The material below, composited into a single PDF file, constitutes the package I had put together to solicit quotations for the fabrication of the replacement starboard diesel tank.

It includes a cover email, the scope of work document, and a series of drawings of the 3 smaller tanks that were to bolt together to make up the larger tank. The scope of work document speaks of AutoCAD files with various levels that needed to be viewed to pick up the various aspects of the desing. Since it's not likely that most people viewing the web site will have a copy of AutoCAD available, I've gone ahead and rendered the drawings as PDF files.

Although the holding (sullage) tank was not part of the diesel tank scope of work, a drawing of the holding (sullage) tank is also attached for the sake of completeness.

Gentlemen:

I need to replace a corroded steel diesel tank that has been on my yacht for over 20 years. Because of space limitations, I will need to replace the one tank with three smaller tanks and have elected to have the replacement tanks built from aluminium. This email is to request from you quotes for various services you might provide for building these tanks.

I have attached several items to this email. The first is a DOC file that provides a full description of the work I'm considering, including a Bill of Materials. The second attachment is a DXF file that contains a number of drawings, including patterns for cutting aluminium sheet on your CNC cutting machine and drawings showing the configuration and welding for each individual tank.

I am requesting that you provide firm quotes for both the cutting and fabrication of these tanks as per the attached material. I may elect to provide the sheet aluminium or have you supply it and I may decide to have the fabrication done elsewhere. So please provide quotations with the following structure;

1) Cut only (client supplies sheet aluminium)
2) Supply and cut (you supply sheet aluminium)
3) Fabrication (note that I will only have you fab if you also cut)
4) Hourly shop rate for fabrication (I may elect to go Time & Material rather than fixed price)

I will arrange to pick up the results of your work so the quotes should be FOB your shop. Please advise the street address for pickup of either the cut pieces or the finished tanks. Also, please advise a contact name, telephone number and email address (if available) for both the cutting and fabrication phases. Lastly, please let me know of any schedule constraints you may anticipate and any financial terms you have. Note that I intend to release this work as soon as I have received and evaluated all quotes and will advise you of my decision as soon as possible.

Please reply to this request by return email to: redact. If there are any questions, please feel free to contact me by email or by telephone (0428-579-905). Likewise, please contact me if you have an alternative approach to suggest or have identified serious flaws in what I am proposing.

S/ John Olson

SCOPE OF WORK
STARBOARD DIESEL TANK REPLACEMENT
For
John Olson
Mob 0428-579-905

OVERVIEW:
The yacht I cruise on and live aboard was originally equipped with two 100-gallon (380 liter) diesel fuel tanks, made of carbon steel. One of these tanks has corroded to the point that a pinhole leak has developed. The tank could not be repaired in place nor could it be removed in one piece for repairs because of access limitations. The work being quoted here is to allow construction of three smaller aluminium tanks that can be slipped into place then bolted and piped together to replace the original single tank.

The original tank was shaped like wedge lying on its side. The bottom face of the wedge, which was against the hull, was curved to match the hull shape and tapered both horizontally and vertically. There was a short vertical wall section where the “sharp” part of the wedge would be (i.e. the “back” or outer part of the tank). The tank had piping connections for filling, fuel supply and return, vent, and drain and had been fiberglassed into place during construction.

The other original tank, roughly a mirror image of the first but with a cut-out corner, may also be replaced but a decision on that work will be deferred until after the installation of this first set of tanks is complete.

The design of the tanks and layout of the cutting patterns was done using AutoCAD 2002. The design files are attached to this package as a DXF file with multiple layers. Scale on these drawings is 1:1 and dimensions are in millimeters.

CUTTING:
Deliverables from the cutting operation include all labeled panels and labeled off cuts. The half-sheet off cut is <u>only</u> a deliverable if the client has elected to provide materials and these materials come in the form of three (3) full sheets. The remaining excess material is scrap for you to dispose of per your normal practice. As a further note, all of these panels and cut outs will be used in fabrication except:

1. 2 retaining clips (for use during installation)
2. 2 brace legs (for use during installation)
3. 1 blocking plate (for use during installation)
4. any labeled off cuts (future use)

The panel layout for use by a CNC cutting machine can be found on Layer “CutLayout”, which shows the panel outlines layed out on 1200 by 2400 sheets. Labels for the panels can be found on Layer “CutLabels”. Material requirements

are: 2-1/2 ea. 1200 x 2400 sheets of type 5083 aluminium, 5mm thick. There is at least a 10mm gap between every panel or cut-out item, to allow for waste and cutter kerf. The mate-up flanges, where adjacent tanks bolt together, have a series of 6.6mm diam. holes for ¼" bolts. The mounting flanges, on the forward face of the forward tank and the aft face of the aft tank, have a series of 4mm diam. holes to locate mounting carriage bolts.

FABRICATION:

Deliverables from the fabrication phase include three tanks, per the attached design drawings, pressure tested, dry and clean, as well as two minor weldments consisting of the brace pads and feet (see Layer "MidWelds" for details).

MECHANICAL CONFIGURATION:

The replacement three smaller tanks are designed be placed side by side longitudinally and then be mechanically fastened together to form a solid assembly. Interconnecting piping – equalizing connections -- will allow them to act as a single tank hydraulically. The tank bottoms will be curved and sides and bottom tapered consistent with the hull shape. They will be held in place by a series of clips and braces and by being bolted to bulkheads at each end of the completed assembly.

The original tank could not be removed intact. Surrounding structures and mechanical equipment in the area forced me to cut the tank into smaller pieces to allow removal. The replacement tanks are sized to just barely fit through all the openings that they need to pass through. As a consequence, no part of these replacement tanks can be allowed to exceed 500mm in vertical dimension at any point. The maximum allowable side/side dimension is 600mm. I have verified the fit and clearance of these designs by constructing mock-ups of 3mm MDF; if needed, these mock-ups can be made available for reference during fabrication.

Each tank, referred to separately as the "Forward", "Middle", and "Aft" tanks, has a set of three drawings associated with the fabrication phase. These are presented as layers within the attached DXF file. The layer titled "FwdPanels" refers to a panel drawing for the forward tank and identifies those panels from the cutting phase that are required for that individual tank. The "MidWelds" layer delineates the welding requirements and joint configurations for the middle tank. And the "AftOrtho" layer is an orthogonal drawing of the aft tank's (top, front, both sides) with dimensions and annotations. And so on

The orthogonal drawings show that all three tanks have protruding edges or flanges on both sides of their tops and on both sides of their fronts. These flanges are intended to allow adjacent tanks to be bolted together and to allow the end pieces to be bolted to bulkheads on each end. Each

tank has 1 access hatch, 2 vent connections on the top, one near the back and one near the front, and one or two pipe connections at the bottom of their front sides for drain and interconnection. The aft tank has an added connection on top for fuel return. The forward tank has a 1-1/2 inch threaded pipe for filling that extends into the interior roughly 2/3rd of the max depth. The forward tank also has a ½" dip tube for the supply connection that extend almost to the bottom of the tank. The client will supply the access hatches, pipes, and threaded sockets for these connections, as reflected on the included bill of materials.

