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MODEL DOCUMENT FOR CODE OFFICIALS ON
SOLAR HEATING AND COOLING OF BUILDINGS

First Draft

March 1979

Work Performed Under Contract No. EM-78-C-01-4281

Council of American Building Officials
Building Officials and Code Administrators International, Incorporated
International Conference of Building Officials
National Conference of States on Building Codes and Standards, Incorporated
Southern Building Code Congress International, Incorporated

U.S. Department of Energy

Solar Energy

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✓ **FIRST DRAFT**
MODEL DOCUMENT FOR CODE OFFICIALS
ON SOLAR HEATING AND COOLING
OF BUILDINGS.

Prepared for the

DEPARTMENT OF ENERGY

UNDER CONTRACT NO. EM-78-C-01-4281

Prepared jointly by:

COUNCIL OF AMERICAN BUILDING OFFICIALS
BUILDING OFFICIALS AND CODE ADMINISTRATORS INTERNATIONAL, INC.
INTERNATIONAL CONFERENCE OF BUILDING OFFICIALS
NATIONAL CONFERENCE OF STATES ON BUILDING CODES AND STANDARDS, INC.
SOUTHERN BUILDING CODE CONGRESS INTERNATIONAL, INC.

March 1979

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Benny Steel
Authorizing Official
Date: 7-19-02

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FORWARD

The Solar Energy Document is the result of a contract between the Council of American Building Officials (CABO) and the Department of Energy (DOE). The DOE funding support enabled this document to be developed as a useful guide in the code enforcement field using the state of the art now available in the solar energy field.

The primary purpose of this document is to promote the use and further development of solar energy through a systematic categorizing of all the attributes in a solar energy system that may impact on those requirements in the nationally recognized model codes relating to the safeguard of life or limb, health, property and public welfare.

Although solar energy systems are inherently provided for in the model codes it was necessary to develop these guidelines not only as an aid to the designer, consumer, builder and enforcement official but also as an instrument to promote further research in solar energy and the development of meaningful new standards.

The Solar Energy Document was developed using consensus procedures which included balanced representation from the consumers, public interest groups, professionals, builders,

code enforcement officials, manufacturers, energy suppliers, standards organizations and material suppliers. The initial draft was developed by a project team composed of technical advisors from the Building Officials and Code Administrators International, the International Conference of Building Officials and the Southern Building Code Congress International. The initial draft was reviewed by balanced technical committees, each having expertise in the four disciplines of building, plumbing, mechanical and electrical. Subsequently regional hearings were held in order to obtain input from all interested parties.

Support is being provided for the document through the development of appropriate educational and innovative systems approval programs. Training courses have been developed under another phase of this joint effort. The course material for the training of those personnel in the use of this document will be made available to state and local governments.

In most regions of the United States solar energy will be used to supplement conventional energy systems used for space heating and cooling, for water heating and for processing purposes. Therefore it will be necessary for the designer, builder and enforcement official to integrate the provisions of this document with existing requirements in the codes relating to

conventional systems. The more frequently used and applicable code requirements and standards are reproduced from the model codes in order to make the document as self-sustaining as possible.

Administrative provisions have been included to integrate this document with presently adopted codes, so as to allow incorporation into traditional building, plumbing, mechanical and electrical codes. In those areas where model codes are not used it is recommended that the requirements, references and standards herein be adopted to regulate all solar energy systems.

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SECTION A
ADMINISTRATION AND ENFORCEMENT

A-101.0 Scope and General Requirements

A-101.1 Title

This document shall be known as the Solar Energy Document, may be cited as such, and will be referred to herein as "document".

A-101.2 Purpose

The purpose of this document is to safeguard life or limb, health, property and public welfare by regulating and controlling the design, construction, installation, materials, location, operation and maintenance of solar energy systems (active and passive) in buildings and appurtenant structures.

A-101.3 Intent

The provisions of this document shall apply to the erection, installation, alteration, repair, relocation, replacement, removal, addition to, use, or maintenance of solar energy systems used for space heating and cooling, for water heating and for processing purposes in buildings and appurtenant structures.

It is also the intent to include in this document the necessary references wherever these provisions affect or are

affected by the requirements of other nationally recognized standards or model codes.

Where different provisions specify different materials, methods of construction or other requirements, the most restrictive shall govern.

A-101.4 Existing Buildings

Solar energy systems may be installed in or on existing buildings or appurtenant structures without having the entire building or structure comply as required for new construction, provided the added solar energy systems and the affected portions of the existing building, mechanical, plumbing and electrical systems comply as required for new construction.

A-101.5 Existing Solar Energy Systems

Solar energy systems lawfully installed shall be permitted to have their existing use continued provided their use and maintenance is not a hazard to life, health or property.

Systems that are non-conforming or dangerous to life, limb, health, property or public welfare shall be abated in accordance with the Building Code or Appendix B.

A-102.0 Maintenance and Identification

A-102.1 Maintenance

All solar energy systems, both existing and new, and all parts thereof shall be maintained in a safe and sanitary

condition. Required devices or safeguards shall be maintained in accordance with the provisions of this document. The owner or his designated agent shall be responsible for the maintenance of these solar energy systems.

Maintenance instructions for components shall be clearly stated on a readily accessible label. Such label may be limited to identifying, by title or publication number, the operation and maintenance manual for that particular model and type of product.

A-102.2 Identification

Materials and equipment shall bear the manufacturers' label or otherwise be identified in order to determine compliance with this document.

A-103.0 Alternate Materials and Methods of Construction

A-103.1 General

The provisions of this document are not intended to prevent the use of any solar energy system or component. Such system or component shall be determined by the enforcement agency to be equivalent in strength, durability, fire resistance and safety to the solar energy systems permitted herein. Substantiating data shall be submitted by the applicant as required by the enforcement agency.

A-104.0 Plans, Permits and Inspections

A-104.1 General

Plans, permits and inspections shall be provided for solar energy systems in accordance with this document.

A-104.2 Plans

With each application for a building permit, and when required by the enforcement agency, plans and specifications shall be submitted. The enforcement agency may require plans, specifications and calculations be prepared by an engineer or architect licensed to practice by the State. The plans and specifications shall show in sufficient detail, all pertinent data and features of the solar energy system in order to determine compliance with this document. The details shall include, but not be limited to, design criteria, details of solar energy components and size and type of apparatus, equipment and systems controls.

A-104.3 Permits

Solar energy systems shall not be erected, constructed, enlarged, altered, repaired, moved, improved, removed, converted or demolished without first obtaining a permit from the enforcement agency.

A-104.4 Called Inspections

The owner or his representative shall notify the enforcement agency, orally or in writing, that work covered by

the permit is ready for inspection. Such notification shall be given not less than twenty-four (24) hours before the work is to be inspected.

A-104.5 Concealed System

That portion of any solar energy system intended to be concealed by any permanent portion of the building shall not be concealed until tested, inspected and approved by the enforcement agency.

A-104.6 Connections

Solar energy equipment covered by this document shall be inspected and shall not be connected to the building, plumbing, mechanical or electrical systems until authorized by the enforcement agency.

A-104.7 Final Inspection

When the installation of any solar energy system is complete a final installation inspection shall be made.

A-105.0 Validity

A-105.1 General

If any part of this document is for any reason held to be unconstitutional or otherwise illegal, such decision shall not effect the validity of the remaining portions of this document.

A-106.0 Violations and Abandonment

A-106.1 Violations

Any person, firm, corporation or agent who shall violate a provision of this document shall be determined guilty in accordance with the Building Code or Appendix B.

A-106.2 Abandonment

Abandoned solar energy systems or parts thereof shall be disconnected from any remaining systems, drained, plugged and capped in an approved manner.

SECTION D
DEFINITIONS

D-101.0 General Requirements and Definitions

D-101.1 General

For the purpose of this document, certain terms, words, phrases and their derivatives shall be construed as specified in this section. Words used in the singular include the plural and the plural the singular. Words used in the masculine gender include the feminine, and the feminine the masculine.

D-101.2 Terms not Defined

Where terms are not defined, they shall have their ordinarily accepted meanings or such as the context may imply.

D-101.3 Appendix

When no building, mechanical or plumbing codes have been adopted by the enforcement agency Appendix D (Definitions) shall be a part of this document.

D-101.4 Conflicts

Where conflicts occur between definitions contained herein and other reference standards, these definitions shall apply.

D-102.1 Definitions

Absorber - The absorber is that part of the solar collector which receives the incident radiation energy and transforms it into thermal energy. It may possess a surface through which energy is transmitted to the transfer fluid; however, the transfer fluid itself can be the absorber.

Absorber Area - The absorber area is the total heat transfer area from which the absorbed solar irradiation heats the transfer fluid or of the absorber media if both transfer fluid and solid surfaces jointly perform the absorbing function.

Absorber Surface - The surface of the collector plate which absorbs solar energy and transfers it to the collector plate.

Active Solar Energy System - An assembly of collectors thermal storage device, and transfer medium which converts solar energy into thermal energy, and in which energy in addition to solar is used to accomplish the transfer of thermal energy.

Adversely affected - Having been interfered with in a manner detrimental to function.

Automatic - Self-acting, operating by its own mechanism when activated by some impersonal influence.

Auxiliary Energy Systems - Equipment utilizing energy other than solar both to supplement the output provided by the solar energy system as required by the design, conditions, and to provide energy backup requirements during periods when the solar energy system may be inoperable. (Also called a "backup system").

Backflow - The unintentional reversal of flow in a potable water distribution system which may result in the transport of foreign materials or substances into the other branches of the distribution system.

Backflow Preventor - An approved device or means to prevent backflow.

Building Code - Adopted building code of the jurisdiction.

Collector - A component used for absorbing solar radiation, converting it into useful thermal energy, and transferring the thermal energy to a heat transfer fluid.

Combustible Medium - A gas or liquid which will ignite when heated to temperatures greater than 100° F below their flash points under either operating or "no-flow" conditions.

Component - An individually distinguishable (i.e., collector, pump controls or storage tank) product that forms part of a more complex product (i.e., collector subsystem or complete system).

Corrosive Medium - Liquids which when in contact with living tissue will cause damage to such tissue, or will ignite when in contact with organic matter or other chemicals.

Cover, Collector - The collector cover is the material covering the aperture to provide environmental protection.

Electrical Code - The adopted electrical code of the jurisdiction.

Enforcement Agency - The agency and assigned staff designated by the legislative body, charged with the administration and enforcement of this document.

Gross Collector Area - The maximum projected area of the complete collector module including integral mounting means.

Heat Transfer Medium - A liquid, air or solid used to transport thermal energy.

Maintenance - Any procedure required on a regular basis to keep equipment operating in accordance with this document.

Manual (Adverb) - Operated by personal intervention.

Mechanical Code - Adopted mechanical code of the jurisdiction.

Non-automatic - Action requiring personal intervention for its control.

Outgassing - The emission of gasses or vapors by materials and components usually during exposure to elevated temperature or reduced pressure.

Passive Solar System - An assembly of building components including collectors, thermal storage devices and transfer medium which converts solar energy in a controlled manner and in which the transfer of heat to space is predominantly by natural means.

Plumbing Code - Adopted plumbing code of the jurisdiction.

Significantly impaired - Having been damaged or diminished in functional capacity to an extent greater than that allowed for in design or to an extent which results in production of a hazard.

Solar Collector - A device designed to absorb incident solar radiation and to transfer the energy to a fluid passing through it.

Solar Energy System - A complete assembly of components, equipment, controls, interconnecting means and terminal elements needed to convert solar energy into thermal energy for space heating or cooling, water heating or process energy. Such solar energy systems may work in combination with auxiliary energy systems when required.

Storage - The solar energy system component which receives thermal energy and retains it for future use.

Toxic - Potentially producing illness or injury, either as an immediately evident effect or as an effect evident after a latent period. Effects may be manifested either as injury to the individual exposed or as birth defects in that individual's future progeny.

Toxic fluids - Liquids or gases whose effect is toxic. Such substances are classified under the Federal Hazardous Substances Act, Part 191, Chapter I, Title 21.

Toxic mediums - A toxic medium is defined as a medium which is equivalent to or less toxic than a Group 6 gas or vapor as classified by Underwriters Laboratories, Inc. Classification method¹ for gases and vapors.

Transport System - That portion of a solar energy system which contains a heat transfer medium and moves energy throughout the system through ducts, pipes or other means.

Ultra-Violet Stability - The ability of materials and components to withstand ultra-violet radiation.

SECTION B

BUILDING

B-101.0 General

B-101.1 Scope

The provisions of this section shall apply to the construction, installation, alteration, location, maintenance and removal of solar systems and accessories connected to or attached to a building or structure.

B-101.2 Building Code

The provisions of this section shall be used in conjunction with the Building Code. In the event a Building Code has not been adopted Appendix B becomes part of this section and declared to be part of this document.

B-101.3 Systems and Components Integral with the Building

Passive systems and components of active systems which are an integral part of the building shall comply with this document and all applicable sections of the Building Code or Appendix B Section 101.3.

B-102.0 Access, Location and Clearances

B-102.1 Location

(a) The location of solar energy components in fire districts, yards, courtyards, and public areas shall conform

with the Building Code or Appendix B. Section 102.

(b) Location of solar energy components in areas identified by the Building Code as fire separation areas shall be prohibited.

(c) Solar energy components shall not be located so as to interfere with the normal use or operation of doors, windows or other building components.

(d) Provisions shall be made over pedestrian and vehicular ways to restrain or deflect sliding snow and ice.

B-102.2 Access

Solar energy components shall be accessible for routine maintenance without trespassing on adjoining property or disassembling any major portion of the structure of a building or appurtenance.

B-102.3 Clearances

(a) Combustible materials adjacent to solar components shall not be exposed to elevated temperatures which may cause ignition. Clearances to combustible materials specified in the collector listing or certification report shall be maintained.

(b) Clearance to combustible materials of non-listed collectors shall be subject to approval of the enforcement agency.

B-103.0 Material Test and Specification

B-103.1 Tests

The enforcement agency may require tests or test reports as compliance with this document. Tests, if required, are to be made at the expense of the owner or his agent, by an approved testing laboratory or other approved testing agency. Copies of such test reports or the results of all such tests shall be kept on file in the office of the enforcement agency.

B-103.2 Standards

All design and construction shall comply with the provision of this section governing quality of materials and manner of construction and shall be of adequate strength and proportions to support all superimposed loads within working stresses prescribed in the Building Code or Appendix B - Section 103.2.

B-104.0 Collectors

B-104.1 Fire Safety Requirements

(a) All fire-resistive requirements are expressed in terms of the number of hours of satisfactory performance in accordance with SS B-6.

(b) Collectors located on buildings shall, when required, comply with the fire resistance requirements of the Building Code or Appendix B Section 104.1.

B-104.2 Collector Supporting Structure

(a) The collector and supporting structure shall be designed and constructed to support the following loads:

- (1) Dead load of the collector, components and transfer liquids.
- (2) Live loads required by the Building Code or Section 3 of SS-B-7.
- (3) Snow loads required by the Building Code or Section 7 of SS-B-7.
- (4) Wind loads required by the Building Code or Section 6 of SS-B-7.
- (5) Seismic loads required by the Building Code or Section 8 of SS-B-7.
- (6) Expansion and contraction loads resulting from temperature changes.
- (7) Combination of loads of Section 104.2 in accordance with the Building Code or Section 4 of SS-B-7.

(b) Excavations adjacent to any footings shall meet the requirements of the Building Code or Appendix B - Section 104.3(a).

(c) Collectors shall be designed for thermal distortion.

(d) Collector plates shall be designed to resist hail loading in accordance with Appendix B - Section 304.3(b).

B-104.3 Flashing

Flashing shall be placed around openings and extensions of collector supports through the roof as necessary to provide adequate drainage and prevent the penetration of water.

B-105.0 Distribution System

B-105.1 Fire Rated Assemblies

Penetrations of fire rated assemblies shall conform to the Building Code or Appendix B - Section 105.1.

B-105.2 Firestopping

Firestopping shall meet the requirements of the Building Code or Appendix B - Section 105.2.

B-105.3 Fire Dampers

Fire dampers shall be installed in duct work in accordance with the Building Code or Appendix B - Section 105.3.

B-105.4 Thermal Insulating Materials

Insulating materials, including vapor barriers, breather papers and similar coverings shall comply with the requirements of the Building Code or Appendix B - Section 105.4.

B-105.5 Structural Integrity

Holes, notches, or cuts made in structural elements to allow the passage of distribution system components shall

not reduce the structural integrity of a member. Notches on the ends of joists or rafters shall not exceed one-fourth the depth. Holes bored for pipes or cable shall not be within two (2) inches of the top or bottom of the joists or rafters and the diameter of any such hole shall not exceed one-third the depth of the member. Notches for pipes in the top or bottom of joists or rafters shall not exceed one-sixth the depth and shall not be located in the middle third of the span. In addition, other specific requirements shall conform to the Building Code or Standard SS-B-1 through SS-B-5.

B-105.6 Flashing

Flashing shall be placed around all distribution system openings through the roof as necessary to provide adequate drainage, and prevent the penetration of water.

B-105.7 Protection Against Vermin or Rodents

Solar distribution systems shall not contribute to the entry or growth of vermin or rodents. Protection from vermin or rodents shall be in accordance with the Building Code or Appendix B - Section 105.9.

B-106.0 Storage Systems

B-106.1 Firestopping

Firestopping for storage systems which are an integral part of the building shall meet the requirements of the Building Code or Appendix B - Section 106.1.

B-106.2 Supporting Structure

(a) The storage system and supporting structure shall be designed and constructed to support the following loads:

- (1) Dead loads of the tank, components, transfer liquids and storage medium.
- (2) Live loads required by the Building Code or Section 3 of SS-B-7.
- (3) Seismic loads required by Building Code or Section 8 of SS-B-7.
- (4) Expansion and contraction loads resulting from temperature change.

(b) Excavations adjacent to any footings shall meet requirements of the Building Code or Appendix B - Section 104.

B-106.3 Insulation

Thermal insulating materials shall conform to the requirements of the Building Code or Appendix B-Section 105.4.

B-107.0 Controls

B-107.1 Fire Rated Assemblies

Control wiring penetrating fire rated assemblies shall conform to the Building Code or Appendix B-Section 105.1.

B-107.2 Fire Stopping

Firestopping shall meet the requirements of the Building Code or Appendix B-Section 105.2.

B-107.3 Holes, Notches or Cuts

Holes, notches or cuts made in structural elements shall conform to Section B-105.5.

B-107.4 Flashing

Flashing shall be placed around openings through the roof as necessary to provide adequate drainage and prevent the penetration of water.

B-107.5 Vermin and Rodents

Protection from entry of vermin and rodents shall be in accordance with the Building Code or Appendix B-Section 105.4.

SECTION E
ELECTRICAL

E-101.0 General

E-101.1 Scope

Electrical materials and equipment and their installation shall be in accordance with reference standard SSE-1 (National Electrical Code, NFPA 70, ANSI C1).

Those conditions typically encountered in the installation of solar energy systems are covered in this section. Other methods, materials and subject matter covered in reference standard SSE-1 are also recognized by this document. References in brackets [] are to specific Articles or Sections in reference standard SSE-1.

E-101.2 Prevention of Fire Spread

Electrical installations shall be so made that the possible spread of fire or products of combustion through fire-rated, fire-resistant or fire-stopped walls, partitions, ceilings and floors; hollow spaces; vertical shafts; and ventilating or air-handling ducts will not be substantially increased, and shall conform to the requirements of Section B-104.1. [Sec. 300-21]

E-101.3 Holes and Notches in Structural Members

Holes and notches in structural members shall be made so as to minimize weakening of the building or structure, and shall be in accordance with Section B-105.5 or

the Building Code. Raceways and cables run through holes or notches shall be protected from physical damage. [Sec. 300-4].

E-101.4 Loads

Electrical equipment shall be supplied by branch circuit, feeder, and service equipment and conductors which are adequate for the load. No existing branch circuit, feeder, or service shall be overloaded. [Art. 210, 215, 220, 230, 240, 424, 430, 440].

E-101.5 Overcurrent Protection

Conductors and equipment shall be protected against overcurrent as required by reference standard SSE-1, Articles 240, 430 and 440.

