Glidepath Reference Datum Height: Considerations and Recommendations

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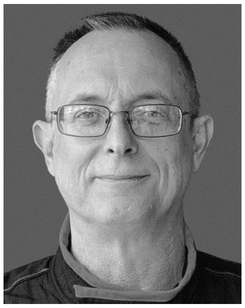

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1. Executive Summary

Reference Datum Height (RDH) is a glidepath flight inspection parameter related to the height of an aircraft as it crosses the runway threshold on an ILS approach.

Standards and tolerances for RDH are specified by both ICAO and FAA. Both organizations provide guidance for determining RDH, including the use of regression techniques applied to selected portions of the approach.

However, ICAO does not clearly specify a reference point for glidepath measurements or a single, well-defined analytical method for determining RDH. For these reasons the measurement, interpretation, and application of RDH specifications are inherently subject to variation, and universally consistent and reproducible results are not guaranteed.

This paper examines the concept of RDH, including its historical development, mathematical basis, and practical application. The discussion is grounded in the original analytical work that led to current methods, including the development of best-fit straight-line (BFSL) techniques, as well as in subsequent operational experience.

Through examination of analytical development, numerical examples, and real-world operational data, it is shown that RDH is a derived parameter rather than a direct physical measurement. Its value depends on the method used for its determination, including the portion of the glidepath selected for analysis, the geometrical reference point (aiming point), and the characteristics of the signal-in-space.

The results presented indicate that RDH, while useful as an engineering parameter, does not in all cases provide a reliable indication of actual aircraft threshold crossing performance. Care should therefore be taken in its use as a primary acceptance criterion without consideration of the underlying glidepath structure and operational data.

2. Geometry of an Ideal Image-Type Glidepath

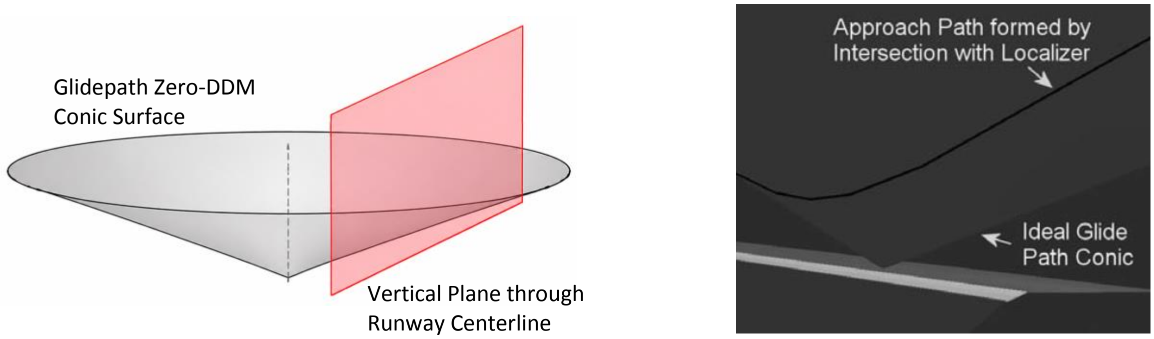
The vast majority of glidepath installations are image-type systems. In these systems, the signal in space is formed by the combination of direct signals from the glidepath antennas and reflected signals from the terrain in front of the antennas. (The term “image” is from the electromagnetic theory).

When simplified to a geometric model, the locus of points corresponding to a constant glidepath indication forms a conic surface. The intersection of this surface with the vertical plane of the approach path produces a curve that is hyperbolic in form. This is shown graphically in the diagram below.

It is common to assume that the glidepath is a straight line, however the figure below should make clear that the actual ideal glidepath is a hyperbola. While a straight-line approximation is convenient for analysis, it does not accurately represent the true glidepath geometry, particularly in the region close to the runway threshold where the curvature becomes more pronounced.

This hyperbolic glidepath represents the ideal signal-in-space for a properly functioning system over uniform terrain. It is important to emphasize that this curved path is not an error or imperfection, but rather the expected result of the physical mechanism by which the glidepath signal is generated.

This distinction between the actual hyperbolic glidepath and its straight-line approximation is fundamental to understanding the behavior of RDH, as discussed in the following sections.



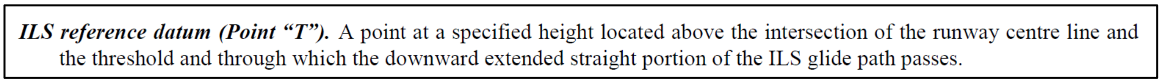
The constant glidepath indication forms a conic surface. Its intersection with the vertical plane of the approach path is a hyperbola, not a straight line. The difference is most significant near the runway threshold

3. Reference Datum Height References and Definitions

ICAO RDH References

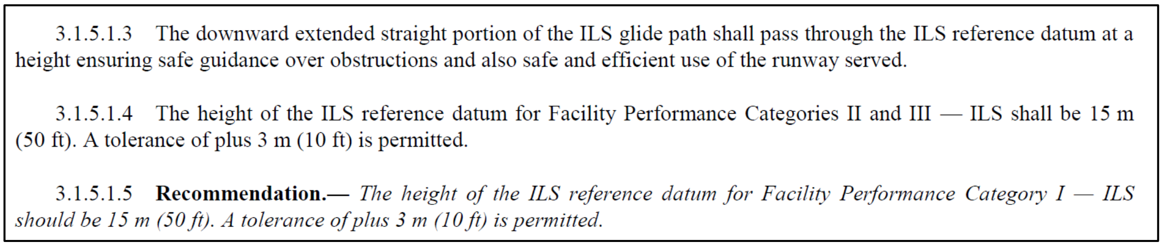
ICAO specifies Reference Datum Height (RDH) standards and tolerances as part of the ILS glide path characteristics but does not provide a standalone formal definition or a uniquely prescribed method for its determination.

RDH is indirectly specified by ICAO as a glide path parameter representing the height of the ILS glide path above the runway threshold. A formal definition of "ILS reference datum" comes from Annex 10, Volume I, Chapter 3, 3.1.1:



ILS reference datum (Point "T"). A point at a specified height located above the intersection of the runway centre line and the threshold and through which the downward extended straight portion of the ILS glide path passes.

