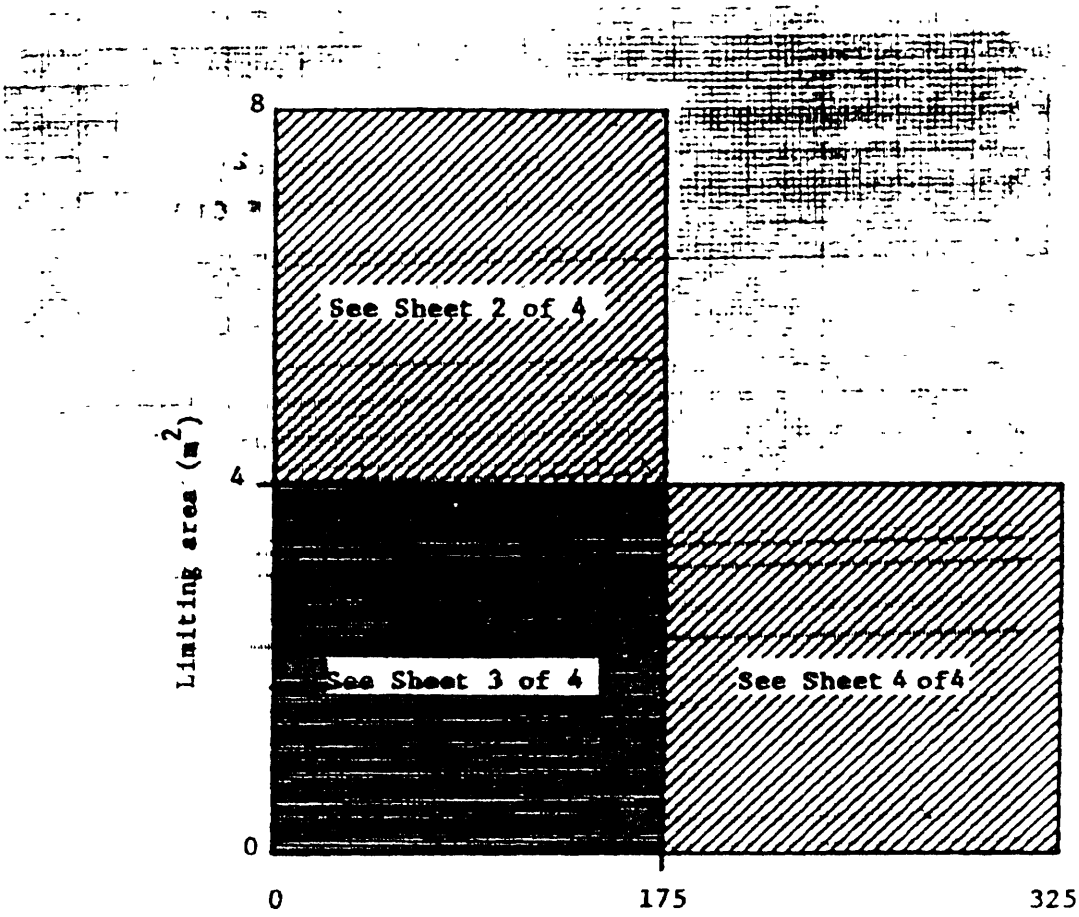
FIGURE 1. Permissible areas of electrically continuous loops constituting piping systems for ships (metric). (Sheet 3 of 4).



SH 12212

C. Conductivity between 50 percent and 106 percent of copper.

FIGURE 1. Permissible areas of electrically continuous loops constituting piping systems for ships (metric). (Sheet 4 of 4).



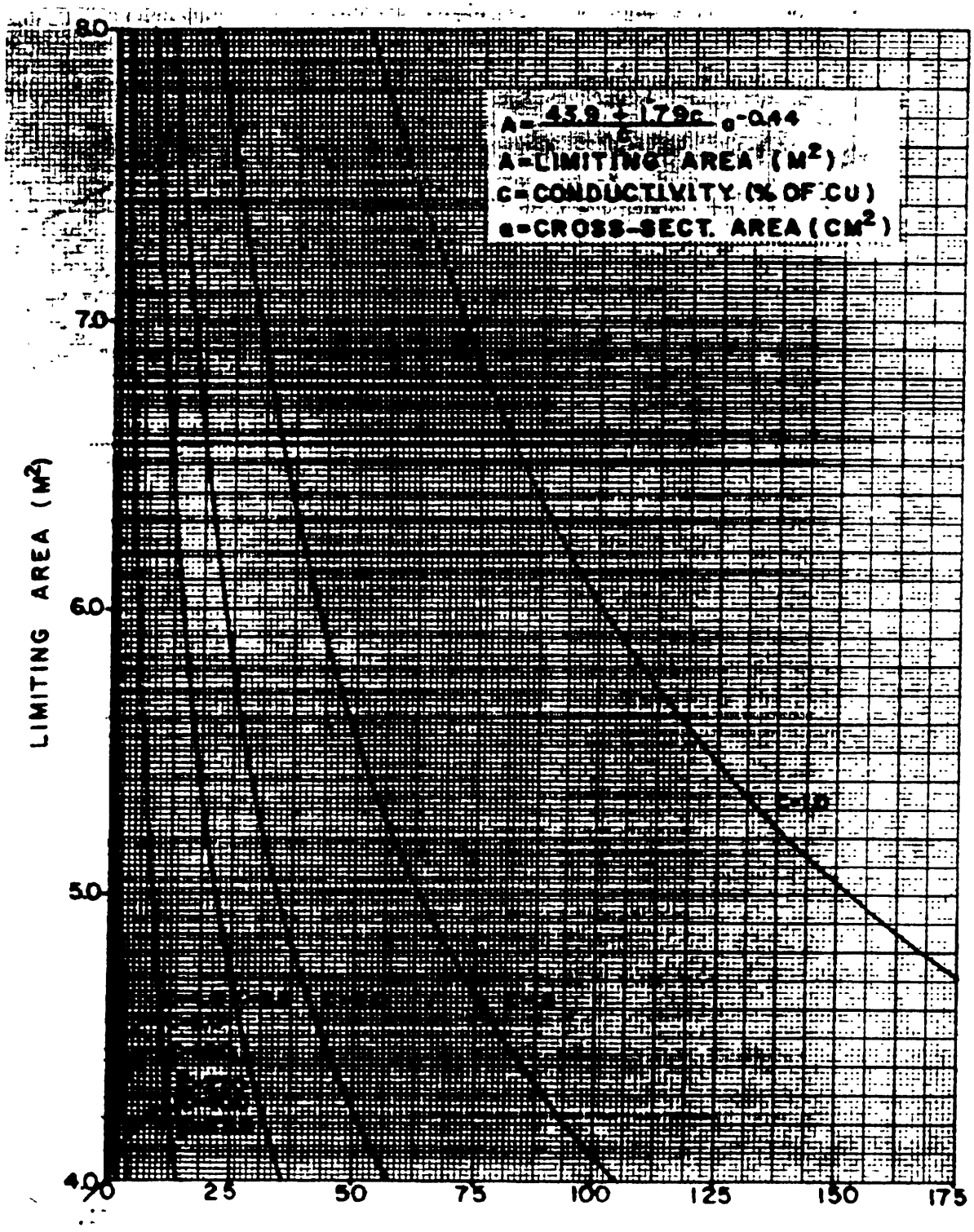
SH 12213

FIGURE KEY

NOTES:

1. Percentage of conductivity refers to the electrical conductivity of materials relative to copper. Common materials having conductivity greater than 10 percent of copper are: copper, aluminum, brass and bronze. Common metals having conductivity less than 10 percent of copper are: steel (all types) and Monel.
2. For a loop having non-uniform cross-sectional areas, an equivalent cross-sectional area may be used. This equivalent cross-sectional area shall be the area that will provide the same electrical resistance around the loop as the non-uniform cross-sectional area.
3. These curves are not applicable to closed loops of electrical cable, including grounding straps and armor.

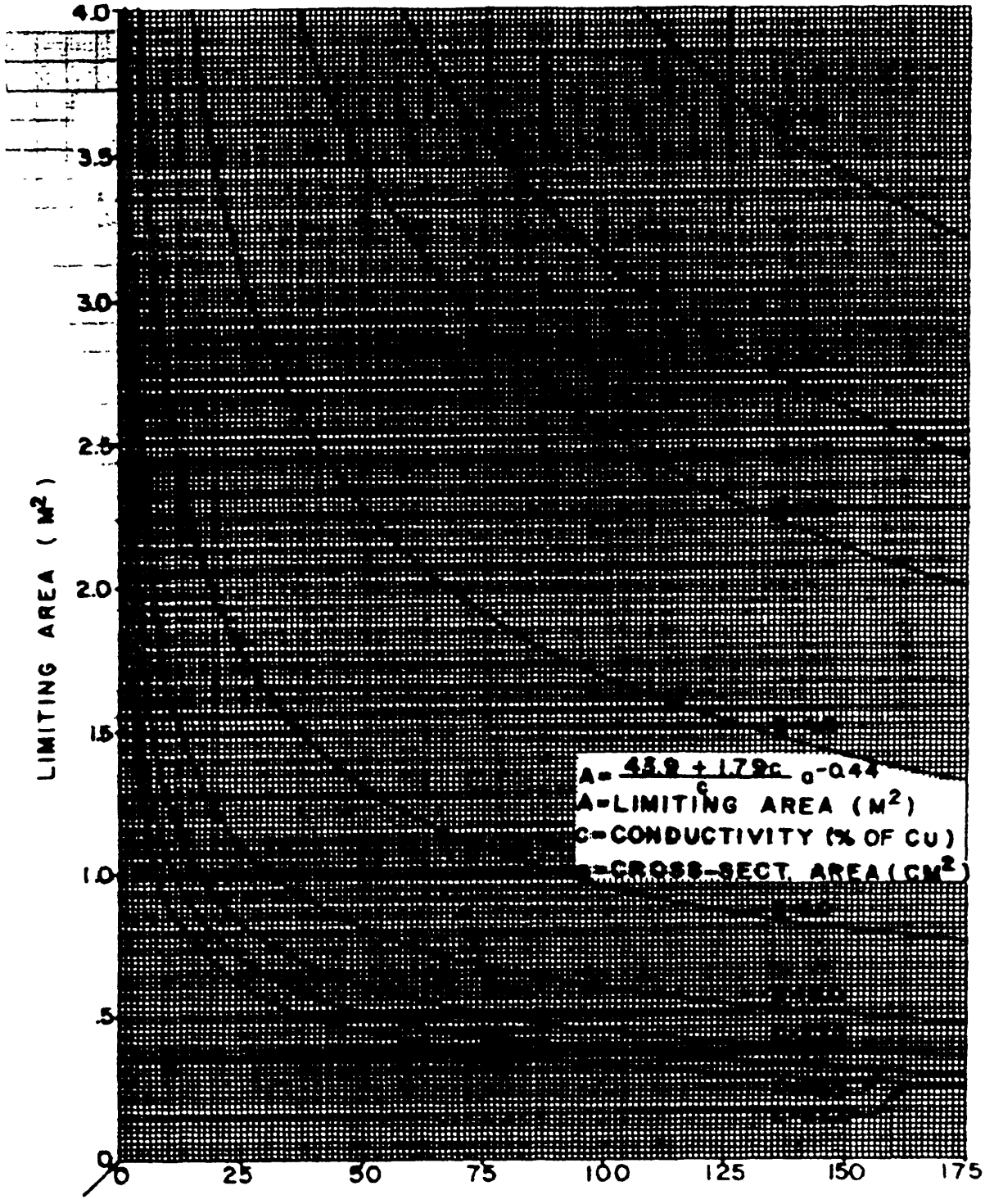
FIGURE 2. Permissible areas of electrically continuous loops other than loops constituting piping systems for ships (metric). (Sheet 1 of 4).



SH 12213

A. Limiting area between 4.0 and 8.0 m^2; cross-sectional area between 0 and 175 cm^2.

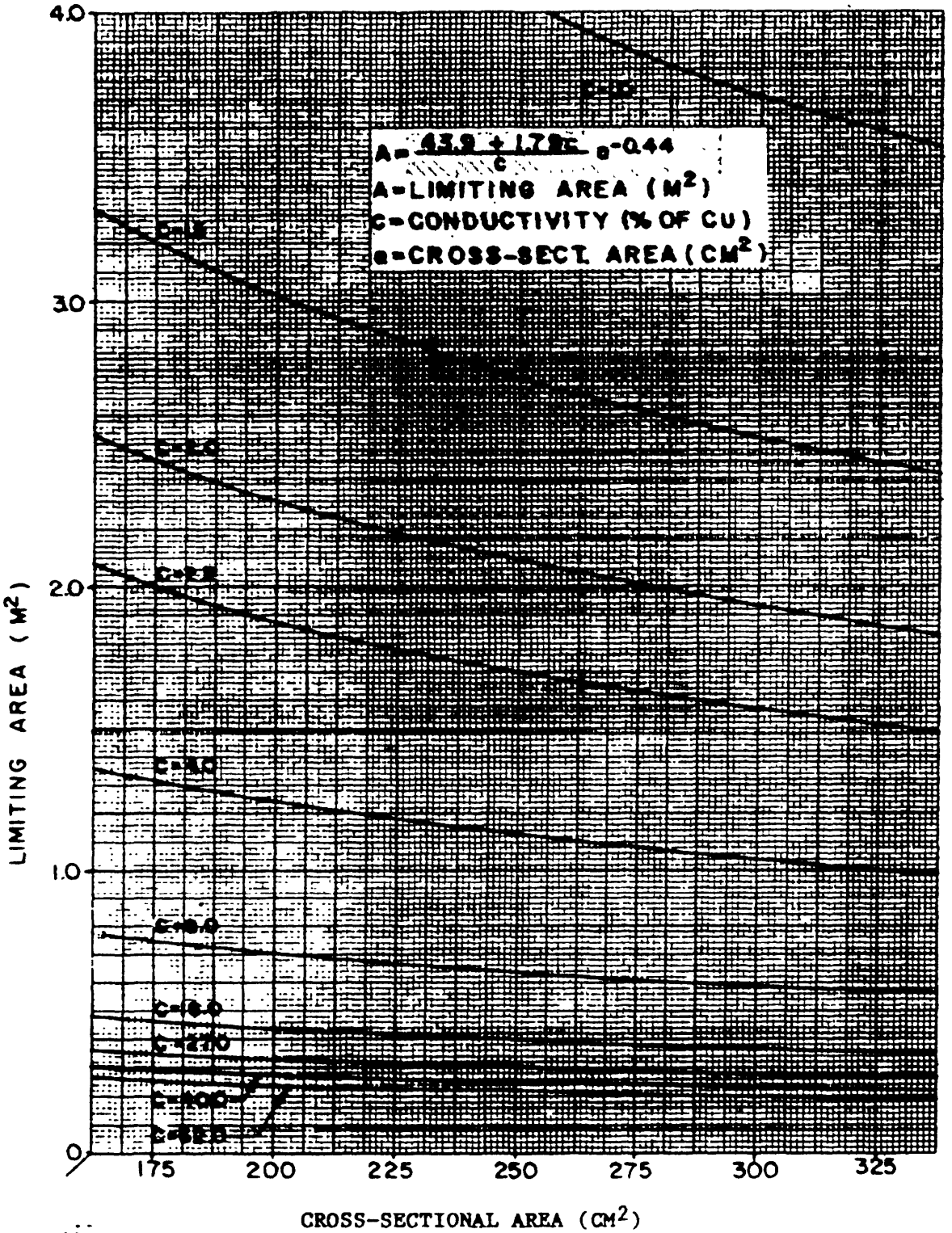
FIGURE 2. Permissible areas of electrically continuous loops other than loops constituting piping systems for ships (metric). (Sheet 2 of 4).



