CHECK & CHECK AGAIN

How a carbon monoxide indicator in your cockpit may save your life, and why you must inspect fuel filters and undercarriage components

Well, what weather we've all had – the sun's actually got some heat in it at last. Ok, I know that the sun has always got heat in it, but it's nice to actually feel it on our little section of the planet. There's still the possibility of frost though, as was explained to me by a number of allotment holders in our village.

A couple were bemoaning the fact that the low night-time temperatures has "seen off our runner beans." These seasonal North, North Easterlies, so loved by our gliding buddies, keep the temperature down a bit, but I love the fresh feel they bring to the mornings. The longer evenings have given me the opportunity to get the bike out; I actually did a 25K last night and can testify to the rapid evening temperature drop. My times were pretty poor, which is quite normal for me early on in the season. Umm, who am I trying to kid? They are also pretty poor at the end of the season! Anyway, if I'm going to take a tumble, it will be in these early training sessions. Perhaps there is a good lesson here for all sportsmen and women; take it easy to start with, and spend time going through a good warm-up routine.

Flying an aeroplane needs to be looked at with the same caution – our sport requires a high level of hand-eye skills, and good coordination comes from practice and rehearsal. There is generally a little blip in the accident statistics early on in the season, many of which could have been avoided if more attention to warming up the physical and intellectual muscles had been taken.

One thing I would advise every sport pilot to do is to give yourself a few dummy engine failures. Get yourself up to a sensible height and pull back the power to idle. Go through the drill afterwards and be honest with yourself – would you have survived a real one? I had a teacher once who used to say as we were lining up for a take-off, "Ok, where are you going when the engine fails?" On every flight that I have made since my first real EFTO, I have always recited that little chant!

One thing that catches people out is the partial engine failure – it's where 'decision making' becomes critical. Notice that I didn't say 'correct' decision making. The problem is not normally whether the decision was correct or incorrect, quite often accidents happen because no decision was made when one was desperately needed and a bad situation became impossible. You can practice, or perhaps more accurately rehearse, this situation by pulling the power back to, say, 40%.

You will note immediately that there are a number of possibilities, and notice how tempting it is to delay making a firm decision. You'll probably be coming down, but not that fast.

The "I will worry about that in a few moments" scenario begins. What happens if I drop a bit of flap? Would the best thing be to get rid of the failing engine completely and treat the situation as a standard engine failure? Would it be better to drag this aeroplane to the next airfield, "I might just make it!" Remember, as far as accident and incident reporting goes, an engine failure in a Permit aircraft or a microlight should be no big deal. Practice it so that it isn't!

SportCruiser – exhaust problems

THERE have been mutterings for some time about problems with the exhausts on SportCruisers. Actually, it's not fair to label the problem specifically as a SportCruiser issue, but we've had quite a few reports from SC owners about cracking around the exhaust flange to outlet tube weld.

I remember the same thing occurring a while back on the Pioneer 300. The problem then was due to the fact that the exhaust itself was being held too firmly and there was no room in the material for the normal expansion and contraction expected as temperature varied. In the case of the Pioneer, the problem was solved (at least the reports of cracking in the welds stopped!) by fitting a spring joint into the system. This method was used by Teledyne Continental on some of its systems so the idea has a good pedigree.

The problem on the SportCruiser has been noted by the manufacturer and the later exhaust pipes, as supplied to the LSA variant, have a strengthening fillet welded into the system over the point where the system has been failing. We have had a preliminary look at this as a strengthening modification for LAA machines, but we have one or two problems with the design in its preliminary form. I have explained my concerns in the photo's accompanying text.

First, let's look at what can actually happen if the exhaust system springs a leak. I have two specific examples to discuss. The first incident was reported to me by the owner after he had made a successful landing. In the second incident, sadly this was not possible. Let's start with the first incident, which started for me when I received a call from SportCruiser owner Ian Speight a week or so ago.

