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METAL BUILDING MANUFACTURERS ASSOCIATION

Members of this Association are manufacturers of metal building systems which are used widely by private and governmental agencies in industrial, commercial, institutional, and agricultural installations. These buildings are normally low rise buidings, and, for this reason, this manual applies specifically to that type of structure.

One of the primary objectives of this Association is to compile and publish recommended design standards that, when incorporated into building specifications, will insure high quality metal buildings. The sections of this manual pertaining to minimum loads, load combinations and application of loads are equally applicable to other materials of construction. Included in the Recommended Design Practices Manual is a Commentary on Loadings.

This manual is in continual review by the Technical Committee of this Association, and new editions are published as revisions or additions are made by that Committee. In this latest edition of the Metal Building Systems Manual, you will also find the Recommended Guide Specifications, Metal Building Systems Nomenclature and Recommended Code of Standard Practice for the Design, Manufacture, Sales and Erection of Metal Building Systems.

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Recommended Design Practices Manual

Section 1—INTRODUCTION

This manual presents data which reflects years of designing, testing, and observing thousands of buildings in actual use.

Basic engineering principles seldom change. New applications of these principles, however, are continually being discovered. Building design requirements and building codes must reflect these new applications. An example is the change from load bearing exterior walls of great thickness to curtain walls supported on steel skeleton frames. Similarly, the state of metal building technology today makes possible the use of greater refinement of detail of the design.

No attempt has been made to establish values for snow and wind loads for specific jurisdictions. Building codes establish these, based on local conditions. Recommended load application methods and design standards have been included. Only data that have been amply documented by recognized authorities have been used.

In areas not covered by building codes, consulting engineers or architects must be guided by experience, by weather bureau statistics, and other available data, in establishing proper design loads.

Section 2—DEFINITIONS OF LOADS

Dead load of a building is the weight of all permanent construction, such as floor, roof, framing and covering members.

Roof live load means all loads, including snow, exerted on a roof, except dead, wind and lateral loads.

Seismic load is the assumed lateral load acting in any horizontal direction on the structural system due to the action of earthquakes.

Wind load is the load caused by the wind blowing from any horizontal direction.

Auxiliary loads are all specified dynamic live loads, other than the basic design loads which the building must safely withstand, such as cranes, material handling systems, and impact loads.

Collateral loads are all specified additional dead loads other than the metal building framing, such as sprinklers, mechanical and electrical systems, and ceilings.

Section 3—ROOF DEAD AND LIVE LOADS

The **Roof Dead Load** shall be assumed to be distributed uniformly over the entire roof area.

The **Roof Live Load** shall be considered to act vertically upon the horizontal projection of the roof.

Recommended Minimum Roof Live Load
(Pounds Per Square Foot)

ROOF SLOPE	TRIBUTARY LOADED AREA IN SQUARE FEET FOR ANY STRUCTURAL MEMBER		
	0 to 200*	201 to 600*	Over 600
Flat or rise less than 4 inches per foot.	20	16	12
Rise 4 inches per foot to less than 12 inches per foot.	16	14	12
Rise 12 inches per foot and greater.	12	12	12

In areas where snow load exceeds the above stated minimum, the roof live load shall be not less than the stipulated snow load.

Structural members supporting a roof sloped to prevent ponding, arranged so as to create continuity need be designed only for the condition of loading all spans simultaneously. Background information is included in the commentary.

*May be 12 pounds per square foot where permitted by map of Estimated Ground Snow Load shown in this manual.

Section 4—WIND LOADS

GENERAL

This section defines procedures for determining and applying wind pressures in the design of single and multi-gable metal buildings. Background information and typical examples are included in the commentary.

WIND PRESSURES

The basic velocity pressures to be used in design shall be determined in accordance with either of the following expressions, whichever is applicable:

A) $q = 0.00256V^2$ (when velocity is specified)

B) $q = p/(c_1 + c_4)^* = p/1.30$ (when pressure is specified)

where:

q = Basic velocity pressure in pounds per square foot
V = Specified wind velocity in miles per hour
p = Specified unit wind pressure in pounds per square foot
c_1 = Shape coefficient for wind pressure on windward wall
c_4 = Shape coefficient for wind suction on leeward wall

Minimum unit wind pressure (p) shall be 15 psf

SHAPE COEFFICIENTS

(A) Enclosed Building—The design wind pressures to be applied to the various portions of the primary members shall be determined by multiplying the basic velocity pressure, q, by the appropriate shape coefficient, c. Shape coefficients for the various portions of the primary member and other building components receiving loads from large areas for single gable buildings are given in Table No. 1.

In the case of multiple-gable buildings, the shape coefficients to be used shall be based on the coefficients given in Table No. 1 for an equivalent single gable building, with the h/w ratio based on the total width of the building. The coefficients so determined shall be modified as follows:

Windward Wall	1.00 x c_1
First Windward Slope	1.00 x c_2
First Leeward Slope	1.00 x c_3
Second Windward Slope	1.00 x c_4
Remaining Windward Slopes	0.05 x c_2
Remaining Leeward Slopes	0.67 x c_3
Leeward Wall	1.00 x c_4

The shape coefficients, c_1 and c_3, shown for the windward and leeward sidewalls shall also apply to the windward and leeward endwalls when the wind is considered as acting parallel with the ridge.

*Absolute values.

(B) Open Sided Buildings — In the case of open sided buildings (both sidewalls open), the shape coefficients for the roof areas for all value of h/w shall be as follows:

1) For roof slopes of 30° and larger:
$c_2 = +0.8$
$c_4 = -0.8$

2) For roof slopes less than 30°:
$c_2 = +0.6$
$c_3 = -0.6$

For multi-gable buildings, these coefficients shall be modified in the same manner indicated above for totally enclosed buildings.

(C) Roof Overhangs and Canopies — Roof overhangs and canopies shall be designed for 1.3 q uplift.

(D) Panels, Purlins, Girts, Wind Bracing,* and Other Secondary Members — Roof panels, purlins, and their fasteners shall be designed for 1.3 q acting outward normal to the surface for the corresponding height zone.

Wall panels, girts, and other secondary members and their fasteners shall be designed for 1.3 q inward or 1.0 q outward for the corresponding height zone.

Wind bracing shall be designed for 1.3 q for the corresponding height zone.

*Coefficients are maximum for wind from any direction.

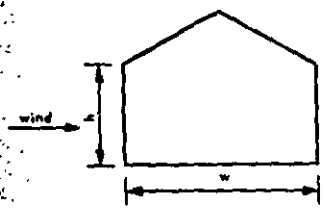
TABLE NO. 1

SHAPE COEFFICIENT "C" FOR EXTERNAL WIND LOADS*

For the Design of
Trusses, Columns, Rigid Frames, End Wall Post
and Other Main Members

h/w	WIND-WARD WALL (c_1)	WINDWARD ROOF Roof Slope (c_2)								LEE-WARD ROOF (c_3)	LEE-WARD WALL (c_4)
		0.1:12	1:12	2:12	3:12	4:12	5:12	6:12	7:12		
.10	.80	-.43	-.36	-.24	-.14	-.03	.04	.12	.19	-.50	-.50
.15	.80	-.60	-.53	-.34	-.20	-.04	.03	.12	.19	-.50	-.50
.20	.80	-.60	-.60	-.46	-.27	-.05	.03	.12	.19	-.50	-.50
.25	.80	-.60	-.60	-.58	-.34	-.06	.03	.12	.19	-.50	-.50
.30	.80	-.60	-.60	-.60	-.40	-.15	0	.08	.15	-.50	-.50
.35	.80	-.60	-.60	-.60	-.47	-.23	-.10	.04	.12	-.50	-.50
.40	.80	-.60	-.60	-.60	-.53	-.30	-.17	0	.08	-.50	-.50
.45	.80	-.60	-.60	-.60	-.58	-.36	-.25	-.08	.04	-.50	-.50
.50	.80	-.60	-.60	-.60	-.60	-.41	-.29	-.14	0	-.50	-.50
.60	.80	-.60	-.60	-.60	-.60	-.46	-.35	-.20	-.07	-.50	-.50
.70	.80	-.60	-.60	-.60	-.60	-.50	-.40	-.26	-.13	-.50	-.50
.80	.80	-.60	-.60	-.60	-.60	-.54	-.44	-.30	-.18	-.50	-.50
.90	.80	-.60	-.60	-.60	-.60	-.58	-.48	-.35	-.23	-.50	-.50
1.00 or more	.80	-.60	-.60	-.60	-.60	-.60	-.51	-.39	-.28	-.50	-.50

Negative values indicate external suction on roof or wall surface.



V = Wind velocity in miles per hour

q = Velocity pressure = .00256V² in lbs. per sq. ft.

c = Shape coefficient, from table above

cq = Wind pressure normal to a given surface in lbs. per sq. ft.

* Data taken from NAVFAC DM2 (October 1970) Figure 1-6

Section 5—APPLICATION OF CRANE LOADS

The following information on crane loads was taken from the latest AISC Specifications. Additional information in regard to these data can be found in the Appendix of the AISC Manual.

Impact — For structures carrying live loads which induce impact or vibration, the assumed live load shall be increased sufficiently to provide for same. If not otherwise specified, the increase shall be 25% for traveling crane support girders and their connections.

Crane Runway Horizontal Forces — The lateral force on crane runways to provide for the effect of moving crane trolleys shall, if not otherwise specified, be 20% of the sum of the weights of the lifted load and of the crane trolley (but exclusive of other parts of the crane), applied at the top of rail one-half on each side of runway, and shall be considered as acting in either direction normal to the runway rail.

The longitudinal force shall, if not otherwise specified, be taken as 10% of the maximum wheel loads of the crane, applied at the top of rail.

Vertical Impact, Longitudinal, and Lateral forces* computed per AISC specifications, considering the lifted load and only the weights of those component parts of the crane (bridge, hoist and trolley) that are electrically powered.

Bridge	Electric (E)				Hand Geared (HG)			
Hoist	E		HG		E		HG	
Trolley	E	HG	E	HG	E	HG	E	HG
Vertical	25%	25%	0	0	25%	25%	0	0
Longitudinal	10%	10%	10%	10%	0	0	0	0
Lateral	20%	0	20%	0	20%	0	20%	0

*The direction of longitudinal and lateral forces are oriented with respect to the crane runway. Vertical load plus Vertical Impact, and Longitudinal, or Lateral forces shall be applied simultaneously in designing crane runways.

tion 6—APPLICATION OF SEISMIC FORCES

It is recommended that the formula for seismic forces in areas subject to earthquakes should be as set forth in the latest edition of the "Uniform Building Code" and that buildings should be designed to withstand the loads as set forth therein.

Section 7—COMBINATIONS OF LOADS

The following combinations of loads where they apply shall be considered in the design of all members of the structure.*

a. Dead Load plus Live Load.
b. Dead Load plus Wind Load.
c. Dead Load plus one-half Wind Load plus Live Load.
d. Dead Load plus Wind Load plus one-half Live Load uniformly distributed over full span.
e. Dead Load plus Crane Load plus one-half Wind Load or one-half Live Load whichever is critical.
f. For Roof Trusses, Dead Load plus full Live Load Uniformly distributed over the leeward slope.
g. For Roof Trusses, Dead Load plus one-half Live Load distributed over either half of the span.
h. Dead Load plus Seismic Force.**

Each member shall be designed to withstand the stresses resulting from the combinations of loads that produce the maximum percentage of actual to allowable stress in that member.

Allowable stresses for combinations b, c, d, f, and h (e if Wind Load is critical) (those including Wind or Earthquake Load) may be increased by 33⅓%, provided the member thus required is not less than that required for the combination of Dead Load, Live Load, and Impact (if any). However, the 33⅓% allowable stresses is not applicable to bracing systems for seismic forces.

Combinations c and/or d need only be applied when snow conditions warrant their application.

Collateral and auxiliary loads shall be included in the above combinations of loads where specified.

*Where Roof Live Load is the result of Snow Load, see "Commentary on Loadings—Application of Snow Loads."

**Seismic Design "h" applies only where required.

Section 8—DESIGN

SCOPE—These specifications shall be used for design and selection of all members of metal buildings.

DESIGN AUTHORITIES—Members shall be designed in accordance with recognized engineering practices as follows:

(a) STRUCTURAL STEEL, INCLUDING WELDED BUILT-UP SHAPES—AMERICAN INSTITUTE OF STEEL CONSTRUCTION. Only those sections of the "Specification for the Design, Fabrication, and Erection of Structural Steel for Buildings" relating to design requirements and allowable stresses.*

(b) COLD-FORMED STEEL—American Iron and Steel Institute—Only these sections of the "Specification for the Design of Cold-Formed Steel Structural Members" relating to design requirements and allowable stresses.*

(c) WELDING—American Welding Society—Only those sections of the "Structural Welding Code" relating to welding procedures.*

(d) ALUMINUM—The Aluminum Association. Ony those sections of the "Specification for Aluminum Structures" and "Aluminum Formed Sheet Building-Sheathing Design Guide" relating to design requirements and allowable stresses.*

*Fabrication and Erection tolerances will be established in future MBMA publications.

The latest edition of each of the specifications mentioned shall be applicable.

Section 9—DEFLECTION

Members directly supporting roof covering shall be proportioned with due regard to deflection produced by design loads.

Section 10—MINIMUM STANDARD OF THICKNESS

In the design of cold-formed steel members, proper proportioning of the component elements, consistent with their width to thickness ratio and their unit stress, is the factor of impor-

tance ure safe structural performance. Cold-formed structural m. bers will function satisfactorily, if designed in accordance with the procedure prescribed in the AISI Specification for the Design of Cold-Formed Steel Structural Members.

No minimum thickness limitations are necessary to assure sound structural behavior. In building construction, however, it is not unusual to specify certain minimum thickness limitations based upon prevailing practices, practical considerations, and experience in handling standard products in the field. The following thickness provision for cold-formed steel construction is recommended by the Metal Building Manufacturers Association.

Thickness—Cold-formed steel members shall be of thickness not less than the following, except that the use of material of less thickness may be allowed upon the submission of test reports from approved authorities or calculations sealed by a registered professional engineer verifying the structural adequacy of the members formed from such material.

(a) Individual Structural Members 18 MFG Standard Gage*

(b) Panels ..... 26 MFG Standard Gage*

The definitions of the two listed categories are as follows:

(1) INDIVIDUAL STRUCTURAL MEMBERS—Members such as purlins, girts, struts, etc., that are not attached side by side to other members.

(2) PANELS—Members that function structurally and also enclose space by virtue of continuous side joints or side laps. Corrugated or ribbed sheets shall be considered as panels when they span between supports such as girts or purlins.

