

## RA 3291 – Precision Approach Radar

<p><b>Rationale</b></p> <p><i>There is a requirement to provide a precision approach capability in poor weather conditions.</i></p>	<p><b>Contents</b></p> <p><b>3291(1): Precision Approach Radar</b></p> <p><b>3291(2): Precision Approach Radar for Civil Pilots</b></p>
<p><b>Regulation</b></p> <p><b>3291(1)</b></p>	<p><b>Precision Approach Radar</b></p> <p>3291(1) Controllers <b>shall</b> provide Precision Approach Radar (PAR) approaches in accordance with (iaw) specified procedures.</p>
<p><b>Acceptable Means of Compliance</b></p> <p><b>3291(1)</b></p>	<p><b>Precision Approach Radar</b></p> <p>1. When a controller is providing a PAR they <b>should</b>:</p> <ul style="list-style-type: none"> <li>a. <b>Range Selection.</b> Select an appropriate range scale that will allow accuracy to be maintained throughout the approach. When an Air System is within 4 nm of touchdown, PAR <b>should</b> be conducted using the 5 nm range selection in order to maintain the appropriate accuracy when reporting elevation positions; the 3 nm and 1 nm range scales <b>should not</b> be used.</li> <li>b. Set appropriate Decision Height ► / <b>Decision Altitude</b> ◀ as obtained from the pilot.</li> <li>c. <b>Prior to Descent.</b> Obtain a readback of the correct altimeter setting from the pilot.</li> <li>d. <b>During Descent.</b> Prior to obtaining a clearance, obtain a positive notification that the undercarriage is down. There is no requirement to check fixed undercarriage Air Systems, but if the controller is in any doubt a 'check gear, acknowledge' instruction <b>should</b> be given.</li> <li>e. <b>Clearance.</b> <ul style="list-style-type: none"> <li>(1) Obtain a clearance from the Aerodrome Controller using the Radar Clearance Line (RCL). The clearance <b>should</b> be obtained and repeated verbatim to the pilot; the controller <b>should</b> request an acknowledgement of the clearance from the pilot. Unit orders <b>should</b> detail the range at which a clearance <b>should</b> be obtained.</li> <li>(2) Use the RCL and the PAR frequency simultaneously for the readback of the clearance. If there is a failure of the RCL, the PAR controller <b>should</b> request a clearance using the channel intercom facility on the Aerodrome frequency.</li> <li>(3) In the event of the clearance being delayed, make a further attempt to obtain a clearance, or an instruction to break off the approach; this clearance or break-off instruction <b>should</b> be passed to the pilot not less than 2 nm from touchdown or the minimum specified in Local / Unit Orders.</li> <li>(4) Instruct the pilot to break-off the approach if a clearance has not been passed to the pilot by 2 nms or as specified in Local / Unit Orders.</li> </ul> </li> <li>f. <b>Approaching / Passing Decision Height ► / Decision Altitude.</b> Warn the pilot that they are approaching their Decision Height ► / <b>Decision Altitude</b>. ◀ The pilot <b>should</b> also be informed when the Air System's radar return passes through the Decision Height ► / <b>Decision Altitude</b> ◀ cursor line.</li> </ul> <p>2. <b>RN Units.</b> Specific methods of obtaining and passing a clearance are employed at RN units and controllers operating at these units <b>should</b> adhere to Local / Unit Orders.</p>

