APPENDIX A: ENERGY MODELS

R-40 Model – R-40 with approx ¼ of structure below grade.

Modeling Parameters	
Reference City:	Newtok, AK
Occupants:	5, 50, 100, 300
Heated Floor Area (sqft):	7,410 (10,470 w/ mechanical & garage)
Wind Shielding:	Shielded
Floor, Insulation:	R-40 EPS (white/bead-board; R-Tech)
Main Wall Type:	2" x 6" Single Stud (24" O.C)
Main Wall Cavity:	None
Main Wall, Headers:	Insulated
Main Wall, Siding & Sheathing:	Present
Main Wall, Insul Sheathing:	R-40 EPS (white/bead-board; R-Tech)
Ceiling (Floors 0):	11.5' (average)
Ceiling (Floors 1):	13.968' (average)
Ceiling (sqft)	7,678
Ceiling, Framing Type:	Energy Truss (24" O.C.)
Ceiling, Insulation:	R-40 EPS (white/bead-board; R-Tech)
Exterior Doors:	7x (Metal - Urethane, therm. break)
Garage Doors:	3x (Thermacore 190 – Overhead Door, Insulating blanket)
Windows, South Facing (sqft):	181.82
Windows, Not South Facing (sqft):	126.12
Glass Type:	Triple, 2 Low-E Coatings (Insulated Fiberglass/Vinyl)
Certified U-Value:	0.15
Air Changes per hour (50 Pa):	0.6 (1,300 CFM @ 50 Pascals)
Conditioned Space (cu ft):	130,580.56
Average Ceiling Height to Ground or Exposed Floor:	13.968'
Ventilation:	Heat Recovery Ventilation
Heating Thermostat Setpoint (^{o}F):	70
Primary Heating System:	Direct to Space heater w/ sealed combustion (AFUE 92%, #2 FO)
Heat Distribution:	0% Unconditioned, 0% Semi-Conditioned
Night Setback Thermostat:	Controls all the building
Hot Water Heater:	Oil: On Demand (EF = .76; #2 FO; Insulated WH blanket)
Location of Water Heater:	Conditioned Space
Dryer:	Electric
Range:	Electric
Miscellaneous Electric Use:	(5 = Low, 50, 100, 300 = Average)

Notes

1. EPS substituted in AkWarm model for spray foam due to lack of spray foam option in AkWarm.
2. Main Wall Type listed as 2x6 single stud (24" O.C.) because AkWarm does not have an option for 6x6 (8' O.C.).
3. Exterior Doors listed as "good" doors. "Metal –Urethane, therm. Break" chosen to represent this.
4. Garage Doors listed as "good" doors. "Thermacore 190 – Overhead Door, w/ insulating blanket" chosen to represent this.
5. Certified U-Value for windows taken from http://cpd.nfrc.org/search/searchdefault.aspx. Specifically for Capitol Glass, Argon-filled, triple pane, 2 Low-E Fixed windows.
6. For Primary heating system, "direct to space heater w/ sealed combustion" is a number of zoned monitor or toyostove-type units.

Preliminary estimates for whole structure:

BTU/hr/deg-F		Heating Load	
Living Space UA	Garage UA	BTU/hr Design Load	BTU/hr System Size*
653.0	118.8	83,156	117,397
* AkWarm calculation based on 85% AFUE and 20% safety margin.			

Preliminary estimates of fuel requirements:

R-40 Actual			
Occupants	Gallons #2 FO Space Heating	Gallons[1] #2 FO Water Heating	Estimates[2] Gallons #2 FO (for 1 month)
5	1,428	254	142
50	878	2,459	279
100	537	4,908	454
300	89	14,707	1,233
[1] Based on AkWarm internal calculation that uses 20 gallons H^2O/person/day.			
[2] Based on proportional weighting for October DD for Newtok, AK)			

Pilings Model – R-40 on exposed pilings.

Modeling Parameters	
Reference City:	Newtok, AK
Occupants:	5, 50, 100, 300
Heated Floor Area (sqft):	7,410 (10,470 w/ mechanical & garage)
Wind Shielding:	Exposed
Floor, Insulation:	R-40 EPS (white/bead-board; R-Tech)
Main Wall Type:	2" x 6" Single Stud (24" O.C)
Main Wall Cavity:	None
Main Wall, Headers:	Insulated
Main Wall, Siding & Sheathing:	Present
Main Wall, Insul Sheathing:	R-40 EPS (white/bead-board; R-Tech)
Ceiling (Floors 1):	11.5' (average)
Ceiling (Floors 2):	13.968' (average)
Ceiling (sqft)	7,678
Ceiling, Framing Type:	Energy Truss (24" O.C.)
Ceiling, Insulation:	R-40 EPS (white/bead-board; R-Tech)
Exterior Doors:	7x (Metal - Urethane, therm. break)
Garage Doors:	3x (Thermacore 190 –Overhead Door, Insulating blanket)
Windows, South Facing (sqft):	181.82
Windows, Not South Facing (sqft):	126.12
Glass Type:	Triple, 2 Low-E Coatings (Insulated Fiberglass/Vinyl)
Certified U-Value:	0.15
Air Changes per hour (50 Pa):	1.00 (2,175 CFM @ 50 Pascals)
Conditioned Space (cu ft):	130,580.56
Average Ceiling Height to Ground or Exposed Floor:	19.0'
Ventilation:	Heat Recovery Ventilation
Heating Thermostat Setpoint (^oF):	70
Primary Heating System:	Direct to Space heater w/ sealed combustion (AFUE 92%, #2 FO)
Heat Distribution:	0% Unconditioned, 0% Semi-Conditioned
Night Setback Thermostat:	Controls all the building
Hot Water Heater:	Oil: On Demand (EF = .76; #2 FO; Insulated WH blanket)
Location of Water Heater:	Conditioned Space
Dryer:	Electric
Range:	Electric
Miscellaneous Electric Use:	(5 = Low, 50, 100, 300 = Average)

Notes

1. EPS substituted in AkWarm model for spray foam due to lack of spray foam option in AkWarm.
2. Main Wall Type listed as 2x6 single stud (24" O.C.) because AkWarm does not have an option for 6x6 (8' O.C.).
3. Exterior Doors listed as "good" doors. "Metal –Urethane, therm. Break" chosen to represent this.
4. Garage Doors listed as "good" doors. "Thermacore 190 – Overhead Door, w/ insulating blanket" chosen to represent this.
5. Certified U-Value for windows taken from http://cpd.nfrc.org/search/searchdefault.aspx. Specifically for Capitol Glass, Argon-filled, triple pane, 2 Low-E Fixed windows.
6. For Primary heating system, "direct to space heater w/ sealed combustion" is a number of zoned monitor or toyostove-type units.

Preliminary estimates for whole structure:

BTU/hr/deg-F		Heating Load	
Living Space UA	Garage UA	BTU/hr Design Load	BTU/hr System Size*
762.3	202.4	103,937	146,734
* AkWarm calculation based on 85% AFUE and 20% safety margin.			

Preliminary estimates of fuel requirements:

R-40 On Pilings			
Occupants	Gallons #2 FO Space Heating	Gallons[1] #2 FO Water Heating	Estimates[2] Gallons #2 FO (for 1 month)
5	1,835	254	176
50	1,249	2,459	310
100	861	4,908	482
300	194	14,707	1,242
[1] Based on AkWarm internal calculation that uses 20 gallons H^2O/person/day.			
[2] Based on proportional weighting for October DD for Newtok, AK)			

More Insulation Model – R-60 with approx ¼ of structure below grade.