In the description of glidepath characteristics of, ICAO refers to the "straight portion" of the glide path, which forms the basis for defining glidepath structure and tolerances. However, Annex 10 does not explicitly define how this straight portion is to be derived from the actual signal-in-space. From Annex 10, Volume I, Chapter 3, 3.1.5:

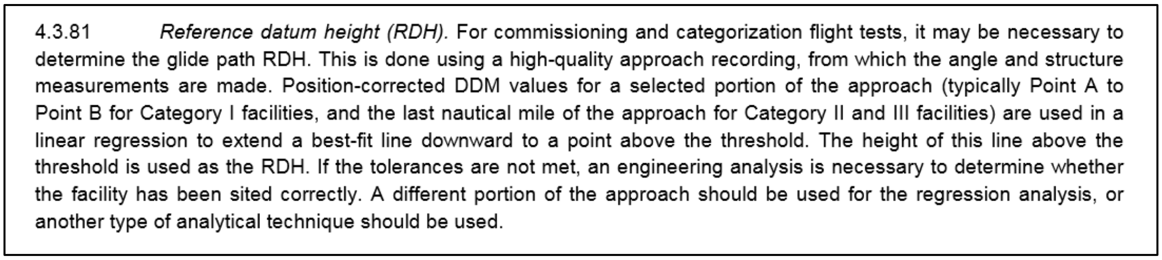


3.1.5.1.3 The downward extended straight portion of the ILS glide path shall pass through the ILS reference datum at a height ensuring safe guidance over obstructions and also safe and efficient use of the runway served.

3.1.5.1.4 The height of the ILS reference datum for Facility Performance Categories II and III — ILS shall be 15 m (50 ft). A tolerance of plus 3 m (10 ft) is permitted.

3.1.5.1.5 **Recommendation.—** *The height of the ILS reference datum for Facility Performance Category I — ILS should be 15 m (50 ft). A tolerance of plus 3 m (10 ft) is permitted.*

The practical method for determining RDH is described in ICAO Doc 8071, Volume I, 4.3.81.



4.3.81 *Reference datum height (RDH).* For commissioning and categorization flight tests, it may be necessary to determine the glide path RDH. This is done using a high-quality approach recording, from which the angle and structure measurements are made. Position-corrected DDM values for a selected portion of the approach (typically Point A to Point B for Category I facilities, and the last nautical mile of the approach for Category II and III facilities) are used in a linear regression to extend a best-fit line downward to a point above the threshold. The height of this line above the threshold is used as the RDH. If the tolerances are not met, an engineering analysis is necessary to determine whether the facility has been sited correctly. A different portion of the approach should be used for the regression analysis, or another type of analytical technique should be used.

Note the use of the word "typically," and the allowance for alternative analytical techniques if tolerances are not met. ICAO provides guidance for determining RDH, including the use of regression techniques applied to selected portions of the approach. However, the allowable flexibility in data selection and analysis means that RDH is not uniquely defined, and consistent, reproducible results are not guaranteed.

In particular, the ICAO guidance for procedure allows variation in:

- The portion of the approach used for analysis (e.g., Point A to Point B, or the final segment of the approach),
- The specific implementation of the regression analysis, and
- The treatment of data when tolerances are not met, including the use of alternative analytical techniques.

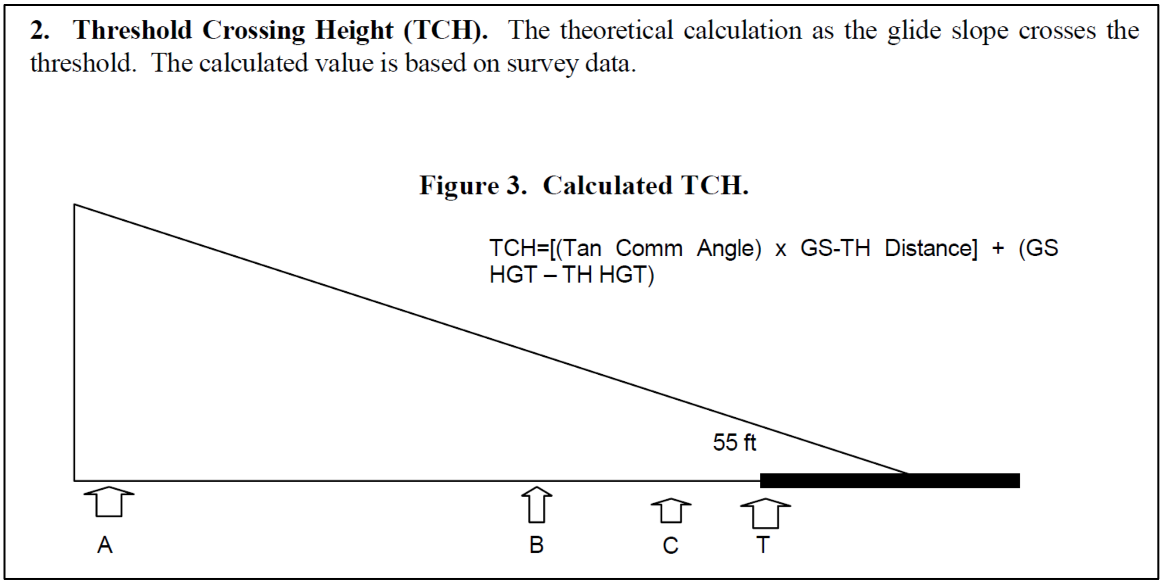
As a result, the RDH value derived from this process depends on the details of the selected method and data set, rather than representing a single invariant property of the glidepath.

<u>FAA RDH References</u>

In contrast, FAA procedures define RDH through a more explicitly prescribed analytical method.

In FAA Order 8240.47, RDH is determined using a best-fit straight-line (BFSL) derived from glidepath measurements over defined portions of the approach, with specified procedures for data selection, regression, and reference point definition. The mathematics for the BFSL based procedure for determining RDH are clearly defined and a worked example is provided for clarity and reference. This approach provides a consistent and reproducible implementation.

TCH related reference from FAA Order 8200.1 below:



2. Threshold Crossing Height (TCH). The theoretical calculation as the glide slope crosses the threshold. The calculated value is based on survey data.

Figure 3. Calculated TCH.

