Federal Aviation Administration, DOT

§ 171.313

(2) Organization and timing. The organization and timing of digital auxiliary data must be as specified in Table 7b. Data containing digital information must be transmitted with the least significant bit first. Alphanumeric data characters must be encoded in accordance with the 7-unit code character set as defined by the American National Standard Code for Information Interchange (ASCII). An even parity bit is added to each character. Alphanumeric data must be transmitted in the order in which they are to be read. The serial transmission of a character must be with the lower order bit transmitted first and the parity bit transmitted last. The timing for alphanumeric auxiliary data must be as shown in Table 7c.

(3) Auxiliary Data A content: The data items specified in Table 8c are defined as follows:

(i) Approach azimuth antenna offset shall represent the minimum distance between the Approach Azimuth antenna phase center and the vertical plane containing the runway centerline.

(ii) Approach azimuth to MLS datum point distance shall represent the minimum distance between the Approach Azimuth antenna phase center and the vertical plane perpendicular to the centerline which contains the MLS datum point.

(iii) Approach azimuth alignment with runway centerline shall represent the minimum angle between the approach azimuth antenna zero-degree guidance plane and the runway centerline.

(iv) Approach azimuth antenna coordinate system shall represent the coordinate system (planar or conical) of the angle data transmitted by the approach azimuth antenna.

(v) Approach elevation antenna offset shall represent the minimum distance between the elevation antenna phase center and the vertical plane containing the runway centerline.

(vi) MLS datum point to threshold distance shall represent the distance measured along the runway centerline from the MLS datum point to the runway threshold.

(vii) Approach elevation antenna height shall represent the height of the elevation antenna phase center relative to the height of the MLS datum point.

(viii) DME offset shall represent the minimum distance between the DME antenna phase center and the vertical plane containing the runway centerline.

(ix) DME to MLS datum point distance shall represent the minimum distance between the DME antenna phase center and the vertical plane perpendicular to the centerline which contains the MLS datum point.

(x) Back azimuth antenna offset shall represent the minimum distance between the back azimuth antenna phase center and the vertical plane containing the runway centerline.

(xi) Back azimuth to MLS datum point distance shall represent the minimum distance between the Back Azimuth antenna and the vertical plane perpendicular to the centerline which contains the MLS datum point.

(xii) Back azimuth antenna alignment with runway centerline shall represent the minimum angle between the back azimuth antenna zero-degree guidance plane and the runway centerline.

§ 171.313 Azimuth performance requirements.

This section prescribes the performance requirements for the azimuth equipment of the MLS as follows:

(a) Approach azimuth coverage requirements. The approach azimuth equipment must provide guidance information in at least the following volume of space (see Figure 9):

### Table 8b—Auxiliary Data Word Address Codes

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Note: Parity bits I19 and I20 are chosen to satisfy the equations:

\[ I_{19} + I_{15} + I_{16} + I_{17} + I_{18} + I_{19} = \text{EVEN} \]
\[ I_{14} + I_{16} + I_{18} + I_{20} = \text{EVEN} \]

### Table 8c—Auxiliary Data

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<th>Word (See note 6)</th>
<th>Data content</th>
<th>Type of data</th>
<th>Maximum time between transmissions (Seconds)</th>
<th>Bits used</th>
<th>Range of values</th>
<th>Least significant bit</th>
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Federal Aviation Administration, DOT

§ 171.313

TABLE 8C—AUXILIARY DATA—Continued

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NOTE 1: Parity bits I₀ to I₁₆ are chosen to satisfy the equations which follow:

For BIT I₁₀:

Even: $(I₁₃ + \ldots + I₁₆) + I₁₃ + I₁₂ + I₁₁ + I₁₀ + I₉ + I₈ + I₇ + I₆ + I₅$ + I₄ + I₃ + I₂ + I₁ + I₀

Odd: $(I₁₃ + \ldots + I₁₆) + I₁₃ + I₆ + I₉ + I₁₂ + I₁₁ + I₁₀ + I₉ + I₈ + I₇ + I₆ + I₅$ + I₄ + I₃ + I₂ + I₁ + I₀

