LEGACY REPORT

ER-5621

Reissued October 1, 2006

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Legacy report on the 1997 *Uniform Building Code*™

DIVISION: 07—THERMAL AND MOISTURE PROTECTION
Section: 07410—Metal Roof and Wall Panels

VARCO-PRUDEN STANDING SEAM PANEL AND STANDING SEAM CLIP

VARCO PRUDEN BUILDINGS, INC.
3200 PLAYERS CLUB CIRCLE
MEMPHIS, TENNESSEE 38125

1.0 SUBJECT

Varco-Pruden Standing Seam Panel and Standing Seam Clip.

2.0 DESCRIPTION

2.1 General:

Varco-Pruden (VP) Standing Seam Roof (SSR) Panels are cold-formed steel roof decks supported by roof purlins spaced a maximum of 5 feet (1524 mm) on center. The SSR panels are recognized to resist vertical loads (dead and live), lateral loads (wind and earthquake), and uplift loads (wind). The panels must be installed with VP Standing Seam Roof Clips, supplied by V-P Buildings, Inc.

2.2 Materials:

2.2.1 Varco-Pruden Standing Seam Roof (SSR) Panels: SSR panels are fabricated from cold-formed steel conforming to ASTM A 653, SS, Grade 50, having a minimum yield strength of 50 ksi (345 MPa). The steel has an aluminum-zinc alloy coating complying with ASTM A 792. SSR panels are rolled in 24-inch (610 mm) widths from No. 22 and No. 24 gage [design base-metal thicknesses of 0.0273 and 0.0220 inch (0.69 and 0.56 mm), respectively] steel, with a 3-inch (76 mm) rib that interlocks at the seam. See Figure 1.

2.2.2 Varco-Pruden Standing Seam Roof Clips: VP SSR Clips consist of two cold-formed sections. The base section of the clip is cold-formed from No. 12 gage [base-metal thickness of 0.097 inch (2.46 mm)] steel, and the top section of the clip is cold-formed from No. 28 gage [base-metal thickness of 0.0187 inch (0.47 mm)] steel. The steel for both parts of the clip must conform to ASTM A 653, SS, Grade 50, having a minimum yield strength of 50 ksi (345 MPa). The steel must be galvanized in accordance with ASTM A 653 with a G90 minimum coating class. When the clips are installed in accordance with this report, the No. 28 gage top section is nested in SSR panel side laps. The clips are manufactured in four different heights. Clips of various heights are used, depending on the amount of roof insulation used in the roof assembly. The clips are referred to as either tall, medium, short, or zero clearance, and are designated as Model No. 80049, No. 80039, No. 80029, or No. 80019, respectively. A typical SSR clip is shown in Figure 2.

2.2.3 Fasteners: Each SSR clip is attached to intermediate purlin framing members using two $^{1}/_{4}$-inch-diameter (6.4 mm) (No. 14) by $1^{1}/_{4}$-inch-long (31.7 mm), self-drilling, self-tapping sheet metal screws. When required, panel edges are attached to eave purlins (boundary diaphragm members) using five $^{1}/_{4}$-inch-diameter (6.4 mm) (No. 14) by $1^{1}/_{8}$-inch-long (28.6 mm), self-drilling, self-tapping sheet metal screws.

2.2.4 Varco-Pruden Reinforcing Clamps: The VP Reinforcing Clamps are extruded from 6060–T5 aluminum. Each clamp is fastened with a $^{3}/_{8}$-inch-diameter (9.5 mm), group 1 (304) stainless steel bolt complying with ASTM F 593. A typical clamp is shown in Figure 3 and a typical clamp installation is shown in Figure 6.

2.2.5 Roof Purlins: Roof purlins supporting the VP SSR panels must be designed to meet code requirements. The minimum thickness of purlins is dependent on the allowable wind uplift capacities shown in Table 4. All purlins must have a minimum yield strength of 55 ksi (379 MPa).

2.2.6 Sub-Purlins: Varco-Pruden sub-purlins are used in conjunction with the VP Standing Seam Roof clips to achieve higher wind uplift capacities for the VP Standing Seam Roof panels. The sub-purlins are cold-formed from ASTM A 572, Grade 55, steel with a minimum nominal base-metal thickness of 0.120 inch (3.1 mm). Varco-Pruden sub-purlins are designated Model No. SCS1, and are shown in Figure 4.

2.3 Allowable Loads:

2.3.1 Vertical Loads (Dead and Live): SSR panel section and strength properties are shown in Table 1. SSR panels must be supported by the VP Standing Seam Roof Clips at every panel seam along the length of each purlin. The allowable vertical capacity of all VP Standing Seam Roof Clips is 1,047 pounds (4,659 N).

2.3.2 In-plane Lateral Loads (Diaphragm Shear): Three diaphragm fastening schedules are recognized in this evaluation report:

1. Field/Normal Seam (Floating Eave): Diaphragm field attachment determined by wind uplift with no attachment at diaphragm eave or ridge (floating eave condition). Refer to Section 2.4.1 of this evaluation report for installation requirements and Table 2 for allowable diaphragm capacity.
2. Field/Button-Punch Seam (Floating Eave): Diaphragm field attachment determined by wind uplift with no eave or ridge attachments, but all SSR panel seams must be

button-punched with a Varco-Pruden SSR seaming tool. Refer to Section 2.4.2 of this evaluation report for installation requirements and Table 2 for allowable diaphragm capacity.

3. Field/Button-punched Seam plus Eave/Ridge Attachment: Diaphragm field attachment determined by wind uplift with condition and all SSR panel seams must be button-punched with a Varco-Pruden SSR seaming tool. Additionally, the panels must be fastened to eave and ridge framing in accordance with Section 2.3.4 of this evaluation report. Refer to Tables 2A and 2B for allowable.

Maximum drag strut loads that can be transferred into the SSR diaphragm are shown in Table 3. Stiffness values that are used to determine longitudinal strut deflections are also shown in Table 3.

Diaphragm deflections must not exceed the permitted relative deflections for walls between the diaphragm level and the floor below. Refer to Table 5 for diaphragm flexibility and deflection limits.

2.3.3 Wind Loads (Uplift): VP Standing Seam Roof panel systems have allowable uplift capacities shown in Table 4 when installed as described as follows:

System 1: Consists of either No. 22 or No. 24 gage SSR panels; SSR panel clips; and 0.059-inch-thick roof purlins spaced 5 feet on center. See Figure 5.

System 1A: Consists of either No. 22 or No. 24 gage SSR panels; SSR panel clips; and 0.120-inch-thick roof purlins spaced 5 feet on center. See Figure 5.