TCH=[(Tan Comm Angle) x GS-TH Distance] + (GS HGT – TH HGT)

RDH related reference from FAA Order 8200.1 below:

Parameter	Reference	Inspection		Tolerance/Limit
		C	P	
Reference Datum Height (RDH)	15.5.h	X		CAT I: Maximum 60 ft CAT II and III: 50 to 60 ft. (Also CAT I authorized use below CAT I minima)

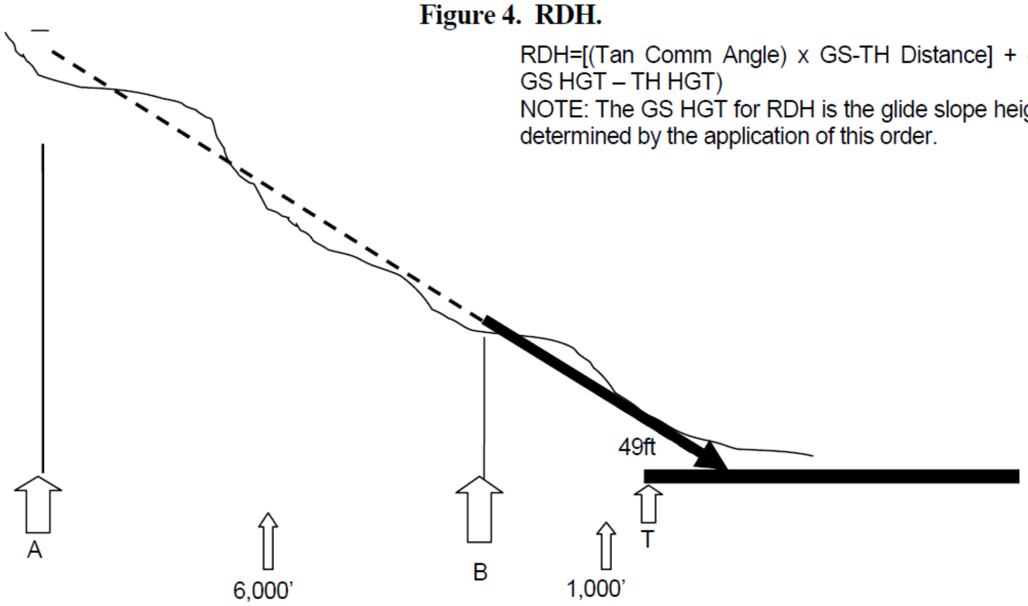
RDH related definitions from FAA Order 8240.47 below:

1. **Best Fit Straight Line (BFSL).** A straight line segment of the glidepath derived by using a least squares mathematical technique. The slope of this straight line defines the height of the glidepath angle relative to the approach surface baseline and threshold. Upon application of this order, the BFSL in ILS Zone 2, projected through the threshold to the runway surface, becomes the RDH reference.

3. **ILS Reference Datum Height (RDH).** The height of the commissioned glidepath located vertically above the runway threshold. The RDH is computed the same as the TCH except the glide slope height is the derived glide slope height computed after the application of this order. RDH is synonymous with the ILS reference datum as defined in the International Civil Aviation Organization (ICAO) Annex 10.

Figure 4. RDH.

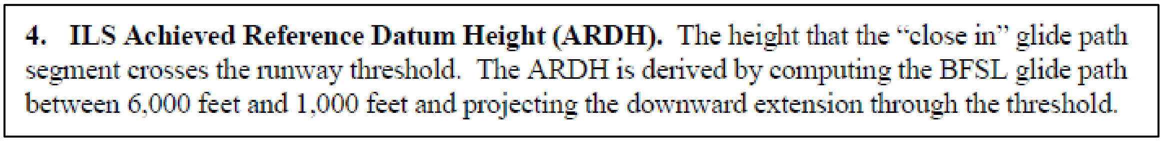
RDH=[(Tan Comm Angle) x GS-TH Distance] + (AFIS GS HGT – TH HGT)
NOTE: The GS HGT for RDH is the glide slope height as determined by the application of this order.



FAA ARDH References

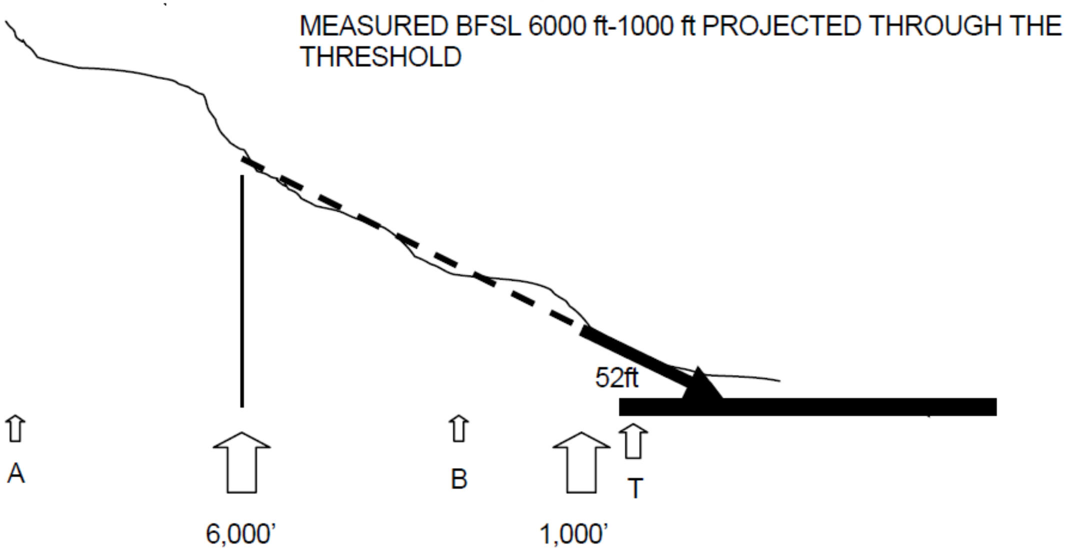
FAA defines a related parameter, Achieved Reference Datum Height (ARDH), which is determined using a similar regression method over a different portion of the approach, 6000 to 1000 feet from threshold. This range is similar, but not identical, to the ICAO suggested Cat II/III analysis range of “the last nautical mile of the approach”. ARDH exhibits the same method dependencies as RDH.

