
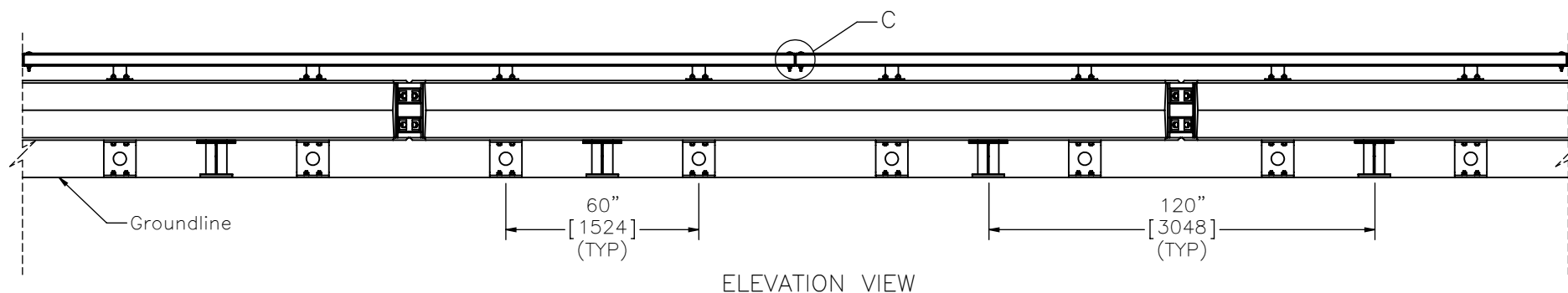
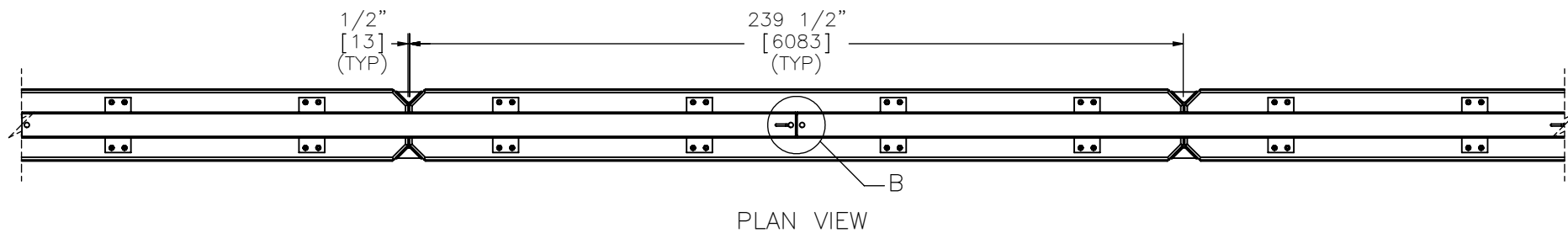


- Notes: (1) Impact location is 51 3/16" [1300] upstream from joint between barrier nos. 5 and 6.
- (2) Overall nominal height of barrier may decrease once assembled due to the weight of the rail on rubber.

	SAFER For Highway - Angle Joint (SFH-1)		SHEET: 1 of 23
	System Layout		DATE: 3/24/2015
Midwest Roadside Safety Facility	DWG. NAME: SFH-1_R10		DRAWN BY: SDB/JGP/JEK
	SCALE: 1:300 UNITS: in./mm		REV. BY: JDS/SKR/KAL



Midwest Roadside
Safety Facility

SAFER For Highway -
Angle Joint (SFH-1)

Barrier Assembly

DWG. NAME.
SFH-1_R10

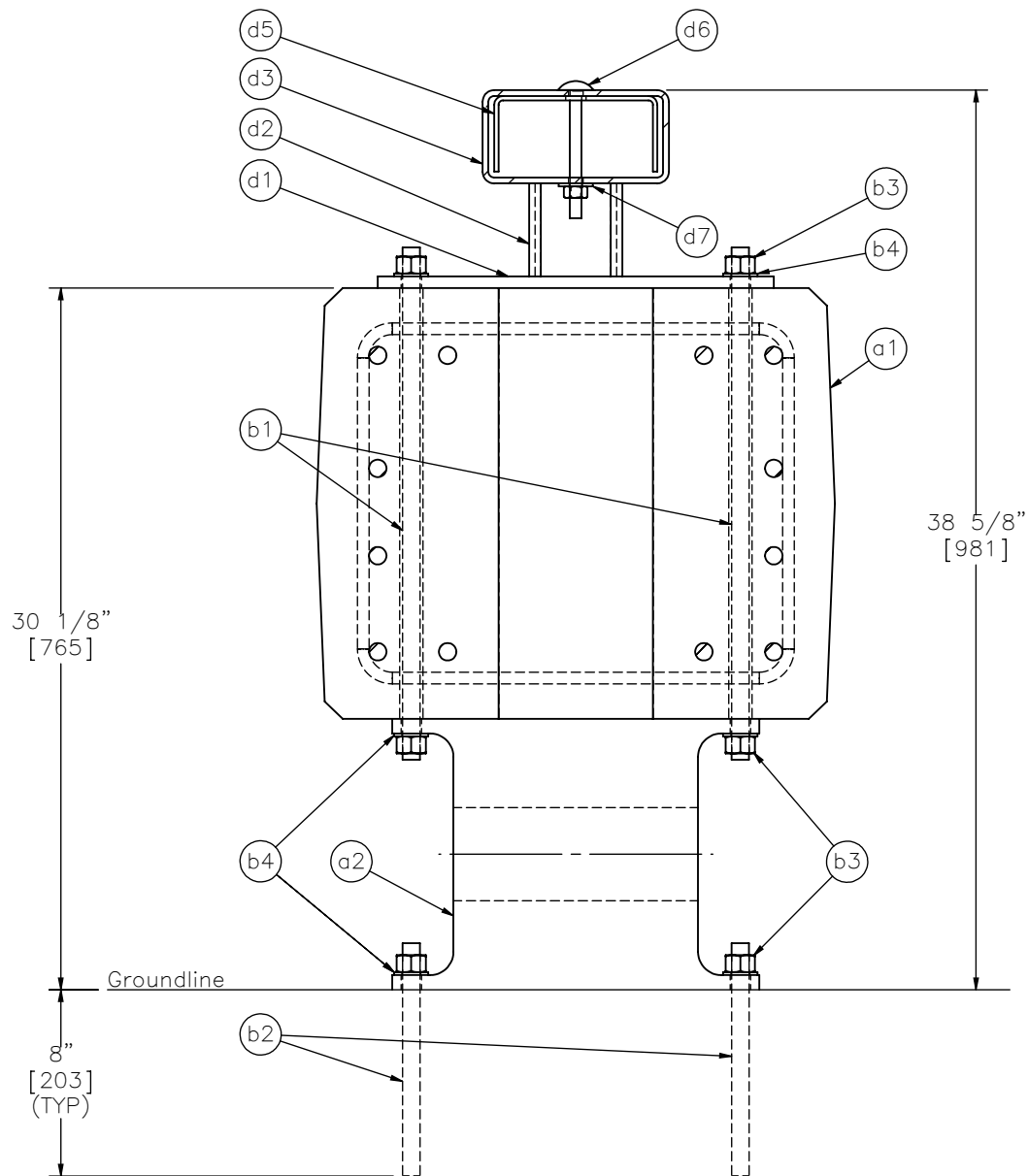
SCALE: 1:50
UNITS: in./mm

SHEET:
2 of 23

DATE:
3/24/2015

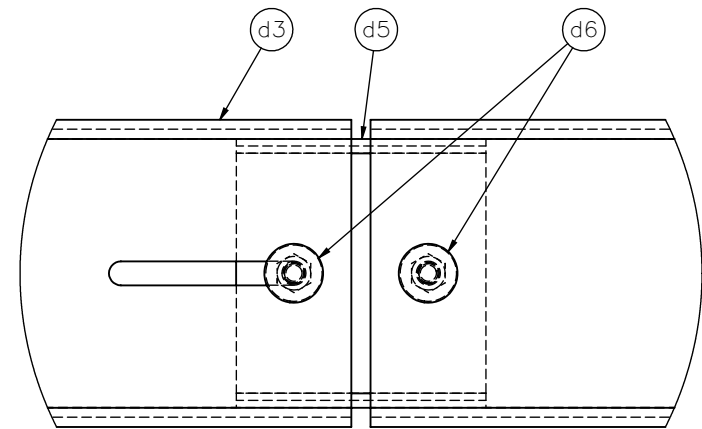
DRAWN BY:
SDB/JGP/JE
K

REV. BY:
JDS/SKR/
KAL

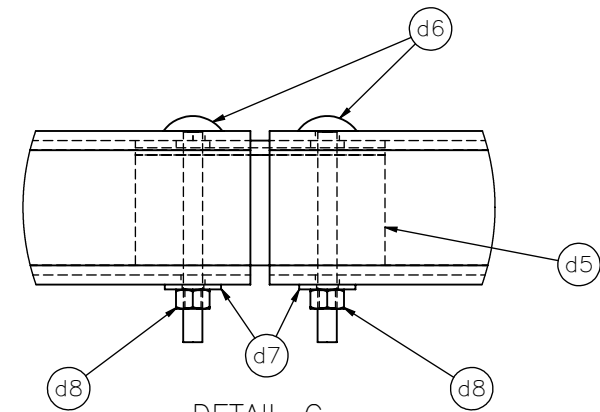


SECTION A-A

Notes: (1) Anchor part b2 into tarmac with HILTI HIT-RE500 epoxy.



DETAIL B
SCALE 1 : 5



DETAIL C
SCALE 1 : 5



Midwest Roadside
Safety Facility

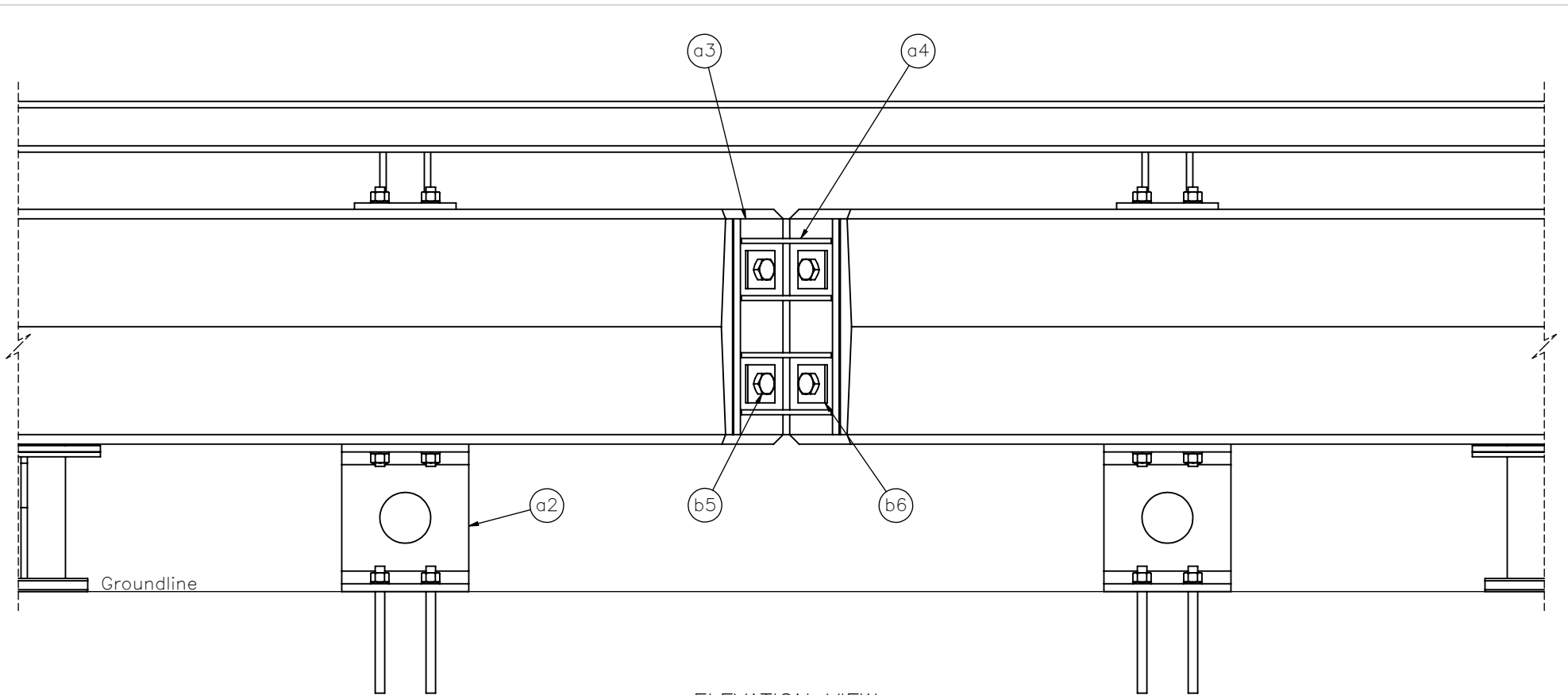
SAFER For Highway -
Angle Joint (SFH-1)

Post and Tubing Details

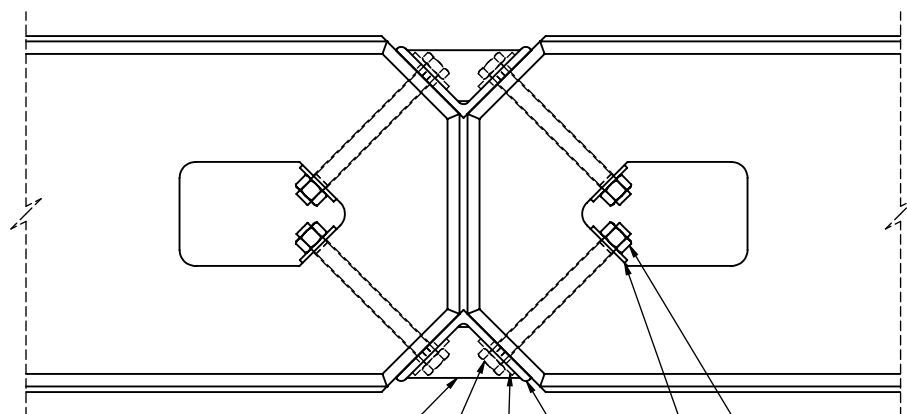
DWG. NAME.
SFH-1_R10

SCALE: 1:8
UNITS: in.[mm]

SHEET:
3 of 23
DATE:
3/24/2015
DRAWN BY:
SDB/JGP/JE
K
REV. BY:
JDS/SKR/
KAL



ELEVATION VIEW
SPICE DETAIL



PLAN VIEW
SPICE DETAIL

Notes: (1) Rebar, top steel tube assembly, and shear fenders removed from Plan View.



