

Section 901

**SECTION 901
SIGN FABRICATION**

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901-1 DESCRIPTION

Fabricate and furnish signs, including sign face, supporting frames, hardware and package the signs for shipment.

901-2 MATERIALS

Refer to Division 10.

Item	Section
Retroreflective Sheeting	1092-2
Signs and Hardware	1092-1

901-3 CONSTRUCTION METHODS

(A) General

Details concerning the fabrication and erection of the signs are shown in the contract. Sign designs not shown in the contract are available from the Engineer.

Fabricate all items within 1/8" of design measurements. Scribe each sign, shield, arrow, overlay or blank on the back with the month and year.

Do not begin fabrication of Type A, B and C signs until S-dimension verification revisions have been approved.

Provide mounting holes in the Z-stringers of the signs in accordance with the details shown in the contract or approved shop drawings. Provide a space between the Z-bar and backing strip not greater than 1/8".

Date the erection of all signs and sign assemblies using printed self-adhesive stickers designed for punching the appropriate day, month and year numbers with a hole punch. Place the sticker on the back of each sign in the lower corner nearest the roadway. The Sign Fabricator will provide a sufficient quantity of the stickers for each sign. Print on the back of each sign the size of that sign [e.g. 144" x 48"] with a black permanent marker with numbers at least 2" in height and located near the self-adhesive sticker.

Ship all multi-panel signs to the project intact, completely assembled and ready to be installed. Fabricate signs taller than 12 ft as 2 separate signs with a horizontal splice, ready to be spliced and installed. No assembly other than a horizontal splice will be permitted except when a route shield or copy is required to be attached because of the horizontal splice.

(B) Department and Contractor Furnished Signs

Use the contract to determine whether the signs are to be fabricated and furnished by the Contractor or whether the Department will provide them to the Contractor.

For both Department and Contractor Furnished Signs, the Contractor provides all mounting hardware consisting of, but not limited to, shims, backing plates, mounting bolts, washers and nuts.

The sign fabricator will provide vertical Z-bars required for attaching secondary signs to the primary signs.

Confirm in writing at least 4 months in advance, the actual date the Department furnished signs will be required. The signs will be made available to the Contractor for pickup at the North Carolina Department of Correction sign fabrication facility on N.C. 39 near Bunn, North Carolina, unless otherwise indicated in the contract. Provide for all transportation.

1 The Engineer will inspect and approve the signs before they are packaged and crated for
 2 shipment. Take delivery of all signs within 60 days of the date requested or the date they
 3 are made available, whichever occurs last, and within 96 hours of receiving the first sign.
 4 The Engineer shall approve any exception to the above delivery procedure. At the time
 5 the signs are delivered to the project, provide to the Engineer one copy of the sales ticket
 6 furnished with the signs.

7 After taking possession of the signs, be responsible for any damage or theft that occurs to
 8 signs before final acceptance by the Engineer. Comply with the reflective sheeting
 9 manufacturer's recommendations for handling, transporting, erecting and storing of the
 10 signs. Acceptably repair or otherwise correct any damage to the signs or refabricate
 11 them. When requested by the Contractor, the Department may have the necessary repairs
 12 made or the signs refabricated, and deduct the associated cost thereof from monies due
 13 the Contractor.

14 (C) Signs

15 Construct all signs, supporting frames and assemblies in accordance with the details
 16 shown in the contract and Tables 901-1 and 901-2.

TABLE 901-1				
SIGN TYPE PARAMETERS				
Sign Type	Vertical and Horizontal Dimensions	144" x 48" Aluminum Panels	Horizontal Z-Bars	Aluminum Thickness
A	Vertical or Horizontal > 144" or Vertical and Horizontal > 48"	Multiple	Yes	0.125"
B	Vertical and Horizontal < 144" and Vertical or Horizontal < 48"	Single	Yes	0.125"
C	-	Single, Dual	Yes	0.125"
D	-	Single	No	See Table 901-2
E	-	Single	No	See Table 901-2
F	-	Single	No	See Table 901-2

17 (1) Type A Signs

18 Fabricate Type A signs from multiple aluminum sheet increments of the thickness
 19 shown in Table 901-1, with welded studs for attachment to the supporting frame.