'We became aware of a strong smell of exhaust gas... the CO indicator had turned black'

PHOTO Ian Speight

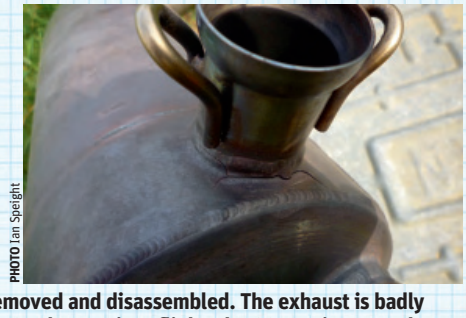

PHOTO Ian Speight

These are pictures of Ian's exhaust after it was removed and disassembled. The exhaust is badly cracked in two separate areas, which is worrying. On the previous flight, the CO monitor was clear which suggests that this failure occurred fairly rapidly once it got started. The LAA is conducting a survey among SportCruiser owners about their experiences with cracking.

He described an incident that occurred to him while on an evening jolly with the co-owner of the aircraft, and I asked Ian to 'put pen to paper'; he did, and thanks Ian for that. Here is his report:

"We first became aware of the problem on Thursday, 8 April. My co-owner Paul Goslin and I took off from Henstridge at 18.30. It was a perfect still evening. About 40 minutes into the flight we were over the Somerset Levels at c2000ft when, just after Paul remarked, 'It doesn't get much better than this,' we both became aware of a strong smell of exhaust gas. While we were discussing this, I noticed that the CO indicator had turned black. The cabin heat was already off so we opened the two fresh air vents, and the smell didn't seem too bad. Apart from Yeovilton, which was closed and nearly as far as Henstridge, there was no runway nearby so we breathed as little as possible and headed home!

"A couple of interesting points: At the 25-hour

check the box had been checked for security, but the subsequently cracked areas are not easily visible with the heat shield in place.

"G-SCPI hadn't flown for a couple of weeks and on the previous occasion the cabin heat had been fully on with no ill effects. As we noticed no build up of fumes, I think that the cracks must have developed very rapidly.

"As per your advice, the box is being expertly welded and will be refitted awaiting the proposed mod. However, I intend to block off the scat pipe to the cabin just in case."

After they landed, they unbuttoned the cowl and checked out the exhaust.

Take a look at the excellent picture taken by Ian of the crack around the weld. What worried me more than almost anything is the fact that carbon monoxide (CO) was present in the cockpit even though the cabin heater was off. Well done to the pair of them for fitting a CO monitor, which are very sensitive devices and will measure even small concentrations of this dangerous gas.

After seeing the picture of the crack I decided to write to all SportCruiser owners and ask them for their experiences. Altogether, there are 39 aircraft using the Rotax 912 ULS operating under an LAA Permit to Fly and, at the time of writing, I've had responses from roughly half of these owners.

Interestingly, none of the 'early response' group has suffered any problems at all with their exhausts, which, of course, doesn't mean that the other half won't have!

One comment that has been made by many of the responders is that they have been very careful to keep the joints between the various components within the exhaust assembly well lubricated. Most seem to use copper slip for this.

I cannot stress how important it is to keep a very close eye on your exhaust system. As far as I am concerned, it's the single most important item to inspect under the cowling during the daily inspection. Everything, as far as possible, should be looked at during the DI of course, but exhaust systems and propellers must feature at the top of the list. Never go flying without having a look under the cowling; don't get me started discussing designers who insist on making cowling removal difficult on sports aircraft, I could end up using the rest of the space in the magazine.

'The cracked areas are not easily visible with the heat shield in place'

I think Ian and Paul should thank their lucky stars that they were not overcome by exhaust fumes. I have been taught that about 1% of the exhaust gas in a normal four-stroke engine running efficiently will be carbon monoxide. That means that the 912 ULS will be producing about 300ccs of the stuff per second. Bear in mind that an average male's normal breath would equate to about 500ccs every five seconds or so and you can see the problem. It is essential that exhaust gas is kept out of the cockpit.

It is probably worth mentioning here that while it is possible to smell the exhaust from two strokes because of their total loss oil systems, four strokes (especially modern 'lean burn' types), aren't so obvious.

The dangers of carbon monoxide to humans is well known. Before recent advertising campaigns focusing on high blood pressure stole the label, carbon monoxide held the title of 'the silent killer'. The reason why is that it's a non-irritating, colourless, odourless and tasteless gas. In other words, you won't know that you are sharing an environment with carbon monoxide.

Carbon monoxide kills when haemoglobin levels reach abut 50% by inducing central nervous system depression. These effects are insidious and victims are often completely unaware of their plight or, even if they are, may be unable to help themselves.