System 2: Consists of either No. 22 or No. 24 gage SSR panels; SSR panel clips; SSR reinforcing seam clamps over the SSR roof panels at each SSR roof clip; and 0.120-inch-thick roof purlins spaced 5 feet on center. See Figure 6.

System 3: Consists of either No. 22 or No. 24 gage SSR panels; SSR panel clips; and 0.059-inch-thick roof purlins spaced 2.5 feet on center. See Figure 5.

System 3A: Consists of either No. 22 or No. 24 gage SSR panels; SSR panel clips; and 0.120-inch-thick roof purlins spaced 2.5 feet on center. See Figure 5.

System 4: Consists of either No. 22 or No. 24 gage SSR panels; SSR panel clips; Varco-Pruden's standard Z-shaped subpurlins placed between the roof purlins and SSR clips; SSR reinforcing seam clamps over the SSR roof panels at each SSR roof clip; and 0.059-inch-thick roof purlins spaced 2.5 feet on center. See Figure 7

2.4 Installation:

2.4.1 General: SSR Panels are installed having field attachment requirements based on wind uplift capacity (refer to Section 2.3.3 of this evaluation report) and eave/ridge attachment requirements based on diaphragm shear capacity (refer to Section 2.3.2).

For all diaphragms, each SSR roof clip located at eave ends of the SSR panels must be attached to the steel boundary purlins using a minimum of five $^1/_4$-inch-diameter (6.4 mm) (No. 14) by $1^1/_8$-inch-long (28.6 mm), self-drilling, self-tapping, corrosion-resistant sheet metal screws.

Each SSR roof clip located in the field of a diaphragm must be installed at a panel seam [24 inches (610 mm) on center], and must attach the SSR panels to intermediate framing members (purlins) using two $^1/_4$–14 by $1^1/_4$-inch-long (31.7 mm), self-drilling, self-tapping sheet metal screws. Maximum spacing of roof purlins is either 2.5 (762 mm) or 5 feet (1524 mm), depending on the wind uplift capacity shown in Table 4. Side lap seams must be field-formed by mechanically crimping the roof panel laps to the No. 28 gage top section of the SSR roof clip.

When System 4 is used for increased wind uplift capacity, the Z-shaped subpurlins described in Section 2.2.6 of this report must be continuous and must be installed parallel to the SSR panel length and sandwiched between the SSR clips and the roof purlins. A typical Z-shaped subpurlin installation is shown in Figure 7.

Roof purlins supporting the SSR roof panels must have a minimum base-metal thickness as described in Section 2.3.3 of this evaluation report, except the roof purlins at the ridge and at the eave must have a minimum 0.0622-inch (1.6 mm) base-metal thickness.

2.4.2 Field/Normal Seam (Floating Eave Condition): SSR clips at 24 inches (610 mm) on center attach the panels to intermediate framing members spaced either 5 feet (1524 mm) or 2.5 feet (762 mm) on center, depending on the allowable uplift capacity. Each clip must be attached to a framing member using two or three $^1/_4$–14 by $1^1/_4$-inch-long (31.7 mm), self-drilling, self-tapping sheet metal screws. The number of screws depends on the wind uplift capacity desired. Refer to Table 4. The No. 28 gage tab portion of the clip must be nested in the panel sidelaps. The sidelap seams are field-formed by mechanically crimping the roof panel laps using a Varco-Pruden seamer supplied by the panel manufacturer.

2.4.3 Field/Button-Punch Seam (Floating Eave Condition):

The panels are installed in a manner similar to that for the Field/Normal Seam assembly described in Section 2.4.2. In addition, the high-rib seams of the panel are set with button punches to achieve additional diaphragm strength and stiffness. Sidelap seams must be seamed together using the Varco-Pruden SSR seaming tool that forms button punches that measure 0.04 inch (1 mm) in depth. Button punches must be spaced 3.125 inches (86 mm) on center. Refer to Figure 8 for details of the Varco-Pruden SSR seaming tool.

2.4.4 Field/Button-Punch Seam plus Eave-Gutter (Screwed Condition): The panels are installed in a manner similar to that for the Field/Button-Punch Seam assembly described in Section 2.4.3; however, to achieve additional diaphragm strength and stiffness, the panels are fastened to eave and ridge framing members using 12-14 by $1^1/_4$-inch-long (31.7 mm) fasteners. Five screws must be installed, per panel, as shown in Figure 9.

2.5 Identification:

Panels, clips, clamps, and subpurlins bear a label or tag noting the manufacturer's name (VP Buildings, Inc.) and the evaluation report number (ER-5621). Labels for the panels also identify the deck type and the thickness.

3.0 EVIDENCE SUBMITTED

Data in accordance with the Acceptance Criteria for Steel Decks (AC43), dated January 2002, and quality control manuals.

4.0 FINDINGS

That the Varco-Pruden Steel Decks described in this report comply with the 1997 *Uniform Building Code*™, subject to the following conditions:

4.1 Panels are manufactured and installed in accordance with this report and the manufacturer's instructions.

4.2 A one-third increase in allowable shear values is not permitted for horizontal forces due to earthquake or wind.

This report is subject to re-examination in one year.

TABLE 1—SECTION AND STRENGTH PROPERTIES FOR VP STANDING SEAM ROOF PANEL[1,2,3]

PANEL TYPE	GAGE	BASE-METAL THICKNESS (inch)	DECK TOP IN COMPRESSION			DECK BOTTOM IN COMPRESSION		
			I (inch^4)	M_a (inch-kip)	V_a (kip)	I (inch^4)	M_a (inch-kip)	V_a (kip)
VP Standing Seam Roof Panel	24	0.0220	0.291	3.593	0.516	0.129	2.335	0.516
	22	0.0273	0.361	4.491	0.795	0.170	2.994	0.795

For **SI:** 1 inch = 25.4 mm, 1 inch-kip = 0.113 kN-m, 1 kip = 4.448 kN.

[1]Tabulated values are based on a 1-foot-wide section. See Figure 1 for steel deck profile.

[2]Moment of inertia, I, is for deflection determination of uniformly loaded panels, $I = (I_x + 2I_{on})/3$, where I_x = Full moment of inertia and I_{on} = Effective moment of inertia, normal position.

[3]When combined stresses are considered, interaction formulae from the code must be used.

TABLE 2—ALLOWABLE DIAPHRAGM SHEAR AND SHEAR STIFFNESS[1]

PANEL CONDITION	ALLOWABLE SHEAR[2] (pounds per foot)	SHEAR STIFFNESS [3], G' (kips per inch)
Field (normal seam)	18	1.0 K/in.
Field (button-punched seam)	72	1.24 K/in.
Field seamed plus eave/ridge attachment	See Tables 2a and 2b	

For **SI:** 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 lb./ft. = 14.59 N/m, 1 kip/inch = 175 kN/m.