Modeling Parameters	
Reference City:	Newtok, AK
Occupants:	5, 50, 100, 300
Heated Floor Area (sqft):	7,410 (10,470 w/ mechanical & garage)
Wind Shielding:	Shielded
Floor, Insulation:	R-60 EPS (white/bead-board; R-Tech)
Main Wall Type:	2" x 6" Single Stud (24" O.C)
Main Wall Cavity:	None
Main Wall, Headers:	Insulated
Main Wall, Siding & Sheathing:	Present
Main Wall, Insul Sheathing:	R-60 EPS (white/bead-board; R-Tech)
Ceiling (Floors 0):	11.5' (average)
Ceiling (Floors 1):	13.968' (average)
Ceiling (sqft)	7,678
Ceiling, Framing Type:	Energy Truss (24" O.C.)
Ceiling, Insulation:	R-60 EPS (white/bead-board; R-Tech)
Exterior Doors:	7x (Metal - Urethane, therm. break)
Garage Doors:	3x (Thermacore 190 – Overhead Door, Insulating blanket)
Windows, South Facing (sqft):	181.82
Windows, Not South Facing (sqft):	126.12
Glass Type:	Triple, 2 Low-E Coatings (Insulated Fiberglass/Vinyl)
Certified U-Value:	0.15
Air Changes per hour (50 Pa):	0.6 (1,300 CFM @ 50 Pascals)
Conditioned Space (cu ft):	130,580.56
Average Ceiling Height to Ground or Exposed Floor:	13.968'
Ventilation:	Heat Recovery Ventilation
Heating Thermostat Setpoint (^{o}F):	70
Primary Heating System:	Direct to Space heater w/ sealed combustion (AFUE 92%, #2 FO)
Heat Distribution:	0% Unconditioned, 0% Semi-Conditioned
Night Setback Thermostat:	Controls all the building
Hot Water Heater:	Oil: On Demand (EF = .76; #2 FO; Insulated WH blanket)
Location of Water Heater:	Conditioned Space
Dryer:	Electric
Range:	Electric
Miscellaneous Electric Use:	(5 = Low, 50, 100, 300 = Average)

Notes

1. EPS substituted in AkWarm model for spray foam due to lack of spray foam option in AkWarm.
2. Main Wall Type listed as 2x6 single stud (24" O.C.) because AkWarm does not have an option for 6x6 (8' O.C.).
3. Exterior Doors listed as "good" doors. "Metal –Urethane, therm. Break" chosen to represent this.
4. Garage Doors listed as "good" doors. "Thermacore 190 – Overhead Door, w/ insulating blanket" chosen to represent this.
5. Certified U-Value for windows taken from http://cpd.nfrc.org/search/searchdefault.aspx. Specifically for Capitol Glass, Argon-filled, triple pane, 2 Low-E Fixed windows.
6. For Primary heating system, "direct to space heater w/ sealed combustion" is a number of zoned monitor or toyostove-type units.

Preliminary estimates for whole structure:

BTU/hr/deg-F		Heating Load	
Living Space UA	Garage UA	BTU/hr Design Load	BTU/hr System Size*
545.8	97.2	69,278	97,801
* AkWarm calculation based on 85% AFUE and 20% safety margin.			

Preliminary estimates of fuel requirements:

R-60 Actual			
Occupants	Gallons #2 FO Space Heating	Gallons[1] #2 FO Water Heating	Estimates[2] Gallons #2 FO (for 1 month)
5	1,113	254	115
50	612	2,459	257
100	334	4,908	437
300	41	14,707	1,229
[1] Based on AkWarm internal calculation that uses 20 gallons H^2O/person/day.			
[2] Based on proportional weighting for October DD for Newtok, AK)			

More Insulation Model – R-60 with approx ¼ of structure below grade.

Modeling Parameters	
Reference City:	Newtok, AK
Occupants:	0 (1 for modeling minimums)
Heated Floor Area (sqft):	3,060 (Mechanical & Garage)
Wind Shielding:	Shielded
Floor, Insulation:	R-60 EPS (white/bead-board; R-Tech)
Main Wall Type:	2" x 6" Single Stud (24” O.C)
Main Wall Cavity:	None
Main Wall, Headers:	Insulated
Main Wall, Siding & Sheathing:	Present
Main Wall, Insul Sheathing:	R-60 EPS (white/bead-board; R-Tech)
Ceiling (Floors 0):	11.5' (average)
Ceiling (sqft)	3,060
Ceiling, Framing Type:	Energy Truss (24” O.C.)
Ceiling, Insulation:	R-60 EPS (white/bead-board; R-Tech)
Exterior Doors:	1x (Metal - Urethane, therm. break)
Garage Doors:	3x (Thermacore 190 – Overhead door w/ insulating blanket)
Windows, South Facing (sqft):	0
Windows, Not South Facing (sqft):	0
Air Changes per hour (50 Pa):	0.6 (350 CFM @ 50 Pascals)
Conditioned Space (cu ft):	35,190
Average Ceiling Height to Ground or Exposed Floor:	4.2 (average); modeled at 7.0 (AkWarm minimum)
Ventilation:	Heat Recovery Ventilation
Heating Thermostat Setpoint (^{o}F):	40
Primary Heating System:	Direct to Space heater w/ sealed combustion (AFUE 92%, #2 FO)
Night Setback Thermostat:	Controls all the mechanical
Hot Water Heater:	None
Location of Water Heater:	N/A
Dryer:	None
Range:	None
Miscellaneous Electric Use:	Low

Notes
1. EPS substituted in AkWarm model for spray foam due to lack of spray foam option in AkWarm.
2. Main Wall Type listed as 2x6 single stud (24” O.C.) because AkWarm does not have an option for 6x6 (8’ O.C.).
3. Exterior Doors listed as “good” doors. “Metal –Urethane, therm. Break” chosen to represent this.
4. Garage Doors listed as “good” doors. “Thermacore 190 – Overhead door, w/ insulating blanket” chosen to represent this (effective R-16.3).

5. For Primary heating system, “direct to space heater w/ sealed combustion” is a number of zoned monitor or toyostove-type units.

Preliminary estimates for mechanical insulated section:

BTU/hr/deg-F	Heating Load	
Living Space UA	BTU/hr Design Load	BTU/hr System Size
198.8	21,418	30,238
* AkWarm calculation based on 85% AFUE and 20% safety margin.		

Preliminary estimates of fuel requirements:

R-60 Mechanical Only			
Occupants	Gallons #2 FO Space Heating	Gallons[1] #2 FO Water Heating	Estimates[2] Gallons #2 FO (for 1 month)
1	112	58	14
[1] Based on AkWarm internal calculation that uses 20 gallons/person/day.			
[2] Based on proportional weighting for October DD for Newtok, AK)			

APPENDIX B: SPECIFICATIONS

FIRE Retardants Inc.™
The Decision You Make May Save A Life!
123 Columbia Court North • Suite 201 • Chaska, MN 55318
952-448-7377 • FAX:952-448-2613
Fire Retardant "HOT LINE" 1-800-913-9385
e-mail: info@fireretardantsinc.com
Visit Our Web Site at www.fireretardantsinc.com

BURN BARRIER™ 6-3 HALOGEN-FREE CLASS A CLEAR WATER BASE FIRE RETARDANT

BURN BARRIER™ 6-3 is a clear and colorless surface impregnation for application on interior surfaces of unpainted wood and plywood to reduce flame spread and smoke when exposed to fire. BURN BARRIER™ 6-3 does not contain Halogen or Sulphur compounds (Chlorine less than 0.005% by weight; Sulphur less than 0.020% by weight).

