ATC'S SECRET RADARS

From Precision Approach Radar to Precision Runway Monitoring, ATC has a burgeoning bag of tricks to keep aircraft separated and help on the approach.

by Fred Simonds

Most of us think of ATC radar in terms of Airport Surveillance Radar around terminal areas and Air Route Surveillance Radars in ARTCC airspace. This article beams some ink at lesser-known radar services that also contribute to our safety.

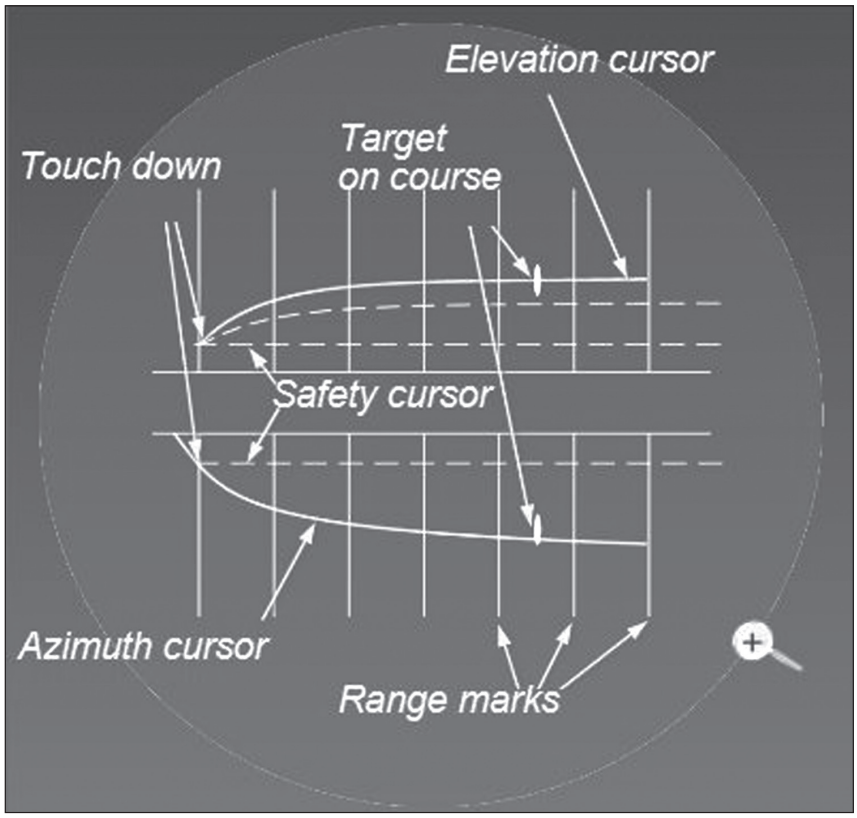
Radar Approaches

On a radar approach, the controller issues course and altitude guidance to a runway while monitoring the progress of the flight on radar until the pilot can land visually. While only for emergencies and distress, some sites permit practice ASR approaches.

Radar approaches require only a working radio. There are two types: Precision (PAR) and Surveillance (ASR).

Radar approaches may be granted on request and may be offered to distressed aircraft or to expedite traffic. An ASR might not be approved unless ATC needs it operationally or in an unusual or emergency situation.

If you accept a PAR or ASR, weather requirements remain. Making a radar approach with reported weather below minimums is your decision.



Precision Approach Radar screen presentation. The upper (Elevation Picture) portion of the display gives a side view of the landing approach down to the runway touchdown point with an imaginary line for reference. It shows altitude determined by the height-finding radar. The lower (Azimuth Picture) portion of the display shows azimuth determined by the PAR's horizontal sector scanning. Both pictures show distance.

Precision Approach Radar (PAR)

PAR couples a precise conventional radar with an accurate height-finding radar, allowing PAR to display elevation without Mode C. It does this with two antennas located right next to the runway, one scanning vertically and the other horizontally.

