

LocoGear

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Technical Bulletin - 16

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Fabricating Instructions for Cab, Lima Card Number 227-A-5003, and Fuel Bunker, Lima Card Number 837-A-5000

The following instructions are for fabricating the Cab (Lima Card Number 227-A-5003) and the Fuel Bunker (Lima Card Number 837-A-5000) for the **Western Maryland Railway #6**. On both drawings for **WM #6**, Lima references the drawings used to fabricate the Cab and Fuel Bunker for the **Greenbrier, Cheat & Elk Railroad #12**, which were Lima Card, Numbers 223-A-5013 and 833-A-5003. Thus it can be assumed that these components shared many similarities between these two Shays, and in general, can be constructed in a similar manner. Photographs of these two Shays show a striking resemblance between the two Cabs and Fuel Bunkers. However, this *LocoGear Technical Bulletin* will focus on fabricating the Cab and Fuel Bunker of the **WM #6**.

Prototype drawings of these major components for both the **WM #6** and the **GC&E #12** are available from both the Allen County Historical Society, and the California State Railroad Museum Library. See *LocoGear Technical Bulletin - 05* for instructions on how to order prototype drawings. We recommend that you have copies of the prototype drawings before beginning to fabricate the Cab and Fuel Bunker of a live steam model of either Shay.

The Cab and Fuel Bunker are both covered together in this *LocoGear Technical Bulletin* because they are riveted together forming a single unit when completed. The Cab and Fuel

Bunker can also be removed from the Engine Frame as a unit for boiler maintenance by removing a series of bolts that hold this assembly to the Engine Frame and the Right and Left Side Running Boards.

We have also made certain design modifications from the prototype to allow for the center portion of the Cab roof to be removable allowing access to operate the controls of the live steam model. There are two break lines running from the front to the back of the roof along the two rain gutters, which will form the sides of the removable roof section. This design allows the model to appear "prototypic" when the roof section is in place. When the roof section is removed, it allows ample access to the inside of the Cab.

Lima originally made the Cab and Fuel Bunker from 1/4" steel plate and 2" x 2" x 1/4" and 2" x 2 1/2" x 1/4" steel angles. For the live steam model, these components can be fabricated from 16-gauge (0.063") steel plate and 1" x 1" x 0.063" thick wall steel tube stock. The added thickness of the plates and angles will give added strength and weight to the live steam model, yet we will otherwise remain faithful to the prototype design.

1. The first step is to bend two pieces of 16-gauge steel plate in the shapes shown in the drawings on pages 2 and 3. If you do not

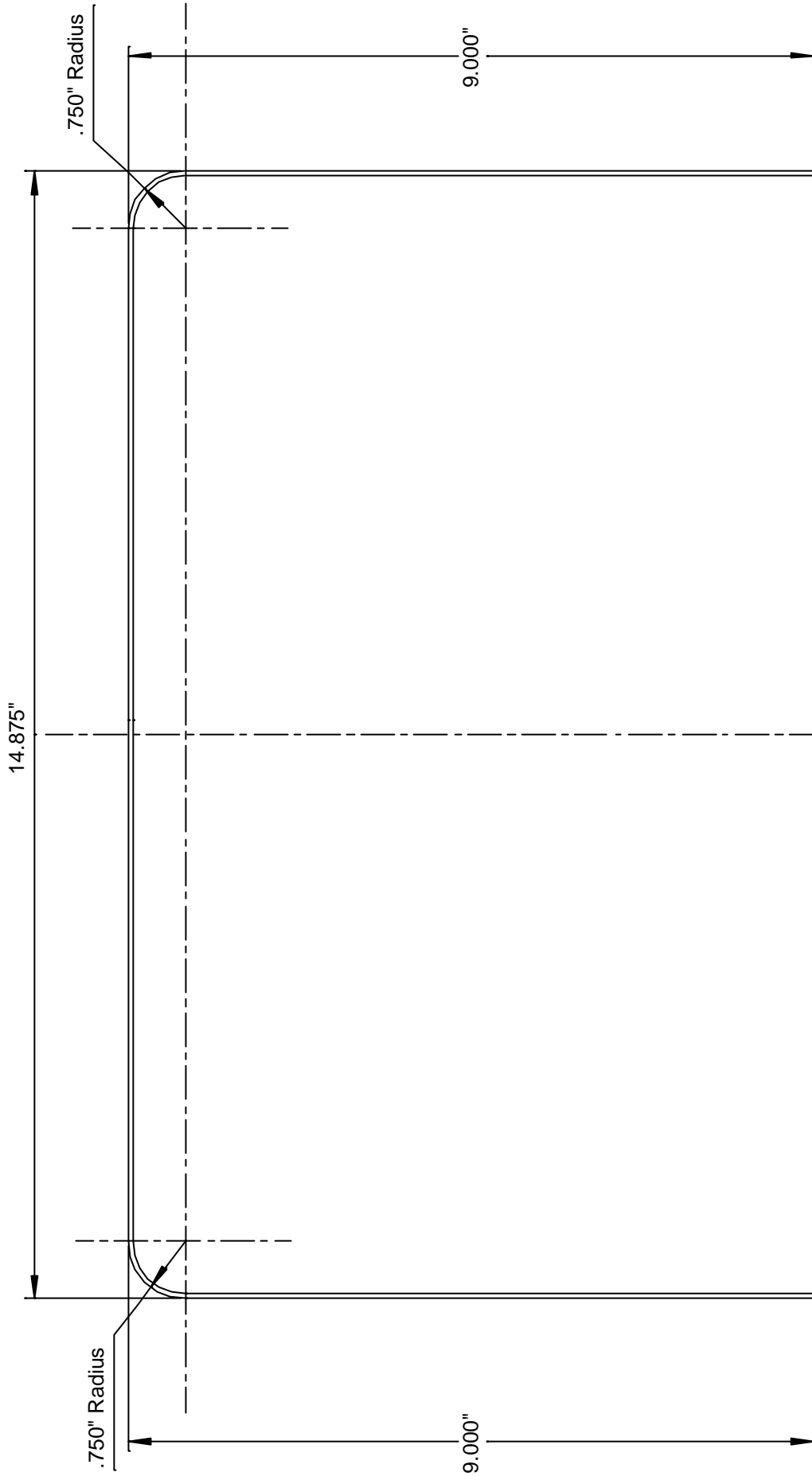
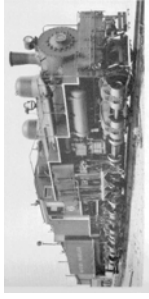
Western Maryland Railway Shay #6