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3. **Radar Fault / Failure.** When a major alert, or a Maintenance type minor alert such as "RADAR WORKING WITH ALERTS" is received, the Maintenance Personal Computer **should** be checked immediately, in order to assess the status of the PAR system and its suitability for continued use. Controllers **should** report indications other than 'Green' to the appropriate engineering service authority.
4. In the event that an approach has to be terminated due to a radar fault / failure, the pilot **should** be informed, and the following actions **should** be taken, dependent on the stage of the approach:
  - a. **At any Stage.** Handover the Air System to the Director / Approach controller with appropriate radiotelephony (RT) instructions.
  - b. **Early in the Procedure.** Where possible, arrange for the approach to continue as a Surveillance Radar Approach (SRA), or resume the precision approach if the fault is rectified.
  - c. **Before a Positive Final Clearance Has Been Issued.** Instruct the pilot to contact the Tower controller for clearance to join the visual circuit, ►make straight in approach◀ or break off the approach and execute the Missed Approach Procedure, or to 'fly-through dead-side' (if local procedures permit), depending upon whether the pilot is visual with the Aerodrome.
  - d. **After a Positive Final Clearance Has Been Issued.** Instruct the pilot to continue iaw the issued clearance, or execute the Missed Approach Procedure, depending upon whether the pilot is visual with the aerodrome.
5. **Loss of Radar Contact.** In the majority of cases, a loss of radar contact will be accompanied with an appropriate equipment alert / fault message. If a PAR radar contact is lost for more than 3 secs, the pilot **should** be informed, and further action **should** be taken in the same manner as for a radar fault / failure.
6. If a radar contact is regained within 3 secs, control of the Air System **should** be resumed provided the Air System is within 1 nm of the position that the contact was lost, is correlated and the new contact's track can be directly matched / related to that of its history trails.
7. If a radar contact is regained after 3 secs and / or outside 1 nm of the position that the contact was lost, the PAR can or cannot be resumed as follows:
  - a. **Outside 4 nms.** Outside 4 nms, control of the Air System can be only be resumed once the Air System has been formally re-identified. Identification **should** only take place if the controller considers there is sufficient time to do so. In order to effect identification, the Air System's position **should** be confirmed to the PAR controller by the Director, or if it can be checked, a specific operation of the Air System's transponder.
  - b. **Inside 4 nms.** If radar contact is regained within 4 nms of touchdown, action **should** be taken in the same manner as for a radar fault / failure.
8. **On Completion of the PAR.** On completion of the PAR, the controller **should** use the appropriate facility to inform Director 'Talkdown free'. Prior to conducting the next PAR, the controller **should** select the appropriate range scale. The Reset Default button **should not** be used to reset the display as the OBS mapping will automatically be selected. In the event of an Air System painting on the display prior to the controller stating 'Talkdown free' the controller **should** select the Air System's Data Block and state "Talkdown free, contact ... (range of the radar return)".
9. **PAR Azimuth-Only Approaches.** Units may continue to provide PAR Azimuth-Only approaches as an alternative to providing SRA; in such instances the published SRA procedure minima **should** be utilized for the approach.
10. **Track Merge.** In situations where 2 Air System cross tracks in azimuth or elevation at the same range, and the tracks merge, only one radar contact will be displayed until the tracks have diverged sufficiently for the PAR to distinguish and display both Air Systems. In such cases, provided the 're-displayed' track of the PAR Air System can be directly matched / related to its history trail prior to the merge, the PAR can continue. If any doubt exists however, the approach **should** be terminated as detailed in paragraph 4.

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11. **Conflicting Tracks.** In situations where the controller observes an un-notified radar contact on one element of the PAR display (azimuth or elevation) which is on a conflicting track or in a conflicting position, they **should** immediately check the other element of the PAR display (eg, if a confliction is seen in azimuth, check for related contact in elevation) in order to ascertain the relevance of the apparent confliction and act iaw ►Table◀ 1 below.

►Table◀ 1 – Conflicting Tracks

Conflicting Track's Behaviour	Action
Not displayed in both elements (AZ / EL)	No action required. Contact may be deemed to be outside the coverage area of one PAR element and therefore, no confliction exists.
Displayed in both elements - collision risk only apparent in one	No avoiding action required. Traffic Information to be provided to pilot if considered relevant (eg, Radar to Visual joins passing overhead, circuit traffic turning ahead / behind).
Collision risk apparent in both elements	Advice on suitable action for collision avoidance passed to pilot together with information on conflicting traffic. Instructions for manoeuvres in a vertical plane <b>should</b> normally only result in stopping descent or applying a climb. Where a heading change is involved, Air Systems <b>should</b> be climbed to the relevant RVC height if the Air System cannot be maintained within PAR Azimuth cover.

12. Controllers **should** only use 'Small A/C' setting as the use of the 'Large A/C' setting is not currently covered by the PAR System Safety Case.

13. Controllers **should not** change Rain / Clear Mode during an approach. Rain mode **should** only be selected if the weather conditions are such that spurious 'correlated' returns are present.

14. On completion of a runway change, controllers **should** ensure that all runway change alerts are cleared prior to commencing a PAR.