[1]The one-third increase normally allowed for allowable stresses shall not be used for resistance to horizontal forces due to earthquake or wind.

[2]For resistance to horizontal forces due to wind, the allowable shears shall be permitted to be increased by a factor of 1.06.

[3]See Table 5 for diaphragm deflection computations.

TABLE 2a—ALLOWABLE SEISMIC (1) DIAPHRAGM STRENGTH, NORMAL SEAM PLUS EAVE ATTACHMENT (pounds)

BLDG. LENGTH	EAVE TO RIDGE									
	20	40	60	80	100	120	140	160	180	200
20	1131	746	617	553	514	489	470	456	446	437
40	2262	1491	1234	1106	1028	977	940	913	891	874
60	3393	2237	1851	1658	1543	1466	1410	1369	1337	1311
80	4524	2982	2468	2211	2057	1954	1881	1826	1783	1748
100	5655	3728	3085	2764	2571	2443	2351	2282	2228	2186
120	6786	4473	3702	3317	3085	2931	2821	2738	2674	2623
140	7917	5219	4319	3869	3599	3420	3291	3195	3120	3060
160	9048	5964	4936	4422	4114	3908	3761	3651	3565	3497
180	10,179	6710	5553	4975	4628	4397	4231	4107	4011	3934
200	11,310	7455	6170	5528	5142	4885	4701	4564	4457	4371
300	16,965	11,183	9255	8291	7713	7328	7052	6846	6685	6557
400	22,620	14,910	12,340	11,055	10,284	9770	9403	9128	8913	8742
500	28,275	18,638	15,425	13,819	12,855	12,213	11,754	11,409	11,142	10,928
600	33,930	22,365	18,510	16,583	15,426	14,655	14,104	13,691	13,370	13,113
700	39,585	26,093	21,595	19,346	17,997	17,098	16,455	15,973	15,598	15,299
800	45,240	29,820	24,680	22,110	20,568	19,540	18,806	18,255	17,827	17,484

[1]For wind allowable load, multiply table values by 1.06.

[2]Interpolation between values is permissible.

[3]For deflection calculations, use G = 1.0 K/in.

TABLE 2b—ALLOWABLE SEISMIC (1) DIAPHRAGM STRENGTH, BUTTON-PUNCHED SEAM PLUS EAVE ATTACHMENT (pounds)

BLDG. LENGTH	EAVE TO RIDGE									
	20	40	60	80	100	120	140	160	180	200
20	2211	1826	1697	1633	1594	1569	1550	1536	1526	1517
40	4422	3651	3394	3266	3188	3137	3100	3073	3051	3034
60	6633	5477	5091	4898	4783	4706	4650	4609	4577	4551
80	8844	7302	6788	6531	6377	6274	6201	6146	6103	6068
100	11,055	9128	8485	8164	7971	7843	7751	7682	7628	7586
120	13,266	10,953	10,182	9797	9565	9411	9301	9218	9154	9103
140	15,477	12,779	11,879	11,429	11,159	10,980	10,851	10,755	10,680	10,620
160	17,688	14,604	13,576	13,062	12,754	12,548	12,401	12,291	12,205	12,137
180	19,899	16,430	15,273	14,695	14,348	14,117	13,951	13,827	13,731	13,654
200	22,110	18,255	16,970	16,328	15,942	15,685	15,501	15,364	15,257	15,171
300	33,165	27,383	25,455	24,491	23,913	23,528	23,252	23,046	22,885	22,757
400	44,220	36,510	33,940	32,655	31,884	31,370	31,003	30,728	30,513	30,342
500	55,275	45,638	42,425	40,819	39,855	39,213	38,754	38,409	38,142	37,928
600	66,330	54,765	50,910	48,983	47,826	47,055	46,504	46,091	45,770	45,513
700	77,385	63,893	59,395	57,146	55,797	54,898	54,255	53,773	53,398	53,099
800	88,440	73,020	67,880	65,310	63,768	62,740	62,006	61,455	61,027	60,684

[1]For wind allowable load, multiply table values by 1.06.
[2]Interpolation between values is permissible.
[3]For deflection calculations, use G = 1236 lbs./in.

TABLE 3—STRUT-PURLIN TRANSFER LOADS AND STIFFNESSES[1]

STRENGTH, S_n (plf)	STIFFNESS, K (lbs./in./ft.)
350	186

For **SI:** 1 lb./ft. = 14.59 N/m, 1 lb./inch/ft = 0.574 N/mm/m.

[1]The deflection for any strut can be determined by dividing the strut load by the strut length and by 186.

TABLE 4—UPLIFT CAPACITIES

SYSTEM[1]	PURLIN SPACING[2] (feet)	PURLIN THICKNESS (inch)	SUBPURLINS	SEAM CAP	NUMBER OF SCREWS, SSR CLIP TO PURLIN	ULTIMATE LOAD (psf)	ALLOWABLE UPLIFT LOAD (psf)
1	5.0	0.059[1]	No	No	2	65.9	37.4
1A	5.0	0.120	No	No	2	71.1	40.4
2	5.0	0.120	No	Yes	3	88.8	49.5
3	2.5	0.059[1]	No	No	2	111.0	63.1
3A	2.5	0.120	No	No	2	117.9	67.0
4	2.5	0.059	Yes	Yes	3	172.0	99.0

For **SI:** 1 inch = 25.4 mm, 1 foot = 304.8 mm.

[1]Tabulated uplift capacities are for the following SSR-panel/SSR-panel-clips/roof-purlin systems:
System 1: Consists of either No. 22 or No. 24 gage SSR panels; SSR panel clips; and 0.059-inch-thick roof purlins spaced 5 feet on center. See Figure 5.
System 1A: Consists of either No. 22 or No. 24 gage SSR panels; SSR panel clips; and 0.120-inch-thick roof purlins spaced 5 feet on center. See Figure 5.
System 2: Consists of either No. 22 or No. 24 gage SSR panels; SSR panel clips; SSR reinforcing seam clamps over the SSR roof panels at each SSR roof clip; and 0.120-inch-thick roof purlins spaced 5 feet on center. See Figure 6.
System 3: Consists of either No. 22 or No. 24 gage SSR panels; SSR panel clips; and 0.059-inch-thick roof purlins spaced 2.5 feet on center. See Figure 5.
System 3A: Consists of either No. 22 or No. 24 gage SSR panels; SSR panel clips; and 0.120-inch-thick roof purlins spaced 2.5 feet on center. See Figure 5.
System 4: Consists of either No. 22 or No. 24 gage SSR panels; SSR panel clips; Varco-Pruden's standard Z-shaped subpurlins placed between the roof purlins and SSR clips; SSR reinforcing seam clamps over the SSR roof panels at each SSR roof clip; and 0.059-inch-thick roof purlins spaced 2.5 feet on center. See Figure 7.
[2]Roof purlins must have a minimum base-metal thickness as described above, except the roof purlins at the ridge and at the eave must have a minimum 0.0622-inch (1.6 mm) base-metal thickness.

