COLLINS PRO LINE 21 CNS SENSORS
TECHNOLOGY FOR CHANGING AIRSPACE

Presented by:
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Cedar Rapids, Iowa
52498

Rockwell Collins

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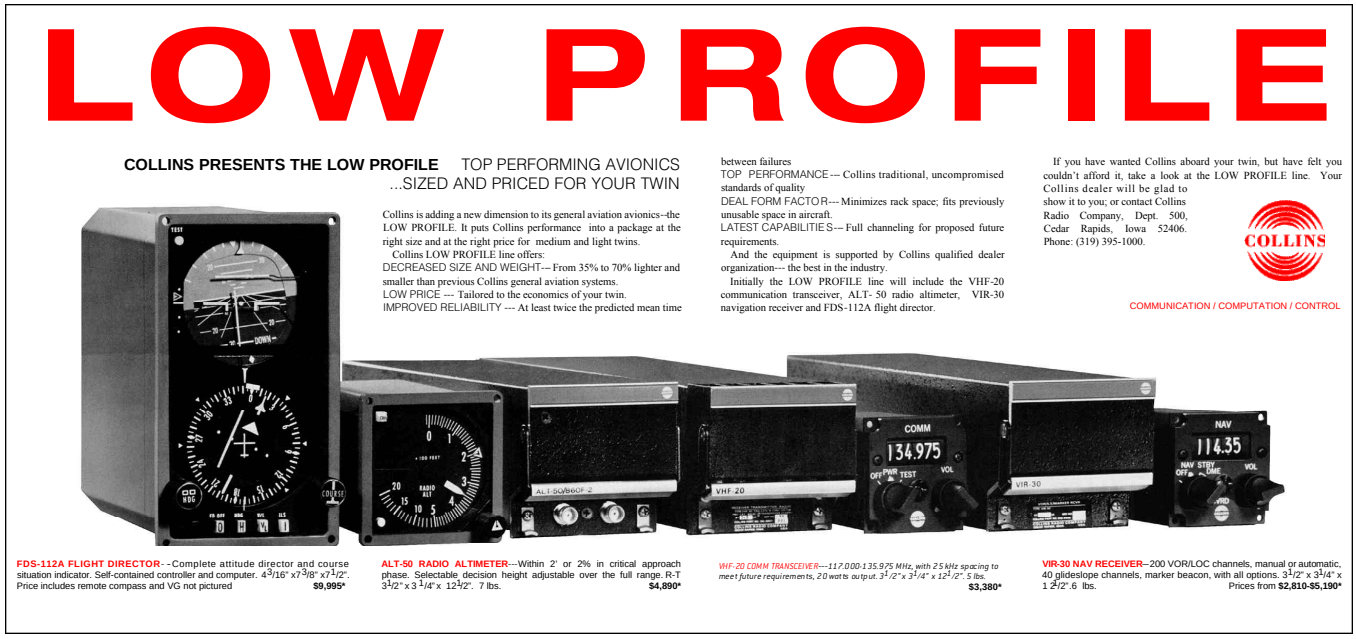
COLLINS PRO LINE 21 CNS

The name Collins has been synonymous with radios for over 70 years. During that time, Collins research has continuously raised the levels of dependability and utility that we have come to take for granted in radio communication, navigation and surveillance.

The Collins legacy began with Arthur Collins' pioneering work in HF communications in the early 1900s. It was Collins who first designed radios specifically to address issues of installation and operation on board an aircraft. It was Collins communications that, in the 1930s, first gave airline operators a greater assurance of safety and efficiency—capabilities that subsequently supported the growth of commercial aviation.

After the war years, Collins led the industry in applying wartime technologies to the rapidly-expanding commercial air transportation industry. By continuously pushing limits of technology, Collins extended the realm of communications from HF into VHF, UHF, L-band and the current era of data communications.

Collins led the application of radio technology into navigation, including the systems we depend upon today—ADF, VOR, ILS, TACAN and DME, IFF and Transponders. In the late 1970s, Collins designed and built the first GPS "user equipment" for the United States Department of Defense. GPS has since become the staple of military operations, and is rapidly becoming the standard for airborne navigation worldwide.



