Tony's Tips for RAM Remote-Start Turbines

In the last two years, starting with the 750F air-start engine in my MiG 15, I have flown about 550 turbine flights. Over 400 have been with the RAM Remote-Start system. This has been with two RAM 1000 RS's and one RAM 500. Since switching to this new system the reliability has been outstanding. In those 400 some flights I have had a total of three flameouts. One was when I was having so much fun I ran the BobCat out of fuel. It would be hard to blame the system for that one. The other two were with early prototype Remote-Start ECU's that went from full throttle to idle very quickly. In both of these flameouts I was in high-speed flight and I just jerked the throttle stick to idle. Later versions of the ECU solved that issue.

The RAM Turbine with the Remote Start System is a fantastic design. The ease of operation and the consistency of it have converted me over completely from the old air-start systems. The throttle response of the new RPM system is second to none. Over this year I think I have learned a few things about the turbine and this system that have helped me get consistently smooth starts and superb in-flight reliability. In this article I'm going to try to give you the benefit of my experiences.

A. Manual

The latest and greatest version of the Remote-Start System Manual is posted on the RAM Website. The best thing you can do to get reliable, consistent operation is to **READ THE MANUAL!** Failure to follow the installation and operation procedures outlined in the manual can cause not only problems in operation, but also can cause damage that will not be covered by the warranty. Read, study and follow it.

B. Installation

1. Air Trap System

The #1 source of nearly all in-flight flameout's is air bubbles in the fuel line. The best thing you can do to eliminate this is to install some sort of air trap system. I have been using the BVM Ultimate Air Trap tank, but there are several other systems available. Since installing air trap systems in my models I have yet to have one of those "mystery" flameouts that would occasionally happen. They were a common event in the MiG until I installed an air trap. The turbine can absorb a certain number and size of air bubbles, but if you get enough of them the fire will go out. An air trap just seems to eliminate this problem.

If using a BVM UAT, when first installed you must follow a process to rid the UAT of all air. Fill the tanks in the model, and then disconnect the fuel line going to the engine at the festo fitting. Hook up a 4mm-fuel line to the fitting and run this back to your fuel can. Now just hook an ECU battery

directly to the fuel pump in the model. This will run fuel through the system. Now start shaking and tapping the UAT. You will probably see air bubbles run through the fuel lines. Keep shaking and tapping until all the air is purged. Once that's the case, the system is ready for the first start.

If you ever empty the UAT by running it dry, fill it back up with fuel. If left to dry out you'll need to repeat the purging process.

The UAT also seems to work better if it is mounted vertically in the model, or at least at some angle that has the front of the tank high.

2. Fuel Tank Filling

The fuel tank system should have a third line to fill through. Do not disconnect any of the lines for filling. This will put air into the fuel lines. A third line, perhaps installed in the air trap header tank, will allow you to fill without disconnecting lines.

3. Fuel Solenoid Valve

Since the software in the ECU opens the fuel solenoid valve anytime the fuel pump is commanded on, the only real purpose it serves is to keep the turbine from flooding when you fill the fuel tanks. But if dirt or some other contaminant gets into the solenoid, it can leak, and the turbine could still get flooded, causing a very bad "wet start". Also, since it takes electrical power to open the valve, in most cases if they fail, they will close, shutting off the fuel supply. You will now be a glider. I eliminate the solenoid valve, and install a 6mm Festo Shut-off Valve instead. Now this requires me to shut this valve after every flight. If I don't, I could get a wet start. So I have developed the habit of shutting it off immediately after shutting down the turbine. This means a bit more responsibility on the operator's part, but I'll take that for the possibility of increased reliability.

If you feel that you may forget to shut-off the festo valve, then leave the fuel solenoid installed. It will give you a back up if you fill the tanks without shutting off the festo.

4. Festo Fuel Fittings

These fittings are very convenient, and in some cases necessary since you do need to occasionally disconnect a line. But you must be very careful when installing them. A leaking Festo is a sure-fire way to get air bubbles in the fuel line. When at all possible I avoid using these fittings. If I can, I use a normal "nipple" type fitting instead of a Festo.

When installing line into a festo fitting, make sure the fuel tubing going into the festo is cut clean and square. Also make sure that it is still round. If the tubing has been wrapped tightly for a long time it can begin to get oval. This will cause leaks. Now once you have the Festo installed, unless absolutely necessary, leave it alone! Do not have a fuel system that requires you to disconnect a Festo to fuel. Use the third line from the

UAT. Another point, the seals in these fittings are o-rings, and they wear with repeated use. I keep spares of these fittings handy. If I have had to disconnect one more then 6 to 8 times, I replace it with a new one.