Surface impregnation by spraying allows BURN BARRIER™ 6-3 to penetrate into the surface of the wood. Application shall be with convention allow pressure, airless, or orchard type sprayer. Spray uniformly over the entire surface using a coarse nozzle. Cover all metal surfaces before spraying. Apply two coats of BURN BARRIER™ 6-3, each coat at 200 square feet per gallon. Allow at least 24 hours drying time between coats. Proper drying conditions of temperature and humidity are necessary. Treated surfaces may be left unfinished, stained, painted or coated with varnish or lacquer. If any residue appears on the surface, sand and wipe clean before applying finish coat. Equipment should be cleaned with water. Before finish system is applied, moisture content of flame retarded wood must not exceed 12% and must be stabilized at least four days.

Recommendations for coatings to be applied over BURN BARRIER™ 6-3 are: Cabot, Cuprinol, and Olympic Stains; Varnishes - One coat Fuller's penetrating wood-finish followed with two coats Fuller's all-clear varnish, Gloss, Semi-gloss, or Flat. Pratt and Lambert's Varnish system may be used as follows; one coat of Pale 38 Trim Gloss followed with two coats of Pale 38 Trim Gloss, Semi-gloss or Flat.

If recommended coating system is not used, the user is responsible to see that an appropriate test is made of the proposed finish system by an independent testing laboratory.

The ASTM E84-80 Fire Hazard Classification for BURN BARRIER™ 6-3 is as follows; Flame Spread – 25, Smoke Density – 5

BURN BARRIER™ 6-3 HALOGEN-FREE CLASS A CLEAR WATER BASE FIRE RETARDANT

BURN BARRIER™ 6-3 is a clear, colorless fire retardant coating. The coating is impregnated into bare, uncoated wood by spraying. Two spray coats are required, each coat at 200 sq. ft. per gallon with at least 24 hours drying in between coats. Good drying condition is a must during spraying. Application by spraying shall be with either conventional low pressure, airless, or orchard type paint spray equipment. Spray uniformly over the entire surface, using a coarse nozzle. Hold spray gun about two feet from material. Apply enough coating to make material thoroughly wet.. Spray equipment is rinsed with water after use. 6-3 treated wood may be stained or varnished. An Oil Base stain should be used and a varnish over it such as Fuller's All-clear, gloss. Stain and fill, as required.

One coat Dupont's Penetrating Wood Finish Two coats DuPont's Clear Gloss Varnish, Interior.

One coat Fuller's All-Clear Varnish, gloss Two coats Fuller's All-Clear Varnish, gloss, semi-gloss or flat.

First coat: Pratt and Lambert's Pale “38” Trim Gloss Second coat: Pratt and Lambert's Pale “38” Trim Gloss Third coat: Pratt and Lambert's Pale “38” Trim Gloss, Dull or flat.

First coat fibbed Second coat of varnish sanded as required Finish coat; no additional treatment.

EXTERIOR PIGMENTED WORK:

Weatherproof paint may be applied over wood treated with 6-3.

EXTERIOR CLEAR COATINGS:

Over wood treated with 6-3

Rezite XX
Cabot Shingle Stain #230
P A R

The clear exterior top coat has to be renewed after approximately 2 years in order to protect 6-3 from being leached out by exposure to rain.

LACQUER SYSTEMS suggested for use over 6-3 treated wood:

Stain and fill as required

First coat: Fuller's Synlac Penetrating Base Coat 7743
Second coat: Fuller's Synlac Sanding Sealer 7782
Third coat: Fuller's Synlac Sanding 7782
Fourth coat: Fuller's Synlac Clear Flat 7781 or 7700

Clear Gloss
(For thinning, use Fuller's Synlac Thinner)

Fire coat nibbed
Second and third coats of lacquer sanded as required
Finish coat: Polish as required

First coat: DuPont's Penetrating Primer No. 1362
Second coat: DuPont's Sanding Sealer No. 1999
Third coat: DuPont's Sanding Sealer No. 1999
Fourth coat: DuPont's Clear Gloss No. 1655, or
Clear Semigloss No. 1541 or Clear Flat No. 1672

(For thinning, use DuPont's No. 3661)

First coat fibbed
Second and third coats as required
Finish coats no additional treatment

FIRE HAZARD CLASSIFICATION OF APPLIED COATING:

Test Specimen	Flame Spread E 84-80	Fuel Contribution	Smoke Density
	25	25	5

Douglas Fir
Applied 2 coats each
at 200 sq. ft. per gallon

Note: Cover all metal surfaces before spraying.

Approved: City of Los Angeles

Information provided herein is based on tests believed to be reliable. Inasmuch as Fire Retardants Inc. has no control over the use or application to which others may put this material, we make no guarantee or warranty. Our products are sold on the condition that each user of the material make their own evaluation to determine the material's suitability for their own particular use.

NOTE: All porous surfaces should be properly sealed before applying fire retardant paint or varnish.

CAUTION: It is recommended that a test application be completed prior to end use.

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SOUTHWEST RESEARCH INSTITUTE
Department of Fire Technology
POST OFFICE DRAWER 28510, 6220 CULEBRA RD. SAN ANTONIO, TEXAS 78284

INVESTIGATION OF SURFACE BURNING CHARACTERISTICS OF:

A CLEAR, FIRE-RETARDANT COATING,
BURN BARRIER™ 6-3

PROJECT NO. 01-6263-339
FINAL REPORT

By C. A. HAFER, P.E.

JULY 31, 1981
CORRECTED AUGUST 10, 1981

Prepared for:

Rendered by Manufacturer and Released to:
Acoustical Surfaces, Inc.
123 Columbia Court North, Suite 102
Chaska, MN 55318

Carl A. Hafer

Carl A. Hafer, P.E.
Manager
Standard Testing Services

I. INTRODUCTION

This report presents the results of a flame spread tunnel test on a clear, fire-retardant coating, submitted for evaluation by manufacturer. The report contains a description of the material tested, the preparation and conditioning of the specimen, the test procedure, and finally, the test results. Note that the results only apply to the specimen tested, in the manner tested, and not to the entire production of this or similar materials, nor to this material's performance when used in combination with other materials. All test data are on file and are available for review by authorized persons.

The test was conducted in accordance with the provisions of ASTM Designation E84-80, "Standard Method of Test for Surface Burning Characteristics of Building Materials." This test method is similar to the test method specified in ANS No. 2.5, NFPA No. 255, UL No. 723, UBC No. 42-1, and ASTM E84-75; however, two improvements have been incorporated in the current E84-80 procedure, i.e., the stack pressure control tap has been relocated to a position forward of the burners and the formulae used to calculate the flame spread have been modified--resulting in slightly lower values.

The purpose of the test was to evaluate performance of the test specimen in relation to that of asbestos-cement board and red oak flooring under similar fire exposure. The results are expressed in terms of flame spread, fuel contribution, and smoke development during a 10-minute exposure and are recorded as a ratio with asbestos-cement board 0 and red oak flooring 100.

II. DESCRIPTION OF MATERIALS

On June 5, 1981, two gallons of clear BURN BARRIER™ Fire Retardant Solution No. 6-3 were received from the Sponsor. The coating had an average gross unit weight of 10 lb 3 oz per gallon.

III. PREPARATION AND CONDITIONING OF TEST SPECIMEN

The 21-in. x 25-ft (0.53 x 7.63-m) specimen was prepared using two 21 x 150-in. (0.53 x 3.81-m) decks prepared from 1 x 4-in. (25.4 x 101.6-mm) tongue and grooved select Douglas fir wood flooring. The decks were held together with 1 x 4-in. (25.4 x 101.6-mm) wood back straps located at 3 to 4-ft intervals. The clear, fire-retardant solution was applied by hand-sprayer in two coats at 200 sq ft/gal (4.91 ℓ/m^2) each on June 11 and 12, 1981.

The specimen was conditioned for 42 days in an atmosphere maintained between 68 and 78°F (20 and 26°C) temperature and 45- to 55-percent relative humidity.

