



PDHonline Course S244 (11 PDH)

Engineered Design of Structural Insulated Panels (SIPs)

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2012

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PRODUCT: SIPA Structural Insulated Panel Certification Report
DIVISION: Wood and Plastics (06)
SECTION: Structural Panels (06 12 16)

Report Holder

SIPA
Structural Insulated Panel Association
Box 1699
Gig Harbor, WA 98335

Manufacturing Locations

None

1. SUBJECT

SIPA Wall and Roof Structural Insulated Panels. Wall and Roof Panels 8-ft to 24ft, 4-5/8-in to 12-3/8-in thick

2. SCOPE

NTA, Inc. has evaluated the above product(s) for compliance with the applicable sections of the following codes:

- 2006 International Building Code (IBC)
- 2006 International Residential Code (IRC)

NTA, Inc. has evaluated the following properties of the above product(s):

- Structural performance under axial, transverse, and racking loads.
- Surface burning characteristics and self-ignition temperature.

3. USES

3.1. General. *SIPA Structural Insulated Panels* are used as structural insulated roof, and wall panels capable of resisting transverse, racking, and axial compressive loads.

3.2. Construction Types. *SIPA Structural Insulated Panels* shall be considered combustible building elements when determining the Type of Construction in accordance with 2006 IBC Chapter 6.^(NACU1)

3.3. Fire Resistive Assemblies. *SIPA Structural Insulated Panels* shall not be used as part of a fire-rated assembly unless suitable evidence and details are submitted and approved by the authority having jurisdiction.^(ACU15)

4. DESCRIPTION

4.1. General. *SIPA Structural Insulated Panels* are factory-assembled, engineered-wood-faced, structural insulated panels (SIP) with an expanded poly-styrene (EPS) foam core. The panels are intended for use as load-bearing or non-load bearing wall and roof panels. Panels are available in 4-5/8-inch through 12-3/8-inch overall thicknesses. The panels are custom made to the specifications for each use and are assembled under factory-controlled conditions. The maximum panel size is 8-ft wide and up to 24-ft in length.

4.2. Materials

4.2.1. Facing. The facing consists of two single-ply oriented strand board (OSB) facings a minimum of 7/16-inch thick conforming to APA PRN-610 and DOC PS 2-04, Exposure 1, Rated Sheathing with a span index of 24/16. Panels may be manufactured with the facing strength axis oriented in either direction with respect to the direction of SIP panel bending provided the appropriate strength values are used.

4.2.2. Core. The core material is 1.0 pcf density expanded polystyrene (EPS) foam (0.95 pcf minimum). The foam core has a flame spread rating not exceeding 75 and a smoke-developed rating not exceeding 450 when tested in accordance with ASTM E84.

4.2.3. Adhesive. Facing materials are adhered to the core material using a structural adhesive. The adhesive is applied during the lamination process in accordance with the in-plant quality control manual.

4.2.4. Material Sources. The facing, core and adhesive used in the construction of *SIPA Structural Insulated Panels* shall be composed only of materials from approved sources as identified in Table 8.

4.2.5. Splines. *SIPA Structural Insulated Panels* are interconnected with surface splines, block splines, dimensional lumber splines, or engineered structural splines (Figure 1).

4.2.5.1. Surface Splines. Surface splines (Figure 1) consist of 3-inch wide by 7/16-in thick or thicker, OSB. At each panel joint, one surface spline is inserted into each of two tight-fitting slots in the core. The slots in the core are located just inside the facing.

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4.2.5.2. Block Splines. Block splines (Figure 1) are manufactured in the same manner as the overall SIP panel except with an overall thickness that is 1-inch less than the overall thickness of the panel to be joined.

4.2.5.3. Dimensional Lumber Splines. Dimensional lumber splines (Figure 1) consist of one or more plies of dimensional lumber.

4.2.5.4 Structural Splines. Structural splines consist of one or more plies of dimensional lumber or an engineered wood product.