*Manufacturers' Standard Gage.

Section 11—ALUMINUM PANELS IN METAL BUILDINGS

When aluminum panels are attached to a metal building frame, the following design requirements should be met:

a. The aluminum panels shall be designed to carry the specified load, and have a minimum thickness of 0.032", except that the use of material of less thickness may be allowed upon the submission of test reports from approved authorities or calculations sealed by a registered professional engineer verifying the structural adequacy of the members formed from such material.

b. Where the aluminum and steel are in direct contact, protection against electrolytic action shall be provided. The area of contact shall be thoroughly covered with paint or other non-metallic coatings. Where the contact areas are likely to be wet frequently or for prolonged periods of time, special protection may be desirable.

Section 12—PLASTIC PANELS IN METAL BUILDINGS

Because more factual information is needed, it is recognized that it is difficult to set forth specifications recommending the extent to which plastic panels should be used in either roofs or sidewalls of buildings. The Society of the Plastics Industry, Inc., in conjunction with various code authorities, is working toward recognized standards.

It is recognized that plastic panels in the sidewall of metal buildings serve as a decorative feature as well as for lighting. The use of plastic panels to provide light is becoming more common, especially in flat glazing of metal sash.

The great extent of their present day use and U. S. Navy tests have indicated that plastic panels in roofs of metal buildings serve as an economical source of light. In the Navy's study (Technical Note N-184, U. S. Naval Civil Engineering Research and Evaluation Laboratory, Port Hueneme, California, dated March 23, 1954, entitled "Skylighting Patterns for Daylight Illumination of the Bureau Standard Rigid Frame Steel Building, 40 feet by 100 feet and Bureau Standard Arch Rib Steel Building, 40 feet by 100 feet - P. J. Rush"), the results indicated that, if in roofs of rigid frame buildings 17 per cent of the projected floor area consisted of glass-fiber reinforced polyester laminate sheets with a theoretical light transmission factor of 62 per cent, the illumination at working surface level would be sufficient for this height and width building. (Varies approximately inversely as ratio of the height squared.)

It has also been found that the temperature at the working level may become uncomfortable if too large an area of the roof

is ma[illegible] of plastic panels. This is especially true of panels, which [illegible]use of their type or color, have a high Radiant Heat Transmission factor (Infra-red and Ultra-violet) coupled with a medium or low light transmission factor.

Commentary On Loadings

The loads on a building may vary as follows:

Dead Load—Except for all-metal construction, this can vary due to different densities of wood or concrete and due to inaccurate thicknesses of concrete, mortar, plaster, etc., caused by sagging forms and lath, or by variations in skill of workmen.

Wind Load—There is little likelihood of exceeding the maximum wind velocity recorded by U. S. Weather Stations over a 50 year period. Even when exceeded, the percent excess is likely to be very small except in the case of tornadoes—and buildings are seldom designed to withstand them. It is usual to use the fastest recorded mile, as a basis for required wind loads. Typical examples of wind load application are shown on pages 19, 20, 21, and 22.

Snow Load—Snow loads may vary considerably, but there is little likelihood of exceeding the Weather Bureau maximum records, and, when the snowfall record is broken, the additional weight is likely to be quite small. It is reasonable to use the largest accumulated ground snow load value shown by the weather bureau statistics expected over a fifty-year mean recurrence. Where roof levels of two abutting buildings are not at the same elevation, where buildings have valley gutters, and other similar conditions exist, these areas should be designed for increased snow load. Typical examples of snow load application are shown on pages 25, 26 and 27.

Floor Loads—These are not based on exact recorded scientific data as in the case of snow and wind loads. An examination of four model codes, one nationally recognized set of standards for building codes, one widely known state code, and the codes of two large cities in the U. S. show the following variations:

1. Dwellings—30 to 40 psf
2. Assembly Rooms—60 to 100 psf
3. Classrooms—40 to 60 psf
4. Offices—50 to 80 psf

5. Retail Stores—75 to 125 psf
6. Storage Warehouse, Light—100 to 125 psf
7. Storage Warehouse, Heavy—200 to 250 (min.) psf
8. Manufacturing, Light—75 to 125 psf
9. Manufacturing, Heavy—100 to 150 psf

Not only are the required minimum floor loads at substantial variance, but many of them could be greatly exceeded in the course of using the building.

The building codes, from which the above floor load figures were obtained, permit reductions on columns, walls and piers, foundations, beams, girders and trusses for tributary areas or in multi-story buildings. The reduction for multi-stories is as much as 50% of the live loads. And such reductions are justifiable, based on the extremely unlikely condition of having all floors of a multi-story building, for example, fully loaded simultaneously.

Codes normally require the investigation of critical conditions of continuous beams, such as alternate or skip loads on floors. Alternate span or skip loading on a roof sloped to prevent ponding need not be considered. This is based on observations made over many years which point out that irregular loads which could cause these types of loadings to become critical are not normally encountered.

Many building codes likewise specifically state that earthquake loads and wind loads need not be applied simultaneously in the design.

Because the buildings made by the members of this Association are of known strength; because floor loads are not ordinarily involved; and because the combinations of known wind and snow loads, each at full value, can hardly be encountered, the load combinations on Page 10 have been adopted. This practice is justified by those who have given the matter the greatest research and study; namely, the leading consulting structural engineers and authors of textbooks on engineering. Hool and Kinne, in "Steel and Timber Structures"; Grinter in Volume I of "Theory of Modern Steel Structures"; and Ketchum in "Steel Mill Buildings", all are in substantial agreement on this approach to combinations of loads.

Applic of Wind Loads—Wind pressure is primarily a function of wind velocity, but it also varies relative to height above ground, air density and exposure or interferences in the wind path, whether natural or man made. Metal buildings may be of a height great enough for this to be an appreciable factor and, as such, it will be accounted for in this manual. Air density is not a consideration for normal building sites, nor are shielding effects of other structures considered to be permanent enough to justify any reduction of wind loads.

It is most common for building codes and specifications to express wind load in pounds per square foot. The pressure intensities exerted on a building by a given wind vary at different parts of the building and are related to building proportions and shape. There is a limited amount of information available concerning the effect of the various factors on wind loading. The more prominent of these are papers contained in ASCE Proceedings, ANSI Standards, and the Design Manual of the Department of the Navy, Naval Facilities Engineering Command, NAVFAC DM-2 (October, 1970). After careful review of the available information, the Technical Committee of the MBMA has selected the criteria contained in NAVFAC DM-2, which is based on extensive wind pressure measurements on models in a wind tunnel, as basis for recommended application of wind load. Also of importance in choosing this wind load distribution system was the consideration that this method was readily applicable to metal buildings. The recommended design procedures defined in Section 4 pertaining to the design of primary framing are based on information and the charts from NAVFAC DM-2. Load coefficients for covering and secondary members have been adjusted to provide for openings and localized pressures or suctions and exceed those of NAVFAC DM-2.

Doors, windows, and other accessories shall be designed to the same load requirements as the wall or roof covering they displace.

Where wind velocity is specified for the design of a building, this velocity may be converted to pressure by the following formula: velocity pressure, q, equals 0.00256 V^2 (V—wind velocity in mph) which is derived from the basic equation of physics that force equals ½ the density of air times the velocity squared and is corrected to a height of 30 feet above the ground.

Data from a U. S. Weather Bureau map showing extreme wind velocities 30 feet above the ground with a 50 year recurrence interval has been used to prepare the wind load map on page 28. This map has had velocity converted to pressure and has been adjusted for buildings less than 30 feet high. For buildings 30 to 50 feet high, the pressure for surfaces above 30 feet should be increased 5 pounds per square foot.

Wind pressures shown on this map are intended to be used in localities where there is no building code establishing wind requirements and are not intended to supersede code requirements.

As an example, assume a 20 foot high building 80 feet wide, 1 to 12 roof slope with a specified wind pressure of 20 pounds per square foot:

$p = 20$ psf (wind pressure)

$p = q\ (c_1 + c_4)$

$q = p/(c_1 + c_4)$

where q = velocity pressure
c_1 and c_4 = pressure coefficients on windward and leeward walls (page 8)

$q = 20/(0.8 + 0.5)$

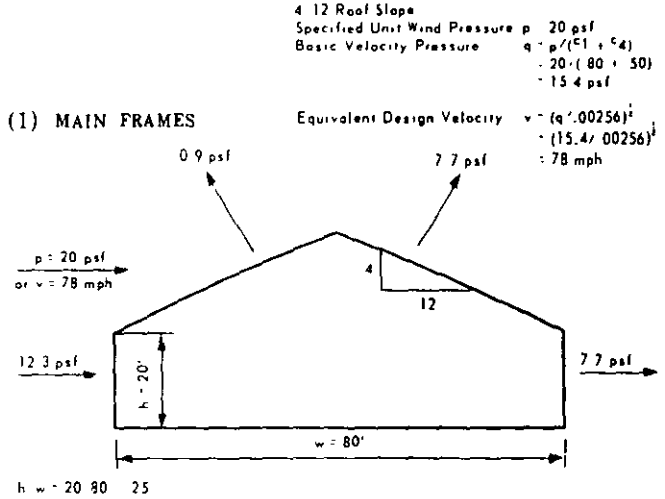
$q = 15.4$ psf

Application of Snow Loads — Actual snow loads on roofs are often difficult to predict. However, results of a comprehensive survey of actual snow loads on roofs and their relationship to ground loads were reported by Peter, Dalgliesh, and Schriever "Variations of Snow Loads on Roofs," Transactions of the Engineering Institute of Canada, Vol. 6, No. A-1, 1963 are referenced in ANSI Standard A58.1-1972. Based on these results, the minimum snow loads for the design of roofs can be determined by multiplying the ground snow load, as indicated on Page 29 (U.S. Weather Bureau—Ground Snow Load Map—50 year Mean Recurrence Interval), by the basic snow load coefficient Cs which equals 0.8.

Consideration of Special Conditions of Snow Load Accumulations are shown on pages 23, 24 and 25 of this manual. These recommendations pertain to the roof covering materials, purlins, canopies, and lean-to's installed below the eave line. Due consideration should also be given to the design of the primary frame in or near the vertical plane of a step-down in the roof. In addition to consideration of the primary frame of a step-down

in . .oof, it is recommended the design snow load, as determined by application of the basic snow load coefficient Cs, be distributed on the entire roof area. However for buildings having a roof slope greater than 10° to and including 20°, the design snow load should also be applied with full intensity to any one contiguous portion of the roof area and half design snow load on the remainder of the area; for buildings having a roof slope greater than 20°, the design snow load should be applied with full intensity to any one contiguous portion of the roof area and zero load on the remainder of the area, whichever produces the most critical design conditions. For further guidance in estimating probable snow loads, a collection of case histories of non-uniform snow loads has been complied by Schriever, Faucher and Lutes, "Snow Accumulations In Canada: Case Histories," National Research Council of Canada, Division of Building Research, NRC 9287, 1967.

TYPICAL EXAMPLE OF WIND LOAD ON ENCLOSED BUILDINGS



Surface	c	q	= cq - - psf
Windward Wall	+ .80	15.4	+ 12.3 (pressure)
Windward Roof	— .06	15.4	— 0.9 (suction)
Leeward Roof	— .50	15.4	— 7.7 (suction)
Leeward Wall	— .50	15.4	— 7.7 (suction)

(2) WIND BRACING:

Design For 1.3 q
(15.4) 1.3=20 psf

(3) PURLINS AND ROOF PANELS:

Normal Uplift = q x 1.3
15.4 x 1.3 = 20 psf

(4) SIDEWALL AND ENDWALL GIRTS AND PANELS:

Pressure = 1.3 q
= (15.4) 1.3 = 20 psf

Suction = 1.0 q
= 15.4 psf

(5) END WALL POSTS:

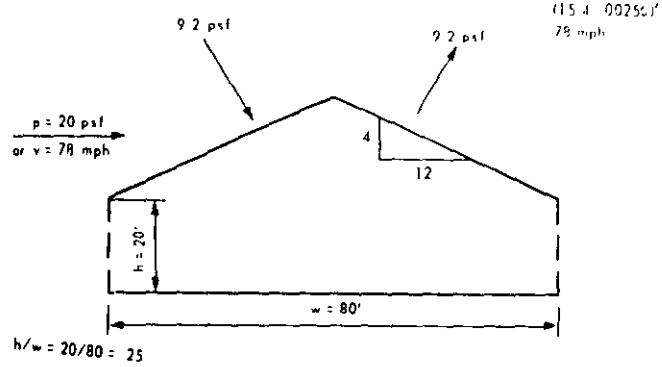
Pressure = .80 q = (15.4 x .8) = +12.3 psf
Suction = —.50 q = (15.4 x —.5) = —7.7 psf

TYPICAL EXAMPLE OF WIND LOAD ON OPEN SIDED BUILDINGS*

4/12 Roof Slope
Specified Unit Wind Pressure p = 20 psf
Basic Velocity Pressure q = p / 1.3
= 20 / 1.3
= 15.4 psf

Equivalent Design Velocity v = (q / .00256)$^{\frac{1}{2}}$
= (15.4 / .00256)$^{\frac{1}{2}}$
= 78 mph

(1) MAIN FRAMES



Surface	c	q	= cq - - psf
Windward Roof	+ .60	15.4	+ 9.2 (pressure)
Leeward Roof	— .60	15.4	— 9.2 (suction)

(2) PURLINS AND ROOF PANELS:

Normal Uplift = q x 1.3
= 15.4 x 1.3 = 20 psf

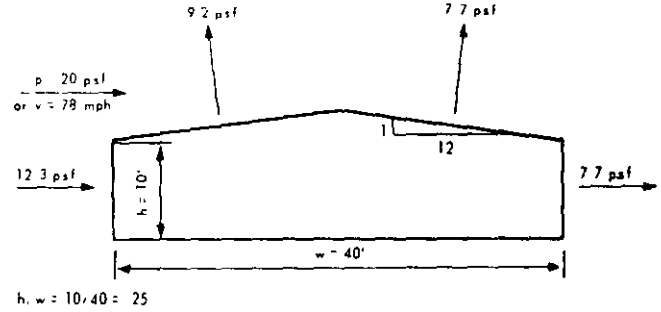
*Both Sidewalls Open

TYPICAL EXAMPLE OF WIND LOAD ON ENCLOSED BUILDINGS

1/12 Roof Slope
Specified Unit Wind Pressure p = 20 psf
Basic Velocity Pressure q = p/(C_1 + C_4)
= 20/(.80 + .50)
= 15.4 psf

Equivalent Design Velocity v = (q / .00256)$^{\frac{1}{2}}$
= (15.4 / .00256)$^{\frac{1}{2}}$
= 78 mph