Midwest Roadside
Safety Facility

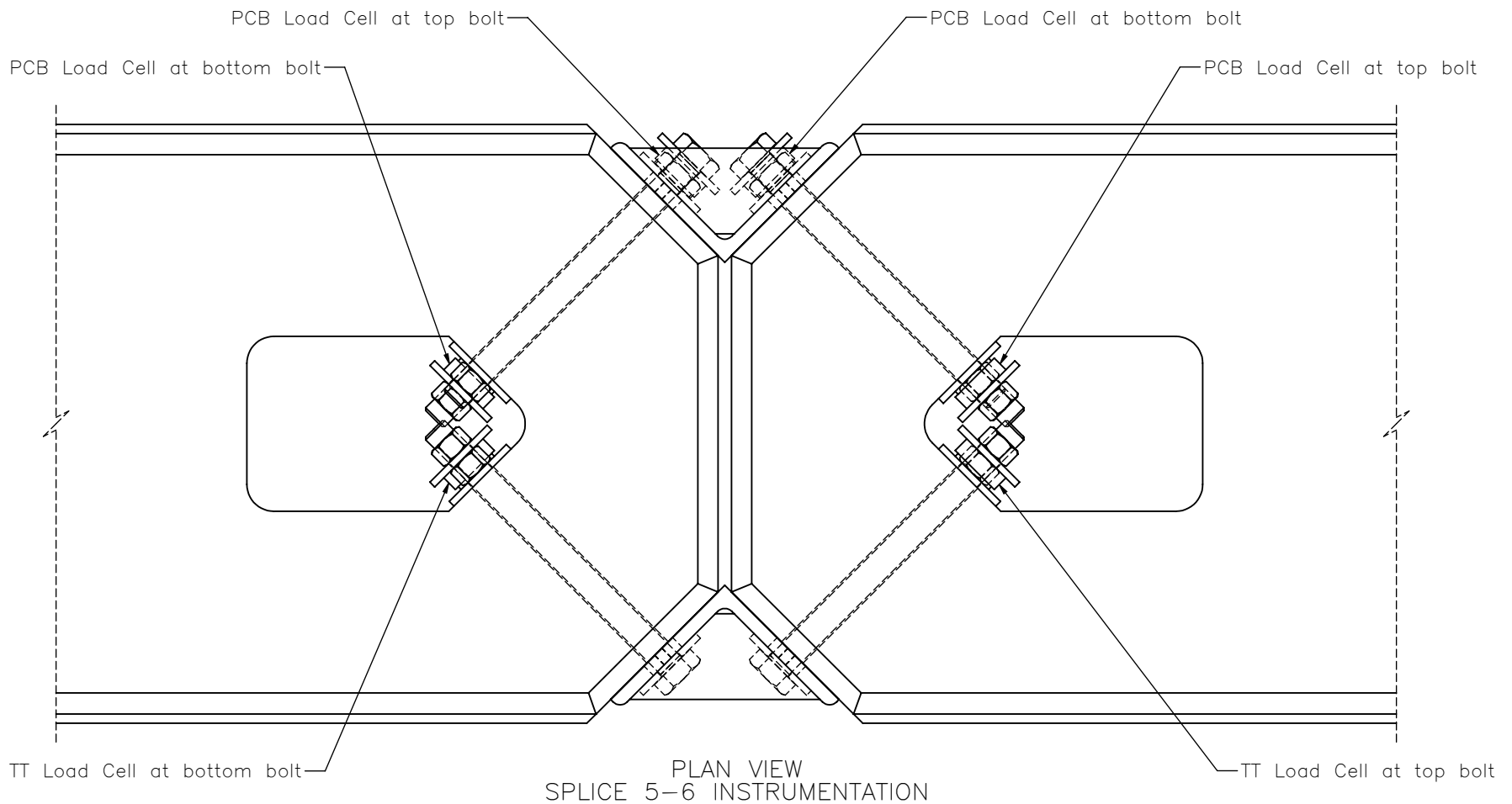
SAFER For Highway –
Angle Joint (SFH-1)

Splice Details

DWG. NAME.
SFH-1_R10

SCALE: 1:12
UNITS: in.[mm]

SHEET:
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DATE:
3/24/2015
DRAWN BY:
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REV. BY:
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KAL



Notes: (1) Rebar, top steel tube assembly, and shear fenders removed from Plan View.

(2) PCB Piezotronics 206C (PCB)
2.00" O.D.
1.024" I.D.
0.500" thickness

(3) Transducer, Technique LW0-80 (TT)
2.05" O.D.
1.025" I.D.
0.610" thickness

(4) Use additional 3"x3"x1/4" [76x76x6] plate washer if available to sandwich load cell.

(5) Anti-friction washer provided by PCB is optional.



Midwest Roadside
Safety Facility

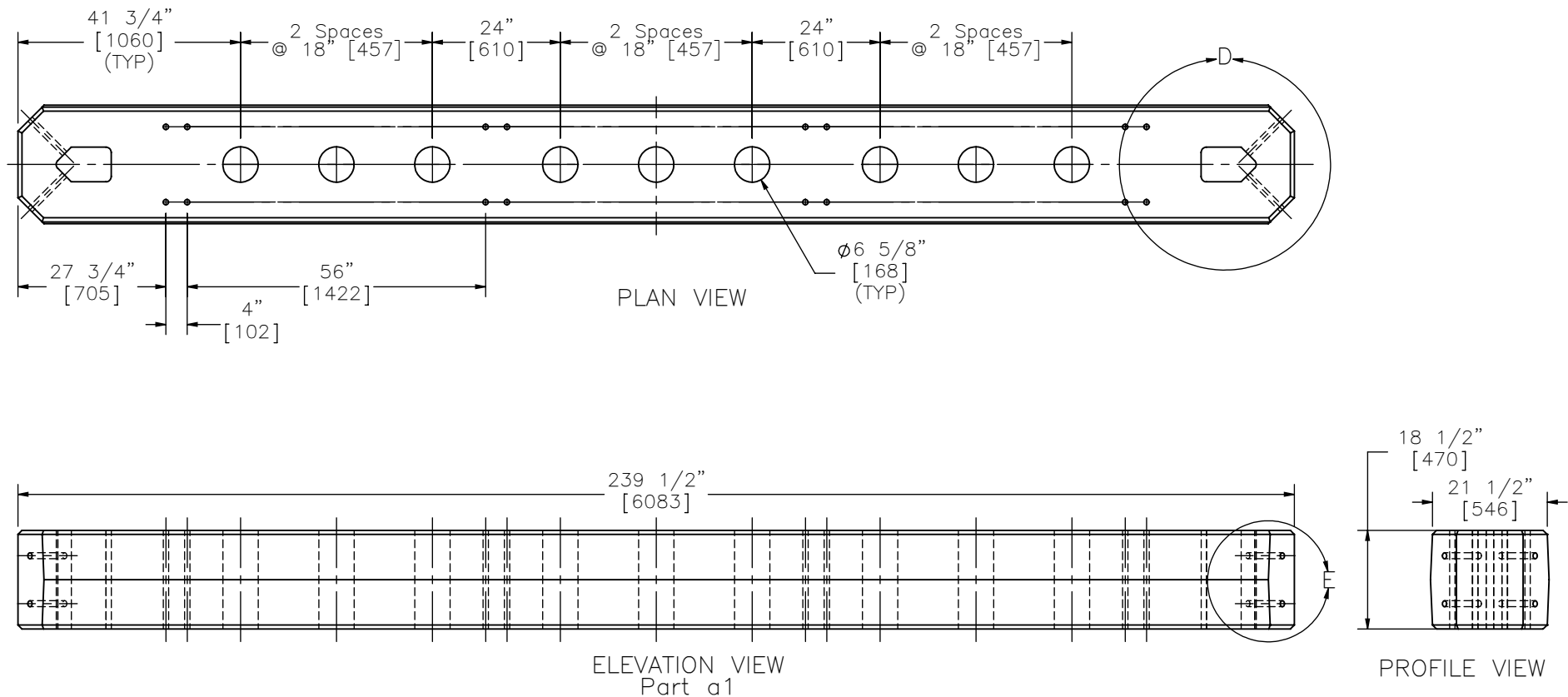
SAFER For Highway –
Angle Joint (SFH-1)

Splice 5-6 Instrumentation
Details

DWG. NAME:
SFH-1_R10

SCALE: 1:6
UNITS: in./mm

SHEET:
5 of 23
DATE:
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DRAWN BY:
SDB/JGP/JE
K
REV. BY:
JDS/SKR/
KAL



- Notes: (1) The $\phi 6 \frac{5}{8}"$ [168] through-hole can be cast around a $\phi 6"$ [152] PVC pipe, and then the pipe can later be removed.
- (2) The 3 surfaces at each end of the barrier must be vertical – front and back of rail drafted for casting purposes.
- (3) Internal Reinforcement not shown.
- (4) See as-built drawings from concrete industries for accurate rebar placement and more details.



Midwest Roadside
Safety Facility

SAFER For Highway –
Angle Joint (SFH-1)

Concrete Rail Geometry

DWG. NAME.
SFH-1_R10

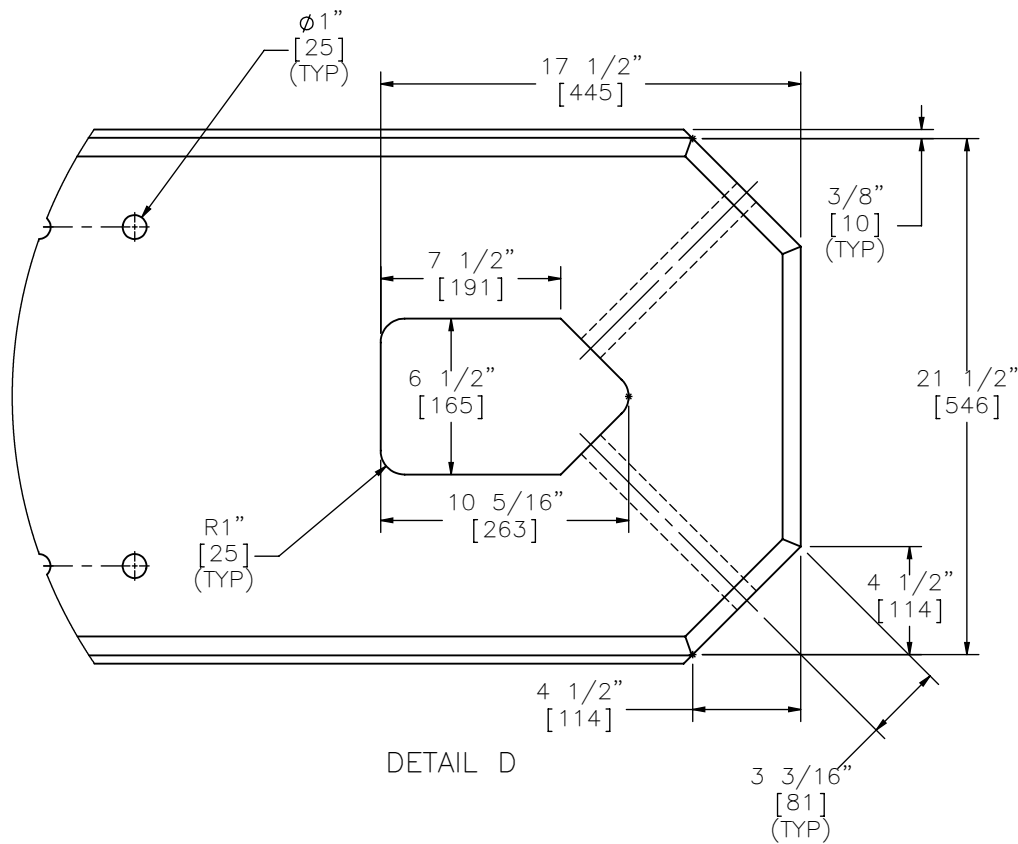
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UNITS: in./mm