IV. TEST PROCEDURE

The test was conducted on July 24, 1981. Reference data were obtained and furnace operation checked by conducting a 10-minute test with asbestos-cement board on the day of the test and by periodic tests with red oak flooring. These tests provided the 0 and 100 references for flame spread, fuel contribution, and smoke density. Ignition over the burners was noted 46 seconds after the start of the test in the most recent calibration with red oak flooring. Each specimen to be evaluated was tested in accordance with the standard procedure.

V. TEST RESULTS

The test results were calculated on the basis of observed flame travel and the measurement of areas under the recorder curves of furnace temperature and smoke density (see Classification Table). To allow for possible variations in results due to limitations of the test method, the numerical results were adjusted to the nearest figure divisible by 5.

Recorded data for flame spread, fuel contribution, and smoke density of the specimen are shown in the figures at the end of this report as a solid line on each graph.

CLASSIFICATION TABLE

Test Specimen	Flame Spread Index E84-80	Fuel Contribution	Smoke Density
Asbestos-Cement Board	0	0	0
Red Oak Flooring	100	100	100
BURN BARRIER™ No. 6-3 Fire Retardant, Clear Coating on Douglas Fir, 100 sq ft/gal (2.46 ℓ/m^2)	25	40	5
Uncoated Douglas Fir	60	60	90

VI. OBSERVATIONS DURING AND AFTER TEST

The observations made during and after the test are summarized as follows: Discoloration was observed at 20 seconds with ignition at 50 seconds. The flame front advanced to 12-1/2 ft (3.81 m) at 8 minutes 15 seconds and receded slightly at 9 minutes 30 seconds. Afterflame persisted for 10 minutes 26 seconds.

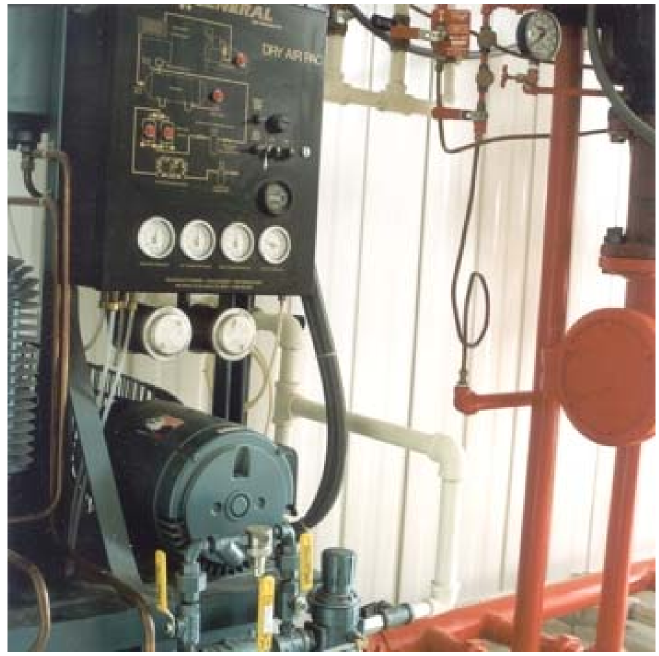
Char depth ranged from 5/32 in. (3.97 mm) at 3-1/2 ft (0.90 m) to 1/32 in. (0.79 mm) at 11 ft (3.36 m). Surface char had occurred to 14 ft (4.27 m) with stain to the end, 25 ft (7.63 m).

FIRE PROTECTION GROUP

APi Group, Inc.

Dry Pipe Fire Sprinkler System

A dry pipe sprinkler system is one in which pipes are filled with pressurized air or nitrogen, rather than water. This air holds a remote valve, known as a dry pipe valve, in a closed position. Located in a heated space, the dry-pipe valve prevents water from entering the pipe until a fire causes one or more sprinklers to operate. Once this happens, the air escapes and the dry pipe valve releases. Water then enters the pipe, flowing through open sprinklers onto the fire.



Compressor for Dry Pipe Sprinkler System

Advantages of using dry pipe fire sprinkler systems include:

• Dry pipe sprinkler systems provide automatic protection in spaces where freezing is possible. Typical dry pipe installations include unheated warehouses and attics, outside exposed loading docks and within commercial freezers.

Many people view dry pipe sprinklers as advantageous for protection of collections and other water sensitive areas. This perceived benefit is due to a fear that a physically damaged wet pipe system will leak while dry pipe systems will not. In these situations, however, dry pipe systems will generally not offer any advantage over wet pipe systems. Should impact damage happen, there will only be a mild discharge delay, i.e. 1 minute, while air in the piping is released before water flow.

Disadvantages of using dry pipe fire sprinkler systems include:

• Increased complexity - Dry pipe systems require additional control equipment and air pressure supply components which increases system complexity. Without proper maintenance this equipment may be less reliable than a comparable wet pipe system.
• Higher installation and maintenance costs - The added complexity impacts the overall dry-pipe installation cost. This complexity also increases maintenance expenditure, primarily due to added service labor costs.
• Lower design flexibility - There are strict requirements regarding the maximum permitted size (typically 750 gallons) of individual dry-pipe systems. These limitations may impact the ability of an owner to make system additions.
• Increased fire response time - Up to 60 seconds may pass from the time a sprinkler opens until water is discharged onto the fire. This will delay fire extinguishing actions, which may produce increased content damage.
• Increased corrosion potential - Following operation, dry-pipe sprinkler systems must be completely drained and dried. Otherwise remaining water may cause pipe corrosion and premature failure. This is not a problem with wet pipe systems where water is constantly maintained in piping.

With the exception of unheated building spaces and freezer rooms, dry pipe systems do not offer any significant advantages over wet pipe systems.

• Click Here for More Information on Fire Sprinkler Systems

Fire Protection Systems ● Fire Sprinkler Systems ● Pre-Action ● Wet Pipe System ● Dry Pipe System ● ESFR ● Fire Pump ● Deluge System ● Residential Fire Sprinklers ● Special Systems ● Fire Suppression ● FM-200® ● CO2 Fire Suppression ● FE-13 ● Argonite ● Water Mist ● Fire Detection ● Fire Alarm

Associated fire Protection

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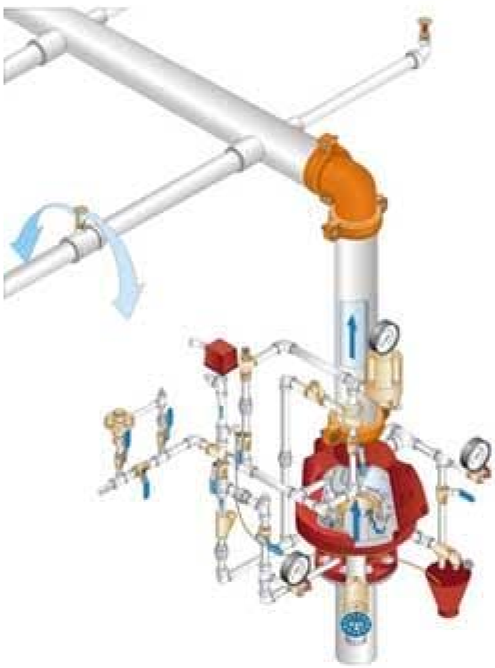
- **Dry Sprinkler System**

Dry Sprinkler System



In a dry-pipe system, sprinklers are attached to pipes that contain pressurized air. When heat activates the sprinklers to open, the air pressure is reduced, allowing the dry pipe valve to open and water to flow from the sprinkler.

Dry-pipe systems are usually used only when temperatures are not high enough to prevent freezing (Below 40 deg. F).

Since they have a slower response time, they should be converted to wet-pipe systems as soon as sufficient heat becomes available.

In situations where only a few sections lack heat, it is recommended to use a combination of dry and wet-pipe systems.

For additional information give us a call at 866-812-3473 or contact us via email.