Intellectual performance is quickly impaired, as is the decision-making process. Lethargy and tiredness are common symptoms in those only slightly affected and, for this reason, carbon monoxide can be a factor in all sorts of accidents. This is especially true where high levels of intellectual performance are required, for example, driving a car or flying an aircraft.

One serious problem of carbon monoxide is that it is dangerous in even low relative concentrations. This is because haemoglobin, the complex molecule that transports oxygen from the lungs to tissues and carbon monoxide from tissues back to the lungs, has a 200-fold greater affinity for carbon monoxide than oxygen. This creates two biological difficulties.

The first is that haemoglobin will tend to 'sweep' up any monoxide molecules it encounters; the resulting carboxyhaemoglobin levels will therefore increase steadily. In other words, exposure time plays a big part in the equation.

Secondly, and in some ways more importantly, blood finds it very difficult to off-load its cargo of carbon monoxide. I can remember doing all sorts of difficult sums during chemistry lessons about disassociation constants, which drove me bonkers at the time.

With this in mind, I will end my little 'soap box' oratory but I hope that you've got the message. Carbon monoxide is dodgy stuff.

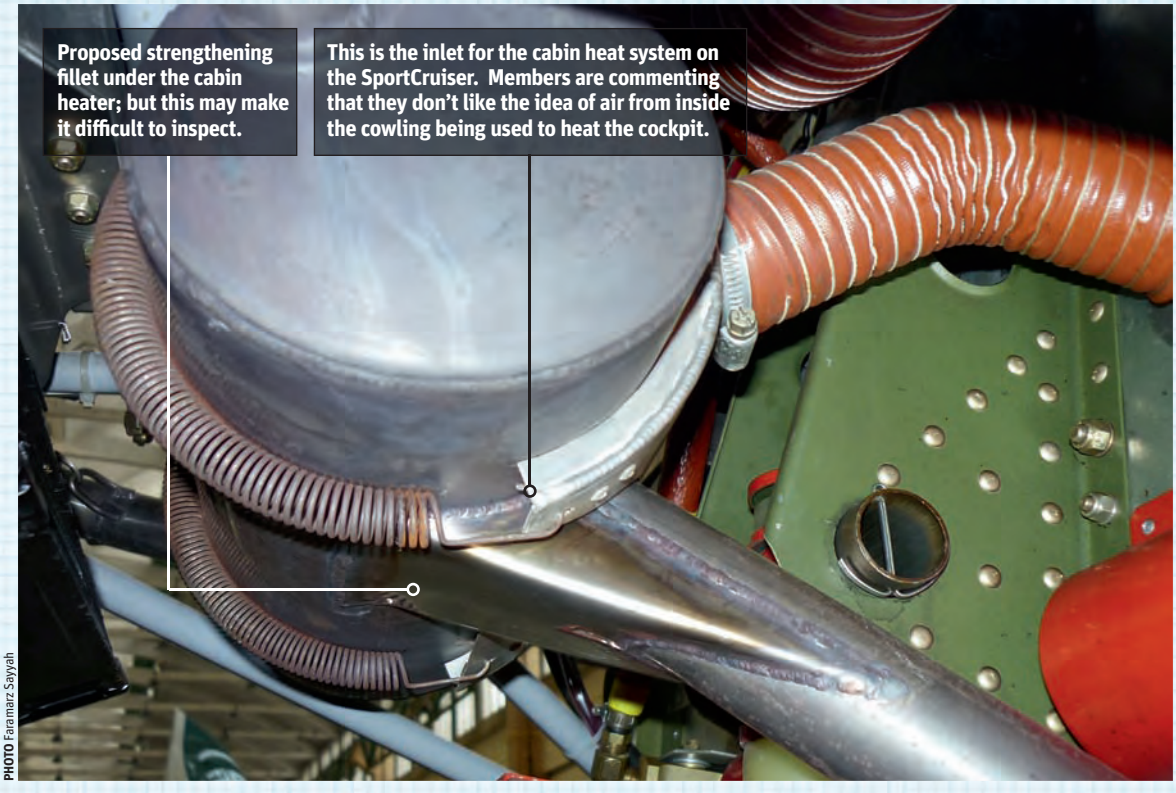

PHOTO Faramarz Sayyah

This is a general picture of a modified exhaust system on a VLA SportCruiser sent to me by LAA Inspector 'Farry' Sayyah.

Farry is designing a mod which should introduce fresh air via a duct to the heat exchanger and thence the cockpit. We're looking forward to assessing the design when Farry has finished the development work.

