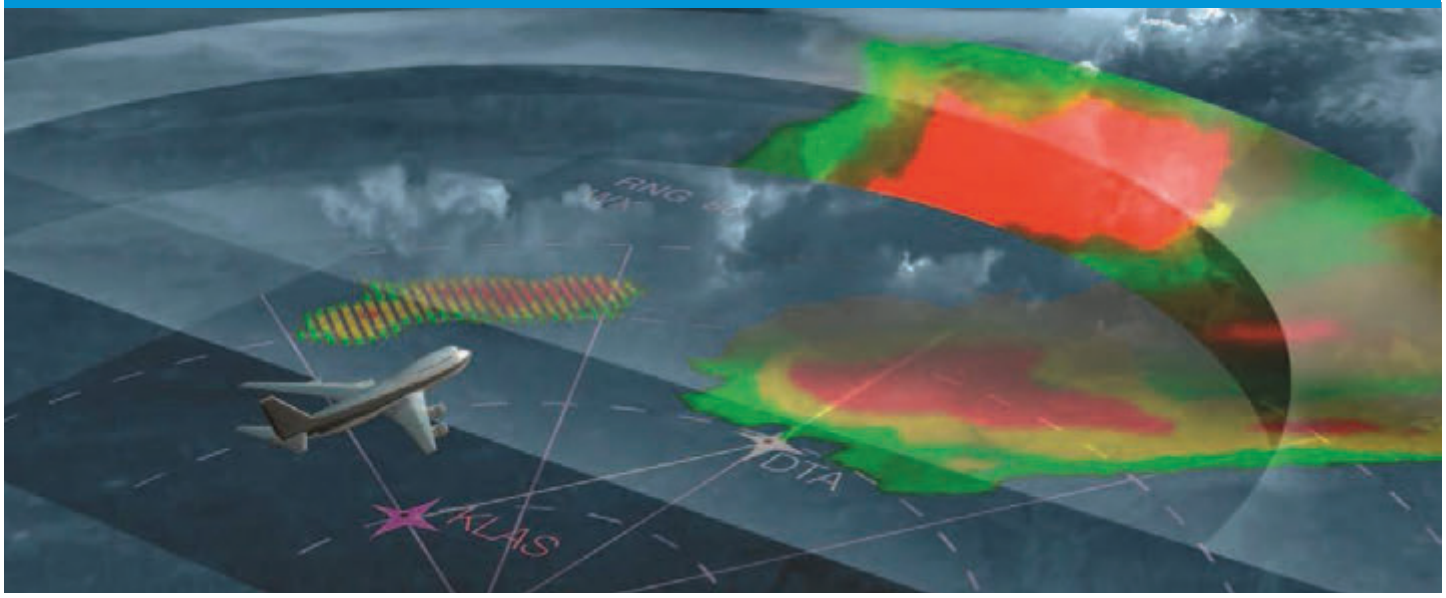
IntuVue®

Honeywell's family of advanced 3D weather radar systems



Introducing IntuVue®– Honeywell's family of advanced 3D weather radar systems for air transport, business and military aircraft. Adverse weather costs the aerospace industry billions of dollars each year through delays, cancellations, diversions, disasters, turbulence and severe storm activity.

IntuVue provides reduced pilot workload and full situational awareness of weather resulting in improved routing around hazards and increased safety which is superior to 2D radars.

The IntuVue family of weather radars uses the latest advances in airborne hazard and weather technology and radio frequency engineering to provide maximum safety, efficiency and value for the user.

The RDR-4000 is a member of the IntuVue family of weather radars and is available to airline operators as a federated system or as part of the integrated Aircraft Environment Surveillance System (AESS) as supplied on the Airbus A380, A350, and Gulfstream G650.

The IntuVue family of weather radars:

— Increase crew efficiency by reducing pilot workload through automatic operation and intuitive displays.

— Provide greater safety by delivering the most advanced predictive windshear detection and alerting capability - the first system certified by the FAA as the Minimum Operating Performance Standard (MOPS) for enhanced turbulence detection.

— Increase safety by providing predictive hail and lightning warnings - the first radar certified to do so.

— Enhance crew and product performance through fleet commonality, increased reliability and advanced weather hazard detection and analysis.

Section A - the need for a next generation weather radar

How weather affects the aerospace industry

Extreme weather poses a direct and real threat to aircraft, regardless of their size and age. Turbulence, lightning, hail and other phenomena can lead to injuries and discomfort on board, and damage to the aircraft, resulting in huge cost to airlines. Poor weather detection and analysis can result in poor pilot decision making which could lead to otherwise completely avoidable danger to flights. In addition, weather-related delays and cancellations cost airlines millions of dollars and cost countries' economies billions of dollars in lost productivity each year.

The figures below make for sobering reading for pilots, operators and passengers alike, especially in a changing global climate which is bringing increasingly variable and severe weather conditions:

- According to the UK Civil Aviation Authority between 2009 and 2013 there were a total of 387 turbulence-related injuries to passengers flying with British airlines.
- The FAA estimates that each year, approximately 58 people in the United States are injured by turbulence while not wearing their seat belts.

*Source: BBC News

FACT: Occurrences of extreme weather are increasing.

- Each turbulence-related incident costs airlines on average $150,000. Total cost to the industry exceeds $100 million a year.
- In 2014, weather accounted for 52.3% of delays across the National Aviation System - Research and Innovative Technology Administration (RITA) - U.S. Department of Transportation.
- In 2014, weather caused 32.6% of the Total Delay Minutes - Source: Bureau of Transportation Statistics.

The need for a fully automatic, 3D weather radar

As the global climate continues to change, and weather conditions become more variable, the need for an advanced weather detection radar is of paramount importance. Airline operators are looking for a solution that can provide greater passenger and crew safety and comfort, increased efficiency, and enhanced performance through better strategic and tactical decision making, and reduced pilot workload.

Pilots need to be able to identify easily and quickly any real weather threats to the aircraft, based on the actual flight plan. Conventional 2D or tilt-based radars can provide only a limited slice of the weather, regardless if it is based on manual or auto tilt control. As a result the pilot does not have full representation of the weather and must periodically use manual tilt control to evaluate storm tops or weather below the aircraft flight level.

Operated manually, thereby requiring detailed training and experience to be effective, these tilt-based radar systems are labour intensive requiring the pilot to make complex geometric calculations using tilt angle and earth curvature data to determine the the altitude and range of potential weather threats. When workload is heavy, it is possible to adjust the radar incorrectly or misinterpret the data.