The supply connection and adjacent vent on the forward tank are to be welded flush with the upper side of the top so as to not exceed the 500mm total height restriction. All other vent and return connections are to be welded flush with the underside of the top.

The locations of the drain and equalizing connections on the fronts of the tanks have not been specified nor have the openings for them been cut during the cutting phase. I have done this for two reasons. First, the left-most of these connections on each tank needs to be as close as practical to the corner so as to minimize loss of effective tank volume. I was concerned that pre-cutting the holes for these connections might interfere with the weld-up. Second, the location of the right-side equalizing connections depends on both the location of the first set of connections as well as the fit up of adjacent tanks and the dimensions of the interconnect piping itself. Better, I suspect, to finish the tank weld-out and bolt them together, then these connections can be located for easy welding and to exactly match the interconnect piping, which will be available for reference.

One of the best ways to minimize corrosion and subsequent failure of tanks such as these is to keep the tanks dry. Accordingly, I have designed standoff pads to be welded onto the bottoms of the forward and aft tanks. These pads will hold the tanks clear of any water that may find its way into the interior of the yacht and allow air to circulate freely around the tanks.

The pads on the forward and aft tanks that are adjacent to the middle tank protrude out to support the middle tank and are slotted to serve an additional purpose. Since this area is blind and inaccessible during and after installation, I have designed a set of tabs for the middle tank that will engage slots in the pads on the forward and aft tanks. These tabs and slots, along with the bolted flanges on the tops and fronts, will help to maintain rigidity of the completed tanks assembly.

The pads will need to be curved to closely fit the contour of the tank bottoms to which they will be welded. Rather than trying to curve each

pad individually, the materials for the pads will come from the cutting operation as two long strips, one with a series of slots. Rolling each strip to a radius of approximately 24 M before cutting the individual pads should result in pads that either conform directly or are slightly overcurved and can be (easily?) flattened a bit.

The two brace pads and feet are shown on Layer “MidWelds”. Each foot and pad assembly consists of a foot piece being welded along the lateral centerline of the pad, offset to one side. The only tricky bit is getting the foot tilted at the correct angle to the pad, both just off 90°.

WELDING:

Joint configurations and welding directions for each tank will be found on Layer “XxxWelds”. Welding symbols are those used by AWS (American Welding Society) and I can provide an explanatory reference if you are not familiar with them. Welding requirements are similar for each tank and consist of 5mm fillet and 5mm bevel welds. In general, open edge joints are all 5mm fillet welds. Bevel welds are found where the edges are tee joints, where mounting and mating flanges and tabs (middle tank only) protrude beyond the tank sides. For tee joints, I have specified 5mm bevel welds as fillet welds on these joints would result in unsealed slots inside the tank (never a good idea) and could also result in weld metal build-up that would interfere with mechanical joints.

There are a number of locations, access hatches and piping connections for example, where the AWS symbols I used call for backing welds. What I’m really calling for here is seal welding. For example, strength welding for the access hatches is 5mm fillet welding around the outer perimeters. A 2-3mm seal weld is called for on the inside of the hatch to prevent any leaks out through hatch blind bolt threads and to close off what otherwise would be an open joint exposed to the interior of the tank. As general guidance, I’m tying to avoid any joint being left unsealed where water, algae, or other contaminants might accumulate.

Standoff pads seal welds aside, I calculate that there is a bit over 7 meters of fillet welding and 14.5 meters of bevel welding in total. Standoff pads require a total about 5.5 meters of weld, approximately twice as much single pass seal welding as 5mm fillet welds.

Weld filler metal should be type 5356 where welding type 5083 joints. Type 5183 filler might work better when welding 5083 to 606X (pipe and sockets, etc.), welder’s choice. Do NOT use type 4XXX filler metal at any point, this would cause a high-low copper content transition zone that is very susceptible to cracking. I do not have any specific welder qualification requirements or weld procedures in mind.

FABRICATION NOTES/SEQUENCE:

The slotted standoff pads are designed with the slot immediately off center. They should be welded on with the pad's centerline flush with bottom edge of the tank they are being welded to. This way, half the pad will be on the welded portion and half the pad will extend out and support the middle tank. The slots should just clear the sides of the forward and aft tanks so that the tabs on the middle tank can engage them.

Proper placement of the slotted standoff pads requires that the tanks first be bolted together into one assembly. The middle tank bottom tabs should then stand proud from the bottoms of the assembled tanks. If the assembly is inverted and the tops held in alignment horizontally (i.e. without any sagging), the slotted standoff pads can be easily placed over the tabs and then welded to the bottoms of the forward and aft tanks. (To ensure proper alignment and tank-to-tank fit up, it might be prudent to first fabricate the forward and aft tanks, then use them to hold the bolted-on sides of the middle tank in position while it is tacked-up.)

The middle tank bottom tabs are designed to be over-long, with excess material so as to protrude slightly (2mm?) past the finished pads during fabricating. Once the slotted standoff pads have been welded up, any excess protruding portions of the tabs should be ground off so that the outer surface of the engaged tab is flush with the outside of the slotted standoff pad.

Note, again, that the maximum acceptable width on any tank is 600mm, including standoff pads.

At this point, with the tanks all bolted together and tabs in slots, the front drain and equalizing connections can be located and threaded sockets installed.

PRESSURE TESTING:

Once the tanks have been completed, they should be pressure tested to check the integrity of all welds to 5 psig or 3.5 meters of water head. The tanks may be tested as an assembly or individually. The testing may be done with compressed air or with water.

If using water, the tanks shall hold pressure without leaks for at least an hour. The tanks and the surface upon which they rest must be dry at the start of the test so as to help identify any leakage. After successfully completing the test, the tanks should be emptied and dried out.

If using air, the tanks must hold pressure overnight. After pressuring but before leaving the tanks to set overnight, it might be wise to check all