ARDH related definitions from FAA Order 8240.47 below:



4. **ILS Achieved Reference Datum Height (ARDH).** The height that the “close in” glide path segment crosses the runway threshold. The ARDH is derived by computing the BFSL glide path between 6,000 feet and 1,000 feet and projecting the downward extension through the threshold.

Figure 5. ARDH.



4. Historical Development of RDH Determination Methods

The current approach to determining RDH did not originate from a formal definition in standards, but from practical flight inspection problems encountered in the field. Early ILS implementations treated the glidepath as a geometric entity defined by antenna siting and nominal angle, with threshold crossing height derived from installation geometry. In practice, this assumption proved incomplete.

United States Air Force (USAF) and Origin of Regression Analysis Method

Flight inspection experience in the 1970s and early 1980s, particularly within USAF TRACALS evaluation programs, showed that real glidepath signals do not behave as ideal straight lines. Measured glidepath structure routinely exhibited curvature, bends, and localized variations caused by terrain, reflections, and environmental effects. These observations made it clear that a purely geometric interpretation of the glidepath was not sufficient to describe actual system performance.

A key step forward came with the application of statistical methods to glidepath analysis. In 1982, a USAF flight inspection engineer with the USA, Capt. Harvey Leister, presented a method using linear regression to analyze measured glide slope structure and improve the positioning of ground-based tracking instruments [Leister, 1982]. Although the stated objective was to determine optimal theodolite placement, the underlying method was more significant. The glidepath was treated as a set of measured data points, and a best-fit straight line was derived using least-squares regression.

This represented a fundamental shift. Instead of assuming a geometric glidepath and measuring deviations from it, the glidepath itself was defined from the data. The “best-fit” line became the reference, rather than the installation geometry.

FAA Implementation in Order 8240.47

This same concept appears only a short time later in FAA flight inspection procedures. FAA Order 8240.47 formalized the use of a best-fit straight line (BFSL) to determine glidepath characteristics, including RDH. The BFSL is mathematically equivalent to a least-squares regression of measured glidepath data. While the Order does not cite earlier USAF work, the methodology is the same: derive a representative straight line from measured data and use it to define glidepath parameters.

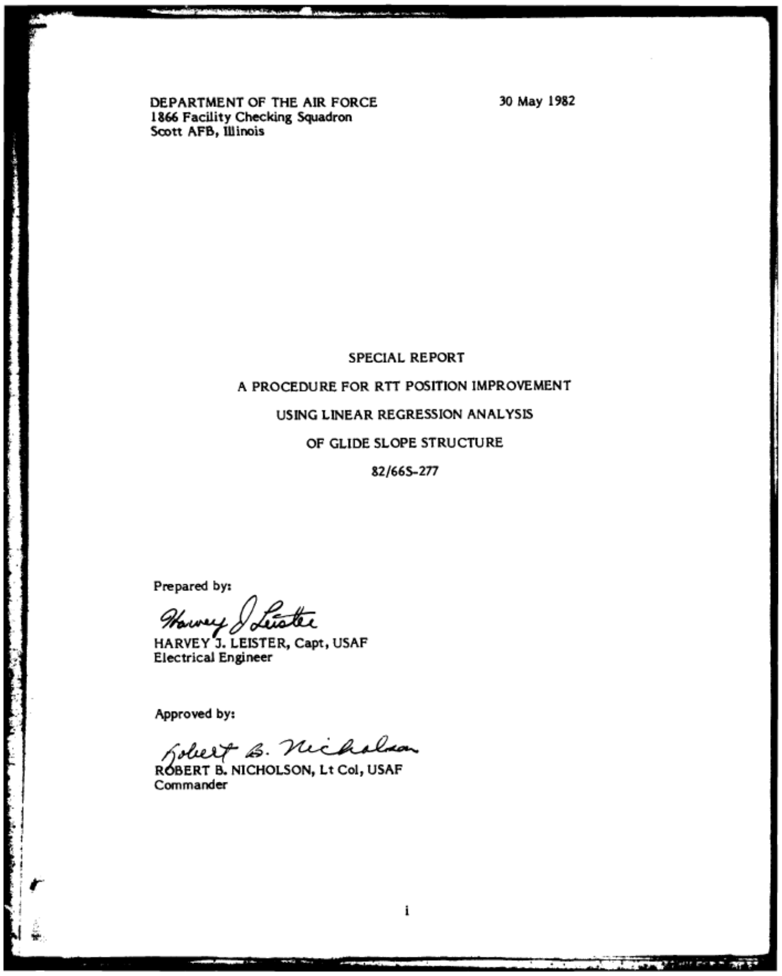
During this period, the practical implications of this approach were well understood by those involved in its development. In discussions with the FAA in the mid-1980s, Lyle Wink—closely associated with the development of FAA Order 8240.47—summarized the method by stating that it could have been called “Where to Put the Theodolite.” This observation reflects the underlying problem being solved: determining a representative glidepath from imperfect, spatially distributed measurements.

The evolution from geometric assumptions to regression-based methods can therefore be understood as a progression:

- From a nominal, installation-defined glidepath,
- To measured glidepath structure observed in USAF TRACALS real-world data,
- To statistical representation of that structure using regression,
- Finally to formalization of those methods in flight inspection procedures.

ICAO Formal Adoption of the Linear Regression and BFSL

Paragraph 4.3.81, which specifically defines the methodology for determining the Reference Datum Height (RDH) during flight testing, was introduced with the Fifth Edition of ICAO Doc 8071, Volume I, published in 2018. This addition was part of a major overhaul of the manual primarily motivated by Amendment 84 to Annex 10, which became applicable in 2009. The update aimed to resolve long-standing ambiguities regarding the measurement of RDH and Threshold Crossing Height (TCH) by formalizing the use of high-quality approach recordings and linear regression to calculate these values.