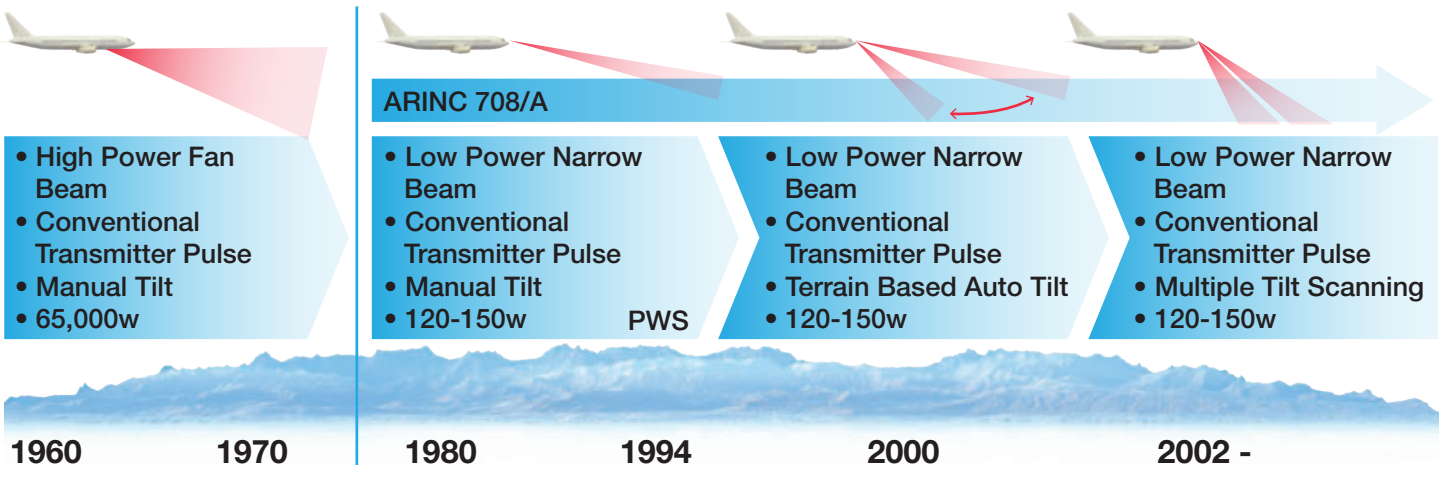


Figure 1 - The evolution of conventional ARINC weather radar

The limitations of conventional 2D radar

As Figure 1 shows, 2D weather radars are simply automating old tilt management operational approaches to find the best slice of weather without addressing the key airline requirements for weather radar. The RDR-4000 represents a significant development in radar technology, and is the first clean sheet radar design to be implemented in 30 years, with a host of advantages over existing market offerings. Table 1 below shows how the RDR-4000 addresses some of the limitations of 2D weather radar design.

The limitations of 2D radar	The IntuVue / RDR-4000 solution
Tilt based manual mode requires pilot calculations to determine cell tops	IntuVue's 3D buffer and removal of the earth's curvature simplifies manual mode with constant flight slices for fast and easy pilot analysis of cell tops
Radar scans only a portion of the airspace in front of the aircraft, using one or two tilt angles	The 3D Volumetric Scanner continuously captures all weather ahead of the aircraft from -80 to +80 degrees in front of the aircraft, from 0 to 320nm ahead and from 0 to 60,000ft – not just a limited 2D slice. This enables the AUTO weather mode to provide a complete situation awareness by showing both on-path weather which may impact the current flight path and off-path weather which may impact flight plan changes or develop further into on-path weather
Radar operation restricted to one view at a time	RDR-4000 enables both pilots to independently and simultaneously operate the radar in any combination of AUTO, MAN and MAP modes. This enables one pilot to perform manual analysis while the other pilot can remain in AUTO mode. AUTO and MAN (tilt) Modes cannot be used simultaneously with conventional radars
Does not provide vertical awareness of weather	Only RDR-4000, powered by the 3D volumetric scanner, is capable of identifying and assessing the vertical development of a storm cell with flight level slices in 1000 ft increments in MAN mode or a vertical situational display (available when supported by the displays or soon via EFB)
Cannot remove ground clutter from the weather returns at all altitudes or during all phases of flight	Patented on RDR-4000 the internal terrain database enables ground returns to be extracted without reducing the intensity of weather returns. This functionality operates on take off and approach in addition to cruise
Does not correct for the earth's curvature	Weather information in the 3D buffer is automatically corrected for the earth's curvature. This enables weather to be assessed relative to the aircraft's altitude and, when in analysis mode, weather at a selected constant altitude to be displayed. Conventional 2D radars require the pilot to make geometric calculations based on tilt angle and earth curvature to locate weather altitude at a specific range
Provides only limited hazard detection capabilities	With the Hazard V1.0 Upgrade, RDR-4000 was the first radar to offer predictive hail and lightning displays, enabling earlier and more effective re-routing decisions. Hazard V2.0 now provides further hazard detection protection that displays distinct hail and lightning predictions and separates convective weather from stratus for optimal pilot planning
Suffers signal losses due to waveguide	IntuVue's innovative design eliminates waveguide runs that reduce power and attenuationdecrease sensitivity
Has less sensitivity and resolution	RDR-4000 is the first commercial weather radar to incorporate pulse compression technology, which provides longer range performance with higher resolution compared to traditional transmitter pulse technology
Restricted scanning of weather threats	RDR-4000 interweaves up to 17 scans at multiple tilt angles to scan the entire airspace ahead of the aircraft, oversampling the weather to provide the highest possible level of weather detection, definition and resolution
Limited weather detection while predictive windshear is active	IntuVue's variable speed scanning allows enough time for both predictive windshear scans and full weather scans for complete situational awareness during take off and landing
Limited 2D scan coverage requires assumptions on expected weather types to adjust the tilt based on geographic location which can lead to under or overscanning	The RDR-4000 uses up to 17 tilt angles and the Volumetric Buffer algorithms to directly measure all weather cells around the world in all seasons. All cell types are detected and no assumptions are needed

Table 1

Section B - Take a flight with IntuVue

1

TAXI

IntuVue begins scanning and filling the 3D buffer during taxi to build a picture of the weather around the airport.

2

TAKE-OFF

IntuVue is the only weather radar to scan +/-80 degrees and display a full +/-90 degrees of weather while Predictive Windshear is active.