The Introduction of Pro Line Radios. *The first Pro Line radio, the VHF-20 VHF Comm, was delivered in 1971. It was followed by the VIR-30 VOR/ILS/MB receiver and the ALT-50 Radio Altimeter in 1972. The DME-40 and TDR-90 Transponder were added in 1974, and the ADF-60 in 1976. Initially known as the Low Profile line (for their small height), they became Pro Line (for the professional pilot) in 1975.*

As the modern era of business aviation began to emerge in the early 1970s, Collins was the first to design a complete set of radios to specifically meet the needs of this new market. The "Pro Line" radios met the demanding performance standards that had been established in the airline industry, yet were half the size and half the weight. Through three generations of Pro Line radios, they have become the industry standard for business aviation and regional airlines, with over 280,000 delivered worldwide. Over 75 percent of the business aviation and regional airline aircraft in service today are flying with Collins radios.

Just as the first Pro Line radios were developed in recognition of a major shift in market needs, the driving factor behind Collins Pro Line 21 CNS is the recognition of a significant shift in airspace requirements—the move toward Communication, Navigation, Surveillance/ Air Traffic Management (CNS/ATM), or "Free Flight."

This new-era requires increased capabilities:

- Digital communications to accommodate the upcoming high-speed data communications requirements
- Wide Area Augmentation System (WAAS)-based and Local Area Augmentation System (LAAS)-based approaches and landings, as well as Global Navigation Satellite System (GNSS)-based en route navigation
- Automatic dependent surveillance to allow new levels of flight tracking and traffic avoidance

Pro Line 21 CNS supports these needs. And like the very first Pro Line radios, Pro Line 21 CNS establishes new standards in reduced size and weight—reductions of 30 to 50 percent over the current functions.

Thousands of customers have relied on Collins as a trusted supplier of radios for over 70 years. Rockwell Collins builds on these strong relationships as we bring the next generation of Pro Line CNS to the next generation of industry-leading aircraft.

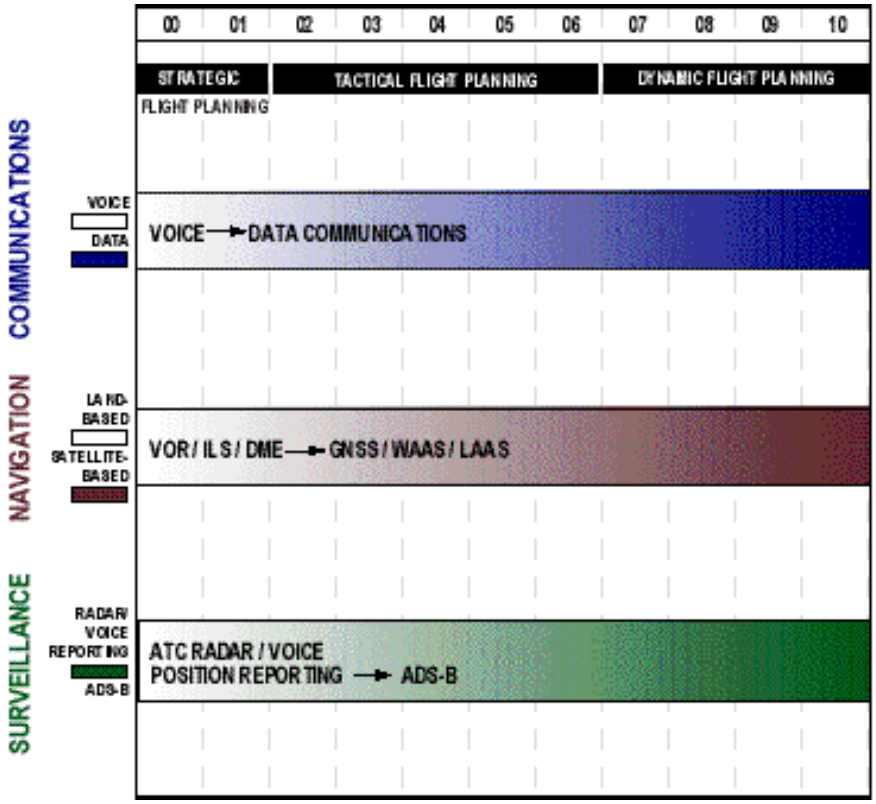
Pro Line 21 CNS. *Providing new capabilities in communication, navigation and surveillance for the 21st Century.*

THE NEW ERA OF CNS/ATM

As commercial aviation moves toward the new era of CNS/ATM, the way we communicate and navigate will transition toward digital satellite-based sources and become less dependent upon the familiar ground-based analog systems.