CONSTRUCTION SPECIFICATION
HEATLOK SOY®
Spray-in-Place Semi Rigid Urethane Foam Insulation

***Note**: This specification should be adopted for each project. All notes are for guidelines only.*

1. GENERAL

1.1. **Work Included -** Spray application of **HEATLOK SOY®** is for providing insulation and air-seal. ***Note**: Areas to be insulated and air-sealed can be described here if desired, referenced on drawings or covered in greater detail in Section* **3. Execution**.

1.2. **Related Sections -** ***Note:** Amend to suit project*.

1.2.1.	Cast in place concrete	Section 03300
1.2.2.	Structural Pre-cast Concrete	Section 03400
1.2.3.	Unit Masonry	Section 04200
1.2.4.	Metal Decking	Section 05300
1.2.5.	Cold Formed Metal Framing	Section 05400
1.2.6.	Rough Carpentry	Section 06100
1.2.7.	Waterproofing	Section 07100
1.2.8.	Vapor-Barrier	Section 07260
1.2.9.	Preformed Roofing and Cladding/Siding	Section 07400
1.2.10.	Fireproofing	Section 07800
1.2.11.	Thermal Barrier	Section 07840
1.2.12.	Flexible flashing	Section 07650
1.2.13.	Metal Support Systems	Section 09110
1.2.14.	Gypsum board	Section 09250

1.3. References

1.3.1. International Code Council – International Residential Code

1.3.1.1.Section 103.7 Alternate Materials and Methods

1.3.1.2.Section R314 Foam Plastic Insulation

1.3.1.3.Section 806.4 Conditioned Attic Assemblies

1.3.2. International Code Council – International Building Code

1.3.2.1.Section 104.11 Alternative materials, design and methods of construction and equipment.

1.3.2.2.Section 2603.0 Foam Plastic

1.3.3. ASTM E84 Surface Burning Characteristics

1.4. Submittals and Samples

1.4.1. Before commencing work, submit in accordance with local code.

1.4.2. Submit independent laboratory test reports, data sheets, physical properties, and samples as required by local code officials.

1.4.3. Submit the technical data sheet from the manufacturer showing the test results from the ASTM E84 (Surface Burning Characteristics).

1.5. **Quality Assurances**

1.5.1. Contractor performing work under this section must be trained by DEMILEC (USA) LLC in the art of applying HEATLOK SOY® and maintain the In*SEAL*-Right Certification.

1.6. Delivery, Storage and Handling

1.6.1. Materials shall be delivered in manufacturer's original sealed containers clearly labeled with manufacturer's name, product identification, safety information, net weight of contents and expiration date.

1.6.2. Material is to be stored in a safe manner and where the temperatures are in the limits specified by the material manufacturer.

1.6.3. Empty containers must be removed from site on a daily basis.

1.7. Protection

1.7.1. Ventilate area to receive insulation to maintain safe working conditions.

1.7.2. Protect workers as recommended by standards and manufacturer's recommendations.

1.7.3. Protect adjacent surfaces, windows, equipment and site areas from damage of overspray.

2. **PRODUCTS**

2.1. Materials

2.1.1. Spray Applied Semi Rigid Polyurethane Foam Insulation System

2.1.2. Product: **HEATLOK SOY®** manufactured by DEMILEC (USA) LLC, Arlington, TX

2.2.Physical Properties

Method	Description	Value
ASTM D 1622	Density	**2.1-2.3 lb/ft^3**
ASTM C 518	Initial Thermal Resistance, 1" Aged Thermal Resistance, 180 days @ 23ºC, 1"	**7.2 ft^{2}hºF/BTU** **6.6 ft.^{2}h.°F/BTU**
ASTM E 283	Air Permeance @ 75Pa, 1"	**0.00004L/sm^2**
ASTM D 1621	Compressive Strength	**28.3 psi**

ASTM D 1623	Tensile Strength	**51.5 psi**
ASTM E 96	Water Vapor Transmission, 1”, Vapor barrier (<1 perm) @ 1-1/4”	**1.2 perms**
CGSB 51.23-92	Off Gassing Tests (VOC Emissions)	**Pass (No toxic vapors)**
ASTM E84	Surface Burning Characteristics (3”) • Flame Spread Index • Smoke Development	**Class I** **20** **450**
ASTM D2856	Closed Cell Content	**> 92%**

2.3. **Equipment -** Equipment used to apply the foam insulation shall have fixed ratio positive displacement pumps and approved by foam manufacturer.

3. **EXECUTION** ***Note:*** *check the adhesion compatibility with: flashing, membranes and coatings.*

3.1. Examination

3.1.1. Verify that surfaces and conditions are suitable to accept work as outlined in this section.

3.1.2. Report in writing, any defects in surfaces or conditions which may adversely affect the performance of products installed under this section to the consultant prior to commencement of work.

3.1.3. Commencement of work outlined in this section shall be deemed as acceptance of existing work and conditions.

3.2. Application

3.2.1. Spray-application of polyurethane foam shall be performed in accordance with manufacturer recommendations.

3.2.2. Apply only when surfaces and environmental conditions are within limits prescribed by the material manufacturer. Refer to technical data sheets.

3.2.3. Apply in consecutive passes as recommended by manufacturer to thickness as indicated on drawings.

Residential and Commercial Construction

Location	**Recommended Thickness**	**R-value of Insulation**
Exterior walls	1.5-3.5 inches	9.9 – 23.1 $ft^2.h.^0F/BTU$
Pony and Hip walls	1.5-3.5 inches	9.9 – 23.1 $ft^2.h.^0F/BTU$
Attic Assembly	3.5-6 inches	23.1 – 39.6 $ft^2.h.^0F/BTU$

3.3 Protection - Except as provided in Section 314.5.3 and Section 314.5.4 of the International

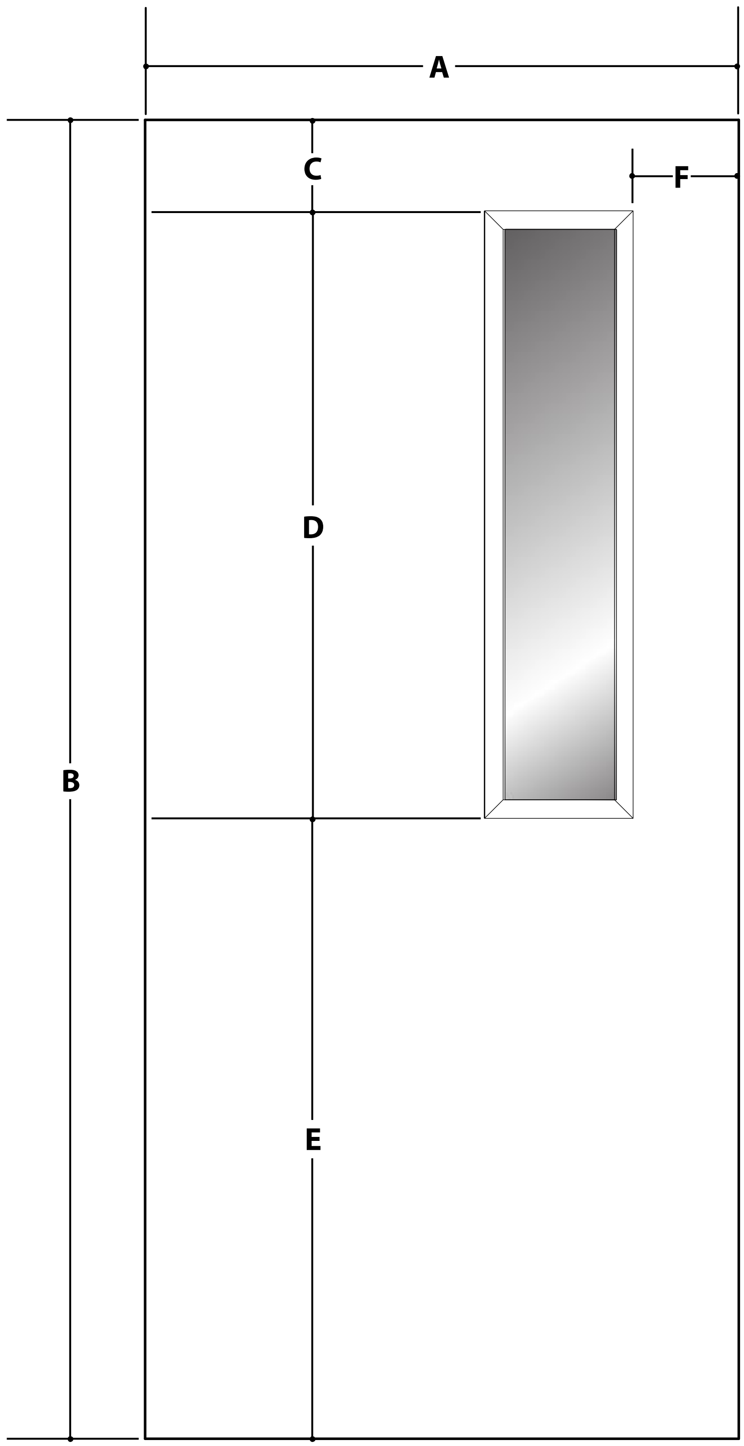
Residential Code, all plastic insulation shall be separated from the interior of the building by an approved thermal barrier of ½ -inch gypsum wallboard or equivalent thermal barrier material.