9

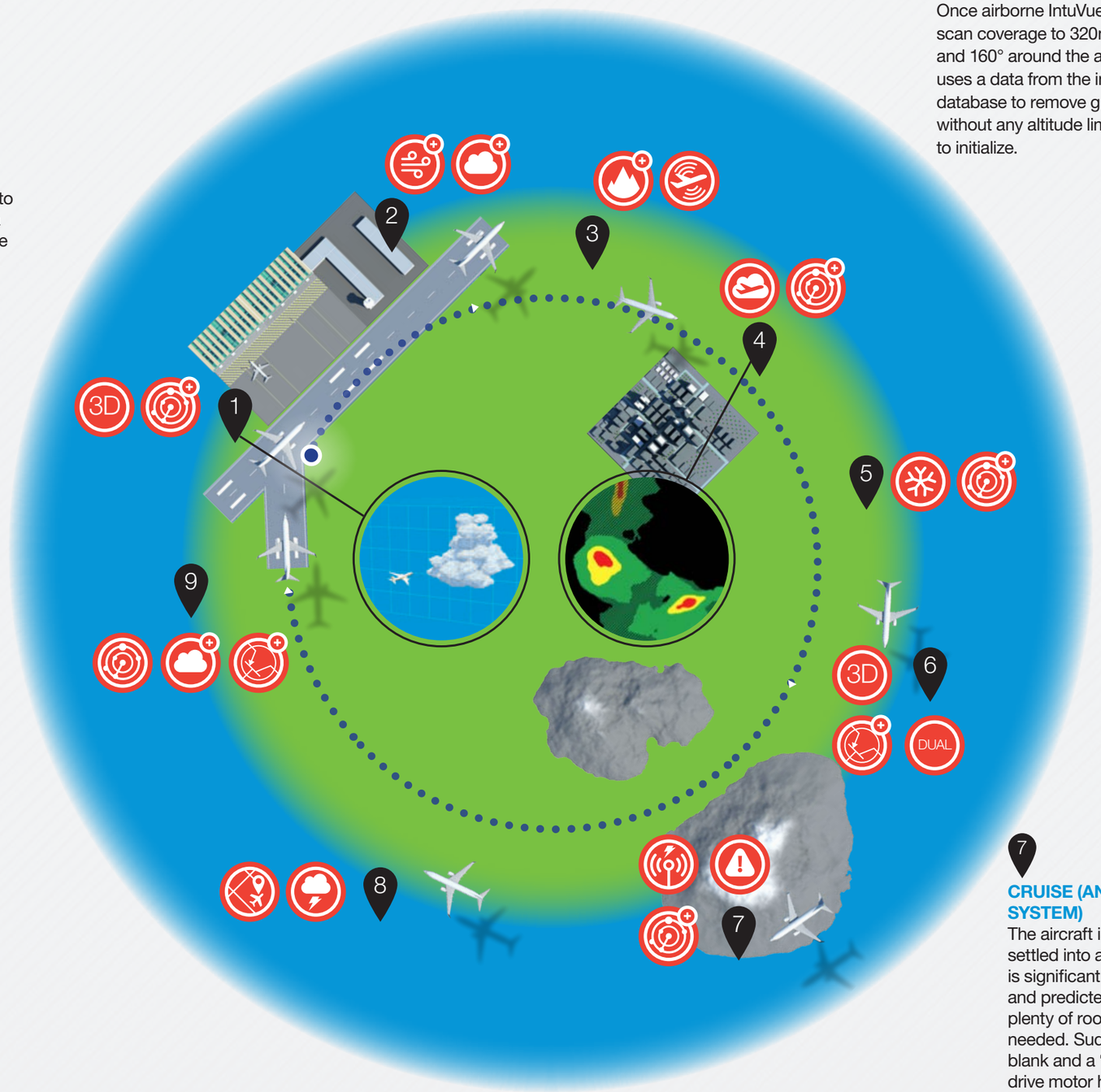
APPROACH (SECONDARY WEATHER – VERTICAL PROFILE)

The pilot prepares to start the descent. A significant area of secondary weather is seen on the flight path to the airport so the pilot evaluates whether this can be overflow or if a deviation is needed. A quick visual check of the elevation/ manual mode shows that the intended flight plan will descend through this weather system which contains a red core at 10,000ft, so the pilot requests a small deviation around it for the approach. This is all managed efficiently before the top of descent.

8

CRUISE (TROPICAL OCEANIC WEATHER)

The aircraft continues on its oceanic crossing and is just entering the topics. There is no need for data base driven changes to the tilt angle based on Latitude because IntuVue is always scanning multiple tilt angles to ensure that low growth cells are not over scanned and that high building cells can be fully measured to find storm tops. One cells shows a hail icon indicating an even larger threat and the need to divert even further on the downwind side.



3

DEPARTURE

Once airborne IntuVue expands its scan coverage to 320nm, 0-60,000ft and 160° around the aircraft. IntuVue uses a data from the internal terrain database to remove ground clutter without any altitude limitations or time to initialize.

4

CRUISE (CONVECTIVE WEATHER DISCRIMINATION)

The aircraft is at cruise and flying over a thick layer of stratus weather at 20,000ft with some embedded convective cells. IntuVue is able to detect convective weather and separate it from the stratus, showing the convective cells as on path (solid color) and the stratus as off path (hashed).

5

CRUISE (FROZEN AND MIXED STATE)

Detection of reflectivity at 35,000ft is possible because all weather returns above 20,000ft are compensated as rain transitions to mixed state and then to frozen ice crystals at higher altitudes.

6

CRUISE (DUAL MODE OPERATION)

During the flight, IntuVue has identified an area of potentially dangerous weather below the flight path – this is indicated by a hashed color display. The First Officer changes into manual mode to evaluate while the pilot remains in auto mode for complete situational awareness. This is possible because IntuVue allows any independent combination of modes between the pilot and first officers without any impact to the other.

7

CRUISE (ANTENNA DRIVE FAILURE – DUAL SYSTEM)

The aircraft is now 3 hours into flight and settled into an oceanic crossing route. There is significant convective weather in the area and predicted for the rest of the crossing, but plenty of room to maneuver around cells if needed. Suddenly, the weather display goes blank and a “WXR FAIL” is shown. The antenna drive motor has failed! The pilot switches to system number two, and recovers the weather function due to redundant antenna motors.

Section C - IntuVue Technical Overview

IntuVue's 'game-changing' technology

The key technological enhancements of the IntuVue RDR-4000 are Volumetric 3D scanning and pulse compression technologies which provide vastly improved weather detection and predictive hazard warnings compared to conventional 2D radar.

3D Volumetric Buffer

The RDR-4000's revolutionary 3D Volumetric Buffer continuously captures all weather and terrain in the entire airspace ahead of the aircraft, from -80 to +80 degrees in front of the aircraft, from 0 to 60,000 ft and up to 320nm ahead. This revolutionises radar operation and the display of data. Other radars require antenna tilt control (whether manually by the pilot or automatically by the radar) to find an optimum setting which captures all the relevant weather for the current flight path. Unfortunately, there is no such optimal setting because weather below the aircraft, at flight level, or above the aircraft can all impact the comfort and safety of the flight.

The RDR-4000 is the only radar that continuously and automatically scans all the weather in front of the aircraft and stores data in a 3D buffer, creating a three-dimensional image of the weather and terrain.

The RDR-4000 is also the only radar that can effectively separate the weather and terrain returns from any flight level to give the pilot a true picture of the weather. The 3D buffer is continuously updated with reflectivity data from new scans, and data is shifted to account for aircraft movement, speed, heading and altitude (see Figure 2 and 3).

Pulse compression

Pulse compression increases long-range detection and resolution at the same time. It's been used on military radars for over 40 years, and is now the industry standard for the most advanced ground based weather radar systems, with undeniable benefits. Current systems sacrifice higher resolution information for long-range weather detection. Pulse compression provides both - and the RDR-4000 is the first commercial weather radar to incorporate this technology (see Table 2).

The theory of pulse compression

The energy of a low power, long duration pulse will be the same as a high power, short duration pulse. This is defined as: P1T1 = P2T2

For the IntuVue the transmitted pulse is:-
P1 = 40 watts,
T1 = 275µsec

Pulse compression results in:-
P2 = 917 watts, T2 = 12µsec

RDR-4000 provides the longest DO-173 avoidance range in the industry with more than 900W effective power vs 150W of other systems, combined with low noise receiver design.