(1) MAIN FRAMES



Surface	c	q	= cq - - psf
Windward Wall	+ .80	15.4	+ 12.3
Windward Roof	— .60	15.4	— 9.2
Leeward Roof	— .50	15.4	— 7.7
Leeward Wall	— .50	15.4	— 7.7

(2) WIND BRACING:

Design For 1.3 q
(15.4) 1.3=20 psf

(3) PURLINS AND ROOF PANELS:

Normal Uplift = q x 1.3
15.4 x 1.3 = 20 psf

(4) SIDEWALL AND ENDWALL GIRTS AND PANELS:

Pressure = 1.3 q
= (15.4) 1.3 = 20 psf

Suction = 1.0 q
= 15.4 psf

(5) END WALL POSTS:

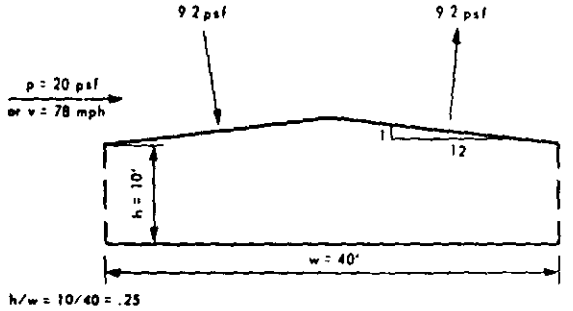
Pressure = + .8 q = (15.4 x .8) = + 12.3 psf
Suction = —.5 q = (15.4 x —.5) = —7.7 psf

YPICAL EXAMPLE OF WIND LOAD ON OPEN SIDED BUILDINGS*

1/12 Roof Slope
Specified Unit Wind Pressure $p = 20$ psf
Basic Velocity Pressure $q = p/(C_1 + C_4)$
$= 20/(.80 + .50)$
$= 15.4$ psf

Equivalent Design Velocity $v = (q/.00256)^{\frac{1}{2}}$
$= (15.4/.00256)^{\frac{1}{2}}$
$= 78$ mph

(1) MAIN FRAMES



Surface	c	q	= cq - - psf
Windward Roof	+ .60	15.4	+ 9.2
Leeward Roof	— .60	15.4	— 9.2

(2) PURLINS AND ROOF PANELS:

Normal Uplift = q x 1.3

= 15.4 x 1.3 = 20 psf

*Both Sidewalls Open

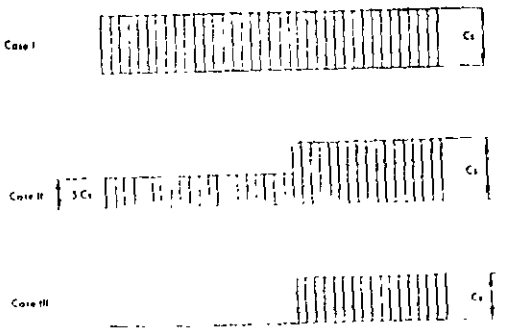
Special Conditions of Snow Load Accumulation

Design: The minimum design snow loads on a roof or any area above ground subject to snow accumulation is obtained by the expression $S = Cs\ g$ where:

S = Design snow load, psf
Cs = Ground snow load coefficient
g = Ground snow load, psf—see Estimated Ground Snow Load Map on page 28.

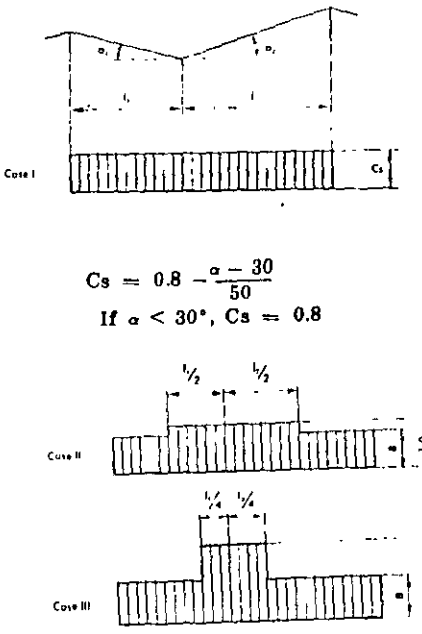
FIGURE I
Roof Slopes

Single Gables



For $\alpha \leq 10°$ Use Case I only.
For $10° < \alpha \leq 20°$ Use Case I or II.
For $\alpha > 20°$ Use Case I or III.

FIGURE II
Valley Area of Sloped Roofs



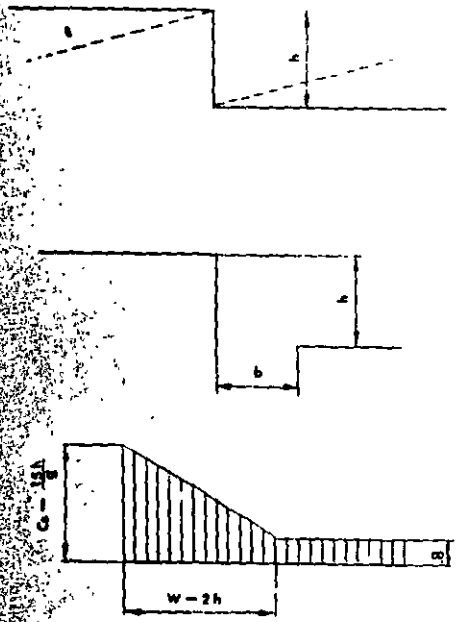
$$Cs = 0.8 - \frac{\alpha - 30}{50}$$

If $\alpha < 30°$, $Cs = 0.8$

$$\beta = \frac{\alpha_1 + \alpha_2}{2}$$

For $\beta \leq 10°$ Use Case I only.
For $10° < \beta < 20°$ Use Case I or II.
For $\beta \geq 20°$ Use Case I, II or III.

FIGURE III
Lower Level of Multi-Level Roofs

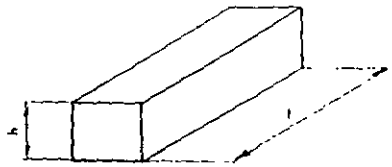


When $\frac{15\,h}{g} < 0.8$ Use Cs = 0.8.

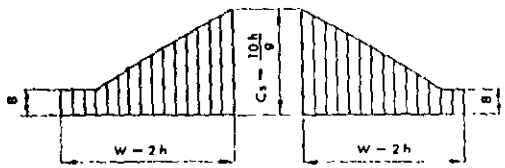
When $\frac{15\,h}{g} > 3.0$ Use Cs = 3.0.

When h < 5 ft. Use W = 10 ft.
When h > 15 ft. Use W = 30 ft.
h = Difference of roof heights in ft.
W = Width of Drift from higher building in ft.
b = Distance between buildings < 15 ft.

FIGURE IV
Roof Projections and Obstructions



If l < g/6, drifting need not be considered.



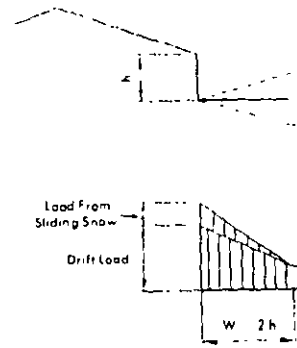
When $\frac{10\,h}{g} < 0.8$ Use Cs = 0.8.

When $\frac{10\,h}{g} > 2.0$ Use Cs = 2.0.

When h < 5 ft. Use W = 10 ft.
When h > 15 ft. Use W = 30 ft.

h = Height of projection in ft.
W = Width of snow drift in ft.
l = Length of projection in ft.

FIGURE V
Lower Roof with Sloping Upper Roof



Design lower roof or canopy for the following:

Drift load, Cs = $\frac{15\,h}{g}$ (See Figure III).

Load from sliding snow = Cs yg .5 where

Cs = Ground snow load coefficient.
g = Ground snow load.
y = Factor of increase due to high density of snow sliding from upper roof.
.5 = 50% of design load from upper roof.

The load distributions should be made depending upon the relative sizes, slopes and positions of the two roofs. If because of a relatively small lower roof or canopy, all sliding snow cannot be retained, appropriate reductions may be made.

Design upper roof for S = Cs g.

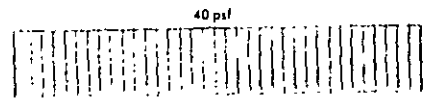
1. Single Gable

1:12 roof slope
Ground snow load (g) = 50 psf.

Roof design snow load (S) = Cs g
= 0.8 × 50
= 40.0 psf

1a. Single Gable

1:12 roof slope (18° 26′ 06″)
Ground snow load (g) = 50 psf

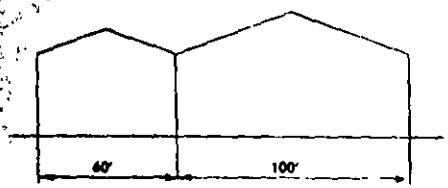


Roof design load (S_1) = Cs g
= 0.8 × 50
= 40 psf

Roof design load (S_2) = .5 Cs g
= (.5) (.8) × 50
= 20 psf

2. Valley Accumulation

4:12 roof slope (18° 26′ 06″)
Ground snow load (g) = 50 psf



$$\beta = \frac{2\ (18°\ 26'\ 06'')}{2} =$$

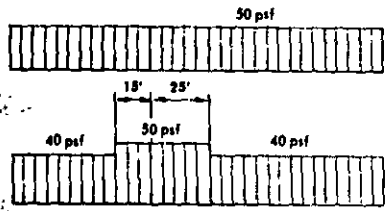
$= 18°\ 26'\ 06'' < 20°$

$\therefore$ Use Case I or II

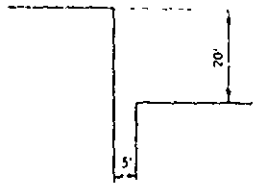
Case I — S $= Cs\ g$
$= 0.8 \times 50$
$= 40$ psf

Case II — S_1 $= .8 \times 50$
$= 40$ psf

S_2 $= 1.0 \times 50$
$= 50$ psf



3. Lower Level of Multi-Level Roofs



Ground snow load (g) = 40 psf
h = 20′
b = 5′

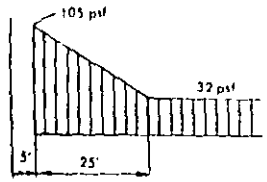
For Cs,

$$\frac{15\ h}{g} = \frac{15 \times 20}{40} = 7.5 > 3.0$$

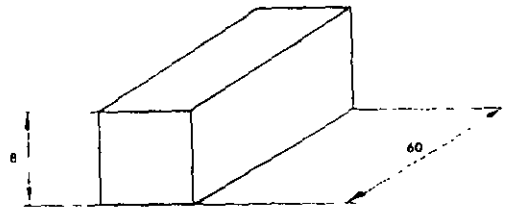
$\therefore$ Use Cs = 3.0
h > 15′ . . W = 30′

$$S_{(DRIFT)} = Cs\ g$$
$$= 3.0 \times 40 - \left(\frac{5}{30}(120 - 32)\right)$$
$$= 105 \text{ psf}$$

Remainder of lower roof
load (S) $= Cs\ g$
$= 0.8 \times 40$
$= 32$ psf



4. Roof Projections

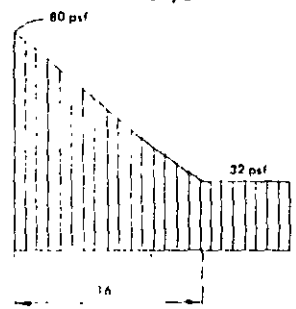


Ground snow load (g) = 40 psf
h = 8′
l = 60′

For Cs, $\frac{10\ h}{g} = \frac{10 \times 8}{40} = 2.0$

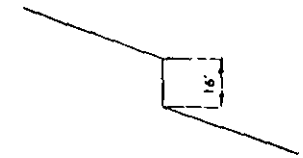
. Use Cs = 2.0
W = 2 h = 2 × 8 = 16′

$S_{(DRIFT)} = Cs\ g$
$= 2 \times 40$
$= 80$ psf



Remainder of roof
load (S) $= Cs\ g$
$= 0.8 \times 40$
$= 32$ psf

5. Lower Roof with Sloping Upper Roof



1:12 Roof slopes
Ground snow load (g) = 50 psf
h = 16′ (h > 15′ . Use W = 30′)
y = 1.5 (Assumed)
Upper roof design
load (S) $= Cs\ g$
$= 0.8 \times 50$
$= 40$ psf

Lower roof
Drift load: For Cs,

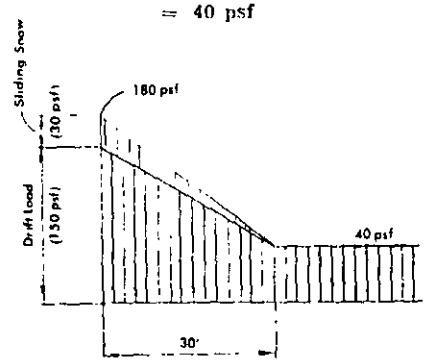
$$\frac{15\ h}{g} = \frac{15 \times 16}{50} = 4.8 > 3.0$$