E-101.6 Grounding

All exposed noncurrent-carrying metal parts of electrical solar energy system equipment likely to become energized shall be grounded in accordance with the requirements of reference standard SSE-1, Article 250.

E-101.7 Electrical Connections

Terminals and splicing devices shall be suitable for the size and number of conductors, and the conductor metal (copper, aluminum, or copper-clad aluminum).[Sec. 110-14]

E-101.8 Identification of Disconnecting Means

Each disconnecting means required by this Document for motors and appliances, and each service, feeder, or branch circuit at the point where it originates shall be legibly marked to indicate its purpose unless located and arranged so the purpose is evident. The marking shall be of sufficient durability to withstand the environment involved. [Sec. 110-22]

E-101.9 Location with Respect to Adverse Environments

Conductors, wiring materials, and equipment shall be inherently suitable or shall be installed so as to be protected when so located as to be affected by:

(a) High temperatures (particularly at collectors and collector piping) and widely varying temperatures.

[Sec. 300-7, 310-9, 402-3, 347-3]

(b) Corrosive influences both above and below ground, and including toxic or corrosive heat transfer fluids. [Sec. 300-5, 300-6, 310-8]

(c) Damp and wet locations. [Sec. 300-6(c), 346-4]

E-102.0 Access and Location

E-102.1 Access

Sufficient access and working space shall be provided and maintained about all electric equipment to

permit ready and safe operation and maintenance of such equipment. [Sec. 110-16]

E-103.0 Material Tests and Specifications

E-103.1 Approved Materials

Products of a type listed by a nationally recognized electrical testing laboratory shall bear the listing mark of such laboratory. One-of-a-kind equipment, or equipment outside the scope of listing of a nationally recognized electrical testing laboratory may be approved by the enforcement agency. [Sec. 90-4, 90-6, Art. 100 definition of "Listed", Sec. 110-3]

E-103.2 Installation and Use

Listed or labeled equipment shall be used or installed in accordance with any instructions included in the listing or labeling. [Sec. 110-3(b)]

E-103.3 Marking

Electrical materials and equipment shall be marked with the manufacturers' identification and such electrical ratings as are necessary for proper installation and use. [Sec. 110-21]

E-103.0 Installations in Ducts

E-103.1 Wiring Methods

Only wiring methods approved by the authority

having jurisdiction for enforcement shall be run within ducts, plenums, and other spaces used for environmental air.

Within ducts and plenums no electrical equipment or devices shall be installed except those necessary for their direct action upon, or sensing of, the contained air. [Sec. 300-22]

E-103.2 Duct Heaters

Supplementary electric heaters installed in air ducts shall be installed in accordance with the manufacturers' instructions in a manner so that operation will not create a hazard to persons or property. [Art. 424 Part F]

E-104.0 Controls

E-104.1 Electrical Controls

Remote-control, signaling, and power-limited circuits not an integral part of a device or appliance shall be Class 1, Class 2, or Class 3 and shall comply with the requirements of reference standard SSE-1, Article 725.

SECTION M
MECHANICAL (AIR SYSTEMS)

M-101.0 Scope

M-101.1 General

All systems or portions of systems designed to utilize solar energy for building heating or processing with the mechanical movement of air shall comply with the requirements of this section.

Heating, ventilating and air-conditioning equipment and systems which are supplemental to or independent of the solar energy system shall be approved by the enforcement agency.

M-101.2 Mechanical Code

The provisions of this section shall be used in conjunction with the Mechanical Code. In the event a Mechanical Code has not been adopted, Appendix M-1 becomes part of this section and declared to be part of this document.

M-102.0 Access and Location

M-102.1 General

All components shall be installed with accessibility for inspection, maintenance, repair or replacement.

M-102.2 Distribution System

(a) Equipment in elevator hoistways, elevator machine rooms and machinery spaces shall be located in accordance with Appendix M-1 or the Mechanical Code.

(b) The use of uninhabited basements, cellars, crawl spaces, cavity walls, areas above ceilings or attic spaces as supply, make up, exhaust air or return air plenums or ducts shall comply with the requirements of Appendix M-1 or the Mechanical Code.

(c) Outside air intakes and exhaust openings shall be located in accordance with Appendix M-1 or the Mechanical Code.

M-103.0 Material Test and Specifications

M-103.1 General

The solar energy system components shall not be affected by external environmental factors or operating conditions to an extent that will impair its function. Compliance with the criteria as required herein shall be deemed as meeting this requirement.

M-103.2 Collectors

(a) Labelling - Manufactured collectors shall be labelled to show the manufacturers' name and address, model number, serial number and collector weight.

(b) Structural - The collector cover and supportive framing shall be adequate to resist the design snow and wind loads specified for the geographic area and height above grade as determined by B-100 of this document.

(c) Thermal Performance

- (1) Manufactured Collectors - Data sheets shall be provided showing thermal performance using the method of testing described in SS-M-1 (ASHRAE 93-77) after subjection to the Exposure Test described in Appendix M-3.
- (2) Site Built Collectors - Data shall be provided showing the average yearly contribution of solar energy collected.

*(d) Durability

(1) Cover Plates

Documentation shall be provided that the cover plate(s) is resistant to degradation by UV radiation for the design life by the manufacturer.

In lieu of other documentation, the transmittance of the cover plate(s) as measured by SS-M-2 shall not change beyond that stated by the manufacturer after exposure using any one of the three aging procedures described in Appendix M-2. The computation of solar transmittance based on the spectrophotometric method

in SS-M-2 (ASTM E-424) shall be standardized on air mass 2.

For collectors with multiple covers, the tests below shall be performed with the cover plates in their design configuration.

(2) Absorber Plates

Organic absorber plates shall be resistant to UV radiation for the design life by the manufacturer stated.

In lieu of other documentation, subsection to the Exposure Test described in Appendix M-3 without softening, cracking, embrittlement or fading shall be deemed as meeting the intent of this criteria.

(3) Absorbative Surfaces

Ultraviolet Stability

Documentation shall be provided that the absorbative coating is resistant to UV radiation for the design life claimed by the manufacturer.

In lieu of other documentation the absorbative coatings shall not exhibit checking, cracking, blistering or flaking after testing using any one of the three aging procedures described in Appendix M-2.

Moisture Stability

Documentation shall be provided that the absorbative coating is not affected by moisture

with which it comes in contact beyond the design life claimed by the manufacturer.

In lieu of other documentation, the absorbtive coating shall not exhibit checking, cracking, blistering or flaking after testing for 30 days according to SS-M-3 (ASTM D 2247-68).

(4) Reflective Surfaces

Ultraviolet Stability

Documentation shall be provided that the reflectance properties of the surfaces are resistant to UV radiation for the design life claimed by the manufacturer.

In lieu of other documentation, the reflectance, as measured for air mass 2 by SS-M-2, method A, shall not decrease by more than 10% after exposure using any one of the three aging procedures described in Appendix M-2.

*The Department of Energy has indicated that a standard is being developed relating to durability of collectors and thermal performance stability. If this standard is developed prior to the publication of this document, it is hoped that these requirements can be deleted and reference made to the test standard.

****(e)** Fire Performance - The collector components which are exposed to the air passage shall be non-combustible or Class I material.

EXCEPTION: When approved smoke detectors are installed in the duct system from the collector designed to stop all air flow through the collector when actuated, plastic collector cover plates may be used when meeting the requirements of Section B of this document.

All insulating materials and adhesives shall have a smoke developed rating not exceeding 50 with a flame spread rating not exceeding 25.

In addition, insulating materials shall not flame, smolder, glow, or smoke when tested in accordance with SS-M-4.

Outlet air temperatures shall be limited to 200°F maximum.

**Underwriters Laboratories is currently developing a standard relating to the fire performance of solar collectors. If this standard is available prior to publication of this document, this requirement could be replaced with a reference to such standard.

M-103.3 Distribution

The materials used for air distribution such as ducts, plenum, duct linings, duct coverings and flexible duct connectors and material shall conform to the requirements of Appendix M-1 or the Mechanical Code of the jurisdiction.

M-104.0 DistributionM-104.1 General

The air distribution system shall be installed in accordance with the requirements of this section.

M-104.2 Fans and Blowers

All fans and blowers shall bear the seal of a nationally recognized testing and inspection agency.

M-104.3 Installation of Ducts

The installation of ducts shall meet the requirements specified in Appendix M-1 or the Mechanical Code.

M-104.4 Fire Dampers

Fire dampers shall be installed in the system locations specified in Appendix M-1 or the Mechanical Code of the jurisdiction.

M-105.0 StorageM-105.1 Tank and Storage Materials

Thermal storage tank materials, including any interior protective coatings and the heat storage medium used shall not impart toxic elements to air distributed to areas of human occupancy.

M-105.2 Rocks and Pebbles

Rocks or pebbles used as sensible heat storage shall be certified by the supplier as being washed and free of loose sand and organic material prior to placement in the rock storage bin.

Sensible heat storage bins using pebbles, rock or other duct producing mediums shall be filtered at the air outlet.

M-105.3 Combustible Materials

Combustible materials enclosing phase change materials or otherwise used in latent heat storage systems shall have a flame spread rating not exceeding 25 and a smoke developed rating not exceeding 50.

As an alternate to this requirement, the storage system materials shall be enclosed in a 1 hour fire resistance rated enclosure in one and two family dwellings and 2 hour fire resistance enclosure in all other occupancies. All openings shall be protected with fire dampers. In addition smoke detectors shall be installed which are designed to stop the air flow through the storage device when activated. Minimum sensitivity of approved smoke devices shall be set to operate when smoke reduces the intensity of a (1) foot long beam of white light by four (4) percent or the equivalent.

M-105.4 Heat Loss

Data shall be submitted showing that the rate of heat loss of the stored energy over a 12 hour period will not exceed 5 percent at design operating temperature.

Test reports based upon SS-M-5 (ASHRAE 94-77) shall also be acceptable.

M-105.5 Waterproofing

Where storage units are located outside or underground, an approved waterproofing material shall be installed.

M-106.0 Controls

M-106.1 Automatic Control

Automatic control of the air circulation between the collector and storage or load shall be used to limit operations to conditions when useful energy can be collected.

SECTION P
PLUMBING (LIQUID SYSTEMS)

P-101.0 General

P-101.1 Scope

All systems or portions of systems using liquid movement or a boiling liquid as a means to utilize solar energy for cooling or heating, for water heating or for processing purposes shall comply with the requirements of this Section.

P-101.2 Plumbing Code

The provisions of this Section shall be used in conjunction with the Plumbing Code. In the event a Plumbing Code has not been adopted the Appendix becomes part of this Section and is declared to be part of this document.

P-101.3 Interconnections

The interconnections of the auxiliary energy plumbing system and components to the solar energy system and components shall be made in a manner which will not result in temperatures or pressures in the auxiliary system exceeding the allowable operating temperatures and pressures of the auxiliary system and shall not bypass the safety devices of the auxiliary system.

P.102.0 IdentificationP-102.1 General

All materials and equipment shall be identified by the manufacturers' label in accordance with Section A-102.2 or otherwise be clearly identified to show compliance with this document.

P-102.2 Labeling

Solar energy plumbing components shall be labeled with the following information:

(a) Piping, fittings and valves

1. Company name or registered trademark of the manufacturer.
2. All markings required by the approved standard.

b) Other components (containing liquids or their vapors)

1. Manufacturer's name and address, model number, serial number, and component weight in the drained condition.
2. All markings required by the approved standard and where applicable, the component performance.
3. The name and address or registered trademark of the agency responsible for determining compliance with the applicable approved standards.

P-102.3 System Labeling

Solar energy plumbing systems and components shall be labeled so as to indicate the type of transfer medium, the direction of flow and the maximum pressure and temperature for the system.

P-103.0 Maintenance

P-103.1 General

Operation and maintenance instructions shall be provided in accordance with Section A-102.1.

P-104.0 Access and Location

P-104.1 General

Solar Energy system components other than piping shall be accessible in accordance with Section B-102.2 for service and maintenance.

P-104.2 Controls

Solar plumbing system control valves, cross-connection control devices and similar devices shall be readily accessible for service and maintenance.

P-104.3 Attic Equipment

Every attic or furred space in which solar energy equipment is installed shall be accessible by an opening and

passageway not less than 30 inches by 30 inches continuous from the opening to the equipment and its controls. Where the passageway is less than 5 feet in height, the opening to the passageway shall be located not more than 20 feet from the equipment measured along the center line of such passageway. Every passageway shall be unobstructed and shall have solid continuous flooring not less than 24 inches wide from the entrance opening to the equipment.

A permanent electric light outlet and lighting fixture, controlled by a switch located at the required passageway opening, shall be provided at, or near, the equipment.

P-104.4 Under-Floor Equipment

Solar energy equipment other than non-pressurized storage tanks installed in the under-floor crawl space area of any building shall comply with the following requirements:

1. An access opening and passageway not less than 30 inches by 30 inches in height and width shall be provided to the working space in front of the equipment. Where the passageway is less than 5 feet in height, the distance from the passageway access to the equipment shall not exceed 20 feet.
2. Equipment supported on the ground shall rest on a concrete or masonry slab at an elevation such that the equipment will not be subject to ground or surface water.

3. The lowest portion of any equipment suspended from the building shall have a clearance such that the equipment shall not be subject to ground or surface water.

Whenever it is necessary to excavate to install any such equipment, the excavation shall extend to a depth of 6 inches below the equipment and 12 inches on all sides of the equipment, except the control side, which shall have a clearance of 30 inches.

Whenever the excavation for either the equipment space or for the passageway exceeds 12 inches in depth, the walls of such excavation shall be lined with waterproof concrete or masonry extending to a height of 4 inches above the adjoining ground level.

In flood plane areas wherever there is a possibility that water may overflow the 4-inch curb, the entire crawl space grade or height shall be such that a 12 inch clearance will exist between the bottom of the equipment and the ground.

4. A permanent electric light outlet and lighting fixture, controlled by a switch located at the required passageway opening, shall be provided at, or near, the equipment.

P-104.5 Exterior Equipment

(a) General. Installation on roofs or exterior walls of buildings shall comply with the requirements for roof and wall structures as specified in the Building Code, and the equipment shall be listed or approved for such use.

(b) Weather Protection. Unless listed or designed for outside installation, equipment located on the roof of a building shall be in a penthouse complying with the requirements of the Building Code, for roof structures, or shall be completely enclosed in a weatherproof housing. This housing when constructed of metal shall be of galvanized steel or aluminum not less than No. 24 U. S. Standard gage supported on a substantial metal frame. The housing shall be not larger than necessary to properly cover and provide a minimum 6-inch clearance around the equipment enclosed therein, including all controls and draft hoods.

(c) Platform. Equipment, other than collectors, located on a roof of a building shall be installed on a substantial level platform. Whenever the roof has a slope greater than 4 inches measured vertically to 12 inches measured horizontally, a level working platform not less than 30 inches in depth shall be provided in front of and at the sides of the equipment. All sides of any working platform facing any portion of the roof edge below the platform shall be protected by a substantial railing 42 inches in height with vertical rails not more than 21 inches apart, except that parapets at least 24 inches in height may be utilized in lieu of rails or guards.

(d) Catwalk. A catwalk not less than 16 inches in width and provided with substantial cleats spaced not more than 16 inches apart shall be provided from the roof access to every required working platform at the equipment.

EXCEPTION: This requirement shall not apply if the slope of the roof is not more than 4 inches measured vertically to 12 inches measured horizontally.

(e) Roof Scuttle Access. Working platforms, railings and catwalks required by (c) and (d) above may be omitted when access to the equipment is through a required roof scuttle and all of the following provisions are met:

1. The required scuttle is located immediately adjacent to the control side of the equipment unit.
2. All controls, filters, burners, fans and motors are accessible for service and repair within 2 feet of the edge of the equipment platform on the scuttle side.
3. The equipment platform is not more than 20 inches above the high side of the scuttle opening.
4. A substantial working platform not less than 30 inches by 30 inches shall be provided directly below the scuttle at a point not less than 30 inches or more than 32 inches below the high side of the scuttle opening.
5. Scuttles located on other than the roof incline side of the equipment unit shall have their lids

or trap doors hinged on the low side of the scuttle. Such lids or trap doors shall be equipped with means to insure an opening radius of not less than 90 degrees nor more than 100 degrees from the closed position. Scuttle lids or trap doors and hardware, when open, shall be capable of withstanding a 300-pound lateral stress from the roof incline side.

6. Access to such scuttles shall comply with the requirements of Section P-104.0.

(f) Access. Equipment installed in or on an exterior wall of a building, which is so designed that the controls are serviceable only from outside the building, shall be readily accessible.

Equipment located on the roof of any building shall be readily accessible.

EXCEPTION: 1. Permanent exterior ladders providing roof access need not extend closer than 8 feet to the finish grade.

2. For equipment on a single-story portion of a Merchantile or Residential Occupancy, a portable ladder may be used.

P-105.0 Material Specifications and Tests

P-105.1 General

Materials used in solar energy systems shall conform to the applicable standards set forth in the Plumbing Code or

the Appendix.

P-105.2 Environment

Materials which may be adversely affected by environmental factors for both filled and drained conditions shall be protected in an approved manner.

P-105.3 Temperature and Pressure

Materials which may be adversely affected when exposed to the temperatures and pressures developed in the solar energy system shall be protected in an approved manner.

P-105.4 Compatibility

Materials which are in contact, including heat transfer fluids, shall be chemically compatible. Provisions shall be made to allow for differences in the expansion and contraction of joined materials due to temperature fluctuations.

P-105.5 Abrasives

Materials which may be adversely affected by abrasive wear caused by the flow of heat transfer fluids, cleaning, or by natural factors such as wind-blown sand shall be protected in an approved manner.

P-105.6 Soil Corrosion

Materials installed in soil shall not be adversely affected or shall be protected by a protective coating. The

coating and its application shall conform to applicable standards.

P-105.7 Ultraviolet Stability

Materials that are normally exposed to UV radiation while in service shall not be adversely affected by such radiation. Documentation shall be provided demonstrating that such materials are capable of withstanding exposure to sunlight when tested in accordance with Standard SS-M-2.

P-105.8 Joints and Connections Between Dissimilar Metals

Dissimilar metals shall either be electrically isolated from each other or documentation shall be provided to demonstrate that the joints and connections are sufficiently compatible to prevent corrosion.

P-105.9 Metals

Metals used in contact with heat transfer liquids shall conform to the requirements in Appendix P-4.

P-105.10 Nonmetallic Materials

Nonmetallic materials in direct contact with the heat transfer liquids shall be tested in accordance with Standard SS-P-1 and found to be satisfactory for the intended use.

P-105.11 Valves

Valves in contact with heat transfer liquids shall be compatible with the heat transfer liquid as required in Appendix P-4 and Standard SS-P-2.

P-105.12 Chemical Decomposition

Products expelled from materials under in use conditions shall not adversely affect the operation of the system.

P-105.13 Sealants

Sealants in pressurized systems shall be tested for the maximum service pressure.

P-105.14 Leakage

Leakage from assemblies or subassemblies which contain heat transfer fluids shall be provided for and shall not adversely affect equipment, structural components or persons which may come in contact with the leaking heat transfer fluid or create a safety hazard.

P-105.15 Pipe Hangers

Pipe hangers shall not damage those materials they are in contact with and shall allow for movement of the supported systems caused by thermal expansion and contraction.

P-105.16 Pipe Insulation

Solar energy piping systems shall be insulated in accordance with Table P-1.

TABLE P-1
Minimum Pipe Insulation
Thermal Resistance (R Value)

Maximum Liquid Operating Temperature - °F.	Pipe Sizes & R Values			
	1" and less	1¼ - 2"	2½ - 4"	4" and larger
200°	4	6	6	8
201° - 250°	6	6	8	10
251° - 305°	6	8	10	10

P-106.0 Health and SafetyP-106.1 Toxicity

Materials shall not introduce toxic substances, impurities or bacteria into air circulation systems.

P-106.2 Fungi Protection

Materials and processes used in solar energy systems shall not promote the growth of fungi, mold, or mildew when tested in accordance with Standard SS -P-3.

P-106.3 Rodent Protection

Solar energy systems shall not contribute to the entry of vermin or rodents as set forth in Section B-105.7.