Parameter	Units	RDR-4000	Conventional Weather Radar
Effective Transmitter Power	Watts	917	150
Effective Pulse Width	µsec	12	25
Pulse Compression Ratio		23	N/A
Antenna Gain (30" HON / 28.5" COL)	Bi	35	34.5
MDS	dBm	119.6	125.0
Install Losses	dB	4.6	8.3
DO-173 Performance Index	**dB**	**240.0**	**236.0**

IntuVue has greater performance
4dB advantage = 10-15% greater range

Table 2

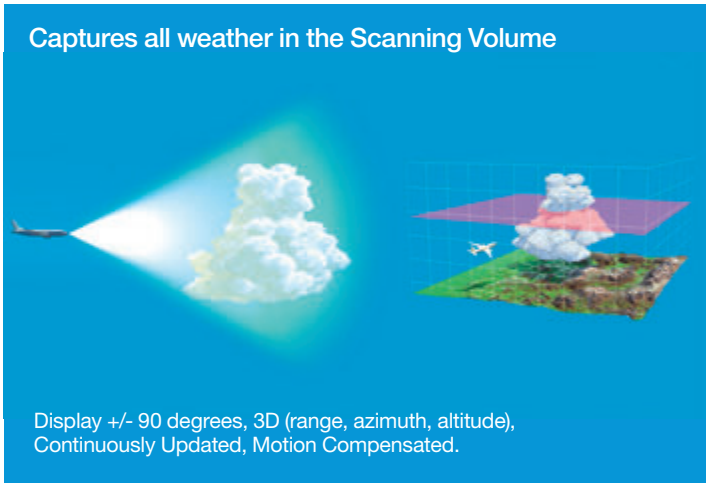


Figure 2

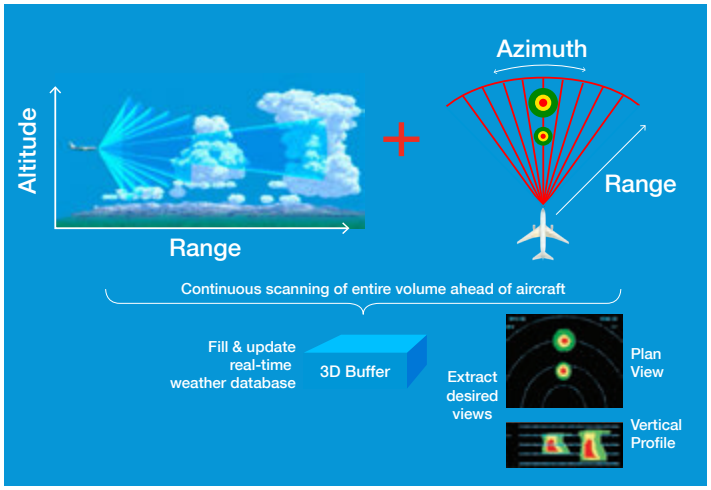


Figure 3

The unique features of IntuVue / RDR-4000

The RDR-4000 is quickly becoming the first choice for airlines worldwide. Its comprehensive features, 3D display, and analysis tools provide pilots with the right information at the right time, to make the most informed decision possible. The RDR-4000 is proven to enhance passenger comfort and safety while reducing fuel consumption and helping on-time arrivals in even the most adverse weather conditions. Here are just a few of the key advantages.

Cutting edge innovation

Unlike traditional weather-detection radar systems, that only give you 2D representations. The RDR-4000s 3D volumetric scan gives you the whole picture. By rapidly scanning 160 degrees in front of the aircraft at many tilt angles the radar captures weather data vertically from 0 to 60,000 ft, up to 320nm to ensure detection of the most reflective part of any storm.

Using unique Maximum Reflectivity Indication (MRI) technology, IntuVue identifies and displays weather both in the flight path and secondary weather below 25,000ft. Although weather below 25,000ft might not directly affect the aircraft during cruise it can grow to influence the flight path and needs watching. Weather above and below the flight path should also be monitored prior to flight level changes. Conventional 2D weather radar cannot achieve this (see Figure 4).

The RDR-4000 is the only weather radar that completely captures the third dimension - altitude. This is important. All radars represent the severity of a storm cell by its reflectivity (black, green, yellow, red), however as experienced pilots will know although flying through red stratus rain is fine, in cruise flying through light green returns close to the aircraft can be very dangerous. The altitude of the storm tops is key in determining the severity of a storm cell, and only IntuVue / RDR-4000 provides analysis of a storm by looking at its vertical development.

On-Path weather is shown in solid colours. Secondary weather is shown with a black cross-hatch pattern

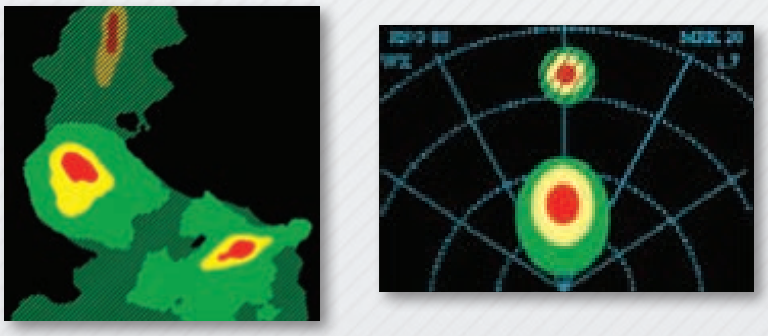


Figure 4

Vertical Profile*

With Vertical Profile, pilots can read the altitude of terrain and weather straight from the display. Vertical Profile Mode provides a complete vertical view of weather, turbulence, vertical flight plan, and terrain data using Honeywell's world-renowned EGPWS database (see Figure 5). Terrain and cell height can be seen easily in relation to the aircraft and its intended flight path.

It also presents a single vertical slice, or a combination of back-to-back slices of the weather, along the intended Flight Management System flight plan, actual track, or pilot-selected relative azimuth angle.

This is highly useful for analysing weather cells, as it allows quick determination of cell height, shape, vertical development, and areas of highest precipitation density – all clues to the severity of the cell. The radar simultaneously provides both the vertical profile display and a traditional horizontal view on the ND.

* The Vertical Profile view requires an Electronic Flight Information System (EFIS) or Multi Functional Display (MFD) not available on all platforms.

Vertical display of the Unwound Flight Plan Mode

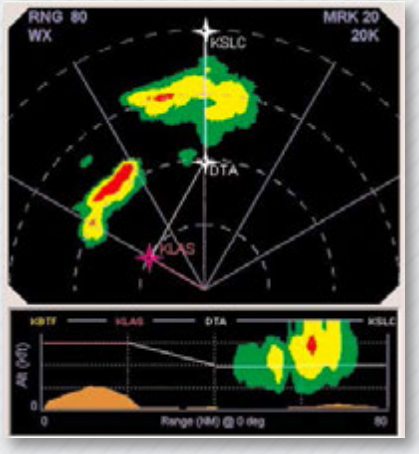


Figure 5

Dual-control capability

Only IntuVue / RDR-4000 offers true dual-control capabilities with individual controls for each pilot (see Figure 6). The pilots can use both the AUTO and MAN modes at the same time, meaning each member of the flight crew can operate the radar without affecting its performance, enabling maximum weather detection and analysis.

Either pilot can use either the MAN or the AUTO Mode to assess the vertical extent of a storm cell. The weather displayed is automatically corrected for the earth's curvature to provide a constant altitude view – removing the need for the complex range, altitude and tilt angle calculations required with conventional radar systems.