PAR's range extends only ten miles, making it unusable for sequencing or separating aircraft. Equally, it is limited in azimuth to 20 degrees and in elevation to only seven degrees.

Unlike conventional radars, and as the figure shows, the controller's scope displays an upper plot of altitude and distance, while the lower plot shows azimuth and distance.

PAR is generally found only at military or joint military/civilian airfields. PAR approaches are listed in the AF/D under the airport of interest at the very bottom. Specific radar instrument approach minima are listed in section N of the FAA Terminal Procedures Publication.

Flying PAR is a matter of following directions. The controller gives the pilot headings and altitudes to fly to remain on the extended runway centerline. About 10-30 seconds before glideslope intercept, the controller advises the pilot and then issues the command to

descend. Decision height [yes, DH not DA] is given the pilot only on request. DH and HAA are published in section N and radio time is precious.

Should the aircraft deviate from the glide path, the pilot is given relative deviations using the terms "slightly" or "well" and the pilot is expected to adjust accordingly. Elevation trends are also issued along with adverbs like "rapidly" or "slowly", e.g, "well below glidepath, coming up rapidly".

Range to touchdown is given at least once a mile. If the aircraft exceeds safety limits consistently, a missed approach or an order to fly a given course is issued unless the pilot has the runway environment in sight.

Guidance continues as the aircraft reaches decision height, then as it passes over the landing threshold and beyond if the pilot deviates from the runway centerline. Radar service terminates automatically on completion. Sounds like fun, huh?

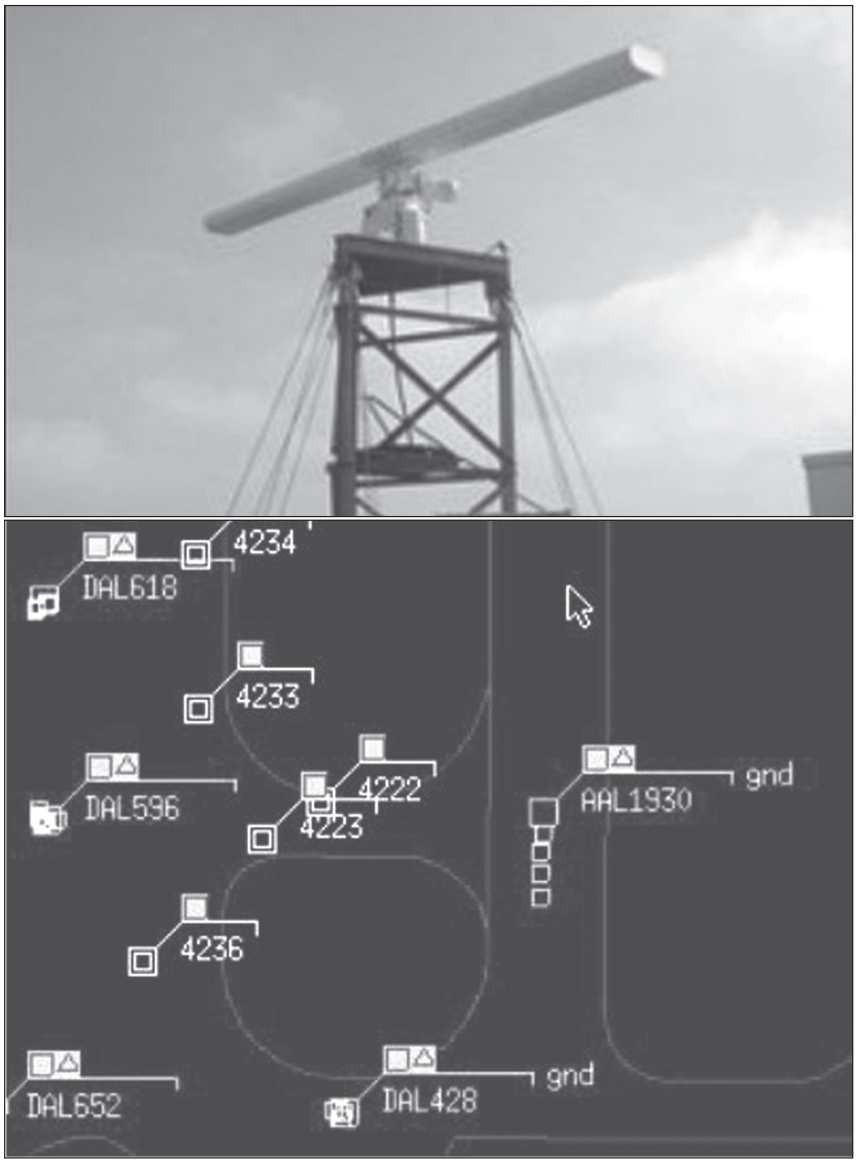
Surveillance Approach (ASR)