15. Controllers **should** ensure that the whole of the Data Block is visible throughout the PAR.

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16. **Takeover of Control - Preparation.** The PAR controller will signify their readiness to take over control of an Air System. Before accepting control, the PAR controller will ensure that a correlated (white) radar track is displayed in both (azimuth and elevation) pictures and that the Air System's Data Block is displayed.

17. **Takeover of Control - Actions.** Once an Air System is handed over, the PAR controller will wait for the pilot's initial call. If, after allowing sufficient time to establish RT contact and an unsuccessful radio check, no contact is made, the controller will transmit instructions to the pilot which involve a change of attitude in azimuth or elevation, or if it can be checked, a specific operation of the Air System's transponder. Visual evidence of compliance will confirm that the pilot is receiving their instructions and will enable the controller to continue the PAR after informing the pilot of their intention to do so.

18. **Range Selection.** Provided that the Air System's return and Data Block can be clearly seen, lower range scales can be selected as soon as the Air System reaches the relevant range from touchdown (ie, at 10 nm from touchdown the 10 nm range scale can be selected, at 5 nm the 5 nm range can be selected). If the PAR controller observes another radar contact, whose position and / or track is likely to affect the PAR close to the point where the range would normally be reduced, then the range

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change may be delayed until the controller is satisfied that they can monitor the situation on the lower range setting.

19. **Range Information.** The PAR controller will provide range information at 1 nm intervals for Air Systems 15-18 nm and ½ nm intervals to Air Systems within 15 nm and on final approach. Range information can be derived by reference to the range lines on the azimuth / elevation display, or from the displayed Data Block information.

20. **PAR Coverage.** Due to the volume of airspace covered by the PAR, it is highly likely that a number of other radar contacts will be observed. The azimuth element of the radar system is, in effect, a search radar that radiates in a specific sector, and its vertical coverage is significantly greater than the displayed elevation sector; the effect of this is that high altitude tracks (possibly up to 30 000 ft), may well be detected and displayed on the azimuth picture.

21. **Track Merge.** On some runways, additional radar returns, or ‘clutter’ may be evident on a semi-permanent basis due to the presence of busy roadways passing over high ground within PAR coverage. In situations where 2 radar returns cross tracks in azimuth or elevation at the same range, the appropriate PAR element (ie, azimuth or elevation) will only ‘see’ and be able to display, one radar contact during the period that the tracks are ‘merged.’ The PAR will display only one radar contact until the 2 Air Systems have diverged beyond the PAR elements resolution ‘bubble’ (eg, an over-flying Air System passing directly over an Air System on PAR may result in only one radar contact being displayed in the azimuth picture until the tracks have diverged sufficiently for PAR to distinguish and display both Air Systems). Once the radar contacts are outside the PAR resolution ‘bubble’, both contacts will be displayed; this will normally take no longer than 2 or 3 secs.

22. **Size of Returns.** The size of the radar return remains constant throughout and is not dependent on the size of the Air System being controlled. The widths of the radar contacts, centreline and glidepath, as displayed by the PAR system, are very similar in size and, as such, even very slight deviations from the indicated glidepath (GP) or centreline (CL) can give an illusion of being more significant than they actually are. Therefore, there can be a temptation to apply an excessive number of corrective turns / height adjustments to Air System that have, in real terms, moved only a small distance from the desired flightpath and controllers will take this into account when providing GP / CL correction advice to pilots.

23. **Data Block.** A Data Block, designated by the controller, provides additional information and assists the controller in confirming that the correct contact has been correlated in both azimuth and elevation. Unlike Secondary Surveillance Radar labels, Data Blocks are not universally ‘tied’ to the contact Air System. Temporary loss of the Data Block, or an observed ‘jump’ to another contact, is not an indication of a radar fault. In cases where 2 Air Systems diverge from each other (eg a formation split, or a track crossing above or below) it will take a finite amount of time, dependent on the relative speed of the separation, for the radar to be able to distinguish and display separate radar contacts for each element; once the second contact is displayed it is possible for the Data Block to become attached to the ‘detaching’ contact, rather than the contact of the Air System that is being controlled.

