STATEMENT OF

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HONEYWELL AEROSPACE

BEFORE THE

SUBCOMMITTEE ON AVIATION

COMMITTEE ON TRANSPORTATION AND INFRASTRUCTURE

U.S. HOUSE OF REPRESENTATIVES

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RUNWAY SAFETY

The airport surface is one of the highest risk environments in aviation today. This is not some potential crisis looming on the distant horizon; it is a problem right now. And it is not a new problem, but as our Nation's skies and runways become more crowded, one that requires some new solutions. There is no option to do "nothing." In this testimony, Honeywell offers our unique perspective as a decades-long leader in safety avionics technology. We will show how, working together, government and industry can improve runway awareness and safety for pilots and passengers – right now, and for the future.

RUNWAY INCURSIONS

Runway incursions are one of the most significant on-going risks to aviation safety. The issue has been included in the National Transportation Safety Board's "Most Wanted" list since its inception in 1990 and remains there today. While the Federal Aviation Administration has made some progress in airport markings, training, and the deployment of ground systems (Airport Movement Area Safety System (AMASS) and Airport Surface Detection Equipment Model X (ASDE-X)), these solutions are insufficient to prevent all runway incursions. Over the past five years, the incursion rate in the U.S. has remained relatively constant (Table 1). *Serious incidents* have actually increased ten percent since 2004.

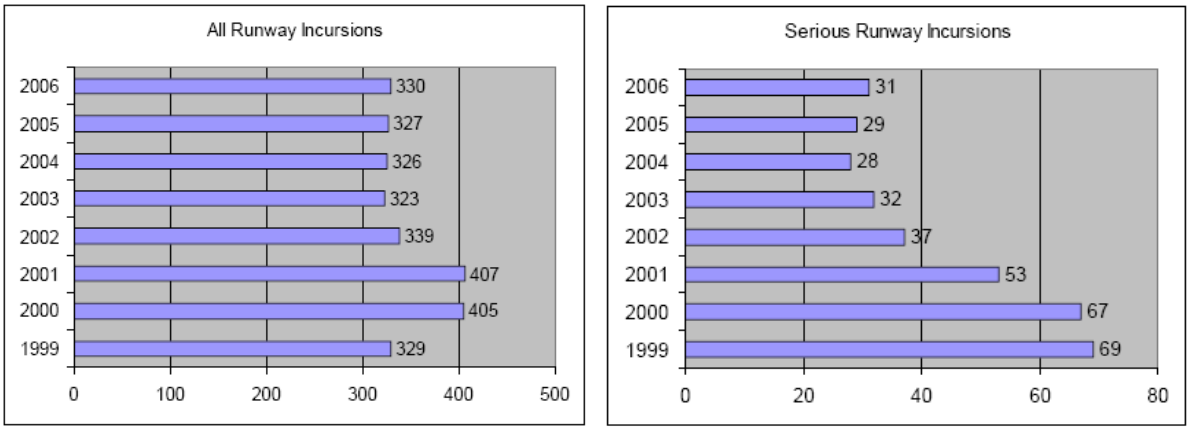


Table 1: Runway Incursion Rates in U.S, 1999 – 2006

Primary factors contributing to runway incursions include human errors that position an aircraft in the path of another aircraft or vehicle, or on a runway or taxiway not designed for the intended operation.

For the past several years, the NTSB has consistently stated that incursion alerts must be made available *directly to the pilot.* Existing solutions generate alerts *only for the air traffic controllers,* who must then verbally notify the pilot of the potential collision via radio. With aircraft traveling at high rates of speed and with limited ability for course alterations or rapid deceleration, response time dependent on this "pass along" verbal communication between controller and pilot can be the difference between a catastrophic collision and a safe resolution. Consider: an aircraft traveling at 150 miles per hour during final approach for landing will cover a quarter mile in just six seconds.

To generate a significant reduction in the runway incursion rate, it is imperative that: (1) Emphasis be placed on providing strategic situational awareness information to the pilot, including aircraft position relative to runways and other aircraft; and (2) In the event of a potential incursion, instantaneous alerting is provided directly to the pilot.

To approach this issue, it is necessary to look at both *short-term* and *long-term solutions.* In the short term, there are applications available now that can improve pilot awareness of their position on the airport surface, reducing the potential for confusion that could lead to an aircraft being in the wrong place at the wrong time. In the long term, technology currently in development will improve pilot awareness of the positions of other aircraft and alert pilots of potential collisions.

Both phases are critically important to reducing the risk of runway accidents; both will require proactive support from the FAA, aircraft operators, airports, labor and manufacturers.

Before a review of these short- and long-term solutions, it may be helpful to have an understanding of Honeywell's history in aviation safety.

HONEYWELL AEROSPACE AND AVIATION SAFETY TECHNOLOGY

Honeywell Aerospace has a long history as a leader in the development and application of avionics safety technology. Our legacy weaves through virtually every aspect of modern aviation history, from the earliest navigational gyroscopes to leadership in the development of technology for the Next Generation Air Transportation System (NextGen).

Our products range from mechanical systems and components for jet engine and airframe manufacture to environmental controls, power distribution, communications and navigation equipment and integrated cockpit controls. Honeywell's leadership in the development of mechanical and electrical aviation technology gives us unique insight into the big picture of challenges facing the aerospace industry worldwide.

Specific to this discussion, Honeywell Aerospace has been a driving force in research, development and application of safety avionics technology. From our earliest involvement in the invention and development of Traffic Alerting and Collision Avoidance Systems (TCAS) in the late 1950s to our leadership in industry-changing Ground Proximity Warning Systems and Enhanced Ground Proximity Warning Systems, Honeywell has been a major contributor to advancements in aviation safety technology.