5. Fuel Line Connections

When installing fuel lines using “nipple” type connections, I safety wire all of these connections. Use .020 wire, and make sure to wrap it around the tubing twice before twisting it. Safety the fuel lines inside the tanks, a clunk leaking air or falling off is a guaranteed flameout. Done properly, safety-wiring these connections will keep them secure and leak-free.

6. Fuel Pump Installation

It is best to secure the fuel pump down in the model somehow. I usually tie-wrap it into place. I have seen some installations that just have it dangling on the ends of the fuel tubing or just loose in the model. Securing it will put less strain on both the fuel lines and the electrical leads. Also, plan your installation such that the R/C antenna will not be running near the pump. It is an electric motor and as such could cause some range problems.

7. Fuel Filters

RAM now supplies a nice metal fuel filter that is installed between the fuel pump and the turbine. Do install it, as even though your fuel should be filtered before putting it into the model, it is possible that little particles can breakaway from your fuel tanks system. This filter will help keep those out of your turbine. The 750 and 1000 turbines have fuel needles that have holes that are around .020” in diameter, and the 500 needles are even smaller. You want to keep these clean.

I install the filter using short lengths of 4mm tubing, safety-wired to the fitting, and then use 4mm festo fittings to install it into the fuel line. This way I can remove the filter for that occasional, necessary cleaning.

8. Gas Canister

The onboard gas canister must be mounted vertically in the model, and it must be upright. The end with the fittings is the “top”. The Powermax fuel is a liquid when filled into the canister. This liquid must evaporate out to supply the turbine with gas, not liquid, fuel. Also, it is best to arrange your installation so that the gas canister is easily removed. Occasionally when it is cold outside, you may need to warm the canister in your hand for a few seconds to get enough gas pressure for ignition.

9. ECU Installation

The ECU should, like the fuel pump, be mounted somewhat securely. I like to use Velcro patches to stick it to a board in the model. This gives some vibration protection, yet keeps it rigid enough that no undue stress

on the attached wires will occur. Also, mount it in a place in the model that fuel will not leak onto it. Kerosene will do bad things to an electronic circuit.

The RAM Remote Start ECU is very clean from an RF standpoint. I have seen installations that had the RX and the ECU right next to each other with no problems. It may be prudent, however, to keep a little distance between the two. And of course, always do a thorough range check prior to that first flight.

10. EGT Thermocouple Probe

When installing the EGT Probe, avoid any sharp bends, particularly near the tailpipe. I have ruined a couple of probes by bending them too tightly. A sharp bend can "short out" the element and cause a failure. Keep all the bends nice and smooth.

11. RPM Sensor Wire

The RPM sensor wire should not be wrapped with any of the turbine system wiring. Some cross feeding can occur which can corrupt the rpm readings.

12. General Installation Tips

While I have yet to see a range problem with a RAM Remote Start system, I do use a few simple guidelines when installing the turbine's systems and the R/C. Along with those that I mentioned earlier, I try to carefully route the wiring of both systems. I usually try to route all the servo and turbine wiring on one side of the model, and the antenna on the other. Keeping the antenna clear is always a good idea. While some are using vertical whips with good success, I have yet to try them, and have yet to see a need for them. And I just don't like the look of a whip antenna on my models.

Also, neatness does count when it comes to installations. It just seems that the troublesome models that I have seen often look like the systems were just thrown into the model. Take a little time to plan out and execute a nice, clean installation. It will usually payoff in the long run.

C. Fuels and Batteries

1. Kerosene

One potential problem with kerosene is the growth of algae in your storage can. Over time, and it can happen quickly, algae will clog the fuel needles inside the turbine, causing a rough idle, difficulty in starting, and possible flameouts. And the algae cannot be filtered out using normal fuel filters.

There have been many discussions on what fuel to use. I personally use and recommend JetA, purchased off a truck at a local airport. Request from the FBO that Prist be added to the fuel at the time of purchase. Prist is an anti-algae agent used in full-size airplanes to combat this problem. This is especially important if you think your fuel is going to be stored for more then a month or so. Since I fly a lot, my fuel doesn't sit around, so I have yet to encounter this problem. But if your fuel has been sitting for a while, keep an eye out for this algae problem. Also, it is best to store the fuel indoors, so that it does not see wide temperature swings. These can cause condensation to develop inside the fuel can. Water itself is not bad in the engine, but water will promote the growth of algae.

Install an automotive type paper filter in the fuel lines on your supply can. Maybe even install two. When refilling your supply can, check for any dirt particles and clean them out before filling the can. BTW, www.jerseymodeler sells a ready-to-go 5-gallon fuel can with pump and filter.