24. **Azimuth Control.** Adjustments to heading in order to maintain the Air System on the CL will decrease as range decreases during the approach. Controllers may consider this when judging the size of heading corrections and avoid using small heading changes at range unless a finely tuned adjustment is required. The aim is to guide the Air System smoothly onto the CL before Decision Height ►/ **Decision Altitude** ◀ and to maintain it in that position. When the Air System passes Decision Height ►/ **Decision Altitude**, ◀ the information the controller passes becomes advisory, and the controller will only pass the direction of turn and the number of degrees. The 2° and 5° azimuth lines (marked in blue) diverge either side of the CL from touchdown, to assist the controller in determining the azimuth position. Heading changes will be assessed using the trend information gained from monitoring the track history ‘trail’. Track histories also show the rate of correction to the centreline. The Air System’s position in relation to the CL will be described as follows:

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►Table◀ 2 PAR Azimuth Interpretation

Azimuth Position	Interpretation
“On CL”	When the radar return is on, or touching, the CL. Note: The CL marked on the display is 50 ft wide.
“Slightly Right / Left of CL”	When the radar return is between the CL and the 2° azimuth line, but not touching either.
“Right / Left of CL”	When the radar return is between the 2° and 5° azimuth lines, or touching either.
“Well Right / Left of CL”	When the radar return is outside the 5° azimuth lines.

25. **Elevation Control.** In circumstances where a late handover has taken place, it is permissible for the PAR controller to initiate descent followed immediately by a request to readback the appropriate altimeter setting. A warning that the Air System is approaching the GP will be relayed to the pilot, as well as an instruction to begin descent. Accepting that allowances have to be made for the type of Air System and approach speed, this warning will normally be issued as the Air System reaches 200 ft below the GP. The instruction to begin descent may be given at a range commensurate with the performance of the Air System. As the Air System descends, the pilot will be advised of their Air System’s position in relation to the GP and its rate of correction (trend), to which they will apply their own adjustments to the Air System’s rate of descent. This rate of correction (*rapidly, nicely, slowly, not correcting*) can be estimated by monitoring the movements of the track history ‘trail’. There can be large fluctuations in the height information provided by PAR Data Block (particularly with larger Air System or formations); therefore, controllers will concentrate on interpreting the overall trend of the descent, rather than report ‘snapshots’ based on single height indications. Where possible, GP information will be given down to 50 ft below the published Procedure Minimum. The Air System’s position in relation to the GP is described as follows:

►Table◀ 3 PAR Glidepath Interpretation

Glidepath Position	Interpretation
“On GP”	When the radar return is on, or touching, the GP cursor. <i>Note: To ensure the appropriate reporting accuracy, the final 4 nm of the approach may be controlled using the 5 nm range scale.</i>
“Slightly Above / Below GP”	When the radar return is no longer touching the GP, but the height information on the Data Block indicates that it is within 60 ft.
“Above / Below GP”	When the height information on the Data Block indicates that the Air System is between 61 ft and 100 ft from the GP.
“Well Above / Below GP”	When the height information on the Data Block is greater than 100 ft from the GP.
“Dangerously Below GP Acknowledge”	When the radar return touches, or is considered to be descending rapidly towards, the Lower Safe Limit Line Cursor (LSLLC). An acknowledgement is required from the pilot.