SH 12213

B. Limiting area between 0 and 4.0 m^2; cross-sectional area between 0 and 175 cm^2.

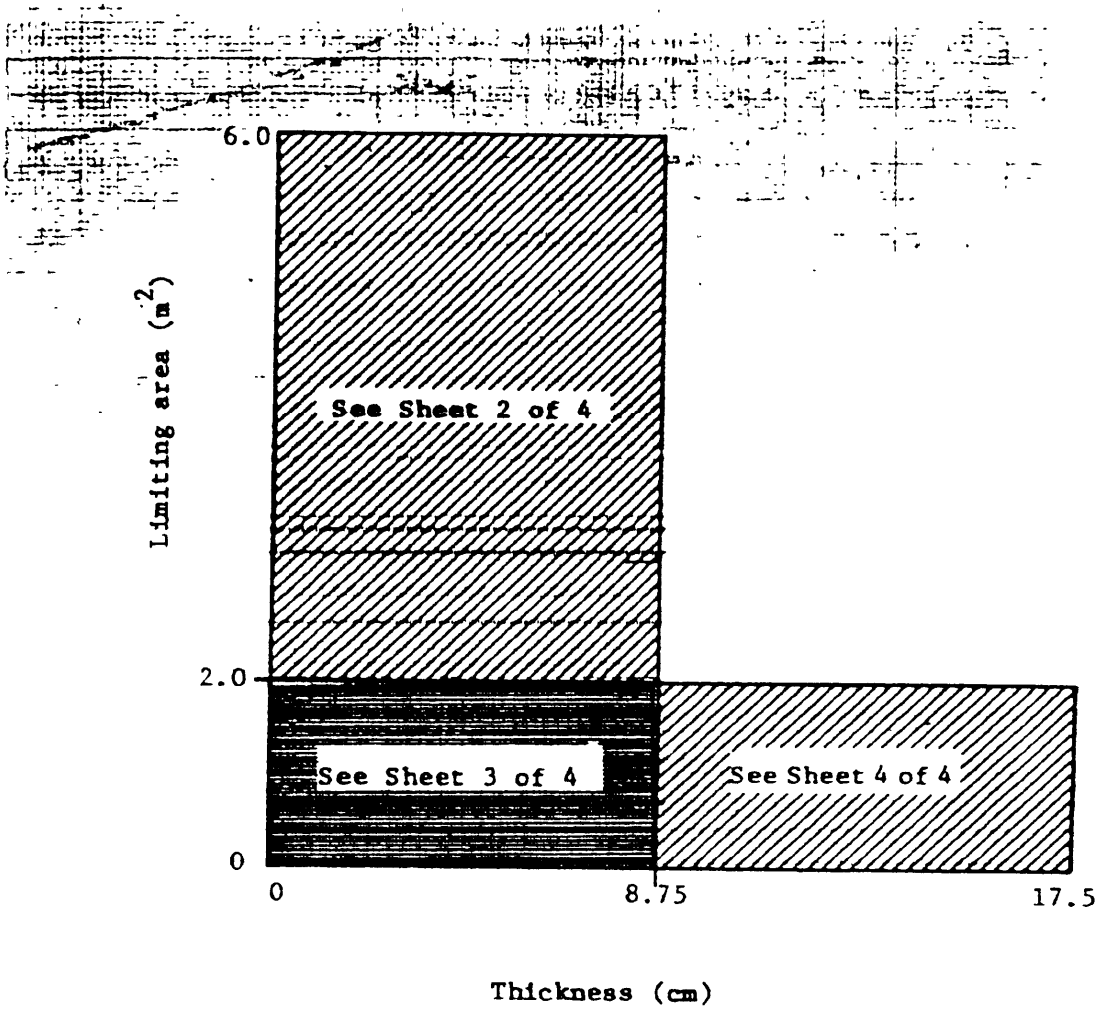
FIGURE 2. Permissible areas of electrically continuous loops other than loops constituting piping systems for ships (metric). (Sheet 3 of 4).



SH 12213

C. Limiting area between 0 and 4.0 m^2; cross-sectional area between 175 and 325 cm^2.

FIGURE 2. Permissible areas of electrically continuous loops other than loops constituting piping systems for ships (metric). (Sheet 4 of 4).



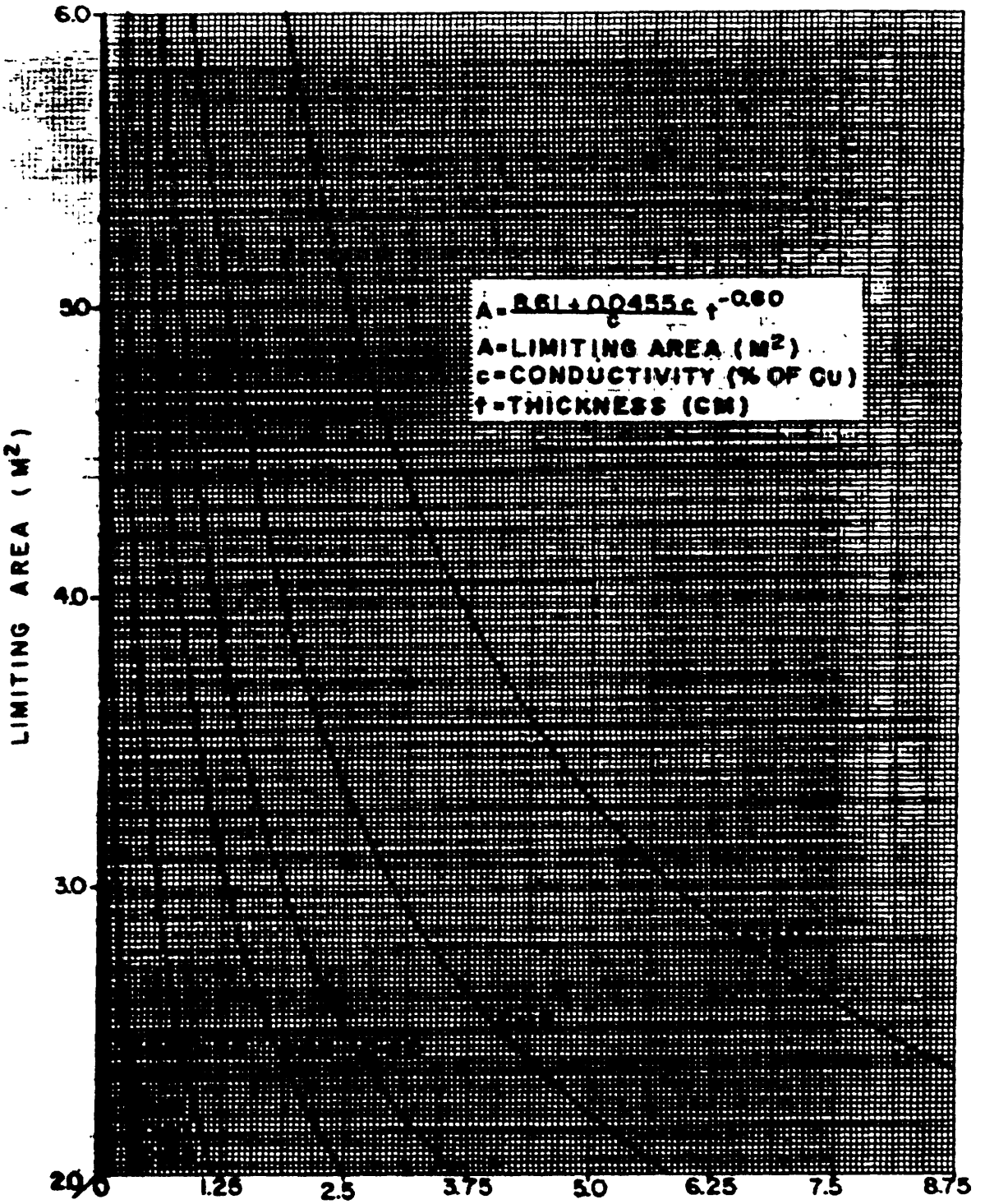
SH 12214

FIGURE KEY

NOTE:

1. Percentage of conductivity refers to the electrical conductivity of materials relative *to* copper. Common materials having conductivity greater than 10 percent *of* copper are: copper, aluminum, brass and bronze. Common metals having conductivity less than 10 percent of copper are: steel (all types) and Monel.

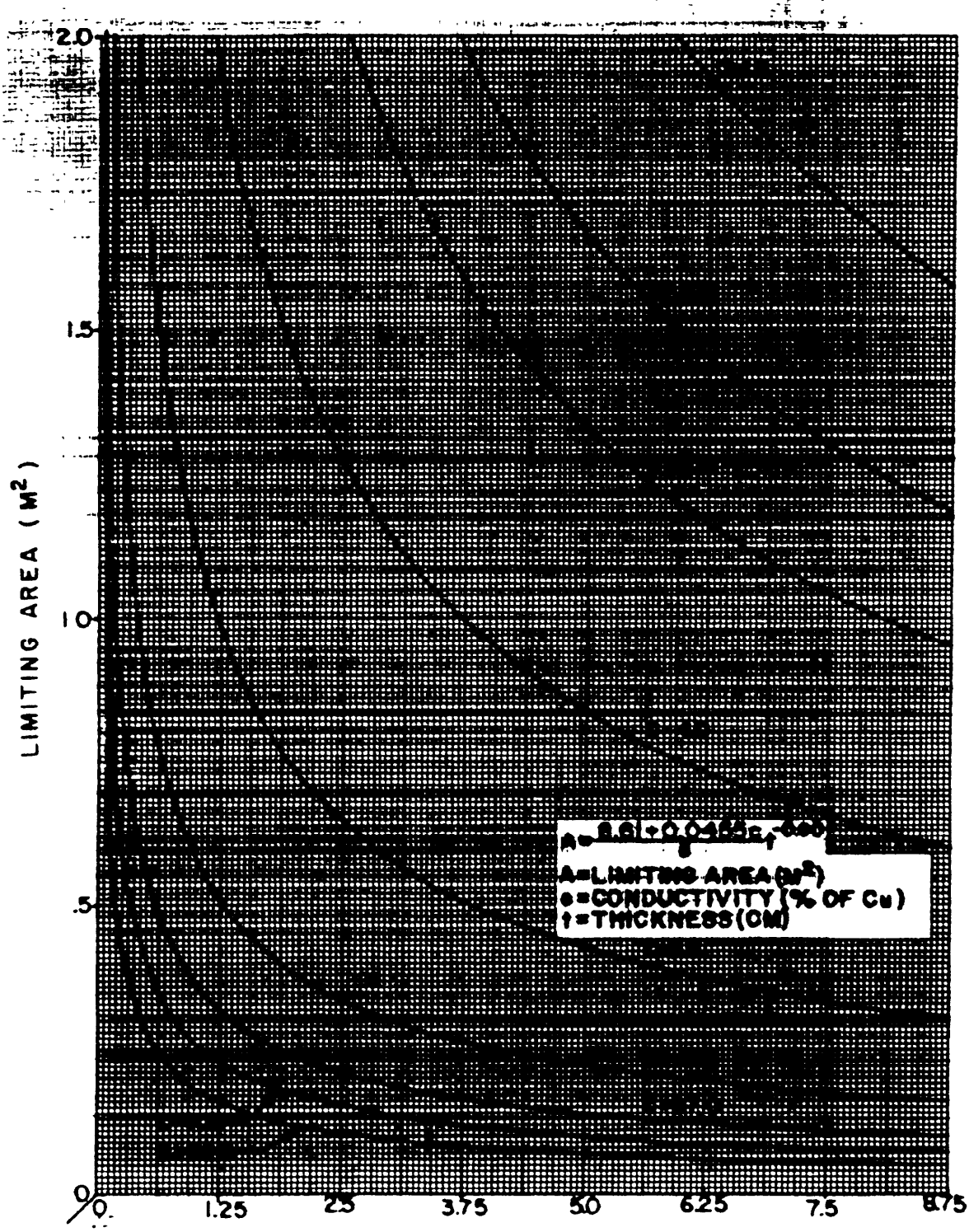
FIGURE 3. Permissible areas of plates of electrical conducting material for ships (metric). (Sheet 1 of 4).



SH 12214

A. Limiting area between 2.0 and 6.0 m^2; thickness between 0 and 8.75 cm.

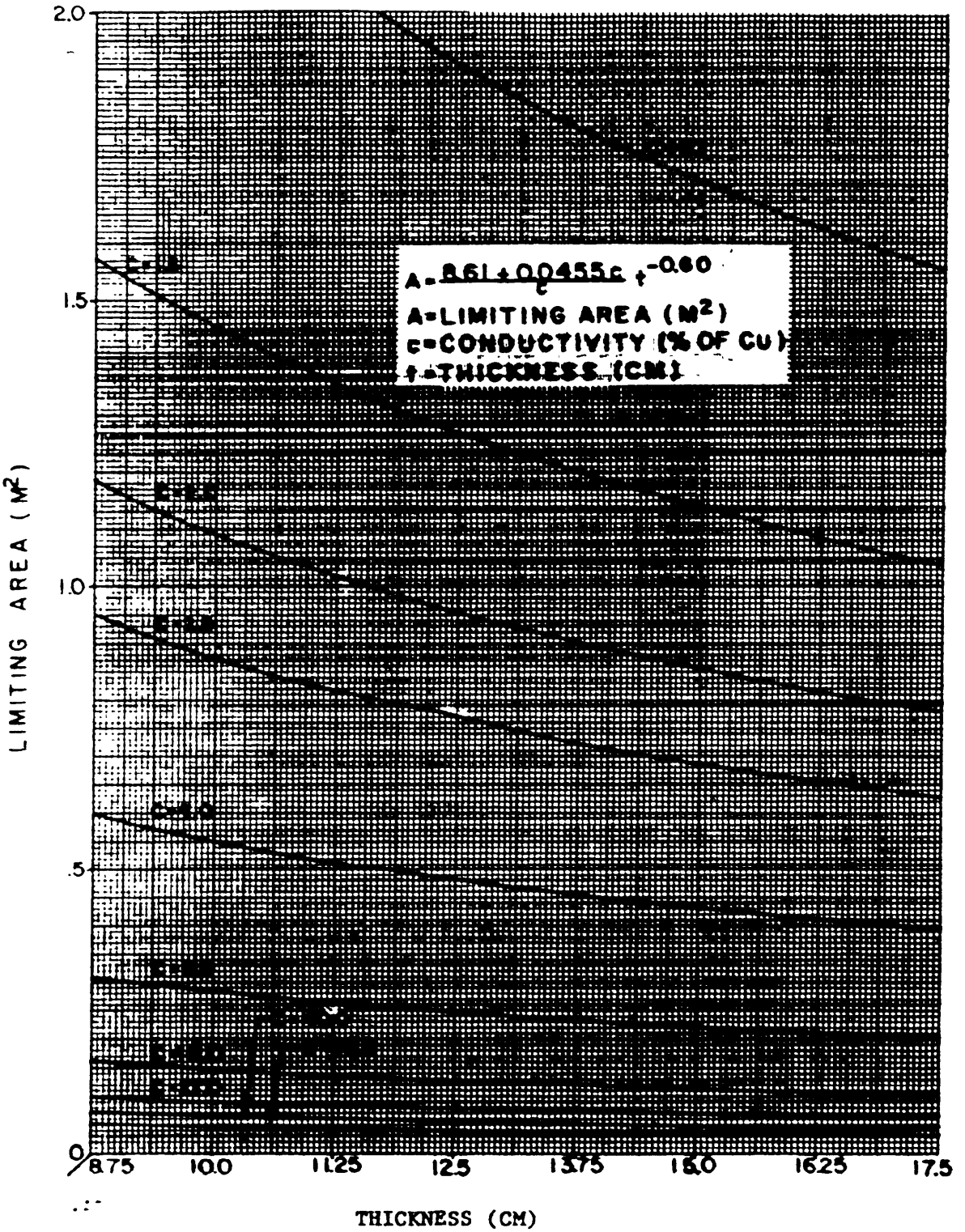
FIGURE 3. Permissible areas of plates of electrical conducting material for ships (metric). (Sheet 2 of 4).