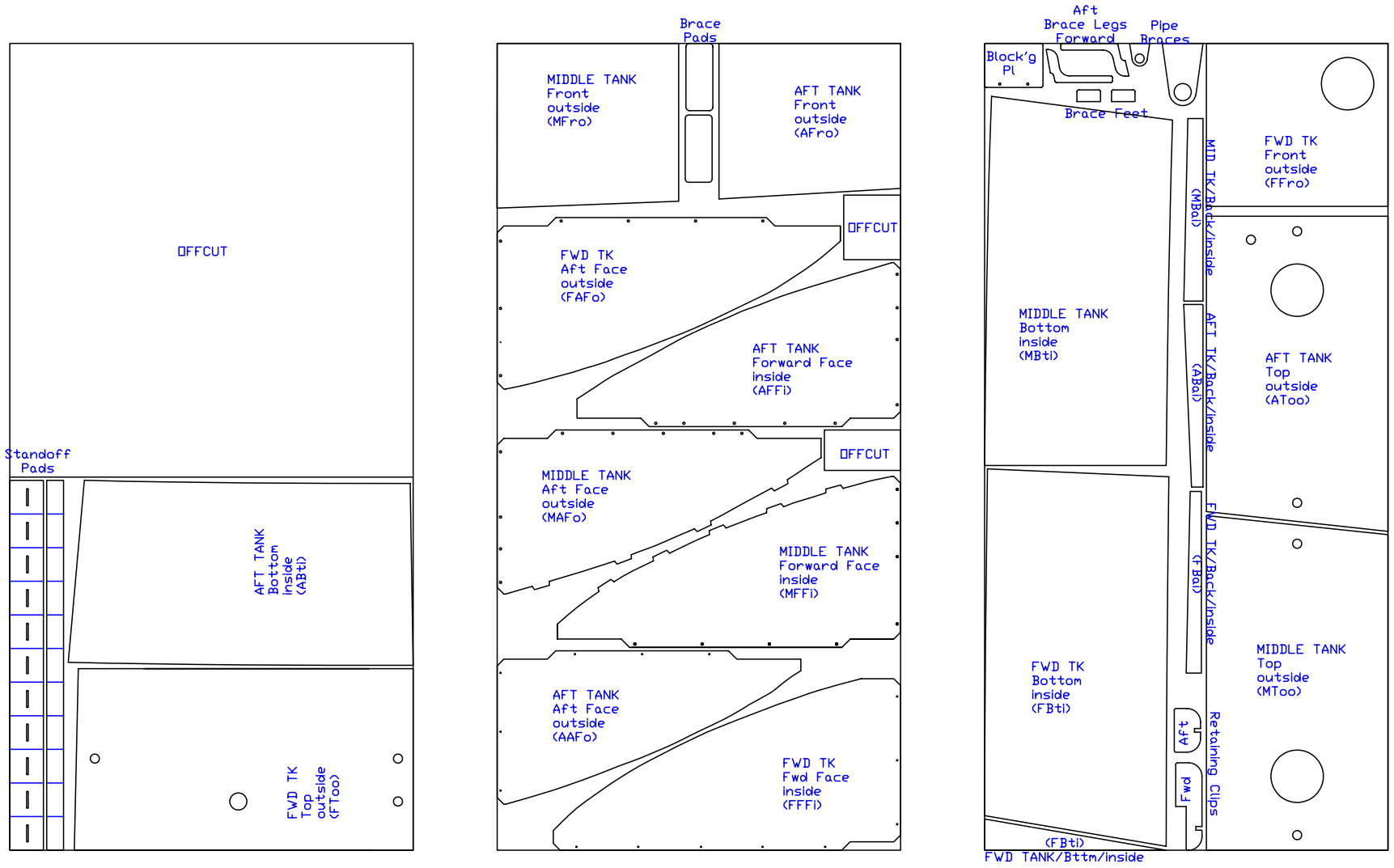
connections and joints with a soap solution so as to short cut a test that would otherwise fail. Record the tank pressure and temperature at the start and finish of the test. NOTE: Use extreme caution when first pressuring the tanks as compressed air has a lot of energy and a sudden weld failure could easily hurt somebody if they were close by.

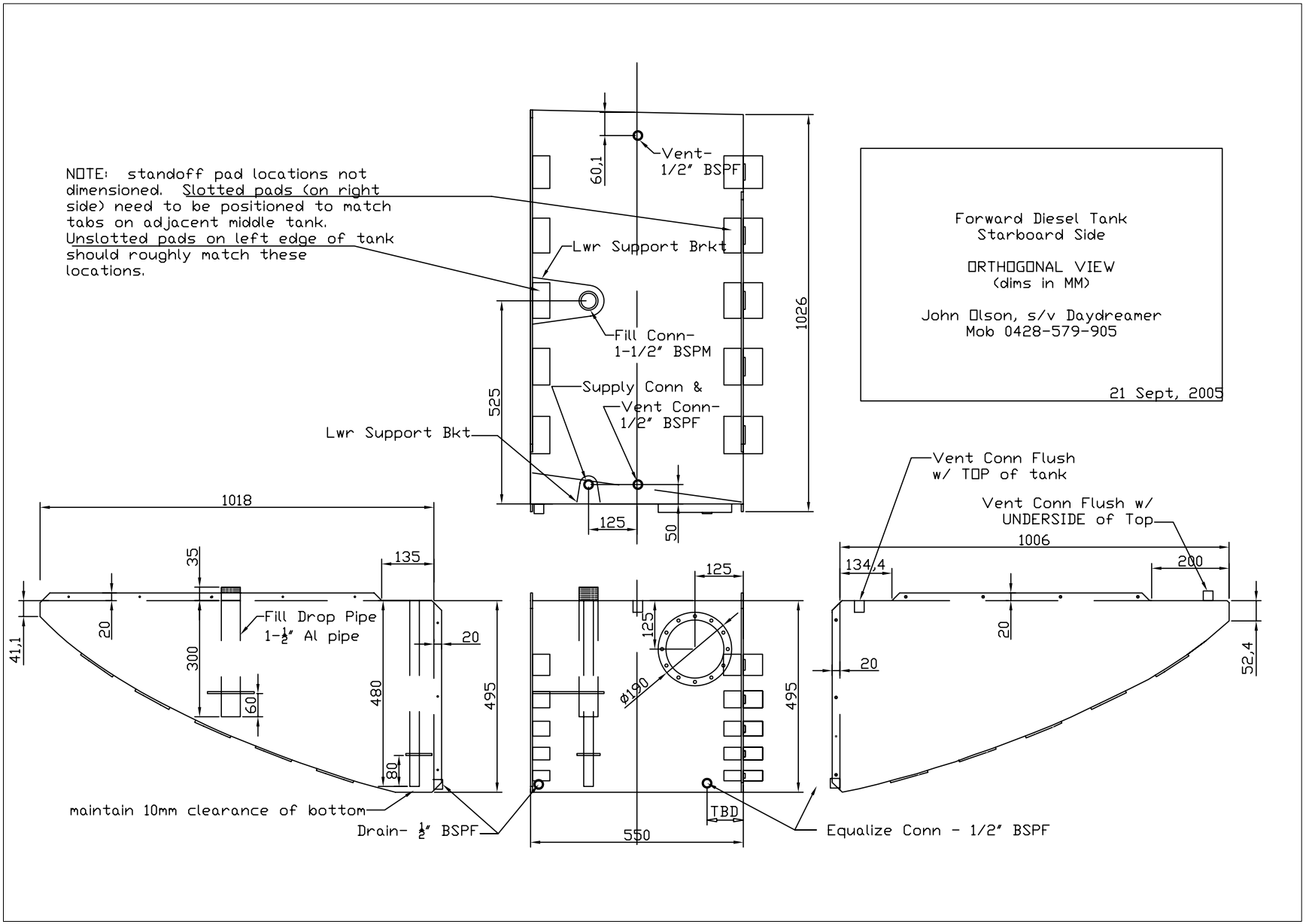
DELIVERY:

Prior to delivery, make sure the tanks are dry and clean inside of all dirt, fillings, cuttings etc. Separate the tanks (if assembled) and box or bag up for return any client-supplied pipe fittings or fasteners used in fabrication or testing.

