Through the Looking GLASS

The glass cockpits of today can display everything from aircraft operation parameters to navigation in a variety of configurations on multiple LCD screens. Never before has so much vital flight information been offered so concisely. Fully understanding these advanced systems is the key to maximizing their potential, as well as gaining widespread acceptance in the helicopter community

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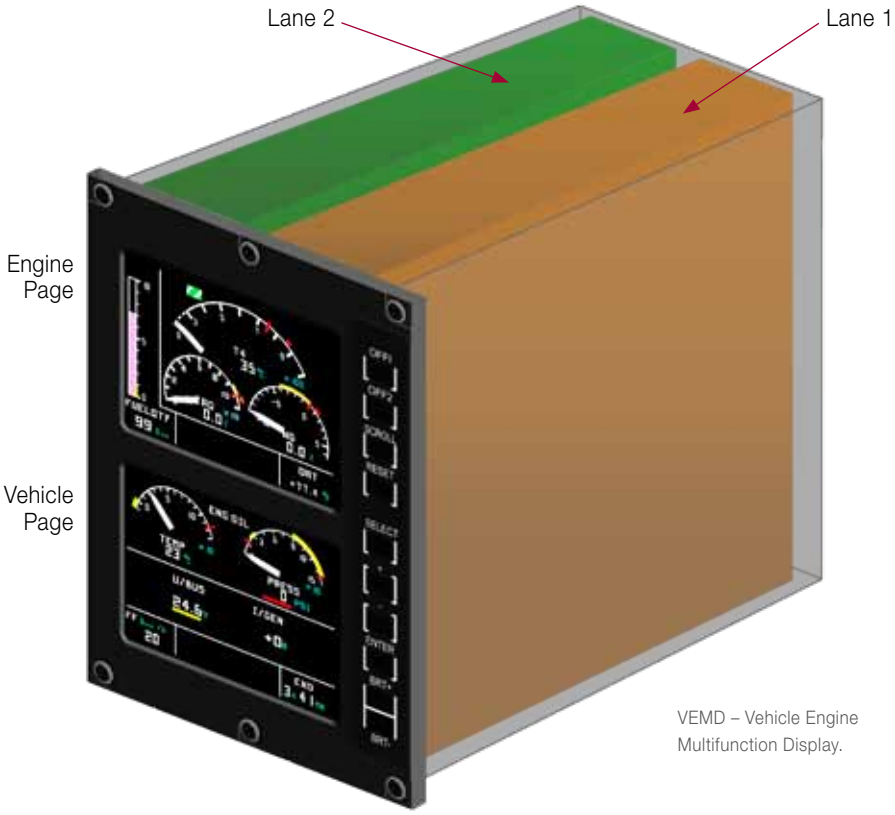

VEMD – Vehicle Engine Multifunction Display.

The manner in which flight information is delivered to pilots in today's cockpit is changing rapidly. The round "steam" gauges that we have become familiar with are disappearing and being replaced by flat-panel displays.

At one time, a pilot could jump from one airframe to another and have an array of gauges in front of him that was very similar to those in other aircraft he had flown. A vertical speed gauge looked the same in almost every aircraft built. Whether you were in a jet, piston airplane or a helicopter, a vertical speed indicator was a vertical speed indicator. Now that same pilot gets into an EC135 and the vertical speed indicator is a ribbon-style format on the right side of the SMD display. This vertical speed indicator not only displays your current vertical speed, but also gives an indication of autopilot vertical speed acquisition.

In today's glass cockpits, everything from navigation to airframe parameter monitoring to basic flight information can be displayed in various configurations on multiple screens. Not only has the amount of information provided to the pilot increased, but the manner and quality of the information is often more usable.

When electronic displays were first introduced the displayed information was more or less just electronic copies of the gauges that pilots were accustomed to seeing. On today's newer display designs, not only have avionic manufactures created new ways in which to display information to the pilot, such as the VSI on the EC135, but they can also interrogate weather, approach plates and synthetic vision into the display.

One would think that the technology to utilize these glass cockpits was a recent development and the airframe and avionics manufactures are just now introducing the aviation world to this newly found invention. Of course, the truth is that these products have been around for a good amount of time, but until recently have had very little acceptance within the helicopter community.