B. Limiting area between 0 and 2.0 m^2; thickness between 0 and 8.75 cm.

SH 12214

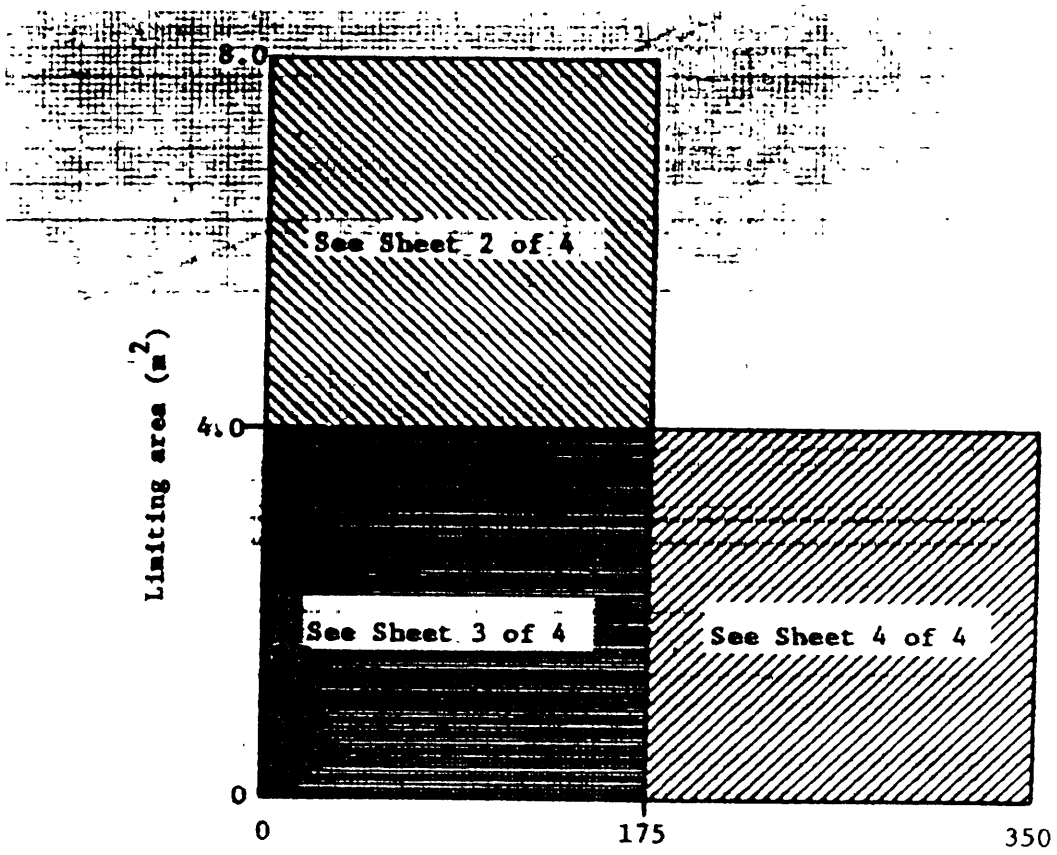
FIGURE 3. Permissible areas of plates of electrical conducting material for ships (metric). (Sheet 3 of 4).



C. Limiting area between 0 and 2.0 m^2; thickness between 8.75 and 17.5 cm.

SH 12214

FIGURE 3. Permissible areas of plates of electrical conducting material for ships (metric). (Sheet 4 of 4).



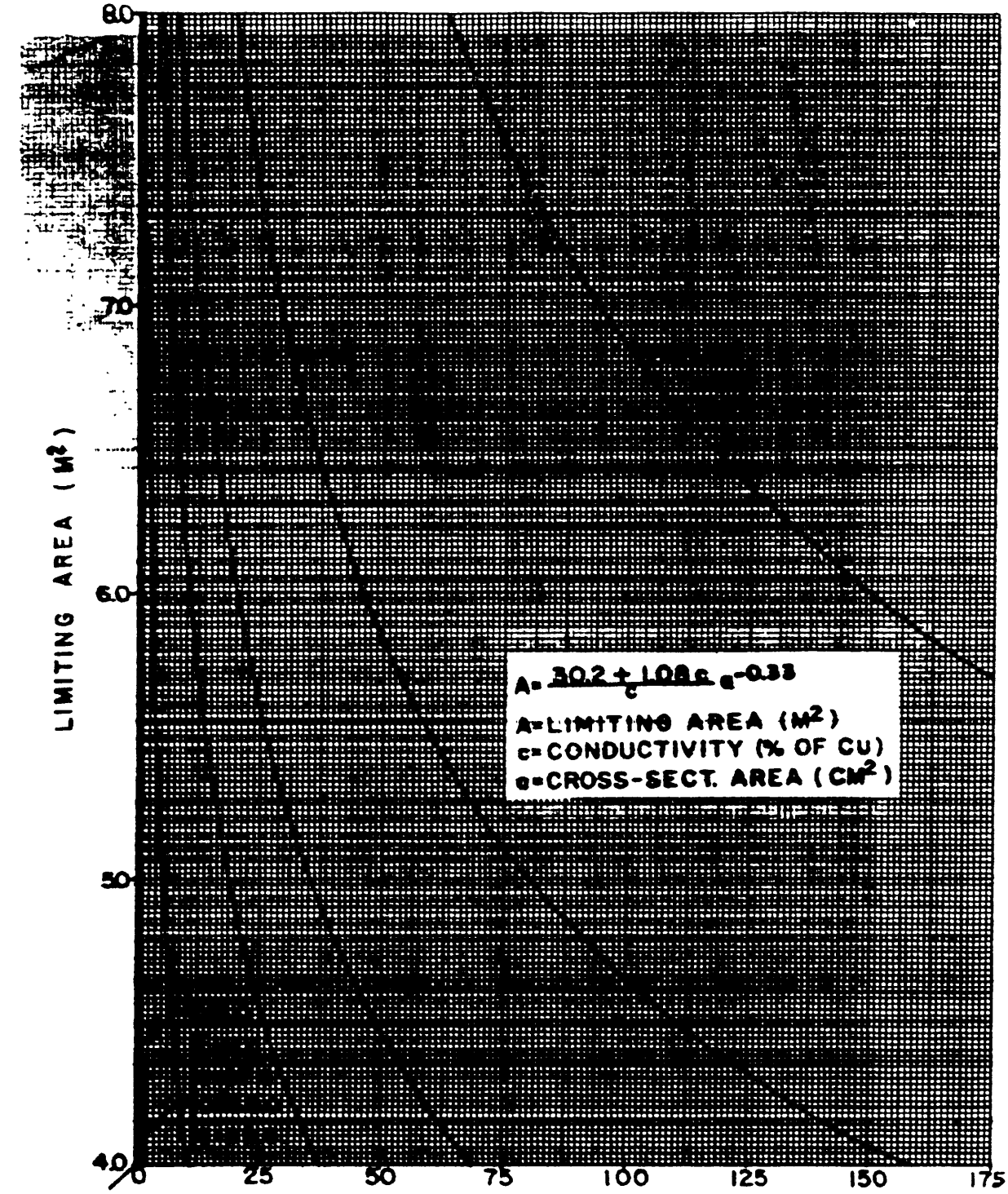
SH 12215

FIGURE KEY

NOTES:

1. Percentage of conductivity refers to the electrical conductivity of matetials relative to copper. Common materials having conductivity greater than 10 percent of copper are: copper, alumimum, brass and bronze. Common metals having conductivity less than 10 percent of copper are: steel (all types) and Monel.
2. The face of the box whose cross-sectional area shall be considered is that side having the largest continuous conducting area.
3. The cross-sectional area shall be determined by the product of the thickness of the material and the dimension of the box perpendicular to the face selected in note 2.

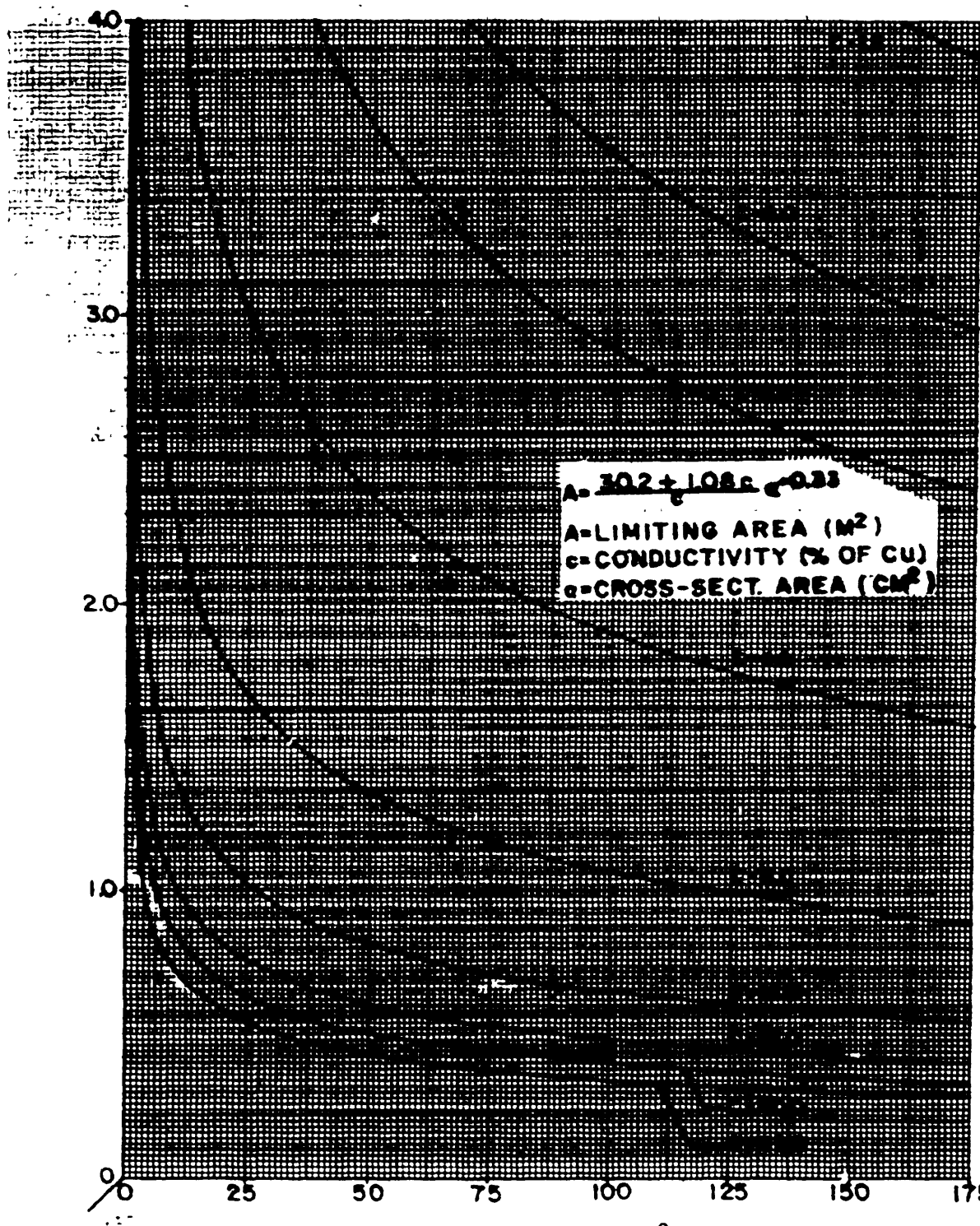
FIGURE 4. Permissible sizes of enclosures constructed of electrically continuous conducting materials for ships (metric). (Sheet 1 of 4).



SH 12215

A. Limiting area between 4.0 and 8.0 m^2; cross-sectional between 0 and 175 cm^2.

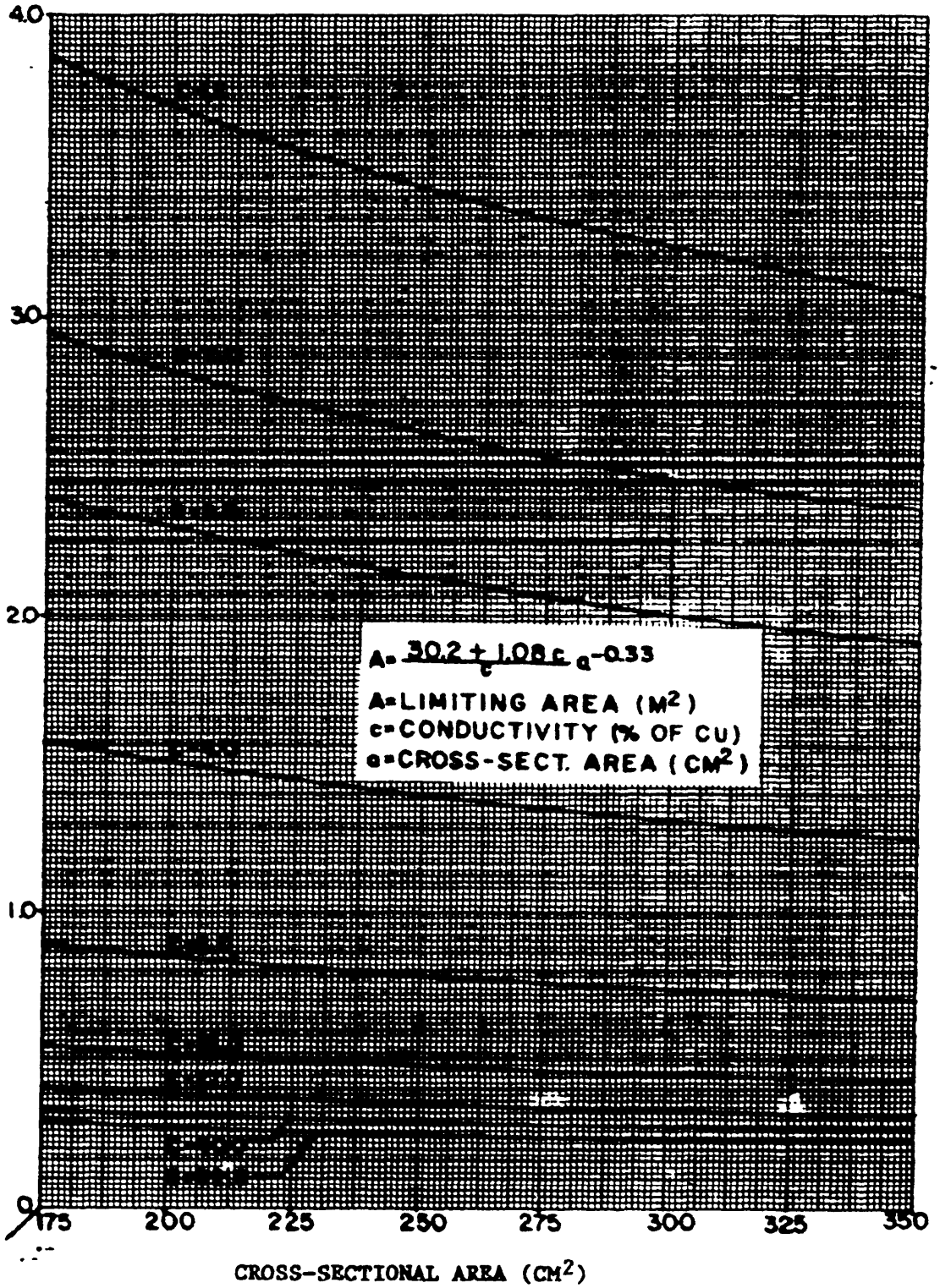
FIGURE 4. Permissible sizes of enclosures constructed of electrically continuous conducting materials for ships (metric). (Sheet 2 of 4).



SH 12215

B. Limiting area between 0 and 4.0 m^2; cross-sectional between 0 and 175 cm^2.

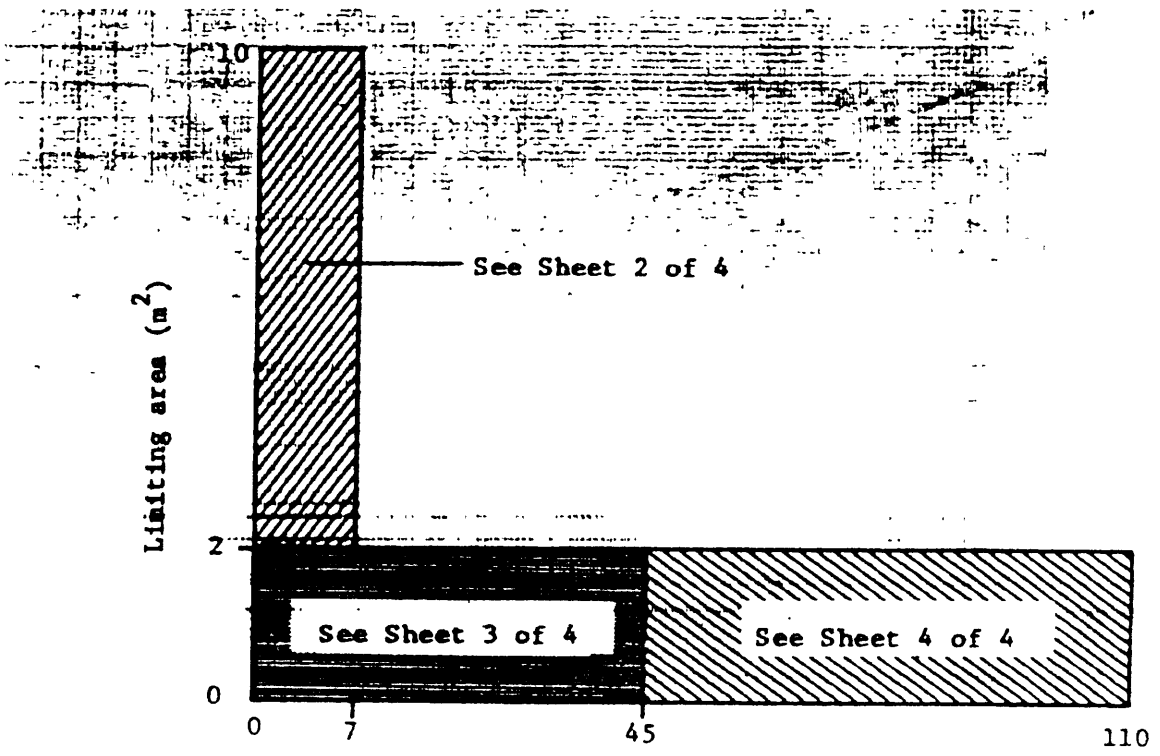
FIGURE 4. Permissible sizes of enclosures constructed of electrically continuous conducting materials for ships (metric). (Sheet 3 of 4).



