

# Light Plane Maintenance<sup>®</sup>

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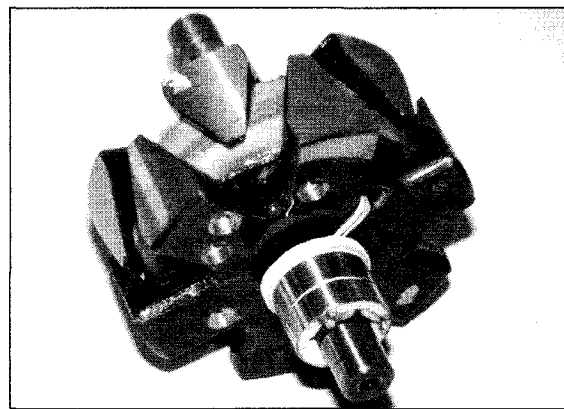
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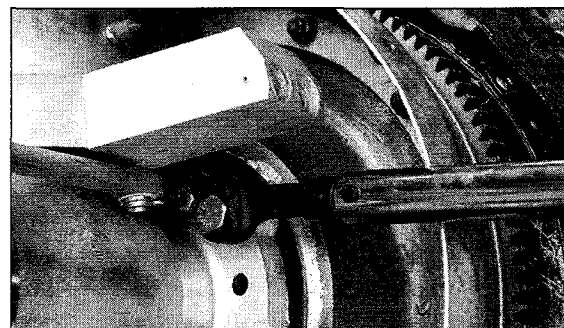
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# JPI EDM 930 installation

*There is no reason you cannot bring an older airplane into the 21st century with a terrific panel upgrade.*

BY RICHARD KOEHLER, IA

I fly a '63 Mooney M20C that, although it has had several avionics upgrades, still had the original engine and fuel system analog instruments.

In particular, as original equipment the Mooney had a six-gauge "cluster gauge" manufactured by Garwin that displayed left and right fuel quantity, amps, oil temperature and pressure, and cylinder head temperature (CHT).

Garwin has long since been out of business and there are no parts left to repair the cluster gauge. I knew the fuel gauges were notoriously wrong (I used a dip stick and time) with one reading from ¼ to ¾ while the other registered from way below empty to way above full.

The ammeter gauge needle stopped at 5 with the power off. Oil temperature and pressure appeared okay. I had done a rough calibration of oil temperature using a kitchen thermometer, but accuracy was still a question. For instance the oil pressure green band was 3/16 inch long and the needle was 1/16 wide!

Cylinder head temperature was the single probe type, on only cylinder #3. I

Original panel from a 1963 Mooney Before EDM 930 installation. Lots of stuff to move.

had called several instrument shops and the few that agreed to look at the cluster gauge wanted at least \$50/indicator (\$300 minimum for the cluster) with no guarantee of success fixing the gauge.

In fact, it was possible that the attempt to repair would damage the cluster enough to make it obviously unairworthy. The other original analog engine instruments included RPM (recently overhauled by Century) and combined MAP and fuel pressure, each in a 3½" gauge.

Several years ago I had installed the JPI EDM-800 multi-probe engine analyzer with fuel flow on a 2¼ inch display to record flight test data for prototyping the PowerFlow exhaust system on the M20C. Its recording feature allowed back-to-back plotting of flight test data for "before" and "after" comparison to meet the FAA STC requirements.

I was very pleased with the EDM-800 finding its data very useful. I had tied it to the Garmin 430W with a data link so that the Garmin had fuel flow and fuel quantity data, mitigating some of the inaccuracies with the fuel gauges.

JPI Instruments, Inc introduced the EDM-900/930 as an STC'd and TSO'd

primary instrument replacement a couple of years ago, and it immediately caught my attention. The -900 is a monochromatic display, the -930 is color. At Sun N' Fun I chatted with the JPI folks at their booth about an exchange of the EDM-800 gauge for an EDM-930 display; since I was assured that they were connector compatible. However JPI never came out with such an exchange program.

