EUROPA CLUB

AIRCRAFT MODIFICATIONS

CAPACITANCE FUEL GAUGING SYSTEM INSTALLATION

(MOD NUMBER 10447)

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(incorporates additional purchasing information for UK builders)

EUROPA CLUB AIRCRAFT MODIFICATIONS

These modifications are separate from those issued by the factory but have been approved by the PFA. They can be considered as build instructions and should be carried out in consultation with your PFA inspector before submitting the paperwork to the PFA for final approval. Most modifications add weight. Beware of incorporating too many at the expense of performance and payload. When following these instructions read at least three times, measure twice, cut once.

CAPACITANCE FUEL QUANTITY INDICATION SYSTEM

Before launching into the instructions it is worth considering a few facts about fuel quantity indication systems. Firstly there are still several inflight engine failures each year caused by running out of fuel. The importance of reliable and accurate indications cannot be over estimated. The existing system has limitations in both areas. The reliability of the sightglass at first seems very good. There have been however cases where air locks have caused false readings. Accuracy is a problem due to variations of indication with pitch attitude. One calibration for on the ground and another inflight is not ideal. Europa Aircraft quite reasonably distrusted the old float sender system which gives so much trouble. The more recent (to light aviation) capacitance system is much more reliable and accurate as it has no moving parts.

Whichever system is used a means of crosscheck is essential. Ideally visual inspection of the fuel level or dipping the tank should be used but this is not easy on the Europa. One builder has used a mirror placed near the fuel selector and at the same time illuminated the tank so it becomes translucent. Another means of avoiding running out of fuel is to top up and calculate an endurance based on a higher than expected fuel flow. As the Europa tank is a saddle tank it provides a reserve which is helpful and this can be further enhanced by installing dual capacitance senders. Finally if the builder fits a fuel integrator system (available as part of the Rocky Mountain Instruments µMonitor package) fuel quantity calculated from actual fuel flow can be displayed provided it is kept updated when refuelling. This is another technique borrowed from larger aircraft. When submitting the paperwork you should state the type of backup system used.

Purchasing Tips

The capacitance senders are available from the usual aircraft parts suppliers (Aircraft Spruce, Wicks, Skysports etc). Skysports are the wholesaler but you can deal direct with them. Their product knowledge is very good if you have any questions. They have a catalogue of other products which is worth getting. To order the single system quote reference FS and for the dual system DFS. Their current prices (1998) are $135 and $275 respectively which includes a complete kit of parts (fax 001 810 735 9433). It is important to buy the gauge at the same time because the senders are set up to be compatible with the nominated gauge type. Specify 24 inch bendable probes. The bolts supplied are not long enough due to the tank thickness. As tank thickness varies slightly it is probably best to check the length required by measurement after hole cutting (AN3H-12A is about right). For UK builders, the capacitance system is available through Peter Smoothy at Airworld UK (01296 714900). Please mention that it is for a Europa when ordering so that the longer bolts and internal flange are included.

Be sure you fully understand the instructions before proceeding. Any queries please contact me on e-mail nigelcharles@compuserve.com or telephone 01380 860620. If you have any suggestions to improve the modification I would be pleased to pass them on to the PFA for their consideration. On completion get the modification checked and signed off by your inspector quoting the modification reference number on the front cover of this build instruction and submit the application to the PFA.

Nigel Charles

CAPACITANCE SENDER INSTALLATION

Overview

Due to the swarf generated when cutting holes in the tank it is recommended that if possible this modification is initiated before tank installation. This makes it easier to thoroughly rinse the tank with fuel to remove any remaining particles. The factory build instructions require holes to be cut for filler, vent and outlet apertures so the procedures described below should be carried out anyway. The importance of this cannot be overestimated as at least two aircraft have had engine stoppages due to the inline filter becoming blocked with tank swarf (hence the factory dual filter modification).

Either single or dual senders are fitted to the top of the tank inboard of the headrests. This position means that bendable probes are necessary to clear the saddle of the tank (see Figure 1). Rigid probes would require sender mounting inside the headrest making adjustment and maintenance difficult and make retrofits very awkward. Although rigid probes read right to the very top of the tank there will always be some fuel not measured in the filler tube. This is not a problem particularly as the unseen quantity is at the beginning of the flight. Due to the limited space above the tank and to allow access to the senders, holes are also drilled in the top of the tank bulkhead. To maintain bulkhead strength an extra lay-up is used to reinforce it.

In the instructions below it is assumed that dual senders are to be fitted. If a single sender installation is intended only a single reinforcement lay-up is required. In this case consideration should be given as to which side of the tank is used. As the reserve side is rarely used and its capacity is known the normal side is recommended. It is also assumed that the installation will be initiated before tank installation. If this is not the case the reinforcement lay-ups should be done on the topside of the tank bulkhead instead of the underside.