5. DESIGN

5.1. Overall Structural System. The scope of this report is limited to the evaluation of the SIP panel component. Panel connections and other details related to incorporation of the panel into the overall structural system of a building are beyond the scope of this report.^(NACU3)

5.2. Design Approval. Where required by the authority having jurisdiction, structures using *SIPA Structural Insulated Panels* shall be designed by a registered design professional. Construction documents, including engineering calculations and drawings providing floor plans, window details, door details, and connector details, shall be submitted to the code official when application is made for a permit. The individual preparing such documents shall possess the necessary qualifications as required by the applicable code and the professional registration laws of the state where the construction is undertaken. Approved construction documents shall be available at all times on the jobsite during installation.^(NACU4)

5.3. Design Loads. Design loads to be resisted by the SIP panels shall be as required under the applicable building code. Loads on the panels shall not exceed the loads noted in this report.

5.4. Allowable Loads. Allowable axial, transverse, and racking loads may be calculated using the panel properties provided in Tables 1 and 2, or may be selected from Tables 4 through 7. Panel height and span are limited as provided in Table 3. Unless otherwise noted, all properties and allowable loads apply to panels joined with surface or block splines. Allowable loads for reinforced panel capacities shall be designed by a registered professional. Calculations demonstrating that the loads applied are less than the allowable loads described in this report shall be submitted to the code official for approval.^(NACU5) For loading conditions not specifically addressed herein

structural members designed in accordance with accepted engineering practice shall be provided to meet applicable code requirements.

5.5. Concentrated Loads. Axial loads shall be applied to the SIP panel through continuous members such as structural insulated panels or repetitive members spaced at regular intervals of 24-inches on center, or less. Such members shall be fastened to a rim board or similar member to distribute the load to the SIP panel. For other loading conditions, such as concentrated loads, reinforcement shall be provided. This reinforcement shall be designed in accordance with accepted engineering practice.^(ACU13)

5.6. Eccentric and Side Loads. Axial loads shall be applied concentrically to the top of the SIP panel. Loads shall not be applied eccentrically or through framing attached to one side of the panel (such as balloon framing) except where additional engineering documentation is provided.^(ACU14)

5.7. Openings. Openings in panels shall be reinforced with wood or steel designed in accordance with accepted engineering practice to resist all loads applied to the opening as required by the adopted code. Details for door and window openings shall be provided to clarify the manner of supporting axial, transverse and/or racking shear loads at openings. Such details shall be shown on approved design documents and subject to approval by the local authority having jurisdiction.^(ACU8)

5.8. In-Plane Shear Design. Shear walls utilizing block or surface splines shall be sized to resist all code required wind and seismic loads without exceeding the allowable loads provided in Table 7. The maximum panel height-to-width ratio shall be 2:1.^(ACU18) Shearwall chords, holdowns, and connections to transfer shear forces between the wall and surrounding structure shall be designed in accordance with accepted engineering practice. Allowable strengths for shear walls with structural splines along each panel edge shall be designed in accordance with accepted engineering practice and subject to the limitations for wood sheathed shear walls.

5.8.1. Seismic Design. Use of panels as shear walls (racking shear) is limited to structures in Seismic Design Categories A, B and C.^(NACU3) Where SIP panels are used to resist seismic forces the following factors shall be used for design: Response Modification Coefficient, $R = 2.0$; System Overstrength Factor, $\Omega_0 = 2.5$; Deflection Amplification Factor, $C_d = 2.0$.^(ACU17)

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5.9. Combined Loads. Panels subjected to any combination of transverse, axial or in plane shear loads shall be analyzed utilizing a straight line interaction in accordance with *NTA IM14 TIP 01 SIP Design Guide*.

6. INSTALLATION

6.1. General. *SIPA Structural Insulated Panels* shall be fabricated, identified and erected in accordance with this report, the approved construction documents and the applicable code. In the event of a conflict between the manufacturer's published installation instructions and this report, this report shall govern. Approved construction documents shall be available at all times on the jobsite during installation.^(NACU7)

6.2. Splines. *SIPA Structural Insulated Panels* are interconnected at the panel edges through the use of a spline. The spline type may be of any configuration listed in Section 4.2.4, as required by the specific design. The spline shall be secured in place with not less than 0.131-in. x 2-1/2-in. nails, 6-in. on-center, or an approved equivalent fastener. All joints shall be sealed in accordance with the SIP manufacturer's installation instructions. Alternate spline connections may be required for panels subjected to in-plane racking forces. Such panels shall be interconnected exactly as required in Table 7, or as directed by the designer.