SH 12215

C. Limiting area between 0 and 4.0 m^2; cross-sectional between 175 and 350 cm^2.

FIGURE 4. Permissible sizes of enclosures constructed of electrically continuous conducting materials for ships (metric). (Sheet 4 of 4).



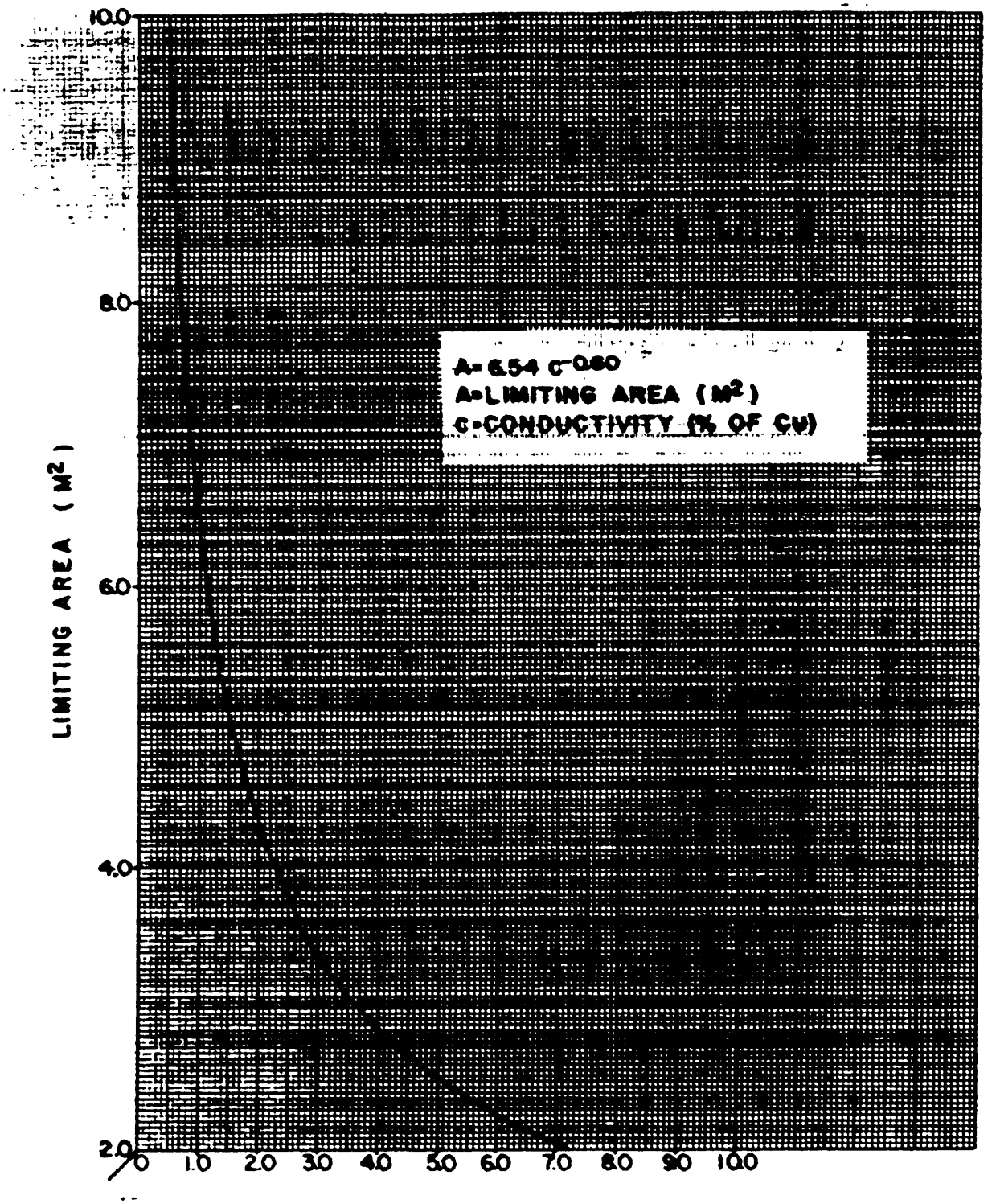
SH 12216

FIGURE KEY

NOTE:

1. Percentage of conductivity refers to the electrical conductivity of materials relative to copper. Common materials having conductivity greater than 10 percent of copper are: copper, aluminum, brass and bronze. Common metals having conductivity less than 10 percent of copper are: steel (all types) and Monel.

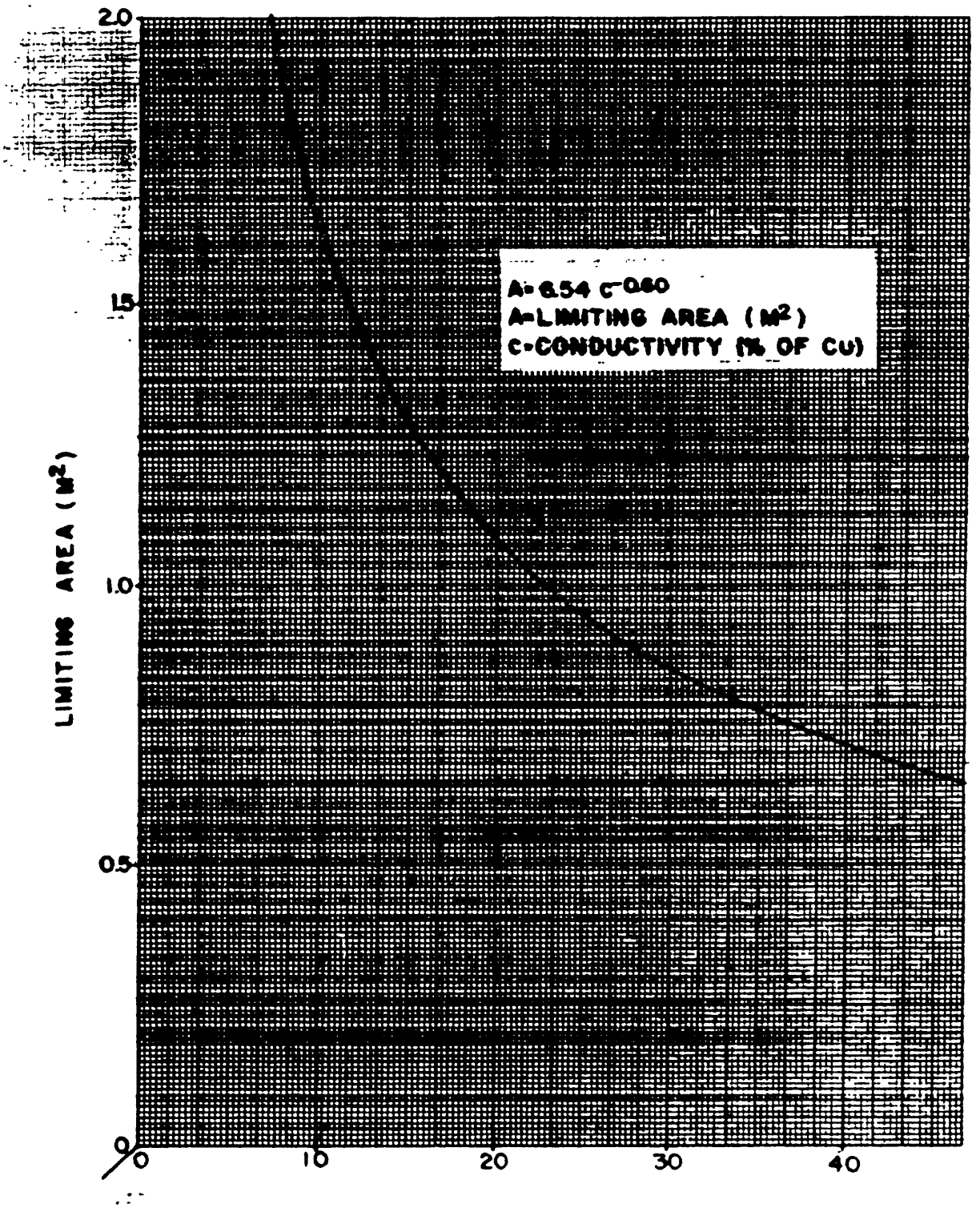
FIGURE 5. Permissible areas of electrically continuous loops consitituting piping systems for craft (metric). (Sheet 1 of 4).



SH 12216

A. Conductivity between 0 percent and 7 percent of copper.

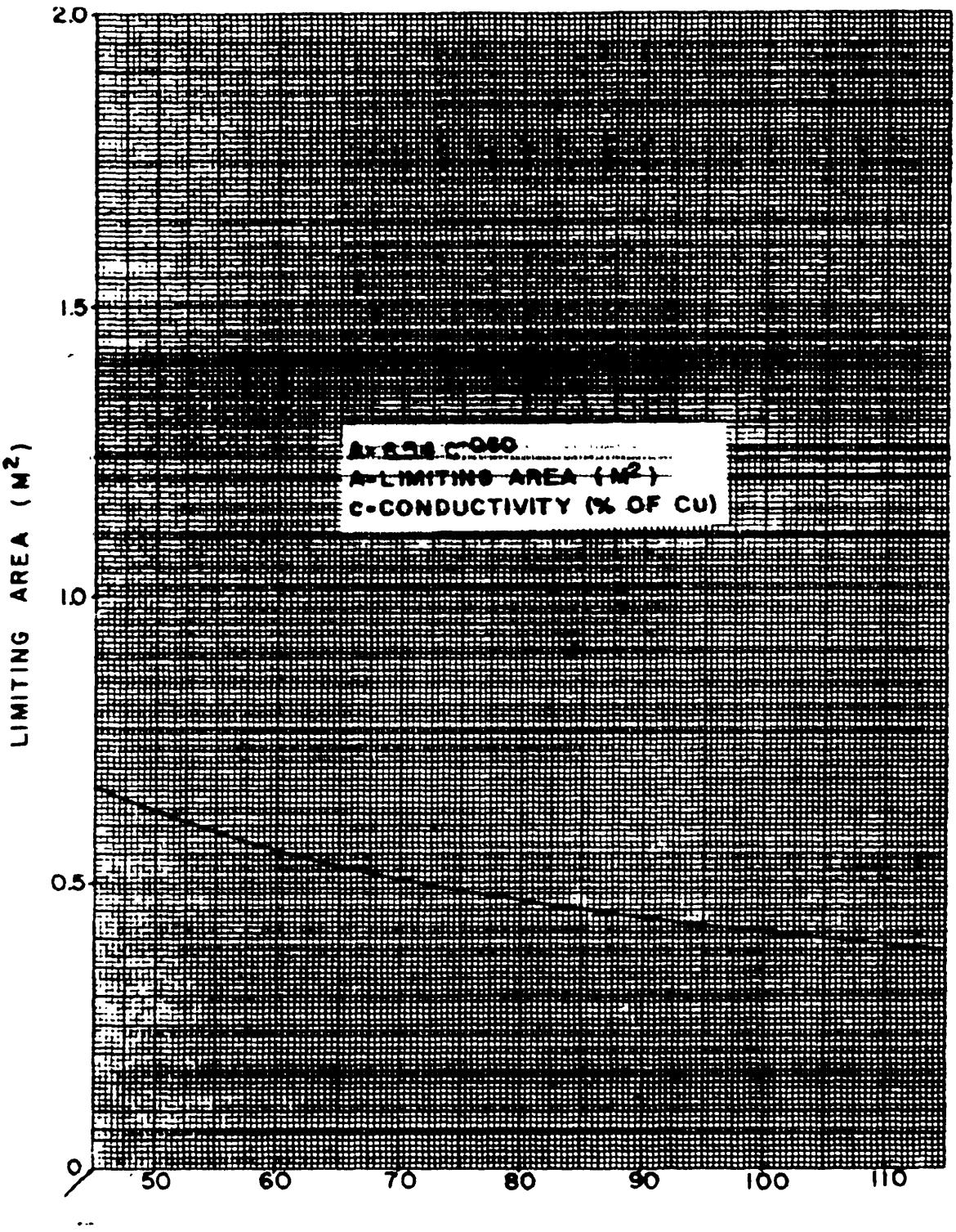
FIGURE 5. Permissible areas of electrically continuous loops constituting piping systems for craft (metric). (Sheet 2 of 4).



SH 12216

B. Conductivity between 7 percent and 45 percent of copper.

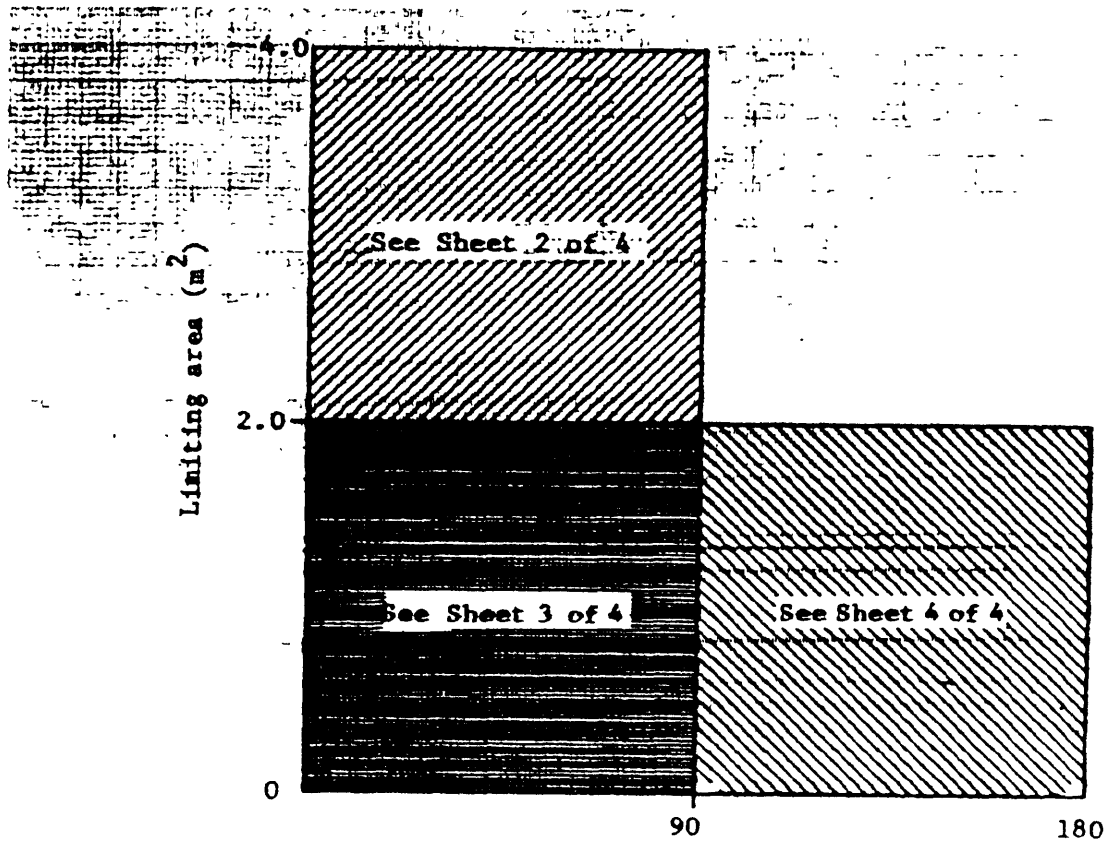
FIGURE 5. Permissible areas of electrically continuous loops constituting piping systems for craft (metric). (Sheet 3 of 4).