20 Use aluminum sheets with increments of 4 ft in width; except, for sign widths that
 21 are not multiples of 4 ft, a maximum of 2 panels may be cut to less than 4 ft. No
 22 panel may be cut to less than one foot. Mount aluminum sheet increments vertically
 23 and provide with backing strips at the vertical joints, held firmly in place, to keep the
 24 abutting sheets in proper alignment. Leave a space of 0.020" to 0.032" between each
 25 panel sheeted with non-prismatic sheeting. Prismatic sheeting is to be trimmed at
 26 a 45° angle from the edge of each panel.

27 Fabricate signs with a height of 12 ft or less, without horizontal joints. One
 28 horizontal joint will be permitted for signs that are more than 12 ft in height. Locate
 29 the joint near the mid-height of the sign. Construct this joint according to the details
 30 in accordance with the contract.

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- 1 (2) Types B and C Signs
2 Fabricate Types B and C signs from multiple aluminum sheet increments of the
3 thickness shown in Table 901-1, with welded studs for attachment to the supporting
4 frame.
- 5 (3) Types D, E and F Signs and Milemarkers
6 Fabricate Types D, E and F signs and milemarkers from single sheets of the
7 thickness shown in Table 901-2, with holes for bolting to the supports.
8 Construct Types E and F signs in accordance with the *FHWA Standard Highway*
9 *Signs*. Apply the retroreflective sheeting to the separate signs in all
10 Types E and F sign assemblies consecutively to provide correct color matching on
11 each completed assembly. Adequately identify each individual sign to the correct
12 assembly. Following the erection of Type E and F sign assemblies, leave the
13 identification markings on the individual signs until Department personnel have
14 verified compliance with these requirements.
- 15 (4) Overlays for Existing Signs
16 Manufacture all overlays for existing signs of the thickness shown in Table 901-2.
17 Do not make holes for rivets in the overlays during fabrication, but instead field-drill
18 them during the erection process.

(D) Aluminum

- 20 (1) Thickness Requirements

Vertical or Horizontal Dimension	Minimum Thickness
<i>Inches</i>	<i>Inches</i>
0-11.9	0.032
12-35.9	0.063
36-47.9	0.080
48 and larger	0.125
Milemarkers	0.080
Overlays	0.063

- 21 (2) Preparation of Aluminum Sign Surfaces
22 Do not handle any metal, except by appropriate handling devices or by workmen
23 wearing clean gloves, between the beginning of the coating operations and the
24 completion of the application of the retroreflective sheeting. Retreat aluminum sign
25 surfaces that come into contact with grease, oils or other contaminants before the
26 application of retroreflective sheeting.
- 27 Before applying retroreflective sheeting to the aluminum, treat the aluminum sign
28 surfaces with a chromate conversion coating. Such coating shall be applied
29 according to the manufacturer's instruction and shall conform to ASTM B449,
30 Class 2, and should range in color from silvery iridescent to pale yellow. The
31 coating weight shall be 10 mg/sf to 35 mg/sf on the entire surface area including
32 along the edges of the sign substrate with a median of 25 mg/sf as the optimum
33 coating weight. Ensure the coating does not appear dusty when wiped with a clean,
34 lint-free cloth and does not show excessive buildup at edges. Sand smooth all burrs
35 and scratches before applying retroreflective sheeting. Sheet all sanded aluminum
36 within the same day to prevent the formation of corrosion on the metal. Do not sand
37 or use abrasive materials on sheeted faces. Aluminum products shall be randomly
38 tested.

(E) Supporting Frames

Use supporting frames for Types A and B signs consisting of 2 or more horizontal aluminum Z-stringers with vertical aluminum bar stiffeners in accordance with the details and dimensions shown in the contract. Use a nylon washer to attach all thru bolts with a play of at least 1/16" and no more than 1/8". Provide stringers with necessary holes and slots for bolting stiffeners, attaching aluminum sheet increments and mounting to supports. Do not field drill holes in any part of the structural assembly, except the field drilling of horizontal Z-bars for attaching new signs to existing supports when necessary.

(F) Welding

Weld studs to aluminum sheets by the capacitor discharge method. If the studs are welded after the retroreflective sheeting has been applied, insure that burn-through does not damage the retroreflective sheeting.

Shoot a test stud on each Type A, B and C sign in the lower left corner of the most left panel facing the back of the sign.