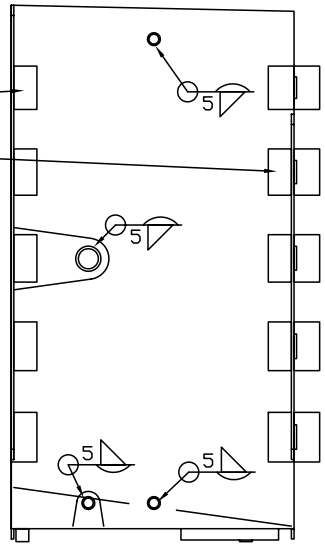
BILL OF MATERIALS:

Item	Quant	Unit	Description	Supplied by	
				vendor	client
CUTTING					
1	2.5	Sheet	Type 5083 sheet aluminium, 1200 X 2400 X 5 mm	If supply & cut	If cut only
FABRICATION					
2	as req'd		All welding consumables, including gases and type 5356 weld filler metal	X	
3	12	Ea	Type 6060 aluminium pipe sockets for return, vent and equalize connections, 25mm OD X approx 30mm OAL (length may vary slightly), ½ inch BSPF threads one end only		X
4	1	Ea	Type 6060 aluminium pipe for supply connection, 25mm OD X 480 mm OAL, ½ inch BSPF threads one end only		X
5	3	Ea	Type 5083 aluminium access hatch bases, blinds, gaskets and bolts		X
6	2	Ea	Equalize piping (to measure fit for interconnecting piping between tanks)		X
7	1	Ea	Type 60661 aluminium pipe for fill connection, , 49mm OD X 340mm OAL, 1-1/2 inch BSPM threads one end only		X
8	as req'd		Bolting to assemble and pipe fittings (caps, plugs, & hose tails) sufficient to pressure test completed tanks		X


OFFCUT
Standoff Pads
AFT TANK Bottom inside (ABti)
FWD TK Top outside (FToo)
Brace Pads
MIDDLE TANK Front outside (MFro)
AFT TANK Front outside (AFro)
OFFCUT
FWD TK Aft Face outside (FAFo)
AFT TANK Forward Face inside (AFFi)
OFFCUT
MIDDLE TANK Aft Face outside (MAFo)
MIDDLE TANK Forward Face inside (MFFi)
AFT TANK Aft Face outside (AAFo)
FWD TK Fwd Face inside (FFFi)
Aft Brace Legs Forward
Pipe Braces
Block'g Pl
Brace Feet
MIDDLE TANK Bottom inside (MBti)
MID TK/Back/inside (MBai)
AFT TK/Back/inside (ABai)
FWD TK/Back/inside (FBai)
FWD TK Front outside (FFro)
AFT TANK Top outside (ATop)
MIDDLE TANK Top outside (MToo)
FWD TK Bottom inside (FBti)
Retaining Clips
aft
fwd
(FBti)
FWD TANK/Bttm/inside


NOTE: standoff pad locations not dimensioned. Slotted pads (on right side) need to be positioned to match tabs on adjacent middle tank. Unslotted pads on left edge of tank should roughly match these locations.
Vent- 1/2" BSPF
60,1
Lwr Support Brkt
Fill Conn- 1-1/2" BSPM
Supply Conn & Vent Conn- 1/2" BSPF
Lwr Support Bkt
1026
525
125
50
Forward Diesel Tank
Starboard Side
ORTHOGONAL VIEW
(dims in MM)
John Olson, s/v Daydreamer
Mob 0428-579-905
21 Sept, 2005
1018
35
135
20
41,1
300
60
Fill Drop Pipe 1-½" Al pipe
480
495
20
80
maintain 10mm clearance of bottom
Drain- ½" BSPF
125
125
Ø190
495
TBD
550
Equalize Conn - 1/2" BSPF
Vent Conn Flush w/ TOP of tank
Vent Conn Flush w/ UNDERSIDE of Top
1006
134,4
200
20
20
52,4

Standoff pads on the left side are not heavily loaded so can be welded up with a single pass, welded all around to seal the pad. The slotted pads on the right might be fairly heavily loaded, so a full 5mm fillet weld around top, bottom and inside edge is appropriate; the outer edge betweeen the pad and tank bottom needs to be seal-welded but a large bead that would interfer with the fit of the adjacent tank's tabs needs to be avoided.