As manufactures started to introduce some or all of their cockpits with LCD displays, many in the aviation community looked at these electrical boxes with skepticism and distrust. From a logical standpoint, if a manufacture can provide the pilot with more information for his or her flight environment, it stands to make sense that this technology would be welcomed with open arms. But this was often not the case, and many customers purchased aircraft without these electronic cockpit display configurations.

When justifying their attitude toward these LCD displays, users often would try to find logic within their beliefs. Any failure of these units would solicit proclamations of righteousness and proof of their mistrust from the wary aviation community. Of course, anyone who has flown an aircraft for any amount of time with conventional gauges has experienced an array of conventional gauge failures. Whether these early attitudes were the result of discomfort or unfamiliarity with modern technology, the aviation community is now embracing the glass cockpit configuration.

With computers and electronics enveloping almost every aspect of our lives, the majority of us are becoming very comfortable with their use. It stands to reason that this transference of knowledge has made its way into the cockpit, allowing us to embrace the electronic method of providing information to the pilot.

Still, the usefulness of any tool hinges on our ability to operate it. If we are unable to understand the information that is presented to us by the display, that information is worthless. If we are unable to find information within a display, we are not receiving all the information that is available.

This has presented pilots with an additional task when learning a new model of helicopter. We were accustomed to sitting in ground school learning the design, limitations and emergency procedures for a power plant, electrical system or hydraulic system. But as far as the instrument panel went, it was mostly just learning the different color markings on our new gauges.

Often when we were taught the design of a power plant there were many similarities from the previous models of engines that we had operated. This transference allowed us to learn the new model more quickly because we were familiar with many of its basic principles.

But the majority of pilots being introduced to the glass cockpit have little experience with this technology. Without any basis of knowledge the pilot has to start, so to speak, from square one. This can be somewhat disheartening to the long-time, experienced pilot and novice alike. With many of us being "Type A" personalities it is difficult to feel as

though we are starting from scratch. But just as the first engine design we were taught about was a challenge, the next was easier, and the next was easier than that. We need to embrace our new LCD displays and make every attempt to learn the units thoroughly. This will provide us with the basis of knowledge we need to learn the next model of display, and the next after that.

A common display system that many helicopter pilots are familiar with is Eurocopter's VEMD (Vehicle Engine Multifunction Display). This unit has been around for more than 13 years with little change, and has proven to be a dependable cockpit resource. This unit provides the pilot with engine parameter, fuel, performance and electrical system information. Along with providing the pilot with parameter monitoring the unit also records flight reports, over limits, failures and the engine power checks.

The VEMD is a good example of a cockpit display unit that is somewhat basic (in today's technological world), but without proper training on the device it can be confusing and many of its features can go unused. As with any display system, it was designed to reduce flight crew workload and improve safety. But if the device is not operating properly, or the pilot does not understand the information provided, the distraction can cause an unsafe situation within the cockpit.

Between the various VEMD installations there exists small differences within the programming of the VEMD, but most of the basics remain the same. This provides the user with the ability to operate in different Eurocopter products with at least a basic understanding of the unit.

The most common version of the VEMD is shared between the AS350B3 and the EC130 B4, making it the most known configuration. The EC120 has a very similar design with the addition of an indication of battery temperature. The new AS350B2 VEMD also has a very similar version of software except for the addition of the fuel pressure gauge on the lower screen (vehicle page), the ability to retain all engine parameters after a lane 1 failure, no power check ability and some small differences on the maintenance and configure pages.

When the VEMD is installed in the Eurocopter multi-engine platforms, the structural makeup of the unit is very similar, but the displayed information is in a different format. The multi-engine unit still displays the popular FLI (first limit indicator), but other parameters are shown with a different "look". Because of the large amount of information that needs to be displayed, an additional single screen VEMD is added to the multi-engine platform to display fuel information and messages.

As an example of the knowledge base needed for a glass cockpit display, let's look at the AS350B3 and EC130B4 installation. Even with a basic unit such as the VEMD, there is a large amount of knowledge a pilot needs for its safe and effective use.

The housing consists of two LCD screens, 10 pushbuttons, and two computer modules, more commonly called "lanes. There is also a remote "scroll" button on top of the EC130's collective head or a switch under the collective head of the AS350B3.