By scanning, capturing and storing all weather from 0 to 60,000ft out to 320nm the RDR-4000s 3D buffer automatically assesses and displays either Flight Path (On-Path) Weather in solid colour or Secondary (Off-Path) Weather in shaded/cross hatched colour. The RDR-4000 uses the Flight Management System flight plan as the primary source of the intended flight path. If no valid flight plan is available, then the Flight Path Angle is used to compute the expected flight path slope.

In MAP mode the plan-view map is generated continuously, and simultaneously with weather de-clutter based on the internal terrain database. Reflectivity data that is considered ground clutter (and removed from the weather views), is the basis for the Ground Map. The map view covers the full range from the aircraft to the horizon.

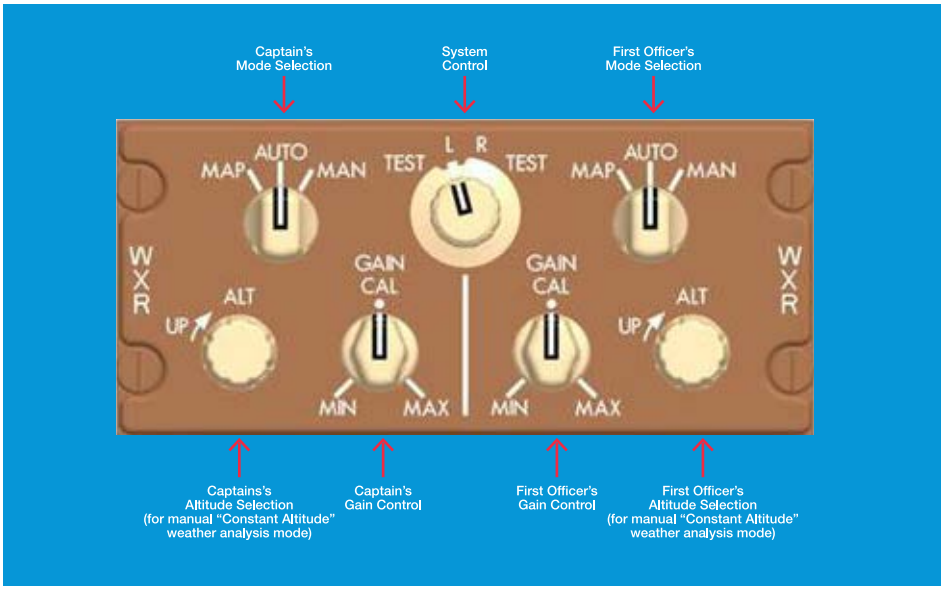


Figure 6

Inherent over-flight protection

Traditional weather radars provide little awareness and protection from turbulence when flying over storm cells close to the aircraft, because less reflective frozen storm tops are 'hidden' from the radar. To pilots this can result in the storm appearing to decrease in intensity or even disappear from view altogether.

The RDR-4000s unique and patented 3D buffer and volumetric scanning, provides inherent over-flying protection with automatic down tilt scans, together with motion compensation to ensure continued situation awareness even as the aircraft passes over the weather. This means the storm remains in view even when passing under the aircraft, with the maximum reflectivity level accurately indicated.

Detecting turbulence

IntuVue incorporates the most up-to-date and sensitive X-band sensor turbulence detection capability. It is the first system certified to the Federal Aviation Administration Enhanced Turbulence Minimum Operating Performance Standard (MOPS). The RDR-4000 can detect turbulence at lower signal-to-noise ratio, enhancing performance at lower reflectivity levels, even in black regions below the green level, and at greater distances, enabling better correlation to predicted aircraft turbulence response. The RDR-4000 displays turbulence (in magenta) out to 40nm in all ranges (this range is extended to 60nm with the Hazard Display Upgrade), enabling earlier avoidance manoeuvre decisions (see Figure 7).

FACT:
Only IntuVue offers true dual-control capabilities with individual controls for each pilot.

Detecting turbulence

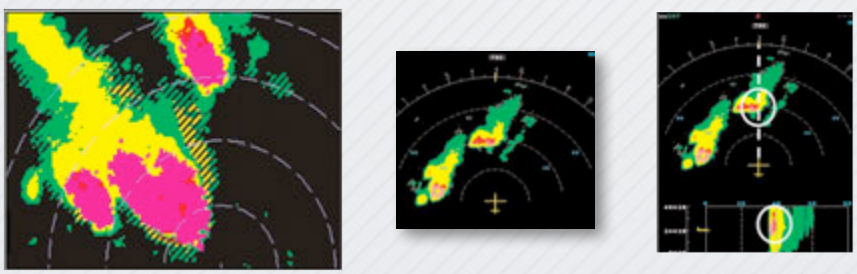


Figure 7

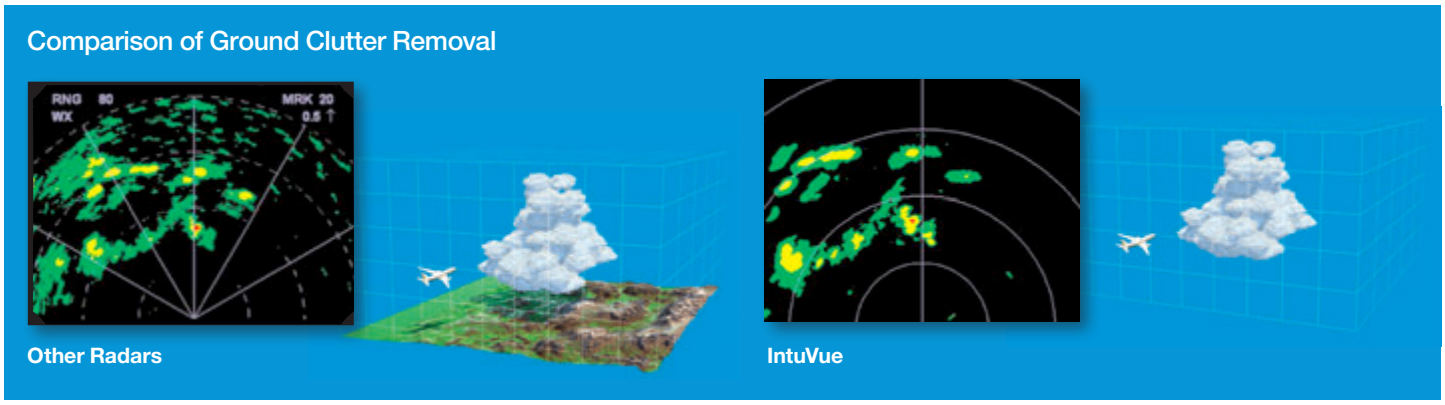


Figure 8

Removing ground clutter

When accessing weather hazards, it's important not to include ground returns as this makes it difficult for the pilot to see the true weather cells. With conventional automatic tilt radars, a dual scan comparison is often used to detect and eliminate ground clutter. This technique is useful in some cruise scenarios but it does not work well on climb out or descent and requires a number of scans to initialize the process.

The RDR-4000s display is virtually free of ground clutter at all altitudes and during all phases of flight. Honeywell's patented advanced algorithms separate weather returns from ground returns even when the antenna beam includes both. Using the radars internal terrain database, based but not dependent on the Honeywell Enhanced Ground Proximity Warning System (EGPWS) - the most proven terrain database in aerospace - ground clutter is suppressed from the weather images, providing a clear accurate representation of weather hazards (see Figure 8).