Reinforcement Lay-ups

This job is best done at the same time as closing off the headrest voids. Abrade two 170mm circles on the underside of the tank bulkhead between the headrests as shown in Figure 1 and apply two 4 ply ‘bid’ lay-ups to the same dimensions.

Hole Cutting

The hole cutting can be done after the tank is permanently fitted but care should be taken as the bulkhead holes are much larger than those drilled in the tank (the gap between the bulkhead and the top of the tank is usually adequate). To minimise the amount of swarf getting inside the tank it is recommended that all the drilling is done with the tank inverted. If the tank has not yet been permanently fitted placing it in position in the module will help line up of the bulkhead and tank holes.

Mark the hole centres on the top of the bulkhead 85mm from the rear edge and 95mm either side of the centreline. Using a 70mm (2.75 inch) hole cutter drill through the bulkhead only**.** It doesn’t matter if the centre drill of the cutter penetrates the tank. Indeed it helps the subsequent tank holes to be concentric with the bulkhead holes (otherwise mark the bulkhead hole centres on the tank after drilling). Clean away the swarf. If not permanently fitted the tank can now be removed for drilling separately (but remember to keep it inverted during drilling). Cleanliness from now on is essential. Using a 30mm hole cutter drill the tank holes. Tank skin thickness can now be assessed to ascertain bolt length required. Allow for thickness of sender head, gasket, tank and flange.

Probe Preparation

Measure the tank depth from the hole. You will notice that this has to be at an angle to clear the saddle of the tank. Cut the outer casing of the probe using a tube cutter to a length so that it does not quite touch the bottom of the tank when fitted. Slide the waste piece away from the inner tube. This process will expose the centre tube and several very small nylon washers. Beware the washers may come away with the outer tube due to the lip caused by the tube cutter. Push the washer closest to the cut end up into the probe. This will ensure spacing at the bottom between inner and outer tubes. You may find this awkward due to a similar lip on the inner edge of the tube due to the tube cutting. Ream this away a little to allow the washer in. The washers are a tight fit on the inner tube (for security) and a loose fit to the outer tube (to allow fuel to pass up the tube). Trim the inner tube to length using side cutters. Do not try to open it out after cutting. Now gently bend the tube so that it clears the saddle and the bottom of the tank when it is fitted. Note that it is only the very top that is bendable (above the mark on the probe).

Sender Fitting

With the sender held in its fitted position and correct orientation drill five 4.8mm holes in the tank using the holes in the sender head as a template. These holes are not quite evenly spaced to prevent subsequently fitting the sender incorrectly. Remove the sender. Drill two small holes in the flange as shown in Figure 3. Place the flange on the tank so that the existing threaded holes line up with those in the tank and, using the newly drilled holes in the flange as a template, drill through the tank (using the bolts to locate the flange can be helpful). Enlarge and tap (8-32 thread) the two holes on the flange. Drill out and countersink the tank holes to a clearance fit for flat head machine screws (MS24693S52 are about right depending on tank thickness). Cut two small slots on opposite sides of the 30mm hole (see Figure 3). Their orientation should be such that they are not in line with the holes nor with the notch in the internal flange when it is fitted (check this by placing the flange on the tank to check orientation of the notch). The width and length of the slots are made just sufficient to allow the threaded internal flange to be posted through the hole using its notch to minimise the length of the slots. All these measures maximise the working area of the gasket which minimises the chance of leaks. Now is a good time to remove any remaining swarf from the tank. Use your finger to drag out any swarf that is near the hole. Now turn the tank upright and suck out any bits that fall to the bottom of the tank using a piece of 15mm tube attached to a vacuum cleaner. Beware not all the swarf will necessarily fall to the bottom of the tank due to static.

The next steps are much easier if the tank is inverted again. Before posting the flange through the hole loop a piece of string through it so that it can be recovered if it falls into the tank. The idea now is to position the plate inside the tank so that the threaded holes line up with those in the tank. Loosely fit the machine screws, remove the string and tighten the screws to secure the flange. To make life easier return the tank to the upright position again. Now fit the sender ensuring the correct fitting of the gasket. Evenly tighten all five bolts until the gasket is compressed and provides a good seal. Finish off using locking wire to secure the bolts.

Testing for Leaks and Tank Cleaning

Ensure that the tank is in a well ventilated space or preferably outdoors. With the bottom outlets closed off pour about five gallons of fuel into the tank. Now seal the inlet and the vent hole. Invert the tank and check for leaks. A small leak will take time to show so leave it inverted for a few hours.