6.3. Plates. The top and bottom plates of the panels shall be dimensional or engineered lumber sized to match the core thickness of the panel. The plates shall be secured using not less than 0.131-in. x 2-1/2-in. nails spaced 6-inches on center, on both sides, or an approved equivalent fastener.

A second plate composed of 1-1/8-in. minimum thickness dimensional or engineered lumber with a specific gravity of 0.42 that is cut to the full thickness of the panel shall be secured to the first top plate using 0.133-in. x 3-in. nails or an approved equivalent fastener.

6.4. Cutting and Notching. No field cutting or routing of the panels shall be permitted except as shown on approved drawings.^(NACU6)

6.5. Protection from Decay. SIPs that rest on exterior foundation walls shall not be located within 8-inches from exposed earth. SIPs supported by concrete or masonry that is in direct contact with earth shall be protected from the concrete or masonry by a moisture barrier.^(ACU6)

6.6. Protection from Termites. In areas subject to damage from termites, SIP panels shall be protected from termites using an approved method. Panels shall not be installed below grade or in contact with earth.^(ACU7)

6.7. Heat-Producing Fixtures. Heat-producing fixtures shall not be installed in the panels unless protected by a method approved by the code official or documented in test reports. This limitation shall not be interpreted to prohibit heat-producing elements with suitable protection.^(NACU9)

6.8. Plumbing Installation. Plumbing and waste lines may extend at right angles through the wall panels but are not permitted vertically within the core. Lines shall not interrupt splines or panel plates unless approved by the local authority having jurisdiction.^(NACU2)

6.9. Voids and Holes

6.9.1 Voids in Core. In lieu of openings designed in accordance with section 5.7 the following are permitted. Voids may be provided in the panel core during fabrication at predetermined locations only. Voids parallel to the panel span shall be limited to a single 1-inch maximum (outside diameter) hole. Such voids shall be spaced a minimum of 4-feet on center, measured perpendicular to the panel span. Two 1/2-inch diameter holes may be substituted for the single 1-inch hole provided they are maintained parallel and within 2-inches of each other.^(ACU12)

Voids perpendicular to the panel span (parallel to the support) shall be limited to a single 1-inch maximum (outside diameter) hole placed not closer than 16-inches from the support. Additional voids in the same direction shall be spaced not less than 28-inches on center.

6.9.2 Holes in Panels. Holes may be placed in panels during fabrication at predetermined locations only. Holes shall be limited to 4-inches x 4-inches square. The minimum distance between holes shall not be less than 4-feet on center measured perpendicular to the panel span and 24-inches on center measured parallel to the panel span. Not more than three holes shall be provided in a single line of holes parallel to the panel span. The holes may intersect voids permitted elsewhere in this report.^(ACU16)

6.10. Panel Cladding

6.10.1 Roof Covering. The roof covering, underlayment and flashing shall comply with the applicable code(s). All roofing materials must be

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installed in accordance with the manufacturer's installation instructions. The use of roof coverings requiring the application of heat during installation shall be reviewed and approved by a registered design professional.

6.10.2 Exterior Wall Covering. Panels shall be covered on the exterior by a water-resistive barrier as required by the applicable code. The water-resistive barrier shall be attached with flashing in such a manner as to provide a continuous water-resistive barrier behind the exterior wall veneer.^(ACU10) The exterior facing of the SIP wall shall be covered with weather protection as required by the adopted building code or other approved materials.^(ACU11)

6.10.3 Interior Wall Covering. The SIP panel foam plastic core shall be separated from the interior of the building by an approved thermal barrier of 0.5-inch gypsum wallboard or equivalent thermal barrier where required by 2006 IBC 2603.^(ACU9)

7. CONDITIONS OF USE

SIPA Structural Insulated Panels as described in this report comply with the codes listed in Section 2.0, subject to the following conditions:

- 7.1. Installation complies with this report and the approved construction documents.
- 7.2. This report applies only to the panel thicknesses specifically listed herein.^(ACU2)
- 7.3. In use panel heights/spans shall not exceed the values listed herein. Extrapolation beyond the values listed herein is not permitted.^(ACU3)
- 7.4. The panels are manufactured in the production facility(ies) noted in this report.^(NACU8)

8. EVIDENCE SUBMITTED

NTA, Inc. has examined the following evidence to evaluate this product:

- 8.1. Review of plant quality assurance manual
- 8.2. Plant certification inspection of manufacturer's production facilities, test procedures, frequency and quality control sampling methods, test equipment and equipment calibration procedures, test records, dates and causes of failures when applicable.
- 8.3. Qualification test data in accordance with NTA *Standard Evaluation Plan 14.1* (SEP14.1).
- 8.4. Follow-up quality assurance audits of the production facility(ies).
- 8.5. Follow-up testing in accordance with NTA, Inc. *Inspection Method 14.0* (IM14).

Evaluation evidence and data are on file with NTA, Inc. NTA, Inc. is accredited by the International Accreditation Service (IAS) as follows:

ISO17020 Inspection Agency (AA-682)

ISO17025 Testing Laboratory (TL-259)

ISO Guide 65 Product Certification Agency (PCA-102)

The scope of accreditation related to testing, inspection or product certification pertain only to the test methods and/or standard referenced therein. Design parameters and the application of building code requirements, such as special inspection, have not been reviewed by IAS and are not covered in the accreditation. Product evaluations are performed under the direct supervision of Professional Engineers licensed in all jurisdictions within the United States as required by the building code and state engineering board rules.

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9. FINDINGS

All panels are manufactured under an in-plant Quality Assurance program to insure that the production quality meets or exceeds the requirements of the codes noted herein and the criteria as established by NTA, Inc. Furthermore, panels must comply with the conditions of this report.

This report expires one year from the issue date noted below.

10. IDENTIFICATION

Each eligible panel shall be permanently marked to provide the following information:

- a) The NTA, Inc. listing mark, shown below;

- b) NTA's Listing No. SIPA120908-10;
- c) in-plant quality assurance stamp;
- d) identifier for production facility;
- e) project or batch number.

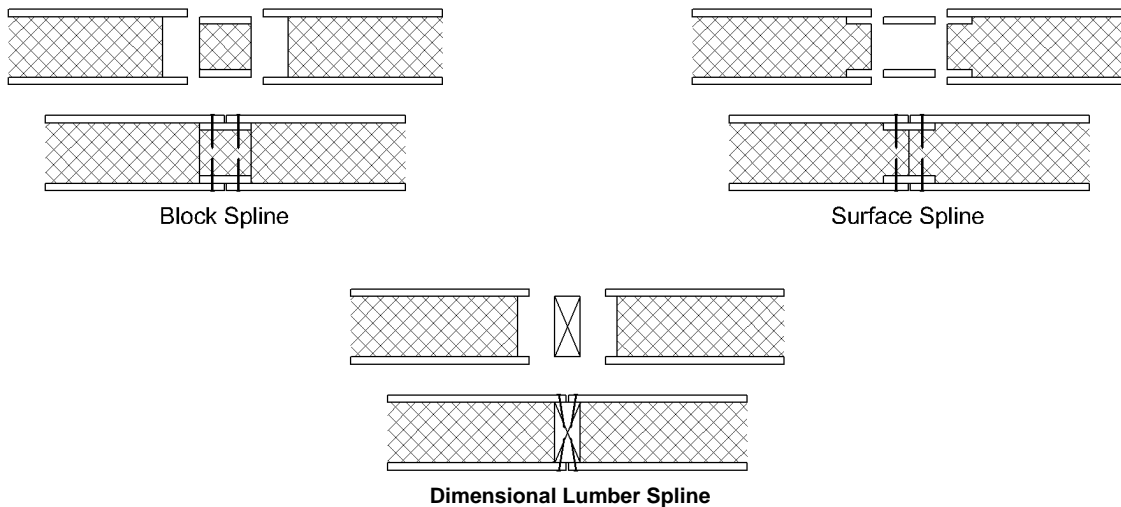


Figure 1: SIP Spline Types

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Table 1: Basic Properties^{1,2}

Property	Weak-Axis Bending	Strong-Axis Bending
Allowable Tensile Stress, F_t (psi)	245	495
Allowable Compressive Stress, F_c (psi)	355	575
Elastic Modulus (Bending), E_b (psi)	771000	760000
Shear Modulus, G (psi)	300	440
Allowable Core Shear Stress, F_v (psi)	6.4	6.4
Reference Depth, h_o (in.)	4.625	4.625
Shear Depth Factor Exponent, m	0.86	0.86

¹ All properties are based on a minimum panel width of 24-inches.