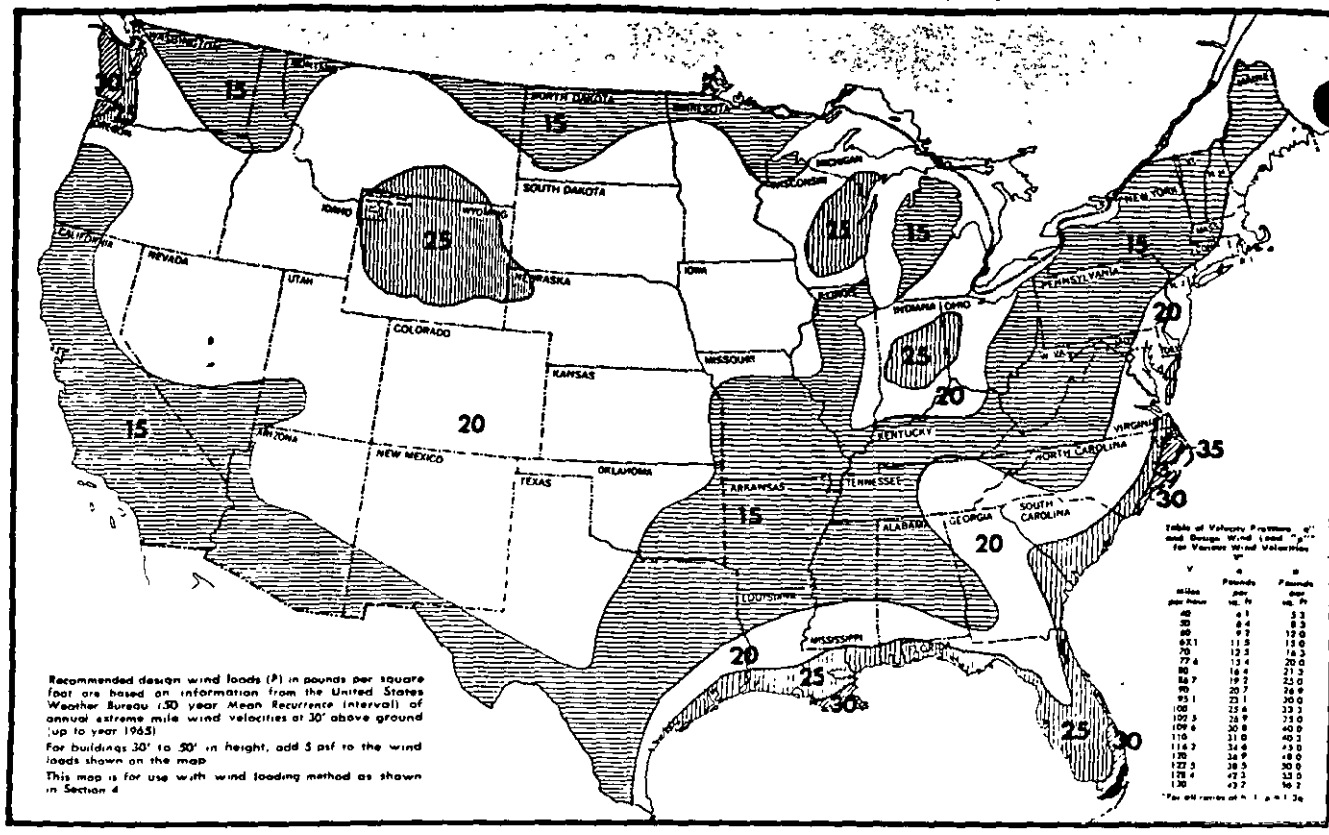
. . Use Cs = 3.0

$S_{(DRIFT\ LOAD)} = Cs\ g$
$= 3.0 \times 50$
$= 150$ psf

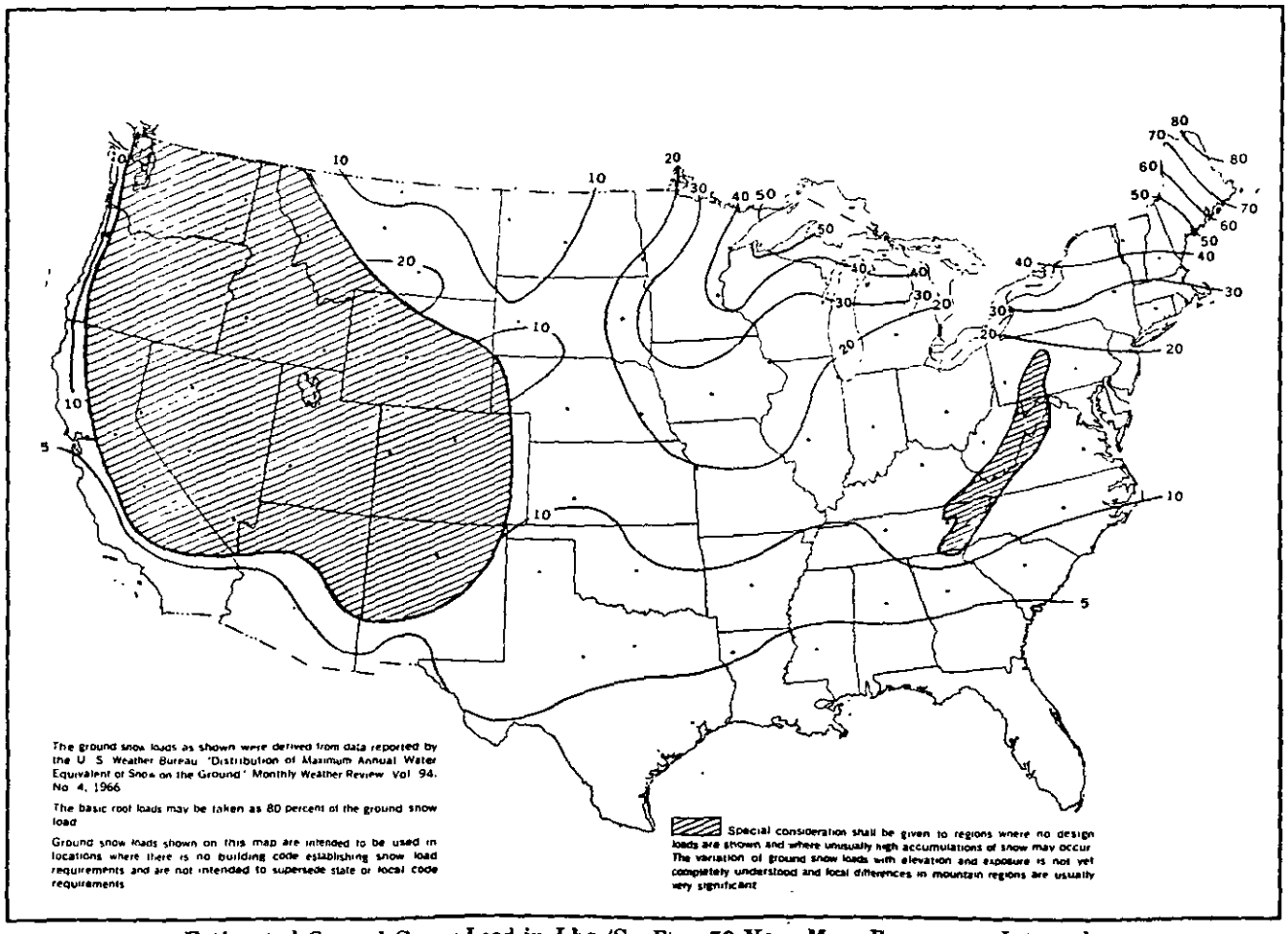
Sliding snow load:
$S = Cs\ yg\ .5$
$S = 0.8 \times 1.5 \times 50 \times .5$
$S = 30$ psf

Remainder of lower roof
load (S) $= Cs\ g$
$= 0.8 \times 50$
$= 40$ psf





Recommended Design Wind Loads for Buildings up to 30' High



Estimated Ground Snow Load in Lbs./Sq. Ft. – 50 Year Mean Recurrence Interval

Recommended Guide Specifications for Metal Building Systems

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Recommended Guide Specifications for Metal Building Systems

This specification, when used in conjunction with the MBMA, "Recommended Design Practices Manual" and the "Recommended Code of Standard Practices for the Design, Manufacture, Sales and Erection of Metal Buildings" is recommended as a guide in the preparation of performance specifications for metal buiding systems:

In this document, reference is made to various material specifications and standards. These are intended to outline performance requirements. This specification provides a standard which will qualify metal building systems for commercial, industrial, institutional, and military installations.

SECTION 1

1. SCOPE

1.1 This specification covers the material for and the fabrication of metal buildings designed and constructed to be weathertight and easily erected.

1.2 The materials furnished shall include the structural framing, roofing, siding, doors, windows, hardware, fasteners, sealants, and/or caulk and any other component parts for the metal buildings only, as specified, including the erection of same if so stated in the proposal. All materials shall be new, unused, and fabricated in a workmanlike manner.

1.3 Unless otherwise provided in the proposal, the metal building does not include:

1.3.1 Reinforcing steel or concrete materials.

1.3.2 Anchor bolts, anchor bolt templates, leveling plates, column base tie rods, or any materials to be set in concrete.

1.3.3 The setting or supervision of setting anchor bolts.

1.3.4 Grouting or filling of any kind under columns or door jambs or in a recess at the base of wall covering panels.

1.3.5 Gutters, their downspouts, or drains.

1.3.6 Interior downspouts or their drains for valley or parapet gutters or otherwise, either under floor or otherwise.

1.3.7 Opening, flashing, framing, or other materials which are required by other trades, or which are required for the assembly or installation of accessories, materials, or equipment supplied by other trades, even though such accessories, materials, or equipment are to be fastened to the metal building system.

1.3.8 Flashing or counterflashing material for tie-in to other structures.

1.3.9 Glass for windows, doors, or other openings, except for those windows and doors furnished glazed.

1.3.10 Insulation material or insulation accessories.

1.3.11 Interior framing and finishing material, including partition material.

1.3.12 Traveling cranes, crane runway beams, crane rails, monorails, hoist or the means for their attachment to the metal building system.

1.3.1 trical apparatus, equipment, or wiring.

1.3.14 chanical equipment, including exhaust fans.

1.3.15 Masonry materials.

1.3.16 Miscellaneous iron or steel including, but not limited to stairs, ladders, railings, platforms, conveyor supports, lintels, edge angles, hangers, and castings.

1.3.17 Field painting.

1.3.18 Overhead doors and track assemblies.

1.4 In case of discrepancies between the plans and specifications for a metal building system, the specifications govern. In case of discrepancies between the scaled dimensions of the plans and the numerical dimensions shown on the plans, the numerical dimensions govern.

SECTION 2

2. DEFINITIONS

2.1 **Primary Members** are the main load carrying members of a structural system, generally the columns, rafters, or other main support members.

2.2 **Secondary Members** are members which carry loads to the main or primary members. In metal buildings, this term includes purlins, girts, struts, base angles, flange and knee braces, headers, jambs, sag members and other miscellaneous framing.

2.3 **Structural Steel Members** are load carrying members. They may be hot rolled sections, cold formed shapes, or built-up shapes.

2.4 **Cold-Formed Steel Members** are formed at room temperature from flat sheet or strip of structural quality and are load-carrying members.

2.5 **Roof Covering** is the exposed exterior roof skin consisting of panels or sheets, attachments, and joint sealants.

2.6 **Wall Covering** is the exterior wall skin consisting of panels or sheets and includes their attachments, trim fascia, and weather sealants.

2.7 **Gable Roof** is a ridged roof that terminates in gables.

2.8 **Single Slope Roof** is a sloping roof with one surface. The slope is from one wall to the opposite wall of a rectangular building.

2.9 **Multi-Span Buildings** are buildings consisting of more than one span across the width of the building. Multiple gable buildings and single gable buildings with interior posts are examples.

2.10 **Basic Design Loads**

2.10.1 **Dead Load** of a building is the weight of all permanent construction such as floor, roof, framing, and covering.

2.10.2 **Roof Live Load** means all loads, including snow, exerted on a roof, except dead, wind and lateral loads.

2.10.3 **Wind Load** is the load caused by the wind blowing from any horizontal direction.

2.10.4 **Seismic Load** is the assumed lateral load acting in any horizontal direction on the structural system due to the action of earthquakes.

2.11 Auxiliary Loads are all specified dynamic live loads other than the basic design loads which the building must safely withstand, such as cranes, material handling systems, and impact loads.

2.12 Collateral Loads are all specified additional dead loads other than the metal building framing, such as sprinklers, mechanical and electrical systems and ceilings.

2.13 Impact Load is the assumed auxiliary load resulting from the motion of machinery, elevators, cranes, vehicles, and other similar dynamic forces.

2.14 Accessories of a building consist of the following: doors, windows, louvers, ventilators, fans, ceilings, insulation, skylights and wall lights, partitions, interior liner, gutters, downspouts, etc.

SECTION 3

3. DESCRIPTION OF TYPES OF BUILDINGS[1]

3.1 Rigid Frame — This type of building utilizes continuous frames consisting of columns and rafters (tapered or uniform depth), as required. This type of framing assumes that rafter-to-column connections have sufficient rigidity to hold virtually unchanged the original angles between intersecting members. The frame spans across the width of the building and is spaced on pre-determined bay lengths and supports the secondary framing and the roof and wall covering.

3.2 Beam and Column — This type of building utilizes frames with tapered or uniform depth beam or girder supported by columns. This type of framing, commonly designated as "simple" framing (unrestrained, free-ended), assumes that, insofar as gravity loading is concerned, the ends of beams, or girders, are connected to resist shear only, and are free to rotate under gravity load. This primary framing is spaced on pre-determined bay lengths and supports the secondary framing and the roof and wall covering.

3.3 Truss Frame — This type of building shall be either a single span or multi-span structure. The truss properly braced shall be supported by columns. This primary framing is spaced on pre-determined bay lengths and supports the secondary framing and the roof and wall covering.

3.4 Self-Framing — This type of building shall be a single span or multi-span structure utilizing the roof and wall covering as a load bearing diaphragm in addition to its function as an exterior skin of the building.

[1]Building Geometry — The roof slope, width, eave height, length of building, and spacing of bents (bays) shall conform to the manufacturers' standards covering the listed types of buildings.

SECTION 4

4. RECOMMENDED APPLICABLE STANDARDS AND SPECIFICATIONS

4.1 Metal Building Manufacturers Association, 2130 Keith Building, Cleveland, Ohio 44115.

4.1.1 "Recommended Design Practices Manual"

4.1.2 "Recommended Code of Standard Practices"

4.2 **Steel** w Institute, 2130 Keith Building, Cleveland, Ohio 44115.
4.2.1 commended Standards for Steel Windows"

4.3 **Architectural Aluminum Manufacturers Association,** One East Wacker Drive, Chicago, Illinois 60601.
4.3.1 "USA Standard Specifications for Aluminum Windows"

4.4 **Steel Door Institute,** 2130 Keith Building, Cleveland, Ohio 44115.
4.4.1 "Standard Steel Doors and Frames"

4.5 **Federal Specifications and Commercial Standards,** Superintendent of Documents, United States Government Printing Office, Washington, D.C. 20402.

SECTION 5

5. DESIGN CRITERIA

5.1 The primary and secondary members and covering shall be designed for all applicable loads and combinations of these loads as set forth in the MBMA, "Recommended Design Practices Manual."

5.2 The basic design criteria, rationally applied to the structure (structures) and its components specified herein, shall conform to the applicable sections relating to design requirements and allowable stresses of the following publications:

American Institute of Steel Construction —
"Specifications for the Design, Fabrication, and Erection of Structural Steel for Buildings"

American Iron and Steel Institute —
"Specification for the Design of Cold-Formed Steel Structural Members"

"Design of Light Gage Steel Diaphragms"

American Welding Society
"Structural Welding Code"

Metal Building Manufacturers Association —
"Recommended Design Practices Manual"

Aluminum Association —
"Specification for Aluminum Structures"
"Aluminum Formed Sheet Building Sheathing Design Guide"

SECTION 6

6. DESIGN LOADS

6.1 The basic design loads shall include live, wind, or earthquake (if applicable), in addition to dead load. All other design loads, whether they be of a static or dynamic nature, shall be considered auxiliary or collateral loads respectively.