SH 12216

C. Conductivity between 45 percent and 110 percent of copper.

FIGURE 5. Permissible areas of electrically continuous loops constituting piping systems for craft (metric). (Sheet 4 of 4).



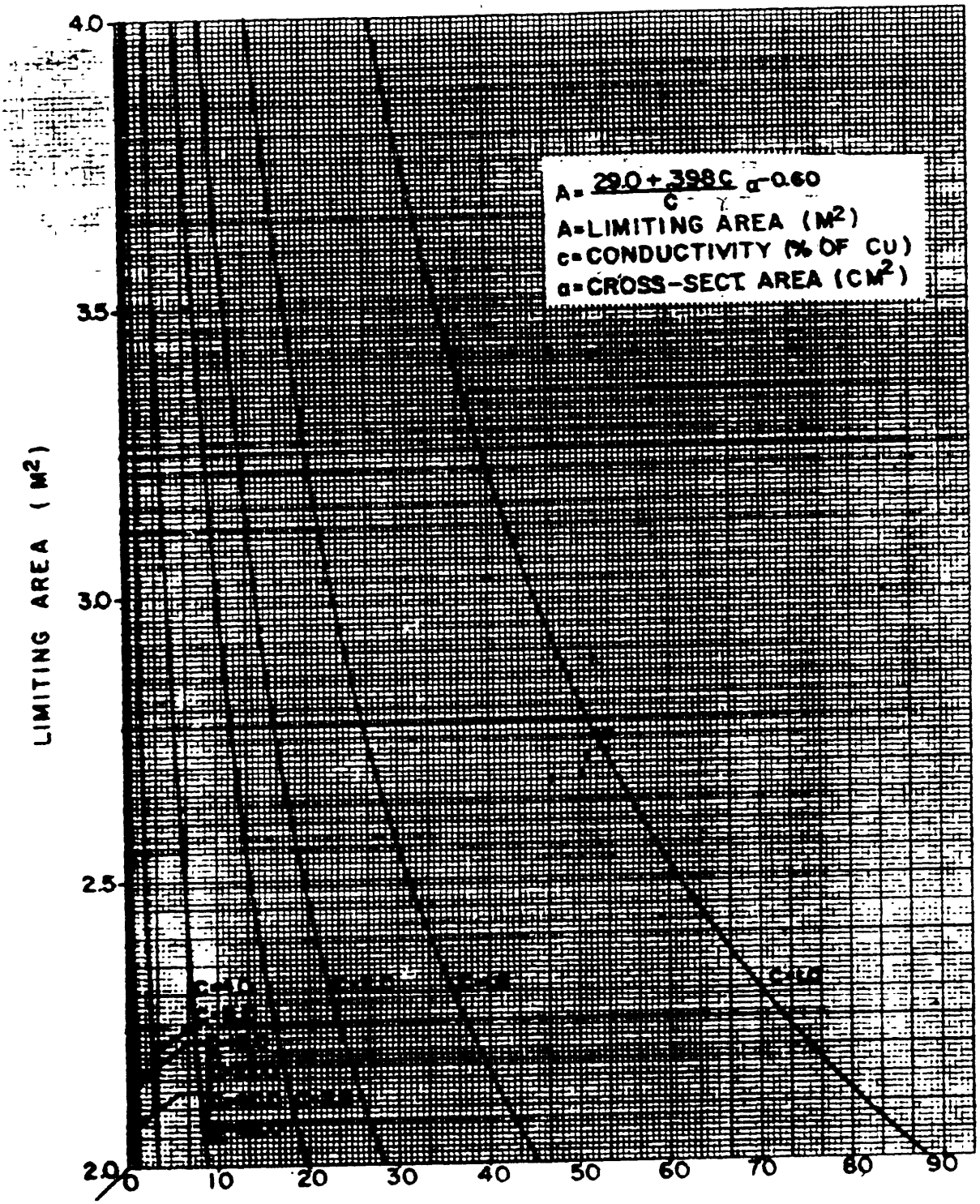
SH 12217

FIGURE KEY

NOTES:

1. Percentage of conductivity refers to the electrical conductivity of materials relative to copper. Common materials having conductivity greater than 10 percent of copper are: copper aluminum, brass and bronze. Common metals having conductivity less than 10 percent of copper are: steel (all types) and Monel.
2. For a loop having non-uniform cross-sectional areas, an equivalent cross-sectional area may be used. This equivalent cross-sectional area shall be the area that will provide the same electrical resistance around the loop as the non-uniform cross-sectional area.
3. These curves are not applicable to closed loops of electrical cable, including grounding straps and armor.

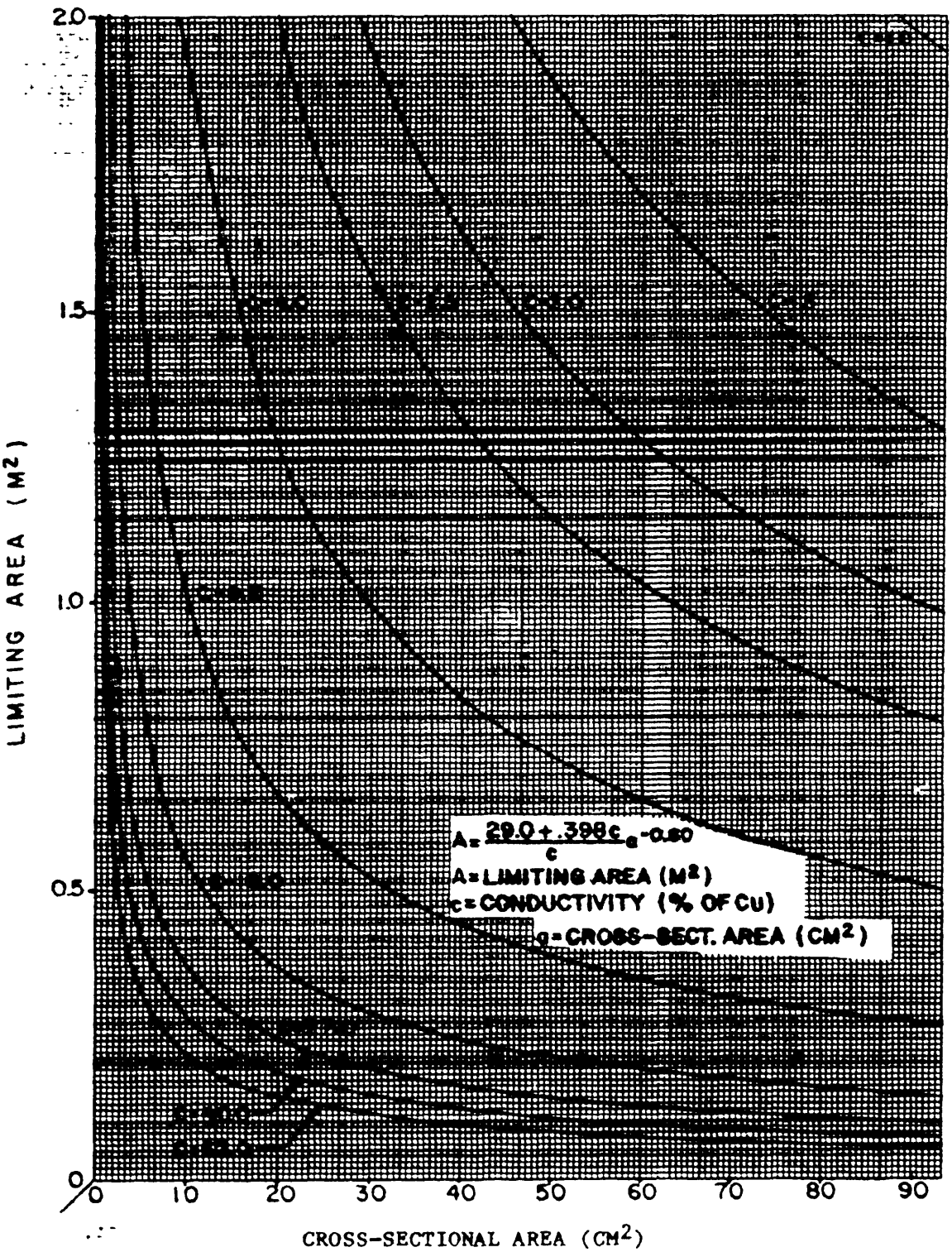
FIGURE 6. Permissible areas of electrically continuous loops other than loops constituting piping systems for craft (metric). (Sheet 1 of 4).



SH 12217

A. Limiting area between 2.0 and 4.0 m^2; cross-sectional area between 0 and 90 cm^2.

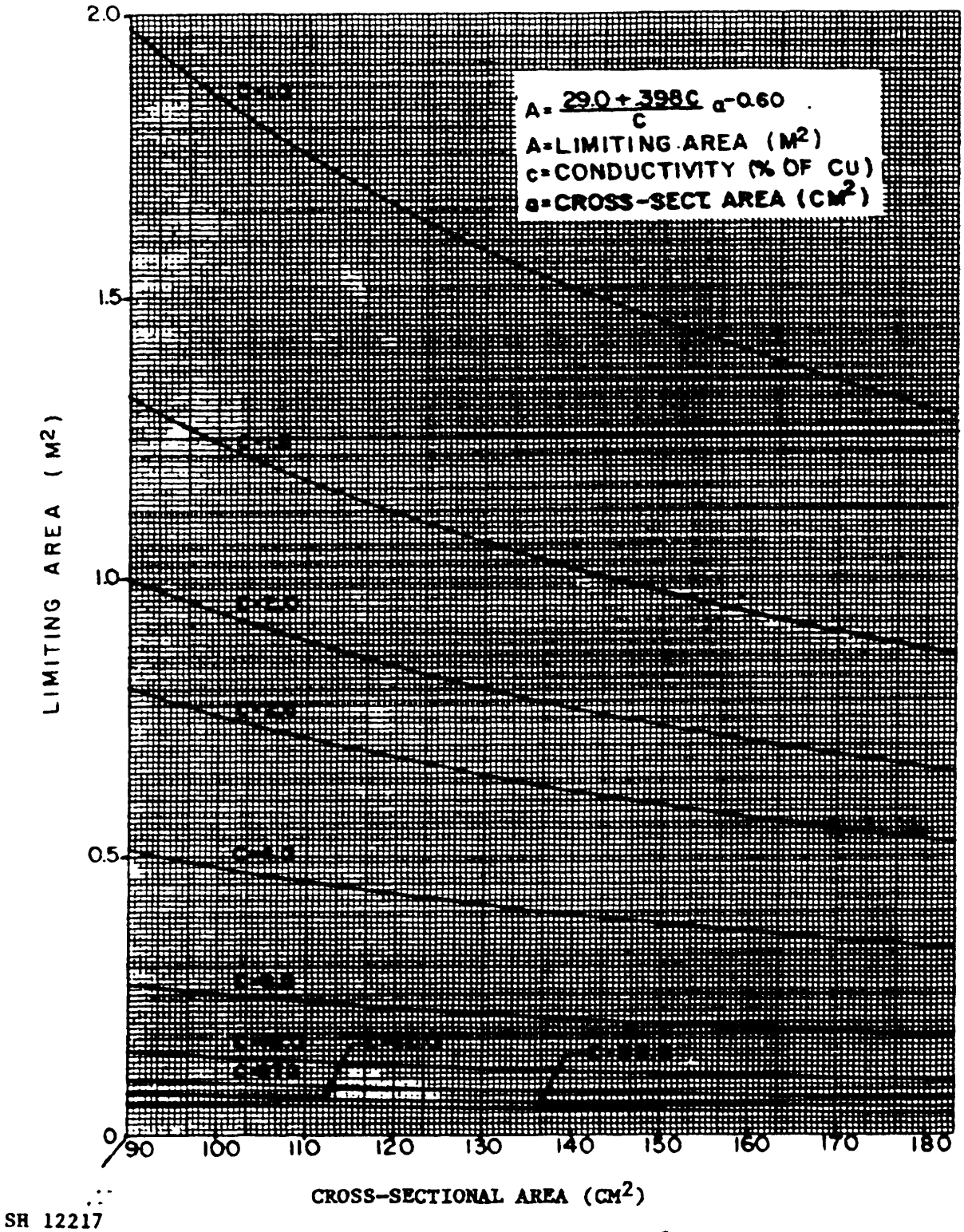
FIGURE 6. Permissible areas of electrically continuous loops other than loops constituting piping systems for craft (metric). (Sheet 2 of 4).



SH 12217

B. Limiting area between 0 and 2.0 m^2; cross-sectional area between 0 and 90 cm^2.

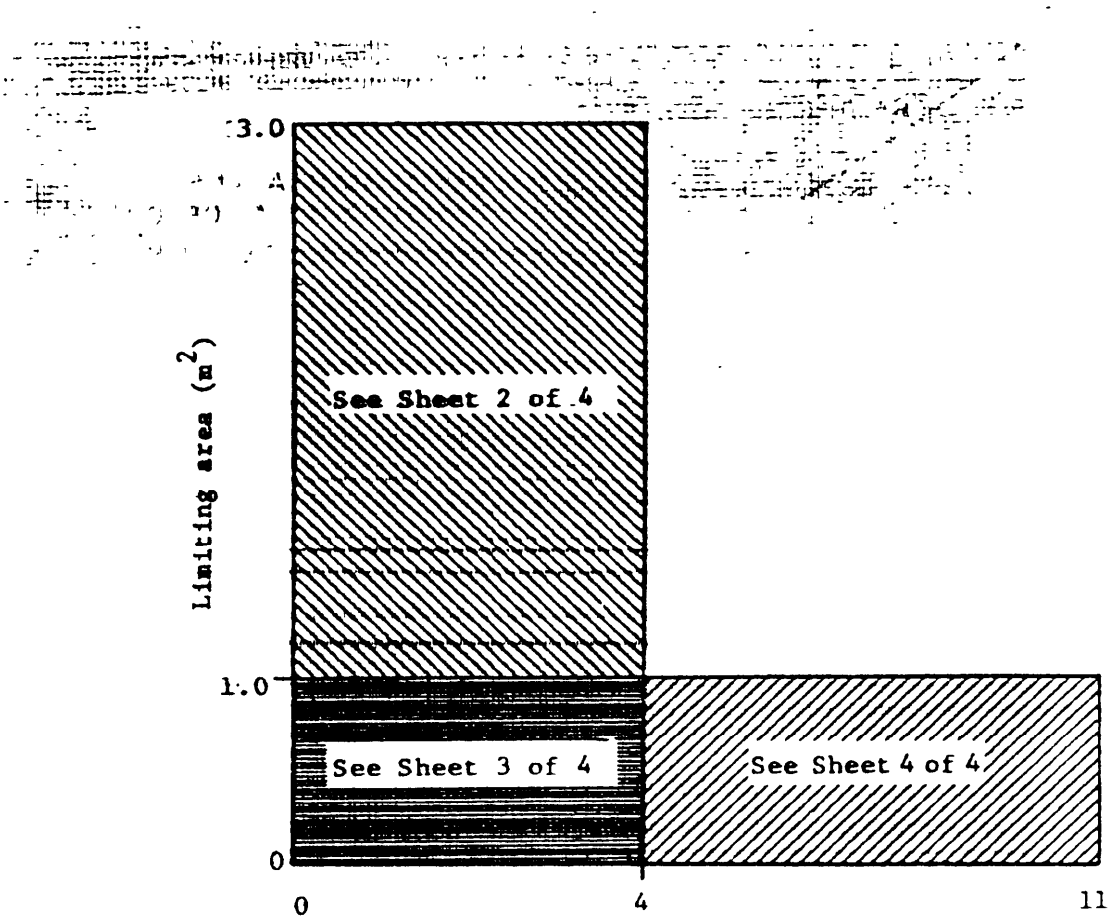
FIGURE 6. Permissible areas of electrically continuous loops other than loops constituting piping systems for craft (metric). (Sheet 3 of 4).