Note: *Work related to thermal barrier installation should be specified under appropriate sections.*

----------------------------------*END OF SECTION*--

CODEL
ENTRY SYSTEMS®

STEEL DOOR COLLECTION C836



2' 0"			
A	23-3/4"		37-3/4"
B	79"		36-1/4"
C	5"		5"
2' 4"			
A	27-3/4"		37-3/4"
B	79"		36-1/4"
C	5"		5"
2' 6"			
A	29-3/4"		37-3/4"
B	79"		36-1/4"
C	5"		5"
2' 8"			
A	31-3/4"		37-3/4"
B	79"		36-1/4"
C	5"		5"
2' 10"			
A	33-3/4"		37-3/4"
B	79"		36-1/4"
C	5"		5"
3' 0"			
A	35-3/4"		37-3/4"
B	79"		36-1/4"
C	5"		5"
3' 6"			
A	41-3/4"		37-3/4"
B	79"		36-1/4"
C	5"		5"
4' 0"			
A	47-3/4"		37-3/4"
B	79"		36-1/4"
C	5"		5"

GBG .... Grids Between Glass
LE .... Low-E Glass
MB .... Mini Blinds in Glass
FG .... Flush Glazed
.... Available in 7^0 Height
.... Available in 8^0 Height
.... Available in Pre-Painted White Door Skins

APPENDIX C: LAMELLA CALCULATION EXAMPLE

CHAPTER XIII.

LAMELLA ROOFS

Lamella roof construction was invented in Europe in 1908 and was introduced to the United States in 1925. Since that time numerous buildings have been erected with Lamella roof structures. This type of construction produces a unique and pleasing architectural appearance as well as providing clear spans of great width.

Basically the Lamella roof is a curved roof framed by a system of intersecting skewed arches made up of relatively short members called Lamellas. These members are bevelled and bored at the ends and bolted together as shown in Figure 65. The intersection of arches in two directions adds to the strength and stability against horizontal forces.

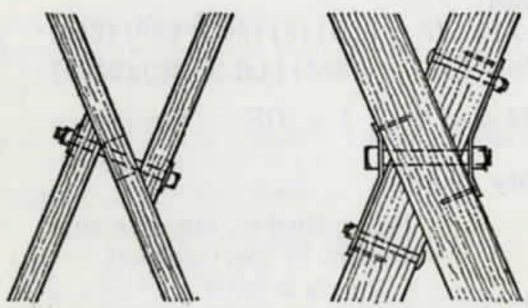


Fig. 65.

Since the Lamella roof is an arch rather than a truss, provision must be made to take care of the horizontal thrust developed. This thrust is usually taken up by tie rods, wood ties, buttresses or extended wall columns developed as cantilever beams. The skewed arches also develop a thrust component in the longitudinal direction of the building. These longitudinal components may be resisted by roof decking, ties extending lengthwise of the building or other suitable construction. Figure 66 shows the four principal types of Lamella roofs.

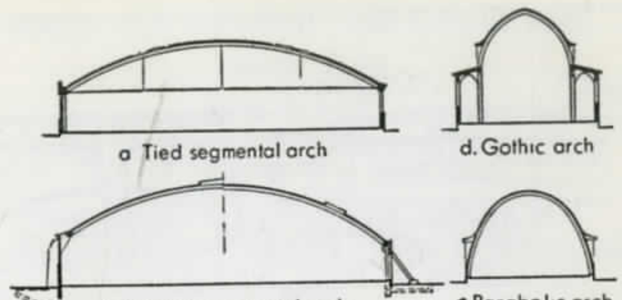


Fig. 66.

ERECTION: Lamella roofs are usually erected from movable scaffolds of the width of the roof and the depth of one bay. The Lamella network is woven from the sill up and from both sides to meet in the center. Figure 67 shows a plan view of a completed Lamella.

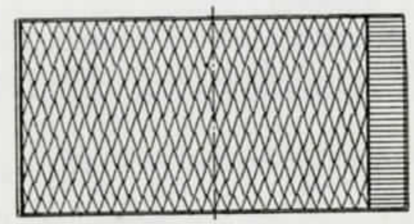


Fig. 67.

DESIGN OF LAMELLA ROOFS: The design of the Lamella roof should be approached on the basis that the Lamella roof is a single 2-hinged arch with a depth equal to the depth of the individual Lamellas and a width equal to the longitudinal length of the building. Next consider a transverse section of the roof 1′ wide forming a single arch which is loaded with the design loads. Then determine the end reactions, thrust, and moments for dead load, live load, unbalanced snow load, and special loads if any.

Several methods are available for the solution of 2-hinged arches. It is beyond the scope of this text to discuss these solutions, but in order to present the mechanics of Lamella design, a short abridged design of a segmental circular Lamella roof is included. It must be realized that the formulas given for the solution of the 2-hinged arch are valid only for the type of arch used.

After determining the reactions, thrusts and moment for the one foot section of a transverse 2-hinged arch, the forces in the direction of the skewed arches are determined and the stresses in the individual Lamellas calculated as shown in the accompanying example.