For BIT I₁₇:

Even: $(I₁₃ + \ldots + I₁₆) + I₁₃ + I₃ + I₁₂ + I₁₁ + I₁₀ + I₉ + I₈ + I₇ + I₆ + I₅ + I₄ + I₃ + I₂ + I₁ + I₀$

Odd: $(I₁₃ + \ldots + I₁₆) + I₁₃ + I₆ + I₉ + I₁₂ + I₁₁ + I₁₀ + I₉ + I₈ + I₇ + I₆ + I₅ + I₄ + I₃ + I₂ + I₁ + I₀$

For BIT I₂₅:

Even: $(I₁₃ + \ldots + I₁₆) + I₁₃ + I₃ + I₁₂ + I₁₁ + I₁₀ + I₉ + I₈ + I₇ + I₆ + I₅ + I₄ + I₃ + I₂ + I₁ + I₀$

Odd: $(I₁₃ + \ldots + I₁₆) + I₁₃ + I₆ + I₉ + I₁₂ + I₁₁ + I₁₀ + I₉ + I₈ + I₇ + I₆ + I₅ + I₄ + I₃ + I₂ + I₁ + I₀$

For BIT I₃₃:

Even: $(I₁₃ + \ldots + I₁₆) + I₁₃ + I₃ + I₁₂ + I₁₁ + I₁₀ + I₉ + I₈ + I₇ + I₆ + I₅ + I₄ + I₃ + I₂ + I₁ + I₀$

Odd: $(I₁₃ + \ldots + I₁₆) + I₁₃ + I₆ + I₉ + I₁₂ + I₁₁ + I₁₀ + I₉ + I₈ + I₇ + I₆ + I₅ + I₄ + I₃ + I₂ + I₁ + I₀$

For BIT I₄₁:

Even: $(I₁₃ + \ldots + I₁₆) + I₁₃ + I₃ + I₁₂ + I₁₁ + I₁₀ + I₉ + I₈ + I₇ + I₆ + I₅ + I₄ + I₃ + I₂ + I₁ + I₀$

Odd: $(I₁₃ + \ldots + I₁₆) + I₁₃ + I₆ + I₉ + I₁₂ + I₁₁ + I₁₀ + I₉ + I₈ + I₇ + I₆ + I₅ + I₄ + I₃ + I₂ + I₁ + I₀$

For BIT I₄₉:

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Odd: $(I₁₃ + \ldots + I₁₆) + I₁₃ + I₆ + I₉ + I₁₂ + I₁₁ + I₁₀ + I₉ + I₈ + I₇ + I₆ + I₅ + I₄ + I₃ + I₂ + I₁ + I₀$

For BIT I₅₇:

Even: $(I₁₃ + \ldots + I₁₆) + I₁₃ + I₃ + I₁₂ + I₁₁ + I₁₀ + I₉ + I₈ + I₇ + I₆ + I₅ + I₄ + I₃ + I₂ + I₁ + I₀$

Odd: $(I₁₃ + \ldots + I₁₆) + I₁₃ + I₆ + I₉ + I₁₂ + I₁₁ + I₁₀ + I₉ + I₈ + I₇ + I₆ + I₅ + I₄ + I₃ + I₂ + I₁ + I₀$

For BIT I₆₅:

Even: $(I₁₃ + \ldots + I₁₆) + I₁₃ + I₃ + I₁₂ + I₁₁ + I₁₀ + I₉ + I₈ + I₇ + I₆ + I₅ + I₄ + I₃ + I₂ + I₁ + I₀$

Odd: $(I₁₃ + \ldots + I₁₆) + I₁₃ + I₆ + I₉ + I₁₂ + I₁₁ + I₁₀ + I₉ + I₈ + I₇ + I₆ + I₅ + I₄ + I₃ + I₂ + I₁ + I₀$

For BIT I₇₃:

Even: $(I₁₃ + \ldots + I₁₆) + I₁₃ + I₃ + I₁₂ + I₁₁ + I₁₀ + I₉ + I₈ + I₇ + I₆ + I₅ + I₄ + I₃ + I₂ + I₁ + I₀$

Odd: $(I₁₃ + \ldots + I₁₆) + I₁₃ + I₆ + I₉ + I₁₂ + I₁₁ + I₁₀ + I₉ + I₈ + I₇ + I₆ + I₅ + I₄ + I₃ + I₂ + I₁ + I₀$

For BIT I₈₁:

Even: $(I₁₃ + \ldots + I₁₆) + I₁₃ + I₃ + I₁₂ + I₁₁ + I₁₀ + I₉ + I₈ + I₇ + I₆ + I₅ + I₄ + I₃ + I₂ + I₁ + I₀$

Odd: $(I₁₃ + \ldots + I₁₆) + I₁₃ + I₆ + I₉ + I₁₂ + I₁₁ + I₁₀ + I₉ + I₈ + I₇ + I₆ + I₅ + I₄ + I₃ + I₂ + I₁ + I₀$

邮寄：The convention for the antenna location is as follows: As viewed from the MLS approach reference datum looking toward the datum point, a positive number shall represent a location to the right of the runway centerline (lateral offset) or above the runway (vertical offset), or towards the stop end of the runway (longitudinal distance).

The convention for the antenna alignment is as follows: As viewed from above, a positive number shall represent clockwise rotation from the runway centerline to the respective zero-degree guidance plane.

Data Word A3 is transmitted at intervals of 1.33 seconds or less throughout the approach azimuth sector, except when back azimuth guidance is provided. Where back azimuth is provided transmit at intervals of 1.33 seconds or less throughout the back azimuth coverage sector.

When back azimuth guidance is provided, transmit at intervals of 1.33 seconds or less throughout the back azimuth coverage sector and 4.0 seconds or less throughout the approach azimuth coverage sector.

The designation “A1” represents the function identification code for “Auxiliary Data A” and address code number 1.

837
§ 171.313 14 CFR Ch. I (1–1–13 Edition)

(1) Horizontally within a sector plus or minus 40 degrees about the runway centerline originating at the datum point and extending in the direction of the approach to 20 nautical miles from the runway threshold. The minimum proportional guidance sector must be plus or minus 10 degrees about the runway centerline. Clearance signals must be used to provide the balance of the required coverage, where the proportional sector is less than plus or minus 40 degrees. When intervening obstacles prevent full coverage, the ±40° guidance sector can be reduced as required. For systems providing ±60° lateral guidance
the coverage requirement is reduced to 14 nm beyond ±40°.

(2) Vertically between:
   (i) A conical surface originating 2.5 meters (8 feet) above the runway centerline at threshold inclined at 0.9 degree above the horizontal.
   (ii) A conical surface originating at the azimuth ground equipment antenna inclined at 15 degrees above the horizontal to a height of 6,000 meters (20,000 feet).
   (iii) Where intervening obstacles penetrate the lower surface, coverage need be provided only to the minimum line of sight.

(3) Runway region:
   (i) Proportional guidance horizontally within a sector 45 meters (150 feet) each side of the runway centerline beginning at the stop end and extending parallel with the runway centerline in the direction of the approach to join the approach region. This requirement does not apply to offset azimuth installations.
   (ii) Vertically between a horizontal surface which is 2.5 meters (8 feet) above the farthest point of runway centerline which is in line of sight of the azimuth antenna, and in a conical surface originating at the azimuth ground equipment antenna inclined at 20 degrees above the horizontal up to a height to 600 meters (2,000 feet). This requirement does not apply to offset azimuth installations.