6.2 The magnitude of all specific auxiliary and/or collateral loads, depending upon the nature and use thereof in the building, shall be clearly set forth in these specifications.

6.3 The magnitude of the design loads shall be as required by the authority having jurisdiction of the area in which the specified structure is erected. In the absence of said authoritative jurisdiction, the basic design loads shall be as indicated by local conditions.

6.4 The minimum wind pressure shall be not less than 15 pounds per square foot, applied and proportioned as horizontal and uplift forces according to the Metal Building Manufacturer's Association, "Recommended Design Practices Manual."

6.5 Roof live loads shall be considered as additive to all roof dead loads and applicable auxiliary and collateral loads. Except in areas where snow may be critical or where local jurisdiction shall govern, the minimum roof live load, considered to act vertically upon the horizontal projections of the roof, shall be not less than as stipulated in the following table.

Recommended Minimum Roof Live Loads in Pounds Per Square Foot

Roof Slope	Tributary Loaded Area in Square Feet for Any Structural Member		
	0 to 200*	201 to 600*	Over 600
Flat or rise less than 4 inches per foot	20	16	12
Rise 4 inches per foot to less than 12 inches per foot	16	14	12
Rise 12 inches per foot and greater	12	12	12

*May be 12 pounds per square foot where permitted by map of Estimated Ground Snow Load shown in the "Recommended Design Practices Manual."

6.6 In areas subject to earthquakes, the minimum seismic loads shall be derived from the formula set forth in the latest edition of the "Uniform Building Code."

6.7 The combination of basic design loads and applicable auxiliary and/or collateral loads shall be as prescribed and recommended by the MBMA "Recommended Design Practices Manual," Section 7 — Combination of Loads.

SECTION 7

7. MATERIALS AND WORKMANSHIP

7.1 All materials furnished shall meet or exceed the stated design requirements.

7.2 Workmanship shall be such that the parts of the building are accurately made and true to dimension, so that in erection of same all parts will properly fit together. However, minor amounts of material and the correction of minor misalignments by the moderate use of drift pins, and a moderate amount of reaming, chipping, or cutting are a part of erection.

7.3 The size and weight of the building components as packaged and shipped shall be such that will permit transportation by common carrier.

7.4 Steel — Steel shall meet or exceed the physical requirements of AISC, "Specifications for the Design, Fabrication, and Erection of Structural

Ste[illegible] Buildings" and/or American Iron and Steel Institute's, "Specifica[illegible]or the Design of Cold-Formed Steel Structural Members," whichever is applicable.

7.5 **Aluminum** — The Aluminum Association's, "Specification for Aluminum Structures" and "Aluminum Formed Sheet Building Sheathing Design Guide" shall be the guide in the design of aluminum parts for building components."

7.6 **Plastic** — Translucent roof and wall covering shall conform to commercial standard CS-214 (latest edition).

7.7 **Welding** — Factory or field welding procedures performed in the fabrication or modification of structural steel and cold formed steel shall be in accordance with the welding procedures of the American Welding Society's "Structural Welding Code."

7.8 **Weathertightness** — Components of the roof and wall covering, including joints, flashing, and attachment of accessories, shall be designed to be weathertight.

7.9 **Minimum Standards for Thickness**

7.9.1 Individual structural members of steel other than roof and wall covering to be a minimum of 18 MFG STD. gage.

7.9.2 Roof and Wall Covering
Steel, minimum of 26 MFG STD. gage.
Aluminum, minimum of 0.032" thickness.
Plastic, minimum of .045" thickness.

7.9.3 Gable and eave trim, fascia closure strips, rake flashings, and copings.
Steel, minimum of 26 MFG STD. gage.
Aluminum, minimum of 0.032" thickness.
Plastic, minimum of .045" thickness.

7.9.4 Interior Gutters
Steel, minimum of 24 MFG STD. gage.
Aluminum, minimum of .040" thickness.

7.9.5 Eave Gutters and Downspouts
Steel, minimum of 26 MFG STD. gage.
Aluminum, minimum of .032" thickness.

7.9.6 Use of materials of less thickness than that given throughout section 7.9 may be allowed upon the submission of test data from approved authorities and/or calculations verifying the structural adequacy and erection feasibility of members formed from such material.

7.10 **Minimum Finish**

7.10.1 **Galvanized (Zinc Coated) Steel Covering** when specified shall be a minimum coating class of 1.25 oz. per sq. ft. according to ASTM A-525. In addition, a mill treatment shall be added to aid in the prevention of oxidation on the zinc coated surfaces.

7.10.2 **Aluminum Coated Steel Covering** shall be a minimum of Type II Federal Specs. MIL-S-4174-A (.75 oz. per sq. ft.).

7.10.3 **Aluminum Cladding over Aluminum Covering** shall be in accordance with "Aluminum Standards and Data," of the Aluminum Association.

7.10.4 **Pre-painted Covering — factory applied** — The primer on pre-treatment shall be the building manufacturer's standard, compatible with the metal surface to be painted as well as the finish coat of paint. The finish coat of paint, on the exposed exterior surface shall consist of a properly stabilized synthetic base coating oven dried and pigmented to obtain optimum performance. The dry film thickness shall be one mil (.001") with a tolerance of minus two tenths mil (.0002"). Color shall conform to the building manufacturer's standards.

7.10.5 **Covering Fasteners** — The minimum coating thickness for covering fasteners of carbon steel shall be 0.0003" electro-galvanized in accordance with ASTM A-164 or 0.0003" Cadmium plated in accordance with ASTM A-165.

7.10.6 **Structural Painting** — All structural framing of the metal building systems, not protected by a corrosion resistant coating, is painted one coat of shop primer by the manufacturer. All surfaces to receive shop primer are cleaned of loose rust, loose mill scale, and other foreign material by the manufacturer prior to painting. The manufacturer is not required to sandblast, flame clean, or pickle the steel framing. The coat of primer is intended to protect the steel framing for only a short period of exposure to ordinary atmospheric conditions.

7.10.7 **Dissimilar Materials** which are not compatible with the adjoining materials when exposed to moisture must be separated by means of coatings, gaskets, or other effective means. Aluminum surfaces which may contact unprotected steel should be separated by brush-on coatings such as per Federal Specs. TT-E-496, Type 1, MIL-P-6883, JAN-P-735 or equal. Aluminum alloys shall be considered compatible with zinc and cadmium coated surfaces and the 300 and 400 AISI Series Stainless Steel Alloys and do not require application of barrier material.

SECTION 8

8. ACCESSORIES* — All accessories shall be the building manufacturer's standard and meet the following minimum requirements:

8.1 **Windows, Aluminum** shall meet the applicable requirements as set forth in the "Architectural Aluminum Manufacturers Association" specifications.

8.2 **Windows, Steel** shall meet the applicable requirements of the "Recommended Standards for Steel Windows" of the Steel Window Institute.

8.3 **Personnel Doors — Steel**, doors shall be either heavy duty or standard duty as specified. Heavy duty doors shall be constructed as specified for 1¾" thick doors, PS-4 or CS-242. Standard duty doors shall meet the minimum construction requirements specified for 1⅜" thick doors, PS-4. Hardware shall conform to building manufacturers standard specification.

8.4 **Slide Doors Horizontal — Steel** — Sliding doors including hardware shall be of a type standard with the manufacturer. Unless indicated otherwise by the manufacturer, the door covering materials shall be of the same type and gage as the wall cover.

*All framed openings for windows, doors, and other accessories shall be designed to structurally replace the wall or roof covering and/or framing they displace.

8.5 C[illegible] Type Doors — The overhead type doors, including hardware, sha[illegible] as shown on the drawings and conform to the specifications of the manufacturer.

8.6 **Ventilators** — The type, size, and location of ventilators shall be shown on the drawings or defined in the manufacturers' specifications. The ventilators shall be weathertight and shall be framed and braced adequately to sustain the designed wind loads.

8.7 **Louvers** — The type, size, and location of louvers shall be as shown on the drawings or defined in the manufacturers' specifications.

8.8 **Skylights** — Skylights shall be in accordance with the drawings and manufacturers' specifications and shall conform to commercial standard CS-214 where applicable.

8.9 **Insulation** — The insulation including its applied facing, if required, shall have a flame spread rating of 25 or less and be in accordance with that shown on the drawings or defined in the manufacturers' specifications.

SECTION 9

9. ERECTION AND INSTALLATION

Unloading instructions, storage of materials, and erection procedures as outlined and recommended by the building manufacturer shall be followed as closely as possible and, together with accepted trade practices, shall conform to details and instructions as shown on the erection or assembly drawings. Erection tolerances are those set forth in AISC "Code of Standard Practice," except individual members are considered plumb, level, and aligned if the error does not exceed 1:300.

SECTION 10

10. DRAWINGS

Proposal drawings, when required, clearly indicating the scope of work along with the proposal shall be considered as sufficient information for bidding documents.

After the contract is awarded, applicable erection, drawings and instructions shall be available prior to shipment of material.

SECTION 11

11. CERTIFICATION

When required by the terms of the contract, the manufacturer furnishes design calculations or a letter of certification signed and sealed by a registered professional engineer for the structural framing and covering panels of the metal building systems. Such design calculations may be manual or by electronic computer at the discretion of the metal building system manufacturer.

Metal Building Systems Nomenclature

The Technical Committee of this Association has listed the Engineering Terms more frequently used in the Metal Building Systems Industry.

This listing, as are other portions of this Manual, is in continual review by the Technical Committee and new editions are published as revisions and additions are made by that Committee.

TERM	DEFINITION
Accessory	An extra building product which supplements a basic solid sheeted building such as door, window, skylight, ventilator, etc.
AISI	American Iron and Steel Institute.
AISC	American Institute of Steel Construction.
AISE	American Iron and Steel Engineers
Aluminum Coated Steel	Aluminum coated steel.
ANSI	American National Standards Institute.
Anchor Bolts	Bolts used to anchor structural members to a foundation or other support. Usually refers to the bolts at the bottom of all columns and door jambs
Anchor Bolt Plan	A plan view showing the size, location, and projection of all anchor bolts for the metal building systems components, the length and width of the foundation (which may vary from the nominal metal building size). Column reactions (magnitude and direction), and minimum base plate dimensions may also be included.
Approval Drawings	Approval drawings may include framing drawings, elevations and sections through the building as furnished by the manufacturer for approval of the buyer. Approval by the buyer affirms that the manufacturer has correctly interpreted the overall contract requirements for the metal building system and its accessories, and the exact location of accessories in the building.
Architectural Drawing	A drawing which shows the plan view and/or elevations of the finished building for the purpose of showing the general appearance of the building, indicating all accessory locations.
ASCE	American Society of Civil Engineers.
Astragal	A closure between the two leaves of a double swing or double slide door to close the joint.
Automatic Welding	A welding operation utilizing a machine to make a continuous, unbroken weld
Auxiliary Loads	All specified dynamic live loads other than the basic design loads which the building must safely withstand, such as cranes, material handling systems and impact loads.
Awning Window	A window in which the vent or vents pivot outward about the top edge giving an awning affect.
AWS	American Welding Society.
Base Angle	An angle secured to the perimeter of the foundation to support and close wall panels.

Base — A plate attached to the base of a column which rests on a fo ...on or other support, usually secured by anchor bolts.

Bay — The space between frame center lines or primary supporting members in the longitudinal direction of the building.

Beam — A primary member, usually horizontal, that is subjected to bending loads. There are three types, simple, continuous and cantilever.

Beam and Column — A primary structural system consisting of a series of rafter beams supported by columns. Often used as the end frame of a metal building.

Bearing Plate — A steel plate that is set on the top of a masonry support on which a beam or purlin can rest.

Bent — The primary member of a structural system.

Bill of Materials — A list of items or components used for fabrication, shipping, receiving, and accounting purposes.

Bird Screen — Wire mesh used to prevent birds from entering the building through ventilators and louvers.

Blind Rivet — A small headed pin with expandable shank for joining light gage metal. Typically used to attach flashing, gutter, etc.

BOCA — Building Officials and Code Administrators International, Inc.

Bonded Roof — A roof which carries a written warranty with respect to weather-tightness for a stipulated number of years.

Brace Rods — Rods used in roof and walls to transfer loads, such as wind loads, and seismic and crane thrusts to the foundation. (Also often used to plumb buildings but not designed to replace erection cables.)

Bracket — A structural support projecting from a wall or column on which to fasten another structural member. Examples are canopy brackets, lean-to brackets and crane runway brackets.

Bridge Crane — A load lifting system consisting of a hoist which moves laterally on a beam, girder or bridge which in turn moves longitudinally on a runway made of beams and rails. Loads can be moved to any point within a rectangle formed by the bridge span and runway length.

Building Code — Regulations established by a recognized agency describing design loads, procedures and construction details for structures. Usually applying to designated political jurisdiction (city, county, state, etc.)

Built-Up Roofing — A roof covering made up of alternating layers of tar and asphaltic materials.

Built-Up Section — A structural member, usually an "I" section, made from individual flat plates welded together.

Butt Plate — The end plate of a structural member usually used to rest against a like plate of another member in forming a connection. Sometimes called a splice plate.

"C" Section — A member formed from steel sheet in the shape of a block "C", that may be used either singly or back to back.

Camber — A predetermined curvature designed into a structural member to offset the anticipated deflection when loads are applied.

Canopy — Any overhanging or projecting roof structure with the extreme end usually unsupported.

Cantilever — A projecting beam that is supported and restrained at one end only.

Capillary Action — That action which causes movement of liquids when in contact with two adjacent surfaces such as panel sidelaps.

Cap Plate — A plate located at the top of a column or end of a beam for capping the exposed end of the member.

Caulk — To seal and make weather-tight the joints, seams, or voids by filling with a waterproofing compound or material.

Channel - Hot Rolled — A member formed while in a semi-molten state at the steel mill to a shape having standard dimensions and properties specified by AISC or the steel producer.

Channel - Cold Formed — Various shapes such as angles, channels, "C" sections, etc., formed from steel at room temperature.

Clip — A plate or angle used to fasten two or more members together.

Closure Strip — A resilient strip, formed by the contour of ribbed panels used to close openings created by joining metal panels and flashing.

Cold Form — The process of using press brakes or rolling mills to cold form steel into desired shapes at room temperature.

Collateral Load — All specified additional dead loads other than the metal building framing, such as sprinklers, mechanical and electrical systems and ceilings.