Fuel Bunker Profile

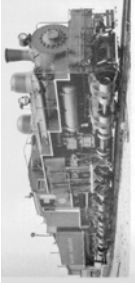
Lima Card Number 837-A-5000

Drawn by John D.L. Johnson 11/19/2001

Made From 16 Gauge (.063") Steel Plate



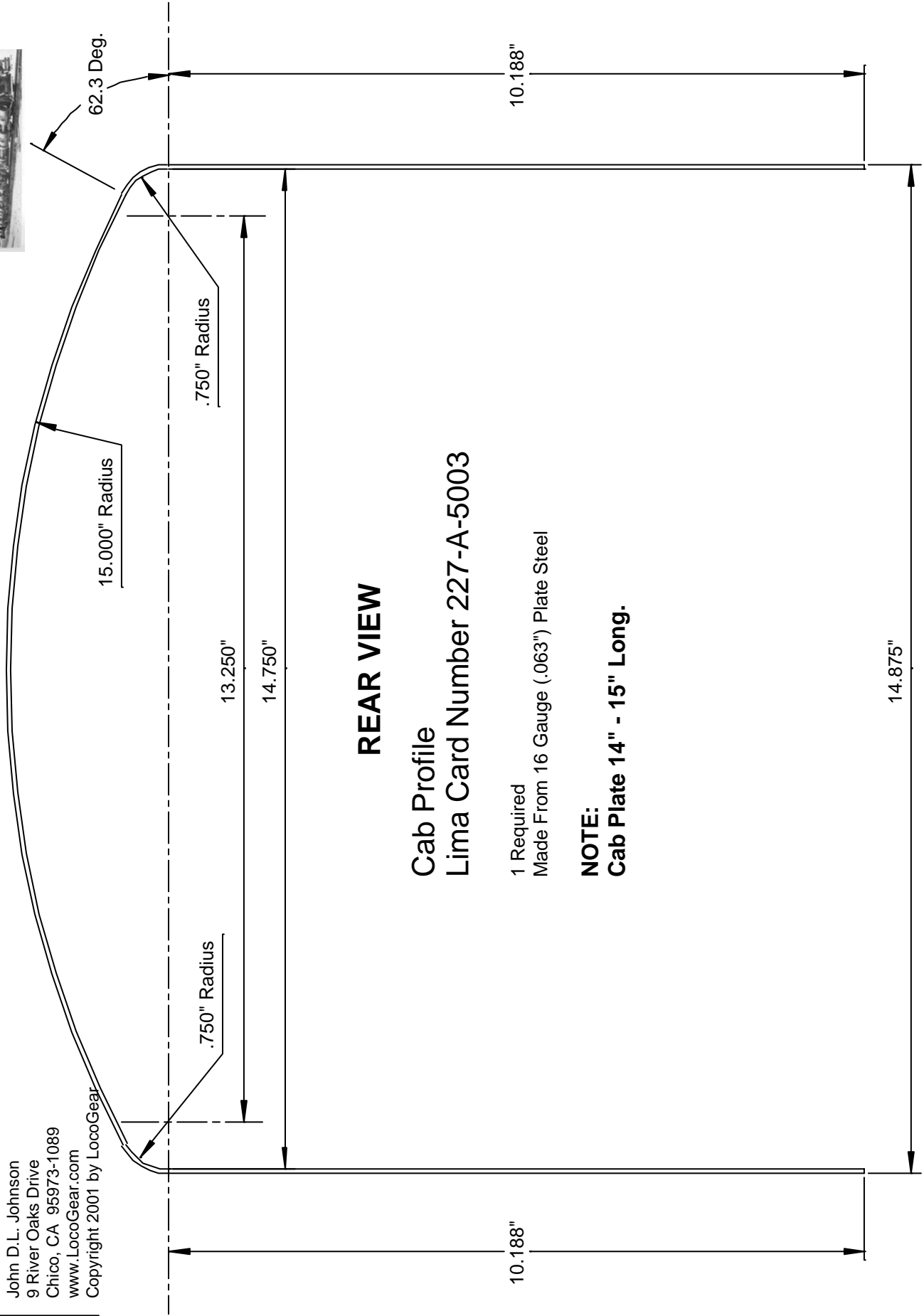
NOTE: TOP VIEW
Fuel Bunker Sides 9.750" Tall.



Western Maryland Railway Shay #6

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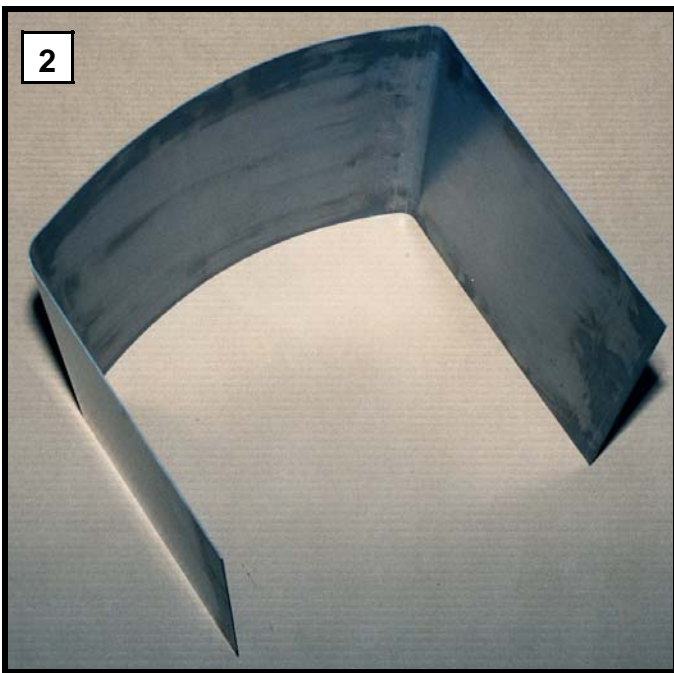
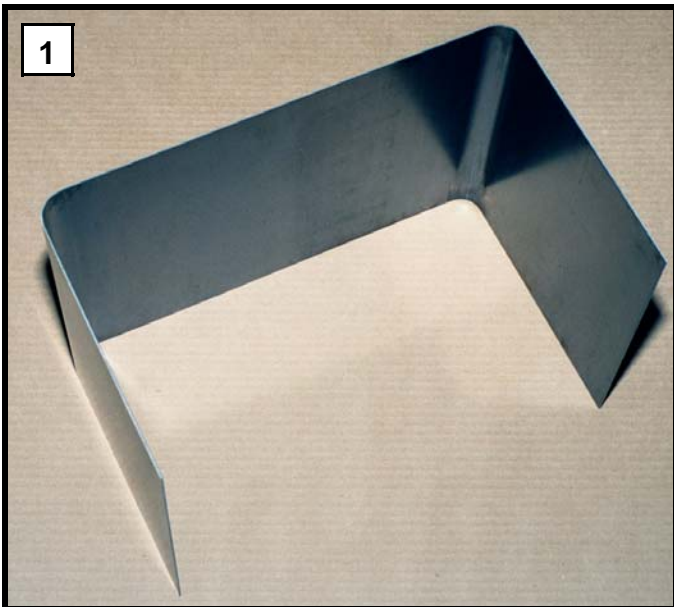


REAR VIEW

Cab Profile
Lima Card Number 227-A-5003

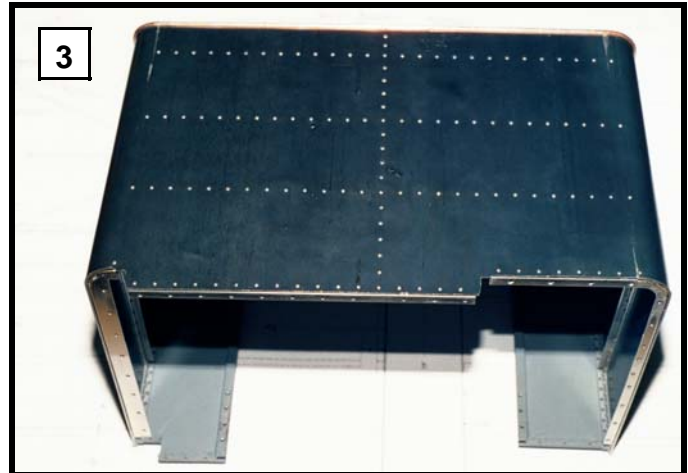
1 Required
 Made From 16 Gauge (.063") Plate Steel

NOTE:
Cab Plate 14" - 15" Long.