As for oil, I have been using Exxon 2380 at 5% for all my flying, and have yet to see any problem with this mix.

2. Powermax Fuel

The gas supply is probably the biggest factor in getting consistently reliable starts. It is best to empty the onboard gas canister before filling it. This will cool the bottle and allow more liquid to enter when the canister is recharged. Just disconnect the festo check valve fitting from the gas canister side and let the gas expel. It can come out pretty briskly; so watch what direction you're pointing the line. Let it empty completely out, and then fill it. Make sure you have an adequately filled Powermax bottle. As the bottle gets nearly empty, it will still sort of feel like it has fuel, but won't supply enough when filling the gas canister. If in doubt, use a fresh Powermax bottle. BTW, I get about 30 to 40 starts on one of these bottles.

3. Batteries

For smooth, reliable starts, I charge the ECU battery before every flight. Charging every flight is not absolutely necessary. In a pinch I have flown my 1000's for two flights and the 500 for three flights between charges. But the best consistency is obtained by charging between every flight. When I plan the installation, I set it up so that I can easily remove and replace the battery. That way, with an extra pack, I can be charging one while I'm flying the other.

It is also a good idea to occasionally cycle the ECU packs. They can lose some capacity with the constant recharging between flights. A deep cycle will restore this lost capacity.

D. Procedures and Adjustments for Smooth Starts

1. Priming the Fuel Pump

When preparing for the first start of a new installation, or if the model has not been flown for a while, it is necessary to prime the fuel pump and purge all the air from the fuel lines. To do this, disconnect the fuel line going into the turbine at the festo connector. Hook up a length of 4mm line to the festo as an overflow. Now open the Shut-off Valve and using the SDT run the pump by pushing the PMP Control Button. Run the pump until a steady stream of fuel comes out of the fuel line. Watch the lines to make sure all the air is purged from the lines. Now disconnect the overflow line and reconnect the fuel line to the turbine. Prime until you see the fuel reach the front cover of the engine. DO NOT PUMP EXCESS FUEL INTO THE ENGINE! This can result in a hot start.

This priming procedure will help the turbine ramp onto the kerosene quickly and smoothly during the start sequence.

After the first run of the day, and if using a third line to fill the tanks, you should not need to prime again for the day. If you should run the fuel system dry, prime again before the next start.

2. Gas Ignition

The first thing that has to happen for a successful start is the ignition of the gas. The Powermax fuel is liquid when it is filled into the onboard gas canister. That liquid evaporates to form the gas that is used for ignition. Temperature changes effect how that liquid evaporates. The colder it is, the slower the gas evaporates and the gas pressure will be lower. The higher the temperature the quicker the liquid evaporates and the gas pressure will be higher. The mixture must be within a correct range for the gas to ignite, much like when you light a propane torch. You have to adjust how far the valve is opened to get the torch to ignite.

Now this is why there is a Gas Adjust feature in the ECU. Think of it as the torch's valve. As the temperature changes, you may have to adjust the Gas Adjust setting to get ignition. As a rule of thumb, the colder it is, the lower the Gas Adjust parameter should be. The warmer it is, the higher that number should be. Remember, the way this parameter works, if you raise the number, it reduces the amount of gas.

On extremely cold days, especially with a RAM 500, it may be necessary to warm the Gas Canister slightly to get enough gas pressure for ignition. I do this by removing it from the model and warming it in my hands. I install the bottle so that I can remove it easily if needed.

The Glow Plug parameter may also need some adjustment. This parameter is somewhat dependent on the condition of the ECU battery. If it is low in capacity or voltage, the glow plug will not be as hot. Also, if it's cold outside, batteries will not provide as much current, so you may have

to raise the glow plug parameter to get ignition. One point, in the new "X" series ECU's, the glow plug parameter is reversed from earlier remote-start ECU's. In that system, lowering the Glow Plug parameter makes the plug hotter.

Check to make sure that enough of the glow plug element is pulled out. At least 1/8" of the coil should be exposed.

If during the start you hear the turbine begin to "pop" when the gas ignites, your glow plug is getting weak and needs replacement. The element may still look fine, and it may even glow, but trust me, they just start to get weak and will cause a poor ignition.

While other plugs may work, the recommended plug is the Rossi R-8. It will give the longest life and the best ignition. If using a different plug, you may have to adjust the Glow Plug setting down to keep from burning it out.