SH 12217

C. Limiting area between 0 and 2.0 m^2; cross-sectional area between 90 and 180 cm^2.

FIGURE 6. Permissible areas of electrically continuous loops other than loops constituting piping systems for craft (metric). (Sheet 4 of 4).



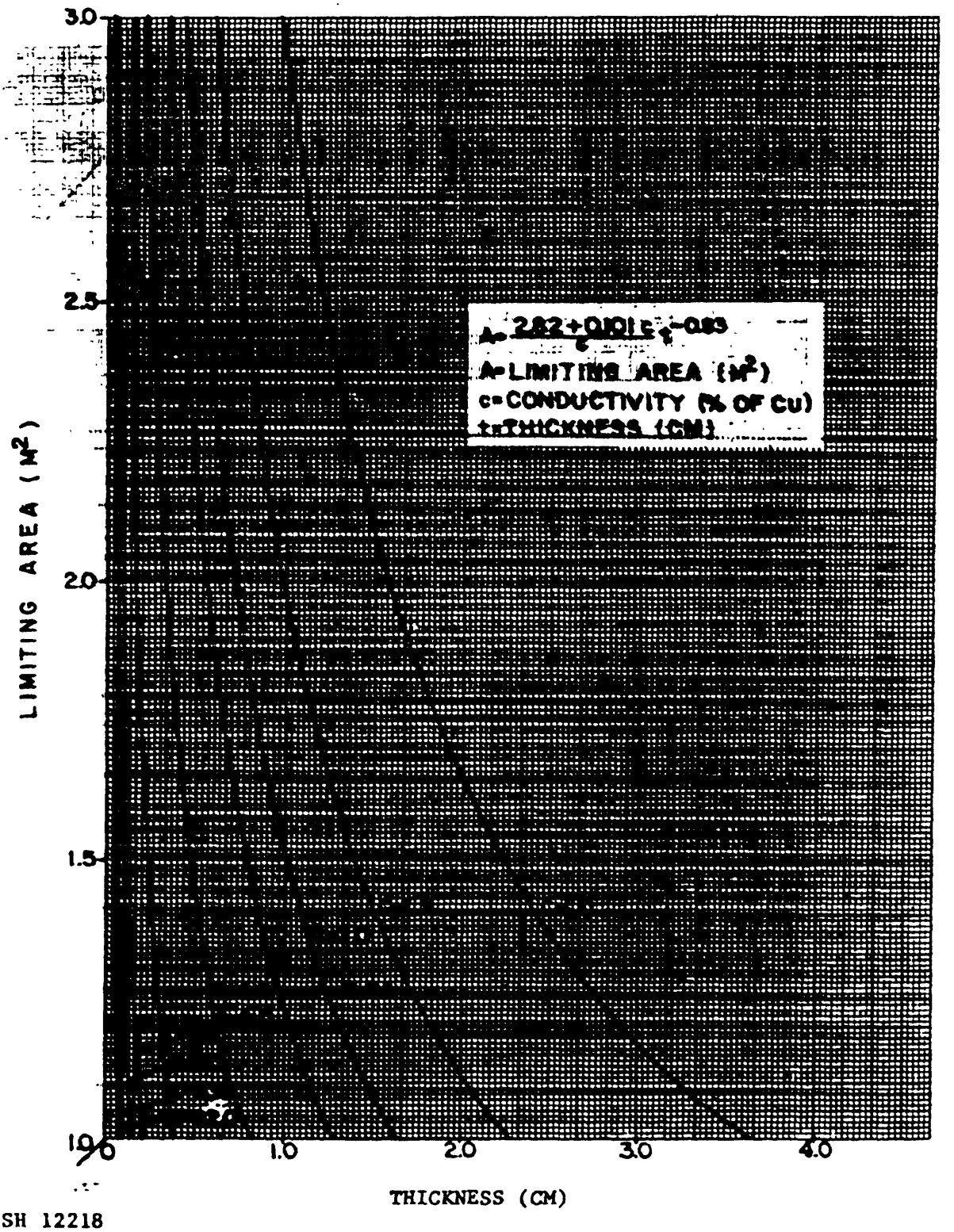
SH 12218

FIGURE KEY

NOTE:

1. Percentage of conductivity refers to the electrical conductivity of materials relative to copper. Common materials having conductivity greater than 10 percent of copper are: copper, aluminum, brass and bronze. Common metals having conductivity less than 10 percent of copper are: steel (all types) and Monel.

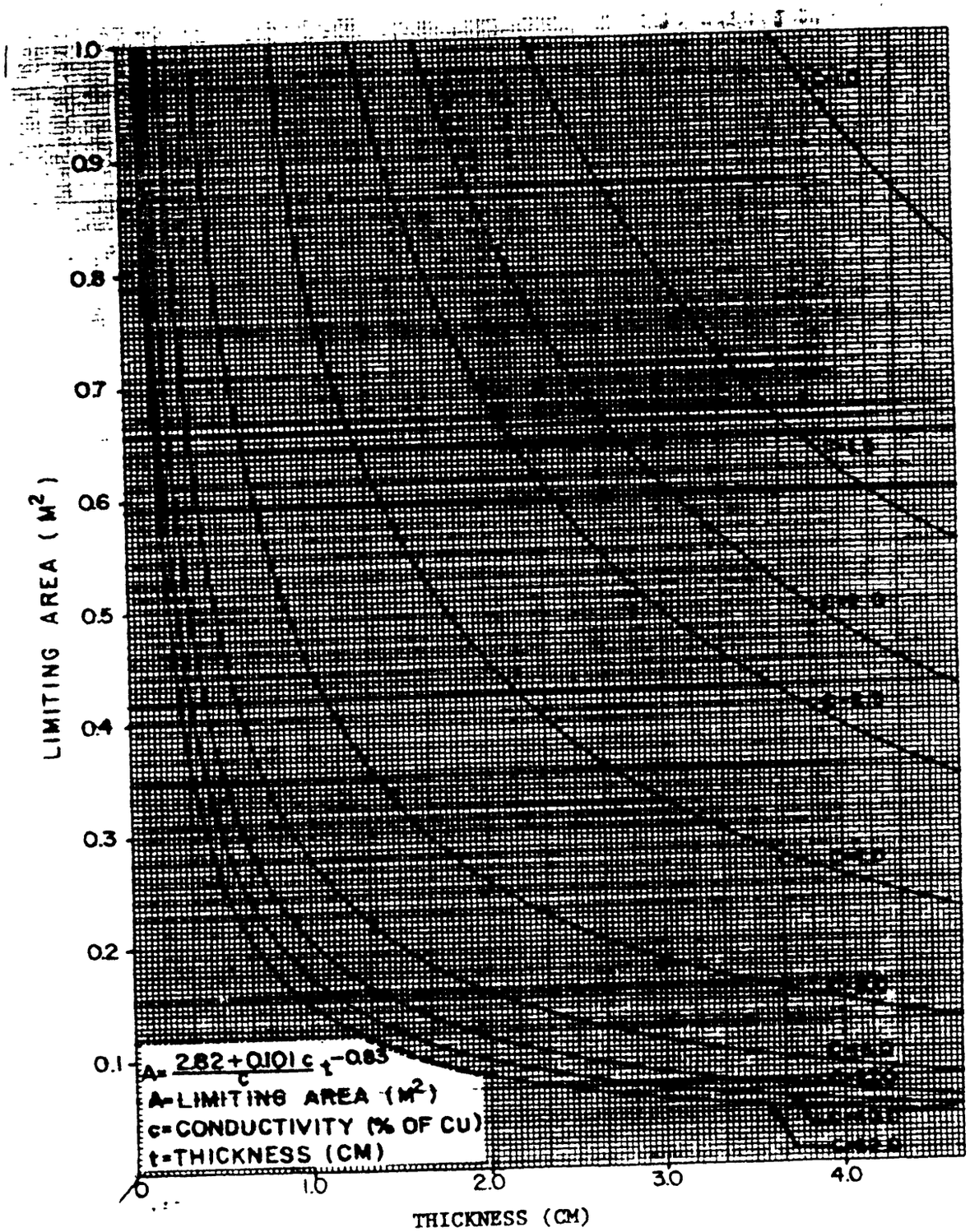
FIGURE 7. Permissible areas of plates of electrical conducting material for craft (metric). (Sheet 1 of 4).



SH 12218

A. Limiting area between 1.0 and 3.0 m^2; thickness between 0 and 4.0 cm.

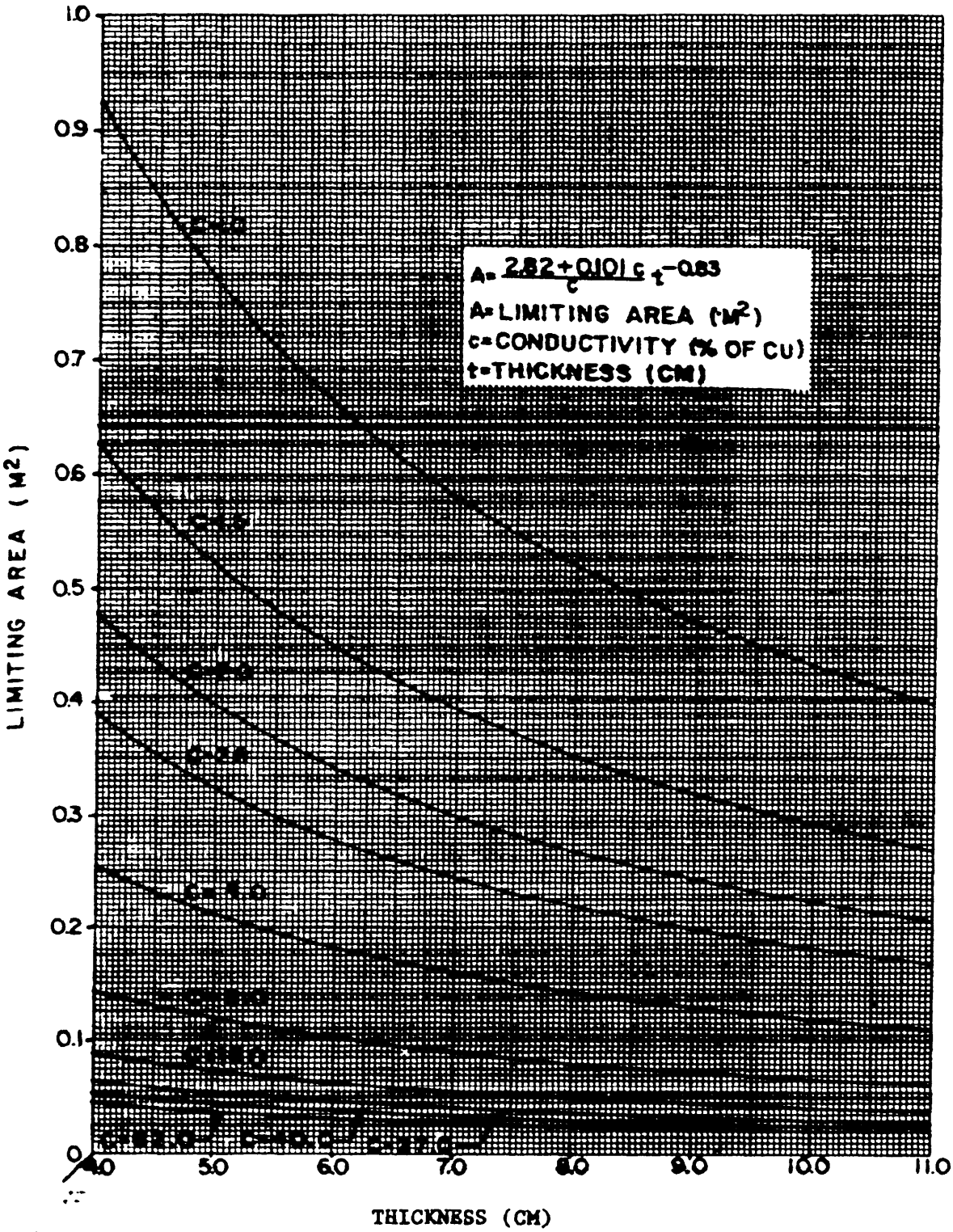
FIGURE 7. Permissible areas of plates of electrical conducting material for craft (metric). (Sheet 2 of 4).



SH 12218

B. Limiting area between 0 and 1.0 m^2; thickness between 0 and 4.0 cm.

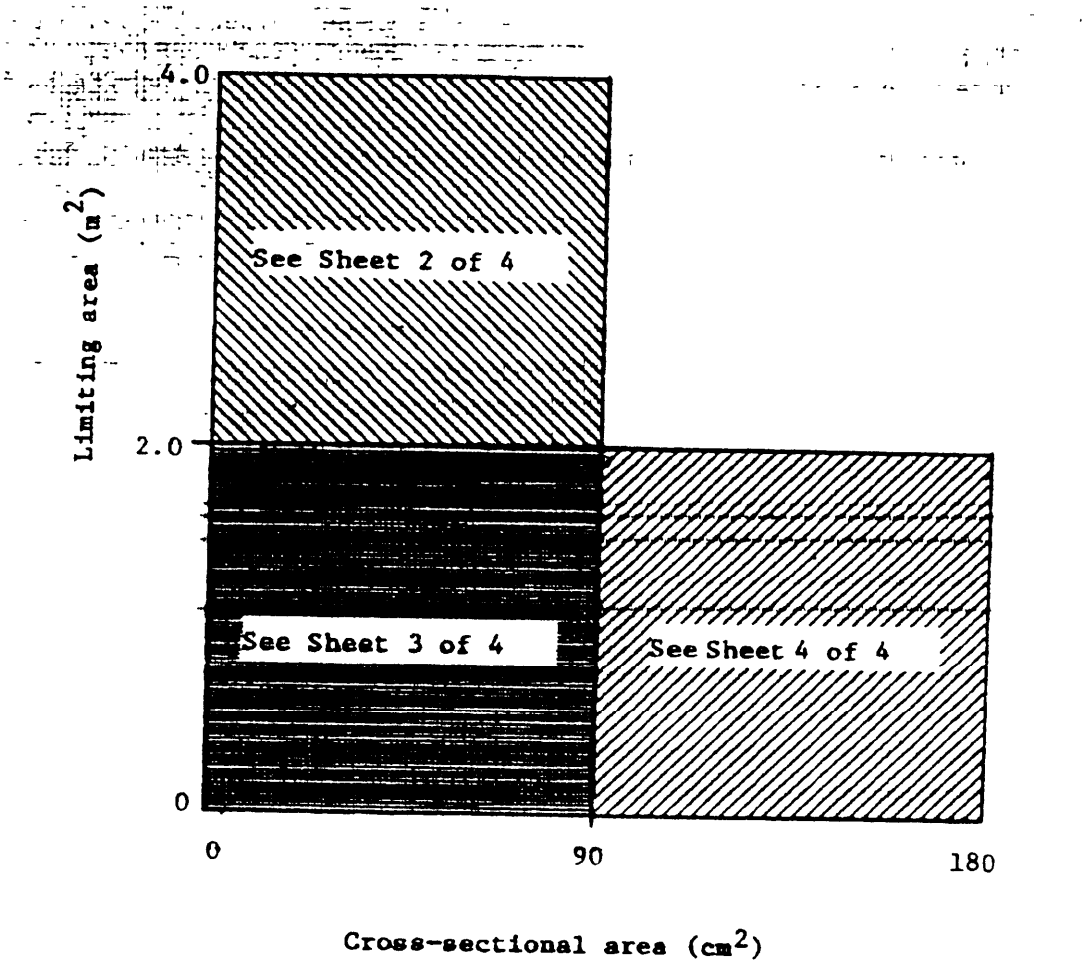
FIGURE 7. Permissible areas of plates of electrical conducting material for craft (metric). (Sheet 3 of 4).



SH 12218

C. Limiting area between 0 and 1.0 m^2; thickness between 4.0 and 11.0 cm.

FIGURE 7. Permissible areas of plates of electrical conducting material for craft (metric). (Sheet 4 of 4).