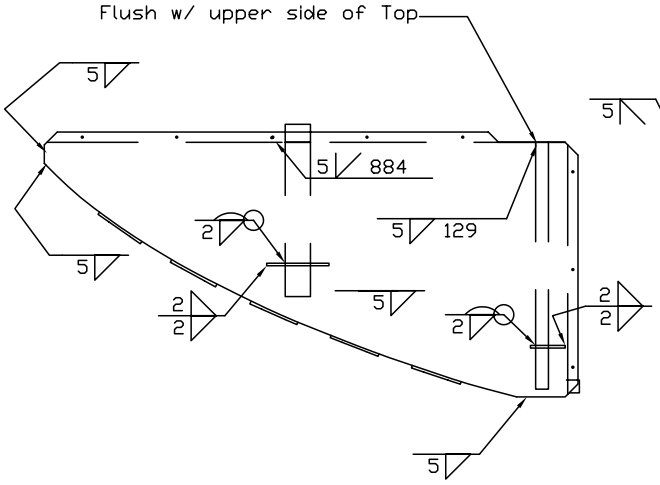


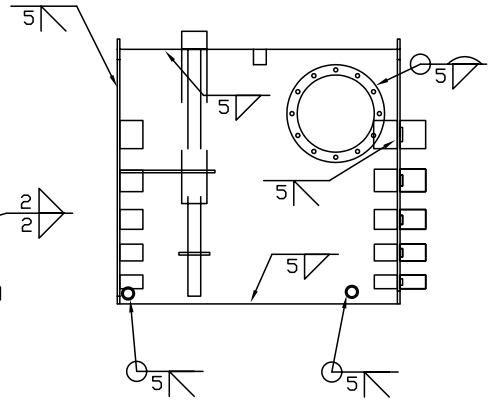
FORWARD DIESEL TANK
on Starboard Side

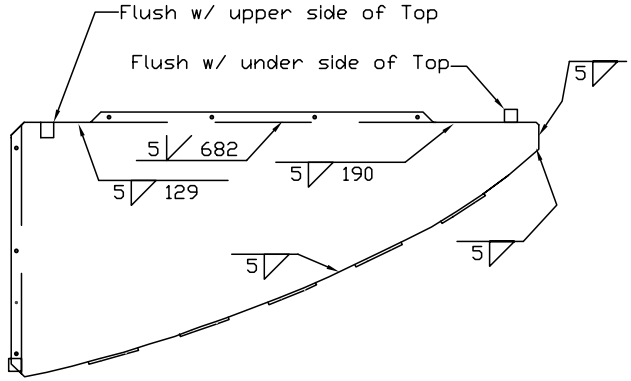
WELDING DIRECTIONS

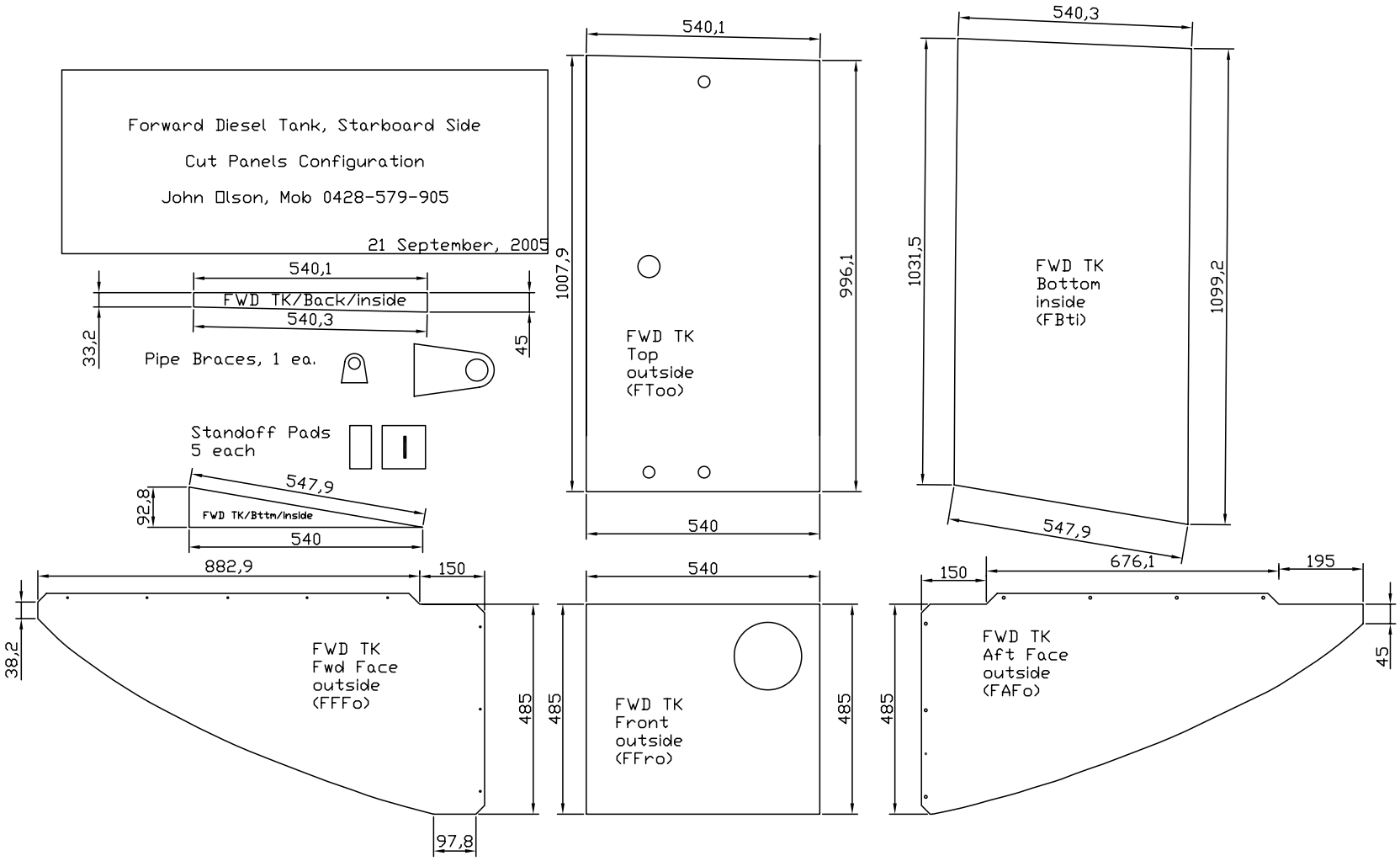
John Olson, s/v Daydreamer
Mob 0428-579-905

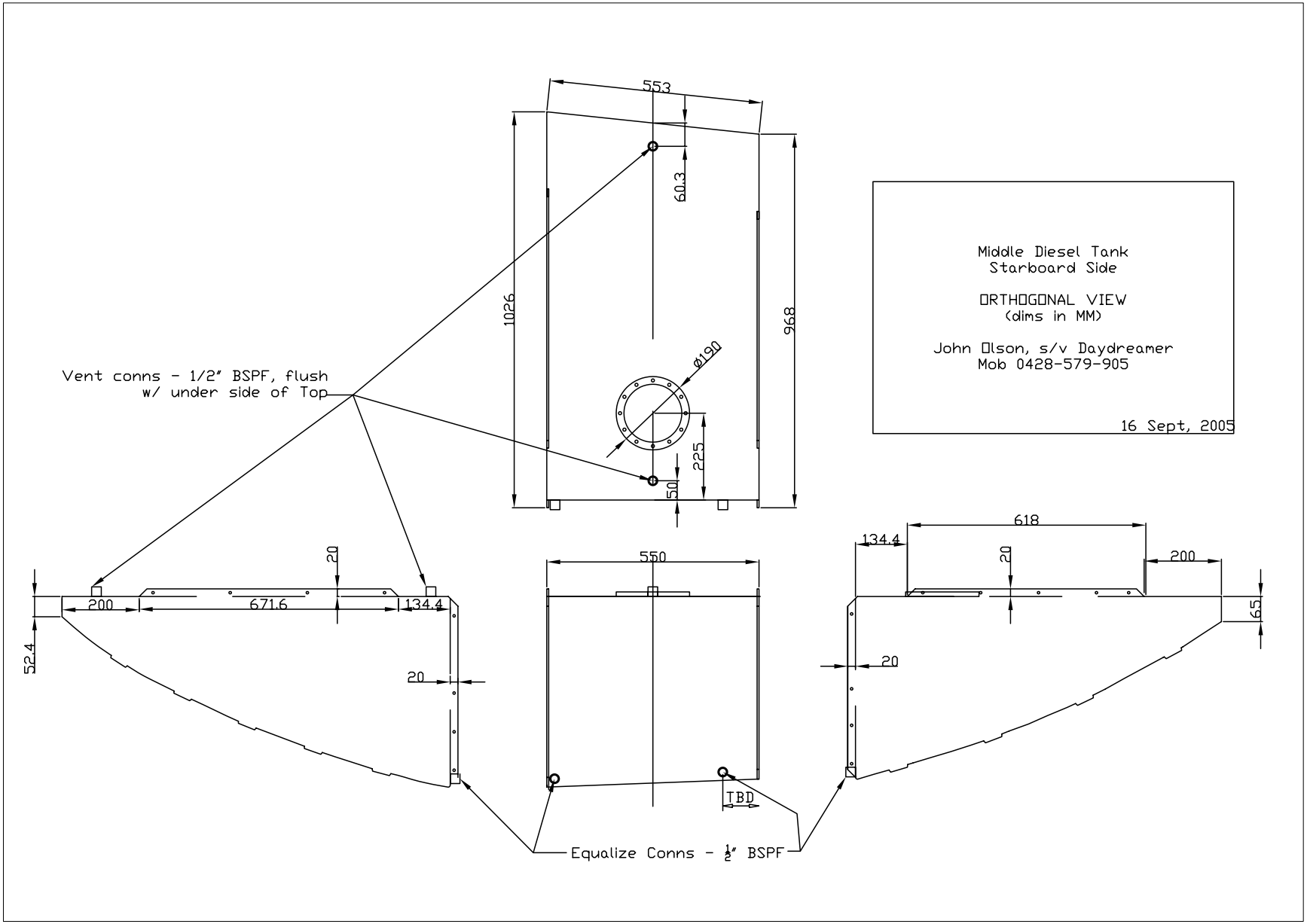
21 Sept, 2005








Forward Diesel Tank, Starboard Side
Cut Panels Configuration
John Olson, Mob 0428-579-905
21 September, 2005
540,1
FWD TK/Back/inside
540,3
33,2
45
Pipe Braces, 1 ea.
Standoff Pads
5 each
547,9
92,8
FWD TK/Bttm/inside
540
882,9
150
38,2
FWD TK
Fwd Face
outside
(FFFo)
485
97,8
540,1
1007,9
996,1
FWD TK
Top
outside
(FToo)
540
540
485
485
FWD TK
Front
outside
(FFro)
540,3
1031,5
1099,2
FWD TK
Bottom
inside
(FBti)
547,9
676,1
150
195
45
485
FWD TK
Aft Face
outside
(FAFo)