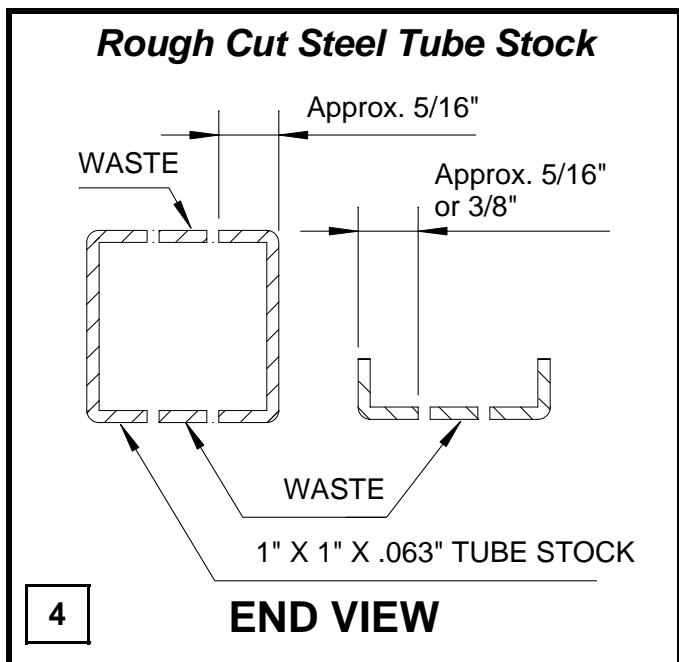


have access to sheet metal equipment to roll and bend these plates, we suggest that you have this work done at a sheet metal fabricator. A moderate degree of precision is needed for these bends. The Fuel Bunker plate is formed from a 16-gauge plate 9.750" wide and at least 33" long. Once the two rear corners of the Fuel Bunker are bent, the two sides can be trimmed to length. The Cab is formed with a 16-gauge plate 14" to 15" wide and at least 38" long. Once the profile of the Cab roof and side walls is bent, the two sides can be trimmed to length. The reason for this added length from front to

back of the Cab roof is that when the center portion of the roof is cut out, the gap left by the saw cut can be eliminated by sliding the center portion forward. More about this point later. Also the Cab side walls extend back along the top edge of the Fuel Bunker so the extra material is needed here (see photos 1 and 2).



2. The Fuel Bunker straddles the Engine Frame (Lima Card Number 480-A-5000), resting on the Right and Left Side Running Boards. The back wall of the Fuel Bunker drops down to the Shoveling Sheet (Lima Card Number 884-A-5008) which spans the area between the Engine Frame. The two side walls of the Fuel Bunker are next trimmed taking 0.625" off the bottom edges and around each curved rear corner to the inside edges of the Engine Frame. Also at the points where the rear wall of the Fuel Bunker drops down between the frames is the upper portions of the Frame End Casting (483-A-5071). Great care should be taken to cut the profile of the Fuel Bunker rear wall to match this irregular profile (see photo 3).
3. On the inside walls of the Fuel Bunker there are a series of $\frac{1}{4}$ " x $\frac{1}{4}$ " x $\frac{1}{16}$ " reinforcing angles riveted to the walls at three levels giving the walls added strength. Also riveted around the bottom edge of the Fuel Bunker are $\frac{1}{4}$ " x $\frac{5}{16}$ " x $\frac{1}{16}$ " angles that attach to the Left and Right Side Running Boards and Engine Frame. Note that the top reinforcing angle and the angle at the base of the Fuel Bunker walls bend continuously around the rear corners. The center pair of reinforcing angles stop at the tangent points of the corners. Since $\frac{1}{4}$ " x $\frac{1}{4}$ " x $\frac{1}{16}$ " and $\frac{1}{4}$ " x $\frac{5}{16}$ " x $\frac{1}{16}$ " angles are not commercially



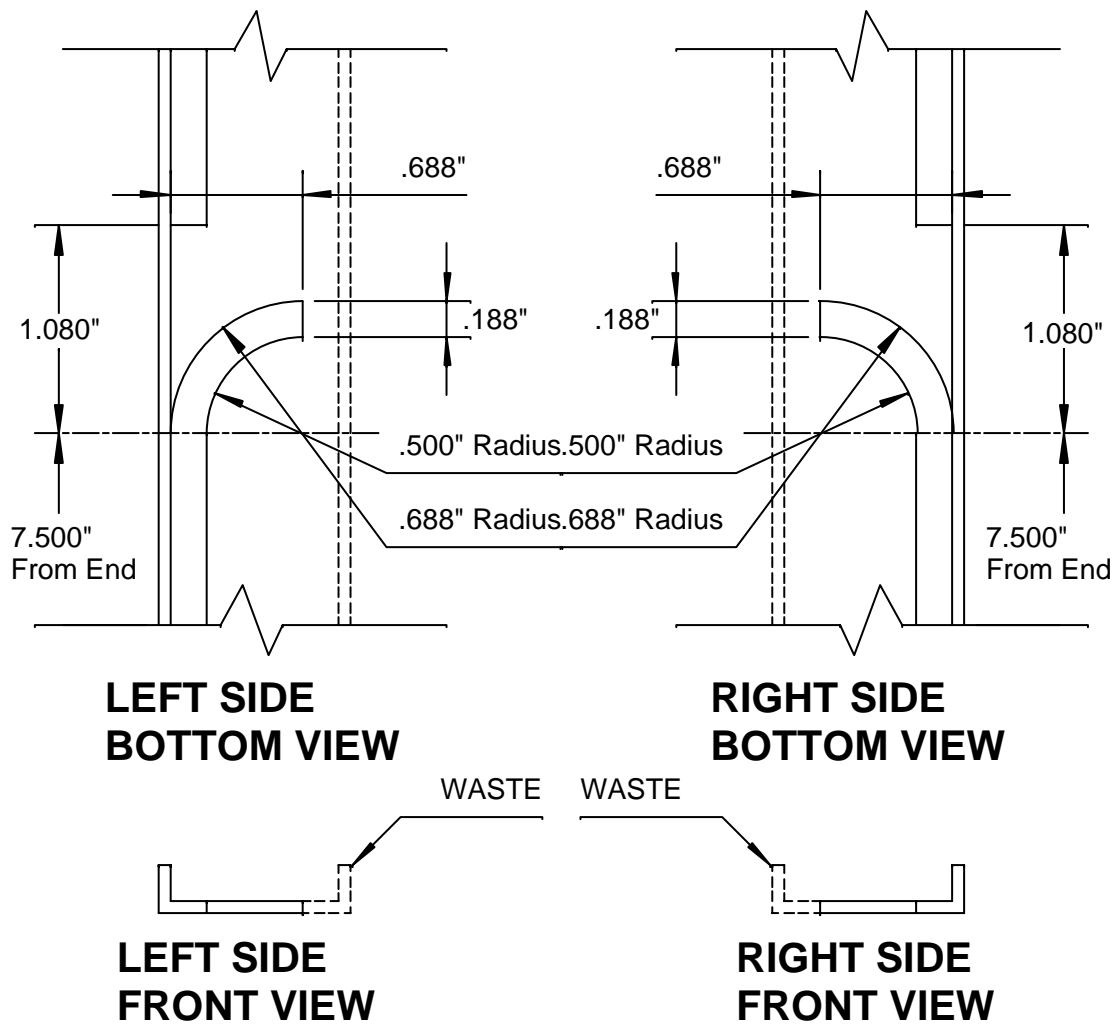
available stock items, we will fabricate these angles by cutting them out of the corner portions of 1" x 1" x .063" thick wall square steel tube stock. Take care to select square steel tube stock with the sharpest outside corners as you can find. Some tube stock has more rounded corners, which will not look good on a model. Also select steel tube stock which has the welded joint close to the center of one. This following method to make angles can also be used in many other parts on the live steam model of the **Western Maryland Ry. Shay #6**.