Column — A primary member used in a vertical position on a building to transfer loads from main roof beams, trusses, or rafters to the foundation.

Continuity — The terminology given to a structural system denoting the transfer of loads and stresses from member to member as if there were no connections.

Covering — The exterior cover for a building.

Crane — A machine designed to move material by means of a hoist.

Crane Rail — A track supporting and guiding the wheels of a bridge crane or trolley system.

Crane Runway Beam — The member that supports a crane rail. Supports may be columns or rafters depending on the type of crane system. On underslung bridge cranes, runway beam also acts as crane rail.

Curb — A raised edge on a concrete floor slab

Curtain Wall — Perimeter wall panels which carry only their own weight and wind load.

Damper — A baffle used to open or close the throat of ventilators.

Dead Load — The dead load of a building is the weight of all permanent construction, such as floor, roof, framing, and covering members.

Deflection - The displacement of a structural member or system under load.

Design —

a. *"Manual of Steel Construction"* of the American Institute of Steel Construction (AISC) for the primary structural steel.

b. *"Cold-Formed Steel Design Manual"* of the American Iron and Steel Institute (AISI).

c. *"Recommended Design Practices Manual"* by the Metal Building Manufacturers Association (MBMA).

d. *"Design of Light Gage Steel Diaphragms"* of the American Iron and Steel Institute (AISI).

Design Loads — Those loads specified in building codes published by Federal, State, or City agencies, or in owner's specifications to be used in the design of a building.

Diagonal Rod Bracing — See brace rods.

Diaphragm Action — The resistance to racking generally offered by the covering system.

Door Guide — An angle or channel guide used to stabilize or keep plumb a sliding or rolling door during its operation

Downspout — A conduit used to carry water from the gutter of a building to the ground or storm drain.

Drift Pin — A tapered pin used during erection to align holes in steel members to be connected by bolting or riveting.

Eave — The line along the sidewall formed by the intersection of the faces of the roof and wall panels.

Eave Height — The vertical dimension from finished floor to the eave.

Eave Strut — A structural member at the eave to support roof panels and wall panels. It may also transmit wind forces from roof brace rods to wall brace rods.

Elastic Design — A design concept utilizing the proportional behavior of materials when all stresses are limited to specified allowable values.

End Frame — A frame at the endwall of a building to support the roof load from one half the end bay.

Erection — The on-site assembling of pre-fabricated components to form a complete structure.

Expansion Joint — A break or space in construction to allow for thermal expansion and contraction of the materials used in the structure.

Fabrication — The manufacturing process performed in a plant to convert raw material into finished metal building components. The main operations are cold forming, cutting, punching, welding, cleaning and painting.

Fascia — A decorative trim or panel projecting from the face of a wall.

Field — The "job site," "building site" or general market area.

Filler Strip — See "Closure."

Finial — Gable closure at ridge.

Fixed Base — A column base that is designed to resist rotation as well as horizontal or vertical movement.

Flange — The projecting edge of a structural member.

Flange Brace — A bracing member used to provide lateral support to the flange of a beam, girder, or column.

Flashing — A sheet metal closure which functions primarily to provide weather tightness in a structure and secondarily to enhance appearance.

Footing — A pad or mat, usually of concrete, located under a column, wall, or other structural member, that is used to distribute the loads from that member into the supporting soil.

Force — The action of one body on another body which changes or tends to change its state of rest or motion. A force may be expressed in pounds, kips or other similar units and may act in any one of the following ways:

a. Compression force: A force acting on a body tending to compress the body. (Pushing action).

b. Shear force: A force acting on a body which tends to slide one portion of the body against the other side of the body. (Sliding action).

c. Tension force: A force acting on a body tending to elongate the body. (Pulling action).

d. Torsion force: A force acting on a body which tends to twist the body.

Foundation — The substructure which supports a building or other structure.

Framed Opening — Frame work (headers and jambs) and flashing which surround an opening in the wall or roof of a building. Usually for field installed accessories such as overhead doors or powered roof exhausters.

Framing — The primary and secondary members (columns, rafters, girts, purlins, brace rods, etc.) which go together to make up the skeleton of a structure to which the covering can be applied.

Framing Drawings — Plans and erection instructions which identify all individual parts in sufficient detail to permit the proper erection and installation of all parts of the metal building system furnished by the seller (also known as Erection Drawings).

Gable — A triangular portion of the endwall of a building directly under the sloping roof and above the eave height line.

Gable Roof — A ridged roof that terminates in gables.

Gage — The numerical designation for the thickness of sheet steel.

Galvanized — Steel coated with zinc for corrosion resistance.

Girder — A main horizontal or near horizontal structural member that supports vertical loads. It may consist of several pieces.

Girt — A secondary horizontal structural member attached to sidewall or endwall columns to which wall covering is attached and supported horizontally.

Glaze or Glazing — The process of installing glass in window and door frames.

Grade — The term used when referring to the ground elevation around a building.

Grade Beam — A concrete beam around the perimeter of a building carrying an exterior wall.

Grout — A mixture of cement, sand and water used to fill cracks and cavities. Often used under base plates or leveling plates to obtain uniform bearing surfaces.

Gusset Plate — A steel plate used to distribute loads.

Gutter — A channel member installed at the eave of the roof for the purpose of carrying water from the roof to the drains or downspouts.

"H" Section — A steel member with an H cross section.

Haunch — The deepened portion of a column or rafter, designed to accommodate the high stress at such points. (Usually occurs at connection of column and rafter.)

Header — A horizontal framing structural member over a door, window or other framed opening.

High Strength Bolts — Any bolt made from steel having a tensile strength in excess of 100,000 pounds per square inch. Some examples are: ASTM A-325, A-354, A-490.

Hinged Base — See "Pin Connection."

Hip Roof — A roof which rises by inclined planes from all four sides of a building. The line where two adjacent sloping sides of a roof meet is called the *Hip*.

High Strength Steel — Structural steel having a yield stress in excess of 36,000 pounds per square inch.

Hoist — A mechanical lifting device usually attached to a trolley which travels along a bridge, monorail or jib crane. May be chain or electric operated.

Hood (Door) — The metal flashing used over exterior slide door track along the full length of the door header to protect the tracks from weather and to conceal them for aesthetic purposes.

Hot-Rolled Shapes — Steel sections (angles, channels, I-beams, etc.) which are formed by rolling mills while the steel is in a semi-molten state.

ICBO — International Conference of Building Officials.

Impact Load — An assumed dynamic load resulting from the motion of machinery, elevators, craneways, vehicles, and other similar moving forces.

Insulation — Any material used in building construction to reduce heat transfer.

Jack Beam — A beam used to support another beam or truss and eliminate a column support.

Jack Truss — A truss used to support another truss or beam and eliminate a column support.

Jib Crane — A cantilevered boom or horizontal beam with hoist and trolley. This lifting machine may pick up loads in all or part of a circle around the column to which it is attached.

Jig — A device used to hold pieces of material in a certain position during fabrication.

Kick-Out (Elbow) — (Turn-Out) A lower downspout section used to direct water away from a wall.

Kip — A unit of measure equal to 1,000 pounds.

Knee (or Haunch) — The connecting area of a column and rafter of a structural frame such as a rigid frame.

Knee Brace — A diagonal brace designed to resist horizontal loads usually from wind or moving equipment. This member normally has the lower end connected to a column and the upper end connected to an eave strut.

Lean-To — A structure such as a shed, having only one slope or pitch and depending upon another structure for partial support.

Leveling Plate — A steel plate used on top of a foundation or other support on which a structural column can rest.

Liner Panel — A panel applied as an interior finish.

Live Load — Live load means all loads, including snow, exerted on a roof, except dead, wind and lateral loads.

Loads — Anything that causes a force to be exerted on a structural member. Examples of different types are:

a. Dead Load
b. Impact Load
c. Roof Live Load
d. Seismic Load
e. Wind Load
f. Crane Load
g. Collateral Load
h. Auxiliary Load

Louver — An opening provided with fixed or movable, slanted fins to allow flow of air.

Masonry — Anything constructed of materials such as bricks, concrete blocks, ceramic blocks, and concrete

Mastic — Caulking or sealant furnished in rolls, normally used on sealing roof panel laps.

MBMA — Metal Building Manufacturers Association.

Mild Steel — (Soft, low carbon) A grade of steel having a low percentage of carbon content and generally lower strength.

Moment — The tendency of a force to cause rotation about a point or axis.

Moment Connection — A connection between two members which transfers the moment from one side of the connection to the other side and maintains under application of load the same angle between the connected members that exist prior to the loading. Also, a connection that maintains continuity.

Moment of Inertia — A physical property of a member, which helps define strength and deflection characteristics.

Monolithic Construction — A method of pouring concrete grade beam and floor slab together to form the building foundation without forming and pouring each separately.

Monorail — A single rail support for a material handling system. Normally a standard hot rolled I-beam.

Multi-Gable Building — Buildings consisting of more than one gable across the width of the building.

Multi-Span Building — Buildings consisting of more than one span across the width of the building. Multiple gable buildings and single gable buildings with interior posts are examples.

NBC — National Building Code.

Parapet — That portion of the vertical wall of a building which extends above the roof line at the intersection of the wall and roof.

Peak — The uppermost point of a gable.

Peak Sign — A sign attached to the peak of the building at the endwall showing the building manufacturer.

Piece Mark — A number given to each separate part of the building for erection identification. Also called mark number and part number.

Pier — A concrete structure designed to transfer vertical load from the base of a column to a footing.

Pig Spout — A sheet metal flashing designed to direct the flow of water out through the face of the gutter rather than through a downspout.

Pilaster — A reinforced or enlarged portion of a masonry wall to provide support for roof loads or lateral loads on the wall.

Pin Connection — In structural analysis; a member connection to a foundation, another member or structure is designed in such a way that free rotation is assumed.

Plastic Design — A design concept based on multiplying the actual loads by a suitable load factor and using the yield point as the maximum stress in any member.

Ponding — The gathering of water at low or irregular areas on a roof.

Pop Rivet — See "Blind Rivet."

Portal Frame — A rigid-frame structure so designed that it offers rigidity and stability in its plane. It is used to resist longitudinal loads where X-rods are not permitted. (Also "Wind Bent.")

Post (End Post) — A secondary column at the end of a building to support the girts and in a beam-and-column endwall frame, to additionally support the rafter.

Pre-Painted Coil — Coil steel which receives a paint coating prior to the forming operation.

Press Brake — A machine used in cold-forming metal sheet or strip into desired shapes.

Prestressed Concrete — Concrete in which the reinforcing cables, wires or rods in the concrete are tensioned before there is load on the member, holding the concrete in compression for greater strength.

Primary Members — The main load carrying members of a structural system, including the columns, end wall posts, rafters, or other main support members.

Primer Paint — This is the initial coat of paint applied in the shop to the structural framing of a building for protection against the elements during shipping and erection.

Prismatic Beam — A beam having both flanges parallel to its longitudinal axis

Purlin — A secondary horizontal structural member attached to the primary frame which transfers the roof loads from the roof covering to the primary members.

Rafter — A primary beam supporting the roof system.

Rails (Door) — The horizontal stiffening members of framed and paneled doors.

Rake — The intersection of the plane of the roof and the plane of the gable. (As opposed to endwalls meeting hip roofs).

Rake Angle — Angle fastened to purlins at rake for attachment of endwall panels.

Rake Trim — A flashing designed to close the opening between the roof and endwall panels.

Reactions — The resisting forces at the column bases of a frame, holding the frame in equilibrium under a given loading condition.

Reinforcing Steel — The steel placed in concrete to help carry the tension, compression and shear stresses.

Ridge — Highest point on the roof of the building which describes a horizontal line running the length of the building.

Ridge Cap — A transition of the roofing materials along the ridge of a roof. Sometimes called ridge roll or ridge flashing.

Rigid Connection — See "Moment Connection"

Rigid Frame — A term used in structural analysis to describe a rafter-to-column connection which is assumed to have sufficient rigidity to hold virtually unchanged, the original angles between intersecting members.

Roof Covering — The exposed exterior roof skin consisting of panels or sheets, attachments and joint sealants.

Roof Overhang — A roof extension beyond the endwall/sidewall of a building.

Roof Pitch — See "Roof Slope".

Roof Slope — The angle that a roof surface makes with the horizontal. Usually expressed in units of vertical rise to 12 units of horizontal run.

Rolling Doors — Doors that are supported on wheels which run on a track.

Sag Rod — A tension member used to limit the deflection of a girt or purlin in the direction of the weak axis.

TERM DEFINITION

Sag Str. . Sag Angle — See "Sag Rod."

Sandwich Panel — A non-composite panel assembly used as covering; consists of an insulating core material with inner and outer skins.

SBCC — Southern Building Code Congress.

Screeding — The process of striking off the excess concrete to bring the top surface of the concrete to proper finish and elevation.

Sealant — Any material which is used to close up cracks or joints to protect against leaks.

Secondary Members — Members which carry loads to the primary members. In a metal building system, this term includes purlins, girts, struts, diagonal bracing, wind bents, flange, and knee braces, headers, jambs, sag members, and other miscellaneous framing.

Section Modulus — A physical property of a structural member. It is used in design and basically describes the bending strength of a member.

Sectional Overhead Doors — Doors constructed in horizontally hinged sections. They are equipped with springs, tracks, counter balancers, and other hardware which roll the sections into an overhead position, clear of the opening.

Seismic Load — Seismic Load is the assumed lateral load acting in any horizontal direction on the structural system due to the action of eathquakes.

Self Drilling Screw — A fastener which combines the functions of drilling and tapping. It is used for attaching panels to purlins and girts.

Tapping Screw — A fastener which taps its own threads in a predrilled hole. It is for attaching panels to purlins and girts and for connecting trim and flashing.

Shear — The force tending to make two contacting parts slide upon each other in opposite directions parallel to their plane of contact

Shear Diaphragms — Membrane-like members which are capable of resisting deformation when loaded by in-plane shear forces.

Sheet Groove (Reglet) — A notch or block out formed along the outside edge of the foundation to provide support for the wall panels and serve as a closure along their bottom edge.

Shim — A piece of steel used to level base plates or square beams.

Shipping List — A list that enumerates by part number or description each piece of material or assembly to be shipped. Also called talley sheet and bill of materials.

Shoulder Bolt — A fastener used to attach wall and roof paneling to the structural frame. It consists of a large diameter shank and a small diameter stud. The shank provides suport for the panel rib.

Shot Pin — A device for fastening items by the utilization of a patented device which uses a powdered charge to imbed the item in the concrete and/or steel.

Sill — The bottom horizontal framing member of an opening such as a window or door.

S Angle — See "Base Angle".