GROUND PROXIMITY WARNING TECHNOLOGY

One key to increased airport runway awareness rests in understanding the core avionics safety technology Honeywell invented and developed into a standard product, which is now installed aboard 95 percent of all commercial aircraft flying today, or approximately 42,000 aircraft. This technology, **Enhanced Ground Proximity Warning System (EGPWS),** utilizes a combination of hardware, software, GPS signals and a global terrain database that assists in avoidance of a class of aviation accident that occurs when a disoriented pilot simply flies a properly functioning aircraft into the ground. This type of accident is known as "controlled flight into terrain," or CFIT.

With EGPWS, pilots can see an indication of terrain and tall structures on a cockpit display. As a result, pilots are less likely to continue flying toward that terrain or structure. Even if the terrain display is turned off as the aircraft approaches terrain, EGPWS will sound an audible alert about a minute away from the terrain, providing ample opportunity for evasive action (e.g. "PULL UP! PULL UP!").

The predecessor to EGPWS, the Ground Proximity Warning System (GPWS) – also developed by Honeywell – significantly reduced CFIT accidents in the U.S. after the FAA mandated its use in 1974 for airlines. Following the GPWS mandate, the U.S. CFIT rate fell to about one to two per year. Since airlines have begun to install EGPWS, the rate has dropped to less than one per year (see Table 2: EGPWS and CFIT, Major Airlines).

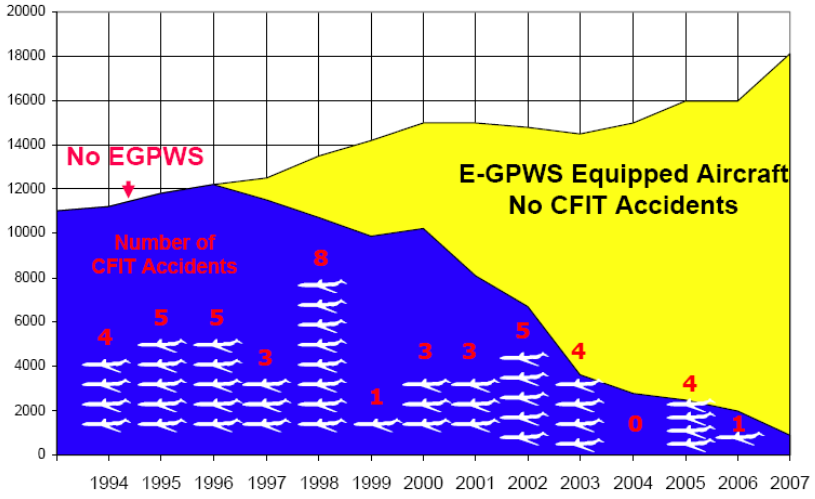


Table 2: EGPWS and CFIT, World Airlines

EGPWS has logged more than 300 million flight legs, or nearly 800 million flight hours, since its inception, without a single aircraft operating with an EGPWS being involved in a CFIT accident.. There have been 30 officially documented instances where EGPWS has broken the chain of events that would have led to CFIT, with an additional 75 incidents anecdotally captured.

Along with vast areas of terrain, the EGPWS database contains *runway information for all known commercial airports worldwide* – a critical factor in the development of automated runway awareness systems.

SITUATIONAL AWARENESS ON THE RUNWAY

Fundamentally, there are three levels of situational awareness for runways and taxiways. At a basic level, the pilot knows the location of his/her aircraft relative to the fixed immediate surroundings. At an intermediate level, the pilot knows there are other objects moving towards, around or away from their own aircraft, including the other objects' direction, speed and velocity. At the highest level of awareness, every pilot within the defined space knows the identity of every other moving object around them, as well as the supposed intent of the other objects' movements.

In order to respond to hazards or threats of incursion, a pilot needs to be able to receive alerts – visual or audible – that inform them of the situation. At that point, the pilot can take appropriate action to correct an error or take evasive action.

Short-term solutions – those currently available – provide a basic level of situational awareness to the pilot. These solutions include systems providing *audible alerts* to pilots, such as Honeywell's Runway Awareness & Advisory System (RAAS); and systems that provide *visual data* to pilots in the cockpit, such as Honeywell's interactive INAV "moving map" applications.

Honeywell's **Runway Awareness & Advisory System (RAAS)** is a software upgrade to the Enhanced Ground Proximity Warning System that provides verbal announcements to pilots of their relative runway position on the ground, on approach and on take-off. These warnings are audio announcements sounded in the cockpit ("Approaching runway 2L" or "On runway 2L" for example), allowing pilots to remain "heads up" and visually alert to immediate surroundings without depending on looking down at a specific cockpit display.

During landing or take-off, RAAS provides immediate verbal feedback if there is improper runway distance. This assists the pilot in making split-second decisions to reject a take-off or abort of a landing. RAAS provides 10 aural advisories to maintain maximum situational awareness (see *Appendix 1- RAAS Advisories*).

The FAA certified RAAS in 2003 and the product is commercially available now. Several Honeywell customers have elected to install it, including Air France, Alaska Airlines, Emirates, FedEx, Lufthansa, Malaysia (approximately 1,200 commercial jets total), and approximately 1,500 business jets.

In RAAS, aircraft operators find an affordable modification to existing equipment that can quickly be installed, providing the immediate benefit of enhanced runway situation awareness for the pilot. Operators can choose the RAAS call-outs that best maximize their operations and reduce pilot workload. Customization can be based on where an aircraft usually flies, the length of flights, and even factors such as the average pilot age and native languages. For those operators frequently flying long distances and into unfamiliar airports (e.g. international flights), the RAAS call-outs confirm the aircraft position relative to the runway. This is true for business jets as well, which often fly into smaller, unknown locations. RAAS is a useful option that helps mitigate other factors as well, from pilot fatigue to unusual or unexpected runway congestion

Airlines are purchasing RAAS for a variety of reasons. Operations with younger pilots find RAAS useful for crews with less experience at certain airports. Some operators place a greater emphasis on safety and technology, and are consistent early adopters. But they share one common goal – a desire to proactively find a near-term solution for runway situational awareness. These operators are leaders in the incorporation of aviation safety technology. They see the value in this technology and they are willing to implement it now.