(G) Retroreflective Sheeting

Apply retroreflective sheeting to the aluminum sign panels in accordance with the retroreflective sheeting manufacturer's recommendations. For each multi-panel increment sign using glass beaded materials, sheet the entire sign from the same roll.

If a sign panel needs to be replaced after sign fabrication, the replacement panel may be sheeted with retroreflective materials from a different lot or drum number than the remainder of the sign; however, use material that visually color matches and meets Article 1092-2.

Take retroreflectometer readings on all 4 corners of each panel and document the readings on the sign design drawings.

Overlap all splices of any encapsulated or enclosed lens sheeting to allow water to run off without running into the splice.

Remove all foreign materials on the sheeted face with compressed air.

Keep a sample of each roll of sheeting and test for retroreflective compliance.

Patch wrinkles in the sheeting around thru bolts by removing the affected sheeting from the metal. Then patch this area with a circular patch encompassing an area 1/4" outside the affected area. This patch shall not exceed the standard patching limits shown in Table 901-3.

Ensure that all patches on the sign have a 1" minimum width or as recommended by the sheeting manufacturer.

Maintain documentation of the lot, drum, inspector, roll size, date received, date sheeted and metal treater on all signs, slip sheeting, copy, borders, shields, overlays, arrows and panels and retroreflectometer readings.

Obtain and assign to the Department in writing warranties for sign sheeting used in the fabrication of all permanent signs from the sheeting manufacturer. Warrant the signs against defective sheeting per the requirements outlined in the contract.

Define "permanent signs" as Types A, B, C, D, E and F signs, overlays for all sign types and milemarkers, and exclude any signs used only for traffic control while the project is under construction.

The reflective sheeting may be patched to repair incidental damage to the sheeting that might occur during manufacture, in transit or after installation; however, the patches cannot exceed the limits in Table 901-3.

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**TABLE 901-3
SIGN PATCHING LIMITS**

Sign Area	Maximum Number and Size of Patches During Fabrication		Maximum Number and Size of Additional Patches After Field Erection	
	Max. Number per Sign	Max. Size in Sq.In.	Max. Number per sign	Max. Patch Size in Sq.In.
0 to 15.0	0	0	0	0
15.1 to 50.0 (Single Panel)	1	1	1	1
30.0 to 80.0 (Increment Panel)	2	2	1	2
80.1 and Greater	A	3	A	3

A. Average not to exceed one patch per panel per sign. Maximum of 3 patches per panel allowed during fabrication with one additional patch per panel allowed after field erection.

(H) Reflectorized Letters, Numerals, Symbols, Border and Shields

(1) General

Use direct-applied retroreflective sheeting or demountable retroreflective sheeting letters, numerals, borders, shields and arrows as indicated on the sign designs.

Use designs of letters and numerals that conform to the *FHWA Standard Highway Signs*. Use border widths, design of route shields and arrows that conform to the MUTCD.

Route shields used on Type A or B signs or overlays shall be demountable.

Space and size all legends and borders in accordance with the contract or approved shop drawings. Any loose, deformed or misplaced legends and borders will be cause for rejection of the entire sign.

(2) Direct Applied

Provide direct-applied reflectorized letters, numerals, arrows and borders that are of the type and color of retroreflective sheeting shown in the contract for each sign. All direct applied copy or border not permanently affixed may be removed and replaced on signs if necessary during manufacture.

(3) Demountable

Attach demountable letters, numerals, borders, shields, arrows and alphabet accessories directly to sign faces with rivets as shown in the contract.

Use letters, numerals, arrows, borders and shields made of adhesive-coated retroreflective sheeting, permanently adhered to a flat aluminum backing, in accordance with the contract.

Use aluminum backing of at least .032" thick aluminum sheeting of 3004 H38, 5052 H38 or 6061 T6 alloy. Treat with a light, tight, amorphous chromate-type coating in accordance with the recommendations of the retroreflective sheeting manufacturer. Apply the retroreflective sheeting to the properly prepared aluminum using the method and equipment prescribed by the sheeting manufacturer.