² Refer to NTA IM14 TIP 01 SIP Design Guide for details on engineered design using basic panel properties.

Table 2: Section Properties

Panel Thickness, h (in.)	Core Thickness, c (in.)	Dead Weight, w_d (psf)	Facing Area, A_f (in. ² /ft)	Shear Area, A_v (in. ² /ft)	Moment of Inertia, I (in. ⁴ /ft)	Section Modulus, S (in. ³ /ft)	Radius of Gyration, r (in.)	Centroid-to-Facing Dist., y_c (in.)
4.63	3.75	3.17	10.50	50.25	46.03	19.90	2.09	2.31
6.50	5.63	3.33	10.50	72.75	96.48	29.69	3.03	3.25
8.25	7.38	3.47	10.50	93.75	160.22	38.84	3.91	4.13
10.25	9.38	3.64	10.50	117.75	252.75	49.32	--	--
12.25	11.38	3.81	10.50	141.75	366.28	59.80	--	--

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Table 3: Allowable Uniform Transverse Loads^{1,4}

Panel Length (ft)	4-5/8-inch Thick SIP			6-1/2-inch Thick SIP		
	Deflection Limit ²			Deflection Limit ²		
	L/180	L/240	L/360	L/180	L/240	L/360
8 WAB³	50.8	44.6	29.7	75.8	71.0	47.3
8	76.4	57.3	38.2	104.8	94.0	62.7
10	50.4	37.8	25.2	80.6	64.5	43.0
12	34.6	26.0	17.3	61.0	45.8	30.5
14	24.6	18.4	12.3	44.5	33.4	22.3
16	--	--	--	33.2	24.9	16.6
18	--	--	--	25.3	19.0	12.7

See Table 4 for notes.

Table 4: Allowable Uniform Transverse Loads (continued)^{1,4}

Panel Length (ft)	8-1/4-inch Thick SIP			10-1/4-inch Thick SIP			12-1/4-inch Thick SIP		
	Deflection Limit ²			Deflection Limit ²			Deflection Limit ²		
	L/180	L/240	L/360	L/180	L/240	L/360	L/180	L/240	L/360
8 WAB³	99.1	96.2	64.1	125.9	125.4	83.6	139.6	139.6	103.2
8	115.4	115.4	86.5	127.4	127.4	114.3	139.6	139.6	139.6
10	87.9	87.9	60.8	95.7	95.7	82.0	103.4	103.4	103.4
12	70.9	66.2	44.1	76.6	76.6	60.6	82.1	82.1	77.8
14	59.5	49.2	32.8	63.9	63.9	45.9	68.1	68.1	59.7
16	49.8	37.4	24.9	54.8	53.0	35.3	58.1	58.1	46.6
18	38.5	28.9	19.2	48.0	41.5	27.7	50.7	50.7	36.9
20	30.2	22.7	15.1	40.7	33.0	22.0	45.0	44.3	29.6

¹ Table values assume a simply supported panel with 1.5-inches of continuous bearing on facing at supports ($C_v = 1.0$) with splines at bearing locations. Values do not include the dead weight of the panel. $C_v=0.4$ Shall be used where no bearing is provided.

² Deflection limit shall be selected by building designer based on the serviceability requirements of the structure and the requirements of adopted building code. Deflection values based on loads of short duration only and do not consider effects of creep.

³ Tabulated values are based on the strong-axis of the facing material oriented parallel to the span direction. WAB indicates weak-axis bending of the facing material (i.e. the facing material weak-axis is parallel to the span direction).

⁴ Permanent loads, such as dead load, shall not exceed 0.50 times the tabulated load.