An ASR differs from PAR because the controller provides only azimuth guidance to the extended centerline of the runway using conventional ASR radar. Less precise than PAR, approach accuracy is lower and higher minimums result.

While altitude guidance is impossible, the pilot will be informed when to begin descent to MDA or to an intermediate step-down fix and then to MDA.

The pilot will also be advised of the Missed Approach Point's location and the aircraft's position each mile on final from the runway, airport, or MAP as appropriate.

If the pilot requests, recommended altitudes will be issued each mile, based on the descent gradient for the procedure, down to the last mile at or above MDA. Navigational guidance will usually be provided until the aircraft reaches the MAP. As with PAR, radar service automatically terminates on completion.

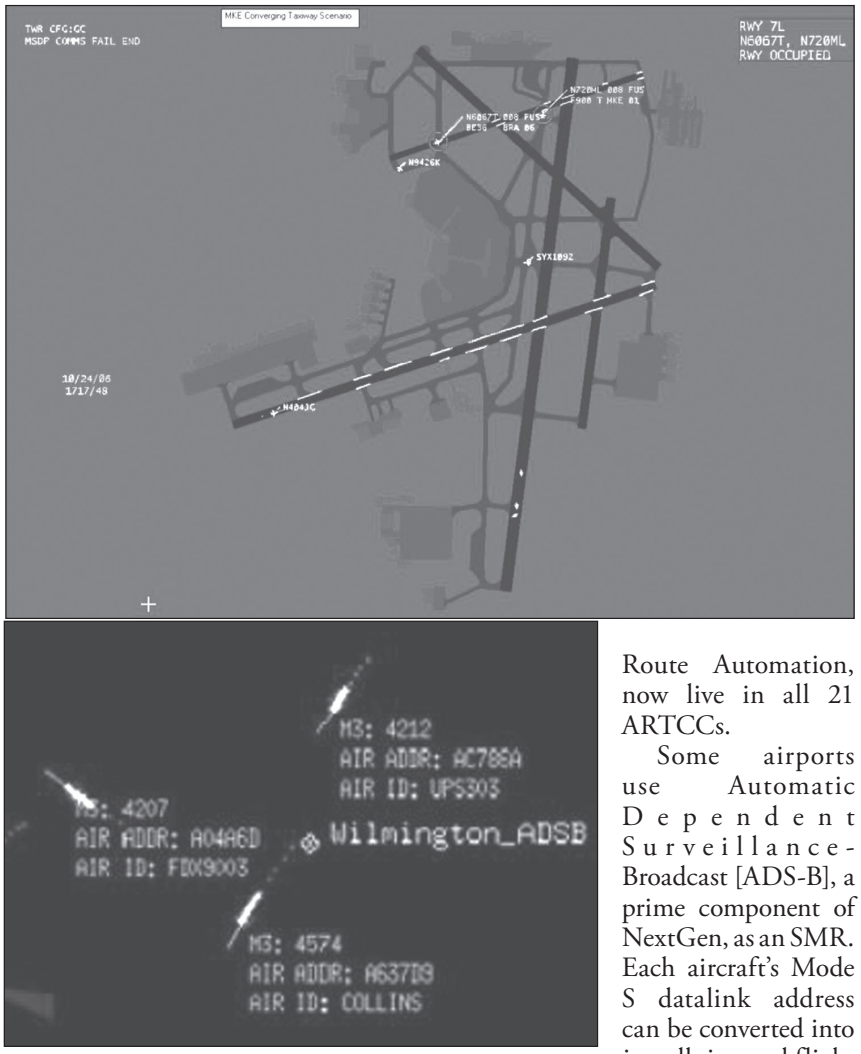


An ASDE radar antenna (top) sweeps 360 degrees per second. Multi Sensor Data Processing (above), a fused view from multiple sensors, showing aircraft and gates.

A no-gyro approach is available should the directional gyro, the magnetometer or AHRS fail or even if no stabilized gyro is installed. In such cases, advise ATC if IFR [per FAR 91.187] and request a no-gyro vector or approach. Make all turns at standard rate and execute the turn immediately when instructed as in, "Turn left," or "Stop turn." With either PAR or ASR, the controller will advise once on final approach that turns should then be made at half standard rate.

Surface Movement Radar (SMR)

SMRs detect all principal surface vehicles and aircraft on an airport, especially in maneuvering areas such as taxi, takeoff and landing areas but excluding ramps and aprons. The image appears on a radar console in the tower; indeed the SMR antenna



ADS-B and ASR tagging (above). Safety logic (top); in this simulation, the ASDE-X screen shows a converging taxiway scenario (the circles) where two aircraft could potentially collide.

is frequently mounted above the cab. SMRs use very short radar pulses and a rapid 60 rpm sweep rate to provide high resolution and a near real-time display. SMR signals are designed to penetrate fog and precipitation at distances up to 4.5 miles.

Newer SMRs interface with other radars such as PAR and ASR. Data processing capabilities allow runway incursion and conflict alerts, target identification and labeling. They also interface with systems such as En Route Automation, now live in all 21 ARTCCs.