Radar data is corrected for the earth's curvature

The effect of the earth's curvature becomes noticeable at ranges beyond 40nm, but is commonly ignored by conventional radars, leading to errors in interpreting the weather image. The RDR-4000 automatically correct images for the effects of the earth's curvature (Figure 9).

Higher system sensitivity

The RDR-4000 eliminates the installation and maintenance costs associated with wave-guide runs and wave-guide switches, at the same time improving performance.

High altitude adjustment

Reflectivity of precipitation differs, and ice is less reflective than rain. IntuVue's patented algorithms automatically adjust for these differences in reflectivity, ensuring frozen storm tops are detected and visible on the display.

Advanced antenna design

The RDR-4000 also features an advanced antenna system design.
The direct drive motor system removes all gearing, improving reliability and producing a quieter antenna system with variable speed scanning for optimal efficiency.
The direct drive motors and advanced control algorithms provide greater pointing accuracy without the need for scheduled maintenance or recalibration, resulting in reduced ground clutter, more accurate storm top depiction and more accurate ground map mode.

NEXRAD (Ground Station) vs RDR-4000

The accuracy of IntuVue's weather detection is best illustrated by the excellent correlation with ground weather readings (see Figure 10).

The Effect of Earth's Curvature

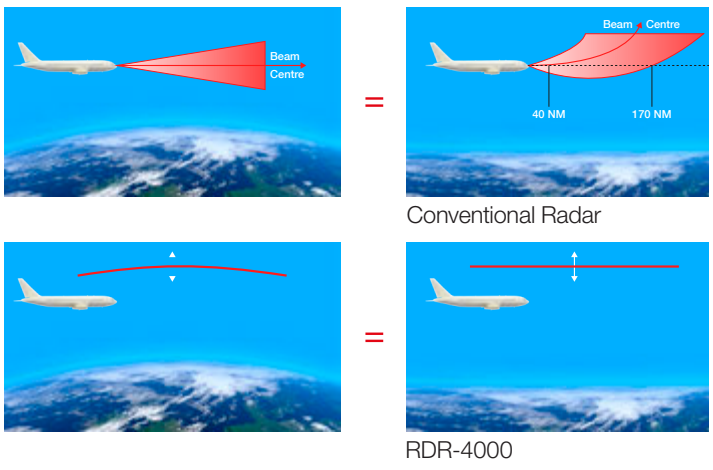


Figure 9

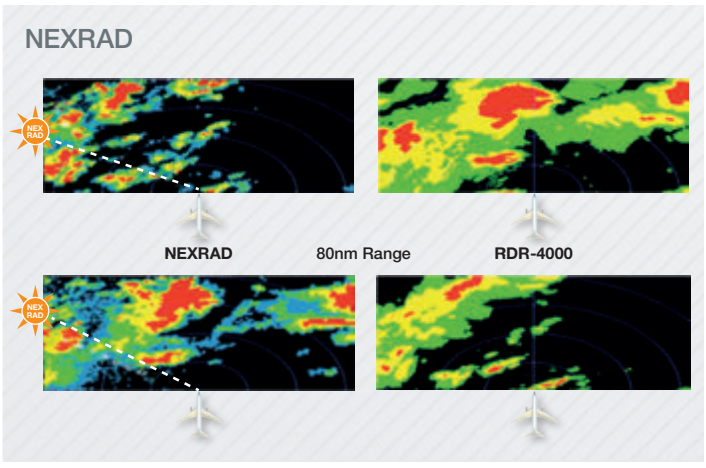


Figure 10

IntuVue / RDR-4000's upgraded predictive hazard features

The IntuVue / RDR-4000 Hazard Display Upgrade offers extended range turbulence detection to 60nm, predictive hail and lightning displays and REACT technology.

Predictive windshear

Encounters with windshear can cause or contribute to accidents during takeoff and landing. RDR-4000's new technology offers a wider windshear detection area (+/- 40 degrees compared to the limited +/- 30 degrees of other radars) and advanced algorithms, detecting smaller windshears embedded in a cluttered environment. RDR-4000's advanced processing techniques have virtually eliminated false windshears warnings which reduces unnecessary go-arounds and gives pilots more confidence in the real alerts.

Predictive hail display

The RDR-4000 is the first radar to offer predictive hail displays, enabling earlier and more effective re-routing decisions. Through a patented analysis technique, RDR-4000 evaluates the 3D weather data to accurately determine which cells are likely to produce hail.

Predictive lightning display

Worldwide research has shown that the conditions required to produce lightning in a convective cell are associated with a mix of water phases; that is, water must exist in both liquid and solid form in a significant volume of the cell (see Figure 11).

RDR-4000 uses a patented technique that analyses 3D weather and environmental temperature data to detect the severity of the convective cell.

By identifying the presence of the mixed phase conditions conducive to lightning, RDR-4000 predicts the generation and separation of charge that could lead to a lightning strike if flying too close to the convective cell. It is worth noting that the lightning strike may actually be initiated by the presence of the conductive aircraft. Honeywell studies show a better than 90% correlation with these proprietary lightning detection algorithms compared to ground-based sensors. RDR-4000 can predict lightning typically 5–10 minutes before it actually occurs.

REACT

Our renowned Rain Echo Attenuation Compensation Technique, or REACT, capability shows areas affected by radar attenuation, and the range at which the out-of-calibration threshold is reached (compared to the rough angular sector indication offered by traditional radars.) Due to the 3D Buffer, RDR-4000 provides more comprehensive information and fewer false and missed alerts in any gain position (see Figure 12).

Extended turbulence detection

With the Hazard v2.0 Display software upgrade RDR-4000 can now display turbulence out to 60nm, allowing avoidance manoeuvre decisions earlier than any other available radar system.

Convective Weather Discrimination

Convective Weather Discrimination (CWD) separates embedded convective cells from surrounding stratus weather to clearly show the pilot where the threats are for early avoidance planning, and shows stratus weather as OFF-Path so that pilots know which areas are safe to over fly. This results in the safest and most efficient paths through complex mixed weather conditions.

Weather Alerting (Airbus Only)

Weather and turbulence alerting provides an advisory indication to crew of potentially significant weather on the current path of the aircraft, to prompt monitoring of the radar display.

Weather Alerting is currently available on the Airbus version of Hazard v2.0. It is an Airbus only feature that is unique to Honeywell IntuVue.

Future enhancements

Our team of expert engineers are currently working on the following enhancements to expand the hazard display concept:

- Two-level turbulence display using multiple doppler thresholds with wing-loading characteristics RDR-4000 will be able to classify turbulence.
- Cell tracking and display: Weather data stored in the 3D Buffer will be analyzed to uniquely identify cells and determine motion parameters (ground track and velocity) and whether it is growing or shrinking.
- High altitude ice crystal detection: working with Airbus and NASA on research into whether weather radar can detect ice crystals.