TABLE 5—DEFLECTION OF SHEAR DIAPHRAGMS

TYPE OF DIAPHRAGM	LOADING CONDITION	Δb	Δs
Simple beam (at center)	Uniform load	$\frac{5wL^4(12)^3}{384EI}$	$\frac{wL^2}{BG'b}$
Simple beam (at center)	Load P applied at center	$\frac{PL^3(12)^3}{48EI}$	$\frac{PL}{4G'b}$
Simple beam (at center)	Load P applied $^1/_3$ points of span	$\frac{23PL^3(12)^3}{648EI}$	$\frac{PL}{3G'b}$
Cantilever beam (at free end)	Uniform load	$\frac{wa^4(12)^3}{8EI}$	$\frac{wa^2}{2G'b}$
Cantilever beam (at free end)	Load P applied at free end	$\frac{Pa^3(12)^3}{3EI}$	$\frac{Pa}{G'b}$

The total deflection of shear diaphragm consists of both the bending and shear deflections:

$$\Delta_{total} = \Delta_b + \Delta_s$$

where:

Δ_{total} = Total deflection of shear diaphragm, inch.

Δ_b = Bending deflection, inch.

Δ_s = Shear deflection including the deflection due to seam slip and profile distortion, inch.

where:

E = Modulus of elasticity of steel, 29,500 ksi.

I = Moment of inertia of flange perimeter members about the centroidal axis of the diaphragm.

G' = Shear stiffness of the diaphragm obtained from test (kip/inch); $G' = K_n + C_e/b$.

L = Span length of a simple beam (feet).

a = Span length of cantilever beam (feet).

b = Depth of analogous beam (feet).

P = Concentrated load (kip).

w = Uniform load (kip/feet).

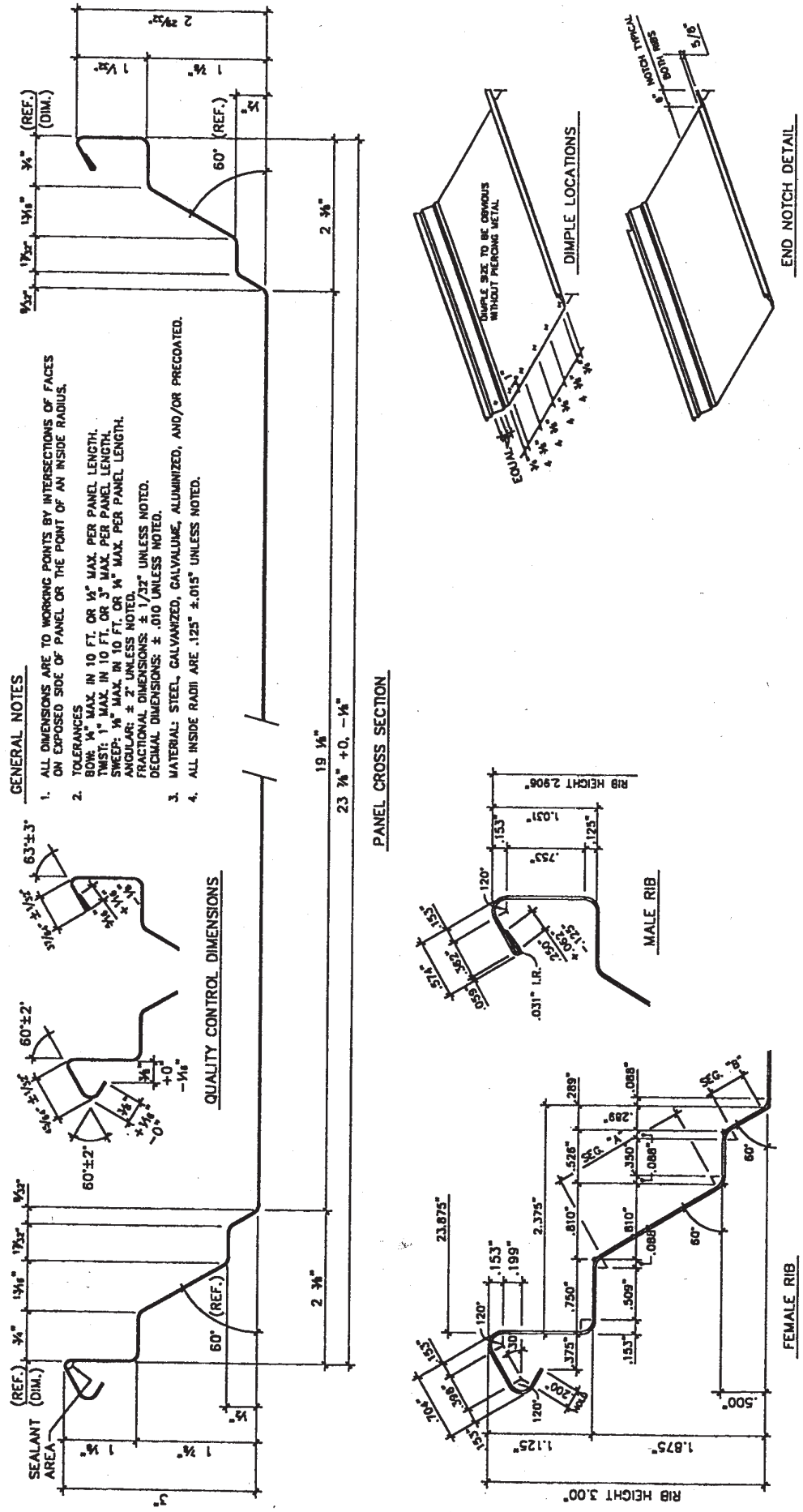
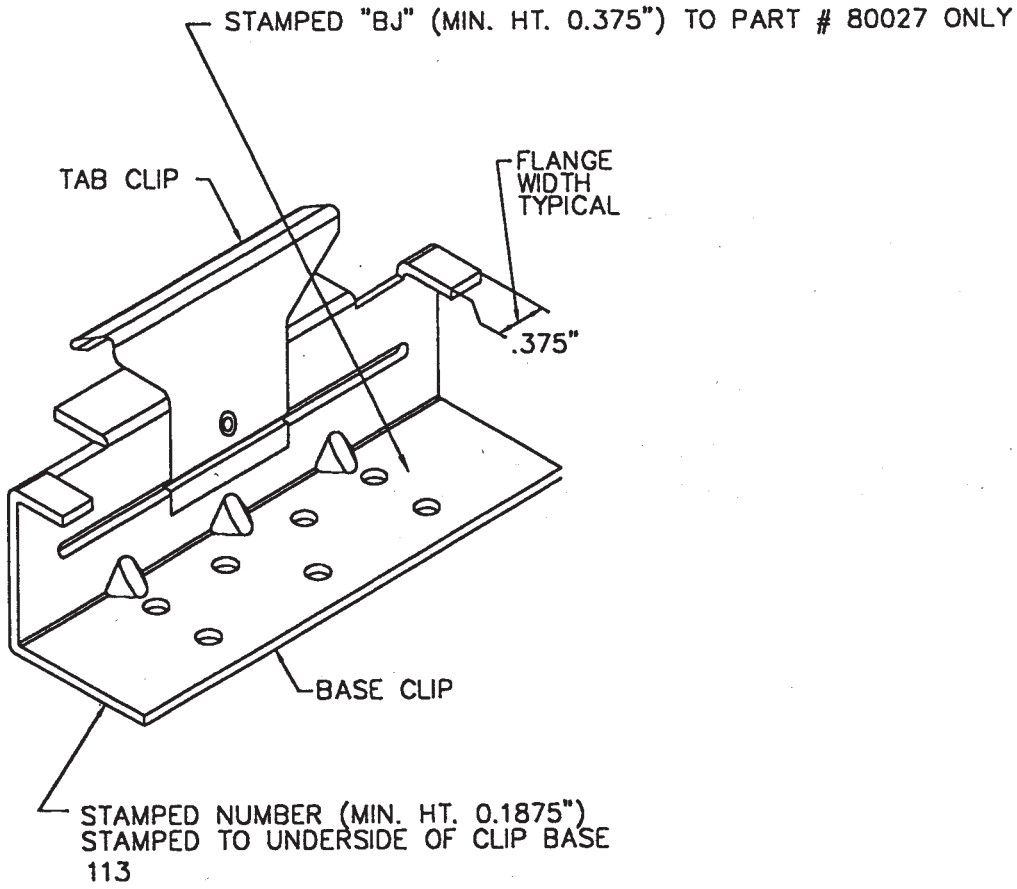