P-106.4 Potable Water Supply Protection

The connection of the solar energy system to the potable water supply system shall conform to the cross-connection requirements of the plumbing code or Appendix P-1 of this document.

P-106.5 Drainage

Solar energy systems shall provide for the drainage of heat transfer fluids in accordance with the indirect and special waste provisions of the plumbing code or Appendix P-2.

P-106.6 Hazardous Material Drainage

Drains in solar plumbing systems where high-temperature or high-pressure fluids are discharged shall have a warning label describing the hazardous properties of the fluid, instructions concerning the safe handling of the fluid, and emergency first-aid procedures. Valves regulating such discharge shall not be accessible to unauthorized personnel.

P-106.7 Heat Transfer Medium

Heat transfer mediums which are classified as refrigerants shall conform to the requirements of the mechanical code or Appendix P-5 for Group I refrigerants.

P-106.8 Hazardous Heat Transfer Mediums

Heat transfer mediums which are toxic, combustible, or corrosive as defined in this document shall not be used in

solar energy systems except when approved by the authority having jurisdiction.

P-106.9 Draining and Filling of Systems

Solar energy systems shall be capable of being vented and filled without air entrapment.

P-106.10 Protection from Heated Components

Solar energy systems and components which are subject to contact by unauthorized personnel and which are maintained at elevated temperatures at or above 140°F, shall be protected in an approved manner to prevent contact.

P-107.0 Fire Safety

P-107.1 Fire Resistance

Solar Energy systems shall be fire protected in accordance with Section B-104.0.

P-107.2 Penetration

Penetrations of fire-resistive assemblies by solar energy system components shall conform to the requirements of Section B-105.1.

P-107.3 Firestopping

Firestopping shall conform to the requirements of Section B-105.2.

P-107.4 Flame Spread

The flame spread classification of insulation materials shall not exceed 200 when tested in accordance with SS-B-8.

P-107.5 Smoke Density

The smoke density classification of insulation materials shall not exceed 50 when tested in accordance with SS-B-8.

P-107.6 Combustible Material Clearance

Clearance shall be maintained between solar energy components operating at elevated temperatures and adjoining combustible materials. Clearance shall be in accordance with the equipment listing.

P-108.0 Life Safety

P-108.1 Pressure Relief

Adequately sized relief devices shall be provided in pressurized solar energy systems and sub-systems which may be isolated by valving. The devices shall be set to relieve the pressure at the lowest maximum design pressure encountered in the system. The devices shall be drained in accordance with Section P-106.5 of this section.

P-108.2 Vacuum Relief

The solar energy plumbing system and components shall be protected against possible collapse by design or by provision of vacuum relief valves.

P-108.3 Temperature Relief

Approved adequately sized and responsive temperature relief devices shall be provided in those parts of the solar energy plumbing system (and components) which may be isolated by valving and which contain components that add energy to the system. Such devices shall be installed with the temperature-sensing element located as close as practical to the hottest point of the above-described section. Additional temperature relief valves shall be installed if required to satisfy all possible modes of operation. The entire system shall be designed to operate at the maximum operating temperature encountered in the system. The temperature relief devices shall be set to relieve at or below this maximum temperature. Temperature relief devices shall drain to locations in accordance with paragraph P-106.5 of this section.

P-109.0 Structural SafetyP-109.1 General

Solar energy systems shall be designed and constructed in accordance with the building, plumbing and mechanical codes or with this document.

P-109.2 Freeze Protection

Solar energy systems subject to freezing of the heat transfer fluid shall be protected by draining, circulation of an antifreeze or other approved method.

P-109.3 Thermal Distortion

Solar energy systems shall be designed to accommodate thermal distortion.

P-110.0 Collectors

P-110.1 Identification

Solar energy collectors shall be identified in accordance with Section 102.0 and shall be installed in accordance with their listing which shall include the following parameters:

- (a) Minimum clearances
- (b) Type of heat transfer fluid
- (c) Maximum operating temperatures
- (d) Maximum operating pressure
- (e) Filled collector weight

P-110.2 Material - Specifications and Tests

P-110.2(a) Thermal Performance: The thermal performance of the collector shall be determined using the following parameters.

1. Manufactured collectors.

Data sheets shall be provided showing the thermal performance using the method of testing described in SS-M-1 (ASHRAE 93-77) after subjection to the exposure test described in Appendix M-3.

2. Site Built Collectors.

Data prepared by a licensed engineer or architect shall be provided showing the average yearly contribution of solar energy collected.

P-110.2(b) Ultraviolet Stability: Ultraviolet Stability of the collector components shall be determined as follows:

1. Cover plates.

Documentation shall be provided that cover plates are resistant to degradation by UV radiation for the design life stated by the manufacturer. In lieu of other documentation, the transmittance of the cover plate as measured by SS-M-2 shall not change beyond that stated by the manufacturer after exposure using any one of the three aging procedures described in Appendix M-2. The computation of solar transmittance based on the spectrophotometric method in SS-M-2 shall be standardized on air mass 2.

For collectors with multiple covers, the tests in Section P110.2(b)2 shall be performed with

the cover plates in their design configuration.

2. Absorber Plates.

Organic absorber plates shall be resistive to UV Radiation for the design life stated by the manufacturer.

In lieu of other documentation, subjection to the Exposure Test described in Appendix M-3 without softening, cracking, embrittlement or fading shall be deemed as meeting the intent of this criteria.

3. Absorbative Surfaces.

Documentation shall be provided that the absorbative coating is resistant to UV radiation stated for the design life by the manufacturer. In lieu of other documentation the absorbative coatings shall not exhibit checking, cracking, blistering or flaking after testing using any one of the three aging procedures described in Appendix M-2.

4. Reflective Surfaces

Documentation shall be provided that the reflectance properties of the surfaces are resistant to UV radiation for the design life stated by the manufacturer.

In lieu of other documentation, the reflectance, as measured for air mass 2 by SS-M-2, method A, shall not decrease by more than 10%

after exposure using any one of the three aging procedures described in Appendix M-2.

P-110.2(c) Moisture Stability. Documentation shall be provided that absorbtive coatings are not affected by moisture with which it comes in contact with beyond the design life stated by the manufacturer. In lieu of other documentation, the absorbtive coating shall not exhibit checking, cracking, blistering or flaking after testing for 30 days in accordance with SS-M-3.

P-110.3 Structural Safety

Solar energy collectors and their supports shall be designed in accordance with Section B-104.2.

P-111.0 Distribution

P-111.1 Material - Specifications and Tests

P-111.1(a) Piping. Piping used in solar energy distribution systems shall be installed in accordance with the plumbing code or Appendix P-3. Hangers and supports shall be installed in accordance with the plumbing code or Appendix P-6. Piping shall be sized to limit the fluid velocity to recommended levels considering the type of fluid and the piping material.

P-111.1(b) Valves. Shut-off valves shall be gate valves, butterfly valves, or similar valves that open to within 90 percent of full pipe bore. Globe, ball, butterfly or similar valves shall be used for flow control.

111.1(c) Heat Exchangers. Heat exchangers used in domestic water heating systems shall comply with Standard SS-P-4.

P-111.2 Structural Safety

Solar energy distribution systems and their supports shall be designed in accordance with Section B-104.2. Tanks shall be provided for thermal expansion in the solar energy distribution system.

P-111.3 Testing

Solar heating systems using liquid heat transfer fluids, not directly connected to the potable water supply, shall be tested for pressures of not less than 1-1/2 times the design pressure for a minimum of 15 minutes. The portion of the system connected to the domestic water system shall be tested in accordance with the plumbing code or Appendix P-7.

P-111.4 System Cleaning

After completion of piping tests and after all equipment has been installed, the entire liquid systems shall be thoroughly flushed to remove sediment, dirt, and loose scale, etc. Strainers shall be cleaned or replaced. During the flushing of the system, the collectors shall be disconnected or bypassed to preclude passage of debris through the collectors. Fluids used for leak testing shall be the same as the fluid to be used in the system or such fluids that will be compatible with the fluid to be used, or the

manufacturers instructions shall be followed.

P-112.0 Storage

P-112.1 Access and Location

Solar energy storage systems and their equipment shall be installed in accordance with Sections P-104.3, P-104.4, P-104.5 and B-102.0.

P-112.2 Material - Specifications and Tests

Solar energy storage systems materials shall conform to the requirement of Section P-105.0.

P-112.3 Health Safety

P-112.3(a) Cleaning. Solar energy storage systems shall be cleaned following installation and piping tests.

P-112.3(b) Covers. All openings into tanks except vents shall be tightly covered to prevent entry of unauthorized persons, dirt, and vermin. Vents shall be screened with corrosion-resistant material having not more than 20 openings per linear inch.

P-112.4 Testing

Pressurized tanks shall be tested in accordance with Section P-111.3. Non-pressurized tanks shall be tested visually for leaks by filling. Fluids used for leak testing shall be the same as the fluid to be used in the system.

P-112.5 Inlet and Outlets

The inlets and outlets piping for thermal storage in solar energy storage systems shall be located in the container so as to prevent thermal "short circuiting" of the fluid flow.

P-112.6 Insulation

Solar energy storage systems shall be insulated to prevent no more than 4 percent heat loss of the stored energy over a 24 hour period except for systems that are used for space heating only and the container is used to supplement the heating requirement of the conditioned space.

P-112.7 Tank Drainage

Solar energy storage systems shall be drainable. Tanks located above grade shall be drained at the lowest point. Underground tanks shall use mechanical means for drainage.

P-112.8 Tank Filling

Solar energy storage systems shall have fluid level indicators and overflows directed away from the building. Make-up water from the potable water system shall be filled in accordance with the plumbing code or Appendix P-1 using an air cap.

P-112.9 Shutoffs

Shutoff valves shall be provided between the supply system and cold and hot water storage tanks.

P-113.0 ControlsP-113.1 General

Solar energy plumbing systems shall be equipped with controls so as to prevent the following conditions from developing:

- (a) The addition of energy to the storage media when the temperature of the storage media has reached its maximum design operating temperature.
- (b) Undesirable energy loss as a result of thermosiphoning.
- (c) Heat transfer fluids in the collector rising above their maximum design operating temperature. The pressure and temperature relief devices required in Section 108 shall not be considered as controls to satisfy this condition.
- (d) Heat transfer fluids that are circulated when they exceed their designed operating temperature range.

Provisions of this subsection shall not apply where adequate data is submitted demonstrating that these conditions will not occur due to the design and location of the system.

P-113.2 Fail Safe

The solar energy control system shall revert to a fail safe mode in the event of a power failure.

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REFERENCE STANDARDS - BUILDING SECTION

SS - B-1 Concrete.

Building Code Requirements for Reinforced

Concrete ACI 318-76

Building Code Requirements for Structural

Plan Concrete ACI 322

SS - B-2 Masonry.

Building Code Requirements for Masonry . . ANSI A41.1-70

Building Code Requirements for Reinforced

Masonry ANSI A41.2-70

SS - B-3 Aluminum.

Specification for Aluminum Structures,

Aluminum Construction Manual AA-SAS30-76

SS - B-4 Steel.

Design of Cold-Formed Steel Structural Members -

Specification for AISI-68

Design, Fabrication and Erection of Structural

Steel for Buildings - Specification for . . AISC-S310-69

Supplement No.1 AISC-S319-70

Supplement No. 2 AISC-S320-71

Supplement No. 3 Revised AISC-S321-75

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Design of Cold-Formed Stainless

Steel Structural Members - Specification for. . AISI-74
 Longspan Steel Joist LJ and LH Series, and
 Deepspan Steel Joists DLJ and DLH Series -
 Standard Specifications for SJI/AISC-74
 Metal Building Systems Manual MBMA-74
 Open Web Steel Joists, J-Series and II-Series-
 Standard Specification for SJI/AISC-74
 Structural Joints Using ASTM A325 or A490 Bolts -
 Specifications for AISC-S314-76
 Welding Code, Structural AWS D1.1-75
 -Revision No. 1 AWS D1.1-Rev.1-76
 -Revision No. 2 AWS D1.1-Rev.2-77

SS - B-5 Wood and Wood Products.

Adhesives for Field Gluing Plywood to Wood Framing -
 Performance Specifications for APA-AFG01-74
 All-Weather Wood Foundation System-
 Basic Requirements NFOPA-TR7-76
 -1977 Supplement NFOPA-TR7-77
 Code of Suggested Practices - Timber
 Construction Standard AITC 106-77
 Construction Details - Typical Timber
 Construction Standard AITC 104-76

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Heavy Timber Construction - Standard for . . . AITC 108-69

Joists and Rafters

Span Tables for NFOPA-77

Design Values NFOPA-77

National Design Specification for Wood

Construction NFOPA-77

-1977 Supplement (Design Value) NFOPA-77

Plywood Commercial/Industrial Construction

Guide APA-Y300-76

Plywood Design Specifications APA-Y510-76

Plywood-Lumber Components - Design Specifica-

tions for (includes curved panels, beams,

stressed-skin panels, sandwich panels,

diaphragm construction and folded plates) . APA-V820-77

Plywood Residential Construction Guide APA-Y405-76

Structural Design Data, Wood NFOPA-70

Structural Design Guide for Hardwood Plywood . . HPMA-HP-SG-72

Structural Glued Laminated Timber -

Inspection Manual for AITC 200-73

Structural Timber Framing-Standard for the

Design of AITC 102-76

Timber Construction Manual AITC-74

Trusses-Design Specifications for Light Metal

Plate Connected Wood TPI-74

Wood Handbook USDA Handbook No. 72-74

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- SS - B-6 - Standard Methods of Fire Tests of
Building Construction and Materials ASTM E119
- SS - B-7 - Building Code Requirements for Minimum
Loads in Buildings and Other Structures ANSI A58.1
- SS - B-8 - Surface Burning Characteristics
of Building Materials ASTM E-84
- SS - B-9 - Standard Methods of Fire Tests
of Door Assemblies ASTM E-152

Building

RS-B-4

March 7, 1979

REFERENCE STANDARDS
ELECTRICAL SECTION

SS-E-1 National Electrical Code NFPA 70

RS-E-1

March 7, 1979

REFERENCE STANDARDS
MECHANICAL SECTION

- SS-M-1 Thermal Performance of Solar
Collectors - TestingASHRAE 93-77
- SS-M-2 Solar Energy Transmittance
and Reflectance ASTM E 424-71
- SS-M-3 Coated Metal Specimens at 100
Percent Relative Humidity -
Testing ASTM D 2247-68
- SS-M-4 Hot-Surface Performance of High-
Temperature Thermal Insulation -
TestASTM C 411-61
- SS-M-5 Thermal Storage Devices Based on
Thermal Performance - Testing . . ASHRAE 94-77

March 7, 1979

REFERENCE STANDARDS

PLUMBING SECTION

SS-P-1	Non-Metallic Materials	- To be developed
SS-P-2	Values	- To be developed
SS-P-3	Fungi Protection	- To be developed
SS-P-4	Heat Exchangers	- To be developed

RS-P-1

APPENDIX D

Accessible - Admitting close approach which may require removal of access panel, door, or similar obstruction.

Accessible, readily - Direct access without the necessity of removing any panel, door, or similar obstruction.

Alley - Any public space or thoroughfare less than 16 feet but not less than 10 feet in width which has been dedicated or deeded to the public for public use.

Area (Building) - Is the maximum horizontally projected area of the building at or above grade, exclusive of court and vent shafts.

Attic - The space between the ceiling beams of the top habitable story and the roof rafters.

Attic Story - Any story situated wholly or partly in the roof, so designated, arranged, or built as to be used for business, storage, or habitation.

Basement - That portion of a building which is partly below and partly above grade, and having at least one-half its height above grade (see "Grade", "Story" and "Cellar").

Building - Any structure used or intended for supporting or sheltering any use or occupancy.

Cellar - That portion of a building which is partly or completely below grade and having at least one-half its height below grade.

Combustible Building Material - One not meeting the standards for a noncombustible building material as defined herein.

Court - A space, open and unobstructed to the sky, located at or above grade level on a lot and bounded on three or more sides by walls of a building.

Fire-Resistance Rating - The time in hours that the material or construction will withstand the standard fire exposure as determined by a fire test made in conformity with the "Methods of Fire Tests of Building Construction and Materials, ASTM E119."

Fire Retardant Treated Wood - Any wood product which, when impregnated with chemicals by an approved pressure process, or by other approved means during manufacture shall, when tested in accordance with ASTM test designation E-84, have a flamespread equivalent to twenty-five (25) or less

and show no evidence of progressive combustion when the test is continued for a period of thirty (30) minutes.

All fire retardant treated wood products shall bear identification showing the fire hazard classification thereof issued by an approved agency having a re-examination service.

Where fire retardant treated wood products are to be subjected to sustained high humidity or exposed to weather it shall be further identified as Exterior type and to indicate that there is no increase in the listed fire hazard classification when subjected to the ASTM D2898 Methods of Test for Durability of Fire Retardant treatment of Wood.

Subsequent to treatment, fire retardant treated lumber and plywood shall be dried to a moisture content of nineteen (19) percent or less for lumber and fifteen (15) percent or less for plywood.

Firewall - A fire resistive wall, having protected openings, which restricts the spread of fire and extends continuously from the foundation to or through the roof.

Flame Spread - The propagation of flame over a surface.

Flame Spread Rating - That numerical value assigned to a material tested in accordance with "Methods of Test for Surface Burning Characteristics of Building Materials, ASTM E84."

Flammable - Subject to easy ignition and rapid flaming combustion.

Grade - A reference plane representing the average of finished ground level adjoining the building at all exterior walls.

Height - As applied to a building, means the vertical distance from grade to the highest finished roof surface in the case of flat roofs or to a point at the average height of roofs having a pitch of more than one foot in four and one-half feet.

Listed - Equipment or materials included in a list published by a nationally recognized testing laboratory, inspection agency or other organization concerned with product evaluation that maintains periodic inspection of production of listed equipment or materials, and whose listing states either that the equipment or material meets nationally recognized standards or has been tested and found suitable for use in a specified manner. The means of identifying listed equipment may vary for each testing laboratory, inspection agency, or other organization concerned with product evaluation, some of which do not recognize equipment as listed unless it is also labeled.

Load (live) - The weight superimposed by the use and occupancy of the building, not including the wind load, earth-

quake load, or dead load.

Load (dead) - The vertical load due to the weight of all permanent structural and nonstructural components of a building such as walls, floors, roofs, and fixed service equipment.

Noncombustible Building Material - One which, in the form and thickness in which it is used, meets any of the following requirements:

1. Materials which pass the test procedure for defining noncombustibility of elementary materials set forth in ASTM E136 when exposed to a furnace temperature of thirteen hundred eighty-two (1382) degrees F. for a period of five (5) minutes, and do not cause a temperature rise of the surface or interior thermocouples in excess of fifty-four (54) degrees F. above the furnace air temperature at the beginning of the test and which do not flame after an exposure of thirty (30) seconds.

2. Materials having a structural base of noncombustible materials as defined in paragraph one, with a surfacing not more than one-eighth (1/8) inch thick which has a flamespread rating not greater than fifty (50) when tested in accordance with the method of test surface burning characteristics of building materials set forth in ASTM E84.

The term noncombustible does not apply to the flamespread characteristics of interior finish or trim materials.

A material shall not be classed as noncombustible building construction material which is subject to increase in combustibility or flamespread rating beyond the limits herein established through the effects of age, moisture or other atmospheric conditions.

Owner - Any person, agent, firm, or corporation having a legal or equitable interest in the property.

Roof - The roof slab or deck with its supporting members, not including vertical supports.

Roof covering - The covering applied to the roof for weather resistance, fireresistance or appearance.

Roof structure - An enclosed structure on or above the roof of any part of a building.

Safety Glazing Materials - Glazing materials constructed, treated or combined with other materials to minimize the likelihood of injuries which result from human contact with these glazing materials.

Shaft - A vertical opening extending through one or more stories of a building, for elevators, dumbwaiter, light, ventilation, or similar purpose.

Story - That portion of a building included between the upper surface of a floor and upper surface of the floor or roof next above.

Street - Any public thoroughfare (street, avenue, boulevard, park) or space more than twenty feet in width which has been dedicated or deeded to the public for public use.

Structure - That which is built or constructed.