(4) Within the approach azimuth coverage sector defined in paragraphs (a) (1), and (2) and (3) of this section, the power densities must not be less than those shown in Table 9 but the equipment design must also allow for:
   (i) Transmitter power degradation from normal by −1.5 dB;

<table>
<thead>
<tr>
<th>Function</th>
<th>Data signals</th>
<th>Angle signals for various antenna beamwidths</th>
<th>Clearance signals</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1°</td>
<td>1.5°</td>
</tr>
<tr>
<td>Approach azimuth</td>
<td>−89.5</td>
<td>−88</td>
<td>−88</td>
</tr>
<tr>
<td>High rate approach azimuth</td>
<td>−89.5</td>
<td>−88</td>
<td>−88</td>
</tr>
<tr>
<td>Back azimuth</td>
<td>−89.5</td>
<td>−88</td>
<td>−88</td>
</tr>
<tr>
<td>Approach elevation</td>
<td>−89.5</td>
<td>−88</td>
<td>−88</td>
</tr>
</tbody>
</table>

(ii) Rain loss of −2.2 dB at the longitudinal coverage extremes.

(b) Siting requirements. The approach azimuth antenna system must, except as allowed in paragraph (c) of this section:
   (1) Be located on the extension of the centerline of the runway beyond the stop end;
   (2) Be adjusted so that the zero degree azimuth plane will be a vertical plane which contains the centerline of the runway served;
   (3) Have the minimum height necessary to comply with the coverage requirements prescribed in paragraph (a) of this section;
   (4) Be located at a distance from the stop end of the runway that is consistent with safe obstruction clearance practices;
   (5) Not obscure any light of an approach lighting system; and

(6) Be installed on frangible mounts or beyond the 300 meter (1,000 feet) light bar.

(c) On runways where limited terrain prevents the azimuth antenna from being positioned on the runway centerline extended, and the cost of the land fill or a tall tower antenna support is prohibitive, the azimuth antenna may be offset.

(d) Antenna coordinates. The scanning beams transmitted by the approach azimuth equipment within ±40° of the centerline may be either conical or planar.

(e) Approach azimuth accuracy. (1) The system and subsystem errors shall not exceed those listed in Table 10 at the approach reference datum.

At the approach reference datum, temporal sinusoidal noise components shall not exceed 0.025 degree peak in the frequency band 0.01 Hz to 1.6 Hz, and the CMN shall not exceed 0.10 degree. From the approach reference
§ 171.313 14 CFR Ch. I (1–1–13 Edition)

datum to the coverage limit, the PFE,
PFN and CMN limits, expressed in an-
gular terms, shall be allowed to lin-
early increase as follows:

(i) With distance along the runway
centerline extended, by a factor of 1.2
for the PFE and PFN limits and to
±0.10 degree for the CMN limits.

(ii) With azimuth angle, by a factor
of 1.5 at the ±40 degree and a factor
of 2.0 at the ±60 degree azimuth angles
for the PFE, PFN and CMN limits.

(iii) With elevation angle from +9 de-
grees to +15 degrees, by a factor of 1.5
for the PFE and PFN limits.

(iv) Maximum angular limits. The
PFE limits shall not exceed ±0.25 de-
gree in any coverage region below an
elevation angle of +9 degrees nor ex-
ceed ±0.50 degree in any coverage re-
gion above that elevation angle. The
CMN limits shall not exceed ±0.10 de-
gree in any coverage region within ±10
degrees of runway centerline extended
nor exceed ±0.20 degree in any other re-
gion within coverage.

NOTE: It is desirable that the CMN not ex-
ceed ±0.10 degree throughout the coverage.

(f) Approach azimuth antenna char-
acteristics are as follows:

(1) Drift. Any azimuth angle as en-
coded by the scanning beam at any
point within the proportional coverage
must not vary more than ±0.07 degree
over the range of service conditions
specified in §171.309(d) without the use
of internal environmental controls. Multi-
path effects are excluded from this
requirement.

(2) Beam pointing errors. The azimuth
angle as encoded by the scanning beam
at any point within ±0.5 degree of the
zero degree azimuth must not deviate
from the true azimuth angle at that
point by more than ±0.05 degree.
Multipath and drift effects are ex-
cluded from this requirement.