SHEET:
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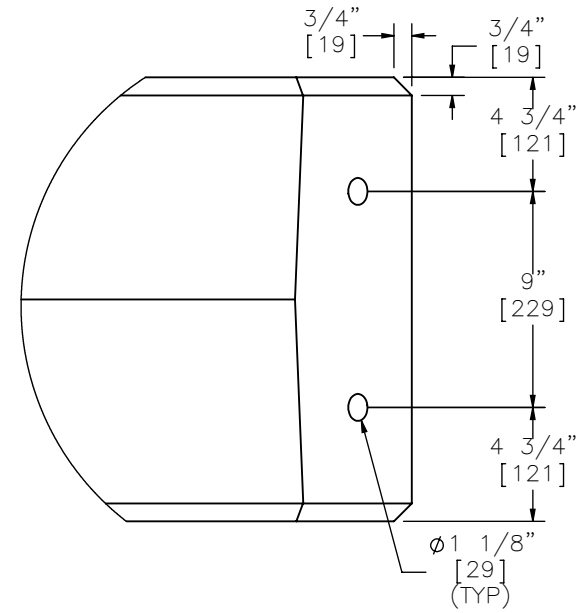
DATE:
3/24/2015

DRAWN BY:
SDB/JGP/JE
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REV. BY:
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KAL



DETAIL D



DETAIL E

- Notes: (1) $\phi 1"$ [25] and $\phi 1 \frac{1}{8}"$ [29] through-holes can be cast with or without an insert left in the beam.
- (2) The "house-shaped" through-hole can be cast around an insert, and then the insert can be removed; the radii can be varied if needed.
- (3) The 3 surfaces at each end of the barrier must be vertical – front and back of rail drafted for casting purposes.
- (4) $\phi 1 \frac{1}{8}"$ [29] holes to be centered on $4 \frac{1}{2}" \times 4 \frac{1}{2}"$ [114x114] chamfer.
- (5) Internal reinforcement not shown.
- (6) See as-built drawings from concrete industries for accurate rebar placement and more details.



Midwest Roadside
Safety Facility

SAFER For Highway –
Angle Joint (SFH-1)

Concrete Rail Details

DWG. NAME.
SFH-1_R10

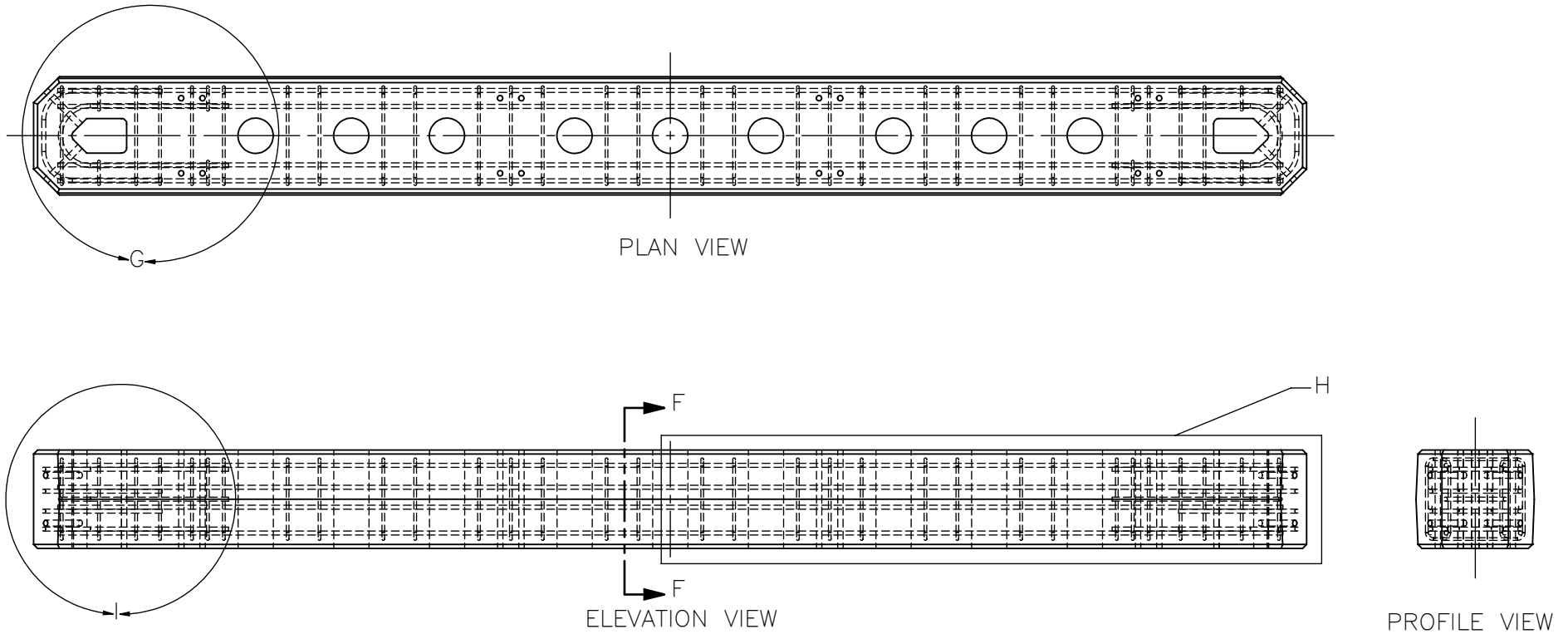
SCALE: 1:8
UNITS: in.[mm]

REV. BY:
JDS/SKR/
KAL

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DRAWN BY:
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Notes: (1) Two single flared coil loop inserts (not shown) were added to each barrier segment.



Midwest Roadside
Safety Facility

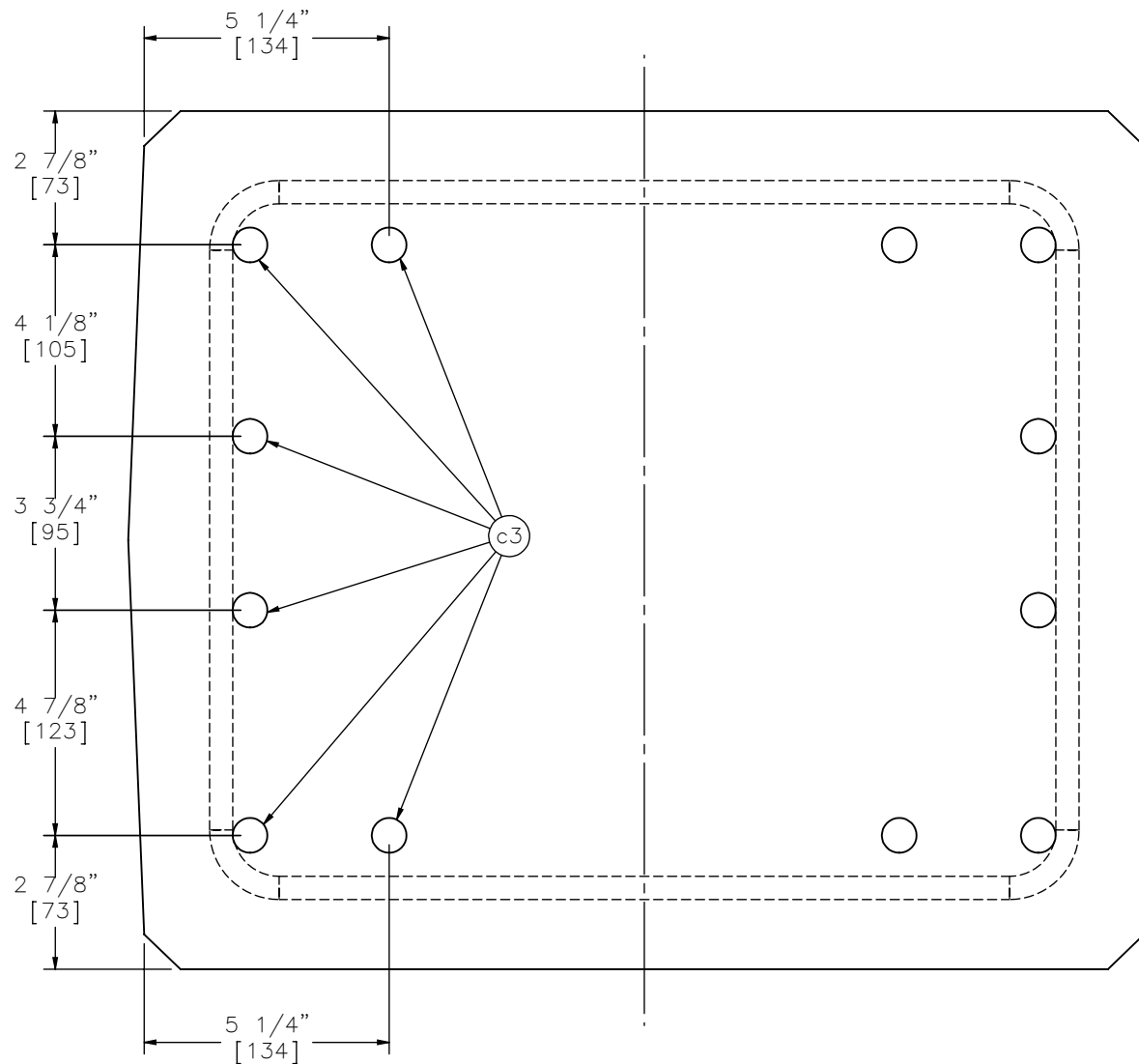
SAFER For Highway –
Angle Joint (SFH-1)

Concrete Rail and Rebar
Assembly

DWG. NAME:
SFH-1_R10

SCALE: 1:30
UNITS: in.[mm]

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DRAWN BY:
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REV. BY:
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KAL



SECTION F-F



Midwest Roadside
Safety Facility

SAFER For Highway –
Angle Joint (SFH-1)

Concrete Rail – Rebar
Assembly Details

DWG. NAME.

SFH-1_R10

SCALE: 1:4

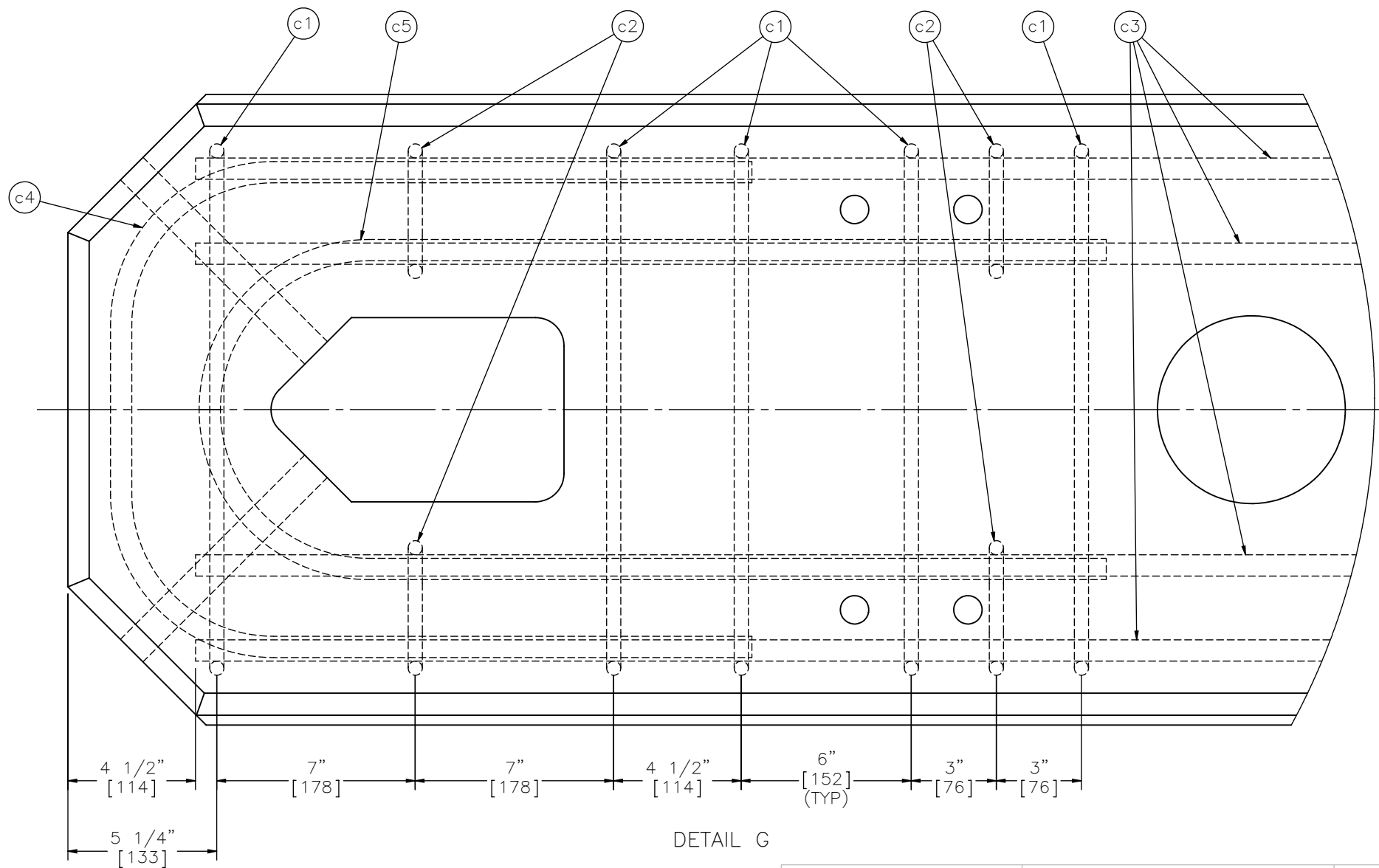
UNITS: in.[mm]

SHEET:
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DRAWN BY:
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REV. BY:
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DETAIL G

Notes: (1) 1 1/2" [38] clear cover for all stirrups and c4 bars at ends.