There are three display modes for the VEMD – the flight pages mode, maintenance pages mode and the configure pages mode. The flight mode is the default status and displays the engine page, vehicle page, performance page, power check pages and flight report page. The maintenance and configure pages can only be accessed when the engine is in a "stopped" state, and they require pushing combinations of buttons to access them. (We will discuss these modes in Part 2.)

Except for torque, NG limits and fuel flow, both lanes receive the same information from various sensors on the aircraft. When a lane receives information from a sensor it does a validity check on the parameter. If one of the lanes finds that the parameter is not valid but the other lane receives a parameter that is valid, the good parameter is used. If both lanes receive a parameter that is not valid, a failure symbol is displayed. For a gauge failure the failure symbol is a yellow arc in place of the gauge. For a failure of a digital item such as fuel flow, the title is displayed in yellow.

Torque, NG limits (which is utilized by the VEMD lanes to calculate Delta NG) and fuel flow are derived from the FADEC and are first transmitted to lane 1. If the signal is valid, lane 1 sends the information to lane 2. If lane 1 fails, lane 2 can display all information with the exception of the above parameters. If lane 2 fails, lane 1 can display all information since it receives these parameters first.

Lane 1 displays its information on the upper screen and lane 2 displays its information on the lower screen. When both lanes are operating properly and are in the flight status mode, lane 1 displays the engine page and lane 2 displays the vehicle page.

The engine page displays engine parameters, bleed-valve status, fuel

Before start.

In flight with FLI displayed.

quantity, outside air temperature and messages. Prior to start, the engine parameters are shown as individual gauges or the “triple pack”. After start, at 60 percent NG, the triple pack switches over to the First Limit Indicator (FLI). The FLI allows the pilot to only have to monitor one gauge in order to assure that the Delta NG, T4 and Torque values are not exceeded. When monitoring these parameters, it takes the value that is closest to its limit and applies that to a percentage gauge (FLI).

If a parameter limit is exceeded but does not exceed the transient limit, a tone is activated in the pilot’s headset after 1.5 seconds. If the transient limit is exceeded, the tone is immediately activated in the headset. When an engine limit is exceeded in time within the transient range or over the transient limit, an “Over Limit Detected” message appears in the message area. This message will remain until 40 percent NG of the next engine start. The value of the over limit can be obtained by consulting the maintenance pages after the flight and will remain in the VEMD memory for the next 31 starts.

If the value of the parameter (or multiple parameters) is in the caution range, a yellow line appears below the digital display of the parameter to the right of the FLI. If the value of the parameter has exceeded its limit a red flashing line appears under the digital display to the right of the FLI. If any one of the Delta NG, T4 or Torque indicators fails, the display will revert back to the triple display with a failure symbol in place of that gauge.

If the pilot wishes to use the triple pack (all engine parameters separately), the scroll button or switch can be used to scroll to the triple display. In most cases the FLI is used exclusively in flight. The only exception is that some pilots prefer to use the triple pack during high-power situations when Delta NG is the limiting parameter since the triple pack Delta NG gauge has a larger takeoff range display.

The engine page also contains the fuel quantity information. This is displayed as a ribbon with the values of 0 to 100 percent of fuel remaining, and a digital readout of quantity. The digital quantity parameter can be displayed as US gallons, imperial gallons, pounds, kilograms or liters. The unit variant desired by the pilot can be set in the configure page.

The outside air temperature is displayed on the engine page in either centigrade or fahrenheit. If the imperial form of measurement is chosen on the configure page the displayed temperature is fahrenheit. If the IS (international standard) form of measurement is chosen the temperature will be displayed in celsius.

The message area for the engine page is located between the digital fuel quantity and the outside air temperature displays. If no messages are present this area is blank.

The vehicle page displays engine oil parameters, electrical system information, fuel flow and endurance. As on the engine page, if a value is in its caution range a yellow line appears below the digital display. If a value is above or below its limits a flashing red line appears below the digital units display.

The engine oil temperature is always shown in centigrade, no matter what is set on the configure page. The engine oil pressure can be displayed in either psi or bars, depending on the unit system set on the configure page.

The electrical voltage that is shown on the VEMD (U/BUS) is the voltage that is present on the main distribution bus. This bus is located in the master electrical box under the floor of the aft baggage compartment. The amperage that is displayed on the VEMD is the load on the starter generator. During start, the value is a negative number and the label is I/START. During all other states, the label is I/GEN and the value is a positive number.