The benefits are varied and significant. The global nature of the system will allow seamless operations, and the improved accuracy will support a higher traffic density with improved safety. From an operational standpoint, the benefits can be summarized as a transition from today's mode of strategic flight planning, in which routes are rigidly assigned from the ground—to tactical flight planning, in which the ground system authorizes changes to the flight plan that are originated in the aircraft—to dynamic flight planning, where flight plan changes are initiated in the aircraft in real time, and simply monitored on the ground.

The conventional terrestrial systems will not disappear overnight. In the United States, FAA plans call for VOR and DME to be in operation for at least another 10 years. But over that time, our dependency upon them will decrease, as more and more of our flight operations are based on GPS for navigation. During that time, VHF communications will move away from voice and toward digital transactions. And our surveillance systems will become more sophisticated, moving from today's Mode S



CNS Transition Timetable. *The transition to CNS/ATM has already begun with use of digital communication for position reporting Future Air Navigation System (FANS) and GPS en route and approach operations. By 2005, the real benefits of the transition will become realized as many transactions are automated and based on digital communication, satellite-based navigation and automated surveillance.*

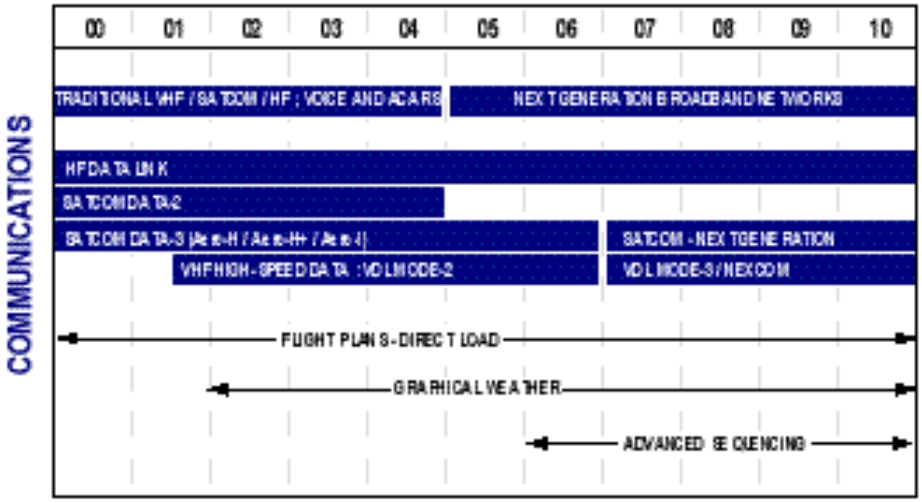
transponders, ATC surveillance radar and TCAS to an enhanced form known as ADS-B—Automatic Dependent Surveillance-Broadcast.

The current transition forecast is depicted in the CNS transition timetables, which are a composite of FAA plans and data from other sources. Timing will be dependent on major changes to the FAA's network infrastructure, other countries' implementation plans and the implementation of new avionics by airborne users. While the transition has not been occurring on the schedule promised, it is underway—not with a "big bang" as was originally suggested, but on a more gradual basis, one that the economics of the governments and the users can more easily accommodate.

If the program continues on the current schedule significant benefits will be realized over the next five years. To achieve these benefits, new requirements are being imposed on the complement of airborne radio sensors.

Communications. Digital communications will obsolete today's VHF comm transceivers —even those we have updated for 8.33 kHz to meet European requirements. The new system will require a radio that can transmit and receive both voice and high-speed data—at 31.5 kBPS. This new system, known as VHF Data Link (VDL) Mode 2, is already in ARINC operation and will be implemented by the FAA in the future. It will be compatible with ATC systems worldwide, as well as company communications such as ARINC and SITA.

Reducing dependency on voice transmissions will reduce workload both on the ground and in the aircraft, and bring new capabilities to the flight deck. The new system will also enable valuable new capabilities, such as automated digital messaging, automatic flight plan loading and graphical weather that gives visibility hundreds of miles ahead.