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Table 5: Allowable Axial Loads (plf)^{1,2,3,4}

Lateral Brace Spacing (ft)	Panel Thickness		
	4-5/8-inches	6-1/2-inches	8-1/4-inches
8 WAB ⁵	2420	2580	2650
8	3700	4080	4230
10	3370	3930	4140
12	2990	3730	4020
14	--	3500	3890
16	--	3240	3720
18	--	2960	3540
20	--	--	3340

1. Permanent loads, such as dead load, shall not exceed 0.50 times the tabulated load.
2. All values are for normal duration and may not be increased for other durations.
3. Axial loads shall be applied concentrically to the top of the panel through repetitive members spaced not more than 24-inches on center. Such members shall be fastened to a rim board or similar member to distribute along the top of the SIP panel.
4. The ends of both facings must bear on the supporting foundation or structure to achieve the tabulated axial loads.
5. Tabulated values are based on the strong-axis of the facing material oriented parallel to the span direction. WAB indicates weak-axis bending of the facing material (i.e. the facing material weak-axis is parallel to the span direction).

Table 6: Allowable In-Plane Shear Strength (Pounds per Foot) for SIP Shear Walls (Wind and Seismic Loads in Seismic Design Categories A, B and C)^{1,2}

Spline Type ³	Nominal SIP Thickness (in.)	Minimum Facing Connections ^{2,4}			Shear Strength (plf)
		Chord ²	Plate ²	Spline ³	
Block or Surface Spline	4.625	0.131"x 2-1/2" nails, 6" oc	0.131"x 2-1/2" nails, 6" oc	0.131"x 2-1/2" nails, 6" oc	380
	6.625	0.131"x 2-1/2" nails, 6" oc	0.131"x 2-1/2" nails, 6" oc	0.131"x 2-1/2" nails, 6" oc	380
	8.375	0.131"x 2-1/2" nails, 6" oc	0.131"x 2-1/2" nails, 6" oc	0.131"x 2-1/2" nails, 6" oc	400

1. Maximum shear wall dimension ratio shall not exceed 2:1 (height : width) for resisting wind or seismic loads.
2. Chords, holdowns, and connection to other structural elements must be designed by a registered design professional in accordance with accepted engineering practice.
3. Spline type at interior panel-to-panel joints only, solid chord members are required at each end of each shearwall segment.
4. Required connections must be made on each side of the panel. Dimensional or engineered lumber shall have an equivalent specific gravity of 0.42 or greater.

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Table 7: Approved Material Sources¹

Facing	Core	Adhesive
Ainsworth Lumber Co. Ltd. Suite 3194 Bentall 4 1055 Dunsmuir Street Vancouver BC, Canada V7X 1L3: Bemidji, MN (Mill 353) Barwick, Ontario (Mill 498)	Falcon Foam, A Division of Atlas Roofing 8240 Byron Center SW Byron Center, MI 49315: Falcon Foam Expanded Polystyrene Insulation Boards (Type I)	Rohm & Haas Chemicals LLC 2531 Technology Drive Elgin, IL 60124: Mor-Ad™ M-640, Mor-Ad™ M-642 Mor-Ad™ M-6575
Tolko Industries Ltd 3203 30 th Avenue Vernon BC, Canada V1T 6M1: High Prairie, AB (Mill 450) Meadow Lake, SK (Mill 492)	AFM Corporation 211 S River Ridge Circle, #102A Burnsville, MN 55337: Foam-Control EPS Boards (Type I)	Ashland Specialty Chemical Company 5200 Blazer Parkway Dublin, OH 43017: ISOSET® EPI WD3-A322 with ISOSETCX47 ISOSET® EPI WD3-A320 with ISOSETCX47
	OPCO, Inc. P.O. Box 101 Latrobe, PA 15650 EPS Boards (Type I)	
	Powerfoam Insulation 550 Murray Street/Highway 287 Midlothian, TX 76065 EPS Boards (Type I)	
	Iowa EPS Products, Inc. 5554 N.E. 18 th Street Des Moines, Iowa 50313 EPS Boards (Type I)	

¹ Panels may be composed of any combination of approved materials. Contact NTA, Inc. for details on identification and labeling of source material.

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