As mentioned previously it is very important to remove any remaining swarf from the tank. It is not easy to see (due to its white translucent colour) and tends to stick to the tank walls due to static electricity. The tank should be partially filled with clean fuel, shaken vigorously and emptied at least 6 times. Filter the fuel through a chamois leather between rinses. After tank installation fuel should be run through the filters several times to ensure no particles remain. If the tank has already been installed help will be needed when it comes to inverting and shaking the fuselage.

Calibration

Beware the next steps involve both fuel and electricity. Sparks are to be avoided at all costs. As the tank is to be filled to the brim it is best to leave this job until the module is fixed in the fuselage and the filler pipe connected. The fuel quantities mentioned are approximate only due to variations in sizes of tanks.

With this system accuracy will be largely unaffected by pitch attitude. To allow for slight variations at very low fuel quantities and to allow for unusable fuel the calibration was done with the fuselage set at 3 degrees nose up. Large pitch up manoeuvres at such fuel levels are likely to cause fuel starvation so calibration at a higher attitude was deemed unnecessary. With the tank empty connect up the gauge and sender as shown in Figure 4. Adjust the 'empty' potentiometer until the needle is exactly on empty. Fill the tank noting the quantity of fuel required (70 litres, 15.4 Imp. Gallons approx). Similarly do the 'full' calibration. It is useful to know the fuel quantity at the intermediate marks. Let fuel out until the needle starts to move. Measure the quantity of fuel removed and subtract it from the full figure. You now know the quantity of fuel above the top of the probe. Let more fuel out until the gauge reads 3/4 and repeat the calculation. Do the same for 1/2 and 1/4 full. With dual senders note the level at which the saddle is reached (indicated by the reserve level) and note the measured quantities on each side of the saddle as each side is emptied (the reserve side is about 7.5 litres, 1.75 Imp. Gallons). As the probe doesn't quite reach the bottom of the tank expect the gauge to read empty just before the tank runs dry. Any fuel obtained after empty is indicated should be considered a bonus. Finally as there is a small amount of unusable fuel left all the fuel quantities calculated should be reduced accordingly .

Reduction = Total fuel put in minus total fuel taken out.

Finally make up a cockpit placard for fuel calibration (similar to the one below) and install it next to the gauge on the panel.

Cockpit Placard for G-MIME

Full Tanks	15.25 Imp Gall
Full indicated both sides	13.50 Imp Gall
3/4 indicated both sides	8.25 Imp Gall
1/2 indicated both sides	6.00 Imp Gall
1/4 indicated both sides	4.00 Imp Gall
Empty Main, 1/4 Reserve	1.75 Imp Gall

Do not forget to check the fuel filters regularly. Every refuel initially and then, if no problems are found, during the servicing schedule.

Figure 1 - Reinforcement Lay-up (Plan View)