DEPARTMENT OF THE AIR FORCE
1866 Facility Checking Squadron
Scott AFB, Illinois

30 May 1982

SPECIAL REPORT

A PROCEDURE FOR RTT POSITION IMPROVEMENT

USING LINEAR REGRESSION ANALYSIS

OF GLIDE SLOPE STRUCTURE

82/66S-277

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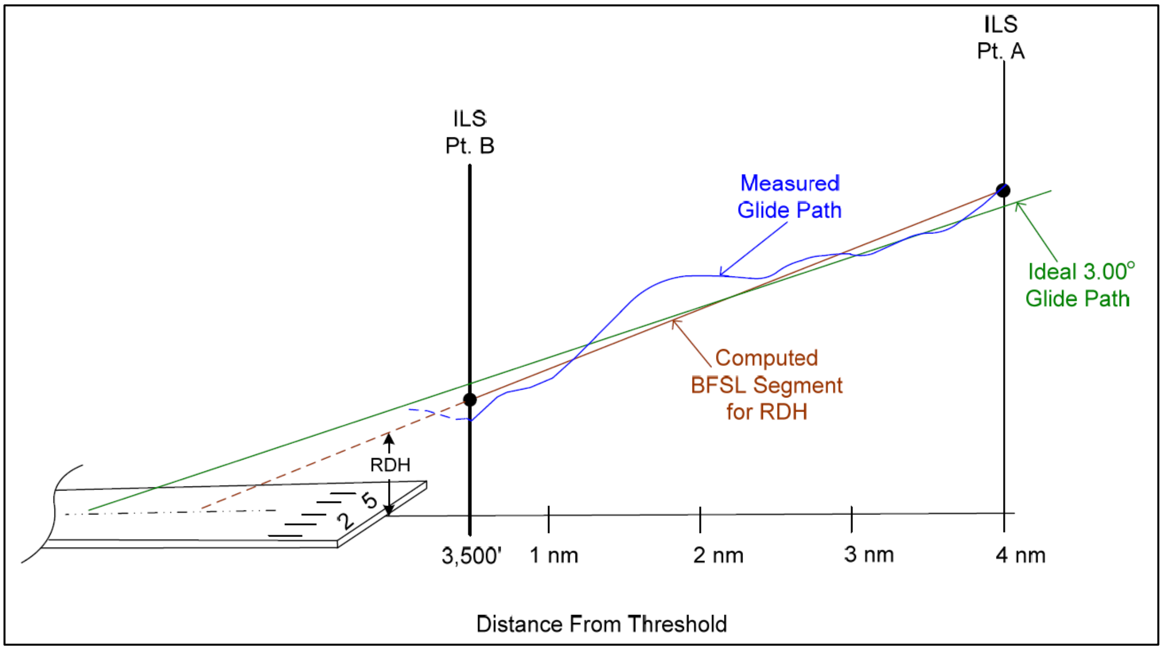
5. RDH Determination Using Linear Regression Method

Reference Datum Height (RDH) is not measured directly at the runway threshold. It is derived from flight inspection data by forming a straight-line representation of the glidepath and extrapolating that line to the threshold.

In practice, this process begins with a recording of the glidepath signal. Measurements of actual glidepath angle along the ILS approach are obtained over a selected portion of the approach. The data are converted to rectangular coordinates and processed using a least-squares regression to define a best-fit straight line (BFSL) representing the glidepath over that segment.

The BFSL is extended toward the runway and its height above threshold is the RDH. The slope of this line is generally not equal to the nominal glidepath angle, reflecting the curvature of the underlying signal.

This is illustrated below in a figure borrowed from Ohio University TM-15689/0006-1.



RDH methodology showing extension of BFSL from measured data samples between ILS Points A and B extended to threshold. In this example the RDH is less than the designed TCH for the 3.00 degree angle.

This approach is consistent with the method described in ICAO Doc 8071, where regression is applied to selected portions of the approach to determine RDH, and with FAA procedures in Order 8240.47, where the best-fit straight line (BFSL) is explicitly defined and used as the basis for glidepath parameter determination.

The key point is that the straight line used to determine RDH is not a physical feature of the glidepath. It is a mathematical construct derived from measured data. The resulting RDH value is therefore dependent on how that line is formed.

Several factors directly influence the result:

- **Data Selection** — The portion of the approach used in the regression affects the slope and position of the best-fit line. ICAO guidance allows different segments to be used, and FAA procedures define specific regions, but in both cases the choice of data influences the outcome.
- **Signal Structure** — The glidepath is not perfectly linear. As shown earlier, the actual signal-in-space follows a hyperbolic form, and will always include some variations due to terrain and other effects. The regression process approximates this structure with a straight line, introducing a modeling dependency.
- **Reference Point Definition** — The derived glidepath parameters depend on the coordinate system used for analysis. In FAA procedures, this is addressed through the aiming point concept, which itself is derived from the regression process.
- **Analytical Method** — While least-squares regression is commonly used, ICAO guidance allows “alternative” analytical techniques if tolerances are not met. What is meant by “alternative” is not defined. This further reinforces that RDH is not uniquely defined by a single method.

Because of these dependencies, RDH is inherently a method-dependent parameter. Different implementations, using different data segments or analytical choices, can produce different RDH values for the same physical glidepath.

This is consistent with the historical development of the method. As discussed in the previous section, the use of regression-based techniques originated as a practical solution to interpreting measured glidepath structure. The modern BFSL method is a direct extension of that approach.

The important conclusion is that RDH should not be interpreted as a direct measurement of glidepath height at the threshold. It is the result of fitting a straight-line model to a curved and potentially non-uniform signal. As such, it reflects the analysis method as much as the underlying signal-in-space.

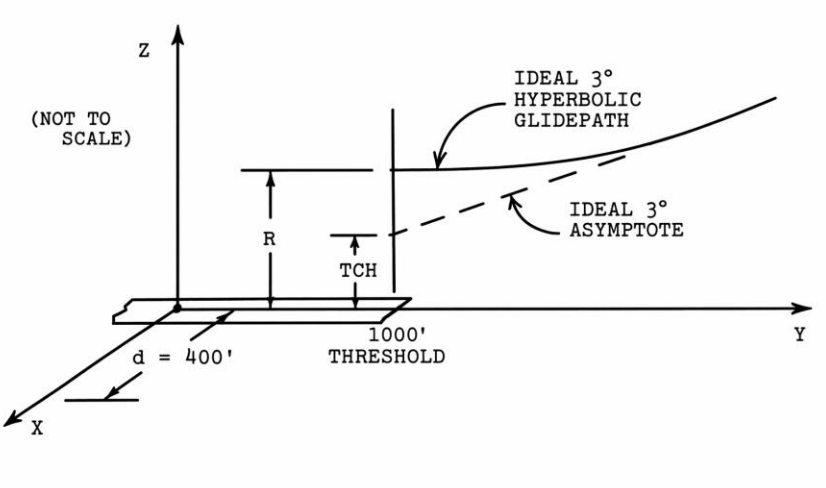
6. Ideal Glidepath Example

In a previous document written by this author in 1985 an ideal glidepath was analyzed using an ILS mathematical model. The glidepath was modeled as perfect image-type system over flat terrain, producing a zero DDM locus that follows the expected hyperbolic form. Note that no attempt was made to set the glidepath backset for a specific TCH; at that time it was common practice to use simple rounded values of 1000' backset and 400' offset to evaluate glide slope characteristics with math models. The intent was to discover general trends and effects, not to calculate absolute numbers.