3. Ramping on the Kerosene

After the gas ignites, the next step in the start process is the Fuel Ramp. The system begins to pump the Jet A into the turbine, it will begin to burn, the rpm's will increase, and the start process will be completed. How quickly and how much kerosene is pumped at this time is adjusted by the Start PW parameter. While the factory does test run and set this parameter before shipping your system, it is based on the fuel supply system in the RAM Test Cell, and the conditions at the time they do the test runs.

The fuel is being supplied to the turbine by an electric fuel pump. This pump is being "pulsed' by the ECU to control how much fuel is sent to the turbine. The fuel systems in each model can vary widely. Some models use one large fuel tank; others use a number of them spread around in the model. These differences cause a variation in the resistance in the fuel supply. This means that a Start PW setting that works well with a single tank model won't work with one that has 4 tanks hooked up. The purpose of the Start PW parameter is to allow the owner/operator to adjust for these different installations and conditions.

If the turbine ignites on the gas, but will not ramp onto the kerosene, or seems to take a long time to complete the ramp, the Start PW parameter needs to be increased. Try raising it in increments of 5 until the start is smooth and reasonably quick. The fuel ramp should begin within one second of the ramping display on the SDT. If you see a lot of excess flame coming out of the tailpipe during a start, try reducing the Start PW.

As mentioned earlier, on a new model, or before the first start of a flying session, prime the fuel pump by disconnecting the fuel line to the turbine and running fuel through the system. For a nice, smooth start all the air needs to be purged from the fuel lines. If you should run the fuel system dry, a prime may be necessary.

4. EGT and Thermocouple

When the engine completes the start process. It will settle into the idle RPM that has been set in the Idle RPM parameter. The EGT at idle should be around 500C. If it is reading plus or minus 50, leave everything alone. If it is deviating more then that, you need to adjust the position of the EGT probe. If the reading is too low, insert the probe further into the tailpipe. If it is reading higher, pull some of the probe out. Check what the EGT is reading at idle on the next run, and further adjust as required.

If the probe is inserted too deeply in the tailpipe, you may get a failed start due to an overtemp. If the EGT reaches too high a value during the start it will abort the process. Checking the Error Message in the Data Menu will tell you if that's what happened. If so, just pull the EGT probe out of the tailpipe a bit, and when the engine is idling on the next run, check the EGT and further adjust the probe if needed.

E. First Flight Preparations

1. Range Check

Let me start by saying that I only recommend PCM receivers in turbine aircraft. I have no experience with the Multiplex IPD receivers, but I hear they're fine. It is important to use a receiver that will have some sort of fail-safe system. Without it a spurious signal can shutdown the turbine. I know some may disagree, but I feel strongly that this is the best way to fly.

Having said that, it's still very important that before the first flight a complete and thorough range check be performed. There are too many factors that can come into play with one of these models. A lot of carbon in the construction, metal tailpipes, electric motor fuel pumps, a lot of long servo leads, these can all be potential problem areas.

When you start to range check, unplug the throttle lead from the receiver and do not plug in the ECU battery into the ECU. You want to get a baseline check without any potential interference from the turbine systems. Then do a range check and make sure you can get the radio manufacturers recommended distance. With my JR 10X's, I want to see 60 to 70 paces with the antenna completely off. Now have a helper rotate the model and check the range from all four quadrants. If you're not getting adequate range start moving things around and checking the condition of the R/C system until you do. Now plug in the ECU battery and the throttle lead into the RX. Check the range again. You should see at least 80% of the baseline distance. If not, move things around again. Usually I see no difference at this stage.

The next step is to check the range with the turbine running. Set the fail-safe on the throttle channel to idle. Start the engine and perform the same range check, again from all four quadrants of the model. Try different throttle settings. When you get to the edge of the range the turbine will begin to go to idle. If the range is reduced, again move things around. Make sure the RX and its antenna are as far from the fuel pump as possible.

Don't fly the model until you are completely satisfied it has passed these checks. It may take a little time to conduct these range checks, but less time then building a new model.

2. Fuel System Check

Prior to flight I always check the fuel system for proper plumbing. I do this by filling the tanks completely. Check for any leaks in the system, particularly at all of the fittings. Then I use the turbine fuel pump to do the emptying. Disconnect the 4mm-fuel line from the fuel pump to the engine at the festo fitting, and then hook up a return line to that. Now just plug in an ECU battery pack directly to the fuel pump, and empty the tanks. Shake the model and if using one, tap on the UAT. Make sure you see no air bubbles in the line coming out of the Air Trap Tank to the pump and none in the line coming out of the pump. Once the UAT is properly purged, any air bubbles in the lines after the UAT are being caused by a leak at one of the fittings. Run the pump until the tanks are empty, leaving the UAT full. This makes sure that all the plumbing in the fuel system is correct and that all the fuel can be drawn out of the tanks. If the tanks are not emptying properly you have either a bad clunk line or a leak at the fittings.