Water Heater - An appliance designed primarily to supply hot water and is equipped with automatic controls limiting water temperature to a maximum of 210 degrees F.

Yard - An open, unoccupied space, other than a court, unobstructed from the ground to the sky, except where specifically provided by this Document, on the lot on which a building is situated.

APPENDIX B
BUILDING

B-101.0 General

B-101.1 Scope

The provisions contained in this Appendix shall be made part of the building section (Section B) of the document in the absence of a legally adopted Building Code.

B-101.2 Reserved

B-101.3 Systems and Components Integral With The Building

Passive systems and components of active systems integral with the building to comply with either the Basic, Standard, or Uniform Building Code.

B-102.0 Access and Location

B-102.1 Access and Location

Solar components located over public property shall conform with the following:

- (a) Every component shall be at least nine (9) feet in the clear between the lowest point of the component and a sidewalk immediately below.
- (b) A component shall not extend or occupy more than two-thirds ($2/3$) of the width of sidewalk

measured from the building, except that the component may occupy the entire width of the sidewalk provided it is fourteen (14) feet in the clear above the sidewalk.

- (c) All combustible materials used in the construction shall be protected with not less than one (1) hour fire-resistance protection.

B-103.0 Material Test and Specification

B-103.1 Reserved

B-103.2 Standards

The following standards shall be considered as accepted engineering practice:

Aluminum	-	SS B-3
Masonry	-	SS B-1
Steel	-	SS B-4
Wood	-	SS B-5

B-104.0 Collectors

B-104.1 Collector Fire Resistive Requirements

Collectors in excess of two hundred and fifty (250) square feet in base area or in excess of fifteen (15) feet in height when located on buildings more than fifty (50) feet in height shall be of non-combustible construction and shall not exceed one-third (1/3) of the roof area off the roof on which they stand.

B-104.2 ReservedB-104.3 Excavations

Excavations adjacent to any footing shall not extend within one (1) foot of the angle of repose or natural slope of the soil under any footing or foundation unless such footing is properly underpinned or protected against settlement.

B-105.0 Distribution SystemsB-105.1 Fire Rated Assemblies

Penetration of solar distribution systems through fire rated assemblies (walls, partitions, floors, roofs, etc.) shall not reduce the fire integrity of the assembly. The penetrations shall be detailed on the plans to indicate the construction to be used to maintain the required fire resistance.

In Type I and Type II Construction materials used for solar distribution systems which do not qualify as non-combustible shall not penetrate or be concealed within any fire-resistive assembly unless enclosed by or totally embedded within non-combustible materials, unless such material and methods of penetration have been tested in accordance with SS-B-8.

B-105.2 Firestopping

All openings around exposed solar system piping shall be filled with approved non-combustible material or shall be

closed off by close-fitting metal caps at the ceiling and floor line, and on each side of a wall or partition.

In firestopping the following materials may be used: concrete, gypsum, asbestos, mineral wool, rock wool or other approved non-combustible materials securely fastened in place to cut off drafts and provide an effective firestop.

Firestopping shall not be covered or concealed until inspected by the Enforcement Agency.

B-105.3 Fire Dampers

Fire dampers complying with the requirements of UL-555 shall be installed in the following locations, unless proper fire tests show that fire dampers are not necessary to maintain the required fire resistance:

- (a) Ducts penetrating walls or partitions having a fire resistance of one or more hours. When a fire wall is of three (3) hours or greater fire resistance, a fire door meeting the requirements of SS B-9 shall be used.
- (b) Ducts penetrating shaft walls having a fire resistance rating of one or more hours.
- (c) Ducts penetrating floors of buildings requiring the protection of vertical openings where the duct is not protected by shafts.

EXCEPTIONS: Fire dampers are not required:

- (1) In buildings which do not require protected floor openings.

- (2) In duct systems serving only one floor and used only for exhaust of air to the outside and not penetrating a wall or partition having a required fire resistance rating of two (2) hours or more or passing entirely through the enclosure for a vertical shaft.
- (3) Where branch ducts connect to return risers in which the air flow is upward and sub-ducts at least 22 inches in length carried up inside the riser at each inlet.

B-105.4 Thermal Insulation

105.4(a) General. Where a flame spread rating or a smoke developed rating is specified in this section, such ratings shall be determined in accordance with SS B-8. Any material which is subject to an increase in flame spread rating or smoke developed rating beyond the limits herein established through the effects of age, moisture, or other atmospheric conditions, shall not be permitted.

105.4(b) Foam Plastics. Foam plastic materials shall be of an approved type. Such approval shall be based on acceptable diversified tests such as, but not limited to, tunnel tests conducted in accordance with ASTM E-84-1970, Standard Method of Test for Surface Burning Characteristics of Building Materials, full scale corner tests and an ignition temperature test.

Foam plastic having a flame-spread of 75 or less may be used in the following locations:

1. Within the cavity of a masonry or concrete wall.
2. On the room side surface of conforming walls or ceilings provided the foam plastic is fully protected from the interior of the building by a thermal barrier of 1/2 inch gypsum wallboard or other approved material having a finish rating of not less than 15 minutes installed so as to remain in place for the required period of time.
3. Within the wall cavity of combustible non-fire resistive wall construction provided the protection is applied as described in item (2) above.
4. Within the cavity of walls classified as combustible fire resistive construction provided fire tests are conducted in accordance with ASTM E-119-1971, Fire Tests of Building Construction and Materials, and the protection from the interior of the building is at least equivalent to that required in item (2.) above.

Foam plastic insulation having a flame-spread of 75 or less when tested in a thickness of 4 inches, may be used in thickness up to 10 inches in cold storage rooms, food processing rooms, ice plants and similar rooms when the room is protected with automatic sprinklers and the insulation is covered

with 1/2 inch Portland cement plaster or other approved materials having a finish rating of not less than 15 minutes. Thermal barriers shall be installed in a manner that will assure that they remain in place for the required period of time.

Foam plastic insulation having a flame-spread of 25 or less may be used in a thickness of not more than 4 inches in or on walls when the foam plastic is covered by a metal facing of not less than 0.032 inches of aluminum or 26 gauge galvanized steel sheet and the insulated area is protected with automatic sprinklers. Such walls shall not be used where non-combustible or fire-resistive construction is required.

105.4(c) Cellulose Fiber. Cellulose fiber thermal insulation shall be tested in accordance with Standard Specification for Cellulosic Fiber (Wood-Base) Loose Fill Thermal Insulation, ASTM C-739. The insulating material shall comply with the following requirements.

1. Density: The density of the insulating material shall not exceed 3.2 pounds per cubic foot.
2. Thermal Resistance: The thermal resistance value, R, shall not be more than five (5) percent less than the thermal resistance value, R, listed for the insulating material.
3. Surface burning characteristics: The flame spread shall not exceed twenty-five (25) when tested in accordance with ASTM E-84.
4. Flame resistance permanency: The surface burning characteristics shall not increase more than twenty (20) percent when retested using the

two (2) foot apparatus or shall not increase when retested using ASTM E-84

5. Moisture absorbtion: The moisture absorbtion shall be no more than fifteen (15) percent by weight.
6. Odor emission: The odor emission shall be no more than a slight trace.
7. Corrosiveness: The insulating material shall meet the test requirement as a noncorrosive insulating material.
8. Starch: The insulating material shall meet the test requirement as having no evidence of the presence of starch.

105.4(d) Concealed Insulation. Insulating materials, when concealed as installed, in buildings of any type construction, shall have a flame spread rating of not more than seventy-five (75) and a smoke developed rating of not more than four hundred fifty (450).

When such materials are installed in concealed spaces in buildings of Type III, Type V, or Type VI construction, the flame spread and smoke developed limitations do not apply to facings, provided that the facing is installed behind and within one and one half (1½) inches of the unexposed surface of non-combustible ceiling or wall finish.

105.4(e) Exposed Insulation. Insulating materials when exposed as installed in buildings of any type construction shall have a flame spread rating of not more than fifty (50) and a smoke developed rating of not more than four hundred fifty (450).

B-105.5 Reserved

B-105.6 Reserved

B-105.7 Reserved

B-105.8 Reserved

B-105.9 Protection Against Vermin or Rodents

All foundation and exterior wall openings around pipes, electric cables and conduits shall be protected against the passage of vermin or rodents by closing such openings with cement mortar, concrete masonry or non-corrodible metal.

B-106.0 Storage Systems

B-106.1 Firestopping

106.1(a) Walls. Firestopping shall be provided in all walls to cut off all concealed draft openings both horizontal and vertical, and to form an effectual fire barrier between stories and between the upper story and the roof space.

Walls, including masonry walls furred with combustible material, and stud partitions shall be effectively firestopped with non-combustible material at floors, ceilings and roofs, except in those parts of a building which are framed with wood, the firestopping may be of wood not less than two (2) inches in nominal thickness.

106.1(b) Floors. Floors of combustible materials shall be firestopped at walls and partitions where openings occur. When wood joists run parallel to a wall, the space between the wall and the nearest joist shall be not less than two and one-half ($2\frac{1}{2}$) inches and shall be solidly filled with non-combustible material.

Joists in all types of construction shall be firestopped at the ends and over supports for the full depth of the joists.

In firestopping, any of the following materials may be used: brick, concrete, gypsum, steel, iron, asbestos, metal lath and cement or gypsum plaster, mineral wool, rock wool, or other approved non-combustible materials, securely fastened in place to cut off drafts and provide an effective firestop.

Appendix M-1

Requirements for Mechanical (Air Systems)

Access and Location

Outside Air Intake

Outside air intakes and exhaust openings for ventilating air shall be located a distance of at least ten (10) feet horizontally from any plumbing vent terminal, unless such intake opening is three (3) feet below the plumbing vent terminal.

Outside air intake openings for ventilating air located in exterior walls shall be located at least ten (10) feet (measured in any direction) from any flues, vents, chimneys, gas meters, gas regulators, streets, alleys, parking lots, loading docks or other hazardous or noxious sources, unless such intake opening is three (3) feet below any vent terminal.

Exceptions to the above may be approved by the authority having jurisdiction.

Outside air intake and exhaust openings shall be located on the exterior of structures with approved projecting guards, covers or other approved means of preventing the creation of a nuisance and shall not circulate air downward in such a manner as to strike pedestrians.

Where outside ventilating air intake and exhaust openings are located in any areaway below grade, the top of the areaway shall be at least twelve (12)

inches above the grade level and at least twelve (12) feet from the surface of any street or alley.

Outside air intake and exhaust openings shall be protected by approved corrosion-resistant screens, louvers or grates.

All outside air intake and exhaust openings shall be protected against weather and water with a weather-resistant hood or louvers.

All outside air intakes shall be made and maintained easily accessible for cleaning.

Outside air intake and exhaust openings shall be protected against exterior fire exposure in accordance with Section B of this document and the building code of the authority having jurisdiction.

Plenums: The use of unihabited basements, cellars, crawl spaces, cavity walls, areas above ceilings or attic spaces as supply, make up, exhaust air or return air plenums or ducts is prohibited.

EXCEPTION: Air ceiling plenums may be installed as supply or return air plenums in all occupancies except one- and two- family dwellings, provided such air plenums meet the requirements of other applicable articles of this document and of the authority having jurisdiction and provided fuel-fired equipment or exposed combustible materials are not located therein. The use of air ceiling plenums shall be confined to one (1) fire area. The floor or roof

assembly above an unlisted air ceiling plenum shall not depend upon the air ceiling for a portion of its fireresistive rating. Panning of the joist or stud space for return air is permitted in one- and two-family dwellings only. Crawl spaces not used as storage areas in one- and two-family dwellings may be used for air distribution systems.

Equipment in Elevator Equipment Spaces

Equipment in elevator hoistways, elevator pits, elevator machine rooms and machinery spaces: Heating and cooling equipment, ductwork or piping shall not be permitted in elevator hoistways, elevator pits, elevator machine rooms and machinery spaces except as permitted by the Safety Code For Elevators, Dumbwaiters, Escalators and Moving Walks.

Materials

One- and Two-Family Dwellings

Duct Material

Supply ducts may be constructed of approved non-combustible material constructed in accordance with Table A or in accordance with accepted engineering practice. Non-metallic supply ducts shall be constructed and installed in accordance with their approval and SMACNA Duct Construction Standards.

Table A
DUCT CONSTRUCTION MINIMUM SHEET METAL GAGES

Metal gauges (duct not enclosed in partitions)		
Round Ducts		
Diameter inches	Minimum thickness galvanized sheet gage	Minimum thickness aluminum B&S gage
Less than 12	30	26
12-14	28	26
15-18	26	24
Over 30	24	22
Rectangular Ducts		
Width, inches	Minimum thickness galvanized sheet gage	Minimum thickness aluminum B&S gage
Less than 14	28	24
14-24	26	22
25-30	24	22
Over 30	22	20
Metal gauges (ducts enclosed in partitions)		
Width, inches	Minimum thickness galvanized sheet gage	Minimum thickness aluminum B&S gage
14 or less	30	26
Over 14	28	24

Tape used for sealing joints shall be of an approved material having a flame spread rating of twenty-five (25).

The panning of joists or studs for return air shall be of galvanized sheet metal at least Number 30 Galvanized Sheet Gage (0.016 inch) or Number 26 B&S Gage aluminum.

Underground Duct Systems

Underground duct material shall be non-combustible

material in accordance with Table A.

The use of organic materials is prohibited.

Duct Coverings; Linings

Duct coverings shall have a flame spread rating not over fifty (50) without evidence of continued progressive combustion and a smoke developed rating of not over one hundred (100). Duct linings and smoke developed rating of not over fifty (50).

Other Than One- and Two-Family Dwellings

Duct Material

Ducts and plenums may be constructed of approved non-combustible material constructed in accordance with Table B or in accordance with accepted engineering practice or other approved materials similar in vapor permeability, structural rigidity, air flow friction co-efficient, flexibility and combustibility. Non-metallic ducts shall be constructed and installed in accordance with their approval and the SMACNA standards. Aluminum ducts shall not be used in equipment, encased in or under concrete slabs on grade, or in systems where air entering the duct is over two hundred fifty (250) degrees F.

Table B
DUCT CONSTRUCTION
MINIMUM SHEET METAL
GAGES

Rectangular Ducts			
Maximum side inches	Steel min.Galv.Sht.Gage	Aluminum min.B&S Gage	
Through 12	26(0.022 in.)	24(0.020 in.)	
13 through 30	24(0.028 in.)	22(0.025 in.)	
31 through 54	22(0.034 in.)	20(0.032 in.)	
55 through 84	20(0.040 in.)	18(0.040 in.)	
Over 84	18(0.052 in.)	16(0.051 in.)	
Round Ducts			
Diameter inches	Spiral seam duct	Longitudinal seam duct	Fittings
	Steel min. Galv. Sht. Gage		
Through 12	28(0.019 in.)	26(0.022 in.)	26(0.022 in.)
13 through 18	26(0.022 in.)	24(0.028 in.)	24(0.028 in.)
19 through 28	24(0.022 in.)	22(0.034 in.)	22(0.034 in.)
29 through 36	22(0.034 in.)	20(0.040 in.)	20(0.040 in.)
37 through 52	20(0.040 in.)	18(0.052 in.)	18(0.052 in.)

Tape used for sealing joints shall be of an approved material with a maximum flame spread rating of twenty-five (25).

Flexible air duct material is permitted in low, medium and high pressure systems and shall conform to the requirements of UL 181. Air duct material is not limited in length.

Flexible air duct connectors are permitted in in low, medium and high pressure systems and shall conform to the requirements of UL 181. Air duct

connectors are limited in length to fourteen (14) feet.

Flexible air duct material and flexible air duct connectors shall be subject to the following provisions: They shall be rated as Class 1 when tested under application sections for flexible connectors and air ducts of the standard for air ducts; They shall not penetrate required fire-resistance rated assemblies; They shall not pass through floors, walls, or ceilings; They shall not be used within six (6) feet of heating element: The temperature of the air conveyed through such connectors and air ducts shall not be more than two hundred fifty (250) degrees F; Connectors and air ducts shall conform to the applicable requirements for air ducts; Connectors and air ducts shall be installed accessible areas only; and connectors and air ducts shall be rated for the system pressure.

Underground Duct Systems

Underground duct material shall be as stipulated above in one- and two-family dwellings.

Duct Coverings; Linings

Duct coverings, duct linings, tapes, and core materials in panels used in duct systems shall have a flame spread rating not over twenty-five (25) without evidence of continued progressive combustion and a smoke developed rating no higher than fifty (50). If coverings and linings are to be applied with

adhesives, they shall be tested as applied with such adhesives, or the adhesives used shall have a flame spread rating not over twenty-five (25) and a smoke developed rating no higher than (50) when in the final dry state.

EXCEPTION: Duct coverings shall not be required to meet these requirements where they are located entirely outside of a building, do not penetrate a wall or roof, and do not create an exposure hazard.

Duct coverings and linings shall not flame, glow, smolder, or smoke when tested in accordance with ASTM C411 at the temperature to which it is exposed in service. In no case shall the test temperature be below two hundred fifty (250) degrees F.

(a) One- and Two-Family Dwellings

Joints and seams of ducts shall be securely fastened and so constructed as to be substantially airtight. Round pipe slip joints shall have a lap of at least one (1) inch, and each joint shall be individually fastened in an approved manner. Duct connections shall not depend entirely on soldered joints or tape. Tape used for sealing joints shall be of an approved material having a maximum flame spread rating of twenty-five (25).

Supports and hangers for ducts shall consist of strips or rods of metal attached to joists or other framing members at intervals of not more than ten (10) feet. Nails shall not be driven through fittings or ducts at any point. Lugs or straps shall not be formed by cutting holes in fittings or ducts. The various members shall be connected so that all joints are locked, and the several members shall be attached to each other so as to be for the purposes intended airtight.

The interior of combustible ducts shall be lined with metal at points where there is danger from incandescent particles dropping through the register, such as directly under floor register, adjacent to outdoor intakes and at the bottom of vertical ducts.

Vertical stacks for return air shall not be connected to registers on more than one (1) floor.

Air shall not be recirculated from toilet rooms, furnace rooms, boiler rooms or garages.

Ventilation systems shall be constructed and arranged so that negative pressure from the ventilation system cannot affect the air supply for combustion nor draw products of combustion from appliances, vents or fire places.

Duct insulation shall be installed as stipulated in (b).

- (b) Other than one- and two-family dwellings.
- Installation of ducts: Ducts shall not be installed so as to impair the effectiveness of the fireprotection materials surrounding structural members of the building.

Supports and hangers for ducts shall consist of strips or rods or other approved hangers of metal attached to framing members at intervals of not more than ten (10) feet.

All supply, return and exhaust duct openings shall be capped with suitable material during construction.

Except when proper fire tests have shown that fire dampers are not necessary to maintain the integrity of the fireresistance rated assembly, fire dampers complying with the SMACNA Fire Damper Guild, or UL 555, listed in Appendix C, shall be installed in the following locations: Ducts penetrating a fire wall. (When a fire wall is of three (3) hour or greater fire endurance, a fire door is required.) Ducts penetrating a fireresistance rated shaft wall. Sub-ducts extending twenty-two (22) inches vertically upward may be used in lieu of fire dampers for exhaust ducts. Ducts penetrating the ceiling of a fireresistance rated floor/roof-ceiling assembly. Ducts penetrating fireresistance rated corridor walls, unless the building is completely sprinklered or unless the ducts are part of an engineered smoke removal system.

Each air handling system shall be equipped with a high temperature shut-off control and disconnect switch located at a convenient accessible point adjacent to the unit for shutting down of the fan in the event of fire.

An approved smoke detection device approved for duct installation shall be installed in each

recirculating air or exhaust system having a capacity greater than fifteen thousand (15,000) cubic feet per minute (cfm). In systems between two thousand (2,000) and fifteen thousand (15,000) cfm, a heat detector shall be installed. Detection devices shall be located in the return or exhaust duct system in such a location that it will be sensing room air only. Systems designed with a separate exhaust system capable of exhausting more than fifty (50) per cent of the air supplied shall have a detection device in both the exhaust air and return air systems. Detection devices shall stop the fan(s) automatically. Detectors shall be of the manual reset type. Minimum sensitivity of approved smoke devices shall be set to operate when smoke reduces the intensity of a one (1) foot long beam of white light by four (4) per cent or the equivalent.