Interactive moving maps provide another short-term solution. Similar to the GPS mapping systems found in newer automobiles, the moving map presents a graphical representation of a pilot's location and surroundings. The display changes as the aircraft moves across the airport surface (see *Appendix 2 – Moving Maps*).

Interactive maps allow a pilot to quickly review and analyze 2D information, with an emphasis on "quickly." While pilots can get distances from other onboard sensors, the moving map shows the context of other environmental variables – such as other aircraft or obstacles – so the pilot is looking at all the pieces in one place. Good decisions are dependent upon complete data. With a moving map centered on your aircraft, you are right in the middle of the big picture.

Honeywell has been on the forefront of moving map technology with our Primus EPIC INAV system, which provides a full flight depiction of the aircraft, the environment including potential hazards such as weather, terrain and traffic, and a graphical method for adapting the flight plan. This system sets the stage for an intuitive controller-pilot datalink interface that can avoid communication errors.

Honeywell's INAV system provides airport maps for many airports. Aircraft without Honeywell's INAV can display airport maps using Electronic Flight Bags (EFB) which can be as simple as a device similar to a "tablet computer" to a more sophisticated display mounted in the cockpit. These devices, provided by many different manufacturers are being adopted by operators in part because of their ability to show airport maps. These devices and Honeywell's INAV system each provide a depiction of the airport's runways and taxiways with a symbol showing where the airplane is currently located.

Newer moving map software, such as that provided by Jeppesen, can provide enhanced features including automatic loading of runway data and system arming just prior to

landing, panning and tracking controls, “north up” or “track up” orientation controls, and the capability to browse the airport map database.

Like RAAS, airport moving maps improve pilots’ situational awareness. And the systems are complementary – with RAAS providing verbal cues while the pilots are looking out the windows and the moving map backing them up with picture of their position on the airport.

As noted, these short-term solutions help pilots avoid placing their airplane in a runway incursion situation. The next step, and the objective of the longer term solutions is to provide pilots with better information about what other aircraft are doing and warn them when a collision is imminent.

AIRPORT SURFACE DETECTION

Longer-term solutions for enhanced runway situational awareness require additional data inputs from airport-based surveillance systems and other aircraft. These systems include **Airport Surface Detection Equipment – Model X (ASDE-X)** and **Automatic Dependent Surveillance Broadcast (ADS-B).** Both of these systems are currently available, but are not comprehensively installed at all airports in the National Air Space.

To explore one potential long-term solution, we will consider ASDE-X technology and how it can be combined with TCAS and EGPWS, leveraging the benefits of each system and creating a higher level of situational awareness.

The Sensis Corporation is the FAA’s supplier for Airport Surface Detection Equipment – Model X (ASDE-X), which uses multilateration, surface radar, and Automatic Dependent Surveillance Broadcast (ADS-B) technology to monitor activity on the ground and transmit real-time information to air traffic controllers. ASDE-X does not provide direct signals to aircraft.

The FAA is currently in the process of installing ASDE-X at 35 of the busiest airports across the United States.

BRINGING THE SYSTEMS TOGETHER

Honeywell and Sensis Corporation have been working in partnership to develop and prototype an integrated real-time runway incursion advisory solution using existing Traffic alert and Collision Avoidance System (TCAS) and ASDE-X technology. By integrating the two solutions, controllers and pilots simultaneously receive alert warnings if there is a runway conflict or potential incursion. This technology was demonstrated to senior FAA and NTSB officials in the summer of 2007.

A primary point of the demonstration was to illustrate that existing ground and airborne technologies can easily be adapted to interact with each other. TCAS provides airborne alerts and warnings of potential aircraft collisions; ASDE-X provides monitoring and alerts to air traffic controllers.

The demonstration included two scenarios: 1) two aircraft simulating simultaneous take-offs on converging runways, and 2) one aircraft simulating a landing while the other aircraft taxis onto the active runway.

[EXAMPLES ILLUSTRATED ON FOLLOWING TWO PAGES]

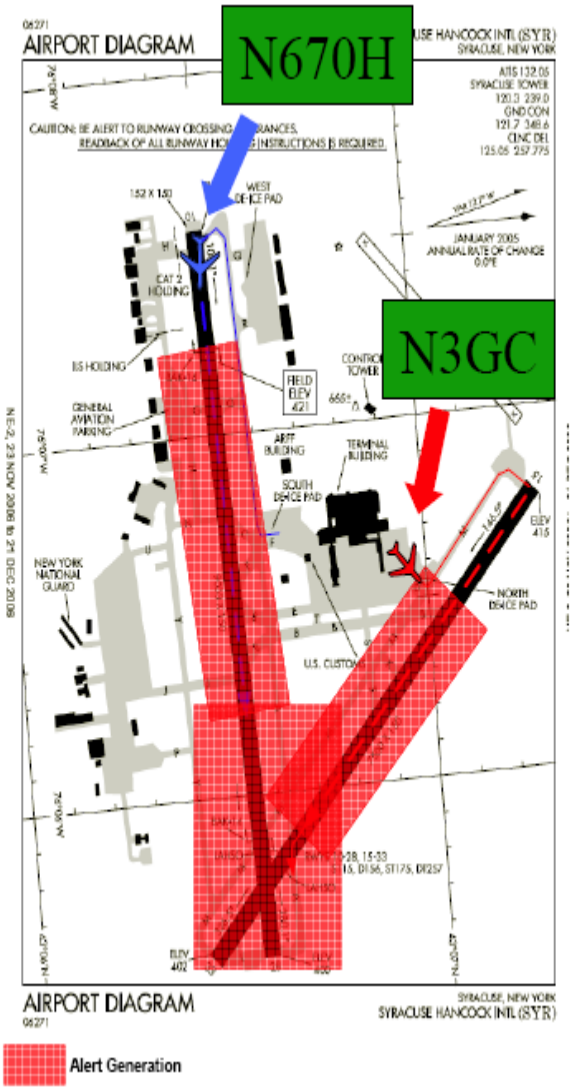


Figure 1 – “Converging Traffic” Scenario

Scenario 1

Converging Traffic (Figure 1)

- Aircraft N670H (BLUE aircraft) taxis onto runway 10 after ATC clearance

- Aircraft N3GC (RED aircraft)is positioned near runway 15

- N670H begins take-off roll upon ATC release

- Simultaneously, N3GC also starts take-off roll on converging runway

- ASDE-X Safety Logic detects approaching conflict; issues alert code to both aircraft; Honeywell avionics translate alert code to audible alert for both pilots: “CONVERGING TRAFFIC! CONVERGING TRAFFIC!”