FIGURE 1—STANDING SEAM ROOF PANEL



MATERIAL REQUIREMENTS

TAB MATERIAL:
ASTM A653 GRADE 50
G-90 GALVANIZED
0.0187" MIN. THICKNESS
0.0247" MAX. THICKNESS

BASE MATERIAL:
ASTM A653 GRADE 50
G-90 GALVANIZED
0.097" MIN. THICKNESS

FIGURE 2—SSR ROOF CLIP

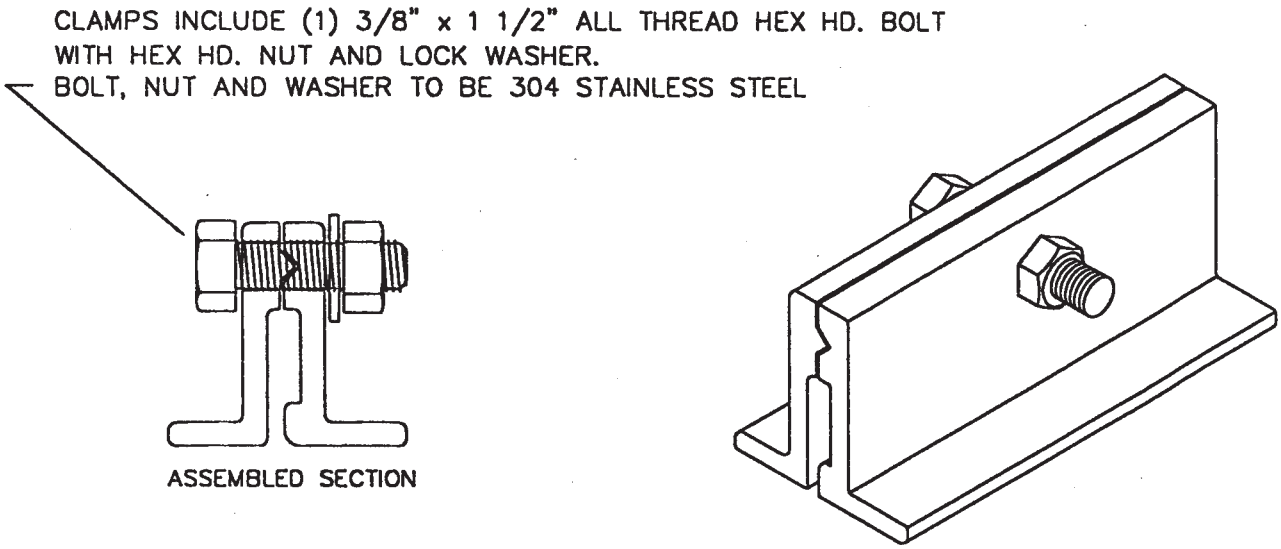
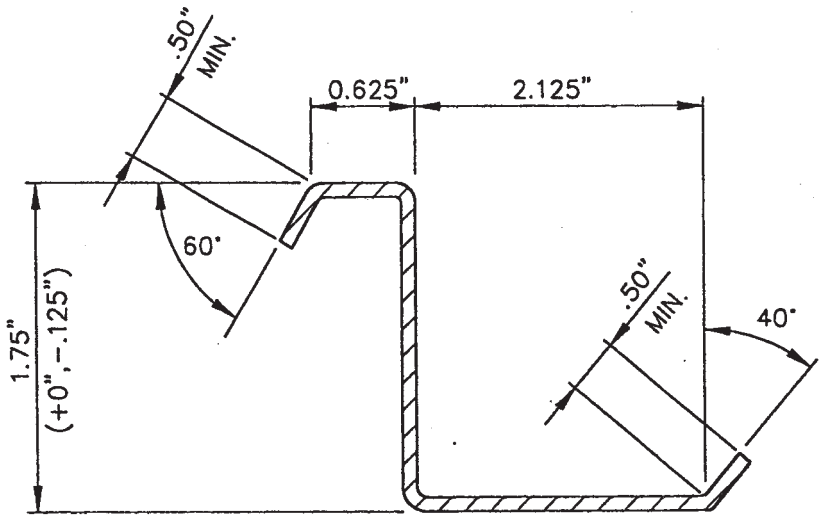


FIGURE 3—VARCO-PRUDEN REINFORCING CLIP



PART MARK: SCS1
BLANK: 5 1/2"
LENGTH: 20'-0"
MATERIAL: .120 ASTM A572, GRADE 55
WEIGHT: 44.9 LBS.