The diagram below is a reproduction of a diagram from that paper showing the relationship between four different representations of the glidepath:

- Ideal hyperbolic glidepath, defined by the zero DDM locus
- Straight-line asymptote to the hyperbola (indicated as TCH)
- RDH (derived from ILS Point A to Point B)
- ARDH (derived from 6,000 to 1,000 feet from threshold).

These four representations describe the same physical signal-in-space, but they produce different results at to the runway threshold.



Parameter	Value (ft)	Description
R	56.4	Hyperbolic glidepath (zero DDM)
TCH	52.4	Straight-line asymptote
RDH	53.1	BFSL-derived value from Point A to Point B
ARDH	54.4	BFSL-derived value from 6000' to 1000'

Comparison of Various Heights at Threshold for an Ideal Glide Slope Site, with Antennas located as shown, for a Path Angle of 3.0 degrees

The hyperbolic glidepath represents the true signal-in-space. As discussed previously, this curvature is a natural consequence of the image-type formation of the glidepath and is not an error. The straight-line asymptote provides a geometric approximation at long range, while the two BFSL's represent the result of applying a regression-based method over two different segments of the approach.

Even in the absence of terrain or signal distortion, the RDH and ARDH values differ from the true glidepath height at the threshold. This difference is not an error, but a direct consequence of representing a curved signal with a straight-line model.

The true glidepath height is defined by the hyperbolic signal-in-space. The asymptote provides a geometric approximation, while RDH and ARDH are derived from regression-based methods. Each produces a different result, even for a perfect glidepath, and even though they are based on the same underlying signal.

This demonstrates that RDH is not simply a measurement of glidepath height. It is the result of applying a particular model to the data. The difference between these values is small in the ideal case, but it is inherent to the method and cannot be eliminated.

In real-world conditions, where terrain and signal structure introduce additional variation, these differences can become more significant, as discussed in the following sections.

7. Reference Point Effects

The determination of glidepath parameters depends not only on the signal-in-space, but also on the position from which that signal is observed.

The glidepath itself is a property of the transmitted signal and is independent of the observer. However, the measured glidepath angle and the parameters derived from it depend on the geometric relationship between the aircraft and the ground facility.

In flight inspection analysis, this relationship is defined by the choice of reference point. In FAA procedures, this is addressed through the concept of the aiming point, which establishes a consistent geometric origin for the calculation. In ICAO guidance, the reference point is implicit in the selection of the data used for regression.

Changing the reference point changes the observed angles, even though the underlying glidepath does not change. As a result, the derived straight-line representation—and therefore the resulting RDH—may also change depending on the reference geometry used in the analysis.

This effect can be understood by considering that glidepath angle is measured as the angle between the aircraft and the ground antenna. If the reference position is shifted, the same physical point in space will be observed under a different angle. When these angles are used in a regression to form a best-fit line, the resulting line—and its intercept at the threshold—will reflect that change.

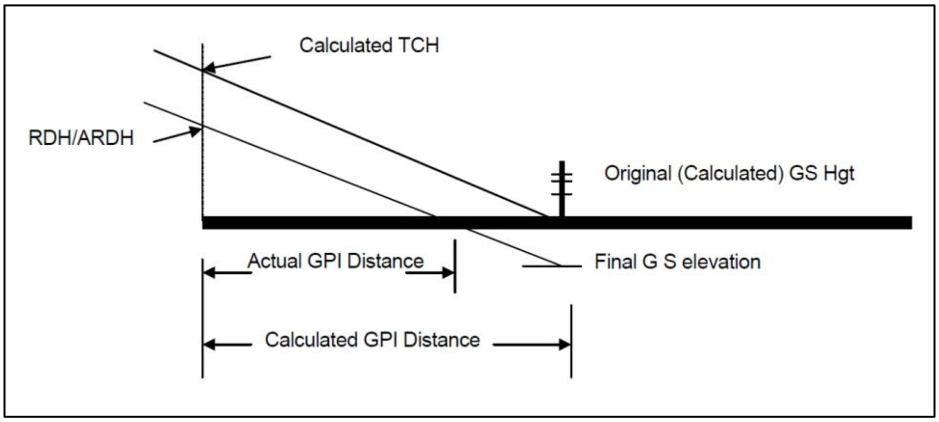
The important point is that the glidepath itself does not change. What changes is the way it is represented in the analysis.

In practice, properly implemented methods account for this effect through consistent definition of the reference point. However, the dependence on reference geometry reinforces the fact that RDH is not a direct measurement, but a value derived from a specific analytical framework.

8. Aiming Point Adjustment

To address the dependence of glidepath measurements on reference geometry, FAA procedures introduce the concept of an aiming point. This provides a consistent reference location from which glidepath angles are evaluated and allows for repeatable determination of glidepath parameters.

In FAA Order 8240.47, the aiming point is not fixed a priori, but is derived as part of the analysis. The best-fit straight line (BFSL) is used to determine the glidepath angle and intercept, and from this the effective reference geometry is established. The figure below from 8240.47 indicates how the aiming point is adjusted based on the RDH/ARDH calculation results.



However, this also introduces an important dependency. The same regression used to define the glidepath is used to define the reference point from which it is measured. In this sense, the aiming point is not an independent physical quantity, but part of the analytical framework used to describe the glidepath.

The result is that the derived glidepath parameters, including RDH and ARDH, are self-consistent within the chosen method, but remain dependent on that method. Different choices in data selection or analysis will produce a different best-fit line, which in turn produces a different effective reference geometry.

This does not represent an error in the method. It is a necessary consequence of representing a curved and potentially non-uniform signal with a straight-line model. The aiming point provides a practical means of standardizing the calculation, but it does not remove the underlying model dependence.