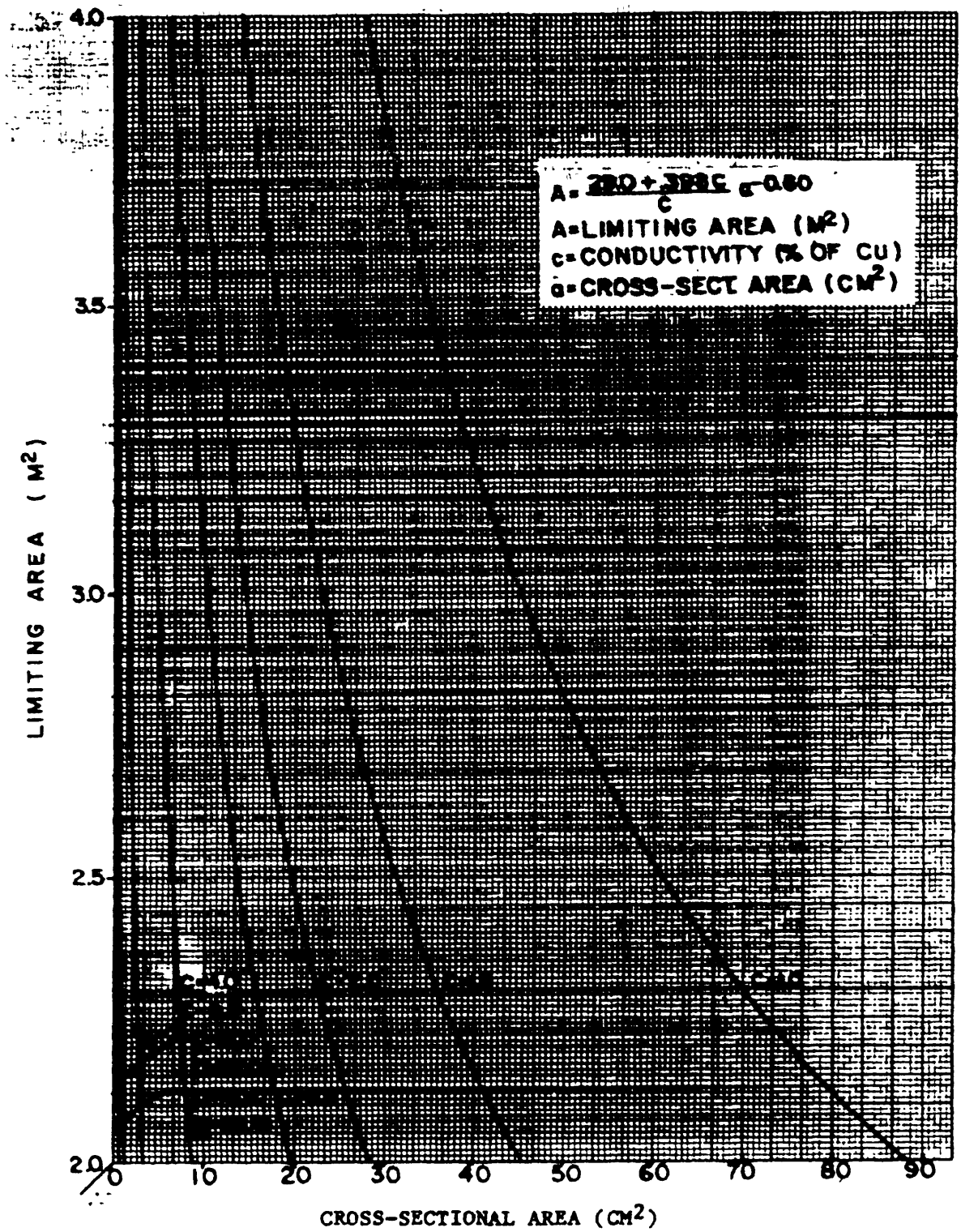
SH 12219

FIGURE KEY

NOTES:

1. Percentage of conductivity refers to the electrical conductivity of materials relative to copper. Common materials having conductivity greater than 10 percent of copper are: copper, aluminum, brass and bronze. Common metals having conductivity less than 10 percent of copper are: steel (all types) and Monel.
2. The face of the box whose crss-sectional area shall be considered is that side having the largest continuous conducting area.
3. The cross-sectional area shall be determined by the product of the thickness of the material and the dimension of the box perpendicular to the face selected in note 2.

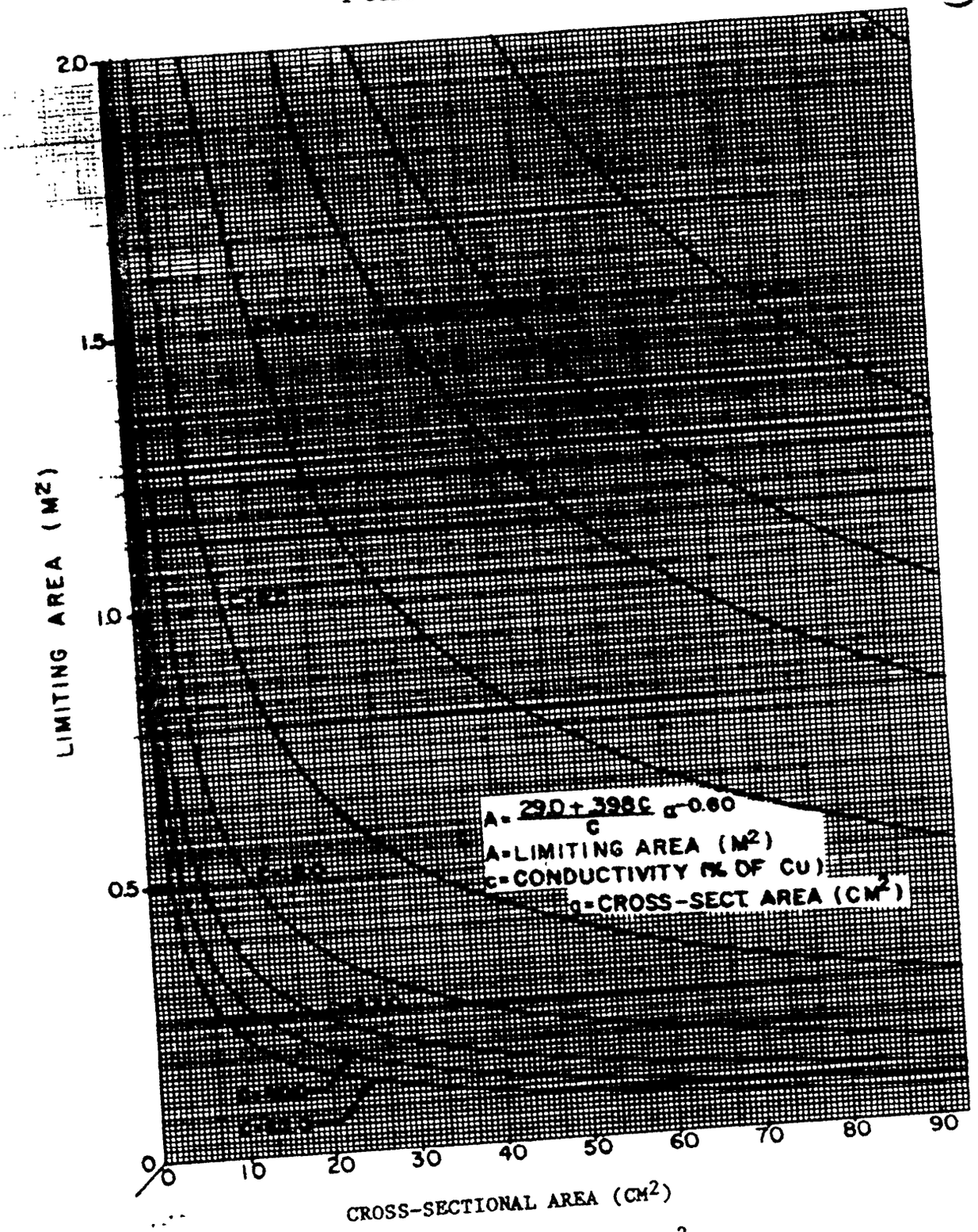
FIGURE 8. Permissible size of enclosures constructed of electrically continuous conducting material for craft (metric). (Sheet 1 of 4).



SH 12219

A. Limiting area between 2.0 and 4.0 m^2; cross-sectional area between 0 and 90 cm^2.

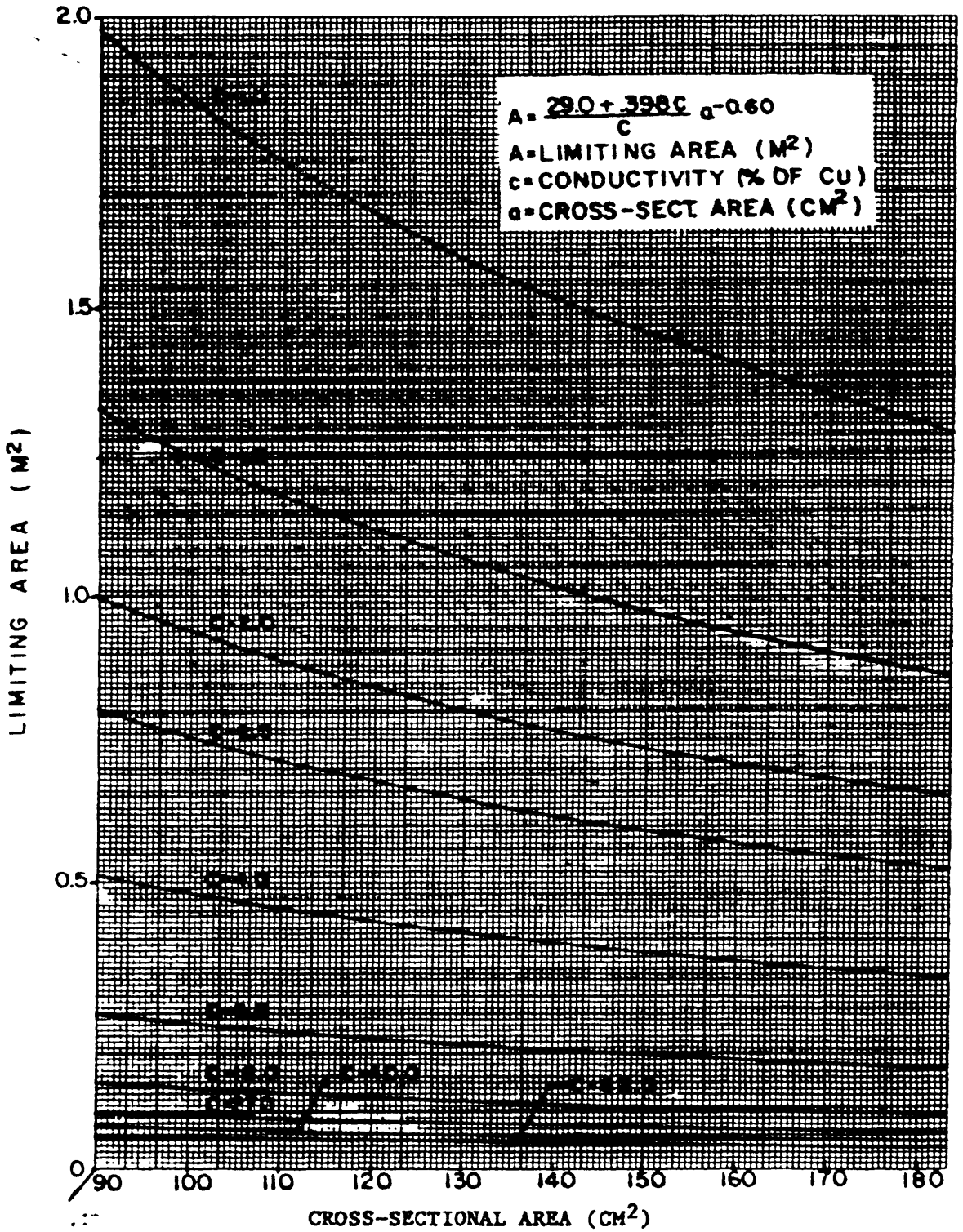
FIGURE 8. Permissible sizes of enclosures constructed of electrically continuous conducting material for craft (metric). (Sheet 2 of 4).



SH 12219

B. Limiting area between 0 and 2.0 m^2; cross-sectional area between 0 and 90 cm^2.

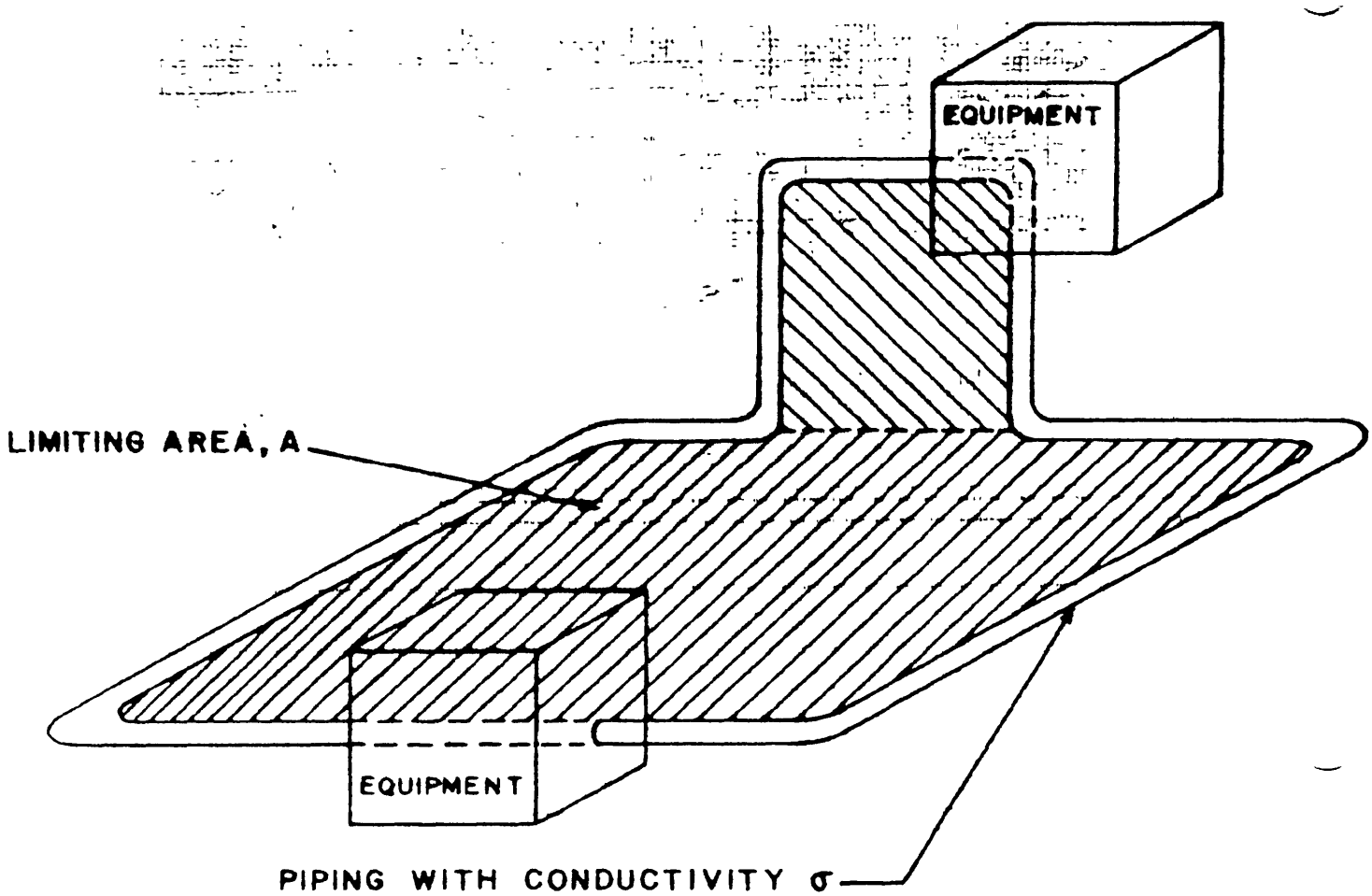
FIGURE 8. Permissible sizes of enclosures constructed of electrically continuous conducting material for craft (metric). (Sheet 3 of 4).



C. Limiting area between 0 and 2.0 m^2; cross-sectional area between 90 and 180 cm^2.

SH 12219

FIGURE 8. Permissible sizes of enclosures constructed of electrically continuous conducting material for craft (metric). (Sheet 4 of 4).