FIGURE 4—VP STANDING SEAM ROOF SUBPURLIN

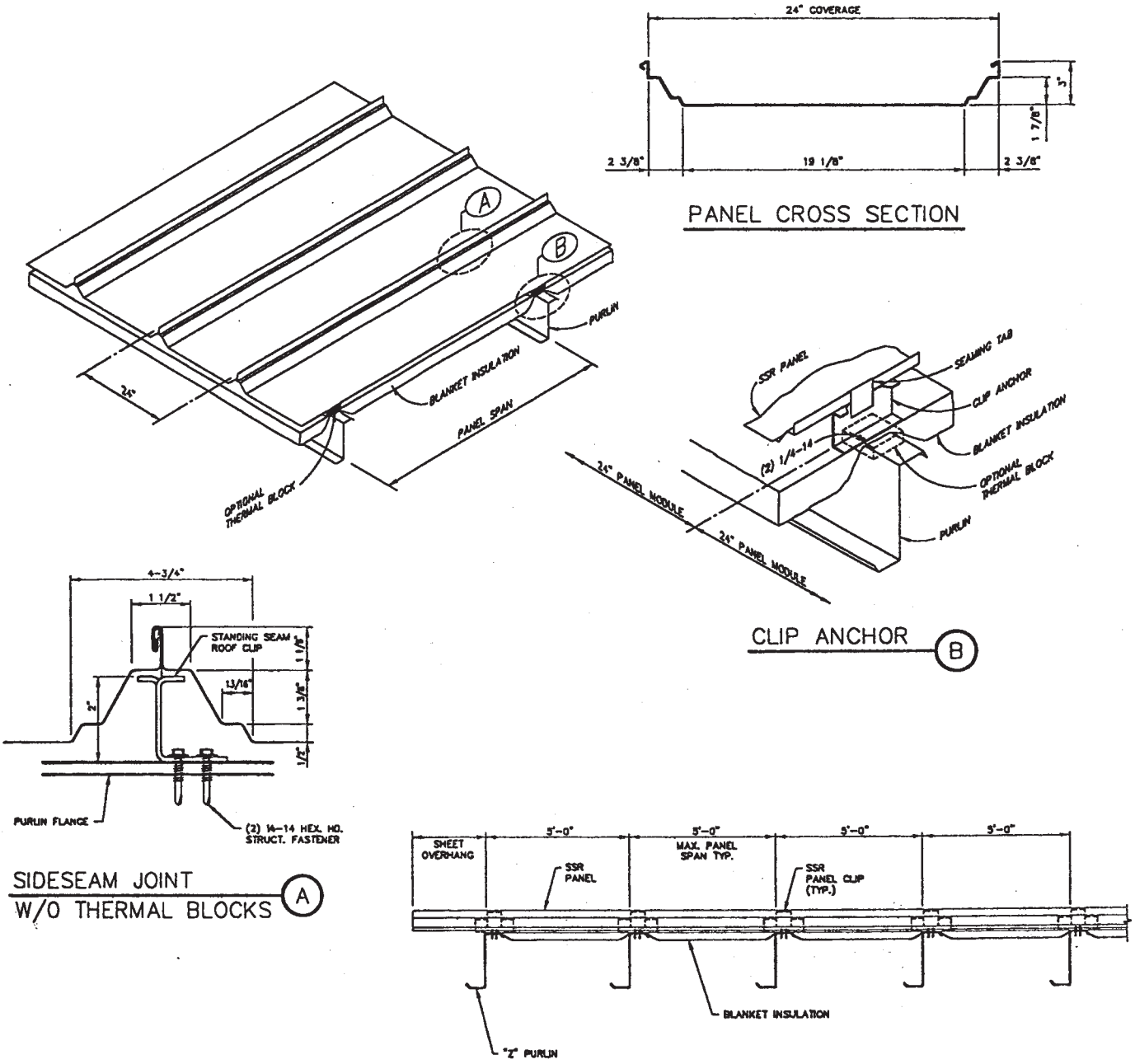


FIGURE 5—SYSTEMS 1, 1A, 3 AND 3A

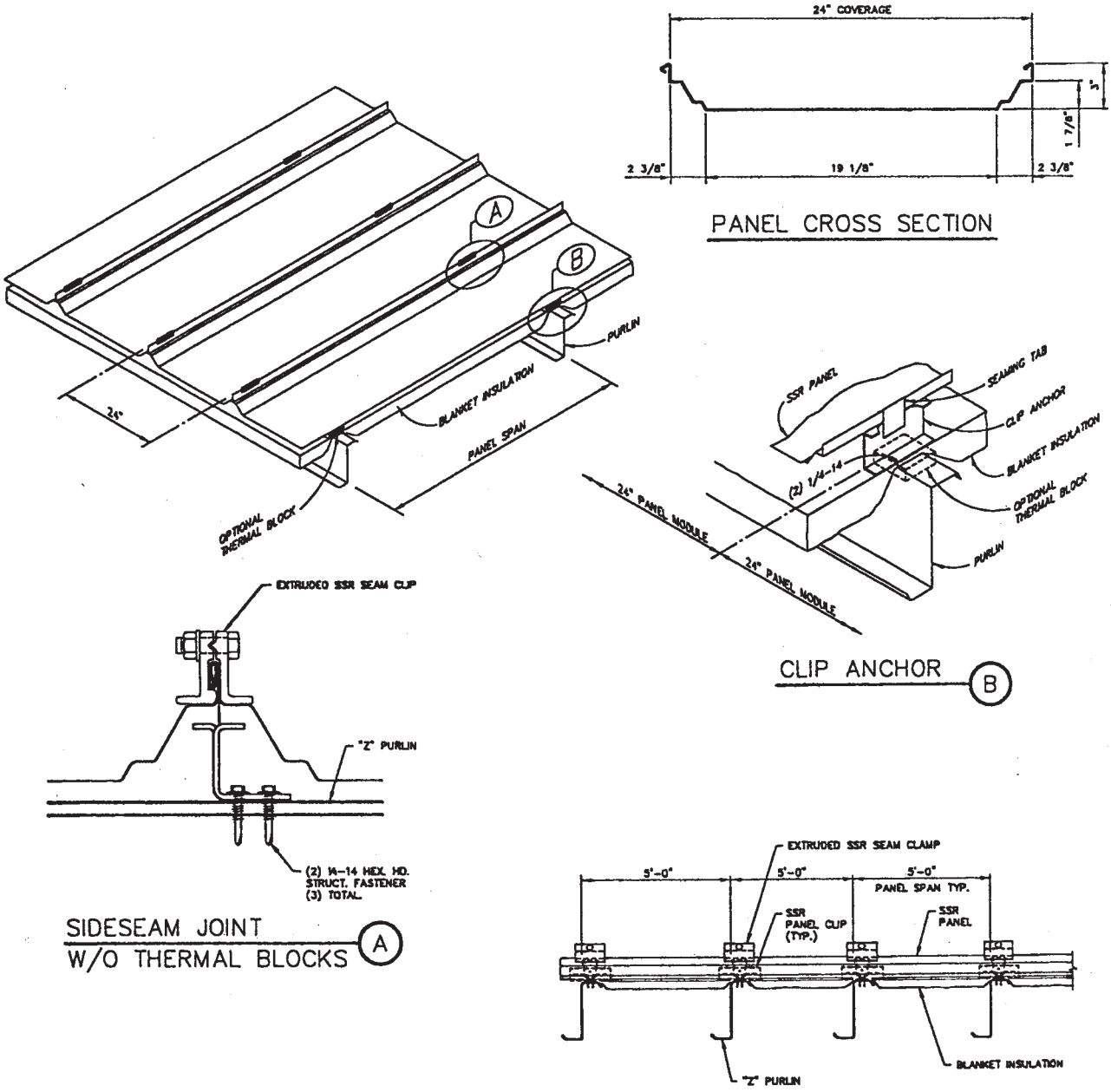