Midwest Roadside
Safety Facility

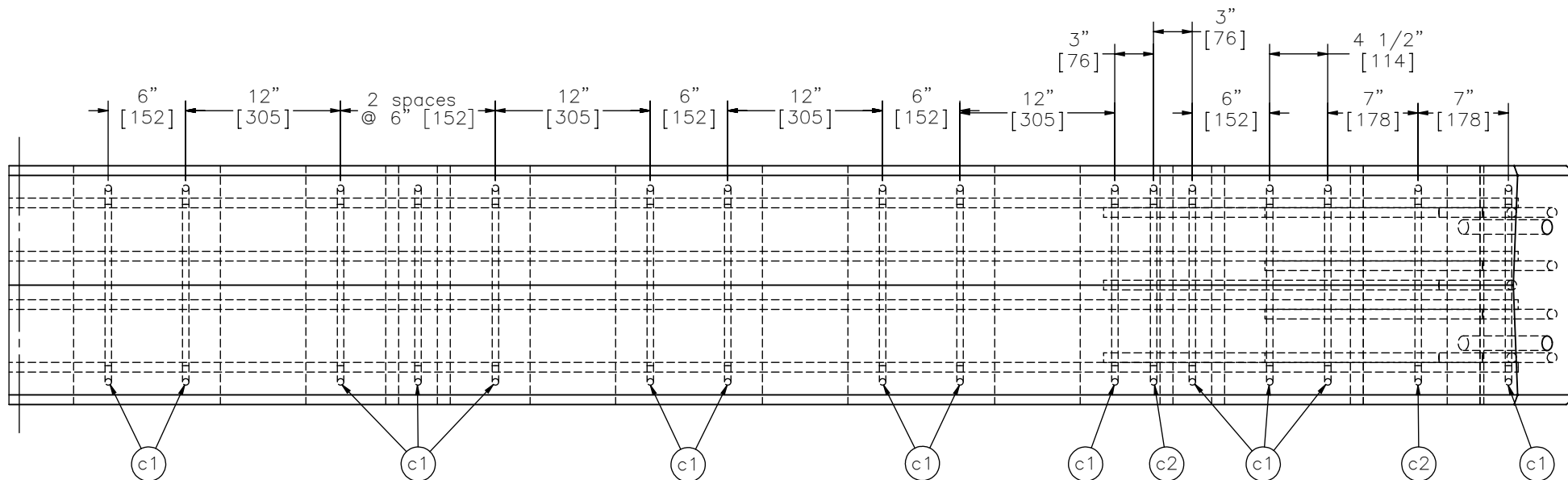
SAFER For Highway –
Angle Joint (SFH-1)

Concrete Rail – Rebar
Assembly Details

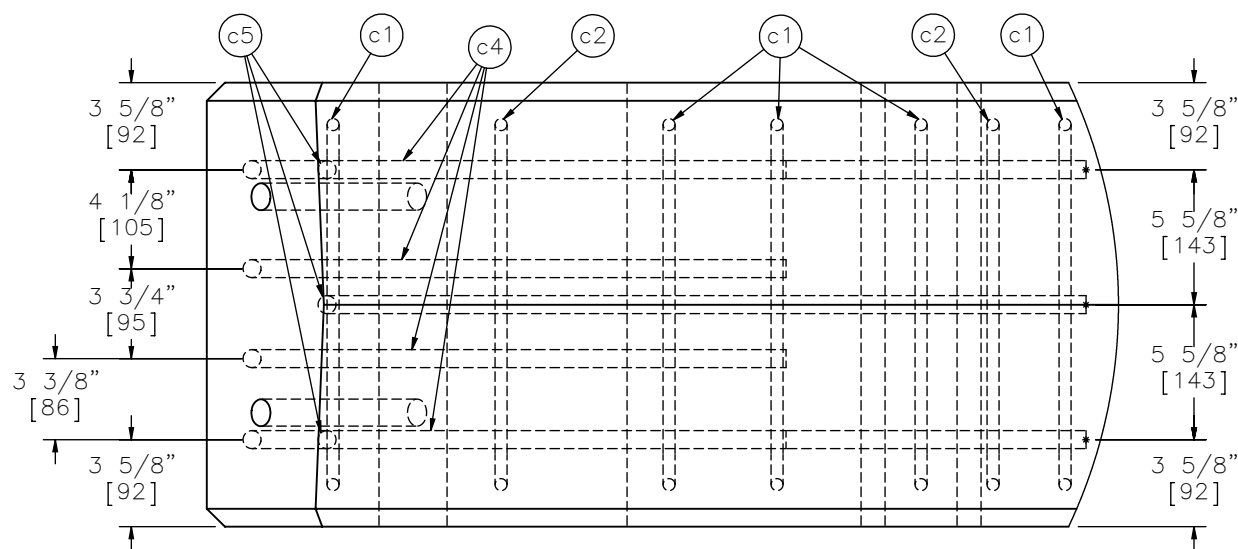
DWG. NAME:
SFH-1_R10

SCALE: 1:5
UNITS: in.[mm]

SHEET:
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DRAWN BY:
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REV. BY:
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KAL



DETAIL H



DETAIL I
SCALE 1 : 8

- Notes: (1) Longitudinal Rebar, Part c3 removed from Detail I for clarity.
(2) Place top and bottom c4 and c5 bars adjacent to longitudinal c3 bars.



Midwest Roadside
Safety Facility

SAFER For Highway –
Angle Joint (SFH-1)

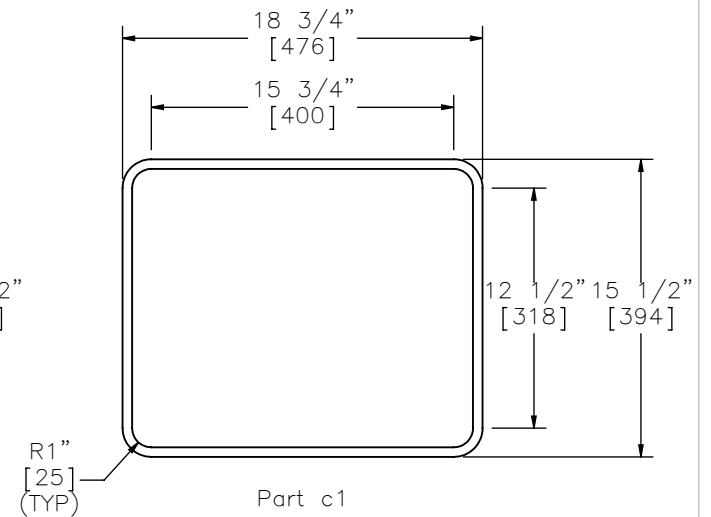
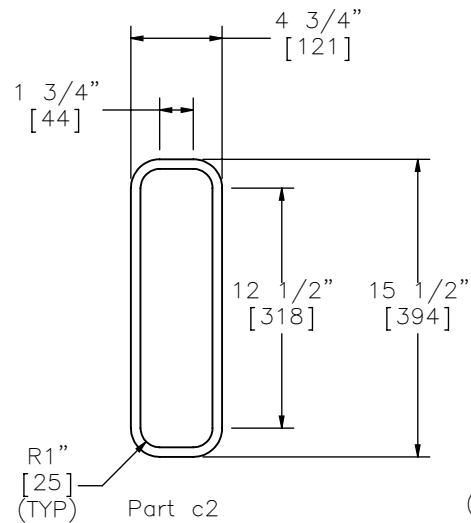
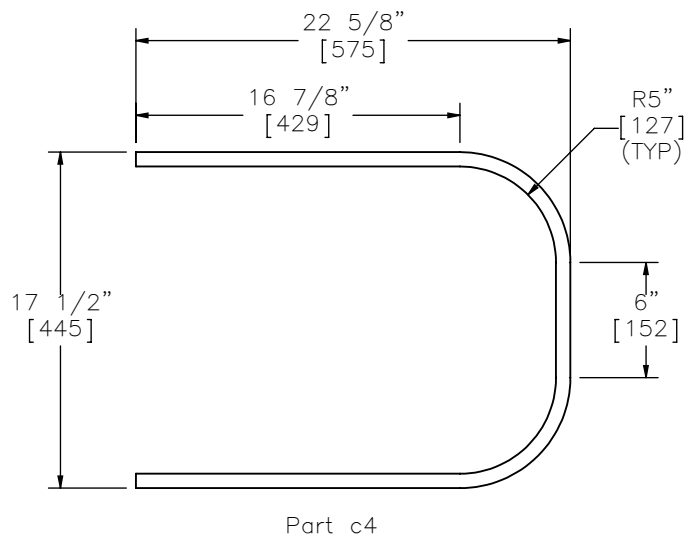
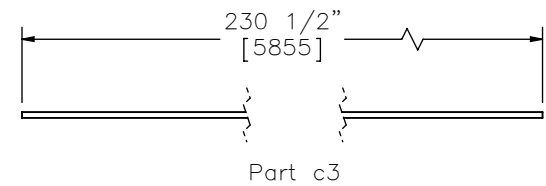
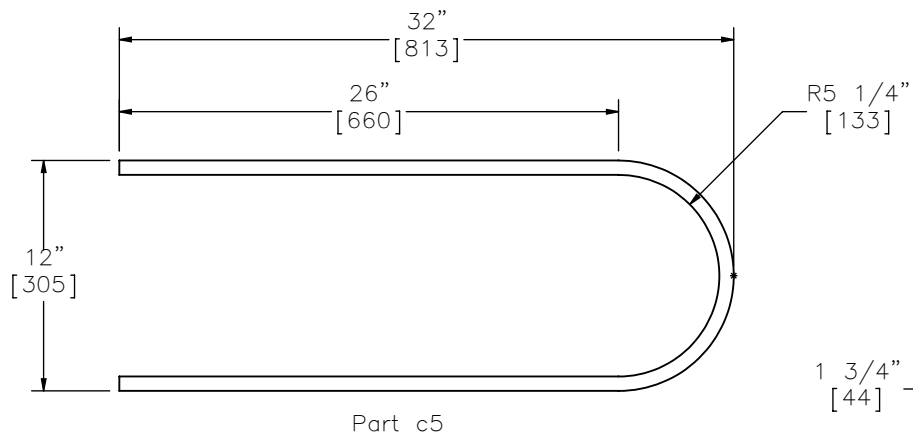
Concrete Rail – Rebar
Assembly Details

DWG. NAME.
SFH-1_R10

SCALE: 1:12
UNITS: in.[mm]

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REV. BY:
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KAL

Bill of Bars			
Item No.	QTY.	Description	Material Specification
c1	28	1/2" [13] Dia., 77" [1956] Long Bent Rebar	A615 Grade 60
c2	8	1/2" [13] Dia., 49" [1245] Long Bent Rebar	A615 Grade 60
c3	12	3/4" [19] Dia., 231" [5867] Long Rebar	A615 Grade 60
c4	8	3/4" [19] Dia., 63" [1600] Long Bent Rebar	A615 Grade 60
c5	6	3/4" [19] Dia., 69" [1753] Long Bent Rebar	A615 Grade 60