Finally a solution came when a friend of mine expressed a desire to buy the EDM-800 from me, if I installed it, for \$2500. I agreed, reasoning that I could use my installed harnesses for an easy 930 hook-up, and use the new harnesses for the 800 install.

The final "convincer" was JPI offering a \$300 rebate on the 930 if ordered at Air Venture this summer (2009). With the wife's concurrence I went to the JPI booth and attempted to order. It turns out JPI won't deal directly with the public, and they suggested I check with one of their distributors.

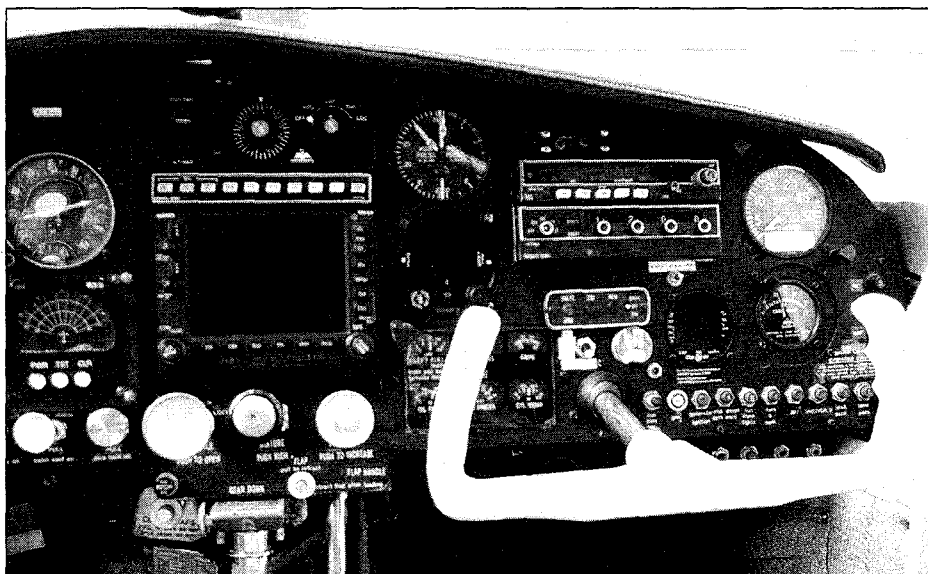
I marched over to Aircraft Spruce and they gladly took my order. JPI listed the EDM-930-4CP at \$4910, but Spruce sold it to me for \$4375 and with the additional \$300 rebate that amounted to a 17 percent saving! I should save a few more dollars when I sell the displaced engine instruments and cluster gauge.

When I purchased the 930 at Air Venture the Spruce salesman told me the unit should ship in two or three weeks. After about two weeks Spruce got back to me that they were sending a three page "Primary Instrument Questionnaire," and that I was to fill it out and return it to JPI.

The Questionnaire turned out to be three pages of requested data on all the primary engine instrument limits and a calibration curve for the fuel tanks.

The primary instrument limits were easy, coming out of the POH, but the fuel calibration required the tanks to be carefully filled with various known quantities of fuel and resistance readings taken at each increment. Since I have the Munroy extended range tanks I can carry up to 45 gallons in each wing, and since the fuel quantity sender is in the inboard tank, the sender resistance is non-linear to the fuel quantity.

As a result we chose to fill the tank in five-gallon increments from a calibrated fuel can, taking readings as we filled and



de-fueled. This rather laborious task took the better part of a day for two of us. I plotted the points, best fit them with a French curve, and recorded the fuel and other data on the questionnaire and faxed it to JPI on August 13, 2009.

I called Spruce on September 3, 2009 for status on the ordered EDM, but got no feedback, so on September 16, I called JPI directly and was told they were waiting for me to provide the Hobbs time that was to be loaded in the EDM! With some frustration in my voice I explained that I had no idea what the engine/airframe time would be since I was flying the plane while waiting for the delivery; I had never been told that the Hobbs time was required; and I didn't care what it was. Few older aircraft have engine/airframe times that match the gauge times. I was told that I would have to return the entire unit if I wanted the Hobbs time set to a specific time at some point in the future. I requested they ship the unit immediately.