4. We will start with the two pairs of 1/4" x 1/4" x 1/16" center reinforcing angles on each of the two side walls of the Fuel Bunker. Cut and finish a length of the 1" x 1" x .063" thick wall square steel tube stock 7.500" long. Draw two lines along the length of the square steel tube stock on one side approximately 5/16" in from adjacent corners. A fine point "Sharpie" marker works well for this. Rough cut along these lines using a vertical power band saw with a metal cutting blade through both the top and bottom of the tube walls (see sketch 4). Next take each of the "U" shaped pieces and draw two lines along the length of the piece on the inside approximately 1/4" from the inside corners. Rough cut along these lines using a power band saw with a metal cutting blade (also see sketch 4). The result will be four lengths of angle approximately 5/16" wide on each leg and four pieces of waste. One of those

pieces of waste will include the steel tube's welded seam. Finally, clamp the angles one at a time in a milling vise and mill off each leg of each angle to the finished width of 0.250".

5. Next drill the rivet holes in the four Fuel Bunker side wall reinforcing angles. Although the Lima's drawing for the Fuel Bunker (837-A-5000) states that the spacing of all rivets is to be at 4" center to center, the fabrication shop obviously did not follow this verbatim. Each of these reinforcing angles has a row of 15 rivets starting 0.125" in from each end. The remaining 7.250" is then evenly split with 14 spaces. This calculates out to about 0.518" center to center. The rivet holes should also be located along the reinforcing angles 0.094" from the edge of the verticle leg or 0.156" from the outside corner. Clamp the reinforcing angles one at a time in a milling vise and drill the rivet holes for 1/16" diameter rivets.
6. It is important to be as consistant as possible in the location and spacing of these holes as these reinforcing angles will be used as drill guides to drill the rivet holes in the side walls of the Fuel Bunker, however, the angles will be turned around to do this. Unless you have a very small drill press, you will not be able to use the reinforcing angles to drill the rivet holes from the inside of the Fuel Bunker because of its "U" shape. Instead, the reinforcing angles will be temporarily clamped to the outside of the side walls of the Fuel Bunker and drilled from the outside. However, before drilling these rivet holes, cut a scrape piece of 3/4" plywood to the shape of the inside of the Fuel Bunker. This will be used to hold the Fuel Bunker walls apart during drilling. Line up the reinforcing angles in the proper location on the outside of the Fuel Bunker and clamp in place. Next place the plywood insert inside the Fuel Bunker as close to the clamps as possible. Then place this assembly on the drill press and drill the rivet holes in the side walls of the Fuel Bunker through the holes in the reinforcing angles. Do this one at a time for all four side wall reinforcing angles. Do not rivet these reinforcing angles in place at this time.
7. The rear wall of the Fuel Bunker also has two center reinforcing angles which are 13.250" long. Cut these two angles from a piece of 1" x

Top Reinforcing Angle Curve Cut Pattern



5

1" x .063" thick wall square steel tube stock and mill the legs to 0.250" wide just as you did in step 4. Each of these reinforcing angles has a row of 27 rivets starting 0.125" in from each end. The remaining 13.000" is then evenly split with 26 spaces at 0.500" center to center. The rivet holes should also be located along the angle 0.094" from the edge of the angle leg or 0.156" from the outside corner. Drill the rivet holes for 1/16" diameter rivets.

8. Drilling the corresponding rivet holes in the rear wall of the Fuel Bunker does not have the clearance problem of the side walls, as explained in step 6, so these reinforcing angles can be positioned on the inside of the Fuel Bunker and used as drill guides for the rivet holes through the rear wall. Do not rivet these reinforcing angles in place at this time.
9. The top reinforcing angle runs continuously

around the Fuel Bunker bending around both rear corners. To just bend this size material would be very difficult. However, this curve can be more easily made by cutting the 1" x 1" x .063" thick wall square steel tube stock as shown in sketch 5. Start with a 16" long piece of 1" x 1" x .063" thick wall square steel tube stock. Cut it into the two "U" shaped pieces as discussed in the first part of step 4. These two pieces will each become half of the total length of the top reinforcing angle and will meet along the rear wall of the Fuel Bunker. While still in the "U" shape, place each piece one at a time in a milling vise and mill the end of the one leg to be used as the vertical leg for the angle on each half to 0.250" wide. The other leg does not need to be milled because it will be waste.