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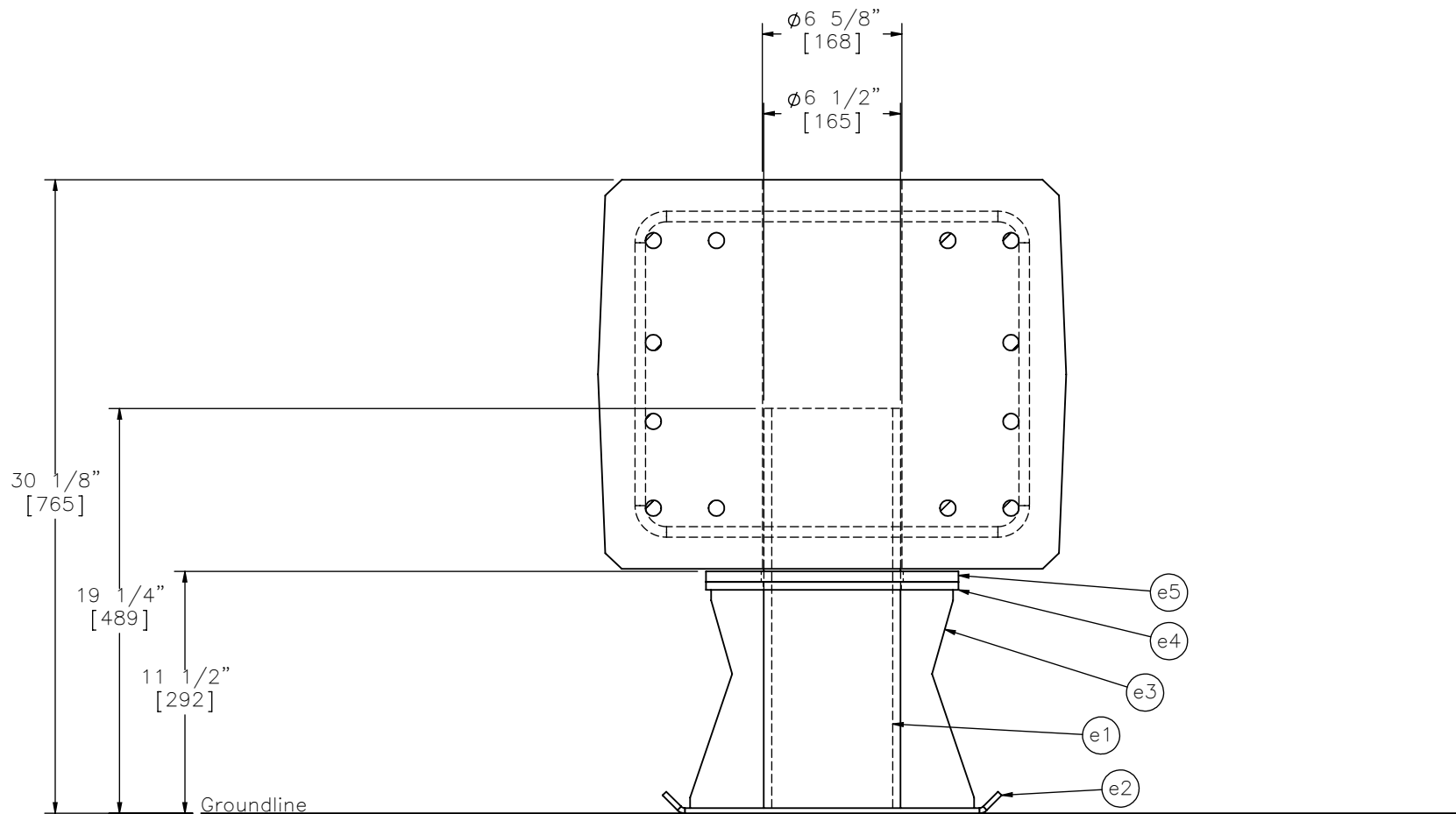
SAFER For Highway –
Angle Joint (SFH-1)

Bill of Bars

DWG. NAME.
SFH-1_R10

SCALE: 1:10
UNITS: in.[mm]

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DRAWN BY:
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SECTION N-N

Notes: (1) Steel Rail not shown for clarity.

(2) Part e5 can compress as needed due to weight of rail.



Midwest Roadside
Safety Facility

SAFER For Highway -
Angle Joint (SFH-1)

Skid Details

DWG. NAME.
SFH-1_R10

SCALE: 1:8
UNITS: in.[mm]

REV. BY:
JDS/SKR/
KAL

SHEET:
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DATE:
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DRAWN BY:
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K

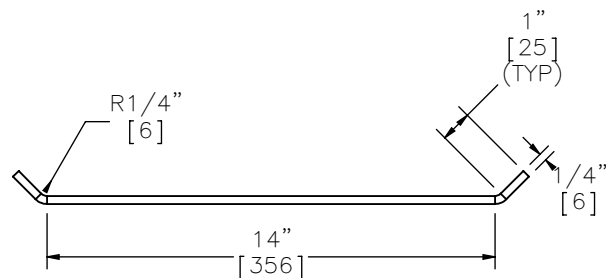
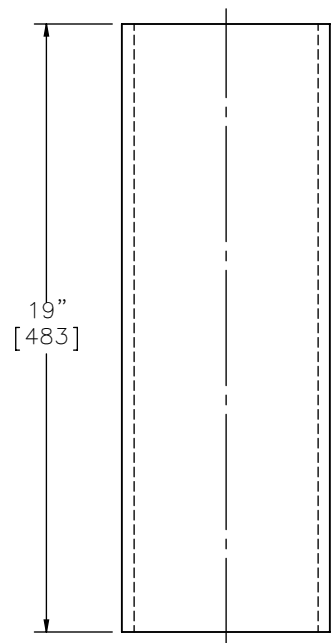
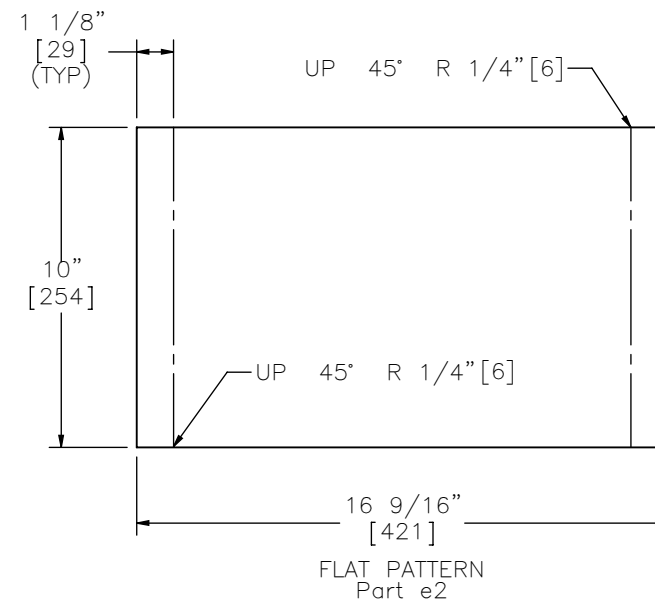
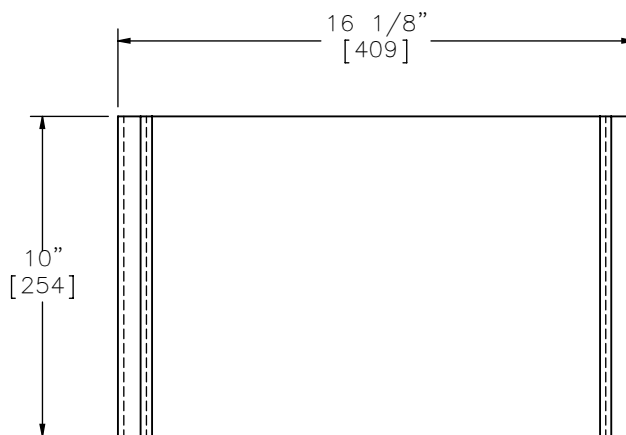
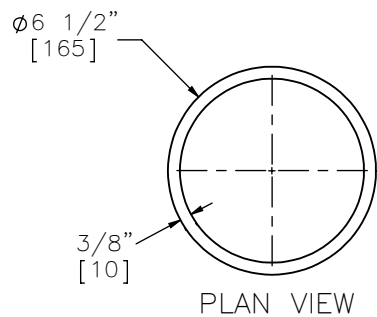
SAFER For Highway -
Angle Joint (SFH-1)

Skid Assembly Details

SFH-1_R10

UNITS: in.[mm]

REV. BY:	
JDS/SKR/ KAI	



Notes: (1) Material for Part a1 can be DOM 6 1/2"x3/8" [165x10], DOM 6 1/2"x1/2" [165x12], or HFS 6 1/2"x1/2" [165x12] or equivalent.



Midwest Roadside
Safety Facility

SAFER For Highway –
Angle Joint (SFH-1)

Skid Component Details

DWG. NAME.
SFH-1_R10

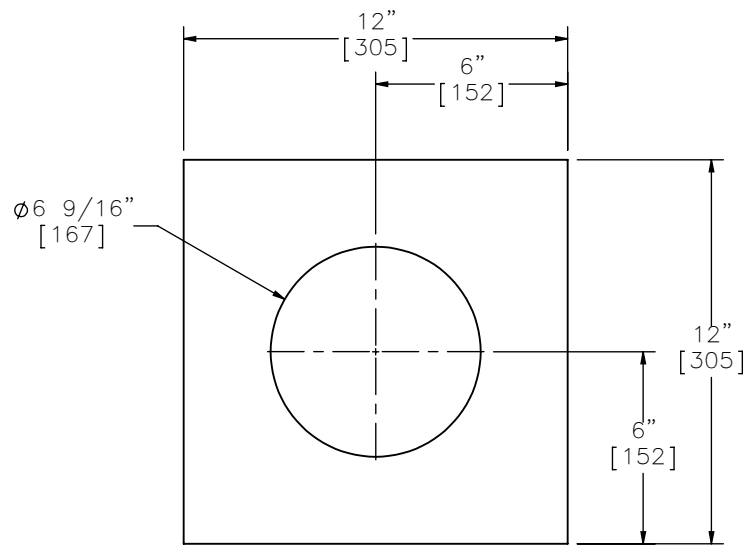
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UNITS: in.[mm]

REV. BY:
JDS/SKR/
KAL

SHEET:
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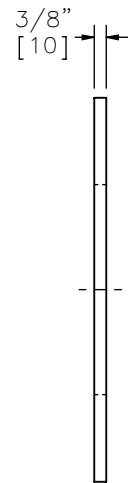
DATE:
3/24/2015