Communications Transition Timetable. *New VDL - VHF Data Link transceivers will become common by 2002, as will high-data-rate Satcom and HF comm systems, enabling new automated capabilities such as real-time weather in the flight deck.*

In the future (2006 and beyond), VHF Data Link Mode 3, also known as NEXCOM, will use the high-speed data format to multiplex digital voice and data on a single frequency, leading to the eventual phase-out of analog voice channels. Additionally, regulatory agencies are giving consideration to implementing a VHF data link mode (VDL Mode 4) that would use the VHF band for automatic position reporting.

For oceanic trips, dependable satellite communications (which is digital by definition) will become the dominant form, supporting the same capabilities that the digital VHF comm provides over land areas. HF will still be in use—although in digital format, and primarily as a back-up.

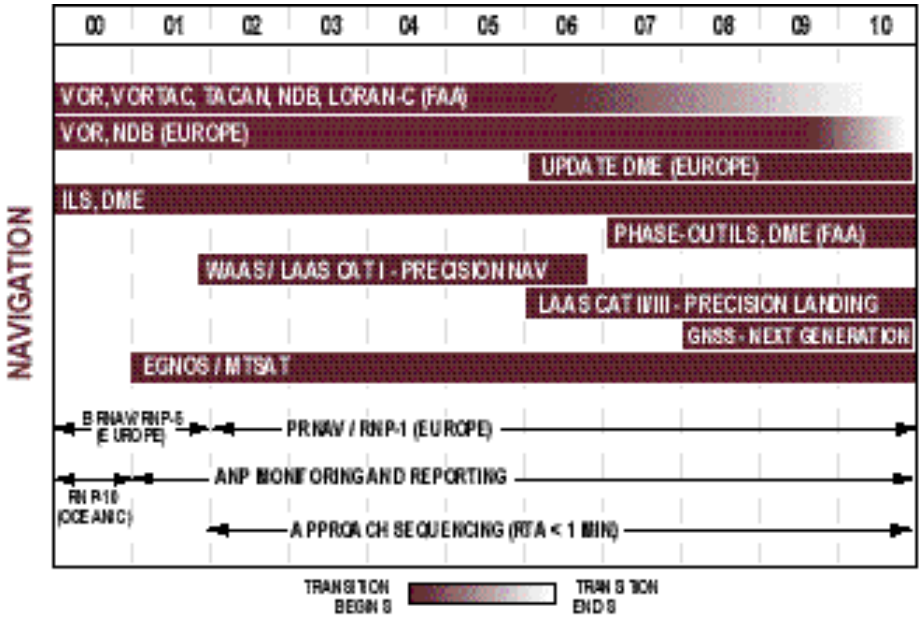
Collins Pro Line 21 CNS will ease the transition into the new era of CNS/ATM.

– The new **Collins VHF-4000 VHF Voice/Data Communications Transceiver** is a key part of the first phase of Pro Line 21 CNS. The VHF-4000 will provide both voice and data, at 31.5 kBPS, to deliver uplinked automated digital messages, flight plan changes and graphical weather depictions. Initially, the VHF-4000 will include Mode 2 capability, but the unit has been designed to also accommodate Modes 3 and 4 without major modification.

– **Collins SATCOM-5000 and SATCOM-6000 Satellite Communications Systems** will provide global Aero I, Aero-H/I and Aero-H+.

– And the **Collins HF-9000 HF Communications System** will be available for back-up voice and data communications worldwide, if needed.

Navigation. We will rely on VOR, ILS and DME sensors for some time—although they will play a diminishing role. Beginning in 2005, the FAA plans to begin phasing out VOR, VORTAC, TACAN, NDB and Loran-C; ILS and DME phase-out will begin in 2007 in the United States. At this time, a continuing role for an enhanced DME is planned in