TERM DEFINITION

Simple Span — A term used in structural analysis to describe a support condition for a beam, girt, purlin, etc., which offers no resistance to rotation at the supports.

Single Slope — A sloping roof with one surface. The slope is from one wall to the opposite wall of a rectangular building.

Single Span — A building or structural member without intermediate support.

Siphon Break — A small groove to arrest the capillary action of two adjacent surfaces.

Skylight — An opening in a roof or ceiling for admitting daylight; also, the reinforced plastic panel or window fitted into such an opening.

Slide Door — A single or double leaf door which opens horizontally by means of overhead trolleys.

Snow Load — A load imposed on buildings or other structures due to snowfall.

Soffit — The underside covering of any exterior portion of a metal building.

Soil Pressure — The load per unit area a structure will exert through its foundation on the soil.

Spall — A chip or fragment of concrete which has chipped, weathered or otherwise broken from the main mass of concrete.

Span — The distance between supports of beams, girders or trusses.

Specifications — A statement of particulars of a given job, as to size of building, quality, and performance of men and materials to be used, and the terms of the contract. The most common specification found in the metal building industry is the "Recommended Guide Specifications For Metal Building Systems" published by the Metal Building Manufacturers Association.

Splice — A connection in a structural member.

Stainless Steel — An alloy of steel which contains a high percentage of chrominum. Also may contain nickel or copper. Has excellent resistance to corrosion.

Stiffener — A member used to strengthen a plate against lateral or local buckling. Usually a flat bar welded perpendicular to the longitudinal axis of the member. Large concentrated loads such as crane loads, usually requires stiffeners at the point of connection.

Stiffener Lip — A short extension of material at an angle to the flange of cold formed structural members, which adds strength to the member.

Stiles — The vertical side members of framed and paneled doors.

Stitch Screw — A fastener used to connect panels together at the side lap.

Strain — A change in length per unit length. It is the deformation of a body that is acted upon by forces.

Stress — A measure of the load on a structural member in terms of force per unit area (kips per sq. in.).

Structural Steel Members — Load carrying members. May be hot rolled sections, cold formed shapes, or built-up shapes.

Strut — A brace fitted into a frame work to resist force in the direction of its length.

TERM	DEFINITION

Stud — . ertical wall member to which exterior or interior covering or collateral material may be attached. May be either load bearing or non load bearing.

Suction — A partial vacuum resulting from wind loads on a building which cause a load in the outward direction.

Tapered Member — A built up plate member consisting of flanges welded to a variable depth web which slopes from one end to the other.

Temperature Reinforcing — Light weight deformed steel rods or wire mesh placed in concrete to resist possible cracks from thermal expansion or contraction.

Tensile Strength — The longitudinal pulling stress a material can bear without tearing apart.

Thrust — The horizontal component of a reaction.

Tie — A structural member that is loaded in tension.

Torque Wrench — A wrench containing an adjustable mechanism for measuring and controlling the amount of torque or turning force to be exerted — often used in tightening nuts of high strength bolts.

Trim — The light gage metal used in the finish of a building, especially around openings and at intersections of surfaces. Often referred to as flashing.

Track — A metal way for wheeled components; specifically one or more lines of ways, with fastenings, ties, etc., for a craneway, monorail or slide door.

Truss — A structure made up of three or more members, with each member designed to carry a tension or compression force. The entire structure in turn acts as a beam.

Turnout — See "Kickout."

UBC — Uniform Building Code.

Uplift — Wind load on a building which causes a load in the upward direction. (See "Suction.")

Valley Gutter — A channel used to carry off water from the "V" of roofs of multi-gabled buildings.

Ventilator — An accessory usually used on the roof that allows air to pass through.

Wainscot — Sheeting or liner panel on the inside of a building that goes from floor to a girt that is below eave height. (Not full height.)

Wall Covering — The exterior wall skin consisting of panels or sheets and their attachments, trim fascia and weather sealants.

Web — That portion of a structural member between the flanges.

Web Member — A secondary structural member interposed between the top and bottom chords of a truss.

Wind Bent — (See "Portal Frame.")

Wind Column — A vertical member supporting a wall system designed to withstand horizontal wind loads.

Wind Load — A load caused by the wind blowing from any horizontal direction.

"Z" Section — A member cold formed from steel sheet in the shape of a block "Z."

Code of Standard Practice

For the Design, Manufacture, Sales and Erection of Metal Buildings

1973 Edition

METAL BUILDING MANUFACTURERS ASSOCIATION

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PREFACE

Concurrently with the development of the metal building systems industry, manufacturers, dealers, erectors, owners, architects, engineers and contractors have developed certain practices relating to the design, manufacture, sale and erection of metal building systems which have become standard. It is the purpose of the Metal Building Manufacturers Association in compiling these standard practices to provide a single publication for ready reference by all those concerned with the use of metal buildings in construction.

Contracts for the design, manufacture, sale and erection of metal building systems necessarily cover many subjects, and it is hoped that this compilation will serve a useful purpose either by being incorporated by reference in such contracts or by serving as a check list of subjects to be covered in such contracts.

The Code of Standard Practice is designed to be incorporated by reference, in whole or in part, into contracts between the following parties:

A Manufacturer as SELLER of a metal building system with or without its erection or other field work to a Dealer or Owner as BUYER.

A Dealer as SELLER of a metal building system with or without its erection or other field work to an Owner as BUYER.

An Erector as SELLER of metal building systems erection service to a Manufacturer, Dealer or Owner as BUYER.

Nothing in this Code of Standard Practice shall be construed to require any member of the Metal Building Manufacturers Association, or any other party to contract on the terms and conditions set forth herein. Rather, the terms and conditions of each contract are a matter for negotiation by the contracting parties.

SECTION 1

DEFINITIONS

See MBMA "Metal Building Systems Manual" for more complete nomenclature and definitions.

1. DEFINITION OF PARTIES REFERRED TO HEREIN

1.1 Manufacturer — A party who designs and fabricates metal building systems.

1.2 Dealer — A party who, as a routine part of his business, buys metal building systems from a MANUFACTURER for the purpose of resale.

1.3 Erector — A party who assembles and erects a metal building system.

1.4 Seller — A party who sells a metal building system and/or its erection or other field work.

1.5 Buyer — A party, including an Owner, who purchases a metal building system with or without its erection or other field work, whether for resale or use. This term includes agents and duly designated representatives of a BUYER or Owner, such as an architect, engineer, contractor or public authority.

2. DEFINITION OF METAL BUILDING SYSTEM — A metal building system consists of a group of coordinated components, including structural framing members, exterior covering panels and fastening devices, which have been designed to work together compatibly and have been engineered so that they may be mass produced and be assembled in various combinations, or in a combination with various collateral materials, to provide a completely or partially enclosed structure that will meet specific design loads and appearance preferences.

2.1 Primary Members — The main load carrying members of a structural system, generally the columns, rafters or other main support structural members.

2.2 Secondary Members — Members which carry loads to main or the primary members. In metal buildings, this term includes purlins, girts, struts, base angles, flange and knee braces, headers, jambs, sag members and other miscellaneous framing.

3. DEFINITION OF SALE OF A METAL BUILDING SYSTEM — The sale of a metal building system includes its design, fabrication and loading for shipment at the MANUFACTURER'S plant in accordance with the contract or contract specifications.

3.1 Material Included — A metal building system includes *only* the following parts, components and accessories:

The structural framing composed of the primary and secondary structural members of the metal building system.

Nuts, bolts and washers for steel to steel connections of the structural framing of the metal building system.

Exterior metal roof and wall covering of the metal building system and the trim and fasteners necessary for their installation.

Only those exterior personnel doors, windows, plastic panels and ventilators that are to be installed in the exterior metal walls and roof of the metal building, including the hardware, framing, trim and fasteners necessary for their installation.

Glass for foregoing accessories that are to be factory glazed.

Sealants and closures, according to the MANUFACTURER'S standards for such items as necessary for installation of the foregoing metal building system materials and accessories.

3.2 Material Not Included — Any components, collateral materials accessories or equipment not included in the preceding Paragraph 3.1 are not a part of the metal building system. Due to the large variety of collateral materials, accessories and equipment used in conjunction with the construction of metal building systems, the following is not to be construed as a complete list of components, collateral materials, accessories and equipment which are not included as a part of a metal building system:

Reinforcing steel or concrete materials.

Anchor bolts, anchor bolt templates, leveling plates, column base tie rods or any materials to be set in concrete.

Setting or supervision of setting anchor bolts.

Interior downspouts or their drains for valley or parapet gutters or otherwise, either under floor or otherwise.

Grouting or filling of any kind under columns or door jambs or in a recess at the base of wall covering panels.

Gutters, their downspouts, or drains.

Opening, flashing framing or other materials which are required by other trades, or which are required for the assembly or installation of accessories, materials, or equipment supplied by other trades, even though such accessories, materials or equipment are to be fastened to the metal building system.

Flashing or counterflashing material for tie-in to other structures.

Glass for windows, doors or other openings, except for those windows and doors furnished glazed.

Insulation material or insulation accessories.

Interior framing and finishing material, including partition material.

Traveling cranes, crane runway beams, crane rails, monorails, hoists or the means for their attachment to the metal building system.

Electrical apparatus, equipment or wiring.

Mechanical equipment, including exhaust fans.

Masonry materials.

Misce us iron or steel including, but not limited to stairs, ladders, railings, platforms, conveyor supports, lintels, edge angles, hangers and castings.

Field painting.

Overhead doors and track assemblies.

SECTION II

DESIGN AND PLANS

1. **BASIC DESIGN CRITERIA** — Metal Building System Design is based upon the following design criteria:

Metal Building Manufacturers Association
"Recommended Design Practices Manual"
"Recommended Guide Specifications for Metal Building Systems"

American Institute of Steel Construction
Only those sections of "Specification for the Design, Fabrication, and Erection of Structural Steel for Buildings" relating to design requirements or allowable stresses

American Iron and Steel Institute
Only those sections of the "Specification for the Design of Cold-Formed Steel Structural Members" and "Design of Light Gage Steel Diaphragms" relating to design requirements and allowable stresses

American Welding Society
Only those sections of the "Standard Code for Arc & Gas Welding in Building Construction" relating to welding procedures

1.1 **Design Calculations and Certification** — When required by the terms of the contract, the MANUFACTURER furnishes design calculations or a letter of design certification signed and sealed by a registered professional engineer for the structural framing and covering panels of the metal building systems. Such design calculations may be manual or by electronic computer at the discretion of the MANUFACTURER.

2. **PLANS** — Two copies of applicable erection drawings for the Metal Building System are furnished by the MANUFACTURER to the BUYER. Such drawings and erection instructions identify all individual parts of the metal building system in sufficient detail to permit proper erection and installation of said parts furnished by the MANUFACTURER These drawings will be sealed by a registered professional engineer. The cost of additional prints is paid by the BUYER.

When erection of the metal building system is not performed by the SELLER, erection drawings and instructions prepared by the MANUFACTURER are furnished by the SELLER to the ERECTOR

2.1 **Approval Plans** — When required by the contract specifications, approval plans composed of roof framing plans, elevations, and sections through the building are furnished by the MANUFACTURER for approval of the

BUYER. In order for the MANUFACTURER to proceed with the preparation of detailed shop drawings and the manufacture of the metal building system, the BUYER returns one set of approval drawings to the MANUFACTURER (within five (5) days unless otherwise provided) with a notation of the BUYER'S outright approval or approval subject to changes or corrections as noted on the plans. Approval as noted by the BUYER affirms that the MANUFACTURER has correctly interpreted the overall contract requirements for the metal building system and its accessories, and the exact location of accessories in the building.

2.2 Anchor Bolt Plan — A plan view showing the size, location and projection of all anchor bolts for the metal building systems components, the length and width of the foundation (which may vary from the nominal metal building size). Column reactions (magnitude and direction), and minimum base plate dimensions may also be included.

2.3 Drawings Not Provided — Detailed shop drawings of individual parts of the metal building system are not furnished by MANUFACTURER or SELLER.

2.4 **Changes, Extras or Discrepancies in Plans or Contract Provisions** — If the BUYER desires to make changes or add extras in previously approved plans or in the contract or the contract specifications, requests for such changes or extras are made to the SELLER in writing. If such changes or extras result in added or reduced costs of design, drafting, drawing reproduction, materials, fabrication, erection or field labor, or shipping, or in added construction time, the contract consideration and construction time are changed as agreed between the SELLER and the BUYER prior to the SELLER proceeding with such changes or extras.

In case of discrepancies between the plans and specifications for a metal building system, the specifications govern. In case of discrepancies between the scaled dimensions of the plans and the numerical dimensions shown on the plans, the numerical dimensions govern.

3. BUILDING CODE COMPLIANCE — Due to the wide variation in building and zoning codes and their interpretations, which are encountered in construction of metal buildings, the MANUFACTURER does not warrant the metal building, erection, collateral materials or equipment, or other field work to comply with any building or zoning code requirements, permit requirement, design procedure, design load, material or equipment requirement, fabrication procedure, or work procedure except those expressly provided herein or in the contract or contract specifications.

Additional costs of any additions, deletions, modifications or changes that may be required to comply with any building or zoning code requirement, permit requirement, design procedure, design load, material or equipment requirement, fabrication procedure, or work procedure which are not expressly provided herein or in the contract or contract specifications are paid by the BUYER. When the size, shape, general characteristics, or design of a metal building are specified by the BUYER, the SELLER is not responsibile for the suitability, adequacy, or legality of the metal building or its design.

4. LIABILITY FOR FOUNDATION DESIGN — The MANUFACTURER does not design and is not responsible for the design, materials or work-

mans the foundation. The SELLER, unless otherwise provided for in the .ract, is not responsible for the design, materials and workmanship of the foundation. The BUYER assures himself that adequate provisions are made in the foundation design for the loads imposed by the metal building (see anchor bolt plan for magnitude and direction of column reactions), other imposed loads, and the soil, bearing capacity and other conditions of the building site.

5. **LIABILITY FOR DESIGN OF VENTILATION SYSTEM** — As ventilation requirements vary, depending on the location and end-use of the building, the MANUFACTURER does not design a ventilation system unless required to do so by the contract and is not responsible for the adequacy of ordered components. The BUYER assures himself that adequate provisions are made for ventilation.

6. **ACCESSORIES** — The design of the framed openings as specified by the contract are the responsibility of the MANUFACTURER. Design of the accessories to fill these openings is the responsibility of the accessory supplier. The BUYER assures himself that adequate provisions are made in the accessory designs for the loads to be imposed.

SECTION III

FABRICATION

1. **FABRICATION** — Metal building system structural framing is fabricated in accordance with the manufacturer's specifications for fabrication.