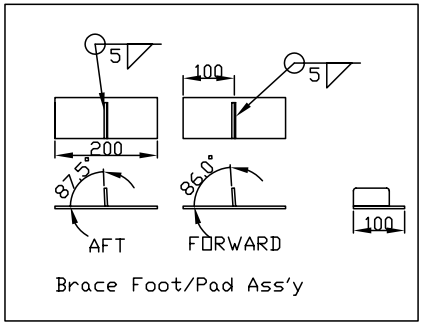


Middle Diesel Tank
Starboard Side

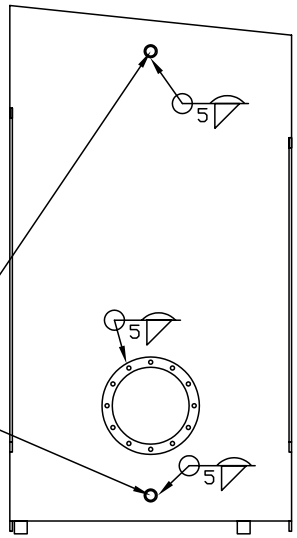
ORTHOGONAL VIEW
(dims in MM)

John Olson, s/v Daydreamer
Mob 0428-579-905

16 Sept, 2005



Brace Foot/Pad Ass'y



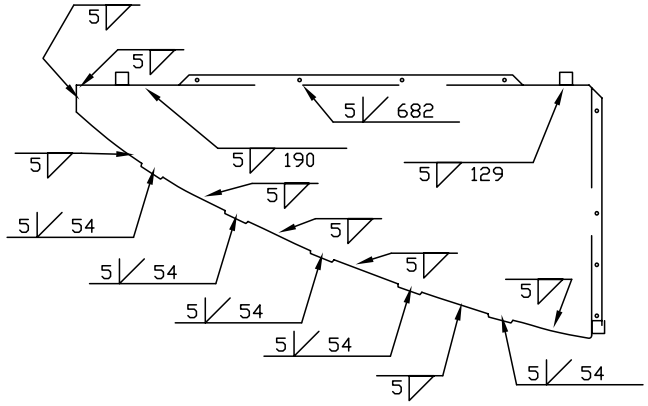
Vent conns flush w/ under side of Top

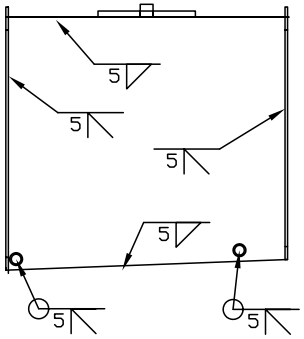
MIDDLE DIESEL TANK
on Starboard Side

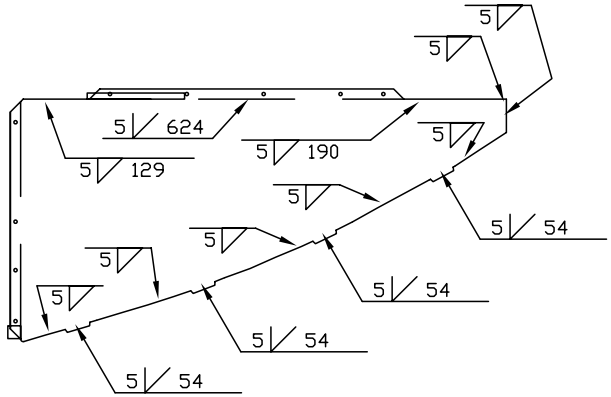
WELDING DIRECTIONS

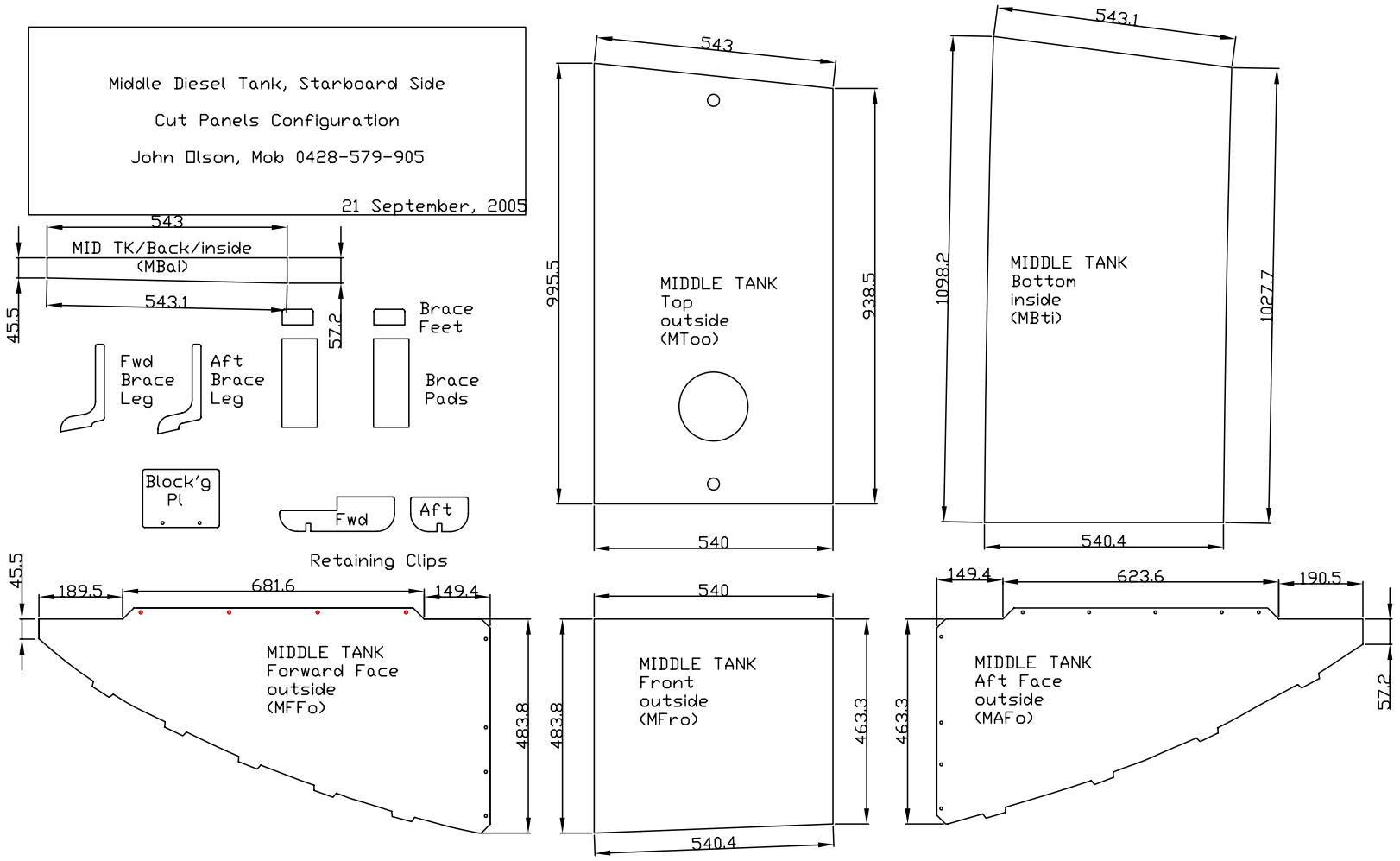
John Olson, s/v Daydreamer
Mob 0428-579-905