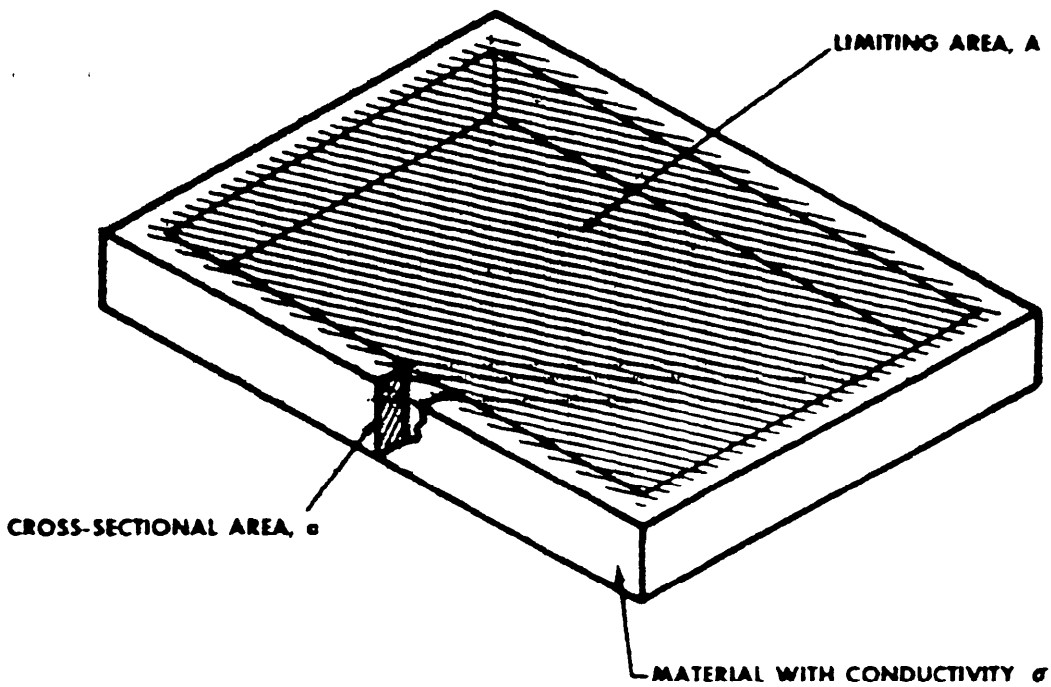
SH 12220

RELATIVE CONDUCTIVITY, $C = \frac{\sigma}{\sigma_{cu}} \times 100$, WHERE σ_{cu} IS

CONDUCTIVITY OF COPPER = 5.8×10^5 siemens/cm AT 20°C

NOTES:
1. Select appropriate curve from figure 1 or f igure 5 for relative conductivity, C.
2. The limiting area, A, can then be determined from the selected curve for the given relative conductivit y.
3. If the actual area of any loop in the piping system exceeds the limiting area, A, the loop must be broken by a resistive joint.

FIGURE 9. Parameters for loops constituting piping systems.



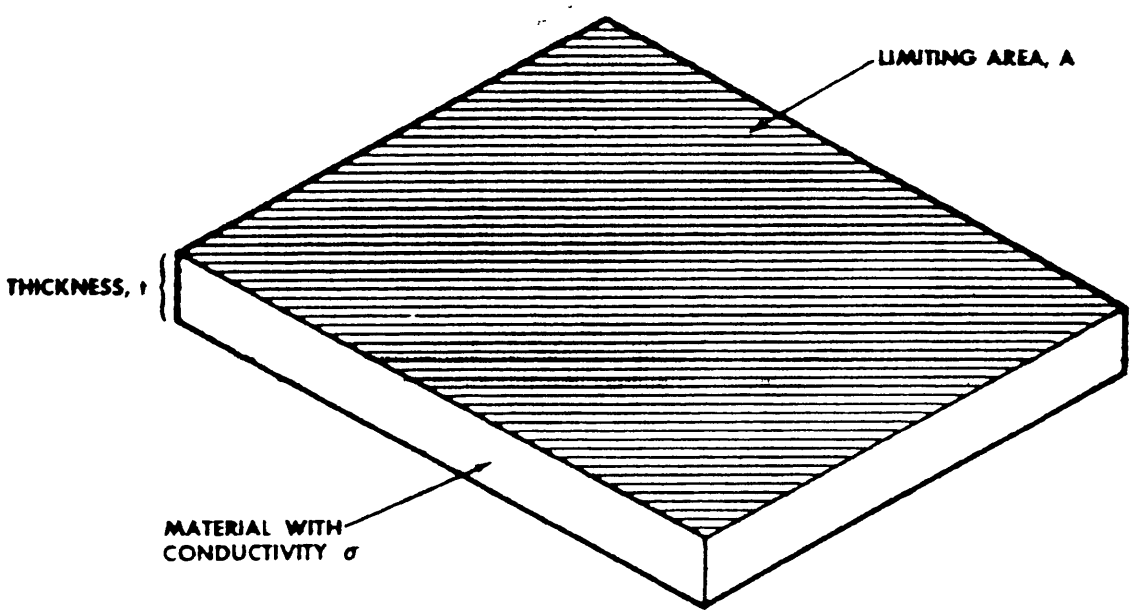
SH 12221

RELATIVE CONDUCTIVITY, $C = \frac{\sigma}{\sigma_{cu}} \times 100$, WHERE σ_{cu} IS

CONDUCTIVITY OF COPPER = 5.8×10^5 siemens/cm AT 20°C

NOTES: 1. Select appropriate curve from figure 2 or figure 6 for relative conductivity, C, and cross-sectional area, a.
2. The limiting area, A, can then be determined from the selected curve for the given cross-sectional area.
3. If the actual area of the loop is larger than the limiting area, the loop must be broken by a resistive joint.

FIGURE 10. Parameters for loops other than loops constituting piping systems.



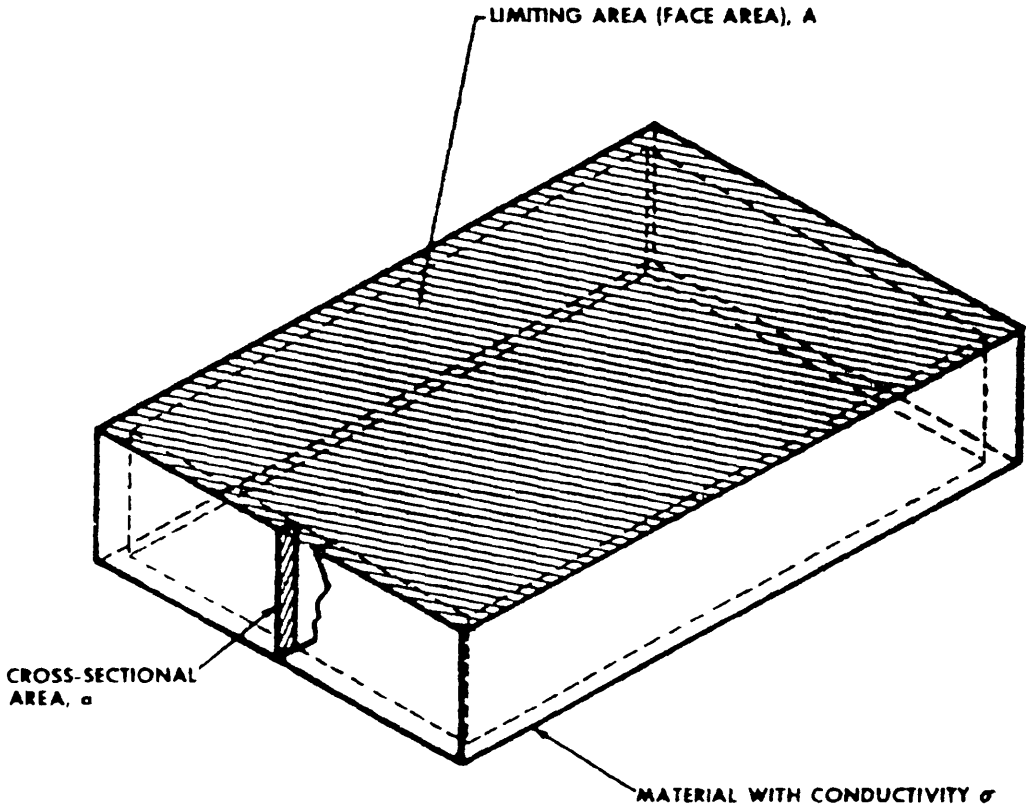
SH 12222

RELATIVE CONDUCTIVITY, $C = \frac{\sigma}{\sigma_{cu}} \times 100$, WHERE σ_{cu} IS

CONDUCTIVITY OF COPPER = 5.8×10^5 siemens/cm AT 20°C

NOTES: 1. Select appropriate curve from figure 3 or figure 7 for relative conductivity, C, and thickness, t.
2. The limiting area, A, can then be determined from the selected curve for the given thickness.
3. If the actual area of the plate is larger than the limiting" area, the plate must be broken by a resistive joint.

FIGURE 11. Parameters for plates.



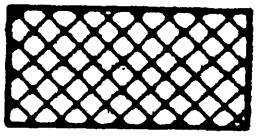
SH 12223

RELATIVE CONDUCTIVITY, $C = \frac{\sigma}{\sigma_{cu}} \times 100$, WHERE σ_{cu} IS

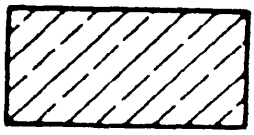
CONDUCTIVITY OF COPPER = 5.8×10^5 siemens/cm AT 20°C

NOTES: 1. Cross-sectional area, a, is determined by multiplying the thickness of the enclosure face with the largest conducting area, A, by the dimension of the enclosure perpendicular to the selected face.
2. Select appropriate curve from figure 4 or figure 8 for relative conductivity, C, and cross-sectional area, a.
3. The limiting area, A, can then be determined from the selected curve for the given cross-sectional area.
4. If the actual area of the enclosure is larger than the limiting area, the enclosure must be broken by a resistive feint.

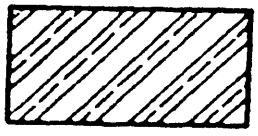
FIGURE 12. Parameters for enclosures.



MAGNETIC MATERIAL



NONMAGNETIC METALLIC MATERIAL



NONMETALLIC MATERIAL

SH 12224

FIGURE 13. Symbols for magnetic information drawing.

APPENDIX A

EXAMPLES OF LIMITATIONS FOR GROUPS OF BOXES ON ANY 6 BY 6 METER SECTION OF A DECK

10. *GENERAL*

10.1 Scope. This appendix illustrates application of the limiting equation presented in 5.3.10 and its English equivalent equation for groups of boxes on any 6 by 6 meter section of a deck.

10.2 Application. Actual data can be substituted for the sample data used in this example, to calculate whether a group of boxes in a 6 by 6 meter section of deck can be accommodated.

20. REFERENCED DOCUMENTS

Not applicable.

30. DEFINITIONS

Not applicable.

40. GENERAL DOCUMENTS

Not applicable.

50• DETAILED REQUIREMENTS

50.1 Data collection. Collect data for each, equipment item being considered. Refer to figure 14 and table I for the data of this sample.

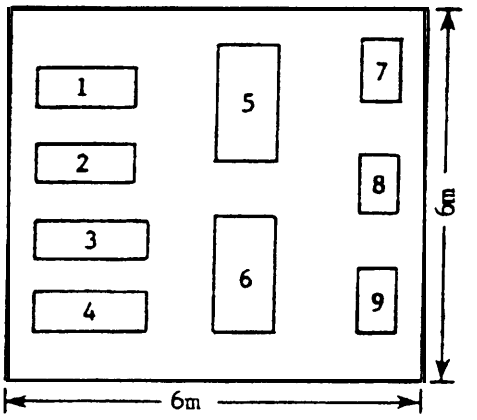


FIGURE 14. Sample equipment layout.

TABLE I. Sample data for equipment layout of figure 14.

Item no.	Length (L) (m)	Width (W) (m)	Height (H) (m)	A (m^2)	$A^{1.5}$	Thickness (t) (cm)	a (cm^2)	Relative conductivity (c)
1	1.5	0.6	0.6	0.9	0.85	0.3175	19	>10%
2	1.5	0.6	0.6	0.9	0.85	0.3175	19	>10%
3	1.8	0.6	0.6	1.1	1.15	0.3175	19	>10%
4	1.8	0.6	0.6	1.1	1.15	0.3175	19	>10%
5	1.8	0.9	0.9	1.6	2.02	0.3175	29	<10%
6	1.8	0.9	0.9	1.6	2.02	0.3175	29	<10%
7	0.9	0.6	1.2	1.1	1.15	0.3175	19	>10%
8	0.9	0.6	1.2	1.1	1.15	0.3175	19	<10%
9	0.9	0.6	1.2	1.1	1.15	0.3175	19	<10%

50.1.1 Sample data collection. Physical data for each item (conductivity relative to copper (C), thickness, length, width, and height) are derived from the equipment. In accordance with 5.3.10, A (maximum face area) is equal to the product of the two largest dimensions for each item. After determining A, ($A^{1.5}$) can be calcluated. "a" can be calculated as the product *of* the thickness and the minimum dimension for each item.

50.2 Application of limiting equation to sample data. As stated in 5.3.10, the limiting equation is given by:

$$\sum_i (a_i \times A_i^{1.5}) + 0.1 \times \sum_j (a_j \times A_j^{1.5}) \leq 440$$

where the first term applies to items with conductivity greater than 10 percent of the conductivity of copper and the second term applies to items with conductivity less than or equal to 10 percent of the conductivity of copper. For the sample data:

Item (i) - C > 10%	$(a_i \times A_i^{1.5})$
1	16
2	16
3	22
4	22
7	22
	98 $\sum_i (a_i \times A_i^{1.5})$

Item (j) - C < 10%	$(a_j \times A_j^{1.5})$
5	59
6	59
8	22
9	22
	162 $\sum_j (a_j \times A_j^{1.5})$

Finally, applying the *above* results to the limiting equation:

$$98 + (0.1 \times 162) \leq 440$$
$$114 \leq 440$$

The equation is valid and consequently, there is room for the boxes.

APPENDIX B

DATA REQUIREMENTS

10. DATA

10.1 Data requirements. When this standard is used in a contract which Incorporates a DD Form 1423 and invokes the provisions of 7-104.9(n) of the Defense Acquisition Regulation (DAR), the data requirements identified below will be developed as specified by an approved Data Item Description (DD Form 1664) and delivered in accordance with the approved Contract Data Requirements List (DD Form 1423) incorporated into the contract. When the provisions of DAR-7-104.9(n) are not invoked, the data specified below will be delivered by the contractor in accordance with the contract requirements. Deliverable data required by this standard is cited in the following paragraph.

Paragraph no.	Data requirement item	Applicable DID no.	Option
5.8	Drawings, engineering and associated lists	DI-E-7031	Level 3 Drawing number contractor Design activity designation - contractor
5.8.2	Aperture cards, (containing 35 mm microfilm)	DI-E-5045	

(Copies of data item descriptions required by the contractors in connection with specific acquisition functions should be obtained from the contracting activity or as directed by the contracting officer.)

10.1.1 The data requirements of 10.1 and any task in the standard required to be performed to meet a data requirement may be waived by the contracting/ acquisition activity upon certification by the offeror that identical data were submitted by the offeror and accepted by the Government under a previous contract for identical item acquired to this standard. This does not apply to specific data which may be required for each contract, regardless of whether an identical item has been supplied previously (for example, test reports).

*U.S. GOVERNMENT PRINTING OFFICE: 1983-0-605-034/2989

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

(See Instructions – Reverse Side)

1. DOCUMENT NUMBER	2. DOCUMENT TITLE
DOD-STD-2143(SH)	

3a. NAME OF SUBMITTING ORGANIZATION	4. TYPE OF ORGANIZATION *(Mark one)*
	☐ VENDOR
	☐ USER
b. ADDRESS *(Street, City, State, ZIP Code)*	☐ MANUFACTURER
	☐ OTHER *(Specify)*:

5. PROBLEM AREAS

a. Paragraph Number and Wording:

b. Recommended Wording:

c. Reason/Rationale for Recommendation

6. REMARKS

7a. NAME OF SUBMITTER *(Last, First, MI)* – Optional	b. WORK TELEPHONE NUMBER *(Include Area Code)* – Optional
c. MAILING ADDRESS *(Street, City, State, ZIP Code)* – Optional	8. DATE OF SUBMISSION *(YYMMDD)*

(TO DETACH THIS FORM, CUT ALONG THIS LINE.)

DD FORM 82 MAR 1426 PREVIOUS EDITION IS OBSOLETE.