FIGURE 6—SYSTEM 3

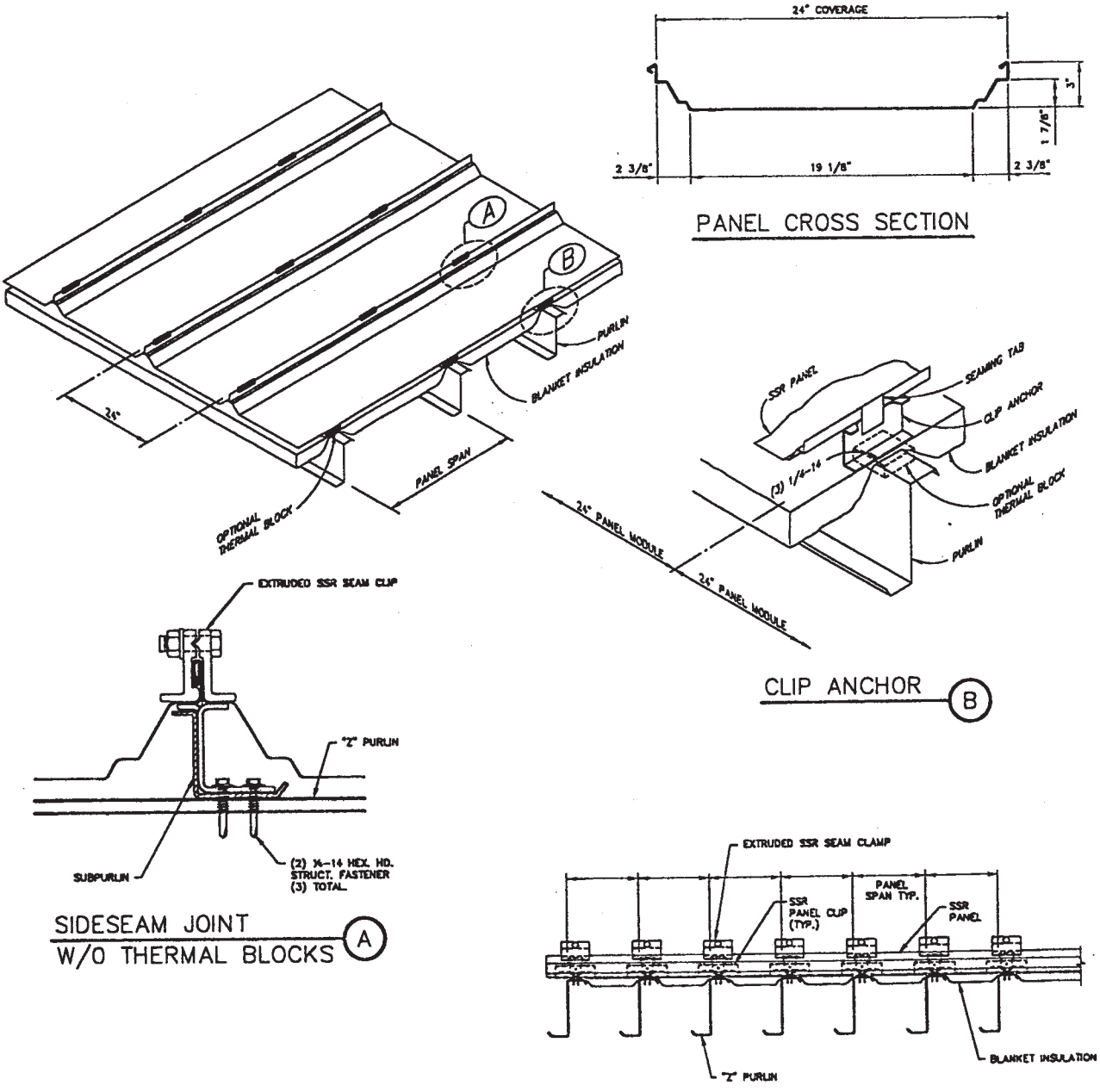


FIGURE 7—SYSTEM 4

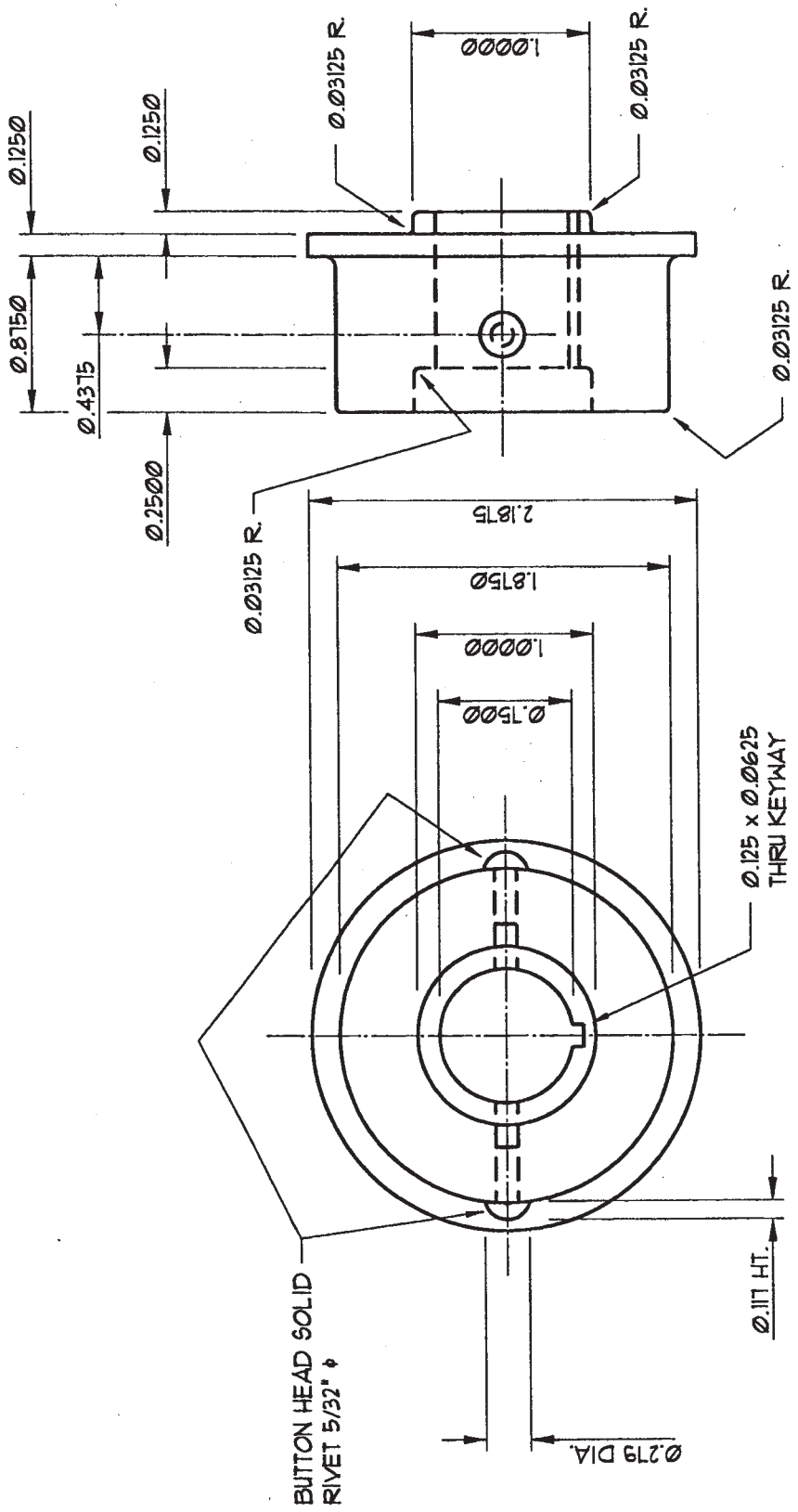