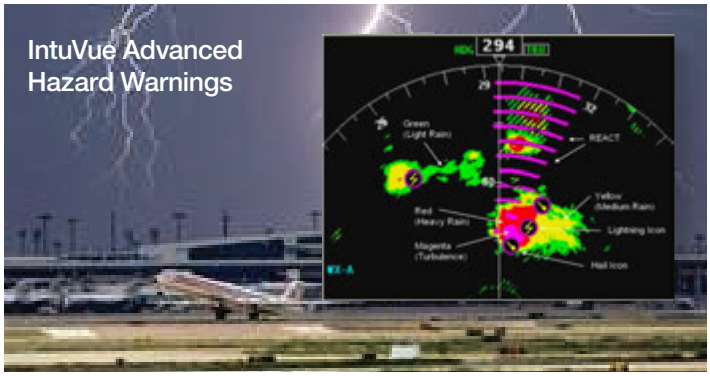


Figure 11

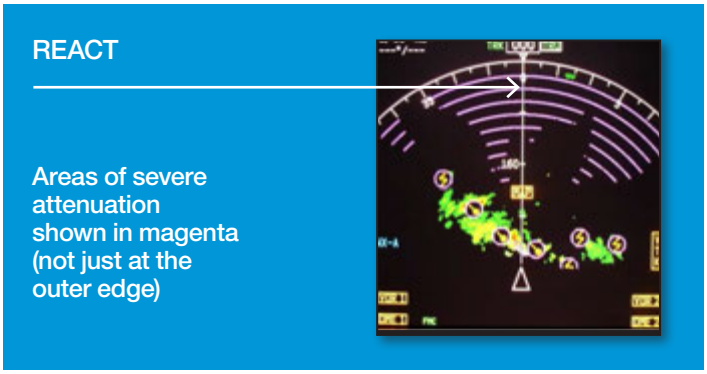


Figure 12

Section D - The business case for IntuVue

The solution - IntuVue / RDR-4000, the world's only truly next-generation radar

The RDR-4000 offers the only fully-automated weather solution available today, with a series of unique features bringing many advantages when compared to conventional weather radar. It is the industry's first completely clean sheet radar design since the 1980s. RDR-4000 helps minimise the impact of severe storm activity and maximises aircraft efficiency, safety and performance, by providing a detailed 3D picture of the weather ahead. Better information in the cockpit means fewer delays, more direct journeys, and huge cost and fuel savings.

IntuVue / RDR-4000 at a glance:

Enables quicker rerouting - due to longer-range weather hazard detection that predicts where the worst weather within a storm is with 90% accuracy. This allows pilots to deviate from their flight paths only when necessary, and plot optimal courses through or around foul weather

Reduces pilot workload - the radar automatically and continuously scans the airspace up -80 to +80 degrees in front of the aircraft, from 0 to 60,000 ft and up to 320nm ahead.

Enhances decision-making - intuitive displays provided by greater data storage and processing, with icons highlighting areas of predicted hail and lightning threats.

Provides greater safety - by using the most advanced predictive windshear and MOPS certified enhanced turbulence detection and alerting capability.

FACT: Conventional weather radars do not identify weather threats effectively.

Available across the fleet - the advanced capabilities of IntuVue's family of advanced weather radars allow us to provide weather detection, analysis and protection for a broad range of aircraft. IntuVue is available with antenna sizes from 18" to 30", so operators with both air transport and regional aircraft can take advantage of the same features, protection, spares, and training across the entire fleet.

The historical development and implementation of IntuVue

Introduced for the Airbus A380, the IntuVue RDR-4000 incorporates a completely new hardware architecture, weather detection and analysis philosophy. It was developed following detailed human factors studies with pilots and flight crew from France, UK, USA, Norway, Japan, Taiwan, Canada and the Philippines. These studies clearly identified that training and knowledge of weather radar was an issue - particularly given the manual nature of the radars. The need for automation was clear.

Subsequent studies using the IntuVue RDR-4000 clearly demonstrated that its fully automatic operation and intuitive displays increased crew efficiency and reduced pilot workload. The studies showed a 17.8% improvement in weather detection in AUTO mode and 13.3% in MAN mode, with weather avoidance decision-making improvements increasing 26% in AUTO mode and 23% in MAN mode.

The RDR-4000 has also been extensively tested by both Honeywell and the leading aircraft manufacturers in trials worldwide. More importantly, it has proven its worth to airline operators across the globe, with over three million logged flight hours, and is available on the B777, B737, A320, A330 and A340 as Supplier Selectable Furnished Equipment/Buyer Furnished Equipment.

It is also part of the integrated surveillance system - the Aircraft Environment Surveillance System - on the Airbus A380, A350 and the Gulfstream G650.

Honeywell's engineers and technicians are evolving the IntuVue family across commercial, business and military platforms, with the Lockheed Martin C130 and Gulfstream G-650 the most recent platform to receive certification.

Now, IntuVue's 'game-changing' technology revolutionises the face of aviation weather radar. Volumetric 3D scanning and pulse compression provide vastly improved resolution of weather and true hazard activity compared to conventional radar. These are described in more detail in Section B.

The RDR-4000 represents a significant development in radar technology, and is the first clean sheet radar design to be implemented in 30 years.

IntuVue firsts

First system certified to the Federal Aviation Administration Minimum Operating Performance Standard (MOPS) for enhanced turbulence. IntuVue has also been EASA Type Certified on the A380 and A320/A340 family

First and only commercial air transport radar to utilse pulse compression technology

First and only radar to offer true dual / split controls

First radar to eliminate waveguide runs and waveguide switches

First and only radar to automatically correct for the earth's curvature

First and only radar to use an internal terrain database to remove ground returns

First and only fully automatic radar, even in MAP mode

First and only radar to provide automatic hazardous weather detection and display along the aircraft's vertical flight path

First and only radar to provide an analysis mode

First and only radar to provide a combined vertical view of weather and terrain

First radar to provide worldwide weather detection capability and over-flight protection based on live 3D data, not database predictions

First radar to be certified as part of an integrated surveillance system

First radar certified with predictive lightning and predictive hail capabilities

First and only system certified with extended turbulence detection to 60nm

FACT: Weather-related incidents affect safety, undermine passenger confidence and cost money.

FACT: IntuVue is the Solution.

FACT: Conventional weather radars are no longer enough.

Section E - Specifications, Certifications and Configurations

CERTIFICATION
Boeing 737, 777
Airbus A320 family, A330/340
Airbus A380, A350 (Aircraft Environmental Surveillance System)
Gulf Stream G650
Dassault 7x
Embraer E2
Sukoi Super Jet (SSJ)
TU-204SM
AN-124-100
Military: A400M, C-17, C-130, C-2 (Japan)