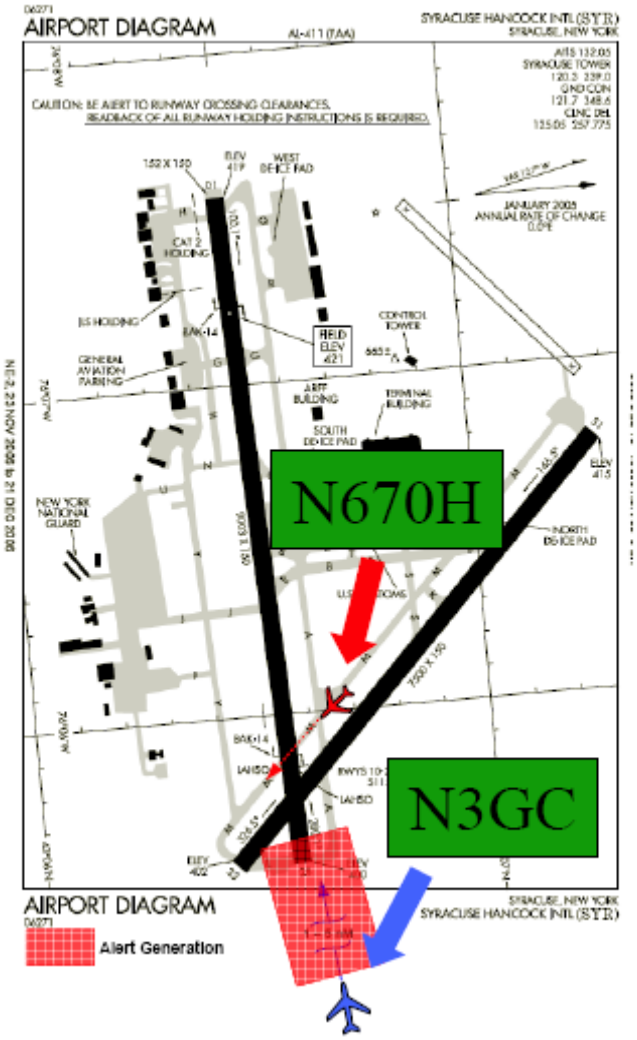


Figure 2 – "Runway Occupied" Scenario

Scenario 2

Runway Occupied (Figure 2)

- Aircraft N3GC (BLUE aircraft) flies short final approach to runway 28

- Aircraft N670H (RED aircraft) is positioned on taxiway "Mike"

- When N3GC is approximately three nautical miles from the end of the runway, N670H begins rolling across runway 28 from taxiway Mike hold line.

- At approximately 1.5 nautical miles, ASDE-X Safety Logic detects the runway incursion; sends an alert code to both aircraft; Honeywell avionics translate the code to an audible alert for both pilots: "RUNWAY OCCUPIED! RUNWAY OCCUPIED!"

Another longer term solution involves the deployment of Automatic Dependent Surveillance – Broadcast (ADS-B). ADS-B technology provides air traffic controllers and pilots alike with actual real-time positions of individual aircraft and surface vehicles, including the vehicle's direction and velocity. ADS-B also supports the active exchange of this data between aircraft and air traffic controllers. With the ability to identify individual vehicles and a one-second refresh rate, ADS-B is a more robust monitoring system than traditional ground radar, and may eventually serve as the primary means of airport surface monitoring.

As more and more aircraft are modified to broadcast and receive this information, the ability to identify and resolve potential conflicts on-board the aircraft will become viable. The currently proposed rule from FAA doesn't require aircraft to broadcast their ADS-B information until 2020, potentially delaying the practical use of this capability for runway incursion prevention until that date. However, the FAA's roll-out of ADS-B services includes a capability referred to as Traffic Information Service – Broadcast (TIS-B) that essentially creates a 100% ADS-B environment using radar and ASDE-X information wherever the TIS-B service is provided. Accelerating TIS-B deployment at ASDE-X and other high risk airports would facilitate the practical use of aircraft-based incursion detection and alerting capabilities at an earlier date.

ADDRESSING TODAY'S CHALLENGE

Airport surface safety will benefit from a continuous evolution in automation for both pilots and air traffic controllers.

- In the short term, enhanced situational awareness systems such as RAAS can provide better safety information to pilots; the FAA is also providing improved tools for controllers, such as ASDE-X.

- In the longer term, integration between ASDE-X and aircraft systems could enable alerts directly to both the pilots and controllers (a long-standing NTSB recommendation). In addition, the availability of Automatic Dependent Surveillance – Broadcast (ADS-B) and Traffic Information Service – Broadcast (TIS-B) coupled with RAAS or similar technology and surface traffic overlays ("moving maps") for display in the cockpit will provide even better information to pilots.

As this technology matures, additional opportunities will emerge to leverage runway awareness systems with other existing and in-development applications for even greater levels of aviation safety. Honeywell is continually on the forefront of these new applications, including:

- Synthetic Vision – Honeywell has recently introduced civil and military applications of 3-D displays of Integrated Primary Flight Display (IPFD) moving maps, which provide real-time images of actual terrain, giving pilots a "clear day" view regardless of actual visibility. Synthetic vision technology could be integrated with on-ground situational awareness applications to create a seamless combination of high-resolution visual displays and audible alerts when aircraft land in bad weather or challenging airport approaches (see *Appendix 3 – Synthetic Vision*);
- Stable Approach Monitoring – a software upgrade to EGPWS that advises a pilot during landing with alerts for improper airspeed, angle of approach, and aircraft configuration (flaps and landing gear) to reduce the chances of runway overrun accidents.

