AEROSPACE INFORMATION REPORT

AIR902™	REV. A
Issued 1966-05 Revised 2017-09 Reaffirmed 2022-11 Superseding AIR902	

(R) Determination of Distance from Ground Observer to Aircraft for Acoustic Tests

RATIONALE

This revised version replaces AIR902 issued May 1966. This version discusses the use of digital imaging equipment and software which did not exist when the previous AIR902 was written. This version also contains added information on using the distance determination during acoustic tests. The original version used the phrase 'Minimum Distance' in the title, but the techniques discussed in this AIR allow users to determine general distances, not just minimums.

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1. SCOPE

This document describes a practical system for a user to determine observer-to-aircraft distances. These observer-to-aircraft distances can be either closest point of approach (CPA) distances during field measurements or overhead distances during acoustic certification tests. The system uses a digital camera to record an image of the subject aircraft. A method of using commercial software to obtain the distance from such an image is presented. Potential issues which may affect accuracy are discussed.

2. REFERENCES

2.1 Applicable Documents

There are no referenced publications specified herein.

2.2 Definitions

CPA: closest point of approach of the object to the camera – this is the minimum distance between observer and object

SPL: sound pressure level

2.3 Terminology

DIGITAL CAMERA: a camera that records and stores digital images

IMAGE: a representation of an object captured and stored by a digital camera

PIXEL: a picture element; the composite of all pixels comprises an image

3. INTRODUCTION

3.1 Theory

The technique of image scaling relies on the geometric principle that the ratio of the lengths of the bases of two similar isosceles triangles is equal to the ratio of their heights. "Similar" in this context has the geometric meaning that the vertex angles of the isosceles triangles are equal. In image scaling, the first isosceles triangle has the distance from the observer to the object as the height of the triangle and the known length of the object as the base of the triangle. The focal length of the digital camera/lens combination is the height of the second isosceles triangle and the length of the recorded object in the image is the base of this second triangle. Note that this definition of the focal length as height of the isosceles triangle from the lens to the image is *not* the focal length of the lens. The geometric principle is represented in Equation 1.

$$\frac{f}{r} = \frac{l'_n}{l_n} \qquad \text{(Eq. 1)}$$

where:

f = focal length of the digital camera/lens system

r = distance from the digital camera lens to the object (also known as the slant range)

l'_n = length of the recorded object in the image

l_n = length of the object normal to the line of sight

Where the length of the object remains constant and the distance between the object and the observer varies, the focal length of the camera/lens system remains constant while the length of the recorded image of the object varies in proportion to the distance between object and observer.

The units used to quantify the physical length of the object and the physical distance between object and observer must be the same. Likewise, the units used to quantify the camera/lens focal length and the length of the recorded object in the image must be the same. However, the camera system units do not need to be the same as the physical distance units. This, in combination with the concept of a calibration image, allows the use of image pixels as the unit of dimension within the camera system. Such a calibration image, taken of an object which has a known length (l_n) at a known distance (r), enables the focal length (f) to be found in units of the length of the recorded object in the image (l'_n). Correct methods of capturing a calibration image are discussed in Section 4. For the calibration, rather than assuming the focal length of the camera system is known, the focal length (in pixels) is calculated from a calibration image, where the other three parameters are either known (l_n, r) or determined (l'_n). This method allows direct counting of the pixels on the recorded image, eliminating the need to convert from pixels to some other unit of length. Figure 1 below shows an example of the geometry of the aircraft/camera system.

Application of this method of determining distance is discussed in two separate sections below. In 3.2, the usage is assumed to be a field measurement where the user must determine the CPA of the aircraft. In 3.3, the usage is assumed to be an acoustic test where the user must determine the height of the aircraft above the ground as it passes over a microphone position.