10. Next layout and cut the straight and curved sections as shown in sketch 5 with the tangent

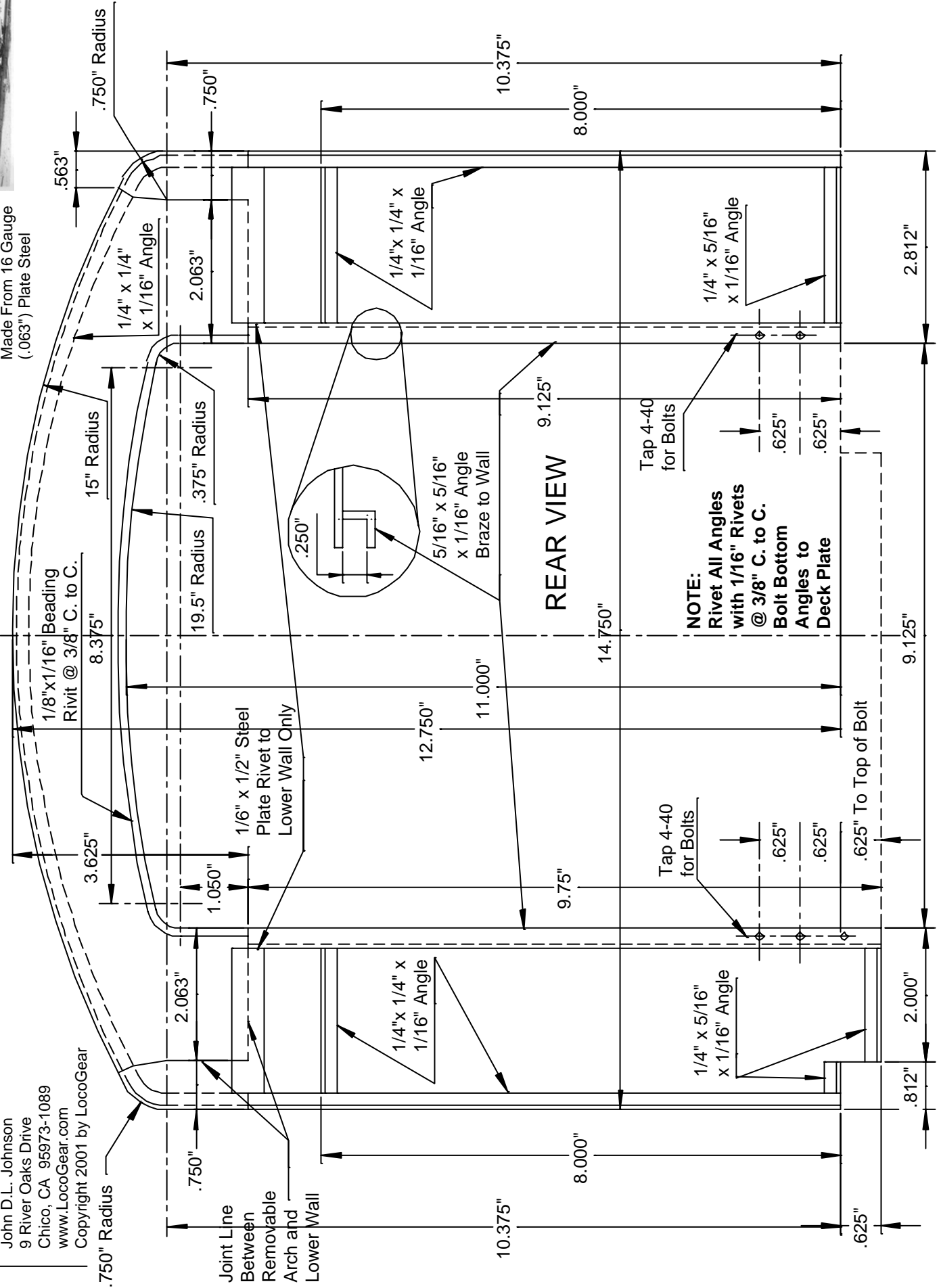
Western Maryland Railway Shay #6

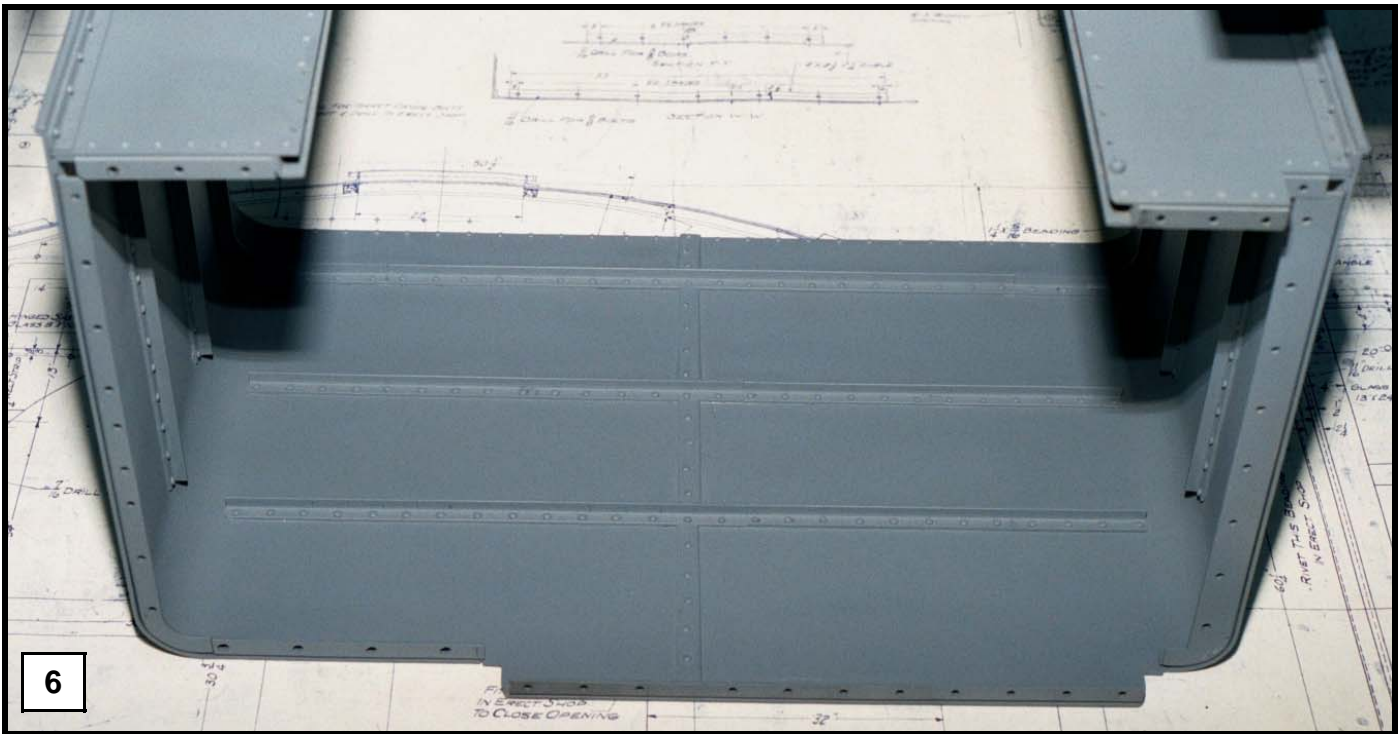
Cab (Rear) Lima Card Number 227-A-5003

Drawn by John D.L. Johnson
11/16/2001 1 Required
Made From 16 Gauge
(.063") Plate Steel