FIGURE 8—BUTTON PUNCH ROLLER FOR VP SEAMER

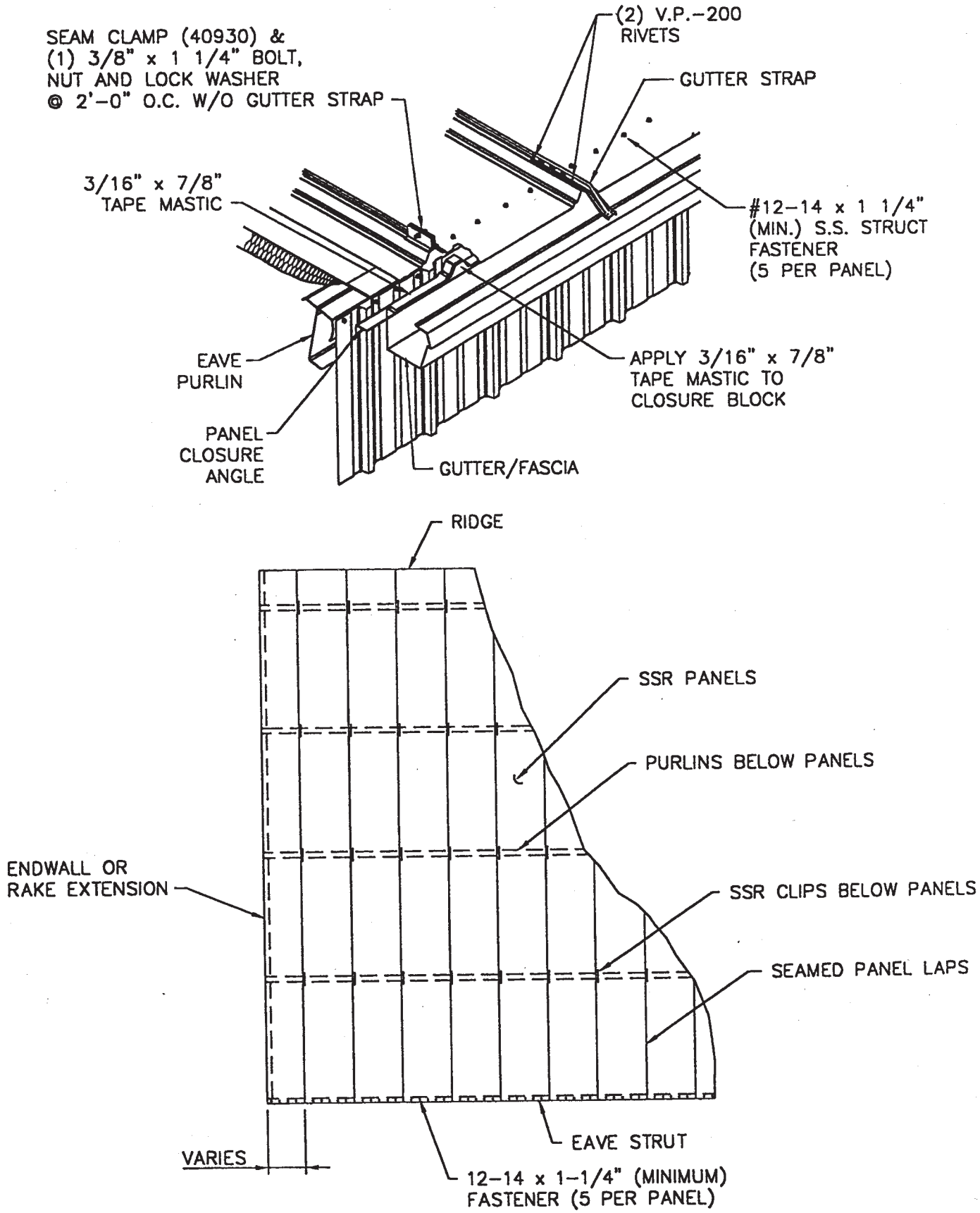


FIGURE 9—STANDING SEAM DIAPHRAGM LAYOUT WITH SCREWED EAVE CONDITION DETAIL