2. **MATERIALS AND MATERIAL TESTS** — The materials used in the fabrication of metal building systems are new and at least equal to the physical requirements of the material specifications set forth in the MBMA "Recommended Guide Specifications for Metal Building Systems."

2.1 **Material Tests** — The MANUFACTURER orders or tests material for stock to meet the design criteria for strength, grade, and quality of each specific part of a metal building system, and each part is fabricated from the stock material specifically ordered for that part. The MANUFACTURER checks and retains test reports covering current inventory materials ordered for stock, but because it is impractical to do so and because many parts are prefabricated in mass production, records are not maintained such that individual parts can be identified against individual test reports. If requested, the MANUFACTURER furnishes test reports of current inventory materials. These practices of ordering, testing, stocking and fabricating make it unnecessary and impractical for the MANUFACTURER to furnish test reports on the specific materials used in the manufacture of a specific metal building system. Any additional tests of material requested by the BUYER are paid for by the Buyer.

3. **SHOP PAINTING:**

3.1 **Structural Framing Shop Primer** — All structural framing of the metal building systems, not protected by a corrosion resistant coating, is painted one coat of shop primer by the MANUFACTURER. All surfaces

to receive shop primer are cleaned of loose rust, mill scale and other foreign material by the MANUFACTURER prior to painting. The MANUFACTURER is not required to sandblast, flame clean, or pickle the steel framing. The coat of shop primer is intended to protect the steel framing for only a short period of exposure to ordinary atmospheric conditions. The coat of shop primer does not provide the uniformity of appearance or the durability of a finish coat of paint. The SELLER is not responsible for deterioration of the shop coat of primer that may result from exposure to atmospheric conditions.

3.2 Factory Painted and Film Laminated Covering and Trim — Factory painted and film laminated covering and trim material is at least equal to that set forth in the MBMA "Recommended Guide Specifications for Metal Building Systems."

4. PIECE MARKING AND IDENTIFICATION — All parts and bundles of identical parts are clearly marked for identification. Bolts and fasteners are packaged according to type, size, and length. Loose nuts and washers are packaged according to size. The shipping documents include shippers or a master packing list which show the quantity, description and piece mark of the various parts.

5. INSPECTION — Material and parts are inspected by the MANUFACTURER during fabrication. Any additional inspections desired by the BUYER are expressly provided for in the contract or contract specifications and are performed in the MANUFACTURER'S plant, the cost of which is paid by the BUYER.

SECTION IV

DELIVERY

If the contract provides for erection of the metal building systems by the Manufacturer, this section is not applicable.

In a contract covering the sale of metal building system erection only, the responsibilities of the Buyer in this section are the responsibilities of the Erector.

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1. DELIVERY OF MATERIALS — The MANUFACTURER delivers the metal building system materials in the order or sequence that is most convenient and economical for the MANUFACTURER, unless the contract or contract specifications provide a specific order or sequence of delivery. The MANUFACTURER is not responsible for material damaged in unloading or for packaged or nested materials including, but not limited to, fasteners, sheet metal, "C" and "Z" sections, and covering panels that become wet and are damaged by the water while in the possession of others. Packaged or nested materials that become wet in transit will be unpacked, unstacked and dried by the BUYER.

1.1 Delivery by Truck — If delivery is by truck, delivery shall be made to the nearest accessible point to the job site, and BUYER will be prepared with adequate workmen and equipment to promptly unload materials upon arrival.

1.2 **Dunnage and Cribbing** — Ownership of dunnage and cribbing material shall with the MANUFACTURER on shipment made on a MANUFACTURER'S truck and/or the buyer will be charged for such dunnage and cribbing material as an extra cost.

2. SHORT OR DAMAGED MATERIALS

2.1 **Short Materials** — Material quantities are verified by BUYER against quantities billed on shipping documents upon receipt of material by the BUYER. Neither the MANUFACTURER nor the carrier is responsible for material shortages against quantities billed on shipping documents when such shortages are not noted on shipping documents upon delivery of materials and are not acknowledged by the carrier's agent. If the carrier is the MANUFACTURER, claim for shortages is made by the BUYER to the MANUFACTURER. If the carrier is a common carrier, claims for shortages is made by the BUYER to the common carrier. If the material quantities received are correct according to the quantities billed on the shipping documents, but are less than the quantities ordered or that are necessary to complete the metal building according to the contract, claim is made to the SELLER.

2.2 **Damaged Material** — Damaged material, regardless of the degree of damage, is noted on the shipping documents by the BUYER and acknowledged by the carrier's agent. If the carrier is the SELLER, claim for damage is made by the BUYER to the SELLER. If the carrier is a common carrier, claim for damage is made by the BUYER to the common carrier. The SELLER is not liable for any claim resulting from the BUYER'S use of damaged material in the metal building system.

SECTION V

ERECTION AND OTHER FIELD WORK

Except when expressly provided for in the contract, the sale of a metal building system does not include erection of the metal building system, inspection, or any other field work or field supervision whatever.

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1. METAL BUILDING SYSTEM ERECTION AND OTHER FIELD WORK

— The ERECTOR is responsible for accurate, good quality workmanship in erection and for careful study of and adherence to the plans and erection instructions furnished by the MANUFACTURER. The finished quality of a metal building system is highly dependent upon the accuracy and quality of workmanship of erection of the building.

When erection of the metal building system is provided for in the contract, *only* those materials and the erection work listed in the following Paragraph 1.1 is included in the metal building system erection.

1.1 **Included Erection Work** — The ERECTOR furnishes all field labor, tools, and equipment necessary to unload from trucks at the building site and to completely erect the metal building system material as defined in Paragraph 3.1 of SECTION I. Some standard and non-standard components and accessories of a metal building system including, but not

limited to, field located openings, special framing, covering panels, flashing, trim, etc., require minor field fabrication, cutting and fitting which is included in erection work.

Furnish glass and glazing for the metal building system accessories that are not factory glazed.

Furnishes the compressed air and electric power required for metal building system erection if commercial power is not available at the job site. Commercial power, if available, is furnished by the BUYER.

Removes from the building and the building site ERECTOR'S temporary buildings, all rubbish resulting from erection work, all unused screws, bolts, and drill shavings.

1.2 Work Not Included in Erection — Any work not included in the preceding Paragraph 1.1 is not a part of metal building system erection. Due to the widely varied types of work encountered in conjunction with the construction of metal building systems, the following is not to be construed as a complete list of the types of work not included in the erection of the metal building system.

Site work.

Foundation or concrete work.

Setting of anchor bolts, leveling plates, column base tie rods or any item to be set or imbedded in concrete.

Grouting or filling of any kind under columns or door jambs or in the recess at the base of wall panels.

Field painting or field touch-up of the structural framing shop coat or the erection bolts, except the touch-up of field cuts and welds of the framing.

Interior finishing or carpentery work of any kind.

Flashing, cutting, drilling or otherwise altering the metal building, as required, for the assembly or installation of accessories, materials, or equipment supplied by other trades.

Glass cleaning.

Electrical, mechanical, masonry or fireproofing work.

2. SITE SURVEY — If the contract provides for metal building system erection or other field work, the BUYER, upon execution of the contract, furnishes a current correct survey of the site, certified by a registered surveyor, and showing property lines and encroachments, bench marks, adjacent tracts, recorded or visible easements, easements known to the suveyor, and access or access restriction to adjacent streets. In addition, BUYER causes property lines to be accurately identified and staked on the job site.

3. CONCRETE SLAB OR FOUNDATION — Whoever has responsibility for the construction of the concrete slab or foundation shall be liable for all additional costs resulting from foundation errors.

ERECTOR is not liable for any damage to concrete slabs, foundations or ramps not caused solely by ERECTOR'S negligence.

4. INTE. ..TIONS, DELAYS, OR OVERTIME WAGES — The erection price is computed on the basis of a normal forty-hour (five eight-hour days) work week (excluding Saturdays, Sundays, and holidays). Any additional cost incurred through interruptions, delays, or overtime wages caused by the BUYER or BUYER'S contractors, is paid by the BUYER. Interruptions include call backs to complete portions of the erection or field work that are postponed at BUYER'S request.

5. HAZARDOUS JOB SITE CONDITIONS — If hazardous job site conditions prohibit the use of exposed arcs, standard electric motors or normal erection tools and equipment, the BUYER pays any additional costs resulting from such prohibition.

6. ACCESSIBILITY OF JOB SITE AND BUILDING FLOOR AREA — The contract consideration for erection is based upon the BUYER furnishing the job site clean, level, fully accessible to trucks for delivery of materials and to erection equipment, and compacted sufficiently hard to support and permit ready movement of such trucks and equipment. In addition, BUYER furnishes the metal building system floor area, together with an area outside the metal building system at least twenty feet (20') wide on all sides of the metal building system, free of any existing structure not being tied-in to by the metal building system, property lines, fences, overhead obstructions, pits, machinery, ditches, pipe lines, electric power lines, unsafe or hazardous conditions or other obstacles and fully accessible to SELLER'S employees, trucks and erection equipment to deliver, store and lay out materials and to erect the building system. The BUYER pays to the SELLER any additional costs incurred by the SELLER resulting from the BUYER'S failure to furnish the foregoing.

7. ERECTION TOLERANCES — Erection tolerances are those set forth in AISC Code of Standard Practice except individual members are considered plumb, level and aligned if the error does not exceed 1:300. Since closer tolerances do not measurably increase a low-rise metal building's functional value, closer tolerances are not economically justified.

8. TEMPORARY GUYS, BRACING AND FALSEWORK — The ERECTOR, during erection, furnishes and installs temporary guys and bracing where needed for squaring, plumbing, and securing the structural framing against loads such as wind acting on the exposed framing and seismic forces comparable in intensity to those for which the completed structure is designed, as well as loads due to erection equipment and erection operations, but not including loads resulting from the performance work by others.

The temporary guys, braces, falsework and cribbing are not the property of the BUYER, and the ERECTOR removes them immediately upon completion of erection. If arrangement is made to leave such temporary materials in place, the BUYER removes and ships them prepaid, in good condition, to the ERECTOR.

9. METHOD OR SEQUENCE OF ERECTION — If the BUYER wishes to control the method or sequence of erection, the contract or contract specifications will so state. Otherwise, the ERECTOR will erect the metal building system according to the method and sequence most economical to the ERECTOR.

10. CORRECTION OF ERRORS — Minor amounts of material and the correction of minor misfits by the moderate use of drift pins, and a moderate amount of reaming, chipping, or cutting are a part of erection.

The BUYER or ERECTOR makes a verbal or written "Initial Claim" for the correction of design or fabrication errors to the MANUFACTURER. This "Initial Claim" shall include:

Description of the nature and extent of the error.

Description of nature and extent of proposed corrective work.

Maximum cost of proposed corrective work.

If the proposed corrective work is the fault of the MANUFACTURER and the maximum cost thereof is accepted by the MANUFACTURER, or if alternate corrective work is directed by the MANUFACTURER, the BUYER or ERECTOR will be authorized in writing by the MANUFACTURER to perform the proposed or alternate corrective work at a cost to the MANUFACTURER not to exceed an authorized maximum cost.

A "Final Claim" will be forwarded by the BUYER or ERECTOR within ten (10) days of completion of the authorized corrective work.

A "Final Claim" shall include only:

Actual man-hours direct labor used on corrective work, including hourly rates of pay.

Tax, insurance and other direct costs on direct labor.

Cost of material authorized by the MANUFACTURER to be purchased from others.

Total actual direct cost of corrective work.

This "Final Claim" shall be certified to be true and correct and signed by the BUYER and the ERECTOR. Such "Final Claims" will be paid to BUYER or ERECTOR by the MANUFACTURER in an amount not to exceed the lesser of the maximum cost first authorized in writing by the MANUFACTURER or the total actual cost of corrective work, including direct labor, taxes and insurance and other direct costs on direct labor, and material authorized by the MANUFACTURER to be purchased from others, specifically excluding cost of equipment, small tools, supervision, overhead and profit of the BUYER and ERECTOR.

The SELLER or MANUFACTURER does not pay such claims unless the foregoing claim and authorization procedure is strictly complied with by the BUYER or ERECTOR, or if corrective work is started prior to receipt by BUYER or ERECTOR of MANUFACTURER'S written authority to perform the corrective work. The SELLER or the MANUFACTURER shall not be liable for any claim resulting from use in the metal building system of any improper material or material containing defects which can be detected by visual inspection.

SECTION VI

GENERAL

1. PERMITS, ASSESSMENTS, PRO RATA AND OTHER FEES — The BUYER obtains and/or pays for all building permits, licenses, public assessments, paving or utility pro rata, utility connections, occupancy fees and other fees required by any governmental authority or utility in con-

nection ... the work provided for in the contract. The BUYER provides at his expense all plans and specifications required to obtain a building permit except those plans to be furnished by the MANUFACTURER in accordance with Section II, Paragraph 2. It is the BUYER'S responsibility that all plans and specifications comply with the applicable requirements of any governing building authorities.

2. **POSTPONEMENT OF SHIPMENT** — The contract consideration does not include provision for the cost of storage of the SELLER'S products beyond the originally scheduled shipping date. If the BUYER requests postponement of shipment of the SELLER'S products beyond the originally scheduled shipping date, the consideration for said products becomes due and payable in full, and the BUYER pays any additional storage, handling, repainting, erection or other additional costs resulting from the requested postponement.

3. **CANCELLATION BY MUTUAL AGREEMENT OR GOVERNMENTAL RESTRICTION** — If the contract is cancelled for whatever cause, and by mutual agreement of the parties thereto, BUYER agrees to pay SELLER all SELLER costs which were incurred prior to cancellation. Such costs include costs of performing and preparing to perform the contract obligations. The SELLER, at his option, may be relieved of any or all obligation if SELLER is unable to perform by reason of any court order or governmental restrictions including, but not limited to, any requirement for obtaining prior approval, permit or licenses from any governmental agency, or control or seizure of materials.

4. **COMPLETION AND ACCEPTANCE** — Upon notice by the SELLER to the BUYER of substantial completion of the work provided in the contract, the BUYER assures himself by whatever means he may elect that the work provided in the contract is satisfactorily completed and delivers to the SELLER a signed completion certificate noted as to any items in need of correction or completion. Failure of the BUYER to deliver such noted completion certificate within ten (10) days after SELLER'S notice of substantial completion conclusively constitutes acceptance of the work as satisfactorily completed and waiver by the BUYER. In addition, partial or complete occupancy of the building by the BUYER or by others with permission of the BUYER conclusively constitutes acceptance of the work as satisfactorily completed and waiver by the BUYER.