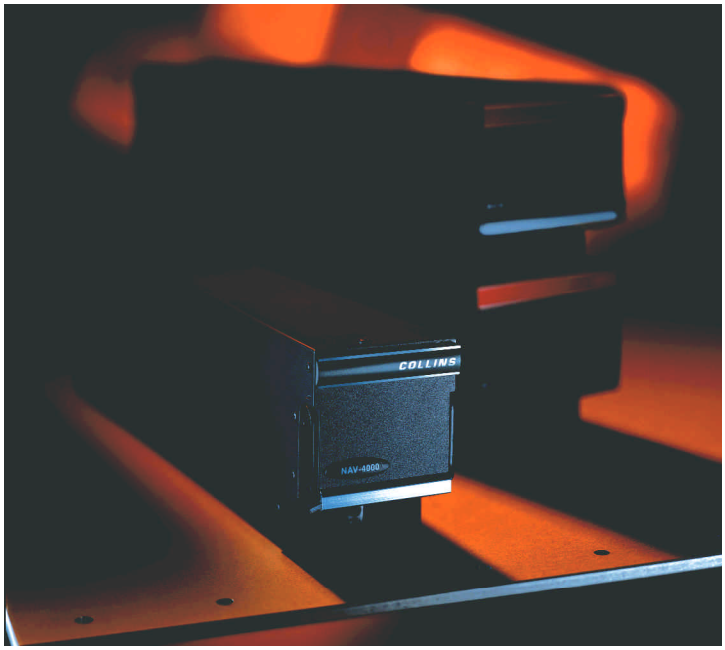


Navigation Transition Timetable. *VOR, ILS, and DME will be with us for many years but their use will diminish as GNSS-based navigation services take over. GNSS will become primary means by 2004 for en route nav, WAAS will support precision approaches beginning around 2001, and LAAS Category I approaches will begin around 2005.*

Europe. As we move toward their total elimination and toward GPS-based navigation, we will only need single installations of each in the aircraft, instead of the dual installations which are common today.

The FAA plans to commission the first phase of WAAS in 2002, which will extend the accuracy of GPS to allow near-Category I approaches at most U.S. airports. Counterpart systems in Europe and the Far East—EGNOS and MTSAT, respectively — will provide equivalent service. For precision approaches, installation of FAA-supported Category I LAAS will begin in 2003.

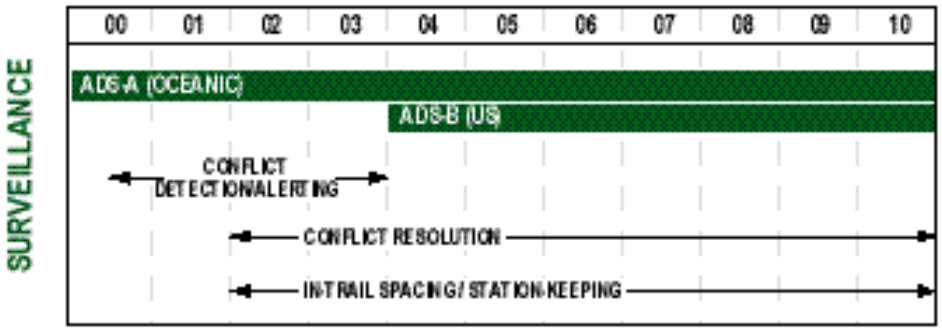
- **Collins NAV-4000 Navigation Receiver** combines the VOR, Localizer, Glideslope, Marker Beacon and ADF functions in one compact unit.
- When coupled with the companion **Collins DME-4000 Distance Measuring Unit**, these sensors will support terrestrially-based navigation with all the dependability one expects from Rockwell Collins.



NAV-4000 Saves Space. *The new navigator receiver consolidates the functions that are currently housed in two larger units.*

Surveillance. The current Mode S Transponders will eventually take on a much more sophisticated role—that of ADS-B operation. As implementation of these capabilities commences around 2003, the transition to true Free Flight will begin. The ADS-B transponders will allow each aircraft to transmit its present position and intent to every other aircraft in the vicinity, as well as to the ground tracking system. This will ultimately allow each aircraft to automatically identify potential conflicts with the flight paths of other aircraft and interactively resolve them, reducing the dependence on human monitoring from the ground. The system will also support much closer in-trail spacing of flights.

- The **Collins TDR-94 and TDR-94D Mode S Transponders** satisfy the currently defined needs for TCAS compatibility, ADS-B and European Enhanced Surveillance Functionality.