The EDM-930 and its installation package arrived a week later, and I began the review of the data and parts for the installation. The FAA Approved Installation Manual is 37 pages long.

It quickly became apparent that it was not going to be practical to use all the harnesses that were already installed in the plane. Several of the sensors were different such as RPM and oil temperature, and there were new harness leads for the ammeter, fuel and oil pressure, and fuel quantity.

Also, the power/ground harness had what looked like an induction choke in the power wires, probably to protect the display from power surges or RF interference. So, with the exception of the EGT/CHT harness (25 pin J2), I replaced the other four harnesses, 25 pin J1 for power, oil temp, OAT, etc., 9 pin J3 for RPM, MAP, oil pressure, etc., 15 pin J4 for fuel flow and GPS interface, etc., and 15 pin J5 for fuel pressure, fuel quantity, amps, etc.

Also, there is a telephone-like plug for a remote display in front of the pilot. All of these harnesses were of good quality with more than adequate leads and connectors for installation.

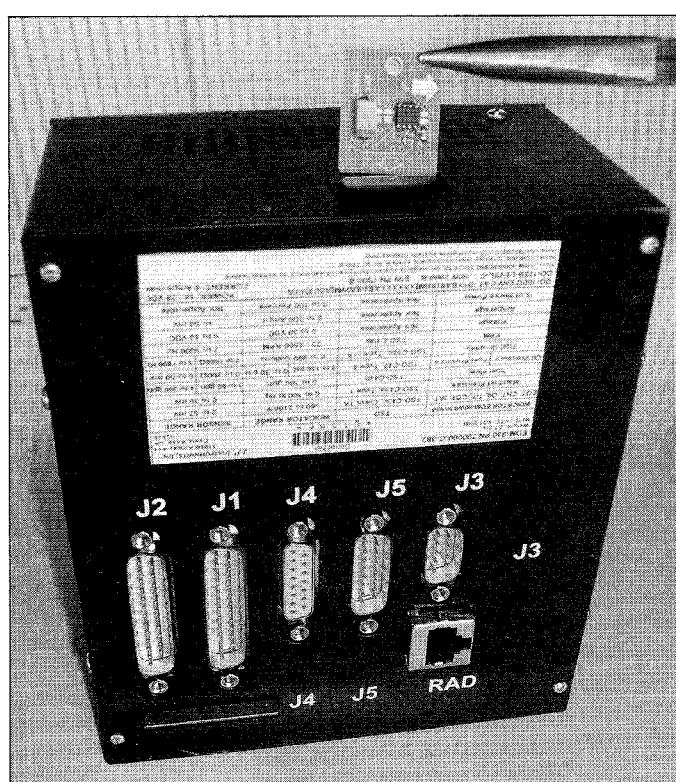
My other major installation issue was making the physical space required for the display. The Installation Manual provides an excellent drawing of a 5.584 wide by 4.787 high cutout that the display mounts in from behind.

Unfortunately there was no space anywhere on my panel that would accommodate such a large area (see old panel shot on page 15). It was obvious that some major rearrangement had to occur. My first plan was to replace the entire right side instrument panel and in the process move things about enough to provide room for the EDM.

I then counted the 13 circuit breakers and decided that a partial panel overlay would be much easier at this point. Looking at the old panel I decided that the easiest approach would be to move the ADF and transponder to the right, filling in most of the hole previously filled by the RPM gauge. The Narco backup radio and marker receiver would drop down into the space where the old cluster gauge resided and the new EDM display would fit in the upper left corner.

I purchased a minimum size 2' by 4' sheet of .050 2024-T3 and began a layout for an overlay of the existing panel covering the left side. The first template was made from brown paper, which was used to create the first metal overlay. This is the unpainted one in the picture.