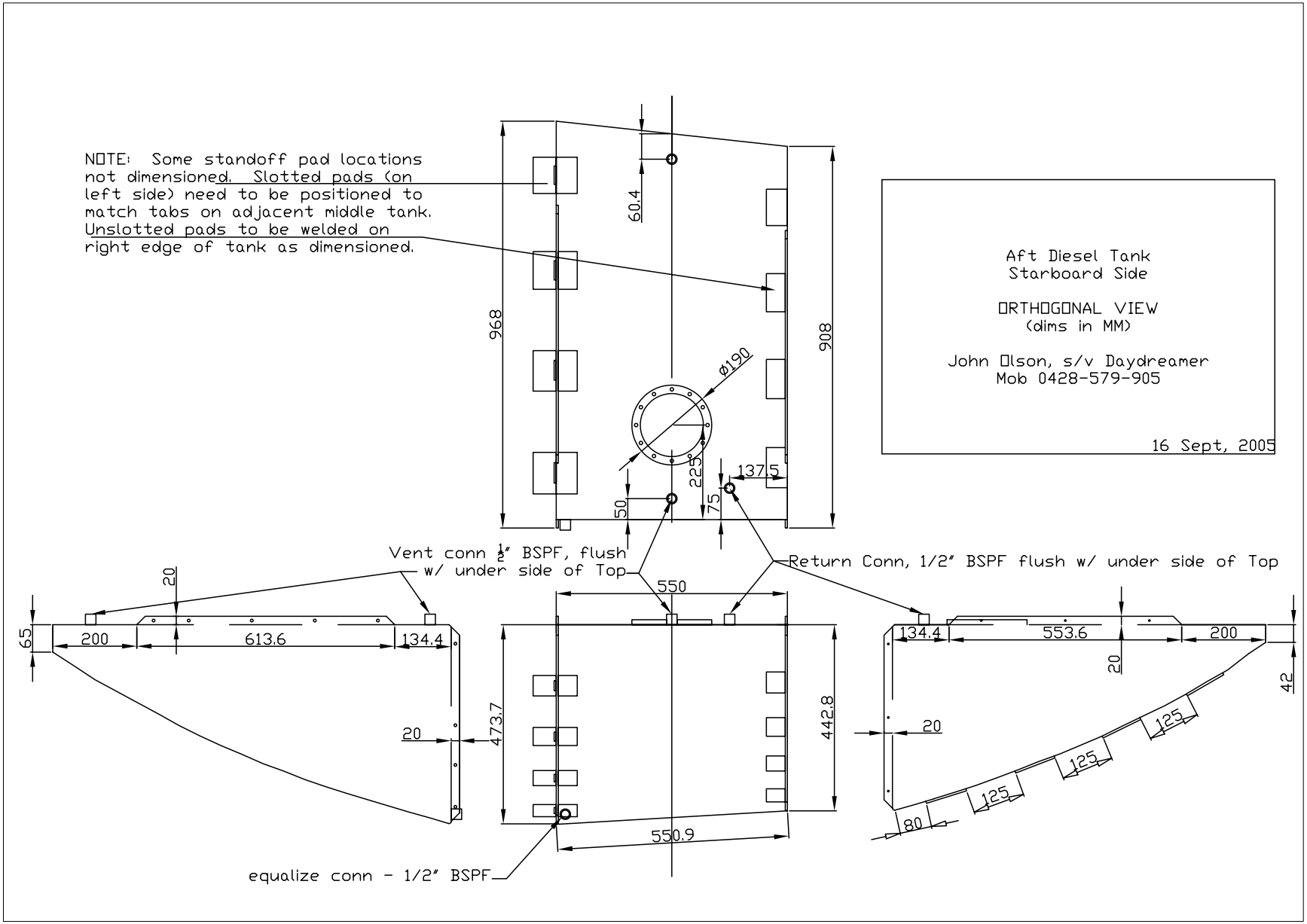
16 Sept, 2005



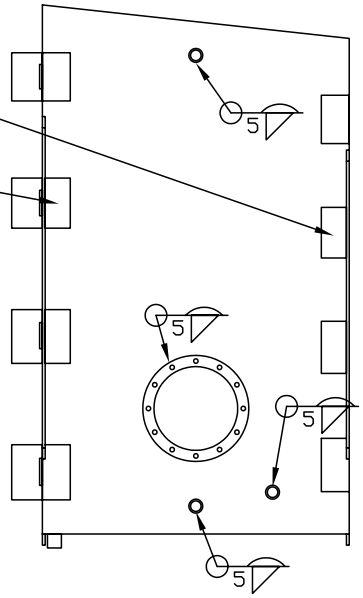





Middle Diesel Tank, Starboard Side
Cut Panels Configuration
John Olson, Mob 0428-579-905
21 September, 2005
543
MID TK/Back/inside
(MBai)
543.1
45.5
57.2
Brace
Feet
Fwd
Brace
Leg
Aft
Brace
Leg
Brace
Pads
Block'g
Pl
Fwd
Aft
Retaining Clips
543
995.5
938.5
MIDDLE TANK
Top
outside
(MToo)
540
543.1
1098.2
1027.7
MIDDLE TANK
Bottom
inside
(MBti)
540.4
45.5
189.5
681.6
149.4
MIDDLE TANK
Forward Face
outside
(MFFo)
483.8
540
483.8
463.3
MIDDLE TANK
Front
outside
(MFro)
540.4
149.4
623.6
190.5
463.3
MIDDLE TANK
Aft Face
outside
(MAFo)
57.2


NOTE: Some standoff pad locations not dimensioned. Slotted pads (on left side) need to be positioned to match tabs on adjacent middle tank. Unslotted pads to be welded on right edge of tank as dimensioned.
Aft Diesel Tank
Starboard Side
ORTHOGONAL VIEW
(dims in MM)
John Olson, s/v Daydreamer
Mob 0428-579-905
16 Sept, 2005
60.4
968
908
ø190
225
137.5
50
75
Vent conn ½" BSPF, flush w/ under side of Top
Return Conn, 1/2" BSPF flush w/ under side of Top
550
20
65
200
613.6
134.4
20
473.7
442.8
134.4
553.6
200
20
42
20
125
125
125
80
550.9
equalize conn - 1/2" BSPF

Standoff pads on the right side are not heavily loaded so can be welded up with a single pass, welded all around to seal the pad. The slotted pads on the left might be fairly heavily loaded, so a full 5mm fillet weld around top, bottom and inside edge is appropriate; the outer edge betweeen the pad and tank bottom needs to be seal-welded but a large bead that would interfer with the fit of the adjacent tank's tabs needs to be avoided.