The fuel flow (FF) displayed on the vehicle page is a mathematical value computed by the FADEC utilizing fuel valve position. Because of this, the VEMD will display a fuel flow when the helicopter is shut down. The measuring unit of the FF will be the same as the measurement unit set for the fuel quantity.

The endurance value given in the right lower corner of the VEMD vehicle

Engine power check.

Engine power check result

Failure of T4 gauge.

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page is the time until flameout if the current FF is maintained. This time is given in hours and minutes.

The pilot can access the power check page by using the scroll function in flight at max continuous power. Engaging the scroll selector once switches the engine page to the triple display. Engaging it again places the power check page on the lower screen in lieu of the vehicle page. The power check automatically starts when this page is displayed as long as a proper power setting is present.

If a vehicle page parameter obtains a value outside of its normal range during the power check, a message will appear on the engine page stating "VEH PARAM OUT OF RANGE." This indicates to the pilot to switch back to the vehicle page by activating the scroll function.

After the power check completes its diagnosis, the results page is displayed on the lower screen. The last eight power check result pages can be referenced after the flight by opening the maintenance pages.

After the power check page, the scroll can be engaged again to display the performance page. The performance page can be referenced before or during the flight and allows the user to determine if the aircraft can hover in or out of ground effect at the weight that is input by the user. The pilot can also change the current altitude to determine if the planned mission will allow landing at a higher altitude.

Flight report.

If a failure of a lane happens, its designated screen will no longer display information. When this occurs the other screen then displays all available parameters.

If lane 1 fails the upper screen goes black and lane 2 takes over all parameter display duties. Since the engine page is the primary display page it will immediately appear on the lower screen. Because lane 1 receives the NG limits, torque and FF first and then transmits them to lane 2, these items will no longer be available. Since there is a loss of these parameters the FLI is no longer available and a failure symbol is displayed for the torque and Delta NG gauges.

With the engine page now on the lower screen, the vehicle page can be displayed by activating the scroll function. If a parameter on the vehicle page becomes out of its normal range with the engine page displayed, a message will appear stating "VEH PARAM OUT OF RANGE."

If lane 2 fails, the lower display goes black and all information is now available on the upper display. Since lane 1 receives all information the FLI will remain active.

If both lanes fail the rotorcraft flight manual recommends limiting the airspeed to 100kts (minus 2kts per 1,000ft) and land without hovering. This will limit the power of the engine to ensure no limits are exceeded for the remaining flight.

After the engine is shut down, the NR is below 70 and the NG is below 10 percent, the flight report page is displayed on the lower screen. Because the engine oil pressure is below the lower limit red line and the vehicle page is not being displayed, a message will appear on the engine page indicating "VEH PARAM OUT OF RANGE." Of course, this is normal since the engine is shut down.

The flight report page displays the time the engine was running, the cycles accrued on the engine during the flight and any messages of failures or over limits. If a message of over limit or failure is displayed on the flight report page the maintenance pages can be consulted.

Many users are unfamiliar with the maintenance and configure pages of the VEMD. But as the pilot in command of your aircraft, it is essential to have a good knowledge of their use. As we continue to highlight the use of the VEMD as an example of the amount of knowledge necessary to operate in today's changing cockpit, we will review these pages in the next issue of *HeliOps*.

This brief discussion of the VEMD flight pages is a mere overview of the system and its operation. To fully utilize the display and have a thorough and useful knowledge of it as a tool in your aircraft requires a much more in-depth study. A large percentage of the users of the VEMD have a knowledge level of its use as if the VEMD was just conventional gauges displayed in an electronic format. With that said, each user needs to evaluate his or her knowledge level and make the effort necessary to achieve a high proficiency level.

This same thought process needs to be applied to all glass cockpit display systems located in our airframe. If one small basic unit such as the VEMD needs this level of knowledge, then a complete glass cockpit configuration would require extended study. To sit in front of our glass displays and feel like a dog watching TV can be a very unsettling state of mind.

It is our job as the captain of our aircraft to have a complete knowledge of all the tools in front of us. For as Frank Herbert said, "The beginning of knowledge is the discovery of something we do not understand." ■

The performance page can be referenced before or during the flight and allows the user to determine if the aircraft can hover in or out of ground effect at the weight that is input by the user.