Negative pressure from ventilation systems:
Ventilation systems shall be designed and installed so that negative pressure from the ventilation system cannot affect the air supply for combustion nor draw products of combustion from appliances, vents or fire places.
Insulation

All duct systems, or portions thereof, exposed to nonconditional spaces shall be insulated to

provide a thermal resistance, excluding film resistances, of

$$R = \frac{t_i - t_o}{15} (\text{hr}) (\text{sq.ft.}) (\text{F}) / \text{Btu}, \text{ where } t_i - t_o \text{ is the design}$$

temperature differential (absolute value) between the air in the duct and the surrounding air.

EXCEPTIONS: Duct insulation, except when needed to prevent condensation, is not required in any of the following cases:

- a. Where $t_i - t_o$ is twenty-five (25) degrees F. or less.
- b. When the heat gain or loss of the ducts, without insulation, will not increase the energy requirements of the building.
- c. Exhaust air ducts.

Where required to prevent condensation, insulation with vapor barriers shall be installed in addition to insulation required above.

Appendix M-2
Aging Procedures

Aging Procedure 1

Expose components or materials to simulated solar radiation (such as xenon arc radiation) for a period of 2000 equivalent sun hours. The exterior surfaces of components which are exposed to rainfall in service shall be subjected to a water spray for a period of 5 minutes during each 60 minutes of the light exposure. For components not exposed to rainfall under normal operating conditions, the water spray shall not be included in the procedure.

Aging Procedure 2

Expose components or materials to concentrated natural solar radiation using machines such as those referenced in ANSI Z97.1-1975, paragraph 4.3.2 for a period of 2000 equivalent sun hours. The exterior surfaces of components which are exposed to rainfall in service shall be subjected to a water spray for a period of 8 minutes during each 60 minutes of sunlight exposure. For components not exposed to rainfall under normal operating conditions, the water spray shall not be included in the procedure.

Aging Procedure 3

Expose components and materials to solar radiation outdoors for twelve (12) months. The average daily flux of the solar radiation, as obtained by

averaging the daily fluxes over the twelve (12)
month period of outdoor exposure, shall be at least
1500 Btu/ft².

Appendix M-3

Exposure Test

Test specimen shall consist of a complete air or collector panel assembly.

Pre-exposure Preparation:

Air collectors shall be sealed and capped with a pressure relief device set to a value within 10% of the collector manufacturer's manimum recommended operating pressure. The inlet shall be equipped with a check valve and desiccant to allow the admission of dry air if internal pressures of less than one (1) atmosphere occur.

Exposure Conditions

Exposure conditions shall consist of 30 days cumulative exposure to a minimum daily incident solar radiation flux of 1500 Btu/(ft²·day) as measured in the plane of the collector aperture. The exposure conditions shall include at least one consecutive four-hour period with a minimum flux of 300 Btu/(ft²·h). In water filled specimens, this must occur after water boilout has occurred. The average ambient temperature shall be 80°F or higher during the 300 Btu/(ft²·h) exposure time. The collector shall be mounted to a rack at a tilt angle such that the incident solar radiation during solar noon is within + 10° of the normal to the plane of the aperture.

Data Records

The exposure conditions including insulation, ambient temperature, wind velocity, and precipitation shall be recorded to enable determination of the average daily values. Values shall be recorded every 30 minutes during the 300 Btu/(ft²·h) exposure.

A regularly scheduled weekly visual inspection shall be made and a record of changes in the physical construction or appearance of the collector kept.

The results of the pre-test and post-test thermal performance shall be plotted on the same graph for comparison purposes.

APPENDIX P-1

PLUMBING

CROSS-CONNECTION CONTROL

Sec. 1604.(a) General. 1. Measurement. The minimum required air gap shall be measured vertically from the lowest end of a potable water outlet to the flood rim or line of the fixture or receptacle into which it discharges.

2. Size. The minimum required air gap shall be twice the effective opening of a potable water outlet unless the outlet is a distance less than three times the effective opening away from a wall or similar vertical surface, in which cases the minimum required air gap shall be three times the effective opening of the outlet. In no case shall the minimum required air gap be less than shown in Table No. 16-A.

(b) Devices. Approved backflow preventers or vacuum breakers shall be installed with all plumbing fixtures or equipment, the potable water supply outlet of which may be submerged and not protected by a minimum air gap.

The potable water supply system shall be protected against backflow from the following fixtures or equipment by one or more backflow-prevention devices as indicated:

1. Low inlet to receptacles containing toxic substances (vats, storage containers, plumbing fixtures):

- A. An approved air-gap fitting
- B. Reduced-pressure unit
- C. Pressure vacuum unit
- D. Atmospheric vacuum breaker unit

2. Low inlet to receptacles containing nontoxic substances (steam, air, food, beverages, etc.):

- A. An approved air-gap fitting
- B. Reduced-pressure unit
- C. Pressure vacuum breaker unit
- D. Atmospheric vacuum breaker unit
- E. Approved double check valve assembly

3. Outlets with hose attachments which may constitute a cross-connection:

- A. An approved air-gap fitting
- B. Reduced-pressure unit
- C. Pressure vacuum breaker unit
- D. Atmospheric vacuum breaker unit

4. Coils or jackets used as heat exchangers in compressors, degreasers and other such equipment involving toxic substances:

- A. An approved air-gap fitting
- B. Reduced-pressure unit
- C. Pressure vacuum breaker unit

5. Direct connections - subject to back pressure:

- A. Nontoxic substances
 - (i) An approved air-gap fitting
 - (ii) Reduced-pressure unit
 - (iii) Approved double check valve assembly
- B. Toxic substances
 - (i) An approved air-gap fitting
 - (ii) Reduced-pressure unit

C. Sewage and lethal substances

(i) An approved air-gap fitting

(c) Approval. Before any device for the prevention of backflow or back-siphonage is installed, it shall have first been certified by a recognized testing laboratory. Devices installed in a building potable water supply distribution system for protection against backflow shall be maintained in good working condition by the person or persons responsible for the maintenance of the system.

(d) Installation. 1. Atmospheric Vacuum Breaker. Atmospheric vacuum breakers shall be installed with the critical level at least 6 inches above the flood-level rim of the fixtures they serve and on the discharge side of the last control valve to any such fixture. No shut-off valve or faucet shall be installed beyond the vacuum breaker.

2. Pressure-type Vacuum Breaker. Pressure-type vacuum breaker units shall be installed at a height of at least 12 inches above the highest fixture, tank, equipment or point of usage.

3. Reduced-pressure Backflow Preventer. A reduced-pressure-type backflow preventer may be installed subject to full static pressure.

4. Equipment Connections. The supply line to steam boilers, pumps, etc., creating higher pressures than the potable water supply system shall be protected by an approved backflow prevention device installed at least 12 inches above the surrounding ground or floor.

5. Access. Backflow-and back-siphonage-preventing devices shall be accessibly located in the same room with the fixture, tank or equipment they serve.

6. Location. In the installation of the following list of fixtures and devices, where an air gap is not provided or is impracticable, approved backflow preventers shall be installed in all supply lines according to Table No. 16-B.

(e) Tanks and Vats. 1. Where a potable water outlet terminates below the rim of a tank or vat and the tank or vat has an overflow of diameter not less than given in Table No. 16-C, the overflow pipe shall be provided with an air gap as close to the tank as possible

2. The potable water outlet to th tank or vat shall terminate a distance not less than one and one-half times the height to which the water can rise in the tank above the top of the overflow. This level shall be established at the maximum flow rate of the supply to the tank or vat and with all outlets closed except the air-gapped overflow outlet.

3. The distance from the outlet to the high water level shall be measured from the critical point of the potable water-supply outlet.

(f) Barometric Loop. Water connections not subject to back pressure where an actual or potential backflow or back-siphonage hazard exists may, in lieu of devices specified in Section 1604, be provided with a barometric loop. Barometric loops shall precede the point of connection.

TABLE No. 16-A - MINIMUM AIR GAPS FOR PLUMBING FIXTURES

FIXTURE	MINIMUM AIR GAP	
	When not Affected by Near Wall ¹ (inches)	When Affected by Near Wall ² (inches)
Effective opening not greater than 1/2-inch diameter	1	1½
Effective openings not greater than ¾ inch diameter	1½	2¼
Effective openings not greater than 1-inch diameter	2	3
Effective openings greater than one inch	2X diameter of effective opening	3X diameter of effective opening

¹Side walls, ribs or similar obstructions do not affect air gaps when spaced from inside edge of spout opening a distance greater than three times the diameter of the effective opening for a single wall, or a distance greater than four times the diameter of the effective opening for two intersecting walls.

²Vertical walls, ribs or similar obstructions extending from the water surface to or above the horizontal plane of the spout opening require a greater air gap when spaced closer to the nearest inside edge of spout opening than specified in Footnote 1 above. The effect of three or more such vertical walls or ribs has not been determined. In such cases, the air gap shall be measured from the top of the wall.

APPENDIX P-2

PLUMBING

INDIRECT AND SPECIAL WASTE PIPING

Air Gap and Air Break

Sec. 1301. (a) Air Gap. The air gap between the indirect waste and the building drainage system shall be at least twice the effective diameter of the drain served and shall be provided by one of the following methods:

1. Extend the indirect waste pipe to an open, accessible individual waste sink, floor drain or other suitable fixture which is properly trapped and vented. The indirect waste shall terminate a sufficient distance above the flood-level rim of the receiving fixture to provide the required air gap and shall be installed in accordance with this code.

2. Provide an air gap in the drain connection on the inlet side of the trap which receives the waste from the indirect waste.

(b) Air Break. When an air break is required between the indirect waste and the building drainage system, the discharge pipe shall be extended below the flood-level rim of the receptacle a sufficient distance to prevent splashing or flooding.

Indirect Waste

Sec. 1302. (a) General. All indirect waste piping shall discharge into the building drainage system through an air gap or air break as set forth in this code.

(b) Materials. Indirect waste piping shall meet the material, pipe sizing and construction requirements of ~~Chapter 14~~ **THE PLUMBING CODE**

(c) Trap. Any indirect waste pipe exceeding 5 feet in length shall be trapped. This requirement does not apply to indirect waste pipes carrying clean water waste only.

(d) Ready Access. Indirect waste piping shall be so installed as to permit ready access for flushing and cleansing.

(e) Where Required. **1. Food-handling Establishments.** In the case of food-handling establishments engaged in the storage, preparation, selling, serving, processing or other handling of foods, indirect waste piping shall be provided for refrigerator coils, walk-in freezers, ice boxes, ice-making machines, steam kettles, steam tables, potato peelers, egg boilers, coffee urns and similar types of enclosed equipment.

The foregoing does not apply to any dishwashing or culinary sink in any food preparation room, unless such receptacle is used for soaking or washing ready-to-serve food.

The indirect waste shall discharge through an air gap or air break into a trapped and vented receptor except that an air gap is required where the indirect waste pipe may be under vacuum (less than atmospheric pressure).

Multiple-compartment sinks, including bar sinks, shall be installed with an indirect connection from each compartment arranged to discharge

through an air gap. Three such indirect drains may discharge into a single trapped branch.

These paragraphs do not apply to private living quarters or dwelling units.

2. **Bar and Fountain Sink Traps.** When sinks in bars, soda fountains and counters are so located that the traps serving such sinks cannot be vented, the sink drain shall discharge through an air gap or air break into a floor drain or sink which is properly trapped and vented.

3. **Sterilizers.** Appliances, devices or apparatus such as stills, sterilizers and similar equipment requiring waste connections and used for sterile materials shall be directly connected by means of air gap.

4. **Air-conditioning Equipment.** No evaporative cooler, air washer, air-handling or similar air-conditioning equipment shall have any drain pipe in connection therewith directly connected to any soil, waste or vent pipe. Such equipment shall be drained by means of indirect waste pipe. The indirect waste shall discharge through an air gap or air break into an open floor sink, floor drain or other approved-type receptor which is properly connected to the drainage system or other approved point of disposal, except that an air gap is required where the indirect waste pipe may be under vacuum.

5. **Drips or Drainage Outlets.** Appliances, devices or apparatus not regularly classed as plumbing fixtures but which have drips or drainage outlets may be drained by indirect waste pipes discharging into an open receptacle through either an air gap or air break as shall be determined by the building official.

6. **Pressure Tanks, Boilers and Relief Valves.** The drains from pressure tanks, boilers, relief valves and similar equipment may discharge indirectly to the drainage system by means of an air gap and without any traps or vents on the indirect piping.

7. **Water Distribution System.** Indirect waste connections shall be provided for drains, overflows or relief pipes from the water distribution system by means of an air gap.

(f) **Drinking Fountains.** Drinking fountain wastes may be indirectly connected.

Receptors and Sumps

Sec. 1303. (a) **Where Required.** The receptor must be located so that the required air gap between the indirect waste line and receptor can be maintained under all conditions of backflow. If this is not possible, then the receptor at such a location must be a sump installed as required under Section 1406 of this code, and the discharge must be indirectly connected to the building drainage system as required by Section 1302 (a).

(b) **Location.** Waste receptors or sumps serving indirect waste pipes shall not be installed in any toilet room nor in any accessible or unventilated space such as a closet or storeroom.

(c) **Prohibited Receptors.** No plumbing fixture which is used for

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domestic or culinary purposes shall be used to receive the discharge of an indirect waste. ~~except that in a residence a kitchen sink trap is acceptable for use as a receptor for a dishwasher and, similarly, a laundry tray as a receptor for a clothes washing machine.~~

(d) **Design.** All plumbing receptors receiving the discharge of the indirect waste pipes shall be of such shape and capacity as to prevent splashing or flooding.

(e) **Strainers and Baskets.** Every indirect waste receptor shall be equipped with a readily removable metal basket over which all indirect waste pipes shall discharge, or the indirect waste receptor outlet shall be equipped with a beehive strainer not less than four inches in height. This does not apply to indirect waste pipes carrying clear water waste only.

~~(f) **Clothes Washer Standpipe.** The standpipe receptor for an automatic clothes washer shall be properly trapped and vented. The standpipe shall extend no more than 50 inches or less than 18 inches above the trap.~~

Waste Water Temperature

Sec. 1304. No steam pipe shall connect to any part of a drainage or plumbing system, nor shall any water above 140°F. be discharged into any part of a drainage system. Such pipes shall be connected by discharging into an indirect waste receptor connected to the drainage system.

Clear Water Wastes

Sec. 1305. Water lifts, expansion tanks, cooling jackets, sprinkler systems, drip or overflow pans or similar devices which waste clear water only, when emptying into the building drainage system, shall discharge through an indirect waste by means of an air gap.

Air-conditioning Condensate

Sec. 1306. (a) Size. Air-conditioning condensate and waste pipes shall not be directly connected to any drainage system and shall not be smaller than:

¾ inch—minimum size through 3 tons

1 inch—serving through 20 tons

1½ inch—serving through 100 tons

When discharge is greater than 7½ gallons per minute, the waste pipe shall be sized as drainage piping in accordance with ~~Section 1404(a)~~.

(b) **Discharge.** Unless expressly prohibited, air-conditioning condensate waste pipes shall discharge as follows:

1. Indirectly to a properly trapped fixture as required in Section 1301
- (a).
2. Indirectly to a sump pump.
3. Indirectly to the building storm drain.
4. An approved leaching well or comparable arrangement.

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Swimming Pools

Sec. 1307. Pipes carrying waste water from swimming or wading pools, including pool drainage, backwash from filters and water from floor drains which serve walks around pools, shall be installed as an indirect waste. Where a pump is used to discharge waste pool water to the drainage system, the pump discharge shall be installed as an indirect waste to the sewer.

Special Wastes

Sec. 1308. (a) Chemical. Separate drainage systems for chemical wastes shall be of corrosion-resistant material. Approved by the building official. Materials acceptable for chemical waste drainage systems include chemically resistant glass pipe, high silicon content cast iron pipe, vitrified clay pipe, plastic pipe specifically approved for the purpose, plastic-lined pipe specifically approved for the purpose and lead pipe.

(b) Corrosive. In no case shall corrosive liquids, spent acids or other harmful chemicals which might destroy or injure a drain, sewer, soil or waste pipe, or create noxious or toxic fumes, or interfere with sewage treatment processes be discharged into the plumbing system without being thoroughly diluted, neutralized or treated by passing through a properly constructed and acceptable dilution or neutralizing device. Such devices shall be provided automatically with a sufficient supply of diluting water or neutralizing medium so as to make its contents noninjurious before discharge into the drainage system. The nature of the corrosive or harmful waste and method of its treatment or dilution shall be submitted to, and accepted by, the building official prior to installation.

APPENDIX P-3

PLUMBING

NOTE: Abbreviations in Table No. 6-A refer to the following organizations:

ANSI	American National Standards Institute 1430 Broadway New York, New York 10018
ASSE	American Society of Sanitary Engineering 960 Aluminating Building Cleveland, Ohio 44113
ASTM	American Society for Testing and Materials 1916 Race Street Philadelphia, Pennsylvania 19103
AWWA	American Water Works Association 6666 West Quincy Avenue Denver, Colorado 80235
CISPI	Cast Iron Soil Pipe Institute 2029 K Street, N.W. Washington, D. C. 20036
CS	Commercial Standards, Commodity Standards Division Office of Industry and Commerce U. S. Department of Commerce Washington, D. C. 20230
FS	Federal Supply Service, Standards Division General Services Administration Washington, D. C. 20405
IAPMO	International Association of Plumbing and Mechanical Officials 5032 Alhambra Avenue Los Angeles, California 90032
MSS	Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. 1815 North Fort Myer Drive Arlington, Virginia 22209
NSF	National Sanitation Foundation Ann Arbor, Michigan 48106
PDI	Plumbing and Drainage Institute 5342 Boulevard Place Indianapolis, Indiana 46208
UL	Underwriters Laboratories, Inc. 207 East Ohio Street Chicago, Illinois 60611

TABLE NO. 6-A
STANDARDS FOR APPROVED PLUMBING MATERIALS AND EQUIPMENT

NO.	DESCRIPTION	ANSI	ASTM	FS	ASSE	OTHER
	Ferrous Pipe, Fittings and Valves					
	Cast iron drainage fittings, threaded	B16.12-1977				
	Cast iron fittings (OT C specials)					LAPMOTS 3-66
	Cast iron screwed fittings (threaded)	B16.4-1971				
	Cast iron pipe (threaded) DWV					
	Cast iron pipe, thickness design of	A21.1-1967 (R1972)				
	Cast iron soil pipe and fittings					
	extra heavy and service weights		A74-75			
	Cast iron water pipe (2")		A377-66			
	Cast iron water pipe (cast in metal molds)		A377-73			
	Cast iron water pipe (cast in sand lined molds)		A377-73			
	Cast iron water pipe fittings		A377-73			
	Ductile-iron pipe		A377-73			
	Hubless cast iron sanitary system					
	with no-hub system fittings					
	Malleable iron screwed fittings 150 lbs.	B16.3-1977				
	Nipples, pipe, threaded			WW-N-351b(1)-1970		
	Pipe fittings, ferrous (bushings, plugs and					
	locknuts) threaded, 125 and 150 lb.	B16.14-77				
	Pipe threads (except dry seal)	B2.1-1968				
	Steel pipe, stainless		A312-75			
	Steel, stainless, water-DWV tubes		A651-71			
	Steel pipe, welded or seamless					
	(for coiling) black or galvanized		A53-76			
	Steel pipe, welded or seamless					
	black or galvanized		A120-76			
	Steel pipe (cement-mortar lining and					
	reinforced cement-mortar coating)	A21.4-1974				

~~NOTE: Standards on materials do not imply that these materials may be used for a specific service. Materials permitted for a specific service shall be specified under the various chapters of this code.~~