The important point is that the aiming point does not define the glidepath. It defines how the glidepath is represented in the analysis.

9. Terrain Effects

Terrain influences glidepath performance in two distinct ways: through its effect on the formation of the signal-in-space, and through its effect on the geometric reference used for analysis.

The ILS glidepath is formed by the interaction of direct and reflected signals. As a result, variations in terrain in front of the antenna can alter the balance of these components and produce measurable changes in glidepath structure.

In practice, this means that the glidepath may not follow a smooth, idealized hyperbolic form. Instead, localized terrain features introduce changes in glidepath indications along the approach path. When a straight-line regression is applied to this data, these variations can bias the resulting best-fit line.

This has a direct effect on derived parameters such as RDH. A change in glidepath angle over part of the approach can shift the slope of the best-fit line, which in turn changes its intercept at the threshold. The resulting RDH value may therefore differ from both the nominal value and the actual glidepath height at the threshold.

This effect was observed during the commissioning of a Category 2 glide path Runway 18R at Dallas/Fort Worth Airport (DFW). A copy of a flight inspection approach recording for that facility from is below. The chart shows the glidepath exhibited a gradual decrease in angle throughout Zone 2 (between ILS Points A and B).

Further analysis and mathematical showed that this behavior was caused by terrain features in front of the antenna, specifically shallow drainage depressions between taxiways. These features altered the reflected signal and produced a measurable change in glidepath structure.

When standard regression methods were applied, the resulting RDH of approximately 44 feet was well below the specified Category 2 tolerance of 55 ± 5 feet for this facility.

Additional analysis and operational data showed that the glidepath continued to provide stable and repeatable guidance to aircraft.

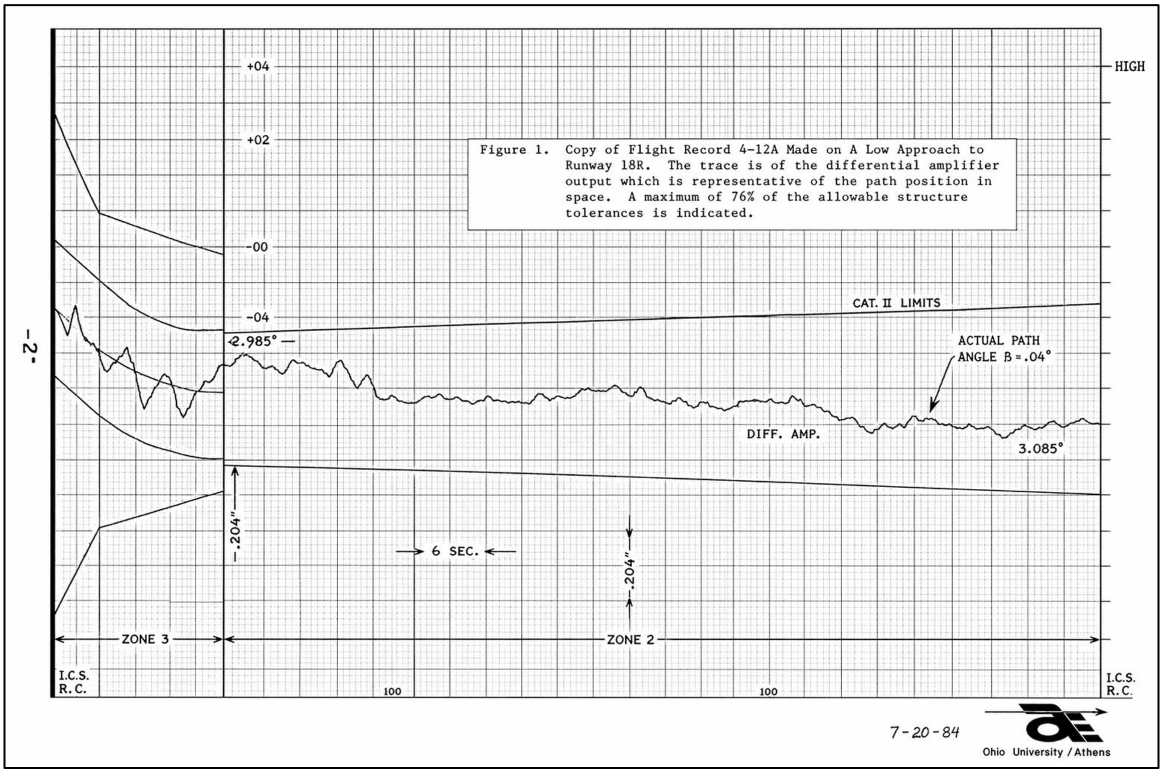


Figure 1. Copy of Flight Record 4-12A Made on A Low Approach to Runway 18R. The trace is of the differential amplifier output which is representative of the path position in space. A maximum of 76% of the allowable structure tolerances is indicated.

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Glidepath approach recording from DFW Runway 18R showing decreasing angle between ILS Points A and B. The facility met all Category 2 commissioning requirements except the then new RDH specification. The steadily decreasing angle caused an out-of-tolerance RDH that was too low, but empirical measurements of actual commercial aircraft flying coupled ILS approaches proved that aircraft were crossing the threshold at nearly the ideal height.

Empirical measurements of antenna crossing heights at the threshold, using actual coupled ILS approaches by commercial aircraft, were made and confirmed that threshold crossing heights remained near nominal values, despite the low value of RDH. In other words, the derived parameter indicated a deficiency, while the actual system performance remained acceptable. In this case, strict application of RDH tolerance alone would have led to rejection of a glidepath that was demonstrably safe in operation.

This example illustrates an important limitation of RDH. The parameter is sensitive to variations in glidepath structure, even when those variations do not significantly affect aircraft guidance. As a result, RDH may indicate non-compliance in cases where the system is performing satisfactorily from an operational standpoint.

This does not imply that RDH is not useful. Rather, it demonstrates that RDH must be interpreted in the context of the underlying signal structure and supported by additional analysis where necessary.