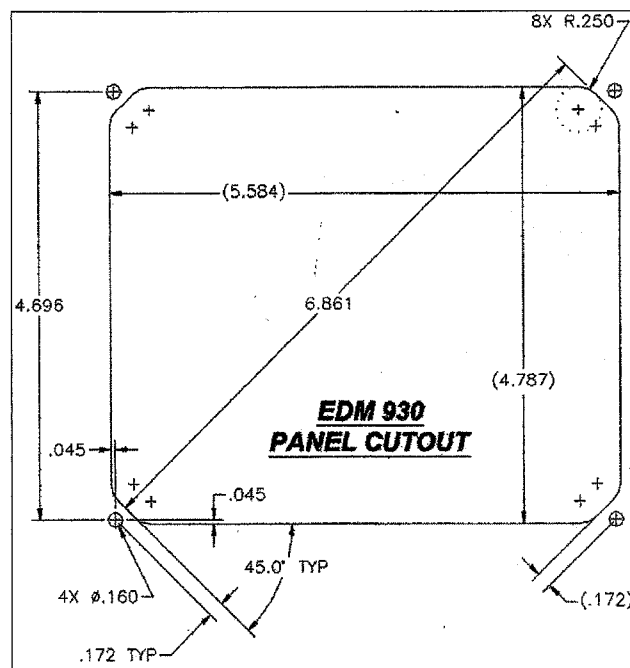
It became quickly obvious that I needed to cover a larger area, extending into the upper right portion of the panel. I first cut away all the unneeded portions of the old panel and made the cut-out to slide the ADF and transponder to the right. I made a small blank-off plate for the uncovered portion of the old RPM gauge and included a 1/2 by 1/2 extruded angle to be the right radio mounting rail.

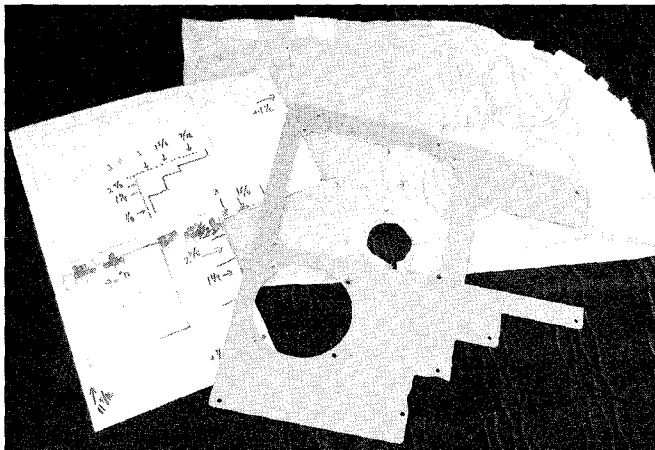


The back side of the JPI 930 with all the jacks and card slot. It takes lots of pre-planning to make sure everything is going to fit.

The other side radio mounting rail was also made from 1/2 by 1/2 angle and mounted to the .050 overlay. The overlay picked up the existing panel mount holes, plus a few extra in strategic areas.

Panel cutout template from the installation manual gets you started.





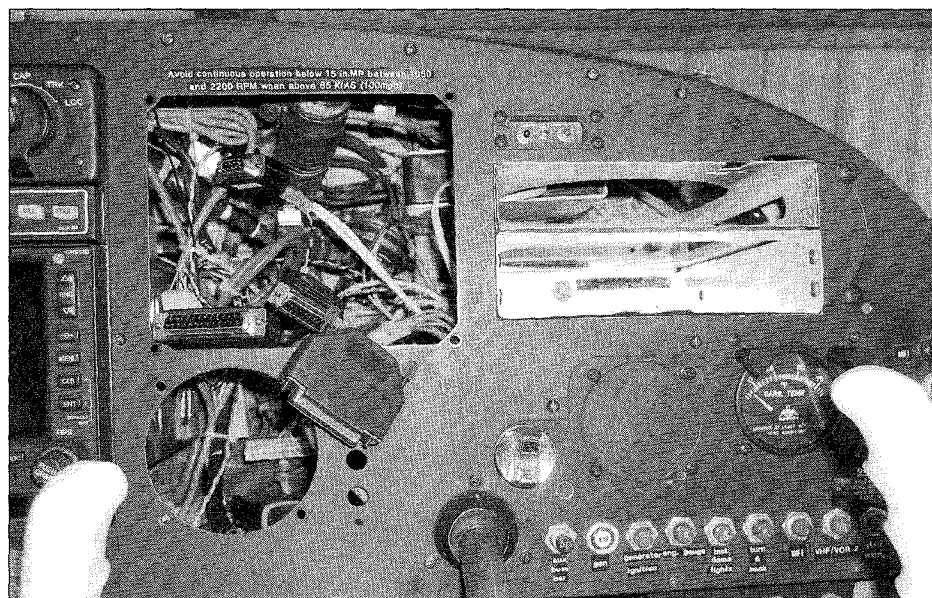
It takes a careful, step-by-step planning process to get to a satisfactory finished product. You don't want to start cutting aluminum until you make sure everything will fit on paper first. You also always have to keep the depth of the box in mind or the best plans will quickly fall apart.