TABLE 10—APPROACH AZIMUTH ACCURACIES AT
THE APPROACH REFERENCE DATUM

<table>
<thead>
<tr>
<th>Error type</th>
<th>System</th>
<th>Angular error (degrees)</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Ground subsystem</td>
<td>Airborne subsystem</td>
<td></td>
</tr>
<tr>
<td>PFE .......</td>
<td>±20 ft. (6.1m)</td>
<td>±0.118° ±0.017°</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CMN .......</td>
<td>±10.5 ft. (3.2m)</td>
<td>±0.030° ±0.050°</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes:
1 Includes errors due to ground and airborne equipment and propagation effects.
2 The system PFN component must not exceed ±3.5 meters (11.5 feet).
3 The mean (bias) error component contributed by the ground equipment should not exceed ±10 feet.
4 The system control motion noise must not exceed 0.1 de-
5 The airborne subsystem angular errors are provided for in-
formation only.

(3) Antenna alignment. The antenna
must be equipped with suitable optical,
electrical or mechanical means or any
combination of the three, to bring the
zero degree azimuth radial into coinci-
dence with the approach reference
datum (for centerline siting) with a
maximum error of 0.02 degree. Addi-
tionally, the azimuth antenna bias ad-
justment must be electronically steer-
able at least to the monitor limits in
steps not greater than 0.005 degree.

(4) Antenna far field patterns in the
plane of scan. On boresight, the azi-
muth antenna mainlobe pattern must
conform to Figure 10, and the beam-
width must be such that, in the in-
stalled environment, no significant lat-
eral reflections of the mainlobe exist
along the approach course. In any case
the beamwidth must not exceed three
degrees. Anywhere within coverage the
−3 dB width of the antenna mainlobe,
while scanning normally, must not be
less than 25 microseconds (0.5 degree)
or greater than 250 microseconds (5 de-
grees). The antenna mainlobe may be
allowed to broaden from the value at
boresight by a factor of 1/cosθ, where θ
is the angle off boresight. The sidelobe
levels must be as follows:

(i) Dynamic sidelobe levels. With the
antenna scanning normally, the dy-
namic sidelobe level that is detected by
a receiver at any point within the pro-
portional coverage sector must be
down at least 10 dB from the peak of
the main beam. Outside the coverage
sector, the radiation from the scanning
beam antenna must be of such a nature
that receiver warning will not be re-
moved or suitable OCI signals must be
provided.

(ii) Effective sidelobe levels. With the
antenna scanning normally, the side-
lobe levels in the plane of scan
must be such that, in the installed en-
vIRONMENT, the CMN contributed by
sidelobe reflections will not exceed the
angular equivalent of 9 feet at ap-
proach reference datum over the re-
quired range of aircraft approach
speeds.
(5) Antenna far field pattern in the vertical plane. The azimuth antenna free space radiation pattern below the horizon must have a slope of at least $-8\,\text{dB/degree}$ at the horizon and all sidelobes below the horizon must be at least $13\,\text{dB}$ below the pattern peak. The antenna radiation pattern above the horizon must satisfy both the system coverage requirements and the spurious radiation requirement.

(6) Data antenna. The data antenna must have horizontal and vertical patterns as required for its function.

(g) Back azimuth coverage requirements. The back azimuth equipment where used must provide guidance information in at least the following volume of space (see Figure 11):

NOTES: 1. The beam envelope is smoothed by a 26 kHz video filter before measurement.
2. $\text{BW} =$ Beamwidth.

Figure 10. Far Field Dynamic Signal in Space
(1) Horizontally within a sector ±40 degrees about the runway centerline originating at the back azimuth ground equipment antenna and extending in the direction of the missed approach at least to 20 nautical miles from the runway stop end. The minimum proportional guidance sector must be ±10 degrees about the runway centerline. Clearance signals must be
used to provide the balance of the required coverage where the proportional sector is less than ±40 degrees.

(2) Vertically in the runway region between:
   (i) A horizontal surface 2.5 meters (8 feet) above the farthest point of runway centerline which is in line of sight of the azimuth antenna, and,
   (ii) A conical surface originating at the azimuth ground equipment antenna inclined at 20 degrees above the horizontal up to a height of 600 meters (2000 feet).