RECOMMENDATIONS

The shared objective of all stakeholders should be to create a safer runway environment. This can be accomplished by establishing systems that allow pilots and air traffic controllers to simultaneously receive real-time data and alerts. Honeywell recommends this Committee aggressively pursue solutions to runway safety challenges that include the following actions:

- Strongly encourage the adoption of better pilot situational awareness capability including the preparation of certification criteria and financial incentives for equipping.
- Accelerate the implementation of Traffic Information Service at airports in the National Air Space.
- Require the regulatory and procedural changes that would allow ASDE-X to broadcast alerting signals for use in the cockpit.

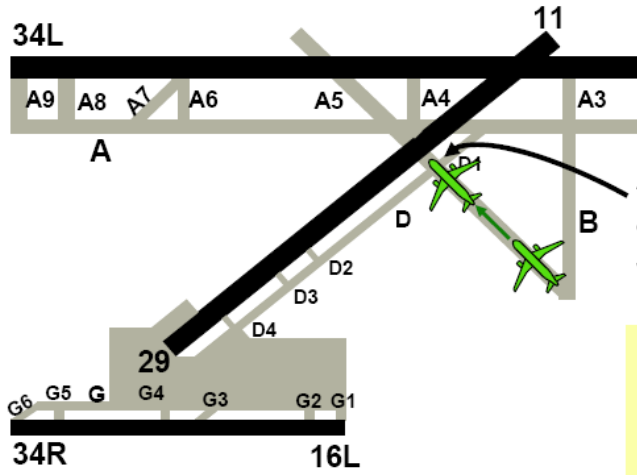
Reaching our shared objectives for runway awareness and safety requires a commitment to applying available technology now, as well as building for the future. As a proven global leader in system solutions for aerospace, Honeywell will continue to play an active role in turning the vision into reality.

APPENDIX 1 – RAAS Advisory Messages

1. Approaching Runway - On Ground

Honeywell

"Approaching One-One"



Advisory designed to typically annunciate when nose-of-aircraft at a distance from runway edge of 1/2 the runway width

Will not necessarily annunciate at hold short line

Conditions for Advisory:

- Function of aircraft groundspeed, heading and nearest runway end
  - *Earlier call-out at higher speeds*
- Inhibited above 40 knots
  - *No distraction during take-off/landing ground roll*
- Does not ensure aircraft will or can be stopped before hold short line

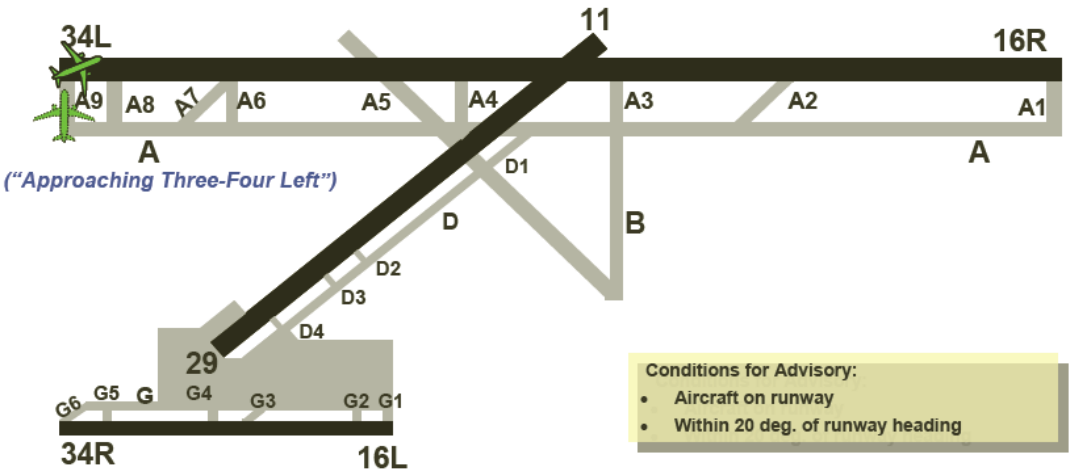
Routine Aural Advisory

Identify the runway before crossing or entering

2. On Runway - On Ground

Honeywell

"On Runway Three-Four Left"



Conditions for Advisory:

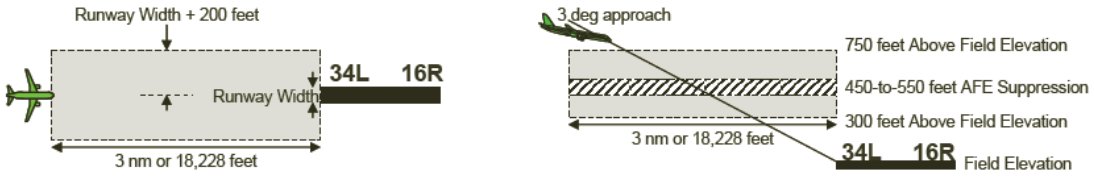
- Aircraft on runway
- Within 20 deg. of runway heading