One of the many important things about exhaust systems is ease of inspection. It's no good designing something on a sports aircraft that makes another item uninspectable.

Nord NC854S - pilot probably succumbed to gas poisoning

WE HAVE eight Nord NC 854 or NC 854S aircraft on our books. For those who have never come across the type, I can explain that it is an example of its generation. Originally, the aircraft type was designed as an army spotter plane, rather like the early Pipers (but with a twin tail). Post-war, the design was modified slightly and the aircraft became one of the early trainers. Our records show that, of the eight, two aircraft have current Permits to Fly, five have expired Permits and one, the subject aircraft G-BGEW, has now been destroyed in a serious accident that occurred last September. The accident claimed the lives of the two occupants, pilot Stuart Francis and passenger Peter Fitzmaurice, both long-term PFA/LAA members.

We class the Nord NC 854 as a 'vintage' type and the fact that five of the series have expired Permits is not unusual. Aircraft built in the 40s and the 50s (Echo Whiskey was built in 1950) all tend to get older together and many come off line for a few years only to appear again as the 'pride of the show' at some later stage. Such is the nature of vintage machines, they can often spend more hours in the workshop than in the air! I didn't know Echo Whiskey but, from pictures I've seen at least, she looked like a fine example of the type and I'm sad that she's no longer around.

'The accident claimed the lives of the two occupants, both PFA/LAA members'

The aircraft itself was powered by the ubiquitous Continental A65 and, therefore, with a MTWA of over 600kg, the machine never had a reputation of being a brilliant climber.

The headline reason for the accident, and the reason for me featuring it in Safety Spot, was that both the pilot and passenger were subsequently found to have very high levels of carboxyhaemoglobin in their blood streams – respectively 24.7% and 9.0%. To put these percentages into some sort of context, 9% would relate to a level found in a cigarette smoker, but by 25%, and to quote the pathologist, the effects would have included "a severe headache and a feeling of grogginess to the extent where the pilot's judgement and performance may have been compromised."

The accident occurred shortly after take-off from Bourne Park where the aircraft was seen to depart from controlled flight, crashing in a steep nose-down attitude and catching fire. The crash was not survivable according to the pathologist and the other possible reasons for a high blood CO were ruled out during the investigation. I do not intend to dwell on this accident – you can download the full report from the AAIB website – except to say that it emphasises the point that CO can be lethal.

Naturally, our thoughts are with the families of the victims.

This picture shows the exhaust flange recovered from the wreckage of the Nord NC854S that crashed, killing both occupants. CO poisoning was implicated and the poor seal afforded by this flange may have contributed. It is possible that the distortion was exacerbated by the crash itself, though, and the poor seal may not have been that obvious during the pre-flight inspection.

This picture shows the poor condition of the exhaust gasket removed from the Nord NC854S during the subsequent inspection by the authorities. Carbon monoxide is a clear, tasteless, colourless and odourless gas. It is essential that exhaust systems on aeroplanes are kept in tip-top condition.

With Malcolm McBride
Airworthiness Engineer

Europa fuel systems

REGULAR readers will know that we've been having a few problems with Europa fuel systems. There's nothing wrong with the fuel system ***per se***, but you may remember that I had a bit of a moan about the implications of naming a fuel tank 'Reserve'; the implication is that there's only a small amount of fuel left which, in the Europa at least, is not the case. My comment to pilots about this was, "It is very important that you, the pilot, should understand exactly how the fuel system works on the aircraft you are flying," (see March 2010 issue, available on the website). The actual article was about Dr Bruce Morris' fuel filter problems –they were blocking up after just a few hours. The problem was traced to a previous heavy landing incident that dislodged largish particles from the tank.

Well, to prove that not everybody reads Safety Spot, we've had exactly the same problem occur. Again the pilot was able to get the aircraft back on the ground by performing a precautionary landing and no damage was done. Again, had the pilot fully understood the fuel system, this 'precautionary' wouldn't have been anything like as fraught. He would have known that by changing to 'Reserve' he was merely selecting another tank (the other half of a saddle tank, in the case of the Europa) with much more than just a small 'safety' quantity.