DRAWN BY:
SDB/JGP/JE
K

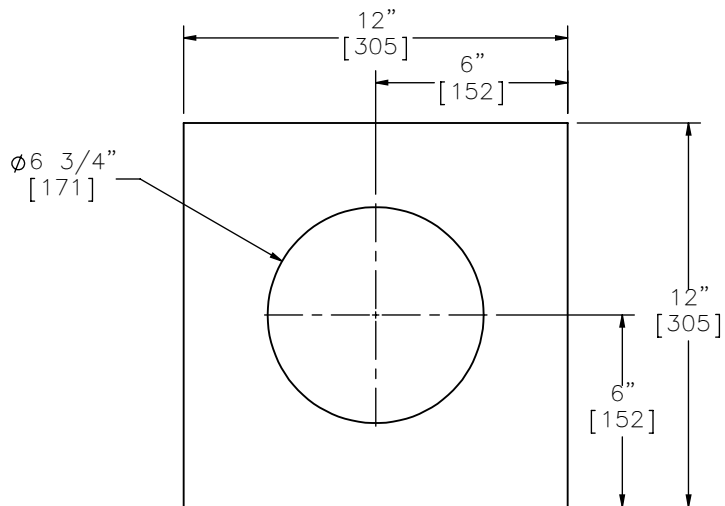


PLAN VIEW

Part e4

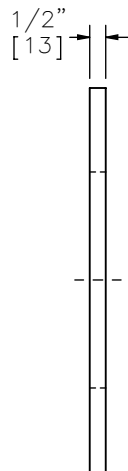


PROFILE VIEW

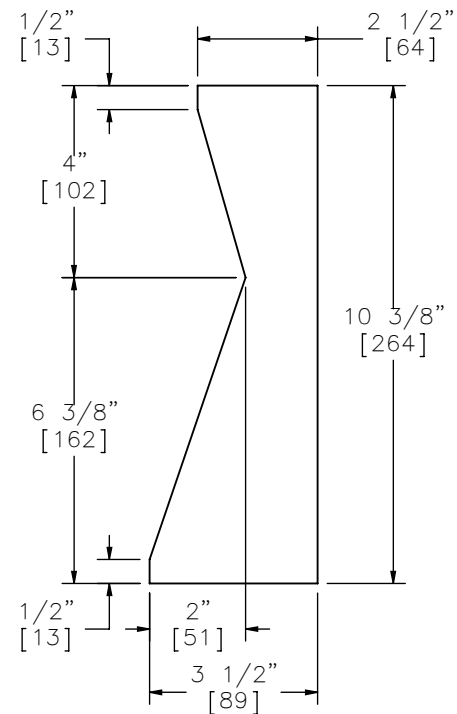


PLAN VIEW

Part e5

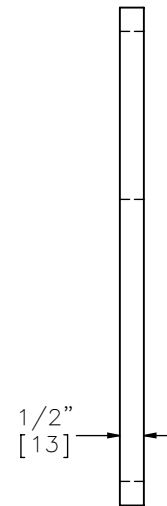


PROFILE VIEW



ELEVATION VIEW

Part e3
SCALE 1:4



PROFILE VIEW



Midwest Roadside
Safety Facility

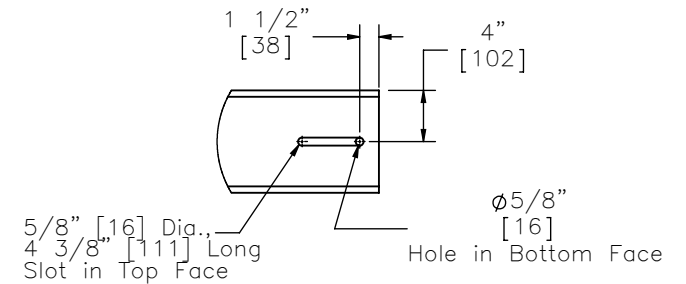
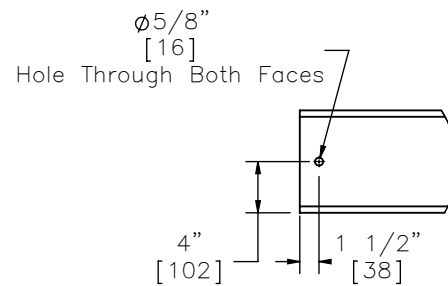
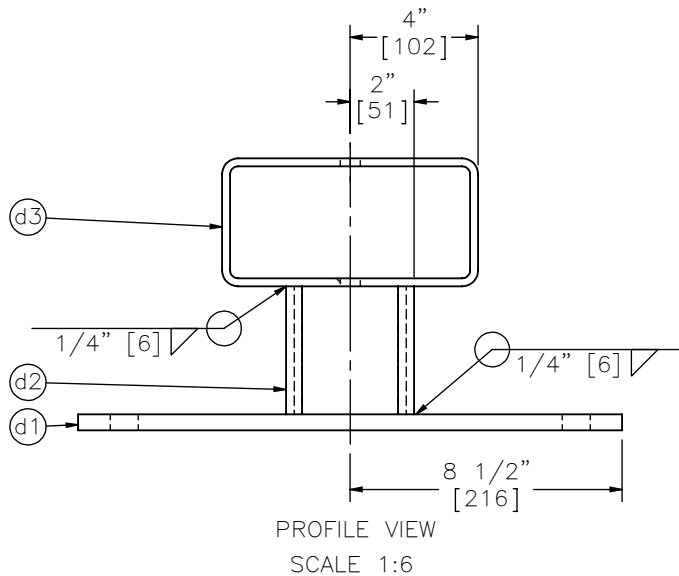
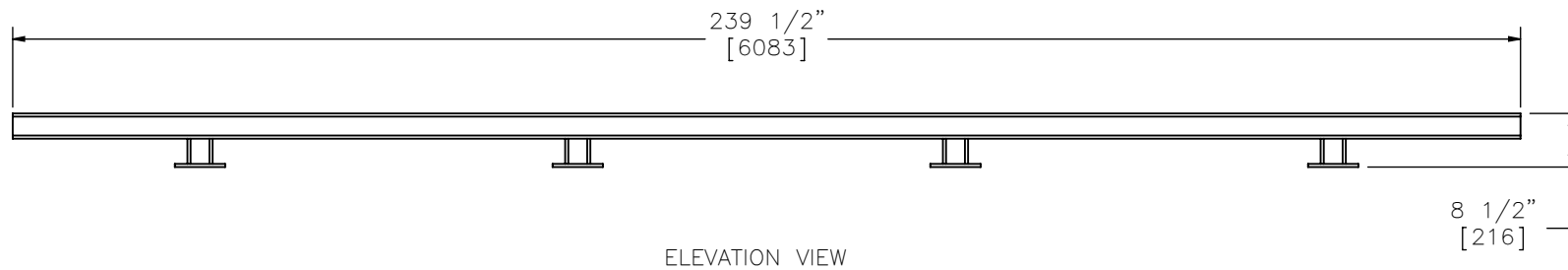
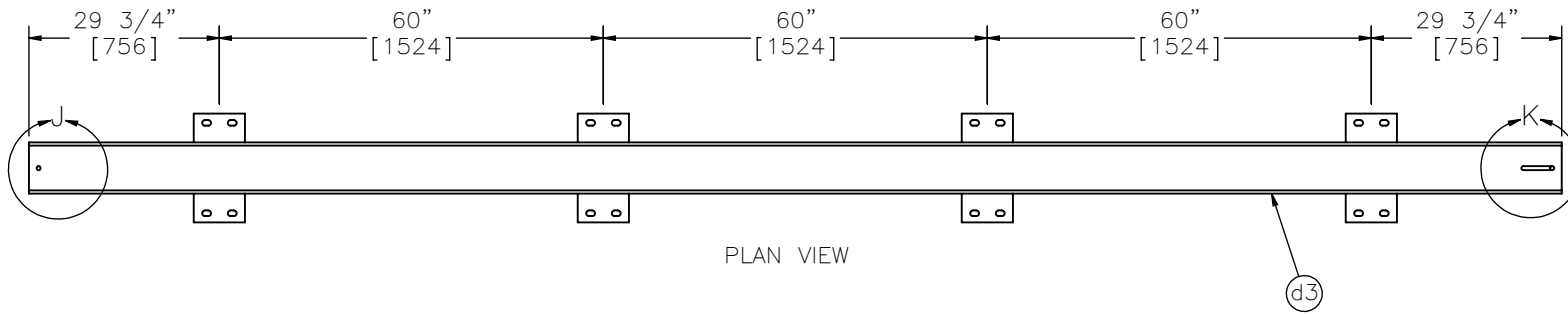
SAFER For Highway –
Angle Joint (SFH-1)

Skid Top Plate Detail

DWG. NAME.
SFH-1_R10

SCALE: 1:6
UNITS: in.[mm]

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DRAWN BY:
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REV. BY:
JDS/SKR/
KAL



- Notes: (1) Dimensions are symmetric across the center line.
(2) Slot dimensions are measured to far exterior points.



Midwest Roadside
Safety Facility

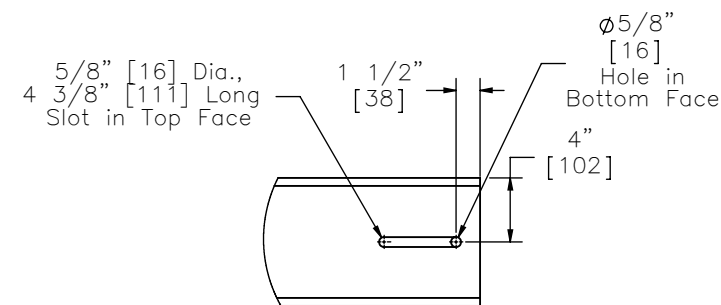
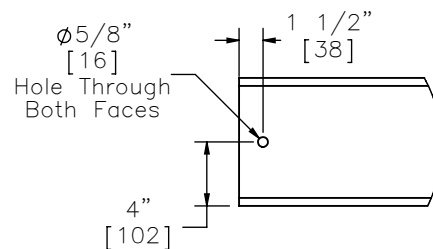
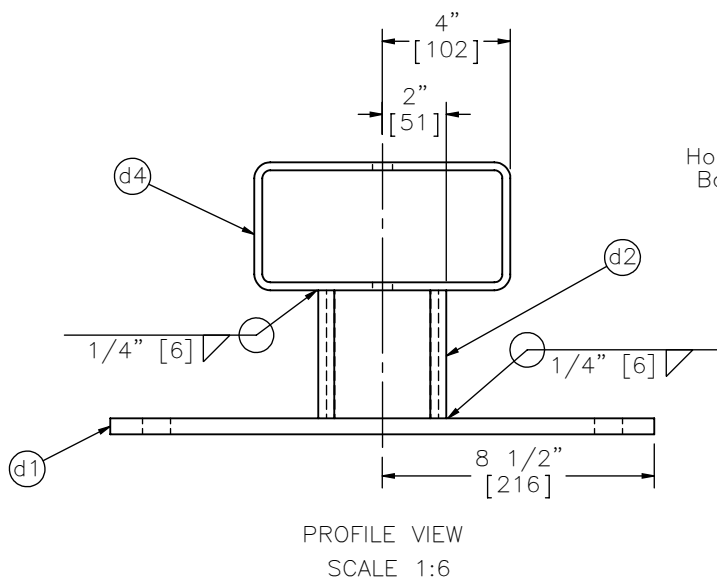
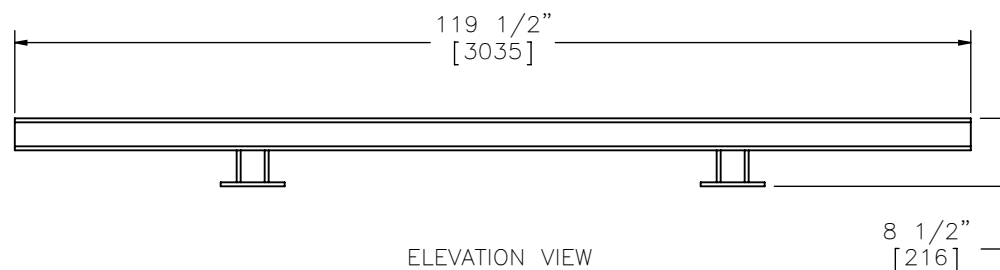
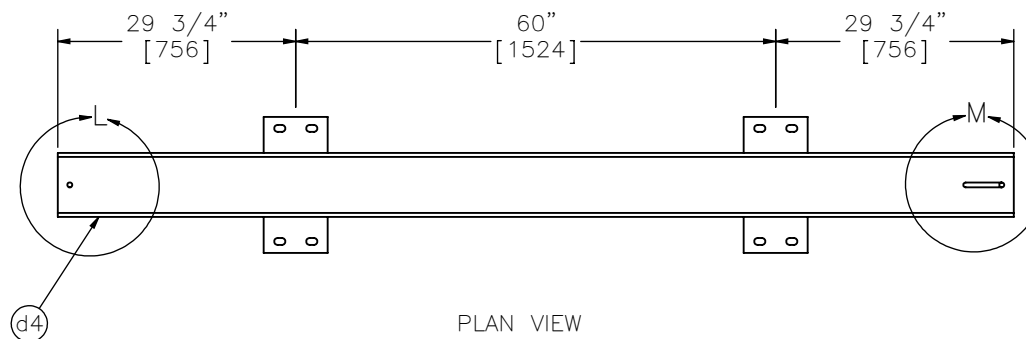
SAFER For Highway –
Angle Joint (SFH-1)

Steel Rail Assembly

DWG. NAME.
SFH-1_R10

SCALE: 1:30
UNITS: in./mm

SHEET:
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DRAWN BY:
SDB/JGP/JE
K
REV. BY:
JDS/SKR/
KAL



- Notes: (1) Dimensions are symmetric across the center line.
(2) Slot dimensions are measured to far exterior points.