TABLE NO. 8-A (continued)
STANDARDS FOR APPROVED PLUMBING MATERIALS AND EQUIPMENT

DESCRIPTION	ANSI	ASTM	PS	ICBO	OTHER
Ferrous Pipe, Fittings and Valves					
Steel pipe (coal tar enamel or cement mortar lining and coal tar enamel coated and wrapped)			WW-P-1432-1970		
Unions, pipe, steel or malleable iron			WW-U-531c-1965		
Valves, ball			WW-V-35a-1965		
			Int Amend 2-1970		
Valves, cast iron, gate 125 and 250 lb.			WW-V-58b-1971		
Valves, cast iron, swing check					MSS-SP-71-1970
Nonferrous Metallic Pipe, Fittings and Valves					
Brass tube, seamless		B135-74			
Brass, red, seamless, pipe, standard sizes		B43-76			
Bronze flanges and flanged fittings	B16.24-1971				
Cast bronze fittings for flare copper tubes	B16.26-1975				
Cast bronze solder-joint pressure fittings	B16.18-1972				
Cast bronze solder-joint drainage fittings	B16.23-1976				
Copper pipe, seamless, standard sizes		B42-76			
Copper pipe, threadless		B302-76			
Copper tube, drainage DWV		B306-76			
Copper tube, seamless		B75-76			
Copper tube, water, seamless, Types K, L, and M		B88-76			
Copper and copper alloy pipe and tube, general requirements		B251-76			
Copper and copper alloy tube (welded)		B543-72			
Copper alloy water tube (welded)		B586-73			
Lead pipe, bends and traps			WW-P-325-1974		
Pipe fittings, brass or bronze, 125 and 250 lb., cast or wrought	B16.15-1971				
Pipe, nipples, brass, copper steel and wrought iron					
Solder-joint fittings, pressure, copper alloy	B16.22-1973				
Solder-joint fittings, drainage, copper alloy	B16.29-1973				

~~NOTE: Standards on materials do not imply that these materials may be used for a specific service. Materials permitted for a specific service shall be specified under the various chapters of this code.~~

TABLE NO. 6-A (continued)
STANDARDS FOR APPROVED PLUMBING MATERIALS AND EQUIPMENT

DESCRIPTION	ANSI	ASTM	FS	ICBO	OTHER
Nonferrous Metallic Pipe, Fittings and Valves					
Unions, brass or bronze, 250 lb.				WW-U-516a-1967	
Valve, ball, copper alloy, iron or steel				WW-V-35a-1965	
				Int Amend 2-1970	
Valves, gate, bronze, threaded and flanged				WW-V-54c-1966	
				Int Amend 1-1970	
Valves, angle, check and globe, bronze, 125 lb. screwed, flanged or solder				WW-V-51d-1967	
Nonmetallic Pipe and Fittings					
Asbestos cement nonpressure sewer pipe		C428-76			
Asbestos cement nonpressure small diameter sewer pipe (4", 5", 6")		C644-76			
Asbestos cement perforated underdrain pipe		C568-76			
Asbestos cement pressure pipe		C296-76			
Asbestos cement storm drain pipe		C663-76			
Asbestos cement transmission pipe		C668-73b			
Bituminized fiber drain and sewer pipe homogeneous wall		D1801-73			
Bituminized fiber drain and sewer pipe laminated wall		D1802-73			
Bituminized fiber pipe, perforated, for septic tank disposal fields, homogeneous wall		D2312-73			
Bituminized fiber pipe, perforated, for septic tank disposal fields, laminated wall		D2313-73			
Clay drain tile, specifications for		C468 (1973)			
Clay drain tile perforated		C498-05 (1973)			
Clay pipe, standard and extra strength		C700-75		IS 14-3	
Clay pipe, perforated, standard and extra strength		C700-75			
Clay pipe sewer lines (low pressure systems)				IS 10-1	

~~NOTE: Standards on materials do not imply that these materials may be used for a specific service. Materials permitted for a specific service shall be specified under the various chapters of this code.~~

TABLE NO. 8-A (continued)
STANDARDS FOR APPROVED PLUMBING MATERIALS AND EQUIPMENT

DESCRIPTION	ANSI	ASTM	FS	ICBO	OTHER
Nonmetallic Pipe and Fittings					
Concrete drain tile		CA 12-74			
Concrete low-head pressure pipe, reinforced		C361-76			
Concrete pipe, prestressed		CA44-73			
Concrete pipe, (sewer, storm drain and culvert) nonreinforced		C14-75			
Concrete pipe, pressure, reinforced, concrete pretensioned reinforcement (steel cylinder-type)			SS-P-381a(1)-1972		
Concrete pipe (culvert, storm drain and sewer) reinforced		C76-74			
Acrylonitrile-butadiene-styrene (ABS) plastic pipe, schedules 40 and 80		D1527-73a			
Acrylonitrile-butadiene-styrene (ABS) plastic pipe (SDR-PR and Class T)		D2282-73a			
Socket-type acrylonitrile-butadiene-styrene (ABS) plastic pipe fittings, schedule 40		D2468-76			
Socket-type acrylonitrile-butadiene-styrene (ABS) plastic pipe fittings, schedule 80		D2469-76			
Threaded acrylonitrile-butadiene-styrene (ABS) plastic pipe fittings, schedule 80		D2465-73			
Acrylonitrile-butadiene-styrene (ABS) plastic drain, waste, and vent pipe and fittings, schedule 40		D2661-76		IS 14-2	
Solvent cement for acrylonitrile-butadiene-styrene (ABS) plastic pipe and fittings		D2235-76a			
Polyethylene (PE) plastic pipe, schedule 40		D2104-74			
Polyethylene (PE) plastic pipe, schedules 40 and 80 based on outside diameter		D2447-74			
Polyethylene (PE) plastic pipe, (SDR-PR)		D2239-74			
Butt fusion polyethylene (PE) plastic pipe fittings, schedule 40		D2610-73			
Butt fusion polyethylene (PE) plastic pipe fittings, schedule 80		D2611-73			
Plastic insert fittings for polyethylene plastic pipe		D2609-74			

~~NOTE: Standards on materials do not imply that these materials may be used for a specific service. Materials permitted for a specific service shall be specified under the various chapters of this code.~~

TABLE NO. 8-A (continued)
STANDARDS FOR APPROVED PLUMBING MATERIALS AND EQUIPMENT

DESCRIPTION	ANSI	ASTM	FS	ICBO	OTHER
Type PSP PVC sewer pipe and fittings		D3033-75			
Polyethylene (PE) plastic tubing		D2737-74			
Chlorinated poly (vinyl chloride) (CPVC) plastic hot-water distribution systems		D2846-73		IS 16-1	
Poly (vinyl chloride) (PVC) plastic pipe (SDR-PR)		D2241-76			
Polyvinyl Chloride (PVC) plastic pipe, schedules 40, 80 and 120		D1785-76			
Socket-type polyvinyl chloride (PVC) plastic pipe fittings, schedule 40		D2466-76a			
Socket-type polyvinyl chloride (PVC) plastic pipe fittings, schedule 80		D2467-76a			
Solvent cements for polyvinyl chloride (PVC) plastic pipe and fittings		D2564-76			
Threaded polyvinyl chloride (PVC) plastic pipe fittings, schedule 80		D2464-76			
Bell-end polyvinyl chloride (PVC) pipe		D2672-76			
Polyvinyl chloride (PVC) plastic drain, waste, and vent pipe and fittings		D2665-76			
Type PSM PVC sewer pipe and fittings		D3034-74			
Styrene-rubber plastic drain pipe and fittings		D2852-74			
Solvent cement for styrene rubber plastic pipe and fittings		D3122-76			
Thermoplastic gas pressure pipe, tubing and fittings		D2513-76			
Pipe Jointing Materials and Gaskets, and Supports					
Caulking, lead wool and lead pig			QQ-C40(2)1970		
Compression joints for vitrified clay pipe		C425-75			
Compression joints for vitrified clay pipe and fittings		C425-75 D3139-73			
Flexible elastomeric joints		D3212-76			
Fixture setting compound			TT-P-001536(1968) Revision of HHC 536a-1954		
Nonmetallic gaskets for pipe flanges	B16.21-1962				

NOTE: Standards on materials do not imply that these materials may be used for a specific service. Materials permitted for a specific service shall be specified under the various chapters of this code.

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TABLE NO. 6-A (continued)
STANDARDS FOR APPROVED PLUMBING MATERIALS AND EQUIPMENT

DESCRIPTION	ANSI	ASTM	FS	ICBO	OTHER
Neoprene rubber gaskets for hub and spigot cast iron soil-pipe and fittings					CISPI HSN 68T
Rubber gaskets for cast iron soil-pipe and fittings		C564-70 (1976)			
Rubber gasket joints for cast iron pressure pipe fittings	A21.11-1972				
Rubber gaskets, molded or extruded, for concrete nonpressure sewer pipe		C443-76			
Rubber rings for asbestos cement pipe		D-1869-66 (1972)			
Rubber gaskets, sheet		D-1330-66 (1972)			
Pipe Joining Materials and Gaskets, and Supports					
Sealing compound, preformed plastic, for expansion joints and pipe joints			SS-S-00210(1965)		
Sealing compound, sewer, bituminous, two-component, mineral-filled, cold-applied			SS-S-168(2)1962		
Pipe hangers and supports			WW-H-171d-1970		
Plumbing Appliances and Appurtenances					
Dishwashing machines, commercial electric					UL 921-73
Dishwashing machines, household	A199.5-73				
Drinking water coolers, self-contained mechanically refrigerated	A112.11.1-1973				
Food waste disposer units, household	A197.3-73				
Home laundry equipment	A197.2-73				
Water heaters, automatic storage-type	Z21.10.1-1975				
Water heaters, circulating tank	Z21.10.3-1975				

~~*NOTE: Standards on materials do not imply that these materials may be used for a specific service. Materials permitted for specific service shall be specified under the various chapters of this code.~~

TABLE NO. 6-A (continued)
STANDARDS FOR APPROVED PLUMBING MATERIALS AND EQUIPMENT

DESCRIPTION	ANSI	ASTM	FS	ICBO	OTHER
Backflow Preventers					
Vacuum breakers, antisiphon					ASSE 1001
Vacuum breakers, hose connection					ASSE 1011
Double check with atmospheric vent					ASSE 1012
Reduced pressure zone device					ASSE 1013
Double check valve assembly					ASSE 1015
Vacuum breakers, pressure-type					ASSE 1020
Miscellaneous					
Air gap standards	A112.1.2-1942 (R1973)				
Arresters, water hammer	A112.26.1-1969				
Enamel, coal-tar, (protective coating)					AWWA C203-73
Clamps, hose			WW-C-440B(a)-1969		
Coating, pipe, thermoplastic resin or thermosetting, epoxy			L-C530B-1970		
Connector, water, flexible copper					IAPMO PS-14-73
Copper, sheet and strip for building construction					
Clay pipe, installation		B370-77			
Clay pipe, testing		C12-74			
Drain for prefabricated and precast showers		C201-72			IAPMO PS-64
Drain, roof	A112.21.2-1971				
Interceptors, grease					DDLC-101
Drain, floor	A112.31.1-1978				
Lead, sheet, grade A			QQ-L-201f(2)1970		
Protectively coated pipe (installation)					
Relief valves, automatic	Z21.22-1971				

~~NOTE: Standards on materials do not imply that these materials may be used for a specific service. Materials permitted for a specific service shall be specified under the various chapters of this code.~~

TABLE NO. 6-A (continued)
STANDARDS FOR APPROVED PLUMBING MATERIALS AND EQUIPMENT

DESCRIPTION	ANSI	ASTM	FS	ICBO	OTHER
Miscellaneous					
Reducing valves, water pressure for domestic water supply system					ASSE 1003
Solder, soft			QQ-S-571d-1963		
Copper tank, metal, bituminous coated					LR 30-1964
Tape, pipe-coating, pressure-sensitive polyethylene			L-T-0075(1)-1966		
For division and waste elbow					SA-DMQ-DE-0-66
Valve, drain, water heater	A112-14.1-1975				ASSE 1005

~~These standards or materials do not imply that these materials may be used for a specific service. Written permission for a specific use must be specified under the various chapters of this code.~~

APPENDIX P-4

PLUMBING

Generally Acceptable and Unacceptable Use Conditions for Metals in Direct Contact with Heat Transfer Liquids in Open Systems

Generally Unacceptable Use Conditions

Generally Acceptable Use Conditions 1/

Aluminum

1. When in direct contact with untreated tap water with pH <5 or >9.	1. When in direct contact with distilled or deionized water which contains appropriate inhibitors and does not contact copper or iron.
2. When in direct contact with aqueous liquid containing less electro positive metal ions such as copper or iron or halide ions.	2. When in direct contact with distilled or deionized water which contains appropriate inhibitors and a means of removing heavy metal ions obtained from contact with copper or iron.
3. When specific data regarding the behavior of a particular alloy are not available, the velocity of aqueous liquid shall not exceed 4 ft/sec.	3. When in direct contact with stable anhydrous organic liquids.
4. When in direct contact with a liquid which is in contact with corrosive fluxes.	

Generally Unacceptable Use Conditions

Generally Acceptable Use
Conditions 1/

Copper

1. When in direct contact with aqueous liquid containing high concentrations of chlorides, sulfates or liquid which contains hydrogen sulfide.	1. When in direct contact with distilled, deionized or low chloride, low sulfate and low sulfide tap water.
2. When in direct contact with chemicals that can form copper complexes such as ammonium compounds.	2. When in direct contact with stable anhydrous organic liquids.
3. When in direct contact with an aqueous liquid having a velocity greater than 4 ft/sec. <u>2/</u>	
4. When in direct contact with a liquid which is in contact with corrosive fluxes.	
5. When in contact with an aqueous liquid with a pH lower than 5.	
6. When the copper surface is initially locally covered with a copper oxide film or a carbonaceous film.	
7. When operating under conditions conducive to water line corrosion.	
-

Steel

1. When in direct contact with untreated tap, distilled or deionized water with pH <5 or >12.	1. When in direct contact with distilled, deionized or low salt content water which contains appropriate corrosion inhibitors.
2. When in direct contact with a liquid which is in contact with corrosive fluxes.	2. When in direct contact with stable anhydrous organic liquids.

Generally Unacceptable Use Conditions

Generally Acceptable Use
Conditions 1/

Steel (contd.)

3. When in direct contact with an aqueous liquid having a velocity greater than 6 ft/sec. <u>2/</u>	3. When adequate cathodic protection of the steel is used (practical only for storage tanks).
4. When operating under conditions conducive to water line corrosion.	
-

Stainless Steel

1. When the grade of stainless steel selected is not corrosion resistant in the anticipated heat transfer liquid.	1. When the grade of stainless steel selected is resistant to pitting, crevice corrosion, intergranular attack and stress corrosion cracking in the anticipated use conditions.
2. When in direct contact with a liquid which is in contact with corrosive fluxes.	2. When in direct contact with stable anhydrous organic liquids.
-

Galvanized Steel

1. When in direct contact with aqueous liquid containing copper ions.	1. When adequate cathodic protection of the galvanized parts is used (practical only for storage tanks).
2. When in direct contact with aqueous liquid with pH <7 or >12.	2. When in contact with stable anhydrous organic liquids.
3. When in direct contact with aqueous liquid with a temperature >55 C.	

Brass and Other Copper Alloys

Binary copper-zinc brass alloys (CDA 2XXX series) exhibit generally the same behavior as copper when exposed to the same conditions. However, the brass selected shall resist dezincification in the operating conditions anticipated. At zinc contents of 15% and greater, these alloys become increasingly susceptible to stress corrosion. Selection of brass with a zinc content below 15% is advised. There are a variety of other copper alloys available, notably copper-nickel alloys, which have been developed to provide improved corrosion performance in aqueous environments.

1/

The use of suitable antifreeze agents and buffers is acceptable provided they do not promote corrosion of the metallic liquid containment system. The use of suitable corrosion inhibitors for specific metals is acceptable provided they do not promote corrosion of other metals present in the system. If thermal or chemical degradation of these compounds occurs, the degradation products shall not promote corrosion.

2/

The flow rates at which erosion/corrosion becomes significant will vary with the conditions of operation. Accordingly, the value listed is approximate.

Generally Acceptable and Unacceptable Use Conditions
for Metals in Direct Contact with Heat Transfer
Liquids in Closed Systems

Generally Unacceptable Use Conditions

Generally Acceptable Use
Conditions 1/

Aluminum

1. When in direct contact with untreated tap water with pH <5 or >9.	1. When in direct contact with distilled or deionized water which contains appropriate corrosion inhibitors.
2. When in direct contact with liquid containing copper, iron or halide ions.	2. When in direct contact with stable anhydrous organic liquids.
3. When specified data regarding the behavior of a particular alloy are not available, the velocity of aqueous liquids shall not exceed 4 ft/sec.	
-

Copper

1. When in direct contact with an aqueous liquid have a velocity greater than 4 ft/sec. <u>2/</u>	1. When in direct contact with untreated tap, distilled or deionized water.
2. When in contact with chemicals that can form copper complexes such as ammonium compounds.	2. When in direct contact with stable anhydrous organic liquids.
	3. When in direct contact with aqueous liquids which do not form complexes with copper.

Generally Unacceptable Use Conditions

Generally Acceptable Use
Conditions 1/Steel

1. When in direct contact with liquid having a velocity greater than 6 ft/sec.<u>2/</u> 2. When in direct contact with untreated tap, distilled or deionized water with pH <5 or >12.	1. When in direct contact with untreated tap, distilled or deionized water. 2. When in direct contact with stable anhydrous organic liquids. 3. When in direct contact with aqueous liquids of 5< pH <12.

Stainless Steel

1. When the grade of stainless steel selected is not corrosion resistant in the anticipated heat transfer liquid. 2. When in direct contact with a liquid which is in contact with corrosive fluxes.	1. When the grade of stainless steel selected is resistant to pitting, crevice corrosion, intergranular attack and stress corrosion cracking in the anticipated use conditions. 2. When in direct contact with stable anhydrous organic liquids.

Galvanized Steel

1. When in direct contact with water with pH <7 or >12. 2. When in direct contact with an aqueous liquid with a temperature >55 C.	1. When in contact with water of pH >7 but <12.

Brass and Other Copper Alloys

Binary copper-zinc brass alloys (CDA 2XXX series) exhibit generally the same behavior as copper when exposed to the same conditions. However, the brass selected shall resist dezincification in the operating conditions anticipated. At zinc contents of 15% and greater, these alloys become increasingly susceptible to stress corrosion. Selection of brass with a zinc content below 15% is advised. There are a variety of other copper alloys available, notably copper-nickel alloys, which have been developed to provide improved corrosion performance in aqueous environments.

1/

The use of suitable antifreeze agents and buffers is acceptable provided they do not promote corrosion of the metallic liquid containment system. The use of suitable corrosion inhibitors for specific metals is acceptable provided they do not promote corrosion of other metals present in the system. If thermal or chemical degradation of these compounds occurs, the degradation products shall not promote corrosion.

2/

The flow rates at which erosion/corrosion becomes significant will vary with the conditions of operation. Accordingly, the value listed is approximate.

APPENDIX P-5

PLUMBING

1501-1503

UNIFORM MECHANICAL CODE

Chapter 15

MECHANICAL REFRIGERATING EQUIPMENT

Scope

Sec. 1501. All mechanical refrigerating systems and equipment shall conform to the requirements of this Code.

A label of an approved agency, which is attached to the equipment, will be accepted as evidence that the equipment is approved.

Refrigerating systems and equipment, including the replacement of parts and alterations, shall comply with the provisions of this Chapter.

Refrigerants

Sec. 1502. The refrigerant used shall be of a type listed in Section 1503 unless the Building Official finds that a proposed refrigerant is no more hazardous to life, limb, health, or property than the type listed.