The gray primed overlay in the picture is the second attempt to meet all my panel needs.

I installed it temporarily and to my horror discovered that the EDM display just interfered with the defroster duct at the top back edge. I tried to modify the duct, to no avail, and finally conceded that the EDM had to be mounted  $\frac{1}{4}$  inch lower to clear!

There was no alternative but to make

Getting a large display to fit safely and avoid any interference takes lots of checks and re-checks, especially for avoiding wiring interfering with existing harnesses. You can't just stuff the box in and hope for the best.



another panel overlay out of the .050. I took the opportunity to refine the fit and actually extend the overlay a bit more to the right, particularly on the top. It took me the better part of a day to make another panel overlay out of the 2024-T3. Good thing I had bought a big piece!

With the panel mount completed, I turned to installing the harnesses and sensors. Again, the EGT/CHT harness and probes was simply reused. Power came from the existing 5 amp "gauges" circuit breaker. The original oil temperature probe was replaced with a new one.

The RPM sensor screwed into the bottom of my right mag, requiring removal of the mag for access in my tight Mooney engine compartment and re-timing. The pressure sensors (oil, fuel, MAP) were all new and since the old gauges were direct reading, I chose to use the existing hoses and firewall fittings and mount the new solid state sensors behind the firewall, even though the installation instructions allow them to be in front of the firewall.

I believe the behind-the-firewall location will enhance the life of the sensors. This did require buying a couple of additional pipe/tube fittings and some large Adel clamps (MS21919). I was able to use existing firewall wire shields for all the harness wiring (new one with the EDM-

800). The "wiring" install of the harnesses took the better part of a day.

Since I had removed the mechanical tach drive, I removed the firewall fitting and installed a stainless cover with stainless screws. The place where the engine tach output comes off the engine accessory case needed to be covered. I found a nice cover cap in Aircraft Spruce for \$20.

After installation of the display box and hook-up of the six connectors, I did the "smoke" check, powering up the system. Even though most of the display limits are set at the factory, the unit still has to be programmed for aircraft peculiar values, such as the fuel flow "k" factor, C or F for temperatures, horsepower constant, MAP calibration, and display resolution.

This can be done on the display or with your PC using JPI's free EzConfig software. Refining the fuel flow "k" factor may take a few flights, but since I reused my fuel flow sensor, I simply reused my old "k" factor and fuel flow appeared to be perfect. Everything worked great on initial start-up, and there appeared to be no installation discrepancies.

Then I looked closer and discovered several problems with the display limits. It turned out that JPI had programmed my display with "standard" '63 M20C limits and ignored some of my data on the Primary Instrument Questionnaire I had completed back in September.

Over the years I had installed a 3-blade McCauley prop and InterAv alternator conversion for instance, and the limits for the old Hartzell prop and generator were totally wrong. I called the JPI tech support line (800 345-4574) and got an RMA and agreement to reprogram the Key Card that contains the limit markings.

It turns out that JPI must have the exact documentation for nonstandard markings, since the 930 is a primary instrument replacement. This time with the Questionnaire I included copies of all the appropriate STC paperwork pages for the nonstandard gauges.

JPI programmed a new Key Card and sent it to me Priority Mail at no cost, with the requirement that I return the old card. All display limits are now correct. My only minor irritation was that the 930 box must be removed from the panel to install the new key card. (see photo at top of page 15).