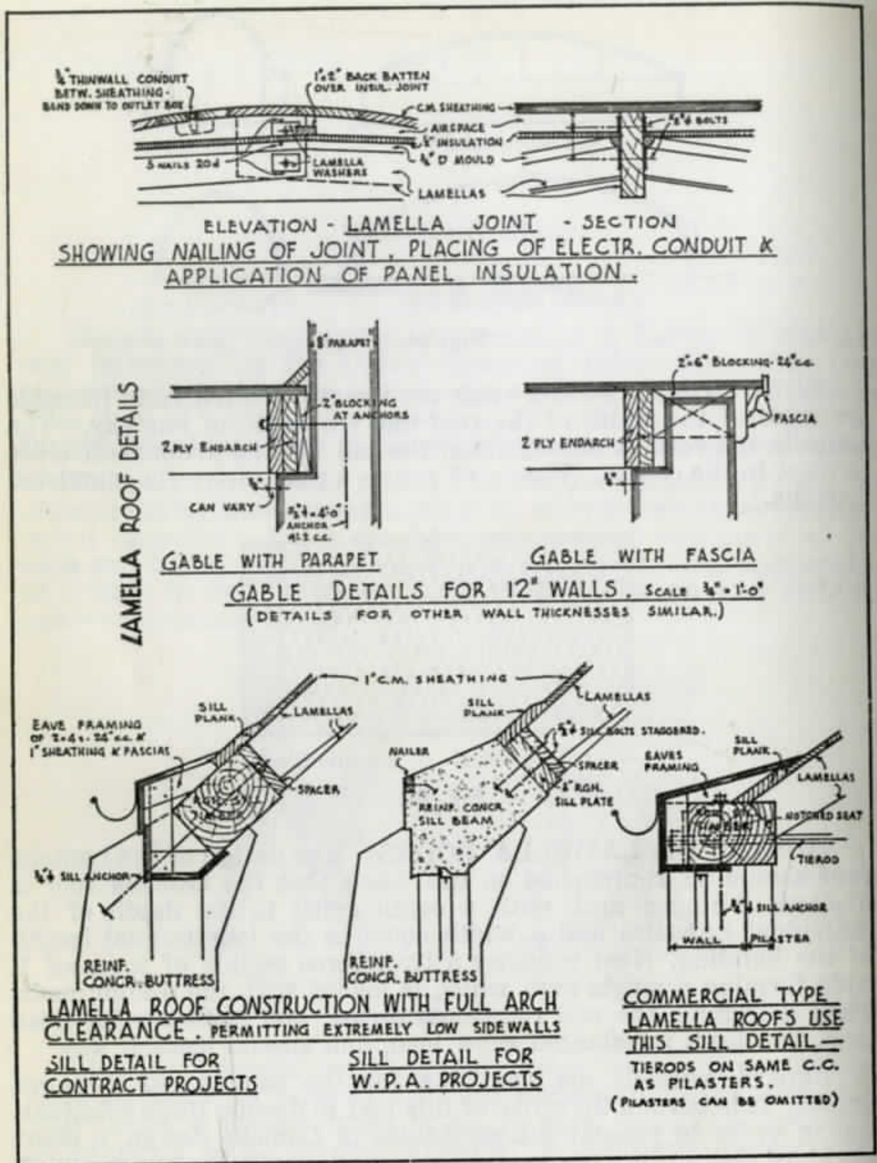


Fig. 68.

Design of a Segmental Arch Lamella Roof

Design Data

Span $S = 60'$
Rise $T = 10'$
Radius $R = 50'$

Two inch roof decking with built-up roof.
Use Dense Structural 58 Southern Pine.

Loads

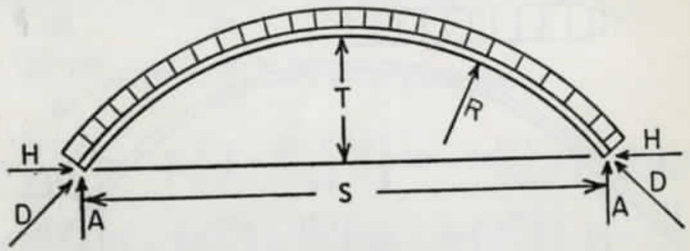
Dead load (Estimated)	$d = 12$ lb./sq. ft. of superficial area
Live load*	$L = 25$ lb./sq. ft. of horizontal projection
Snow load (Drift load)	$s = 12$ lb./sq. ft. of horizontal projection
Wind load	$W = 20$ lb./sq. ft. of vertical projection

*Live load is not assumed to be acting when structure is loaded with wind or snow load

Step 1. Determine the reactions, thrusts, and moments per ft. of length of roof (assume a section 1 foot wide).

Factors: $\frac{R\text{-}T}{R} = 0.8, \ \frac{S}{2R} = 0.6, \ 0.57356T = 5.7356$

a. *Dead Load* reactions, thrust and moment



$$A = 0.5dS\sqrt{1+\frac{16}{3}\left(\frac{T}{S}\right)^2}$$

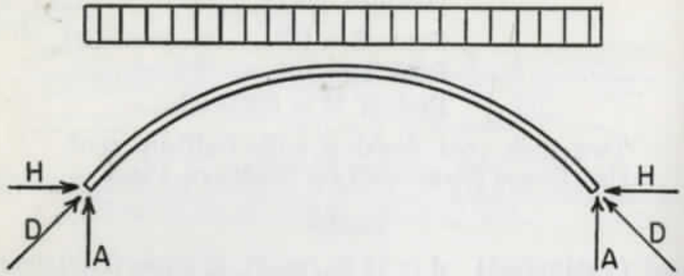
$$A = (.5)(12)\ 60\sqrt{1+\frac{16}{3}\left(\frac{10}{60}\right)^2} = 386 \text{ lbs.}$$

$$H = \frac{AS}{2T} - dR = \frac{386\ (60)}{(2)\ 10} - (12)(50) = 558 \text{ lbs.}$$

$$D = H\left(\frac{R\text{-}T}{R}\right) + \left(\frac{A}{2}\right)\left(\frac{S}{R}\right) = (558)(0.8) + \frac{386}{2}\left(\frac{60}{50}\right) = 678 \text{ lbs.}$$

$$\text{Maximum } M = 0.068\ DT^2 = (0.068)(12)(10)^2 = -81.6 \text{ ft-lbs.}$$

b. *Live Load* reactions, thrust and moment



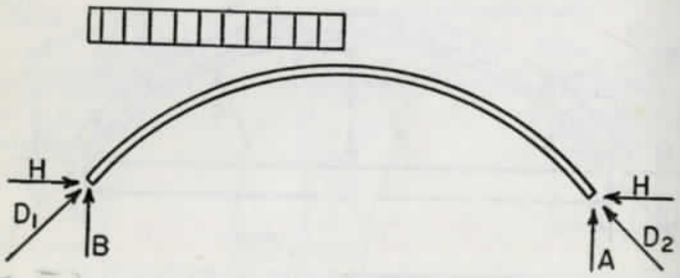
$A = 0.5\ LS = 0.5 \times (25)\ (60) = 750$ lbs.

$H = L(R - 0.57356T) = 25\ (50 - 5.7356) = 1107$ lbs.

$$D = H\left(\frac{R\text{-}T}{R}\right) + \left(\frac{A}{2}\right)\left(\frac{S}{R}\right) = (1107)\ (0.8) + 750\ (0.6) = 1335 \text{ lbs.}$$

$$\text{Maximum } M = -0.09092\ LT^2 = 0.09092\,(25)\ (10^2) = -227.3 \text{ ft-lbs.}$$

c. *Snow load* (drift load) rections, thrusts and moment



$$A = \frac{s \times S}{8} = \frac{12 \times 60}{8} = 90 \text{ lbs.}$$

$$B = \frac{3s \times S}{8} = \frac{3 \times 12 \times 60}{8} = 270 \text{ lbs.}$$

$$H = \frac{s}{2}(R - 0.57356T) = \frac{12}{2}(50 - 5.7356) = 265.6 \text{ lbs.}$$

$$D_2 = H\left(\frac{R\text{-}T}{R}\right) + \left(\frac{A}{2}\right)\left(\frac{S}{R}\right) = 265.6\ (0.8) + (90)\ (0.6) = 267 \text{ lbs.}$$