Midwest Roadside
Safety Facility

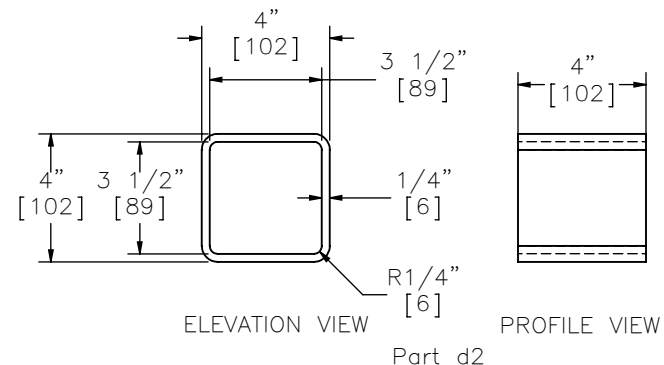
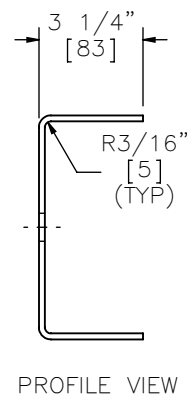
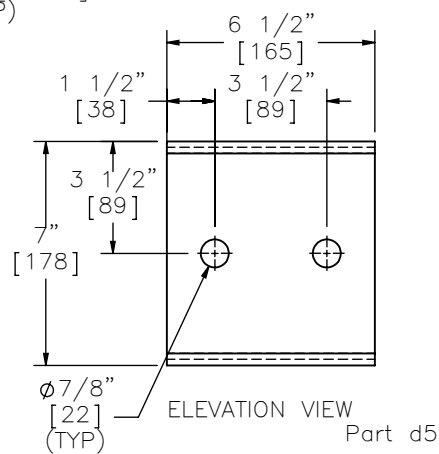
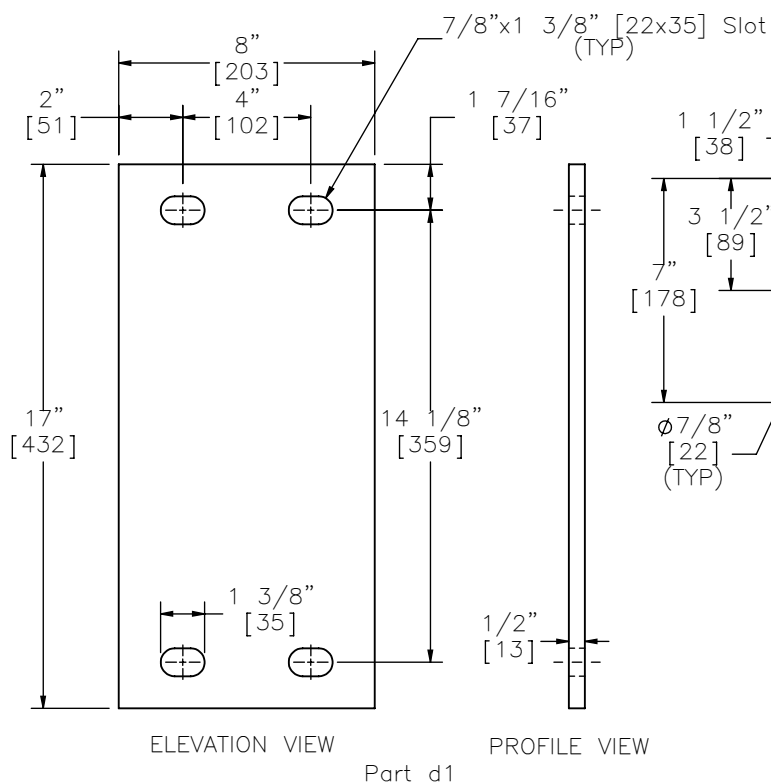
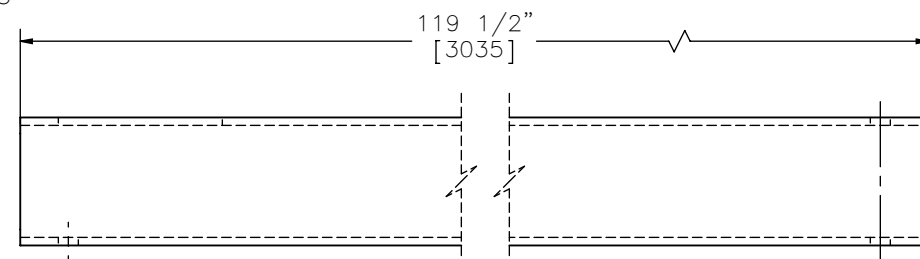
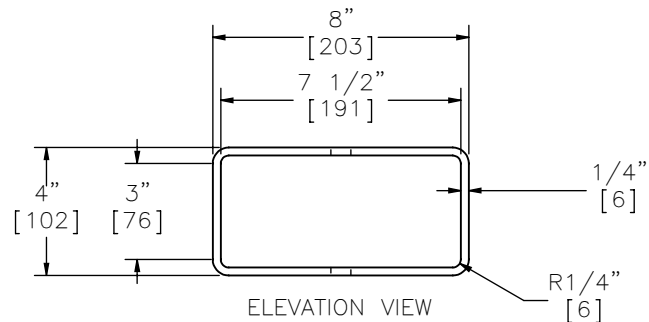
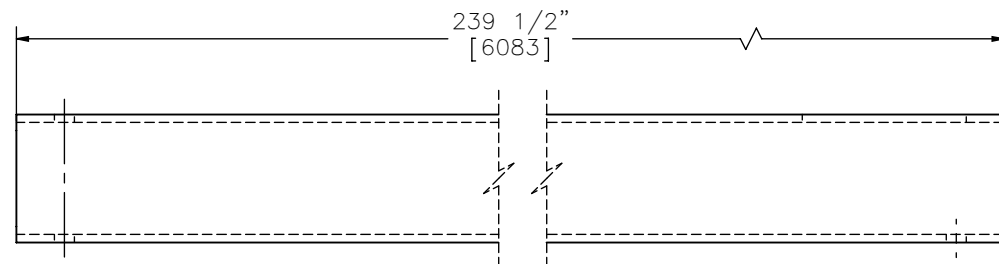
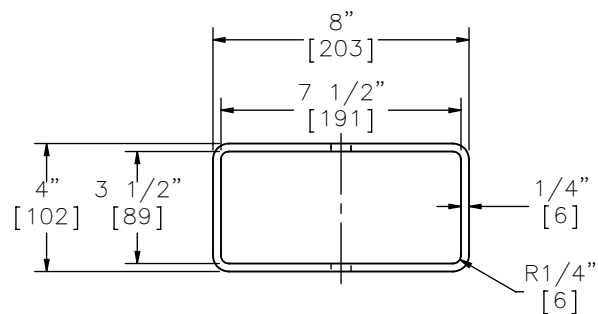
SAFER For Highway –
Angle Joint (SFH-1)

Steel End Tubing Assembly

DWG. NAME.
SFH-1_R10

SCALE: 1:24
UNITS: in./mm

SHEET:
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DRAWN BY:
SDB/JGP/JE
K
REV. BY:
JDS/SKR/
KAL

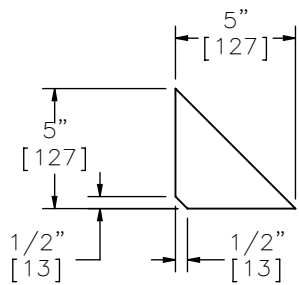
SAFER For Highway -
Angle Joint (SFH-1)

Steel Rail Components

DWG. NAME.	SFH-1_R10
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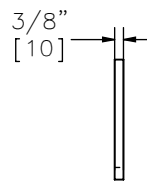
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SHEET:	19 of 23
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DRAWN BY:	SDB/JGP/JK
REV. BY:	JDS/SKR/KAL

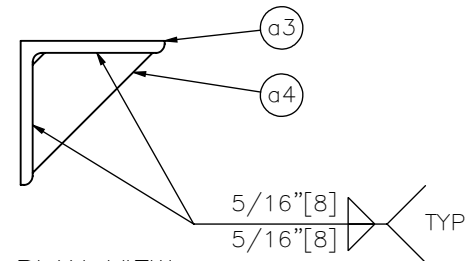


ELEVATION VIEW

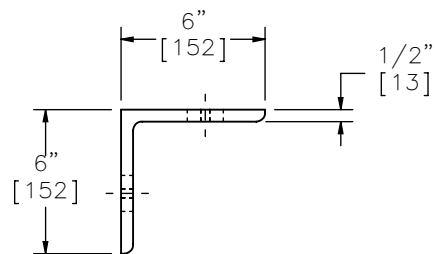
Part a4



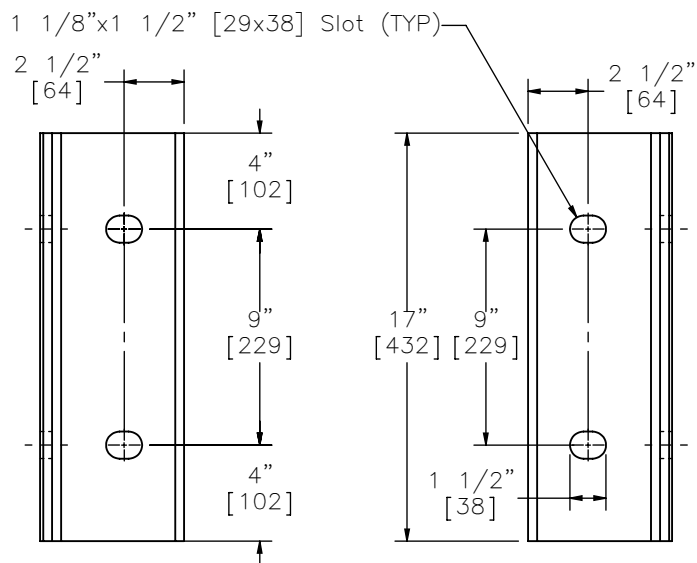
PROFILE VIEW



PLAN VIEW



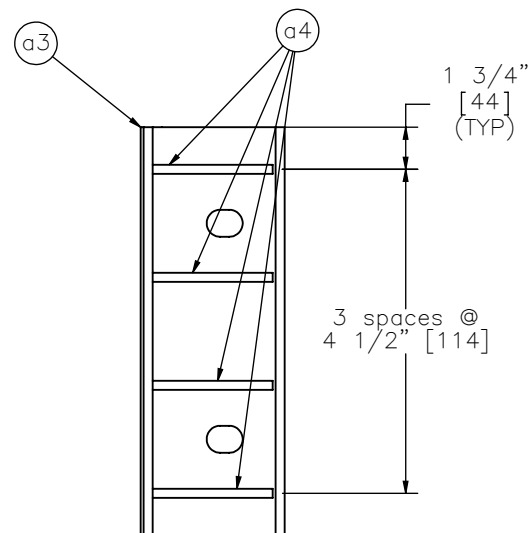
PLAN VIEW



ELEVATION VIEW

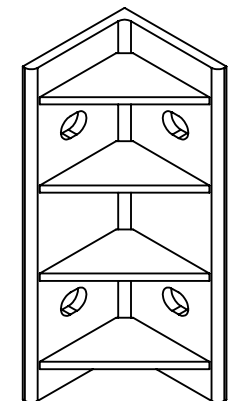
Part a3

PROFILE VIEW



ELEVATION VIEW

- Notes: (1) Slot dimensions measured from exterior points.
(2) Dimensions shown are to center of slot.



ISOMETRIC VIEW



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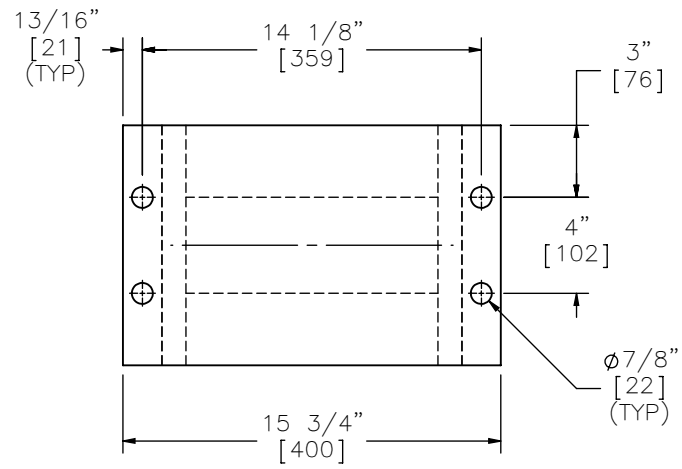
SAFER For Highway –
Angle Joint (SFH-1)

Angle Joint Details

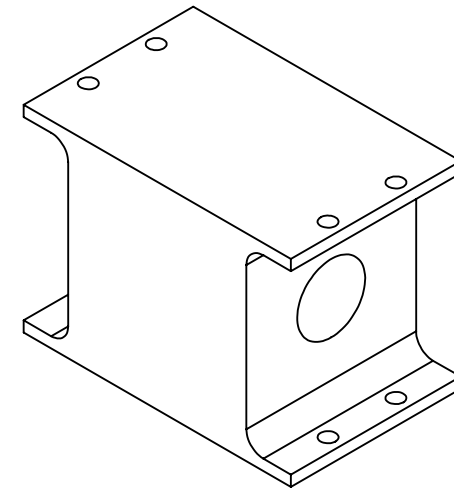
DWG. NAME.
SFH-1_R10

SCALE: 1:8
UNITS: in.[mm]

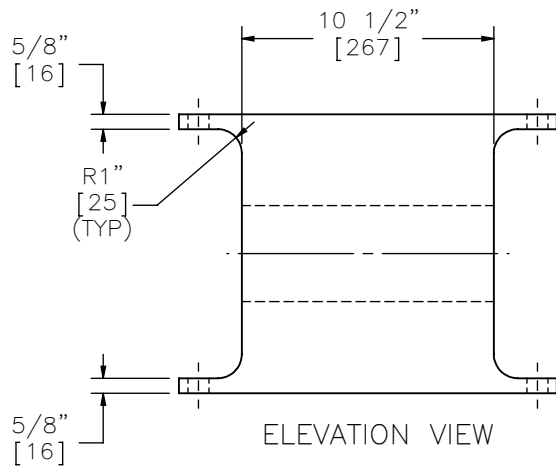
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KAL



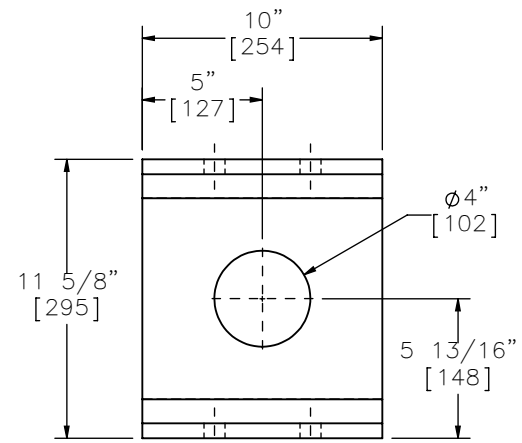
PLAN VIEW



ISOMETRIC VIEW



ELEVATION VIEW



PROFILE VIEW

Part a2



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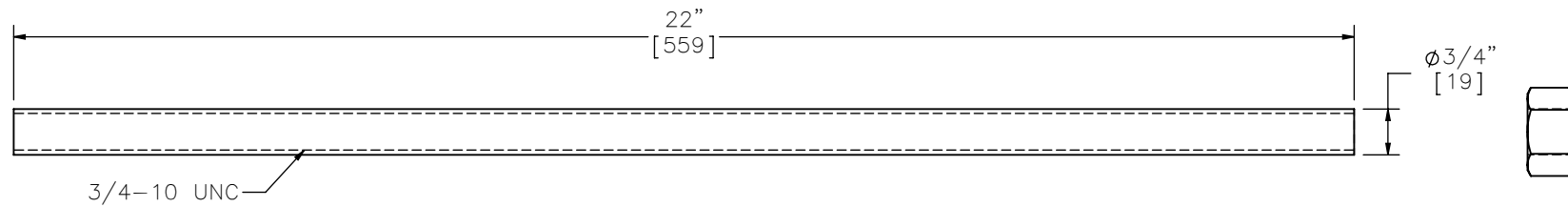
SAFER For Highway –
Angle Joint (SFH-1)