1 Supply each letter, numeral, arrow, border and shield with mounting holes, and
 2 secure to the sign surface with non-twist corrosion resistant aluminum rivets. Use
 3 letters, numerals, arrows and borders that have rivets on all sides and ends spaced not
 4 more than 6" on centers, measured along the edges. Make sure that each legend
 5 piece has at least one rivet in each corner and at least 2 rivets in each end. Attach
 6 route shields as part of Type A or B signs with aluminum rivets spaced not more
 7 than 9" apart, measured along the edges of the shield.

8 Use a 1/4" diameter nylon washer under the head of all pull through type rivets for
 9 all demountable copy and shields.

10 **(I) Silk Screening**

11 Apply all legends and borders on Type E and F signs by silk-screening or reverse
 12 silk-screening after the sheeting is attached to the panels. Perform all screening as
 13 recommended by the manufacturer of the retroreflective sheeting. Use the color of all
 14 legends, borders and backgrounds, and their placement on the sign, in accordance with
 15 the contract.

16 Use opaque black ink for nonreflectorized message application, as manufactured or
 17 recommended by the manufacturer of the retroreflective sheeting.

18 Use transparent ink and thinner, for application on signs reflectorized with white
 19 retroreflective sheeting, as manufactured or recommended by the manufacturer of the
 20 retroreflective sheeting. Use colors that conform to the *FHWA Color Tolerance Charts*
 21 and AASHTO M 268 when thoroughly dry.

22 Test all lots of transparent ink for compliance with the minimum coefficient of
 23 retroreflection equal to 70% of the specified minimum retroreflection of the
 24 corresponding sheeting color and document the retroreflection value.

25 Inspect the first 5 signs of each screening and then every fifth sign. When unacceptable
 26 signs are found, all signs shall be inspected individually.

27 Only 3 nonwets per square foot, no larger than 1/16" in diameter, covering no more than
 28 1/3 of the total area of the sign are allowable. This includes nonwets from either the
 29 sheeting or the screen-printing.

30 Only one tadpole per 6 sf, no longer than 1 1/2" and not readily visible under lighted
 31 inspection is allowable.

32 **(J) Mounting Hardware**

33 Provide all mounting hardware consisting of, but not limited to, shims, backing plates,
 34 mounting bolts, washers and nuts. Provide mounting holes in the Z-stringers of the
 35 ground mounted signs in accordance with the details shown in the contract.

36 **(K) Packaging, Shipping and Storing**

37 Protect all signs during shipment and storage. Before shipping, make sure that all signs
 38 are free of moisture and that all inks are thoroughly dry. Do not apply adhesive tapes to
 39 any sign surface. Keep all packaged signs entirely dry.

40 Use assembled or partially assembled signs other than flat sheet signs that have sufficient
 41 braces securely attached to prevent buckling or warping at all times.

42 Affix a label outlining the retroreflective sheeting manufacturer's recommendations for
 43 handling, transporting and storing all types of signs to each shipping carton or crate.
 44 Provide full details of such recommendations with each shipment of signs.

45 Label each crate or package of signs or panels as to the contents (arrows, shields, etc.),
 46 WBS number and sequence of packages if more than one package is for a single sign.

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- 1 Maintain documentation of the lot, drum, inspector, roll size, date received, date sheeted,
2 metal treater on all signs, slipsheeting, copy, borders, shields, overlays, arrows, panels
3 and retroreflectometer readings.
- 4 Individually rack or separate by foam or slip sheeting on A-frame racks all sheeted
5 panels. Do not use spliced, overlapped, ripped or torn slipsheeting or foam.
- 6 Store all packed signs standing at a 75° to 90° angle.
- 7 Turn all panels and sign faces to the inside of the crates, whenever possible.
- 8 When crating a one-panel sign, provide the face side with an extra piece of foam and
9 cardboard taped to the outside of the face side of the package.
- 10 Pack panels of 102" in length or longer in only 2 per package.
- 11 Ensure all signs are debris free on the back side, with no misplaced writing, tape or
12 extraneous sheeting.
- 13 Crate to allow a 2" space on the inside dimensions larger than the size of the largest
14 package.
- 15 Store completed Type A and B signs back to back with at least 12" between faces.
- 16 When crating 2 panels of different sizes, place the smaller panel with its face to the back
17 of the larger panel and package with an extra piece of foam and cardboard taped to the
18 outside of the larger panel, with its face to the outside of the crate. Provide extra
19 packaging on both outsides of the package for double-faced signs.
- 20 Crate packaged panels to allow the passage of a 1/8" spacer on the inside of each side of
21 the crate, so that the panels are not overly tight or binding in crate.
- 22 Inspect all signs and packaging before shipping to assure compliance with the contract
23 and the *Standard Specifications*. The Department retains the right to inspect the signs
24 and packaging before shipping.