Some airports use Automatic Dependent Surveillance-Broadcast [ADS-B], a prime component of NextGen, as an SMR. Each aircraft's Mode S datalink address can be converted into its call sign and flight number if applicable and tagged accordingly (lower photo to the left).

SMRs are synonymous with ASDE or Airport Surface Detection Equipment, the latest of which is ASDE-Model X.

ASDE-X consists of a primary radar that sweeps the airport surface and its airspace up to 200 feet AGL (upper photo, previous page). As a primary radar it detects and displays even transponder-free aircraft and those with malfunctioning transponders not to mention ground vehicles.

An automation interface in ASDE-X permits aircraft tagging and interfaces with NextGen and the terminal's ASR radar for position information (photo previous page).

Within ASDE-X, its Multi-Sensor Data Processor integrates several kinds of radars into one display, combining all sensor reports into one target. This combination of data ensures that the most accurate information about aircraft location is presented, increasing surface safety and efficiency.

The display itself is a high resolution color monitor that provides controllers with a seamless picture of airport operations on the airport surface (upper photo to the left). At this writing, about 35 airports have or will have ASDE-X.

Precision Runway Monitoring

PRM is a high-update-rate radar system installed at airports with simultaneous independent approaches to closely-spaced parallel runways.

PRM lets ATC improve the airport arrival rate on IFR days to that approaching VFR days, meaning less holding and fewer diversions.

PRM offers a super-accurate picture of the aircraft's location on final. Normal ASRs update every 4.8 seconds, but PRM updates each second, giving the controller more time to react to potential aircraft separation issues. PRM shows "target trails" that provide very accurate trend information, making it obvious if an aircraft starts to drift off the runway centerline.

PRM also predicts the aircraft's track and provides aural and visual alarms if an aircraft comes within 10 seconds of penetrating the non-transgression zone. During PRM sessions, one controller monitors each final approach course and a coordinator manages the overall activity.

Fred Simonds is a Gold Seal CFII, check airman and factory-certified G1000 instructor. See his web page at www.fredonflying.com.