'By changing to 'Reserve' he was merely selecting another tank'

We were able to get a look at the actual filter, which as you can see from the photograph was very nearly completely blocked. I had a look at the filter under the microscope and we got Andy Draper to do a bit of maths. We decided that the weave in the actual filter element, hardly visible using the naked eye, turned out to be more important than we first thought.

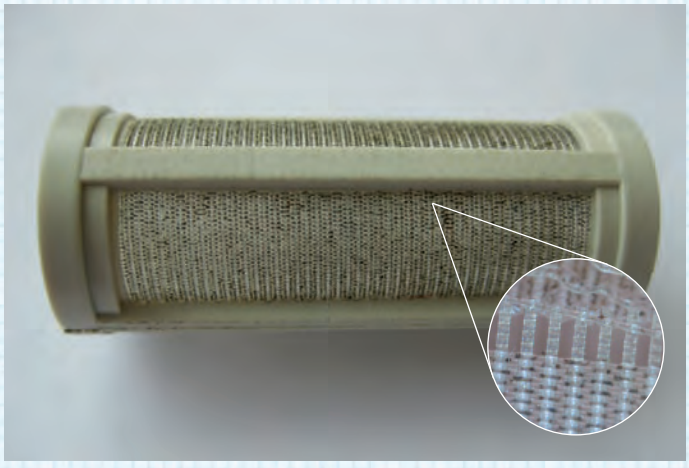

PHOTO Malcom McBride

This is the filter that caused the engine problem and subsequent 'precautionary' on the Europa aircraft recently. It's out of a Purolator type of filter. Note the construction of the filter element itself is made like a basket but on a tiny scale. The majority of the area is made up of the woven material leaving only small gaps for fuel. While this filter only looked a little discoloured, the close up shows the debris blocking the holes in the weave.

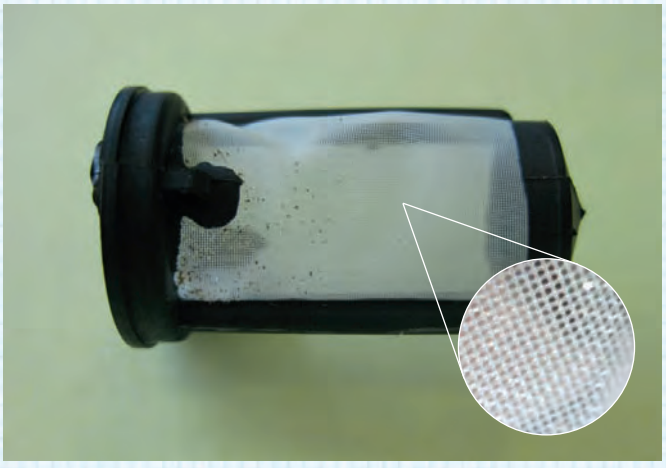

PHOTO Malcom McBride

In this example of a very common filter element note that, although the hole size is roughly the same, the area available for holes is far greater. Look at the construction of the mesh in the blow-up. You can work out for yourself that this second type of construction would be able to absorb far more debris than the first type, even though the filter-ability would be approximately equal.

The heavy landing

THERE can be no doubt that we all make heavy landings from time to time. Hopefully, they are a pretty rare event, but I suppose that the adage 'any landing that you walk away from...' gets used by all of us from time to time!

In this necessarily brief discussion, I do not intend talking about the too highs, too fasts or too lates. Safety Spot is primarily about matters 'Engineering' so you won't be surprised that I want to talk about what you should, and perhaps shouldn't, do after a heavy landing.

It's sometimes easier to sweep the matter under the carpet, take a quick look and say, "Well, I got away with that one," and promptly forget about it. This is, naturally, the last thing you should do.

The decision is made for you, of course, if you break something but, even still, I've heard of some sad chap spreading mud liberally over a crack caused by a 'bad'un' and quietly pushing the machine into the hangar! I suppose he thought that it would probably break on the next bloke during taxying; it would be his fault then, wouldn't it? I wonder how he would have felt if the wing had come off.

The primary point about the very necessary inspections after a heavy landing is that with very light aircraft structures it is almost impossible to predict where the damage, if there is any, will show itself. Some designers add mechanical fuses into the load bearing structure of an undercarriage for example.