Routine Aural Advisory

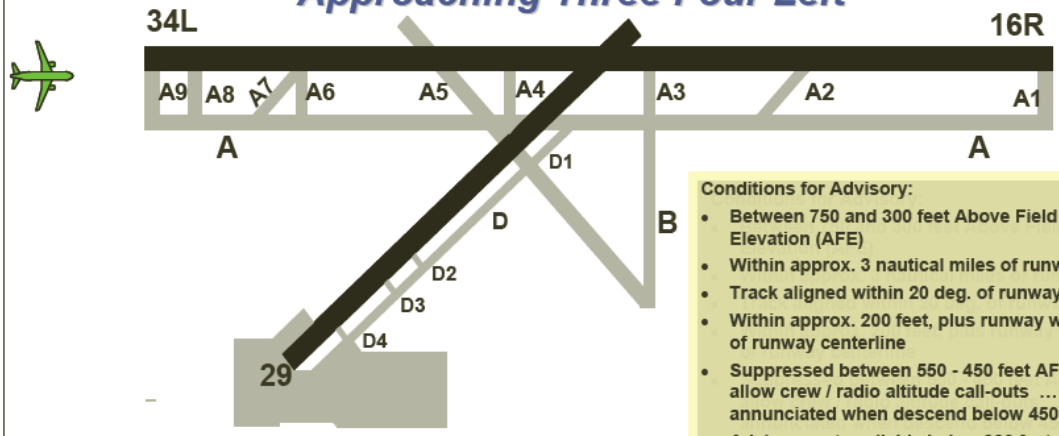
Be sure of the runway before you takeoff

3. Approaching Runway - In Air

Honeywell



"Approaching Three-Four Left"



Conditions for Advisory:

- Between 750 and 300 feet Above Field Elevation (AFE)
- Within approx. 3 nautical miles of runway
- Track aligned within 20 deg. of runway
- Within approx. 200 feet, plus runway width, of runway centerline
- Suppressed between 550 - 450 feet AFE to allow crew / radio altitude call-outs … annunciated when descend below 450 ft
- Advisory not available below 300 feet AFE
- All EGPWS aurals have priority

Routine Aural Advisory

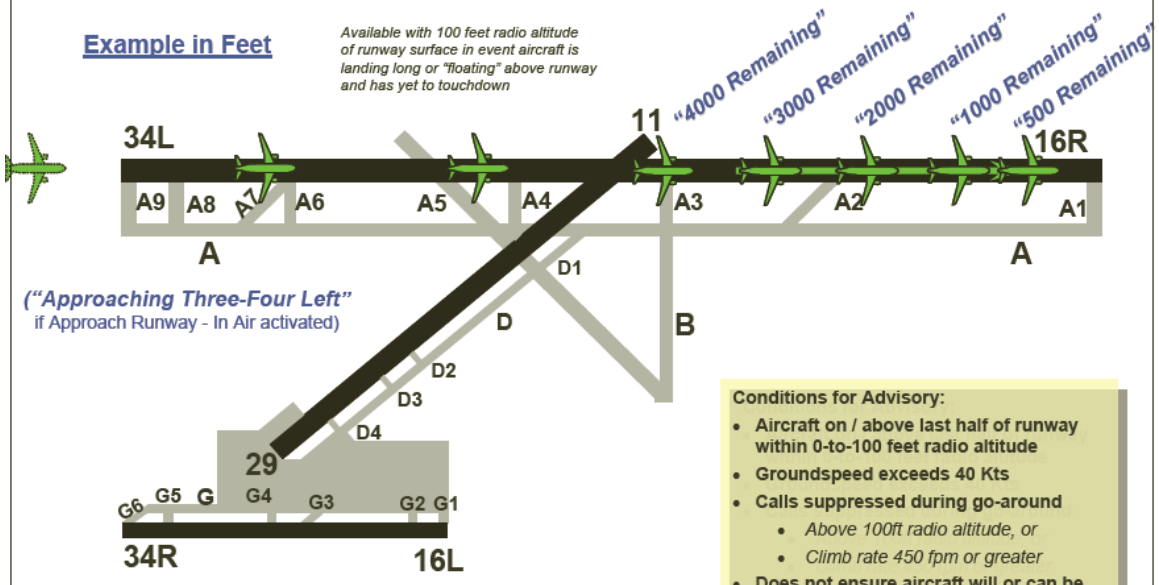
Avoid landing on the wrong runway

4. Distance Remaining, Land& Roll Out

Honeywell

Example in Feet

Available with 100 feet radio altitude of runway surface in event aircraft is landing long or "floating" above runway and has yet to touchdown



("Approaching Three-Four Left" if Approach Runway - In Air activated)

Conditions for Advisory:

- Aircraft on / above last half of runway within 0-to-100 feet radio altitude
- Groundspeed exceeds 40 Kts
- Calls suppressed during go-around
  - *Above 100ft radio altitude, or*
  - *Climb rate 450 fpm or greater*
- Does not ensure aircraft will or can be stopped before runway edge / end

Semi-Routine Aural Advisory

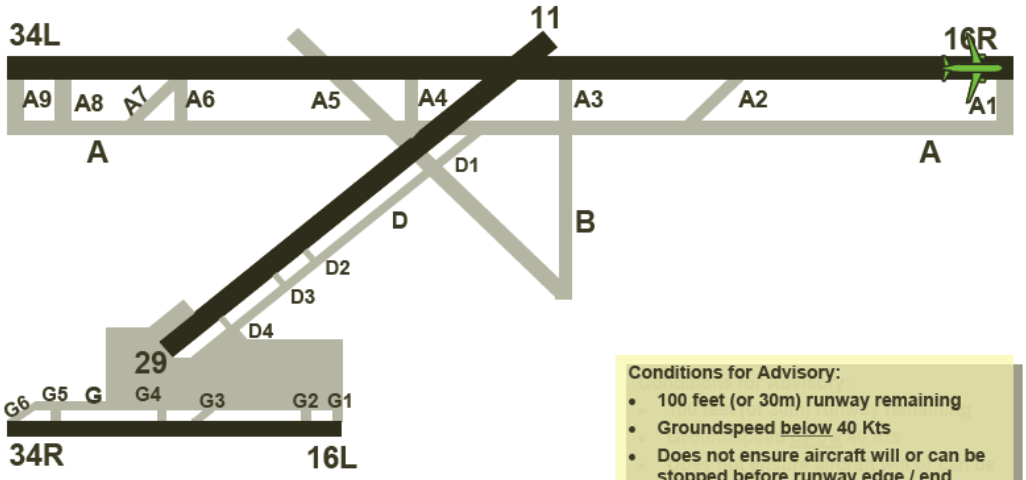
Heads-up awareness of approaching runway end