10. Operational Observations

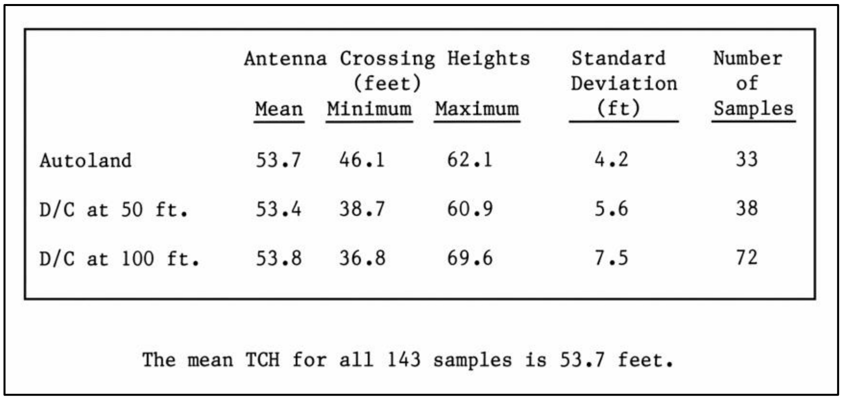
Operational measurements provide a direct means of evaluating glidepath performance independent of derived parameters such as RDH.

A particularly instructive example was observed at Dallas-Fort Worth (DFW) Runway 18R. As described in the previous section, the glidepath exhibited a steadily decreasing angle within Zone 2 due to terrain-induced effects. When standard regression methods were applied, the resulting RDH fell below the specified tolerance for the facility.

Ohio University measured actual aircraft antenna crossing heights during autopilot-coupled ILS approaches. These measurements represent the actual response of aircraft tracking the glidepath signal-in-space, and therefore provide a practical indication of system performance at the runway threshold.

These measurements showed that antenna crossing heights remained near nominal values and were consistent with safe and acceptable operation. The glidepath continued to provide stable guidance to aircraft, and delivered them correctly to the correct height at threshold, despite the apparent non-compliance indicated by the derived RDH value.

The results showed that aircraft antenna crossing heights were consistently near nominal values. The mean crossing height for the data set was approximately 53.7 feet, with relatively small variation across a large number of approaches.



	Antenna Crossing Heights (feet)			Standard Deviation (ft)	Number of Samples
	Mean	Minimum	Maximum		
Autoland	53.7	46.1	62.1	4.2	33
D/C at 50 ft.	53.4	38.7	60.9	5.6	38
D/C at 100 ft.	53.8	36.8	69.6	7.5	72

The mean TCH for all 143 samples is 53.7 feet.

Glidepath antenna crossing heights measured during autopilot coupled ILS approaches by commercial aircraft at DFW Runway 18R Category 2 glidepath. Designed TCH was 55 feet, the flight inspection measured RDH was 44 feet, and the user aircraft were safely delivered to the runway at 53.7 feet.

A notable feature of the data is that the standard deviation of crossing height decreased as the aircraft remained coupled closer to the threshold. This indicates that the aircraft were not only tracking the glidepath accurately, but that the tracking performance improved as the aircraft approached the runway.

These observations are significant. They show that aircraft follow the actual glidepath signal-in-space, not the straight-line approximation used to derive RDH. The measured crossing heights therefore reflect the true operational performance of the system.

In this case, strict application of RDH tolerance alone would have led to rejection of a glidepath that was demonstrably safe in operation.

These results highlight an important distinction. RDH is a derived parameter based on a particular analytical model, while aircraft crossing height is a direct measure of operational performance. When the two differ, the aircraft data provides the more relevant indication of system behavior.

This does not diminish the value of RDH as an engineering parameter. However, it does demonstrate that RDH should not be used in isolation as a primary acceptance criterion without consideration of the underlying glidepath structure and actual aircraft performance.

11. Conclusions

This paper has examined the concept of Reference Datum Height (RDH) from geometric, analytical, and operational perspectives.

The analysis shows that the ILS glidepath is inherently a curved surface, with the zero DDM locus following a hyperbolic form. The use of a straight-line representation to describe this path is therefore an approximation, not a direct representation of the signal-in-space.

Both ICAO and FAA procedures determine RDH by applying a regression-based method to measured glidepath data. The resulting best-fit straight line (BFSL) is then used to derive glidepath parameters, including RDH. This approach is a practical and effective means of analyzing flight inspection data, but it introduces a dependence on the selected data set, reference geometry, and analytical method.

As a result, RDH is not a unique physical property of the glidepath. It is a derived parameter that reflects the method used to calculate it. Even under ideal conditions, different representations of the same glidepath—hyperbolic, asymptotic, and regression-based—produce different threshold crossing heights.

In real-world conditions, additional factors such as terrain-induced signal distortion can further influence the derived RDH value. These effects may cause RDH to fall outside specified tolerances, even when the glidepath continues to provide stable and accurate guidance to aircraft.

Operational data confirm that aircraft track the actual signal-in-space, not the straight-line model used in RDH determination. Measured aircraft antenna crossing heights provide a direct indication of glidepath performance at the threshold, and in some cases differ from the values implied by RDH.

These results demonstrate that RDH, while useful as an engineering parameter, does not in all cases provide a reliable indication of actual aircraft threshold crossing performance. In particular, strict application of RDH tolerances alone may lead to rejection of glidepaths that are operationally safe and effective.

12. Recommendations

1. RDH should be interpreted in conjunction with glidepath structure, signal quality, and other flight inspection parameters. It should not be treated as a standalone indicator of system performance. RDH should not be used in isolation.
2. Variations in glidepath angle and curvature, particularly within Zone 2, should be analyzed as part of the evaluation process. These variations may explain deviations in RDH without indicating a loss of operational performance.
3. Operational data should be considered where available.
4. Measured aircraft antenna crossing heights provide a direct indication of system performance and should be used to support engineering assessment, particularly in cases where RDH does not meet specified tolerances.
5. Flexibility in analytical methods should be applied judiciously, and reasoning should be documented and attached to the flight inspections reports to create a record for future reference.
6. Where permitted by existing guidance, alternative data selections or analytical techniques may be appropriate to better represent the glidepath behavior. Such adjustments should be supported by engineering analysis and operational evidence.
7. Standards and guidance material should be clarified in order to allow comparison of results from (a) different flight inspection service providers and (b) different flight inspection systems.
8. ICAO and FAA documentation should clearly distinguish between the physical glidepath and its analytical representation. The method-dependent nature of RDH should be explicitly recognized to avoid misinterpretation of the parameter.

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