Classification of Refrigerants

Sec. 1503. (a) **Group 1.** The following refrigerants shall be classified as Group 1 refrigerants:

REFRIGERANT DESIGNATION	NAME	CHEMICAL FORMULA
R-11	Trichlorofluoromethane	CCl_3F
R-12	Dichlorodifluoromethane	CCl_2F_2
R-13	Chlorotrifluoromethane	CClF_3
R-13B1	Bromotrifluoromethane	CBrF_3
R-14	Tetrafluoromethane	CF_4
R-21	Dichlorofluoromethane	CHCl_2F
R-22	Chlorodifluoromethane	CHClF_2
R-30	Dichloromethane (Methylene chloride)	CH_2Cl_2
R-113	Trichlorotrifluoroethane	$\text{CCl}_2\text{FCClF}_2$
R-114	Dichlorotetrafluoroethane	$\text{CClF}_2\text{CClF}_2$
R-115	Chloropentafluoroethane	CClF_2CF_3
R-C318	Octafluorocyclobutane	C_4F_8
R-500	Dichlorodifluoromethane, 73.8% and Ethylidene Fluoride, 26.2%	$\text{CCl}_2\text{F}_2/\text{CH}_3\text{CHF}_2$
R-502	Chlorodifluoromethane, 48.8% and Chloropenta- fluoroethane, 51.2%	$\text{CHClF}_2/\text{CClF}_2\text{CF}_3$
R-744	Carbon dioxide	CO_2

(b) **Group 2.** The following refrigerants shall be classified as Group 2 refrigerants:

REFRIGERANT DESIGNATION	NAME	CHEMICAL FORMULA
R-40	Methyl chloride	CH ₃ Cl
R-811	Methyl formate	HCOOCH ₃
R-717	Ammonia	NH ₃
R-764	Sulphur dioxide	SO ₂

General

Sec. 1504. Supports for compressors and condensing units shall be designed to safely carry the load of the equipment supported. Supports from buildings or parts of buildings that are of noncombustible construction shall be noncombustible.

Every compressor or portion of a condensing unit supported from the ground shall rest on a concrete slab extending not less than 3 inches above the adjoining ground level.

An unobstructed access opening and passageway, not less than 24 inches in the least dimension, shall be provided and maintained to every compressor, unless otherwise specified by this Code.

A suitable and substantial metal guard shall be provided around all flywheels, fans, pulleys, and belts which are a portion of any refrigerating machinery.

Refrigerating systems and portions thereof shall not be located in any elevator shaft, dumbwaiter shaft, or any shaft having moving objects therein, nor in any location where it will be subject to mechanical damage.

Every room or space, other than a machinery room complying with the requirements of this Chapter, in which any refrigerant-containing portion of a condensing unit is located, shall be provided with one of the following means of ventilation:

1. Permanent gravity ventilation openings of not less than 2 square feet total area, opening directly to the outside of the building, or extending to the outside of the building by continuous ducts.
2. A mechanical exhaust system of ventilation arranged to provide a complete change of air in such room or space at least every 20 minutes and to discharge to the outer air.

EXCEPTION: This paragraph shall not apply to any portion of a condensing unit in a room or space if the cubical content exceeds 1000 cubic feet per horsepower of the unit or where such room or space has permanent gravity ventilation openings of 2 square feet minimum total area to other rooms or spaces exceeding 1000 cubic feet per horsepower.

Refrigerant compressors of more than one horsepower rating shall be located not less than 10 feet from any exit in any Group A, B, Division 2, E, I or R, Division 1 Occupancy unless separated by a One-hour Fire-resistive Occupancy Separation.

All refrigerant machinery piping and fittings, brine piping and fittings which during normal operation could reach a surface temperature below

the dew point of the surrounding air and are located in spaces or areas where condensation could cause a safety hazard to the building occupants, structure, electrical equipment, or any other equipment, shall be protected in a manner to prevent such damage.

Compressors shall not be placed in any hazardous location.

Group 1 Refrigerants

Sec. 1505. (a) General. Every condensing unit or combination of refrigerant interconnected condensing units totaling 100 or more horsepower rating which contain any Group 1 refrigerant shall be enclosed in a machinery room. A system containing more than the quantity of a Group 1 refrigerant allowed in Section 1505 (b) shall be of the indirect type.

EXCEPTION: The requirements of this Section shall not apply to: 1. Any condensing unit located outside of a building or on the roof of a building and not less than 20 feet from any door, window, or ventilating air opening in any building.

2. Any condensing unit located in a building used exclusively for ice making or cold storage together with the usual accessory rooms in connection therewith.

3. A Group B, Division 2 or 4 Occupancy, if the quantity of refrigerant does not exceed 30 pounds for each 1000 cubic feet of space in the room in which the condensing unit is located.

(b) Direct Systems. The maximum quantity of a Group 1 refrigerant in a direct system in all occupancies other than Group I shall not exceed that set forth in Table No. 15-A.

Direct Systems in Group I Occupancies shall be limited to systems each containing not more than 50 percent of the permissible quantities of Group 1 refrigerants set forth in Table No. 15-A. When the refrigerant-containing parts of a system are located in one or more enclosed spaces, the cubical content of the smallest enclosed humanly occupied space other than the room in which the refrigeration equipment is located, shall be used to determine the permissible quantity of refrigerant in the system. Where a refrigerating system has evaporator coils serving individual stories of a building, the story having the smallest volume shall be used to determine the maximum quantity of refrigerant in the entire system.

When the evaporator is located in an air duct system, the cubical content of the smallest humanly occupied enclosed space served by the air duct system shall be used to determine the permissible quantity of refrigerant in the system.

EXCEPTION: If the air flow to any enclosed space served by a portion of an air duct system cannot be shut off or reduced below one-quarter of its maximum, the cubical contents of the entire space served by that portion of the air duct system may be used to determine the permissible quantity of refrigerant in the system.

**TABLE NO. 15-A—MAXIMUM PERMISSIBLE QUANTITIES OF
GROUP 1 REFRIGERANT FOR DIRECT SYSTEMS**

REFRIGERANT DESIGNATION	NAME	MAXIMUM QUANTITY IN LB. PER 1000 CU. FT. OF HUMANLY OCCUPIED SPACE
R-11	Trichlorofluoromethane	35
R-12	Dichlorodifluoromethane	31
R-13	Chlorotrifluoromethane	27
R-13B1	Bromotrifluoromethane	38
R-14	Tetrafluoromethane	23
R-21	Dichlorofluoromethane	13
R-22	Chlorodifluoromethane	22
R-30	Dichloromethane (Methylene chloride)	6
R-113	Trichlorotrifluoroethane	24
R-114	Dichlorotetrafluoroethane	44
R-115	Chloropentafluoroethane	40
R-C318	Octafluorocyclobutane	50
R-500	Dichlorodifluoromethane, 73.8% and Ethylidene Fluoride, 26.2%	26
R-502	Chlorodifluoromethane, 48.8% and Chloropenta- fluoroethane, 51.2%	30
R-744	Carbon dioxide	11

Group 2 Refrigerants

Sec. 1506. A mechanical refrigerating system or unit refrigerating system containing a Group 2 refrigerant shall not be located within a building unless all refrigerant-containing portions of the system are enclosed in a machinery room. Such systems when installed outside of a building shall be located at least 20 feet from any exit, door, window, or ventilating air inlet in any building.

EXCEPTION: This shall not apply to a building used exclusively for ice making, cold storage, or for the manufacturing or processing of food or drink, provided the occupant load does not exceed one person per 100 square feet of floor area served by such system.

Portions of refrigerating systems containing Group 2 refrigerants shall not be located in an exit.

Machinery Rooms

Sec. 1507. Required machinery rooms shall be of at least one-hour fire-resistive construction with all interior openings protected with fire assemblies having a one-hour fire protection rating. Doors shall be self closing.

There shall be no direct opening between any machinery room containing any Group 2 refrigerant and any room or space in which there is an open flame, spark-producing device, or heating surface in excess of 800°F. Every machinery room containing any Group 2 refrigerant shall

have at least two means of exit located at least one-fifth the perimeter of the room apart. Exit openings shall be not less than 3 feet by 6 feet 8 inches.

Every machinery room containing any Group 1 refrigerant shall have at least one means of exit. Such exit opening shall be not less than 3 feet by 6 feet 8 inches.

Every machinery room door shall open in the direction of egress.

Every machinery room shall have an area of not less than 50 square feet.

An unobstructed working space not less than 2 feet 6 inches in width and not less than 7 feet in height shall be provided around not less than two adjacent sides of all moving machinery in any machinery room.

Machinery Room Ventilation

Sec. 1508. Every machinery room shall be provided with means of ventilation to the outer air. Such ventilation shall be either:

1. An exhaust system of ventilation arranged to provide a complete change of air in such room at least once every five minutes and discharge to the outer air at a location not less than 20 feet from any exterior door, window or ventilation air inlet in any building.

Each exhaust ventilation system shall be controlled by a readily accessible emergency ventilation switch located within 2 feet of the switch specified in Section 1509 and the switch shall be labeled to comply with Section 1519, or

2. Gravity ventilation openings to the outside of the building having a cross-sectional area of one-twentieth of the floor area of the machinery room, but in no case need the area of the openings be more than 1000 square inches. Such openings shall be so installed that approximately one-half of the required area is located within 12 inches of the ceiling and one-half of the required area is located within 12 inches of the floor of the room. Every portion of the lower opening shall be horizontal or slope downward from the opening in the machinery room to the exterior of the building at or above the adjacent ground level.

Equipment in a Machinery Room

Sec. 1509. Combustion air shall not be taken from a machinery room. [See Section 603 (c).]

Electrical equipment or electrical control or control panel other than listed below shall not be located in any machinery room:

1. Lights and receptacles.
2. Machinery room exhaust fans and blowers.
3. Any refrigerating condensing unit or portion thereof.
4. Circulating pumps for condensers, cooling towers, or cooling coils.
5. Air compressors serving only automatic controls within the refrigerating or cooling system.
6. Electrically operated valves for the control of a refrigerant or for the control of the circulation of a cooling fluid.

7. Blowers and fans for cooling towers or for condensers.

8. Any electric control or control panel for any of the above items.

A readily accessible single emergency refrigeration control switch shall be provided to shut off all electrically operated machinery in any machinery room, except the exhaust ventilation system complying with Section 1508. Such switch shall be controlled from a point outside of, and within 10 feet of the required opening to the machinery room it serves, and the switch shall be labeled to comply with Section 1519. For other requirements concerning the location of this switch, see the Electrical Code.

Refrigerant Piping, Containers, and Valves

Sec. 1510. All materials used in the construction and installation of refrigerating systems shall be suitable for the refrigerant in the system, and no material or equipment shall be installed which will deteriorate due to the chemical action of the refrigerant or the oil, or combination of both.

All copper and brass refrigerant piping valves, fittings, and related parts used in the construction and installation of refrigerating systems shall be approved for such use. (See Refrigeration Piping in Equipment Standards, Appendix of this Code.)

All iron and steel refrigerant piping shall comply with the requirements of U.M.C. Standard No. 15-1. Pipe more than 2 inches iron pipe size shall be electric resistance welded, or seamless pipe.

Pipe subject to working pressure in excess of 300 pounds per square inch shall have a minimum wall thickness of not less than that specified in U.M.C. Standard No. 15-1; Table No. 15-1-A for Schedule 80 pipe.

Iron or steel refrigerant piping 1½-inch nominal size and smaller and containing liquid refrigerant shall have a minimum wall thickness of not less than that specified in U.M.C. Standard No. 15-1; Table No. 15-1-A for Schedule 80 pipe, or Schedule 40 pipe if all field joints are welded.

Brass pipe, copper pipe and copper tubing shall conform to the requirements of U.M.C. Standard No. 15-2. Brass pipe and copper pipe subject to working pressures in excess of 250 pounds per square inch shall be not less than extra strong pipe. Copper water tubing used for refrigerant piping shall be not less than type K or L and shall be free from scale and dirt.

Soft annealed copper tubing regulated by this Section shall be not larger than 1 3/8-inch nominal size. No mechanical joint shall be made on any material larger than ¾-inch nominal size.

Soft annealed copper tubing conveying any refrigerant shall be enclosed in iron or steel piping and fittings or in conduit, molding, or raceway which will properly protect such tubing against mechanical injury from an exterior source.

EXCEPTION: The requirements of this Section shall not apply to:

1. Tubing entirely within a refrigerator or tubing within 5 feet of a refrigerant compressor where so located that it is not subject to external injury.

2. Tubing serving a dwelling unit, when such tubing contains Group 1 refrigerant and is placed in locations not subject to damage from an external source.

Erection of Refrigerant Piping

Sec. 1511. Piping and tubing shall be installed so as to prevent excessive vibration and strains at joints and connections.

All piping and tubing shall be securely fastened to a permanent support within 6 feet following the first bend in such tubing from the compressor, and within 2 feet of every other bend or angle. In every case, piping and tubing shall be supported at points not more than 15 feet apart.

Refrigerant piping crossing an open passageway in any building shall be not less than 7½ feet above the floor unless against the ceiling of such space.

All refrigerant piping and tubing shall be installed so that it is not subject to damage from an external source.

Refrigerant piping and joints connected and installed in the field shall be exposed to view for visual inspection and accepted by the Building Official prior to being covered or enclosed.

EXCEPTION: This shall not apply to soft annealed copper tubing enclosed in iron or steel piping conduit, molding, or raceway provided there are no fittings or joints concealed therein.

Copper tubing containing other than a Group 1 refrigerant shall not be located in a public hallway, lobby, or stairway of any building unless enclosed in iron or steel piping and fittings or in metal rigid conduit.

EXCEPTION: This Section shall not apply to hard-drawn copper tubing installed in locations where not subject to injury from an external source.

All iron or steel refrigerant piping placed underground shall be coated with sufficient asphalt paint or equal to inhibit corrosion.

Iron or steel pipe joints shall be screwed, flanged, or welded. Screw joints shall be of an approved type. (See Pipe Threads in Equipment Standards, Appendix of this Code.) Exposed threads shall be tinned or otherwise coated to inhibit corrosion.

Welds shall be of an approved type. (See Refrigeration Piping in Equipment Standards, Appendix of this Code.)

Copper or brass pipe of iron pipe size shall be screwed, flanged, or brazed.

Every tubing joint and connection shall be a flared, lapped, or swaged brazed joint.

EXCEPTION: Soldered joints may be used to connect any valve located outside of an air conditioning duct or plenum to adjoining tubing in any refrigerating system containing Group 1 refrigerant other than carbon dioxide.

Refrigerant Containers

Sec. 1512. Every refrigerant container or evaporator which is not a part of listed equipment, shall be constructed in accordance with approved standards.

Refrigerant Control Valves

Sec. 1513. A stop valve shall be installed in the refrigerant piping of every refrigerating system at the following locations:

1. At each inlet and outlet of every positive displacement type compressor.
2. At each refrigerant outlet of every receiver.
3. At each refrigerant inlet of every pressure vessel containing liquid refrigerant and having an internal gross volume exceeding 3 cubic feet, which vessel is a portion of a refrigerating system equipped with a positive displacement type of compressor.

Stop valves installed in refrigerant lines composed of copper tubing $\frac{1}{4}$ inch or less outside diameter, shall be securely supported independent of the tubing or piping connected to such valve.

Pressure Limiting Device

Sec. 1514. A pressure limiting device shall be installed on every positive displacement refrigerant compressor which is a portion of:

1. Any refrigerating system containing Group 2 refrigerant.
2. Any air cooled refrigerating system containing Group 1 refrigerant of 10 horsepower or more rating.
3. Any water cooled refrigerating system containing Group 1 refrigerant of three horsepower or more rating.

Every pressure limiting device shall stop the action of the compressor it serves at a pressure not in excess of 90 percent of the pressure set forth in Table No. 15-B for the kind of refrigerant contained in such refrigerating system.

A stop or shut-off valve shall not be placed between any pressure limiting device required by this Section and the compressor it serves.

Pressure Relief Valves—Compressors

Sec. 1515. The following compressors of the positive displacement type shall be equipped with a relief valve:

1. Every Group 1 refrigerant compressor of 20 or more horsepower rating which is a portion of any refrigerating system operating at a pressure in excess of 15 pounds per square inch in the high pressure side of the system.
2. Every compressor which is a portion of any refrigerating system containing any Group 2 refrigerant.

EXCEPTION: The requirements of this Section shall not apply to a compressor listed without such relief valve.

Every pressure relief valve shall be connected to the refrigerant discharge side of the compressor it serves, between such compressor and any stop valve.

Every pressure relief valve required by this Section shall discharge into the low pressure side of the refrigerating system it serves or discharge to the outside of the building as required by this Code. Any pressure relief

device that discharges from the high pressure side of the refrigerating system into the low pressure side must be of a type that is not appreciably affected by back pressure.

Every pressure relief valve required by this Section shall be set to function at a pressure not in excess of the pressure set forth in Table No. 15-B corresponding to the portion of the refrigerating system in which such valve is located and the kind of refrigerant contained in such system.

A stop or shutoff valve shall not be installed between any pressure relief valve required by this Section and the compressor it serves.

Pressure Relief Devices—Pressure Vessels

Sec. 1516. Every pressure vessel over 6 inches in diameter which may be shut off by valves from other parts of the system shall be equipped with a pressure relief device or devices complying with requirements of this Code.

Pressure vessels of 3 cubic feet or less gross volume containing liquid refrigerant shall be equipped with either a pressure relief valve, fusible plug, or rupture member, provided, however, that a fusible plug is permitted only on the high pressure side of the refrigerating system.

Pressure vessels having a gross volume of more than 3 cubic feet shall be equipped with a pressure relief valve or rupture member.

Pressure Relief Device Requirements

Sec. 1517. Except as provided in this Section, every pressure relief device for any refrigerant vessel shall be set to function at a pressure not exceeding that set forth in Table No. 15-B for the portion of the system to which the device is connected and for the refrigerant in such container.

Pressure relief devices may be set to start to function at a pressure not to exceed the design working pressure of the pressure vessel as determined by the manufacturer and stamped on the pressure vessel.

WHERE

C = Minimum required discharge capacity of the relief device in pounds of air per minute.

D = Outside diameter of the vessel in feet.

L = Outside length of the vessel in feet.

f = Factor depending upon kind of refrigerant as follows:

Kind of Refrigerant	Value of f
Ammonia	0.5
R-12, R-22, and R-500	1.6
R-502	2.2
All other refrigerants	1.0

The size of the discharge pipe from the pressure relief device shall be not less than the size of the relief device outlet. The discharge from more than one relief device may be run into a common header, the area of which shall be not less than the sum of the area of the pipes connected thereto.

TABLE NO. 15-B—PRESSURES FOR UNLISTED EQUIPMENT

REFRIGERANT	COMPRESSOR PRESSURE LIMITING DEVICE OPERATING PRESSURE (In Pounds per Square Inch)	PRESSURE RELIEF VALVES AND DEVICES OPERATING PRESSURE (In Pounds per Square Inch)	
		High Pressure Side	Low Pressure Side
Ammonia	225	250	150
Carbon Dioxide	1200	1350	1000
Dichloroethylene	5	10	10
Dichloromethane (Refrigerant 1)	25	30	30
Ethyl Chloride	50	55	50
Trichloroethylene	25	30	30
Trichloromonofluoromethane (Refrigerant 11)	25	30	30
Dichlorodifluoromethane (Refrigerant 12)	160	225	125
Dichloromonofluoromethane (Refrigerant 21)	60	70	50
Monochlorodifluoromethane (Refrigerant 22)	245	300	245
Trichlorotrifluoroethane (Refrigerant 113)	25	30	30
Dichlorotetrafluoroethane (Refrigerant 114)	45	50	50
Methyl Chloride	170	200	125
Methyl Formate	25	30	30
Sulphur Dioxide	125	150	95
Refrigerant 500	160	225	125
Refrigerant 502	245	300	150

Whenever the length of the discharge piping exceeds 50 feet, such piping shall be increased one pipe size in diameter.

All piping and fittings used for any relief device discharge piping system shall conform to this Code.

Every pressure relief device shall bear thereon:

1. Name or trademark of the manufacturer of such device.
2. The discharge or bursting pressure setting of such device expressed in pounds per square inch gage.
3. The minimum diameter of the discharge outlet or opening of such valve.
4. The discharge capacity of the pressure relief device in pounds of air per minute.

Every pressure relief valve shall be set and sealed by the manufacturer of such valve or any such valve may be set and sealed in a laboratory approved by the Building Official, provided such valve is properly labeled.

Every pressure relief device required by this Section for any pressure vessel of 3 cubic feet gross volume or more containing Group 1 refrigerant or any pressure vessel containing any Group 2 refrigerant shall discharge to the atmosphere at a location not less than 15 feet above the adjoining ground level and not less than 20 feet from any window, ventilation opening, or exit in any building.

Every pressure relief device required by this Section shall be connected as close as practicable to the refrigerant container or evaporator it serves and above the refrigerant level in such container or evaporator.