(3) Vertically in the back azimuth region between:
   (i) A conical surface originating 2.5 meters (8 feet) above the runway stop end, included at 0.9 degree above the horizontal, and,
   (ii) A conical surface originating at the missed approach azimuth ground equipment antenna, inclined at 15 degrees above the horizontal up to a height of 1500 meters (5000 feet).

   (iii) Where obstacles penetrate the lower coverage limits, coverage need be provided only to minimum line of sight.

(4) Within the back azimuth coverage sector defined in paragraph (q) (1), (2), and (3) of this section the power densities must not be less than those shown in Table 9, but the equipment design must also allow for:
   (i) Transmitter power degradation from normal –1.5 dB.
   (ii) Rain loss of –2.2 dB at the longitudinal coverage extremes.

(h) **Back azimuth sitting.** The back azimuth equipment antenna must:
   (1) Normally be located on the extension of the runway centerline at the threshold end;
   (2) Be adjusted so that the vertical plane containing the zero degree course line contains the back azimuth reference datum;
   (3) Have minimum height necessary to comply with the course requirements prescribed in paragraph (g) of this section;
   (4) Be located at a distance from the threshold end that is consistent with safe obstruction clearance practices;
   (5) Not obscure any light of an approach lighting system; and
   (6) Be installed on frangible mounts or beyond the 300 meter (1000 feet) light bar.

(i) **Back azimuth antenna coordinates.** The scanning beams transmitted by the back azimuth equipment may be either conical or planar.

(j) **Back azimuth accuracy.** The requirements specified in §171.313(e) apply except that the reference point is the back azimuth reference datum.

(k) **Back azimuth antenna characteristics.** The requirements specified in §171.313(f) apply.

(l) **Scanning conventions.** Figure 12 shows the approach azimuth and back azimuth scanning conventions.
Figure 12. Azimuth Guidance Functions Scanning Conventions
(m) False guidance. False courses which can be acquired and tracked by an aircraft shall not exist anywhere either inside or outside of the MLS coverage sector. False courses which exist outside of the minimum coverage sector may be suppressed by the use of OCI.

NOTE: False courses may be due to (but not limited to) MLS airborne receiver acquisition of the following types of false guidance: reflections of the scanning beam, scanning beam antenna sidelobes and grating lobes, and incorrect clearance.

§ 171.315 Azimuth monitor system requirements.

(a) The approach azimuth or back azimuth monitor system must cause the radiation to cease and a warning must be provided at the designated control point if any of the following conditions persist for longer than the periods specified:

(1) There is a change in the ground equipment contribution to the mean course error component such that the path following error at the reference datum or in the direction of any azimuth radial, exceeds the limits specified in §§171.313(e)(1) or 171.313(j) for a period of more than one second.

NOTE: The above requirement and the requirement to limit the ground equipment mean error to ±10 ft. at the approach reference datum. This will limit the electrical component of the mean course error to ±10 ft. The field monitor alarm limit should be set such that with the mean course error at the alarm limit the total allowed PFE is not exceeded on any commissioned approach course from the limit of coverage to an altitude of 100 feet.

(2) There are errors in two consecutive transmissions of Basic Data Words 1, 2, 4 or 5.

(3) There is a reduction in the radiated power to a level not less than that specified in §§171.313(a)(4) or 171.313(g)(4) for a period of more than one second.

(4) There is an error in the preamble DPSK transmissions which occurs more than once in any one second period.

(5) There is an error in the time division multiplex synchronization of a particular azimuth function that the requirement specified in §171.311(e) is not satisfied and if this condition persists for more than one second.

(6) A failure of the monitor is detected.

(b) Radiation of the following functions must cease and a warning provided at the designated control point if there are errors in 2 consecutive transmissions:

(1) Morse Code Identification,

(2) Basic Data Words 3 and 6,

(3) Auxiliary Data Words.