RDR-4000 Specification	
Radar Processor	
Size	Standard ARINC 3MCU
Weight	10.5 lbs (4.76 kg) Max
Mating Connector	ARINC 600
Input Power	115 VAC (96-134 VAC) 360 Hz-800 Hz
Power Dissipated	150 VA nom. (Includes power required for transmitter receiver, antenna drive and control panel)
Environmental	DO-160E (-55°C to +70°C)
Software	RTCA DO-178B Level C
Transmitter/Receiver	
Transmitter Type	Solid State Gallium Arsenide
Transmitter Method	Pulse Compression
Weight	5.1 lbs (2.31kg) Max
Transmitter Frequency	9.375 GHz
Noise Figure	1.9dB
Environmental	DO-160E (-55°C to +70°C)
Minimum Discernable Signal	-124 dBm
Antenna System	
Flat Plate	Gain/Beamwidth/Weight
30"	34.8 dBi nom./3.0 degrees/6 lbs
24"	33 dBi nom./4.2 degrees/4 lbs
18"	31 dBi nom./5.6 degrees/3.0 lbs
Scan Rate	Up to 90 degrees/sec.
Mounting	Standard ARINC-708A
Size	Per ARINC-708A
Weight	16lbs. Single, 29.5 lbs. Dual
Power Dissipated	(included in RP-1 Power)
Environmental	DO-160E (-55°C to +70°C)
System Specifications	
Max Detection Ranges	320 nm - Weather and Ground Map 60 nm - Turbulence 5 nm - Windshear
Azimuth Coverage	+/- 80 degs - Weather and Ground Map +/- 40 degs - Windshear
Performance Index	
X-Band Avoidance	238dB (RTCA DO-173/220)
Interfaces	ARINC-453, ARINC-429, ARINC-575, (RAD ALT), RS-232, Ethernet, EGPWS, CMC/CFDS, AFDX, Radio Altimeter, ACARS, TCAS, EFIS
TSO	C63c

Section E - Continued

BOEING B737NG FAMILY (SINGLE CONFIGURATION) (-600 / 700 / 800 / 900 with CDS BP06 or later)			
Model	**Description**	**Honeywell Part Number**	**Qty Per A/C**
RP-1	Radar Processor (Boeing Hazard v2.0)	930-1000-002	1
RP-1	Radar Processor (Boeing Baseline)	930-1000-003	1
TR-1	Transmitter/Receiver Unit	930-2000-001	1
DA-1A	Antenna Drive Unit, Single R/T	930-3000-001	1
FP30-1	Flat Plate Antenna (30 inches)	930-4301-001	1
CP-1A	Radar Conrol Panel, Single, Grey (B737NG)	930-5101-001	1
Tray Kit	Mounting Tray Kit, comprising - One (1) tray with fan / filter as well as tray-to plate mounting hardware - One (1) adapter plate	930-7501-001 930-7010-001 652-4424-001	1

BOEING B777 FAMILY (DUAL CONFIGURATION) (-200 / 200LR / 300 / 300ER / F with AIMS I / II BP05 or later)			
Model	**Description**	**Honeywell Part Number**	**Qty Per A/C**
RP-1	Radar Processor (Boeing Hazard v2.0)	930-1000-002	2
RP-1	Radar Processor (Boeing Baseline)	930-1000-003	2
TR-1	Transmitter/Receiver Unit	930-2000-001	2
DA-1B	Antenna Drive Unit, Dual R/T	930-3001-001	1
FP30-1	Flat Plate Antenna 30", PWS	930-4301-001	1
CP-1B	Radar Conrol Panel, Dual, Brown (B777)	930-6101-001	1
MT-3	Mount, Single R/T, no connector, no fan	930-7002-001	2

AIRBUS SINGLE AISLE SINGLE CONFIGURATION (STANDARD (A318 / A319 / A320 / A321 with EIS 2 MOD (TBD))			
Model	**Description**	**Honeywell Part Number**	**Qty Per A/C**
RP-1	Radar Processor (Airbus Baseline & Hazard v2.0)	930-1005-002	1
TR-1	Transmitter/Receiver Unit	930-2000-001	1
DA-1A	Antenna Drive - Single Channel	930-3000-001	1
FP30-1	Planar Array, 30", PWS	930-4301-001	1
CP-2B	Radar Control Panel, Dual, (Airbus Baseline)	930-6201-001	1
CP-2B	Radar Control Panel, Dual, (Airbus Hazard v2.0)	930-6201-002	1
MT-3	Mount, Single R/T, no connector, no fan	930-7002-001	2
DUAL CONFIGURATION (OPTIONAL)			
RP-1	Radar Processor (Airbus Baseline & Hazard v2.0)	930-1005-002	2
TR-1	Transmitter/Receiver Unit	930-2000-001	2
DA-1A	Antenna Drive - Single Channel	930-3000-001	1
FP30-1	Planar Array, 30", PWS	930-4301-001	1
CP-2B	Radar Control Panel, Dual, (Airbus Baseline)	930-6201-001	1
CP-2B	Radar Control Panel, Dual, (Airbus Hazard v2.0)	930-6201-002	1
MT-3	Mount, Single R/T, no connector, no fan	930-7002-001	2

AIRBUS LONG RANGE (A330 / A340 with EIS 2 MOD (TBD)) DUAL CONFIGURATION			
Model	**Description**	**Honeywell Part Number**	**Qty Per A/C**
RP-1	Radar Processor (Airbus Baseline & Hazard v2.0)	930-1005-002	2
TR-1	Transmitter/Receiver Unit	930-2000-001	2
DA-1A	Antenna Drive - Single Channel	930-3000-001	1
FP30-1	Planar Array, 30", PWS	930-4301-001	1
CP-2B	Radar Control Panel, Dual, (Airbus Baseline)	930-6201-001	1
CP-2B	Radar Control Panel, Dual, (Airbus Hazard v2.0)	930-6201-002	1
MT-3	Mount, Single R/T, no connector, no fan	930-7002-001	2

Customer Testimonials

On Monday March 19, 2012 the first Southwest Airlines 737-800 flew home to Dallas to be introduced as an addition to the 737 fleet. The flight from PAE to DAL was an exceptional flight in many ways.

Not only did we get to fly this new variant of aircraft, but we were able to use the new RDR-4000 Honeywell Radar and truly see the full functioning capabilities. Our inaugural flight from Washington State to Dallas included many weather deviations utilizing the RDR-4000 weather radar. Throughout the flight we were able to view features like the Map mode, attenuation, Rain Echo Attenuation Compensation Technique and of course the 3D displays. The pilots at Southwest Airlines will be able to maneuver around weather systems with more accuracy, precision and a better level of confidence as a result of the enhanced features on the RDR-4000.

The new Honeywell Radar will add an additional layer of safety while operating in these types of environments.

Kirk Menard
Director, Flight Operations Training, Southwest Airlines

Honeywell's new radar system RDR-4000 will enhance the possibility of detecting all kinds of lightning sources even in less intensive cloud masses. Furthermore, it will help to detect turbulent areas from 60 miles away rather than 40 miles. Both features will play an important role to improve flight safety, which is our prime policy, besides enhancing passenger comfort.

Capt. Kemal Mustafa HELVACIOĞLU
Vice President-Safety (SMS), Pegasus Airlines

Pegasus Airlines wanted to reduce lightning and hail strikes to a minimum and so decided to look at the market for a sophisticated weather radar system. We learned about the new hazard detection capability in Honeywell's RDR-4000 and became the European launch customer.

If you now look at the statistics we can easily see that lightning strikes and hail strikes are diminished more than we expected.

By enabling better planning to avoid weather, it increases flight safety, enhances passenger comfort, reduces the time and cost of aircraft inspections and delivers fuel savings. That's why we recommend RDR-4000 to all airlines.

Captain Cem Alkan, Pegasus Airlines

For more information

As the global climate continues to change, the need for an advanced weather detection radar is of ever-increasing importance, providing greater passenger and crew safety, increasing efficiency, enhancing performance and reducing costs.

To discuss the IntuVue family of advanced weather radars further please contact your Customer Business Manager or Field Service Engineer.

For more information please visit
aerospace.honeywell.com/weatherradar

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