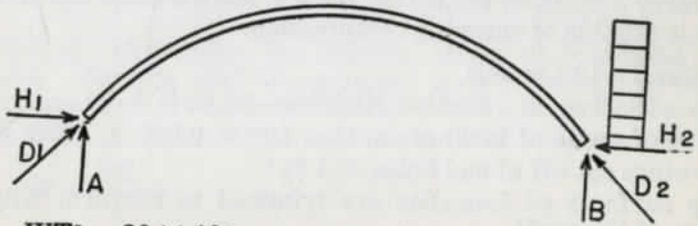
$$D_1 = H\left(\frac{R\text{-}T}{R}\right) + \left(\frac{B}{2}\right)\left(\frac{S}{R}\right) = (266)\ (0.8) + (270)\ (0.6) = 375 \text{ lbs.}$$

$$\text{Maximum } M = A\frac{S}{2} - HT - \left[\left(\sqrt{A^2 + H^2}\right) - H\right] R$$

$$\text{Maximum } M = 90\left(\frac{60}{2}\right) - (266 \times 10) - \left(\sqrt{90^2 + 265.6^2} - 265.6\right) 50$$

$$= -697.5 \text{ ft-lbs.}$$

d. *Wind Load,* Reactions, Thrust and moments



$$A = \frac{WT^2}{2S} = \frac{20 \times 10^2}{2 \times 50} = 20 \text{ lbs.}$$

$$B = -\frac{WT^2}{2S} = \frac{20 \times 10^2}{2 \times 50} = -20 \text{ lbs.}$$

$$H_1 = \frac{19\ WT}{64} = \frac{19 \times 20 \times 10}{64} = 59.4 \text{ lbs.}$$

$$H_2 = \frac{45\ WT}{64} = \frac{45 \times 20 \times 10}{64} = -140.6 \text{ lbs.}$$

$$D_1 = \frac{WT}{64}\left(19 - 3\frac{T}{R}\right) = \frac{20 \times 10}{64}\left[19 - 3\left(\frac{10}{50}\right)\right] = 57.5 \text{ lbs.}$$

$$D_2 = \frac{WT}{64}\left(45 - 29\frac{T}{R}\right) = \frac{200}{64}\left[45 - 29\left(\frac{10}{50}\right)\right] = -122.4 \text{ lbs.}$$

$$\text{Maximum } M = 0.154\ WT^2 = (0.154)\ (20)\ (10^2) = +308 \text{ ft-lbs.}$$

STEP 2. Establish the spacing of the Lamellas. The spacing of 12′ Lamellas is usually 4′, 14′ Lamellas 4½′ or slightly less, and 16′ Lamellas 5′0″ or slightly less. The enclosed angle between intersecting Lamellas should not exceed 45°. It should preferably be between 38°-40°.

Try 12′ Lamellas spaced 4′ apart. This arrangement gives an angle of intersection of 38° and an angle of inclination of 19°.

STEP 3. Determine the stresses in the Lamellas due to thrusts, and moments for the following load combinations:

Dead Load + Live Load
Dead Load + Drift Load
Dead Load + Wind Load

One of these combinations (usually Dead Load + Drift Load) will cause the maximum stress in the member. These combinations are conservative in that maximum moment for dead load does not occur at the point of maximum moment for Live Load or Snow Load, and would tend to decrease the above values. At any intersection of Lamellas, one Lamella is continuous and can take both bending and compression, whereas the opposite Lamellas are bolted to the continuous Lamella and can take compression only. Therefore, consider the continuous Lamella as a portion of a skewed arch inclined at 19° with the tranverse axis of the roof. This Lamella must carry all of the moment in a 4′ section, but it need carry only ½ of the thrust for a 4′ section since the abutting Lamella is capable of carrying compression.

Assume 2 x 12 Lamella

Area—18.69 sq. in. Section Modulus—35.82 in ^{3}

Cosine of angle of inclination, Cos. 19° = 0.945

Curvature cut off at end holes = 4 ⅜″

(Top surfaces of Lamellas are trimmed to conform with the curvature of the roof)

Net end area .... 11.58 sq. in.
Length between bolts (eccentric connection) ... 11′6″

a. Dead Load + live load thrust and moment

D_D = 678# M_D = — 81.6′#
D_L = 1335# M_L = —227.3′#
2013# —308.9′#

b. Dead load + snow (drift) load thrust and moment

D_D = 678# M_D = — 81.6′#
D_S = 375# M_S = —697.5′#
1053# —779.1′#

c. Dead Load + wind load thrust and moment

D_D = 678# M_D = — 81.6′#
D_W = 58# M_W = +308.0′#
736# 226.4′#

By inspection it is obvious that the critical combination of loads will be Dead Load + Drift Load. When spacing is 4′:

$$\text{Moment} = \frac{4 \times 779.1 \times 12}{\text{Cos } 19^\circ} = 39{,}600 \text{ in-lbs.}$$

$$\text{Thrust} = \frac{2 \times 1053}{\text{Cos } 19^\circ} = 2230 \text{ lbs. for dead load + snow load}$$

but = 4260 lbs. for dead load + live load

Since each Lamella is assumed to be a simple beam with an axial compression load, the maximum fiber stress will occur at the mid-point of the Lamella

$$\frac{P/A}{c} + \frac{M/S}{f} = < 1$$

$$\frac{2230 \times 1.15}{1450/18.69} + \frac{39{,}600/35.82}{1750 \times 1.15} = 0.620 < 1 \quad \text{OK}$$

A 2 x 12 is satisfactory although a smaller size might be used provided it satisfies other requirements.

STEP 4. Determine the bearing stress at mid-point of each Lamella. Assume that the moment in the Lamella is caused by the end reaction (beam reaction) of the two abutting Lamellas. In which case:

$$M = \frac{PL}{4} \text{ or}$$

$$P = \frac{4M}{L} = \frac{4(39{,}600)}{138} = 1147\#$$

This is the load on the bolt perpendicular to grain in the Lamella.

STEP 5. Determine the number of bolts and nails required for a Lamella joint using ¾″ bolts.

l = 1⅝″,560 × 1.15 = 644# (Table 2)
5 Nails 12d = 5 × 96 × 1.15 = 552# (Table F)
1196# > 1147#

The usual practice is to put 6 to 8 12d nails in the joint of a 2 x 12 or larger Lamella and 4 nails in a smaller Lamella to supplement the bolts. The angle of the bolt to grain in the continuous Lamella would increase the bolt capacity in that member.

STEP 6. Determine the effect of thrust transfer through the joint. The thrust transfer at the joint (eccentric type) causes tension in the bolt and friction and bearing across grain in the Lamella.

Bearing stress across grain (Dead load + live load)

$$\frac{4260 \times \text{Sin } 38^\circ}{(7\tfrac{1}{8})\ 1\tfrac{5}{8}/\ \text{Sin } 38^\circ} = 140 \text{ psi.} < 455$$

Tension in bolt (Assume no friction exists)

Tension = 4260 × Cos 38° × Tan (90°-38°) = 4290#

3/4″ bolt satisfactory by inspection

$$\text{Required area of washer} = \frac{4290}{455} = 9.44 \text{ sq. in.}$$

Claw type Lamella washer = $2\frac{1}{2}'' \times 4'' = 10$ sq. in.

Friction developed is variable but would tend to reduce the stresses in the bolted connection.

STEP 7. Determine the end shear

$$H = \frac{3V}{2A} = \frac{3}{2} \times \frac{1147/2}{11.58} = 74.2 \text{ lbs./sq. in.}$$

$$74.2 < 120 \times 1.15 \qquad \text{OK}$$

Check end as eccentric bolted joint

$$H = \frac{V}{bhe} \qquad \text{(Page 83)}$$

$$H = \frac{573.5}{(1\frac{5}{8})(5\frac{1}{2})} = 64.1 \text{ lbs./sq. in.} < 120 \times 1.15$$

Calculations show that the 2 x 12 is considerably understressed. Similar calculations show that a 2 x 10 Lamella is satisfactory.

The complete design of the Lamella would include the design of wall beams and tie rods.

More accurate and detailed calculations of Lamella stresses can be made by using the column analogy or Von Karman method.

Lamella roof details are shown in Fig. 68.