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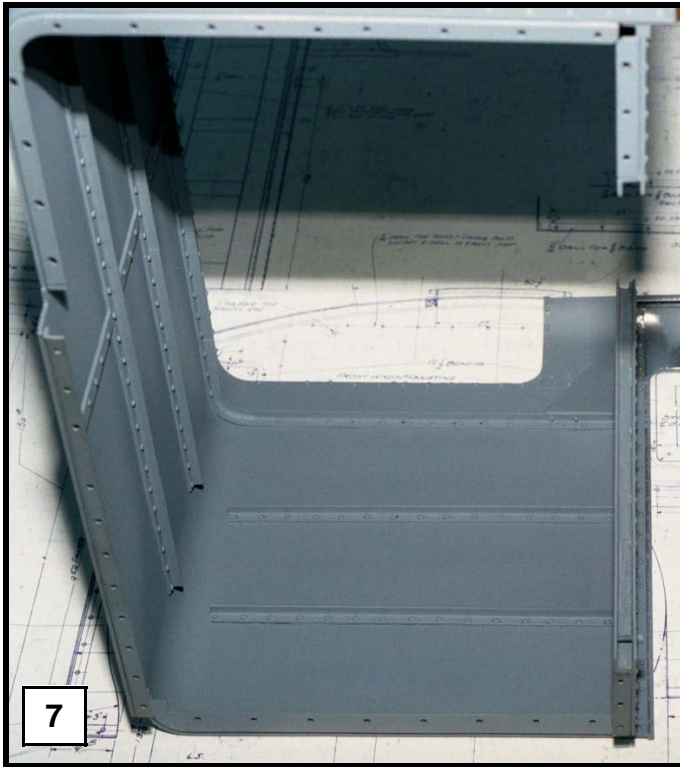


point of the curves 7.500" from one end of each piece. For the straight portions, draw a line along the length of the pieces on the inside approximately $\frac{1}{4}$ " from the inside corner to be used for the angle. For the curved portion, layout according to the dimensions in sketch 5 on the inside of the "U" shaped piece. Note that the 1.080" gap in the horizontal leg of the top reinforcing angle will be filled with the curved portion when each piece is bent to the final shape. Rough cut along these lines using a power band saw with a metal cutting blade. Where the 0.688" radius meets the vertical web of the angle, you may need to cut the horizontal web along the vertical web in the inside corner of the angle down to the tangent point in order to get a smooth bend later to the vertical web. This extra cutting will be filled in with braze later in step 13.

11. After the two top reinforcing angle pieces are cut, place each piece one at a time in a milling vise and mill the end of the horizontal leg along the straight portions to 0.250" wide. Use a hand file to finish the curved portion.
12. Before bending to final shape, drill the rivet holes in the vertical web of the top reinforcing angle pieces. The rivet holes for the side wall and rear wall portions should be the same locations as the center reinforcing angles as described in steps 5 and 7. Choose a convenient

location between rivets along the rear wall to trim the two top reinforcing angle pieces for a butt joint. Do not drill rivet holes in the curved area as such holes may hinder the smooth bend of the vertical web.

13. Bend each angle so the vertical web wraps around the horizontal curved portion. Clamp each angle to the welding table and braze the joint filling it from the inside of the angle with just enough bronze to fill the saw blade gap and make a small fillet. Chip off any flux and wire brush clean.
14. Use the top reinforcing angles as drilling guides to drill the corresponding rivet holes in the walls of the Fuel Bunker as explained in step 6. Do not rivet these top reinforcing angles in place at this time. This completes the fabrication of the top reinforcing angles.
15. Around the bottom edge of the Fuel Bunker is a series of three $\frac{1}{4}$ " x $\frac{5}{16}$ " x $\frac{1}{16}$ " angles that attach the base of the Fuel Bunker to the Left and Right Side Running Boards and the Shoveling Sheet which spans the area between the Engine Frames (see photo 6). The base angles bend continuously around the rear corners and can be made similarly to the top reinforcing angle except that the horizontal web of the base angles are wider. The base angle section on the right side begins at the same point near the front of the fuel bunker running 7.500" along

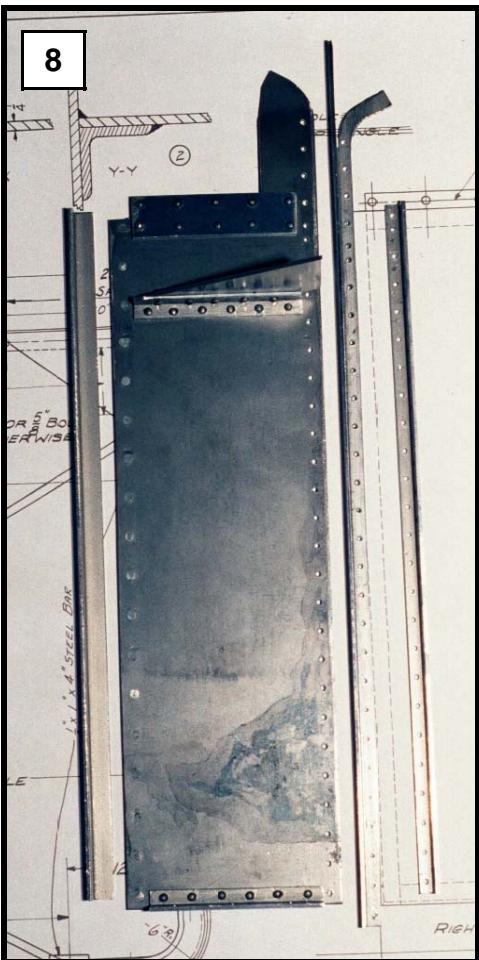
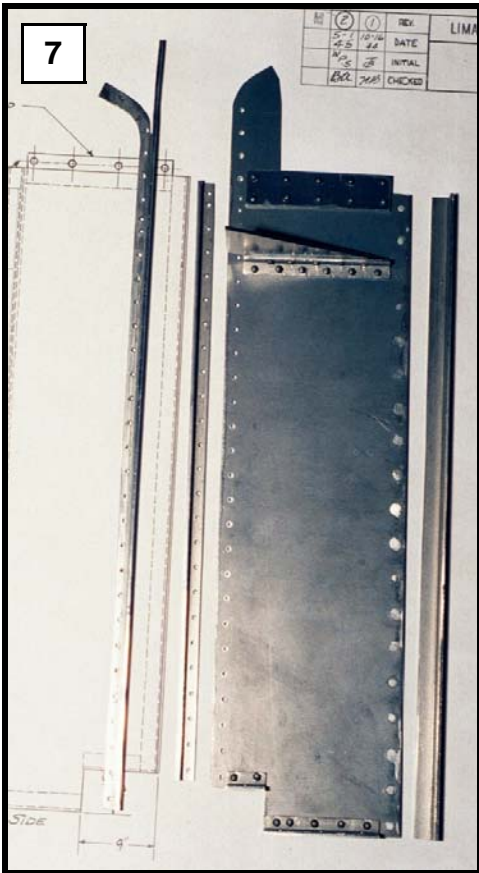


the right side and then curves around the back right corner ending at the inside edge of the right Engine Frame. It can also be made like the top reinforcing angle with the exception that the base flange is $5/16$ " wide. The base angle section on the left side begins at the same point near the front of the fuel bunker running 7.500" along the left side and then curves around the back right corner ending at the inside edge of the left Engine Frame. It can also be made like the top reinforcing angle with the exception that the base flange is $3/4$ " wide. This greater width on the left side base angle is necessary in order to utilize the bolt holes located along the top edge of the left Engine Frame in this area. The third base angle is a straight section of $1/4$ " x $5/16$ " x $1/16$ " angle along the rear wall of the Fuel Bunker between the Engine Frames that connects it with the Shoveling Sheet.