25 (L) Transparent Films

- 26 Use transparent films instead of silk screening when authorized by the Department.
27 Transparent film is a durable, transparent, acrylic colored film coated with transparent,
28 pressure-sensitive adhesive. When the film is applied over reflective sheeting, the
29 coefficient of retroreflectivity shall meet the color and type of sheeting in Tables 1092-3,
30 1092-4 and 1092-5. Use Department approved transparent film approved by the
31 manufacturer of the reflective sheeting to insure the materials meet the manufacturer's
32 warranty and obligation in Subarticle 1092-2(B).

33 901-4 SIGN QUALITY

- 34 Provide signs that present a uniform appearance free from color match problems, non-uniform
35 color, streaks, spots, abrasions, blistering or other defects in the sheeting.
- 36 Sheeting may be inspected before application to sign blanks, after installation to sign blanks,
37 after completion of the sign in the sign fabricator's facility and after installation. Clean all
38 installed signs before final field inspection.

1 The retroreflective sheeting will be unsatisfactory if it has deteriorated due to any cause
 2 except defacement resulting from vandalism or damage resulting from impact by a motor
 3 vehicle or other object to the extent that:

4 (A) The sign is ineffective for its intended purpose when viewed from a moving vehicle
 5 under normal day and night driving conditions, or

6 (B) The coefficient of retroreflection is less than the minimum specified for that sheeting as
 7 shown in Tables 1092-3, 1092-4 and 1092-5 when measured by a Department approved
 8 retroreflectometer, or

9 (C) The screened message and border or reverse screened background has stained,
 10 discolored, streaked, faded, turned dark or has developed cracks, scaling, pitting and/or
 11 blistering, or

12 (D) The sign is unsatisfactory with regard to uniform appearance due to cracking, streaking,
 13 delamination, blistering, crazing or discoloration of the sheeting, or

14 (E) The sign is unsatisfactory with regard to remaining uniform in color over the entire
 15 reflecting surface both day and night and displaying the same color both in daylight and
 16 under lights at night.

17 (1) For glass bead material, sheeting will be subjected to a visual test with the human
 18 eye as the test instrument. Objectionable non-uniformity of color and reflectivity
 19 (retroreflection) under light at night is cause for the sign to be tested for
 20 retroreflection to determine compliance with the following requirements:

21 The retroreflection values on any sign shall not vary from each other by more than
 22 a ratio of 1.10 (1.20 white) at any 2 points at least 12" apart, nor more than
 23 1.30 (1.30 white) at any 2 points anywhere on the sign, nor more than,
 24 1.10 (1.20 white) at any 2 points on the border or between any 2 adjacent letters,
 25 numerals or symbols. Failure to meet the above requirements will result in sign
 26 rejection. Retroreflection will be tested using a Delta RetroSign retroreflectometer.

27 (2) For prismatic material, sheeting will be subjected to a visual test with the human eye
 28 as the test instrument.

29 **901-5 MEASUREMENT AND PAYMENT**

30 Sign fabrication will be measured and paid as the actual number of square feet of sign face
 31 areas of each type, including milemarkers and overlays acceptably fabricated. In measuring
 32 this quantity, the sign face areas will be calculated to the nearest 1/100 of a square foot, using
 33 the dimensions shown in the contract.

34 The areas of odd-shaped signs (e.g. stop signs and shield-shaped route markers) will be
 35 calculated as squares or rectangles using the dimensions shown in the contract. The areas of
 36 round, diamond and triangular signs will be calculated for their true shapes using plan
 37 dimensions.

38 Repair or otherwise correct any damage to the signs or refabricate them at no cost to the
 39 Department. When requested by the Contractor, the Department may have the necessary
 40 repairs made or the signs refabricated, and deduct the associated costs thereof from monies
 41 due the Contractor.

42 Payment will be made under:

Pay Item

Contractor Furnished, Type ____ Sign
 Department Furnished, Type ____ Sign

Pay Unit

Square Foot
 Square Foot