5. Runway End - Aid in Low Visibility Turn-off

Honeywell

Example in Feet

"100 Remaining"



Conditions for Advisory:

- 100 feet (or 30m) runway remaining
- Groundspeed below 40 Kts
- Does not ensure aircraft will or can be stopped before runway edge / end

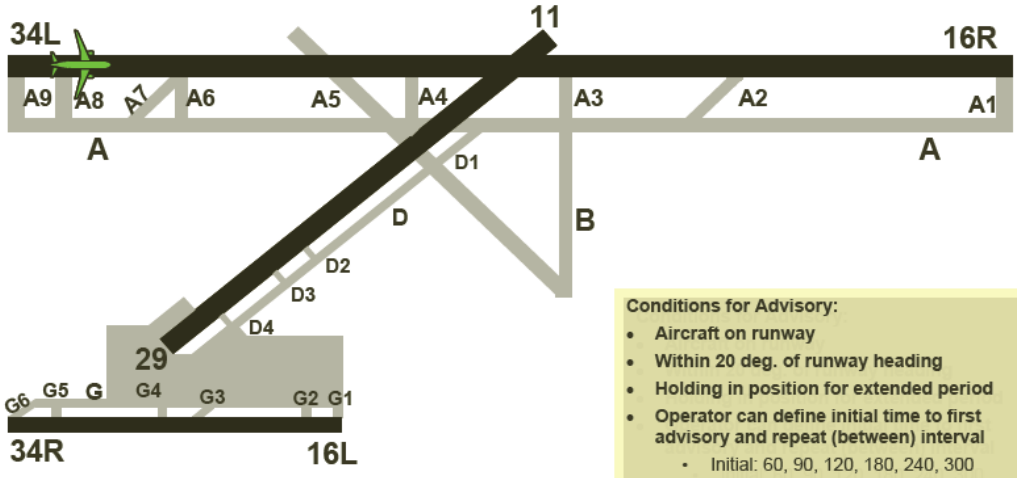
Semi-Routine Aural Advisory

Optional advisory at the last 100 ft of runway remaining

6. Extended Holding On Runway

Honeywell

"On Runway Three-Four Left, On Runway Three-Four Left"



Conditions for Advisory:

- Aircraft on runway
- Within 20 deg. of runway heading
- Holding in position for extended period
- Operator can define initial time to first advisory and repeat (between) interval
  - Initial: 60, 90, 120, 180, 240, 300
  - Repeat: 30, 60, 90, 120, 180, 240, 300

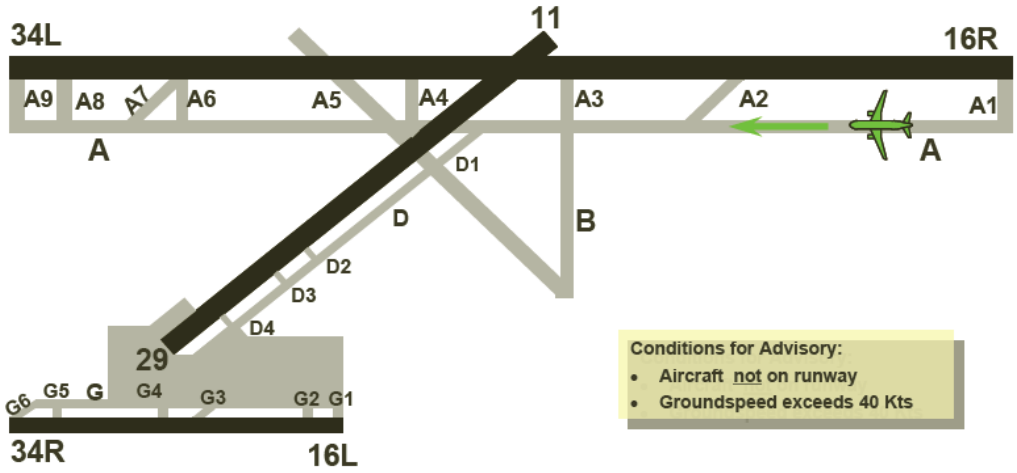
Non-Routine Aural Advisory

How long have we been sitting here awaiting T/O clearance?

7. Taxiway Take-off

Honeywell

"On Taxiway !
On Taxiway !"



Conditions for Advisory:
- Aircraft not on runway
- Groundspeed exceeds 40 Kts

Non-Routine Aural Advisory

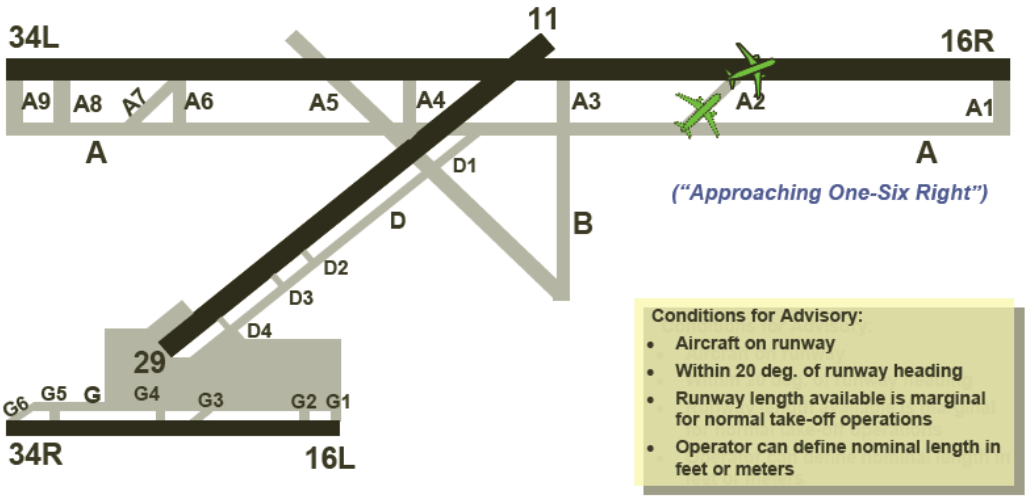
Warns of excessive speed outside runway surfaces