16. To make the base angles start with a 16" long piece of 1" x 1" x .063" thick wall square steel tube stock. Cut it into the two "U" shaped pieces as discussed in the first part of step 4. These two pieces will each become the right and left side base angle along the wall of the Fuel Bunker. While still in the "U" shape, place each piece one at a time in a milling vise and mill the end of the one leg to be used as the vertical leg for the base angle on each half to

0.250" wide. The other leg does not need to be milled because it will be waste.

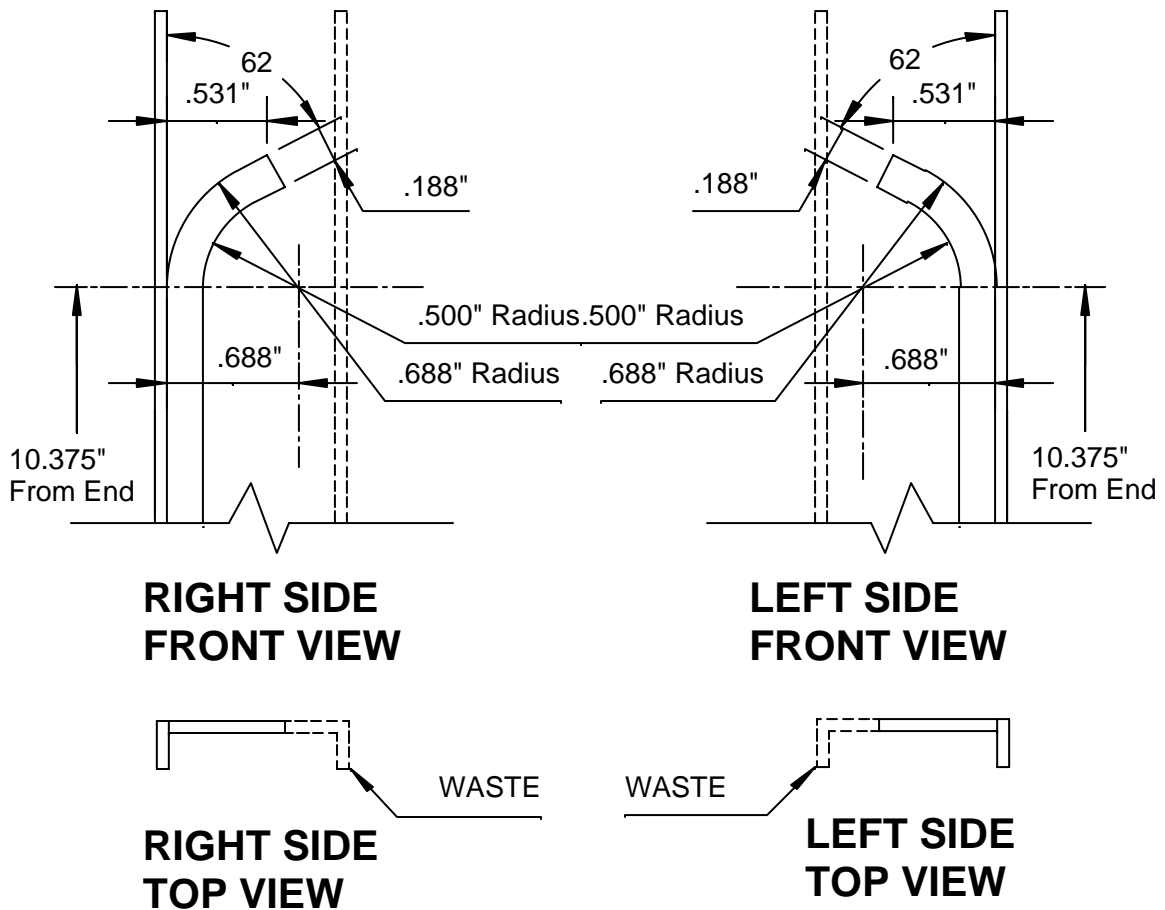
17. Next layout and cut the straight and curved sections as shown in sketch 5 with the tangent point of the curves 7.500" from one end of each piece. For the straight portions, draw a line along the length of the pieces on the inside approximately $5/16$ " from the inside corner to be used for the angle for the right side base angle and $13/16$ " for the left side base angle. For the curved portions, layout according to the dimensions in sketch 5 on the inside of the "U" shaped piece. Note that the 1.080" gap in the horizontal leg of the base angle will be filled with the curved portion when each piece is bent to the final shape. Rough cut along these lines using a power band saw with a metal cutting blade. Where the 0.688" radius meets the vertical web of the angle, you may need to cut the horizontal web along the vertical web in the inside corner of the angle down to the tangent point in order to get a smooth bend later to the vertical web. This extra cutting will be filled in with braze later in step 20.
18. After the two base angle pieces are cut, place each piece one at a time in a milling vise and mill the end of the horizontal leg along the straight portions to 0.313" wide on right side base angle and 0.750" on the left side base angle. Use a hand file to finish the curved portion.
19. Before bending to final shape, drill the rivet holes in the vertical web of the base angle sections. The rivet spacing on the three base angles should match those of the reinforcing angles above them. Do not drill rivet holes in the curved area as such holes may hinder the smooth bend of the vertical web. Also drill #33 clearance holes in the horizontal web for the bolts that will hold the Fuel Bunker to the Running Boards and the Shoveling Sheet.
20. Bend each angle so the vertical web wraps around the horizontal curved portion. Clamp each angle to the welding table and braze the joint filling it from the inside of the angle with just enough bronze to fill the caw blade gap and make a small fillet. Chip off any flux and wire brush clean.
21. Use the base angles, and reinforcing angles as drilling guides to drill the corresponding rivet



holes in the walls of the Fuel Bunker as explained in step 6. Do not rivet these base angles in place at this time. This completes the fabrication of the base angles.