Surveillance Transition Timetable. *ADS-B will be implemented starting in 2003, enabling airborne conflict detection and resolution as well as closer spacing and sequencing of flights.*

THE PAYOFF

Rockwell Collins is taking these first steps to help our customers move into this new era with as little inconvenience and as low cost as possible. The objectives of Collins Pro Line 21 CNS are to provide a system of CNS sensors that:

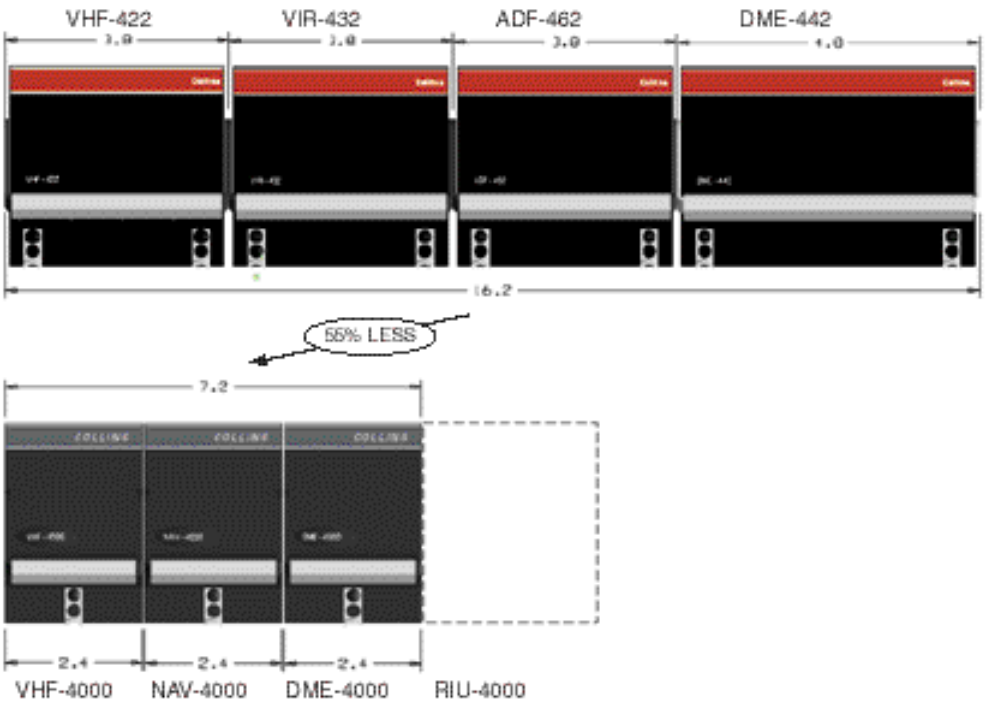
- Occupies less space to permit addition of new functions as required.
- Weighs less.
- Contains all the capabilities needed in the future.
- Is even more reliable than current Collins radios.

The first set of new radios, to be available beginning in 2001, are:

- **VHF-4000 VHF Voice/Data Communications Transceiver**—bringing the benefits of high-speed data communications to the flight deck.
- **NAV-4000 Navigation Receiver**—combining VOR, ILS, marker beacon and ADF, as well as the associated VHF receiver for receiving LAAS correction factors for GPS approaches.
- **DME-4000 Distance Measuring Equipment**—to support precision navigation well into the next century.
- **RIU-4000 Radio Interface Unit**—efficiently interfacing all the radios with the rest of the avionics system, plus providing high-quality audio for the flight deck as well as digital communications management.

Smaller, Lighter and More Capable. By packaging these functions in smaller units, we are able to reduce the overall volume occupied by these functions by over 50 percent, saving space for new functions such as GPS-based navigation sensors. This is accomplished by use of highly-integrated design and advanced components, and in some cases by consolidating functions. The new radios are the same height and length as their Pro Line counterparts, but are significantly narrower. A quick comparison:

- The new VHF-4000 is only 2.4 inches wide — 1.4 inches less than the VHF-22 or VHF-422 it



Pro Line 21 CNS Saves Space. *The new Pro Line 21 CNS sensors occupy 55% less space than their Pro Line predecessors. They weigh 38% less, are 50% more reliable and provide even greater capability.*

replaces. And it does much more — in addition to providing excellent voice communication, it also supports VDL Mode 2 data at 31.5 kBPS.

- The new NAV-4000 is only 2.4 inches wide, saving 5.1 inches over the VIR 32/432 and ADF-62/462 it replaces. And it consolidates two units into one.
- The new DME-4000 is only 2.4 inches wide, saving 2.4 inches over the DME-42/442 it replaces.

In total, this new combination occupies only 322 cubic inches —55 percent less than the four units they replace. And the combined weight is just 11.5 lb. —38 percent less than that of the four replaced units.