8. Insufficient Runway Length - On Ground

Honeywell

Example in Feet

"On Runway Three-Four Left,
Two-Thousand Remaining"



("Approaching One-Six Right")

Conditions for Advisory:
- Aircraft on runway
- Within 20 deg. of runway heading
- Runway length available is marginal for normal take-off operations
- Operator can define nominal length in feet or meters

Non-Routine Aural Advisory

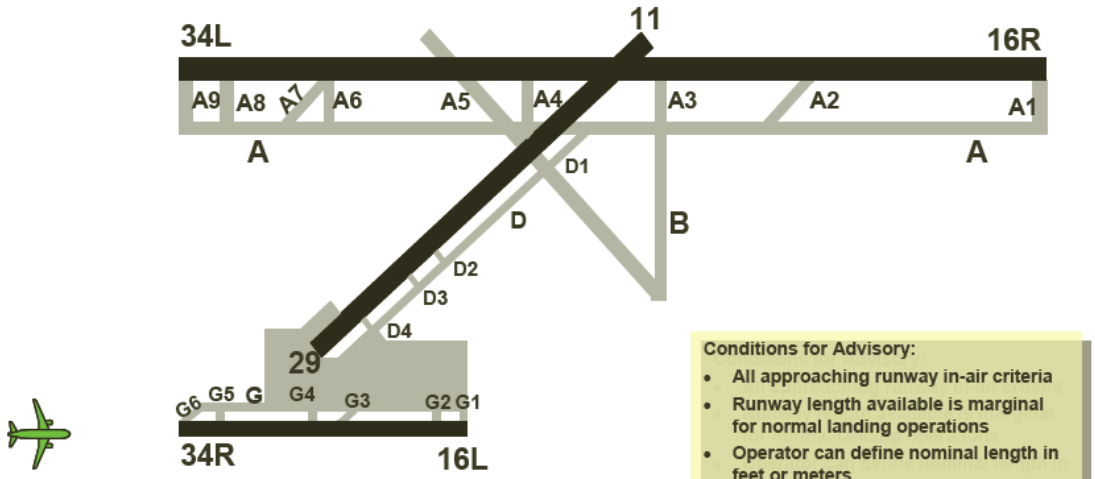
Advises crew of possible insufficient runway for takeoff

9. Approaching Short Runway - In Air

Honeywell

Example in Feet

"Approaching Three-Four Right, Three-Thousand Available"



Conditions for Advisory:

- All approaching runway in-air criteria
- Runway length available is marginal for normal landing operations
- Operator can define nominal length in feet or meters

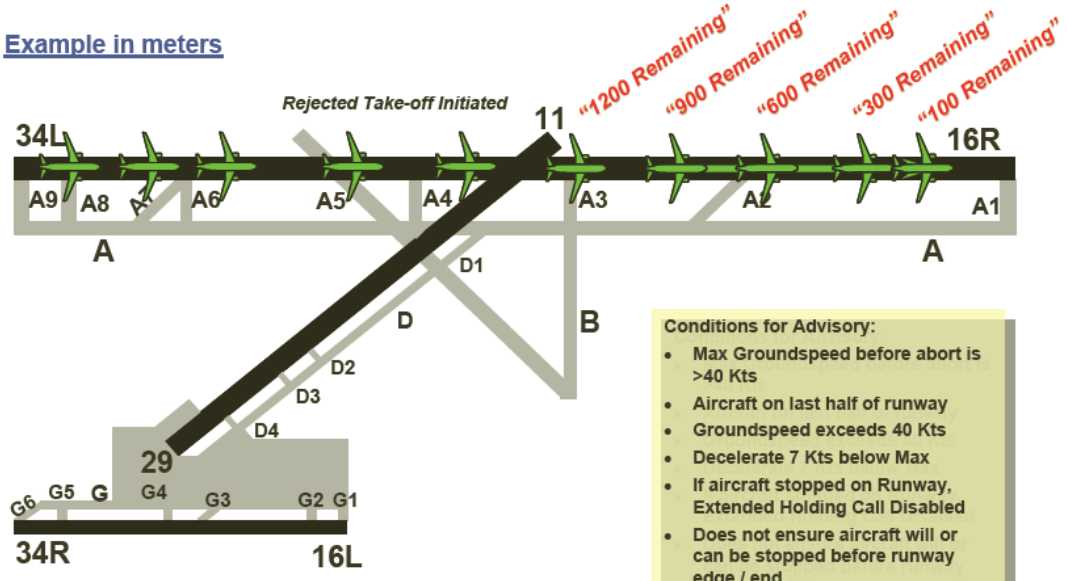
Non-Routine Aural Advisory

Advises crew of possible insufficient runway for landing

10. Rejected Take-off

Honeywell

Example in meters



Conditions for Advisory:

- Max Groundspeed before abort is >40 Kts
- Aircraft on last half of runway
- Groundspeed exceeds 40 Kts
- Decelerate 7 Kts below Max
- If aircraft stopped on Runway, Extended Holding Call Disabled
- Does not ensure aircraft will or can be stopped before runway edge / end

Non-Routine Aural Advisory

Distance remaining announced in a high-workload situation

APPENDIX 2 – MOVING MAPS

Honeywell INAV moving map displays

APPENDIX 3 – SYNTHETIC VISION

ABOVE – On the left, a primary flight display with traditional, standard “blue & brown” display of earth, horizon and sky. At right, the Honeywell IFPD Synthetic Vision System (in commercial business jet application) showing actual terrain and a moving map in real-time, 3-D display. SVS, coupled with RAAS-type technology, could provide seamless integration of terrain and threat advisories in both visual and audible formats.

Examples of Honeywell IPFD Synthetic vision including landing approach and airport surface movement.