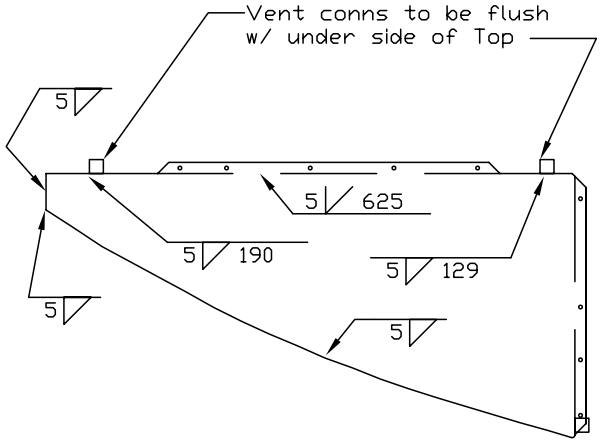


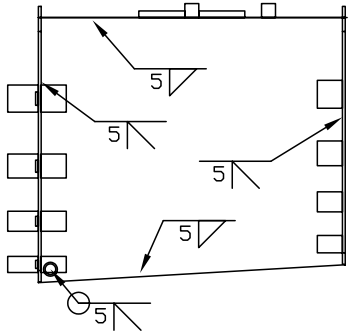
AFT DIESEL TANK
on Starboard Side

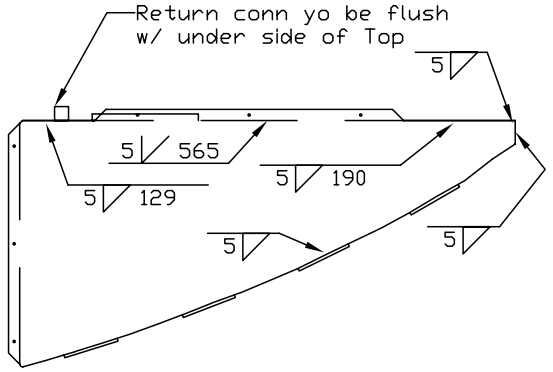
WELDING DIRECTIONS

John Olson, s/v Daydreamer
Mob 0428-579-905

23 Sept, 2005





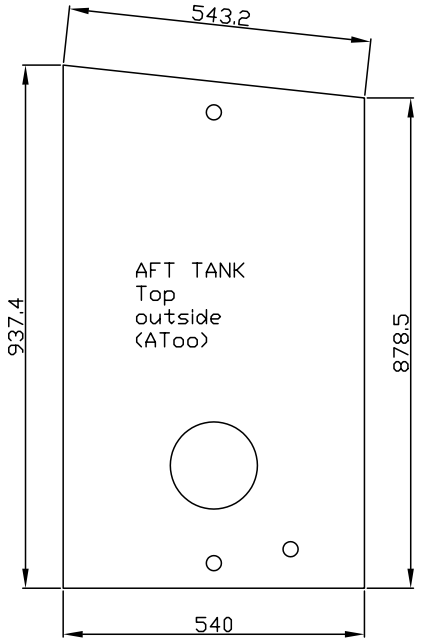


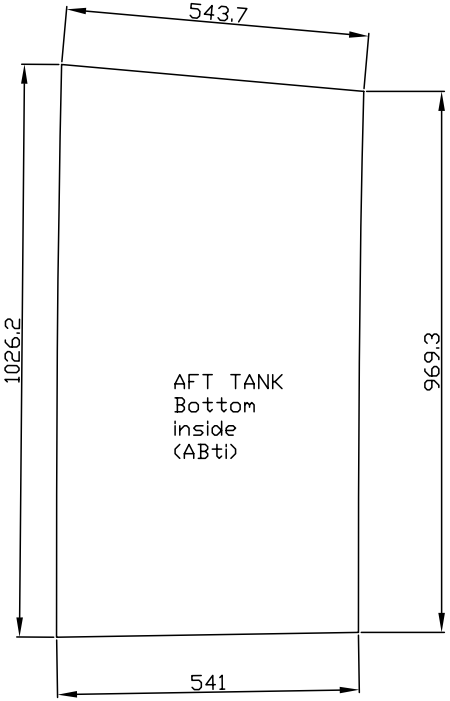
Aft Diesel Tank, Starboard Side

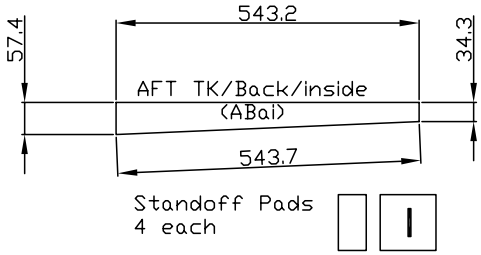
Cut Panels Configuration

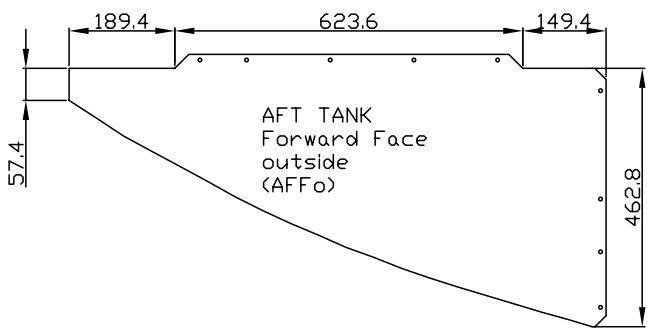
John Olson, Mob 0428-579-905

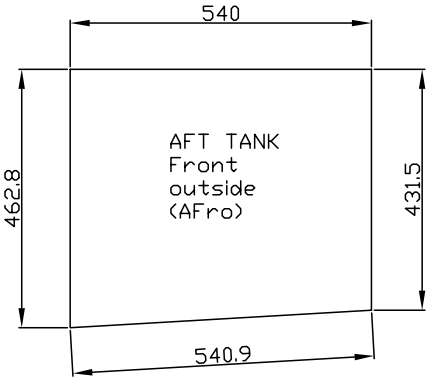
16 September, 2005

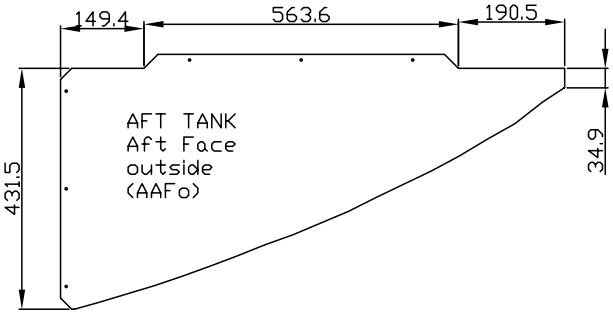












SULLAGE TANK of 10MM HDPE
for
s/v Daydreamer

ORTHOGONAL VIEW
(dims in MM)

John Olson 0428-579-905