22. Along the top edge of the Fuel Bunker is a $5/32$ " half round trim. To make this trim, cut a length of $5/32$ " copper coated welding rod into three pieces, one approximately 12" long and two approximately 8" long. Clamp each one at a time in a fixture to hold it for milling and mill off one half of the thickness.
23. Next we will fabricate the two front walls of the Fuel Bunker (see photos 7 and 8). Cut two pieces of 16-gauge steel plate, one 2.812 " x 11.125 " for the right side front wall and 2.812 " x 11.688 " for the left side front wall (see drawing on page 7). Note the profile both have along the top edge and the notch in the bottom edge of the left side front wall.
24. There are eleven separate angle pieces attached to the front wall plates of the Fuel Bunker. These can be made in the same manner as the reinforcing angles. Note the sizes and lengths as shown in the drawing on page 7. First we will make the two vertical angles on the rear side of each of the Fuel Bunker front wall plates which hold the plates to the side walls. These angles are $1/4$ " x $1/4$ " x $1/16$ " x 9.125 " tall. Each leg of these angles has a row of 25 rivets in a line centered 0.156 " from the outside corner of the angle. The spacing of the rivets on each leg is similar, but also different enough to place most of the rivets between those on the opposite leg. The top and bottom rivets on each leg of each angle are centered 0.156 " from each end. On the legs of the angles against the front walls of the Fuel Bunker, the second rivet down from the top is then centered 0.188 " below the first. The remaining rivets are spaced at 0.375 " center to center. On the legs of the angles against the side walls of the Fuel Bunker, the second rivet up from the bottom is then centered 0.188 " above the first. The remaining rivets are spaced at 0.375 " center to center.
25. Next we will make the two vertical angles on the front side of each of the Fuel Bunker front wall plates which hold the plates to the side walls. These angles are $1/4$ " x $1/4$ " x $1/16$ " x 12 " tall. The top portion of these angles are curved and can be made in a similar manner as the curved portions of the top reinforcing angles (see sketch 7). When cutting out the curved top portion of this angle, leave the legs of the angles against the side walls of the Fuel Bunker extra long for now. This will be trimmed to length after it is bent. Each leg of these angles has a row of rivets in a line centered 0.156 " from the outside corner of the angle. However, the spacing of the rivet holes on each leg of these angles is very different. The rivet spacing on the legs against the Fuel Bunker front plates correspond to those on the matching rear angles. To drill these corresponding rivet holes, temporarily clamp the front

Fuel Bunker Front Wall Front Angles Curved Portion Cut Pattern



7

and rear angles to the edge of the Fuel Bunker front wall plate and use the rear angle as a drill guide to drill the rivet holes through both the plate and the front angle. The rivet spacing on the legs against the Fuel Bunker side walls do not match the rear angles. The first rivet hole up from the bottom on both sides is centered 0.156" from the bottom end. The second rivet hole up from the bottom on both sides is centered 1.000" from the bottom end. Above this are ten more rivets spaced 0.625" center to center. Then there is a space of 1.625" before the highest rivet on the Fuel Bunker side wall in this front angle. Do not drill any of the rivets in this angle that will be attaching it to the Cab roof at this time.

26. The Fuel Bunker front wall plates extend toward the center of the locomotive and these inside edges form the fronts of the pockets for the coal boards. The prototype these coal board pockets were made by riveting together two angles on each side and then riveting them to the

front wall plates. To build the model, we will create the pocket with only one angle per side and braze them in place. Cut two angles 5/16" x 5/16" x 1/16" with one 9.125" tall and the other 9.750" tall. A row of "for show" rivets will be placed along both the inside edges of the Fuel Bunker front wall plates in a line centered 0.156" from the edge. Space the rivet holes 0.500" center to center beginning 0.125" from the top inside corners of the front wall plates. Do not drill rivet holes all the way to the bottom because there are bolt holes that should be located there as shown on the drawing on page 7. These rivet holes should be countersunk on the rear surface. Do not put rivets in these holes at this time. Do not braze on the coal board pocket angles at this time.

27. In the front two corners of the Fuel Bunker there are angled brace plates that rests on top of the upper reinforcing angles and are welded to the rear surface of the front wall plates. Instead of welding this thin material, two short 1/4" x 1/4"

x 1/16" x 2.250" angles are riveted to the front wall plates and under these brace plates as shown in the drawing on page 7. The vertical leg of these angles has a row of 5 rivets in a line centered 0.156" from the outside corner of the angle. The first rivets are centered 0.125" from each end and the remaining three rivets are spaced 0.500" center to center. The horizontal leg of these angles has a row of 4 rivets in a line centered 0.156" from the outside corner of the angle. The first rivets are centered 0.375" from each end and the remaining two rivets are spaced 0.500" center to center. To drill the corresponding rivet holes in the Fuel Bunker front wall plates, temporarily clamp the angles to the front wall plates and use the angles as drill guides to drill the rivet holes through the plate. Do not rivet these angles at this time.

28. Both Fuel Bunker front wall plates have a 1/2" x 2.250" x 1/16" plates along the top edges where the joint between the front wall plates and the archway of the rear wall of the Cab meet. Each joint plate has two rows of five rivets in a line centered 0.125" from the top and bottom edge. The first rivets of each row are centered 0.125" from each end and the remaining three rivets are spaced 0.500" center to center. The four rivet holes in the top rows of both joint plates toward the center of the locomotive are to be countersunk on the front side. To drill the corresponding rivet holes in the Fuel Bunker front wall plates, temporarily clamp the joint plates to the front wall plates and use the joint plates as drill guides to drill the rivet holes through the front wall plates. Do not rivet these joint plates at this time. The four rivets in each joint plate that are for show, can now be riveted in place. File flush any extra rivet material extending above the countersunk holes. These joint plates will hold the lift-out Cab roof section in place when completed.
29. Along the bottom of both Fuel Bunker Front Plates are three short 1/4" x 5/16" x 1/16" angles that attach the front plates to the Running Boards and the Shoveling Sheet. On the right side front wall plate, the angle is 2.250" long. The vertical leg of this angle has a row of 5 rivets in a line centered 0.156" from the outside corner of the angle. The first rivets are cen-

tered 0.125" from each end and the remaining three rivets are spaced 0.500" center to center. The horizontal leg of this angle has a row of 3 #33 pilot holes in a line centered 0.188" from the outside corner of the angle. The first holes are centered 0.375" from each end and the third hole is centered between them. On the left side front wall plate, there are two angles, one is 1.688" long and the other is 0.563" long. The vertical legs of these angles have a row of rivets in a line centered 0.156" from the outside corner of the angle. On the left side short angle, there are two rivets centered 0.125" from each end. The horizontal leg of the short left side angle has one #33 pilot hole centered 0.188" from the outside corner of the angle and centered along its length. On the left side longer angle, there are three rivets. The first rivet is centered 0.125" from the end closest to the center of the locomotive and the remaining two rivets are spaced 0.500" center to center. The horizontal leg of the longer left side angle has a row of 3 #29 pilot holes in a line centered 0.188" from the outside corner of the angle. The first holes are centered 0.375" from each end and the third hole is centered between them. To drill the corresponding rivet holes in the Fuel Bunker front wall plates, temporarily clamp the angles to the front wall plates and use the angles as drill guides to drill the rivet holes through the plate.

30. Now that all of the angles and plates which attach to the Fuel Bunker front wall plates are made, the next step is to attach them. First place the two rows of "for show" rivets along both the inside edges of the Fuel Bunker front wall plates. File flush any extra rivet material extending above the countersunk holes. Next rivet on the base angles, the front and rear side wall angles, and the joint plates. Rivet together the angle brace plates to the brace plate angles, and then rivet these assemblies to the front wall plates. Finally, clamp the coal board angles in place with a piece of 1/4" diameter steel bar stock inside the angle to support it during brazing. Then braze the coal board angles to the front wall plates.