A stop or shutoff valve shall not be placed between any pressure relief device required by this Section and the pressure vessel it serves.

Manual Discharge of Refrigerant

Sec. 1518. (a) Discharge to Atmosphere. Every refrigerating system located in a building and containing carbon dioxide or a Group 2 refrigerant shall be equipped with means for manual discharge of the refrigerant to the atmosphere. Such discharge system shall comply with all of the following requirements:

1. A discharge pipe shall be provided above the liquid refrigerant level from both the high and low pressure side of the system and the pipes shall extend into an emergency refrigerant control box complying with this Section. Each discharge pipe shall have a minimum nominal diameter of 1 inch.

2. A readily accessible stop valve and a high pressure gage shall be installed on each discharge pipe within the emergency refrigerant control box. The gage shall be located ahead of each stop valve and the valves shall have the same capacity as the discharge pipe it serves. A permanent label shall be attached to each valve reading: "Discharge Valve to At-

mosphere" and shall indicate the side of the system to which it is connected.

3. Each discharge pipe shall extend from the discharge side of the valve to a common pipe having a nominal diameter of 1 inch. This common pipe shall terminate outside the building, not less than 6 feet above the highest structure on the building and not less than 20 feet from any window, ventilation opening, or exit, of any building. The outlet opening shall be capped with a low pressure rupturable diaphragm, such as a heavy foil disk in a pair of flanges, or equivalent.

4. A stop valve, which could prevent manual discharge of the refrigerant to the atmosphere, shall not be located between the emergency refrigerant discharge valves and the side of the system they are serving.

(b) **Release from High Pressure Side.** Every refrigerating system required to have means of manual discharge of its refrigerant to the atmosphere also shall be equipped with manual means of releasing the refrigerant from the high pressure side of the system to the low pressure side. This manual means shall comply with all of the following requirements:

1. The high and low pressure side of the system shall be interconnected with a pipe having a minimum nominal diameter of 1 inch. This interconnection shall be made above the liquid refrigerant level.

2. A readily accessible manual stop valve shall be installed in this interconnecting pipe, and the valve shall be located within the emergency refrigerant control box. This valve shall have the same capacity as the pipe connected thereto.

3. A permanent label shall be attached to this valve reading: "High to Low Pressure Control Valve."

4. A stop valve, which could prevent releasing of the refrigerant from the high pressure side of the system to the low pressure side, shall not be installed in this interconnecting pipe between the high and low pressure side of the system.

(c) **Emergency Refrigerant Control Box.** Every emergency refrigerant control box shall be located outside of the building on a street front or shall be equally accessible and shall be not more than 6 feet above the sidewalk or adjoining ground level. This box shall be of iron or steel not less than No. 16 gage thickness and provided with a hinge cover and lock. Such box shall be provided with a permanent label on the outside cover reading: "Emergency Refrigerant Control Box" and the name of the refrigerant in the system.

All piping, valves, fittings, and related parts, required to be installed to comply with this Section, shall conform to Section 1510 of this Code.

Labels

Sec. 1519. In addition to labels required elsewhere in this Code, every

refrigerating system shall be provided with labels complying with the requirements of this Section.

Every condenser, receiver, absorber, accumulator and similar equipment of more than 3 cubic feet gross volume and containing any Group 2 refrigerant shall be equipped with a permanent label setting forth the type of refrigerant in such vessel. Every vessel having a gross volume of more than 10 cubic feet and containing any Group 1 refrigerant shall be equipped with a permanent label setting forth the type of refrigerant in such vessel.

Every manifold or distributing panel shall have a permanent label setting forth the refrigerating equipment controlled by each valve on such panel.

All exposed refrigerant piping shall be labeled at intervals of not more than 30 feet apart plus a label in every area through which the piping extends specifying the refrigerant in such piping.

EXCEPTION: The provisions of this Section shall not apply to:

1. Piping in brine tanks.
2. Piping in that portion of any building used exclusively for ice making, cold storage, or for the processing of any material by means of refrigeration.

Every refrigerating system, which is required to be located in a machinery room, shall be equipped with permanent labels having letters not less than 1/2 inch in height designating the following equipment:

1. The main power disconnect switch for such refrigerating system.
2. Every remote control device for any such main power switch.
3. The main shutoff valve for each liquid refrigerant container.
4. Every pressure limiting device and pressure relief device located outside the room or space in which the refrigerant container it serves is located.

Every exhaust ventilation system control switch required to be installed to comply with Section 1508 shall have a permanent label reading: "Emergency Refrigeration Switch."

Every control switch provided to shut off all electrically operated machinery in a machinery room, as required by Section 1509, shall have a permanent label reading: "Emergency Refrigeration Switch."

In every refrigeration machinery room and for every direct refrigerating system of more than 10 horsepower there shall be placed a permanent sign within 10 feet of the compressor giving the following information:

1. Name of contractor installing equipment.
2. Kind of refrigerant in system.
3. Amount of refrigerant in system.

Every pressure relief device required by this Code shall be labeled to comply with Section 1517.

Testing of Refrigerating Equipment

Sec. 1520. All refrigerant-containing portions of every field assembled

refrigerating system intended or installed to operate at a pressure in excess of atmospheric pressure shall be subjected to a test pressure of not less than the pressure set forth in Table No. 15-C for the kind of refrigerant in such system.

Pressure tests required by this Section shall not be less than the lowest setting of any pressure relief device installed in the side of the system it is protecting.

The requirements of this Section shall not apply to:

1. Any refrigerating system containing 20 pounds or less of Group I refrigerant.

2. Safety devices, pressure gages, compressors, and control mechanisms which have been factory tested.

3. Pressure vessels constructed in accordance with approved standards.

The test pressure applied to any refrigerant container shall not exceed two and one-half times the design working pressure stamped on such container.

The high pressure test for any refrigerating system intended to contain any refrigerant not listed in Table No. 15-B shall be not less than the saturated vapor pressure of such refrigerant at a temperature of 150°F. In no case shall the test pressure be less than 30 pounds.

Every refrigerating system installed to operate at a pressure below atmospheric pressure shall be required to maintain a partial vacuum in the system equal to the pressure of a column of mercury not less than 20 inches in height.

Every refrigerating system shall sustain the test pressure specified in this Section for a period of not less than 10 minutes after the pressure imposing equipment has been cut off or disconnected.

Every pressure test for those portions of any refrigerating system to contain ammonia or carbon dioxide shall be made with air or dry gas.

Refrigerating systems shall not be tested with oxygen.

Brine piping may be tested with air, water, or dry gas.

All brine piping which is a portion of any refrigerating system shall be tested to a pressure of not less than 100 psi for a period of 10 minutes.

Additional tests of any refrigerating system may be demanded by the Building Official when deemed necessary to insure the safety of such system.

Every test required by this Section shall be conducted by the owner or contractor in the presence of the Building Official.

TABLE NO. 15-C—FIELD LEAK TEST PRESSURES IN PSI

REFRIGERANT	HIGH PRESSURE TEST	LOW PRESSURE TEST
Ammonia	300	150
Carbon Dioxide	1500	1000
Dichloroethylene	30	30
Dichloromethane (Refrigerant 1)	30	30
Ethyl Chloride	60	50
Trichloroethylene	30	30
Trichloromonofluoromethane (Refrigerant 11)	30	30
Dichlorodifluoromethane (Refrigerant 12)	235	140
Dichloromonofluoromethane (Refrigerant 21)	70	40
Monochlorodifluoromethane (Refrigerant 22)	300	150
Trichlorotrifluoroethane (Refrigerant 113)	30	30
Dichlorotetrafluoroethane (Refrigerant 114)	50	50
Methyl Chloride	210	120
Methyl Formate	50	50
Sulphur Dioxide	170	85
Refrigerant 500	225	125
Refrigerant 502	300	150

APPENDIX P-6

PLUMBING

Chapter 9 HANGERS AND SUPPORTS

Stresses and Strain

Sec. 901. Piping in a plumbing system shall be installed so as to prevent strains and stresses which will exceed the structural strength of the pipe. Provision shall be made for expansion and contraction of the piping.

Material

Sec. 902. Hangers, anchors and supports shall be of metal, plastic or other approved material of sufficient strength to support the piping and its contents. Piers may be of concrete, brick or other approved material.

Attachment to Building

Sec. 903. Hangers and anchors shall be securely attached to the building construction at sufficiently close intervals to support the piping and its contents.

Plastic Pipe Supports

Sec. 904. Hangers and straps shall not compress, distort, cut or abrade the piping and shall allow free movement of the pipe. Approved restraint fittings and expansion joints shall be installed in accordance with their approval. Support all pipe at intervals of not more than 4 feet at end of branches and at change of direction or elevation. Supports shall allow free movement. Maintain vertical piping in straight alignment. Support trap arms in excess of 3 feet as close as possible to the trap. Installations shall be in accordance with approved methods.

Spacing

Sec. 905. Pipe shall be supported at distances not to exceed those indicated in Table No. 9-A.

Underground Installation

Sec. 907. The trench bottom shall be smooth and of uniform grade with either undisturbed ground or a layer of selected and compacted backfill so that no settlement will be encountered. Pipe must bear on this material throughout its entire length.

TABLE NO. 9-A

PIPE MATERIAL	MAXIMUM HORIZONTAL SPACING	MAXIMUM VERTICAL SPACING
Cast Iron Soil Pipe	5'-0" except may be 10'-0" where 10' lengths of pipe are installed	Base and each story height
Threaded Steel Pipe	1" diameter and under—8'-0" 1½" diameter and over—10'-0"	Every other story height
Copper Tube	1½" diameter and under—6'-0" 1½" diameter and over—10'-0"	Each story height but not to exceed 10'-0"
Lead Pipe	Continuous support	4'-0"
Plastic Pipe ¹	4'-0"	4'-0"

¹For additional support requirements for plastic pipe, see Section 904.

PLUMBING

Chapter 10

TESTS

Concealment Prohibited

Sec. 1001. All new, altered, extended or replaced plumbing shall be left uncovered and unconcealed until it has been tested and approved. Where such work has been covered or concealed before it is tested and approved, it shall be exposed for testing.

Equipment, Material and Labor

Sec. 1002. All equipment, material and labor required for testing a plumbing system or part thereof shall be furnished by the permit holder or the individual requesting inspection.

Required

Sec. 1003. New plumbing systems and parts of existing systems which have been altered, extended or repaired shall be tested as prescribed hereinafter in the presence of the building official to disclose leaks and defects, except that testing may be waived in the following cases:

EXCEPTIONS: 1. In any case which does not include addition to, replacement, alteration or relocation of any water supply, drainage or vent piping; and

2. In any case where plumbing equipment may be set up temporarily for exhibition purposes.

Water-supply Systems

Sec. 1006. Upon completion of a section or of the entire water-supply system, it shall be tested and proved tight under a water pressure not less than the working pressure under which it is to be used. The water used for tests shall be obtained from a potable source of supply. Except for plastic pipe systems, the water test may be substituted by an air test of 50 pounds per square inch. Test pressures shall be maintained for a minimum period of 15 minutes without the system leaking.

APPENDIX P-8

PLUMBING

Trenching, Bedding, Tunneling and Backfilling

Sec. 811. (a) Trenching and Bedding. Trenches shall be sufficient width to permit proper installation of the pipe. Where shoring is required, ample allowance shall be made in trench width for proper working conditions. Where trenches are excavated to a depth such that the bottom of the trench forms the bed for the pipe, care must be exercised to provide solid and continuous bearing between joints, and bell holes shall be provided at points where the pipe is joined. Where trenches are excavated to a depth such that the bottom of the trench does not form the bed for the pipe, the trench shall be backfilled to grade with sand or fine gravel placed in layers of six inches maximum depth and compacted after each placement. The pipe shall not be supported on blocks to grade. Where rock is encountered in trenching, it shall be removed to a point at least three inches below the grade line of the trench and the trench shall be backfilled to grade with sand tamped in place so as to provide a uniform bearing for the pipe between joints. Care shall be exercised to see that the pipe does not rest on rock at any point including the joints. If soft materials of poor bearing qualities are found at the bottom of the trench, stabilization shall be achieved by overexcavating at least two pipe diameters and bringing up to grade with fine gravel or crushed stone or a concrete foundation. Such concrete foundation shall be bedded with sand tamped in place so as to provide a uniform bearing for the pipe between joints.

(b) Tunneling. Where necessary, pipe may be installed by tunneling or jacking, or a combination of both. In such cases, special care shall be exercised to protect the pipe from damage either during installation or from subsequent uneven loading. Where earth tunnels are used, adequate supporting structures shall be provided to prevent future settling or caving. Pipe may be installed in larger conduit which has been jacked through unexcavated portions of the trench.

(c) Backfilling. Until the crown of the pipe is covered by at least two feet of tamped earth considerable care shall be exercised in backfilling trenches. Loose earth, free of rocks, broken concrete, frozen chunks and other rubble, shall be carefully placed in the trench in six-inch layers and tamped in place. Care shall be taken to thoroughly compact the backfill under and beside the pipe to be sure that the pipe is properly supported. Backfill shall be placed evenly on both sides of the pipe and tamped in such manner as to retain proper alignment.

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Protection of Pipes

Sec. 816. (a) Breakage. Pipes passing under or through walls shall be protected from breakage. Any plumbing pipe passing under a footing or through a foundation wall shall be provided with a relieving arch, or there

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shall be built into the masonry wall an iron-pipe sleeve two pipe sizes greater than the pipe passing through, or equivalent protection shall be provided as may be approved in writing by the building official.

(b) **Corrosion.** Pipe and fittings subject to corrosion by passing through or under corrosive fill such as, but not limited to, cinders, concrete or other corrosive material shall be protected against external corrosion by approved protective coating, wrapping or other means which will resist such corrosion.

(c) **Stress Protection.** All piping within a plumbing system shall be so installed that connections or piping will not be subjected to undue stresses or strains. Provisions shall be made for expansion, contraction and structural settlement.

(d) **Maintenance of Structural Integrity—Cutting, Notching, Boring for, and Embedment of Pipes.** 1. **General.** Structural members shall not be weakened or impaired by boring, notching or cutting. Piping shall not be built into nor embedded in concrete or masonry except that designated radiant heating or cooling panels may have black steel, wrought iron pipe or Type L copper tubing embedded. Placement of pipes in unfilled cores of hollow unit masonry is not considered embedment. Piping shall pass vertically or horizontally through masonry or concrete walls by means of sleeves large enough to pass flanges, hubs, couplings and insulation. Unless otherwise specified, sleeves shall be separated by at least three diameters on center.

In the case of penetrations in other than conventional light frame wood construction, the building official may require plans and specifications to be prepared and designed by an engineer or architect licensed by the state to practice as such.

2. **Conventional Light Frame Wood Construction: Joists.** In wood framed structures ~~constructed in accordance with the conventional framing requirements of Chapter 25 of the Building Code~~, notches in the top or bottom of joists shall not exceed one-sixth the depth of the joist and shall not be located in the middle third of the span. Holes bored in joists shall not be within two inches of the top or bottom of the member; the diameter of holes shall not exceed one-third the joist depth.

Stud Walls and Partitions. In exterior walls and bearing partitions, wood studs may be cut or notched to a depth not exceeding one-fourth their depth. In nonbearing partitions, notches may be 40 percent of the stud depth.

Wood studs may be bored to a diameter not exceeding 40 percent of their depth, provided the hole permits at least $\frac{1}{4}$ inch of wood remaining to the edge. Bored holes shall not be located at the same section of stud as a cut or notch. Bored holes not greater than 60 percent of the width of the stud are permitted in nonbearing partitions or in a wall where each bored stud is doubled, and provided not more than two successive doubled studs are bored.

Pipes in Walls. Stud partitions containing plumbing shall be so framed and the joists underneath so spaced as to give the proper clearance for the piping. Where partitions containing piping run parallel to the floor joists, the joists under the partition shall be doubled and spaced to permit the passage of pipes. The joists shall be bridged or solidly blocked for lateral support on both sides of the penetration. If plumbing pipes are placed so as to necessitate cutting a sole or plate, a metal tie not less than $\frac{1}{4}$ inch thick and $1\frac{1}{2}$ inches wide shall be fastened to the plate across and to each side of the opening with not less than four 16d nails.

Sleeves

Sec. 817. In exterior walls, annular space between sleeves and pipes shall be filled or tightly caulked with material found effective and approved as such by the building official.

Waterproofing of Openings

Sec. 818. Joints at the roof, around vent pipes, shall be made watertight by the use of lead, copper, aluminum, plastic or other approved flashing or flashing material. Exterior wall openings shall be made watertight.

Ratproofing

Sec. 819. (a) Strainer Plates. All strainer plates on drain inlets shall be designed and installed so that no opening is greater than $\frac{1}{4}$ inch in least dimension.

(b) Openings. In or on buildings where openings have been made in walls, floors or ceilings for the passage of pipes, they shall be closed and protected by the installation of approved metal collars securely fastened to the adjoining structure or as directed by the building official.

Food-handling Establishments

Sec. 820. Food or drink shall not be stored, prepared or displayed beneath overhead sewer or drain pipes unless such pipes are protected against leakage or condensation reaching the food or drink as described below for new construction. In newly constructed or remodeled establishments, soil or drain pipes located over food preparation, storage, display or serving areas are undesirable. Where building design requires that soil or drain pipes be located over such areas, the installation shall be made with the least possible number of joints and shall be installed so as to connect to a vertical stack at the nearest wall or vertical building support and the construction shall be performed as follows:

1. All openings through floors over such areas shall be provided with sleeves securely bonded to the floor construction and projecting not less than $\frac{1}{4}$ inch above top of finished floor with space between sleeve and pipe or duct sealed.

2. Floor and shower drains installed above such areas shall be equipped with integral seepage pans.

3. Plumbing fixtures in rooms located above such areas shall be of the wall-mounted type, with the exception of bath tubs. Tubs shall have waste

GLOSSARY

Active Solar Energy System - An assembly of collectors, thermal storage device(s) and transfer liquid which converts solar energy into thermal energy and in which energy in addition to solar is used to accomplish the transfer of thermal energy.

Auxiliary Energy Subsystem - Equipment utilizing energy other than solar, both to supplement the output provided by the solar energy system as required by the design conditions, and to provide full energy backup requirements during periods when the solar energy system is inoperable.

Collector, combined - The collector and storage are constructed and operated such that they functionally perform as one unit and the thermal performance of the individual components cannot be meaningfully measured.

Collector, component - Collector that is not structurally integrated with the storage or building. The collector performance can be thermally characterized as an individual component with a moving heat transfer fluid.

Control subsystem - The assembly of devices and their electrical, pneumatic, or hydraulic auxiliaries used to regulate the process of collecting, transporting, storing, and

utilizing energy in response to the thermal, safety, and health requirements of the building occupants.

Design Life - The period of time during which a system is expected to perform its intended function without requiring major maintenance or replacement.

Energy transport subsystem - That portion of a solar energy system which contains heat transfer fluids and transports energy throughout the system.

Heat transfer medium - A medium which is used to transport thermal energy.

Passive solar energy system - An assembly of natural and architectural components including collectors, thermal storage device(s) and transfer fluid which converts solar energy into thermal energy in a controlled manner and in which no fans or pumps are used to accomplish the transfer of thermal energy. The prime elements in a passive solar system are usually some form of thermal capacitance and solar energy control.

Solar Absorbance - The ratio of the amount of solar radiation absorbed by a surface to the amount of radiation incident on it (for terrestrial applications usually calculated for Air Mass 2 characteristics).

Solar Building - A building which utilizes solar energy by means of an active or passive solar energy system.

Solar Energy - The photon energy originating from the sun's radiation primarily encountered in the wavelength region from 0.3 to 2.7 micrometers.

Solar Heating System - The complete assembly of subsystems and components necessary to convert solar energy into thermal energy for heating purposes in combination with auxiliary energy when required.

Solar Transmittance - The ratio of the radiant flux transmitted through and emerging from a body to the total flux incident on it.

Storage Subsystem - The assembly used for storing thermal energy so that it can be used when required.

Subsystem - A major, separable, functional assembly of a system such as complete collector, or storage, assembly.

System - The complete assembly necessary to supply heat, domestic hot water, or other usable form of solar energy to a structure.