F. Flight and Shutdown Operations

1. Start/Taxi Tank

On models that have somewhat small fuel systems, I always use a Start/Taxi auxiliary fuel tank. Particularly at a jet rally, when you may be delayed from taking off due to other traffic. One thing to remember, a turbine engine even at idle is still burning a considerable amount of fuel. They're not like a glow engine that burns very little in idle. I have seen a few jets run out of fuel because they underestimated the fuel burn while they were sitting waiting to take-off. I have to admit, on my MiG 15, which has a huge fuel supply, I often don't worry about it, but on my Bandit and BobCat I use them all the time.

2. After the Start

After the system has completed the start process and returned the turbine to the idle RPM, if you look at the ECU, you'll see that both the green and amber lights will be on steady. At this point, you should go to full throttle. When the engine has stabilized at the programmed High RPM setting, the amber light will go out. You can now go to idle and proceed with the flight. This step allows the ECU to "learn" the current conditions.

If the engine takes a long time to reach full power, check for any restrictions in the fuel system, such as dirt in the fuel filter.

3. In Flight

The ECU is programmed to control the rate of thrust change so that the combustion process stays stable in the turbine. But if the model is flying at high speed and you just slam the throttle to idle, excess air could be forced into the turbine, which will make the fuel mixture too lean and the fire will go out. This is particularly true in a bypass installation. The solution is to move the throttle smoothly when powering down from high-speed flight. If your transmitter has this feature you can program some slowdown into the throttle channel. Set it to go full travel in about 3 to 4 seconds. I use the Flight Modes in the JR 10X radio and just program the Servo Slow in my "flaps up" Flight Mode. When the flaps are down I use no slowdown. That way, if I need quick throttle response in a go-around or a thrust adjustment during the landing approach I get it quickly. But when the flaps are up and I'm cruising around, I don't have to worry about being smooth with the throttle stick.

4. Shutdown

All of the current RAM turbines are lubricated by oil mixed into the kerosene. This is a very reliable, simple system. But it has one disadvantage. The turbine starts initially on the Powermax fuel, and it runs on this for several seconds while the kerosene ramps up. This means that for those few seconds the bearings are only being lubricated by the oil left on them from the previous run. If there isn't much residual oil, the bearings can be quite dry. The turbine rpm's may reach 20 – 25k before the kerosene ramps, and un-lubricated bearings will wear at those rpm's.

To insure that as much oil as possible stays on the bearings for the next run. I follow a shutdown procedure. This process cools the turbine down a bit quicker and keeps more oil on the bearings for that next start.

At the end of the flight when I taxi back, I point the model into the wind, bring the throttle up two clicks from idle, and let it run there for 30 seconds or so. This cools things down in the engine. A turbine at idle is running somewhat hot. You can check this by watching the EGT when it is at idle and when it is a couple of clicks up from idle. It will usually be about 40 to 50 degrees cooler at the slightly higher throttle setting. After

the 30 seconds, I shutdown the turbine by either closing the shut-off valve or with the transmitter.

The Remote Start system will pulse the starter motor to cool down the turbine. At that first pulse it records the spooldown time. I like to avoid the wear and tear on the starting system by using a leafblower. I wait until that first pulse and then I use the blower. I also believe that this cools the turbine down a little quicker, leaving a bit more residual oil on the bearings for that next start.

5. Preventive Maintenance

The ECU records data about each run/cycle. An important piece of data is the Spooldown Time. Keep track of that number, and note if any trends are taking place. If you see a gradual reduction in the spooldown time, it may mean it's time for a bearing change. Better to send the turbine in for a bearing change before a problem occurs, and it's better to have everything ready before that big rally then to have a problem at one.

Occasionally when running the turbine, take the tip of your fingernail and rest it on one of the turbine mounting pads. Run the engine up to full throttle and check for any vibration. An increase in vibration may be an indication of a bearing going bad. Also, listen for any unusual sounds coming from the turbine. A high pitch squeal can also indicate a bearing problem.

Here's another tip that helps get a lot of runs on a turbine between maintenance. Fly a lot, and fly often! These things just love to run. If they sit for long periods of time between flights, oil can dry out and get gummy. If you can't get out to fly, I recommend at least running the turbine once or twice a month. This will help keep things lubricated and ready for when you can go flying.

G. Conclusion

I hope all of this helps you enjoy your RAM turbine engine even more. If you have any comments or questions I can be reached at the following,

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