We've been looking at an issue with the Pietenpol Club recently where their engineering man, Peter Wright, has been in discussions with the designer of the undercarriage, Jim Wills, about just such a safeguard. I hope to chat

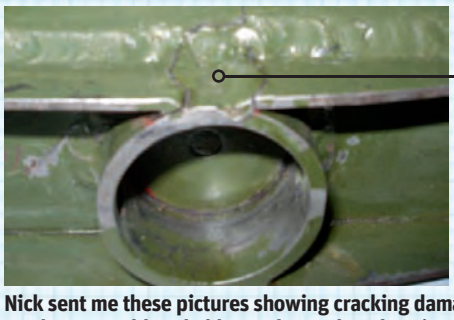

PHOTO Nick Stone

PHOTO Nick Stone

Nick sent me these pictures showing cracking damage to a Culver Cadet undercarriage. To see this crack you would probably need a torch and a mirror without complete disassembly. These 'close inspections' need to be done during a heavy landing inspection and at the annual check. Often the deeper you get into an inspection the more is found.

SAFETYSPOT

With Malcolm McBride
Airworthiness Engineer

about this in the next issue because it's turning into quite an interesting story.

I was talking with LAA Inspector Ray Everitt earlier today when he was pointing out the importance of the post heavy landing/damage repair air test. He described an incident he had had once where, after taking the aircraft up to Vne, he noticed some rippling in the wing skins. A closer inspection revealed that, during the previous accident, the rear spar of the starboard wing had been 'ever so slightly' deformed, and the damage hadn't been spotted during the accident damage survey.

This deformation seems to have changed the load path through the wings in such a way that at the top end of the speed range the wing skins rippled. Ray highlights the importance of a thorough air test after any damage repair and this is why we normally ask this air test to be done by experienced engineering pilots. Putting the aircraft through its paces is also an important feature of the annual air test, which, although it can be troublesome sometimes, is one reason why we ask for the aircraft to be flown to Vne at over 90% MTWA at Permit renewal.

'After taking the aircraft up to Vne, he noticed some rippling in the wing skins'

I could waffle on for hours about what you should be looking for during a heavy landing check and I wouldn't scratch the surface, so I will let the pictures do the talking. During the process of assessing a repair scheme, we normally always talk to the repairer and their Inspector. We remind them, normally unnecessarily of course, of the need to check the airframe completely. It's important not to miss the subtle, sometimes barely visible, changes to material or structure caused by a local overload, especially when the cause of the overload could have been at the other end of the airframe.

Take time to look at the selection of pictures I've found connected with damage found post-overstressing in one way or another. I might add that these pictures are all current; the aircraft are in the hangars as you read this. All the pictures come from LAA members' aircraft, so this is not just theory, it's practice too.

Now, where are those bicycle clips?

Fair Winds.

PHOTO Nick Stone

Check out this photograph of a failed, or very nearly failed, main undercarriage hinge sent to me by owner Justin Kennedy. Like others, he found landing challenging in the early days and did a really heavy landing while learning the best technique. The aircraft was thoroughly inspected and there was nothing amiss. After 600 or so undercarriage cycles all still appeared in order but he noticed that the tyre was scrubbing on one side slightly. A closer look revealed why. This is about the best example of plastic deformation in shear that I've ever seen outside of a lab.

PHOTO Nick Stone

This crack was found in an RV6 main undercarriage leg. RV6s have a bit of a reputation for cracks at the top of the legs. As you can see, this one would be difficult to find without removing the bottom engine cowling. This aircraft had about 280 hours on the clock.

LAA ENGINEERING SCALE OF CHARGES

LAA Project Registration	
Kit Built Aircraft	£300
Plans Built Aircraft	£50
Issue of a Permit to Test Fly	
Non-LAA approved design only	£40
Initial Permit issue	
Up to 390kg	£320
391 - 499kg	£425
500kg and above	£565
Three seats and above	£630
Permit renewal	
Up to 390kg	£105
391 - 499kg	£140
500kg and above	£190
Three seats and above	£210
Modification application	
Prototype modification	£45
Repeat modification	£22.50
Transfer	
(from CofA to Permit or CAA Permit to LAA Permit)	
Up to 499kg	£135
500 kg and above	£250
Three seats and above	£350
Four-seat aircraft	
Manufacturer's/agent's type acceptance fee	£2,000
Project registration royalty	£50
Category change	
Group A to microlight	£135
Microlight to Group A	£135
Change of G-Registration fee	
Issue of Permit Documents following G-Reg change	£45
Replacement Documents	
Lost, stolen etc (fee is per document)	£20

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