A couple of final reflections are in

order, I think. First off, getting the display data and Hobbs time set correctly is a cumbersome process. There are many options that must be addressed. For instance the fuel quantity can be set-up to work with resistance probes, voltage probes or capacitive probes, and in any case JPI requires you to calibrate the probes as part of the Primary Instrument Questionnaire process.

If your probes are original, it is suggested you replace them with new. I burned up at least eight man-hours doing the fuel tank calibration, five gallons at a time, but I now have accurate fuel gauges. Also, if you want the Hobbs to reflect the actual engine and airframe time, you will have to give JPI the numbers and not fly until after the install.

This may result in extended down time. Buying through a smaller supplier than Aircraft Spruce may ease this process, but in the end you will have to deal directly with JPI. It would be a lot easier if you could buy directly from them. I most strongly suggest you discuss all of this with your installer if they do not have 930 experience.

The install manual is available online at the JPI website in the downloads section of the site. And I most strongly suggest you download it prior to ordering the 930 so that you will better understand what is required for installation.

Plan on 30 to 40 man-hours for the install. Big variables are whether you already have JPI EGT/CHT/FF installed or not. Engineering the fuel flow transducer will probably require purchasing at least one new hose and the use of several Adel clamps.

Another big variable is the panel location. The display is designed to fit into a standard radio stack, but if you don't have the space in an existing stack, plan on major panel surgery (remember unit depth requirements as well).

This can be tedious sheet metal work that not all FBOs and avionics shops will want to do. I have Greenly punches for instrument holes and good skills cutting thicker aluminum sheet, and the experience of making the first two panels, but the new third panel still took me about six hours to make, prime, and paint.

Paperwork (337) is easy for the install since the 930 system is covered with an STC for most aircraft. The fuel flow transducer will require another 337, but again

it is easy. Any IA should be able to crank out the 337s with ICAs (instructions for continued airworthiness) in less than an hour. Weight and balance resulted in a net weight decrease of 1.75 pounds for me, which is always good.

I discussed costs above as part of my rationalization for the purchase. All the JPI products are discounted below list so shop around for your 930 and add a couple of hundred dollars for additional needed hardware, plus whatever installation labor costs in your area. As a swag, figure 35 hours at \$80/hr for \$2800. Little of the install is particularly difficult, mostly just a bit tedious. If you have aircraft maintenance skills and a friendly IA, you can consider doing the work yourself.

Do I like the EDM-930? Yes. (See final display cockpit photo, IMAG 1652) I read in *Aviation Bluebook Price Digest* that adding a multi-probe engine analyzer should add \$3000 to the value of an aircraft. Fuel flow and the large color display Primary Instrument Display should add significantly more to the value.

I believe you can make the argument that this is one of the few upgrades you can do for your plane that will almost pay for itself. On the other hand, having accurate data for the operation of your plane can also pay long-term benefits in safety and reliability.

I finally have accurate fuel quan-

tity gauges, and any engine parameter excursion is immediately brought to my attention. I feel smarter, safer, and more relaxed operating my plane with the EDM-930 installed.

*Editor's Note: This is a very comprehensive project, especially because it requires moving lots of existing gear and making everything play well together. Such an undertaking should only be approached by someone who has lots of experience or the help of someone else with the experience who is willing to spend the time (and sign-off where required) to provide detailed guidance. Having done a less comprehensive panel rebuild myself, I can tell you from experience it will be much more difficult than first thought.*

*Richard Koehler is an A&P and IA who is a retired Professor of Aviation Technology at the University of the District of Columbia. He is also a retired Naval aviator who flew 157 missions in Viet Nam in the A-6 Intruder. He has built a KR2 and rebuilt a Globe Swift as well as a Mooney, which he is currently flying. He is the recipient of numerous writing awards, including the EAA's Tony Bingelis award in 2007. He is also active in EAA teaching workshops, and as a technical counselor.*

The finished installation of the JPI 930. We've brought the 60's vintage Mooney into the 21st century of engine monitoring capability.