More Reliable than Ever. Because the new sensors are based on sophisticated designs — for example, using special highly integrated circuit devices, and employing 3-volt logic — the units operate much more efficiently than any previous radios. The result is reduced heat dissipation and even greater reliability — at least 50 percent higher than the current Pro Line radios.

Shared Designs Keep the Costs Down. For the first time, these new radios share use of major functional areas across all sensors:

- It starts with the chassis, that is modular to allow the same frame components to be used in all the units.
- The receiver is the same basic hardware design for all functions, with only the front end filtering and conversion frequencies differing among the products.
- A common digital processing module (A/D converter, decimator circuit and digital signal processor)

utilizing unique software for each function digitizes the signals at the intermediate frequency level and converts them to baseband waveforms.

– A common synthesizer design is tailored to meet the unique needs of each signal type.

This helps reduce the engineering investment and also keeps recurring costs down — providing operators with attractive prices even as functionality increases.

Plenty of Flexibility to Ease Retrofits. Each radio is completely self-contained — allowing the installer to easily replace the existing units with a minimum of rewiring and reconfiguration.

– The current VHF comm can be replaced with the new VHF-4000 by installing a new connector and mounting tray. All of the interfaces of the VHF-422 have been retained, thus requiring no additional wiring to provide the same capability.

– Likewise, the new DME-4000 can replace the existing DME-442 and the new NAV-4000 can replace both the VIR-432 and ADF-462. The DME-4000 requires less than half the space of the DME-442, and the NAV-4000 requires less space than the VIR-432 alone.

– A new function — the RIU-4000 — completes the installation. In its retrofit role, the RIU-4000 provides the communications management function, providing the link between the RF communications sources and the aircraft display system.

The result: new digital capability and a lot of extra space.

We could have made our own job simpler by modularizing the functions, leaving out power supplies and interface circuits, which would have made a complete radio subsystem slightly smaller — but it would have been at the expense of an easy retrofit. And the new smaller units can be installed anywhere space is available, including out-of-the way spots that would be impossible if all the radios were modules in a complete cabinet assembly.

The New Modular Mount Simplifies Installation. *The MME-4000 Modular Mounting Enclosure consolidates the radio subsystem installation, providing a neat, compact installation that is easily interfaced with aircraft wiring through rear-mounted connectors.*

Even More Benefits in New Installations. In a new installation either in a new airframe or as a complete radio replacement, all the radios can be mounted in a custom-designed rack, the MME-4000 (Modular Mounting Enclosure). All the interwiring — for control, 28 vdc power, audio—is imbedded in a backplane which interconnects each radio and consolidates all the functions in several connectors that interface with the aircraft wiring harness. The result—a much simpler, less expensive installation—plus a neat, compact solution. By providing a thermally-designed enclosure for the radios, reliability is enhanced as well.

Integrated Digital Audio Further Simplifies the Installation. When the integrated MME-4000 is used to consolidate all the radio functions, another benefit is available — a high quality, totally integrated digital audio system to provide all required audio to the flight deck headsets and speakers. This function is housed in the RIU-4000, along with modem circuitry for the VHF data comm. A family of audio control panels will match the needs of any installation.

Ready for the Future. The designers of Pro Line 21 CNS recognize that there will be more changes as the new CNS/ATM environment evolves. There is plenty of capacity in the new system to grow with the needs. Many changes can be incorporated by rapid software updates, minimizing down-time. So the investments made now will continue to have a long productive life, with minimum risk.

21st Century Packaging. In the flight deck, all the Pro Line 21 controls and displays feature a new, ergonomically-designed styling. This has been extended to the new radio units, which have undergone a major restyling. No more black boxes! The new radios are a subdued gray with a distinctive Collins styling on the front panel.

THE BOTTOM LINE

Collins Pro Line 21 CNS is a comprehensive solution to the challenges of the new era of CNS/ATM. Collins is actively involved with the industry groups defining the new environment, and is helping shape the future. As a result, Pro Line 21 CNS is designed with intimate knowledge of what's going to be needed...and with enough margin to accommodate the unpredictable.

Collins Pro Line 21 will allow operators to move into the new era of CNS/ATM with minimum expense and disruption. It's easy to retrofit...provides all the capabilities needed to support the airplane's mission... and supports future needs.

And as in the past, Rockwell Collins delivers this new performance capability in less space, with less weight and with even greater dependability.

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