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26. **LSLLC.** An LSLLC is provided on the elevation display to assist the controller in determining when an Air System is approaching the lower limits of the PAR procedure. The position of LSLLC is determined for each runway and is calculated on figures provided by No1 AIDU based on the Obstacle Clearance Surface for the lowest approved GP angle of the runway in use. The LSLLC will only be set by engineering staff.
27. An Air System approaching Decision Height ► / **Decision Altitude** ◀ below GP may approach the LSLLC before the criteria for "Below / Well Below" are met. In this situation, advice on proximity to the LSLLC will take priority as Air Systems will be operating close to the limits of the PAR procedure.
28. Where possible, controllers will avoid passing instructions which result in co-incident capture of centreline and GP to minimize pilot workload.
29. **Clearances.** It is the responsibility of the PAR controller to ensure that a clearance appropriate to the type of approach is obtained. In the event of a delayed clearance, while obtaining the delayed clearance at 2¼ nm will normally suffice, the range may need to be increased for faster Air Systems in order to ensure the issue of a clearance no later than 2 nm.
30. **Late Handovers.** Controllers will consider carefully their allocation of priorities in order to resolve the situation and will control the Air System by issuing positive control instructions before attending to administrative matters. In some circumstances turn and descent instructions may have to be initiated in one transmission, and while it is accepted that both controller and pilot workload will be increased, controllers will take care not to unduly overload the pilot.
31. **Formations.** Whilst Air Systems are in close formation, the PAR tracks the centre of the formation rather than displaying the position of the lead and / or individual formation elements; in real terms, the effect of this is negligible and is similar to the way larger Air Systems (eg C17) are tracked. When a formation splits, the effect on the radar is similar to the 'Merged Contacts' situation, where the radar will only be able to display one radar contact until individual formation elements have separated beyond the radar's resolution 'bubble'. During this portion of a formation split, controllers will be aware of, and thus ready to anticipate, a possible 'jump' in the displayed positions as the single radar contact becomes 2 or more separate contacts.
32. **Separation / Avoidance of Other Contacts.** There are no separation minima to be maintained by the PAR controller as it is the responsibility of the Director and / or local operating procedures to ensure that the prescribed separation requirements are met. The PAR controller's duties will provide the pilot with the necessary information to avoid a collision rather than to maintain any specified separation minima.
33. **Built In Test Monitoring System.** The PAR has a continuous Built In Test monitoring system, which provides the operator with an indication of a change in the radar's condition. Alert messages are provided visually via the display monitor and, in the case of major alerts, an audio alarm will also sound. The alerts provided can either be of an advisory nature, or can be used to alert the operator to minor or major problems with the radar as follows:
- a. **Advisory / Minor Alerts.** Advisory and minor alerts are displayed in normal video and provide information about the system which does not adversely affect the current performance criteria of the radar.
  - b. **Major / Critical Alerts.** Major / critical alerts are displayed in inverse (ie, highlighted) video and are accompanied by an audible alarm. These alerts provide warnings of radar or system malfunctions, or combination of malfunctions, which prevent the PAR operating to specification, or which could adversely affect the performance criteria. The receipt of a major alert in itself does not necessarily require the approach to be terminated; some alerts, such as "DAS REDUNDANCY NOT AVAILABLE" (ie, one of the 2 radar consoles is not available for use) simply indicate that a parallel / standby element of the system has failed or has been disconnected, but the radar can still be used.
34. **Moving Target Indicator (MTI) Marker.** The PAR relies on the receipt of a continuous signal from the MTI Markers to confirm the correct alignment of the radar

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system. If the radar is misaligned or loses sight of the MTI Marker for a prolonged period of time the controller will receive a 'Major Alert' "MTI REFLECTOR OUT OF TOLERANCE" message on the display. The equipment resets itself automatically as soon as the MTI signal is received again.

35. **Aircraft Target Size.** The PAR has 2 processing algorithms, 'Large A/C' and 'Small A/C'. The default algorithm for the initial detection of all Air Systems is 'Small', and this is the normal setting to be used when designating (tagging) individual Air Systems, irrespective of the actual size. In some circumstances, when controlling larger Air Systems with 'Small A/C' selected, additional 'ghost' images, (also known as buddy tracks) may be observed to appear behind the Air System for a short period; the presence of these tracks does not affect the conduct of the PAR and controllers can continue to control the 'tagged' contact.

36. **Rain / Clear Modes.** The PAR has two modes of operation, CLEAR mode and RAIN mode. The purpose of RAIN mode is to prevent heavy rainfall, or other precipitation, being displayed as correlated returns. Selection of RAIN mode reduces the maximum useable range of the radar by 5 nm (ie to 15 nm). Following any toggle of Rain / Clear Mode the system processor is reset, causing all targets to disappear from the screen. Target data will reappear within a few seconds of the toggle (typically 4-5 sec, but could be up to 10 sec).

37. **PAR Azimuth Only.** Due to the manner in which PAR operates, it is highly unlikely that the elevation element of the system would ever fail in isolation, or fail in such a way that the alert message indications would still permit the system to be used 'Azimuth-Only'.

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3291(2)****Precision Approach Radar for Civil Pilots**

3292(2) Controllers **shall not** offer PAR approaches to civil pilots.

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38. Controllers **should not** assume that a civil pilot has been authorized and trained to fly a PAR.

39. If the captain of a civil Air System specifically requests a PAR, the approach **should** be provided.

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40. Nil.

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