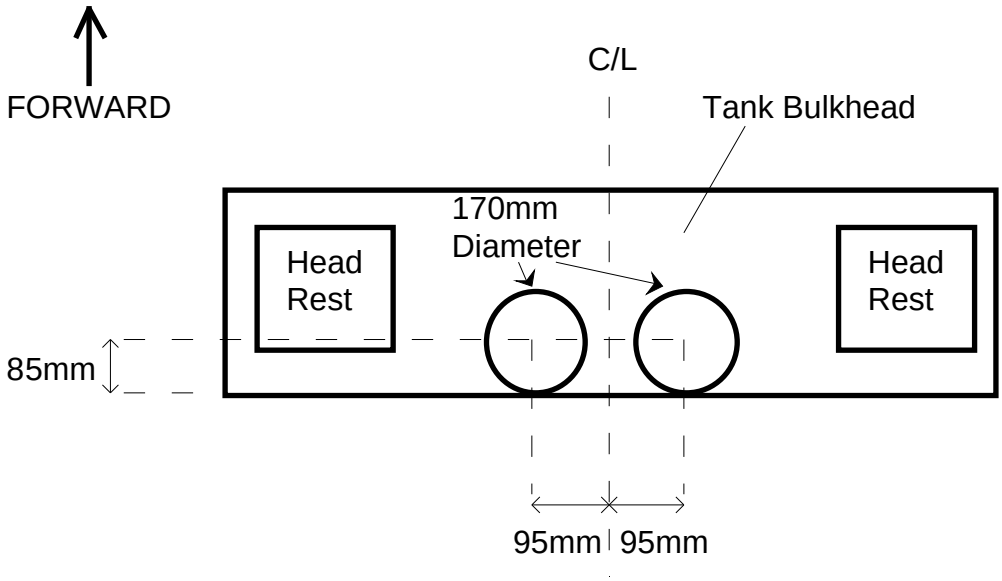

Figure 2 - Sender Installation

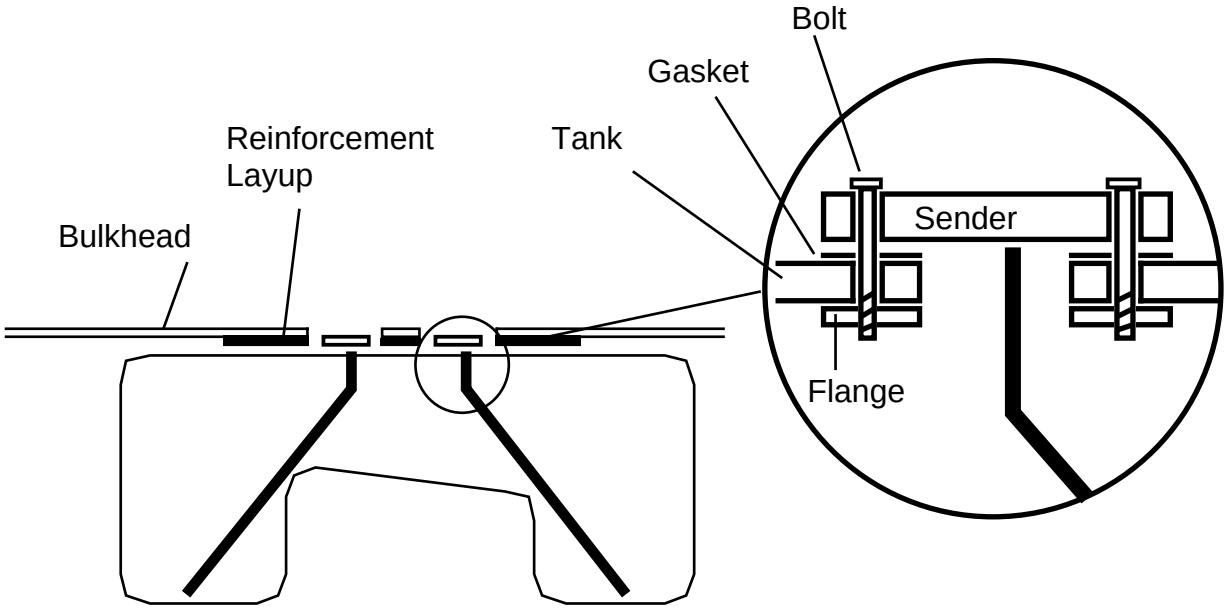

Figure 3 - Hole Cutting Diagram

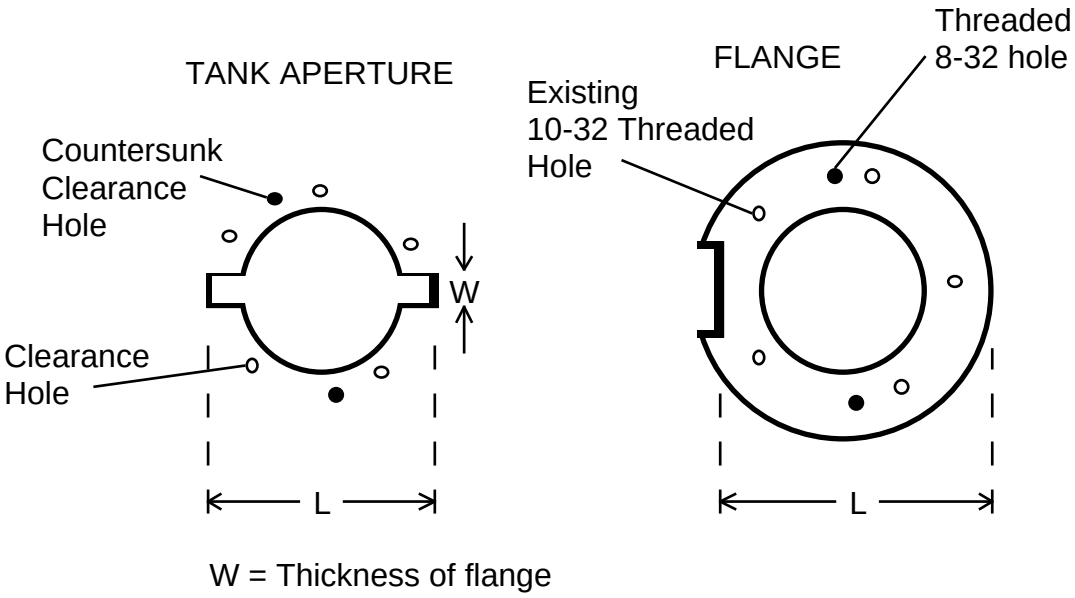

Figure 4 - Wiring Diagram