Rubber Post Details

DWG. NAME.
SFH-1_R10

SCALE: 1:8
UNITS: in.[mm]

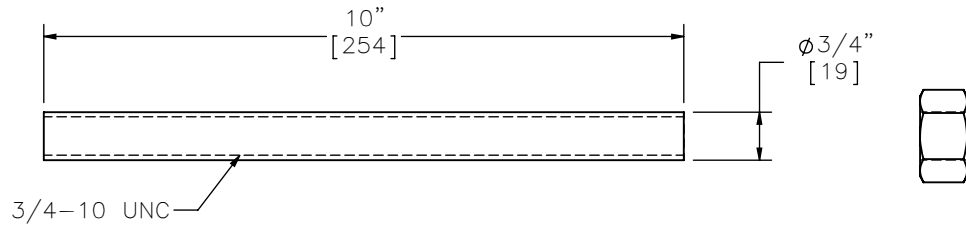
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ELEVATION VIEW
Part b1



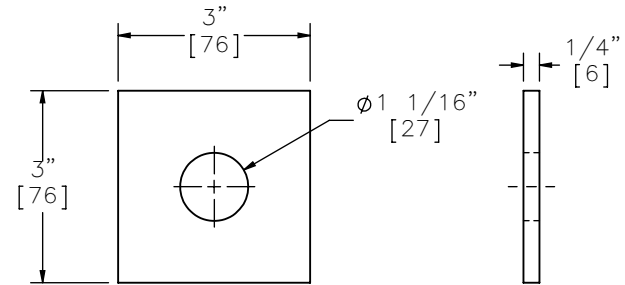
ELEVATION VIEW
Part b3



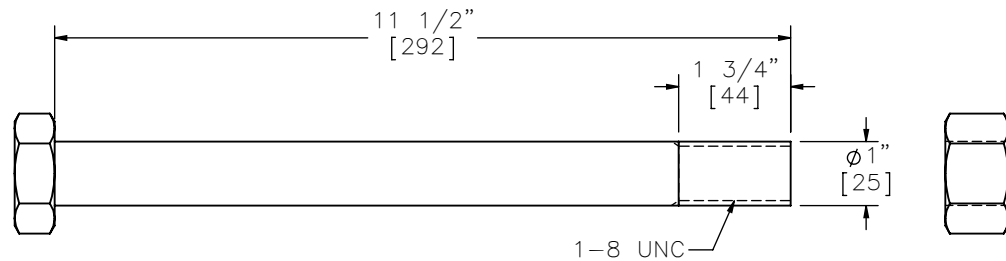
ELEVATION VIEW
Part b2



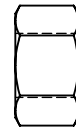
ELEVATION VIEW
Part b3



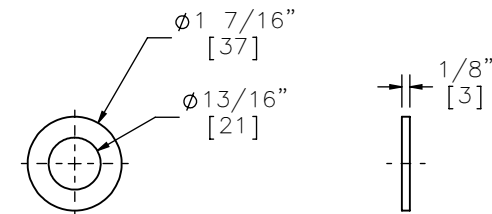
ELEVATION VIEW PROFILE VIEW
Part b6



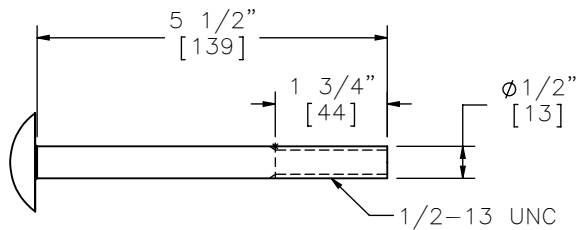
ELEVATION VIEW
Part b5



ELEVATION VIEW
Part b7



ELEVATION VIEW PROFILE VIEW
Part b4



ELEVATION VIEW
Part d6



ELEVATION VIEW
Part d8



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SAFER For Highway -
Angle Joint (SFH-1)

Fastener Details

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SFH-1_R10

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UNITS: in.[mm]

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Item No.	QTY.	Description	Material Specification	Hardware Guide
a1	12	Lightweight Concrete Rail	min f'c=5 ksi [34.5 MPa], density=110 pcf	—
a2	48	Morse E46496 Shear Fender	ASTM D2000	—
a3	22	6"x6"x1/2" [152x152x13], 17" [432] Long L-Bracket	A992 Galvanized	—
a4	88	5"x5"x3/8" [127x127x10] Gusset Plate	A572 Grade 50 Galvanized	—
b1	192	3/4" [19] Dia. UNC, 22" [559] Long Threaded Rod	ASTM A193 Grade B7 Galvanized	—
b2	192	3/4" [19] Dia. UNC, 10" [254] Long Threaded Rod	ASTM A193 Grade B7 Galvanized	—
b3	576	3/4" [19] Dia. UNC Heavy Hex Nut	ASTM A194 Grade 2H Galv.	—
b4	576	3/4" [19] Dia. Flat Washer	ASTM F436 Galv.	FWC20b
b5	88	1" [25] Dia. UNC, 11 1/2" [292] Long Hex Head Bolt	ASTM A325 Galv.	FBX24b
b6	176	3"x3"x1/4" [76x76x6] Square Washer	A572 Grade 50 Galvanized	—
b7	88	1" [25] Dia. UNC Heavy Hex Nut	ASTM A563 DH Galv.	FNX24b
c1	336	1/2" [13] Dia., 77" [1956] Long Bent Rebar	A615 Grade 60	—
c2	96	1/2" [13] Dia., 49" [1245] Long Bent Rebar	A615 Grade 60	—
c3	144	3/4" [19] Dia., 231" [5867] Long Rebar	A615 Grade 60	—
c4	96	3/4" [19] Dia., 63" [1600] Long Bent Rebar	A615 Grade 60	—
c5	72	3/4" [19] Dia., 69" [1753] Long Bent Rebar	A615 Grade 60	—
d1	48	17"x8"x1/2" [432x203x13] Anchor Plate	ASTM A572 Grade 50 Galvanized	—
d2	48	4"x4"x1/4" [102x102x6], 4" [102] Long Tube	A500 Grade B Galvanized	—
d3	11	8"x4"x1/4" [203x102x6], 239 1/2" [6083] Long Tube	A500 Grade B Galvanized	—
d4	2	8"x4"x1/4" [203x102x6], 119 1/2" [3035] Long End Tube	A500 Grade B Galvanized	—
d5	12	12 3/4"x6 1/2"x3/16" [324x165x5] Bent Plate	ASTM A572 Grade 50 Galvanized	—
d6	24	1/2" [13] Dia. UNC, 5 1/2" [140] Long Dome (Round) Head Bolt	ASTM A307 Grade A Galvanized	—
d7	24	1/2" [13] Dia. Flat Washer	ASTM F844 Galvanized	FWC12a
d8	24	1/2" [13] Dia. UNC Heavy Hex Nut	A563A Galvanized	FNX12b
d9	—	Epoxy	HILTI HIT-RE500	—
e1	24	6 1/2" [165] Dia., 3/8" [10] Thick, 19" [483] Long Steel Pipe	AISI 1026	—
e2	24	16 9/16"x10"x1/4" [421x254x6] Base Plate	ASTM A572 Grade 50 Steel	—
e3	48	3 1/2"x10 3/8"x1/2" [89x264x13] Plate Gusset	ASTM A572 Grade 50 Steel	—
e4	24	12"x12"x3/8" [305x305x10] Top Plate	ASTM A572 Grade 50 Steel	—
e5	24	12"x12"x1/2" [305x305x13] EPDM Rubber Sheet	Minimum 50 durometer	—



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SAFER For Highway –
Angle Joint (SFH-1)

Bill of Materials

DWG. NAME.
SFH-1_R10

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REV.	DATE OF ISSUE	Page	NATURE OF CHANGES	REVISED BY
R0	11/27/2013	–	Used "SAFER For Highway: Concrete Beam with 10" Shear Fender" (SFH_CWSF) for reference only.	SDB
R1	12/9/2013	–	Top Tube assembly added.	SDB
		–	Concrete rail detail page moved before rebar assembly details.	
		–	Tube detail pages inserted (Now pages 13–16)	
		3	Details B and C of Tube assembly added.	
		6	Chamfer added to rail. General dimensions added. Detail E added. Notes 1–3 added.	
		8	Missing dimensions added. Part c5 Rebar placement corrected.	
		10	Missing dimensions added.	
		13	Tube detail pages inserted (Now pages 13–16)	
		14	Tube detail pages inserted (Now pages 13–16)	
		15	Tube detail pages inserted (Now pages 13–16)	
		16	Tube detail pages inserted (Now pages 13–16)	
		17	Welding note added.	
		18	Missing dimensions added.	
		20	Part b5 changed to 11 1/2". Missing annotations added.	
		21	Parts d1–d9 added. Part b5 description changed. Parts a1 and b3 Material Specs corrected.	
R2	12/17/2013	1	Note 2 added.	SDB
		3	Note 2 added. Tube Height Dim added.	
		4	Detail from Page 5 moved to page 4. Note added.	
		5	Detail D removed. Notes Added. General Dimension edits.	
		6	Detail I removed.	
		7	Changed to section view in middle of barrier	
		8	Note added. General Dimension edits.	
		9	Notes added. Detail H and I moved to single page.	
		11	Note 2 added.	
		12	End tube assemblies combined to be same part. Now shown all on single page.	
		13	Part d1 and d5 now shown.	
		14	Assembly and components now on single sheet. Notes added. Weld note corrected.	
		17	Parts d2–d4 description changed.	

R3	12/20/2013	3	Longitudinal Rebar Placement corrected.	SDB
		5	Notes 1 and 3 corrected.	
		7	Longitudinal Rebar Placement corrected. Part designations added.	
		8	2 Part c2 rebar pieces replaced with one part c1 and moved to maintain equal spacing.	
		9	Dimensions added to Detail I. Notes 2 and 3 changed.	
		10	Part c4 length changed to 213 1/2"	
		11	Hole and slot locations corrected.	
		13	Part d5 length changed to 6 1/2"	
		14	Welding note changed.	
		17	Part a1 quantity changed. Part c1 and c2 quantity changed. Part d5 description changed.	
R4	6/17/2014	–	3 new pages added between pages 10 and 11.	JEK
		–	Skid details added to new pages (10, 11, 12).	
		1	Skid added to assembly.	
		2	Skid added to assembly.	
		4	Skid added to assembly.	
		20	BOM updated to reflect skid use.	
R5	6/18/2014	–	New page added between pages 5 and 6.	JEK
		–	New page added between pages 10 and 11.	
		1	Section line N added. Section placed on new page (12).	
		2	Dimension added for spacing of skid.	
		5	Detail D and E moved to new page (6). Notes 1, 3, and 5 moved to new page (6). New note added.	
		6	Detail D adjusted to same scale as Detail E, set to page scale. Scale notes removed.	
		14	General dimension changes. Flat pattern corrected to show bend lines.	
		18	Tangent edges removed on Parts d3 and d4 to clarify slot location. Part d4 orientation adjusted so that slot is on top. General dimension changes.	
R6	6/18/2014	12	Note 1 corrected. Note 2 added.	JEK
R7	6/30/2014	1	Impact location mirrored to other side of system. Numbers and DS/US labels changed accordingly.	SDB
		5	Splice 5–6 Instrumentation page added.	
R8	10/15/2014	–	Rebar corrected to "as built" and hardware changed to cosmetic thread.	SDB
		5	Load Cells corrected to "as tested"	

R8	10/15/2014	8	Note 1 added.	SDB
		9	Rebar corrected to CI drawings.	
		10	Rebar corrected to CI drawings.	
		11	Rebar corrected to CI drawings.	
		12	Rebar corrected to CI drawings. Parts c1–c5 length and assembly dimensions corrected.	
		22	Hardware changed to cosmetic threads. Part d6 and d8 added to page	
		23	Nuts and Bolts separated into two parts. Hardware guide designations added to parts b4, b7, d7, and d8.	
R10	3/24/2015	7	Note 2 case changed to cast.	JEK
		15	Metric for bend lines.	
		22	Sheet description corrected.	
		23	Part d1 metric dimension correction.	