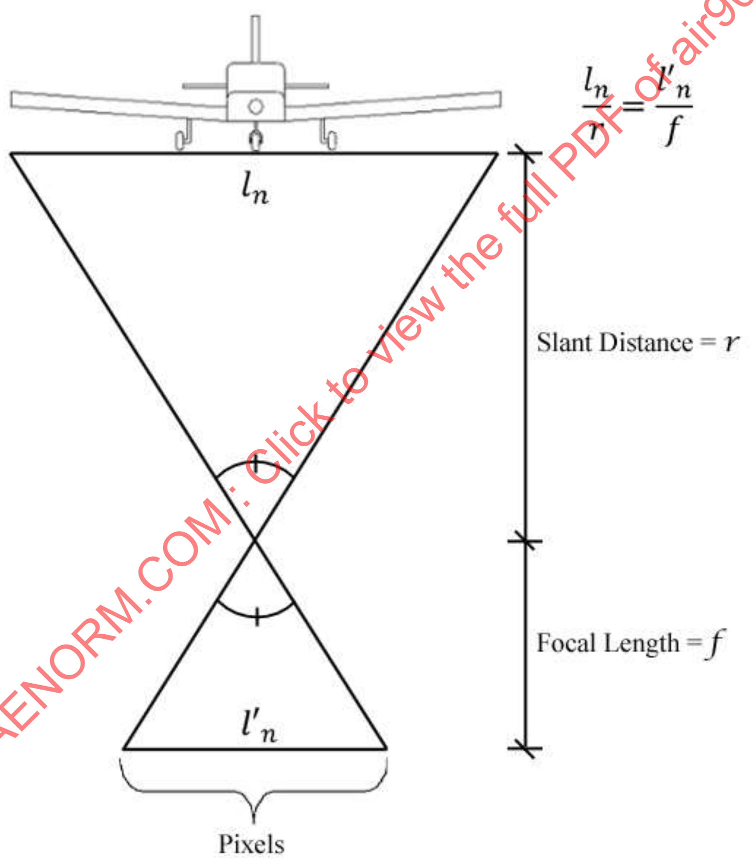

Figure 1 - Basic photo-scaling geometry

3.2 Field Measurements - Aircraft Lateral to the Observer

When the observer is lateral to (i.e., to the side of) the aircraft and the aircraft is at the CPA, the observed aircraft has no optical foreshortening. Optical foreshortening distorts the observed length of the object for those dimensions which are not perpendicular to the line from the camera to the object. These effects are discussed in Section 7. In most field measurements, the fuselage of the aircraft is the dimension of interest. With most multi-engine aircraft with wing-mounted engines, the user can estimate the CPA by noting when the engine on the closest wing either blocks or aligns with the observer's view of the farther engine. For single engine aircraft, which generally have unswept wings, the user should capture the image when the wings appear perpendicular to the fuselage. Issues with field measurements are further discussed in Section 5.

In a field measurement, the user of the camera system usually tracks the aircraft with the camera system until the user determines that the aircraft is at the CPA. This tracking of the aircraft with the camera is also referred to as 'panning'. When the aircraft is at the CPA, the user records the image.

Figure 2 below shows a notional view of a field measurement. The aircraft is lateral to the observer while flying level. The observer tracks the aircraft with the camera until the aircraft is at the CPA as determined by the methods discussed above. At the CPA point, the observer records the image. The CPA distance can then be determined from the recorded image using the techniques discussed in 3.1.

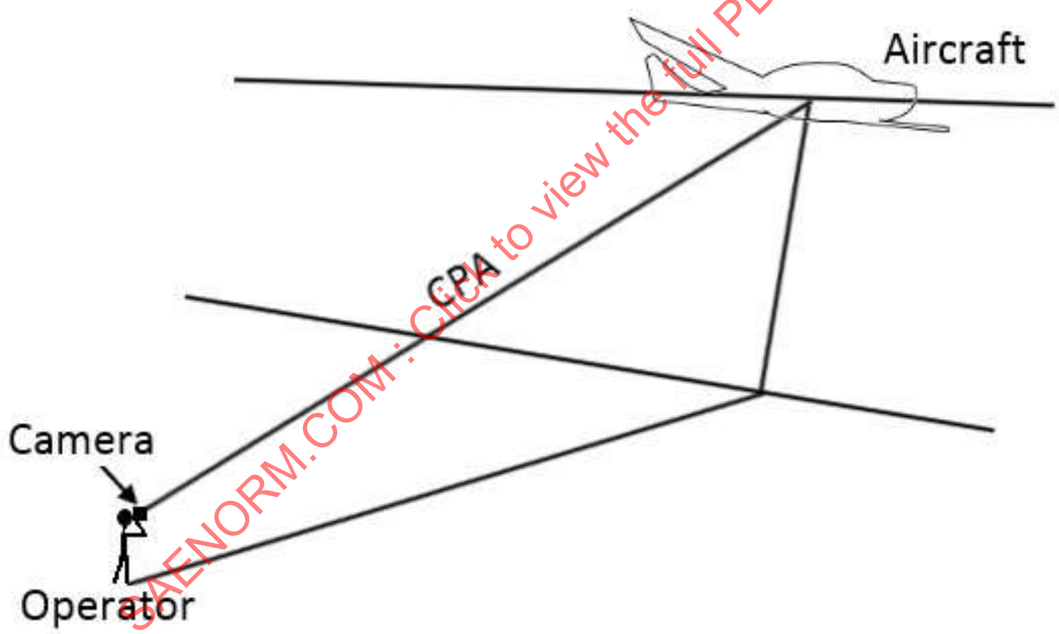

Figure 2 - Notional geometry for field measurement

3.3 Acoustic Tests - Aircraft Over-Flying the Observer

For over-flights during acoustic tests, the distance between the aircraft and the observer can be determined at a known aircraft position relative to the observer. Over-flights will typically use the wingspan of the aircraft, rather than the fuselage length, for l'_n and l_n; the methods for determining the distance are the same. Acoustic flight test issues are discussed in more detail in Section 6.

In an acoustic test, the user of the camera system usually mounts the camera system at a fixed position close to the microphone location under the expected flight track. The camera is usually pointing vertically up. When the aircraft is at the overhead position relative to the camera system, the user records the image. In this case, the wingspan of the aircraft is the aircraft dimension which is perpendicular to the observer.

Figure 3 below shows a notional view of an acoustic test. The aircraft is over-flying the observer/camera while in a climb. The observer waits until the aircraft is overhead as determined by the methods discussed above. At the overhead point, the observer records the image. The overhead distance (Z_{OH} in the Figure 3) can then be determined from the recorded image using the techniques discussed in 3.1.

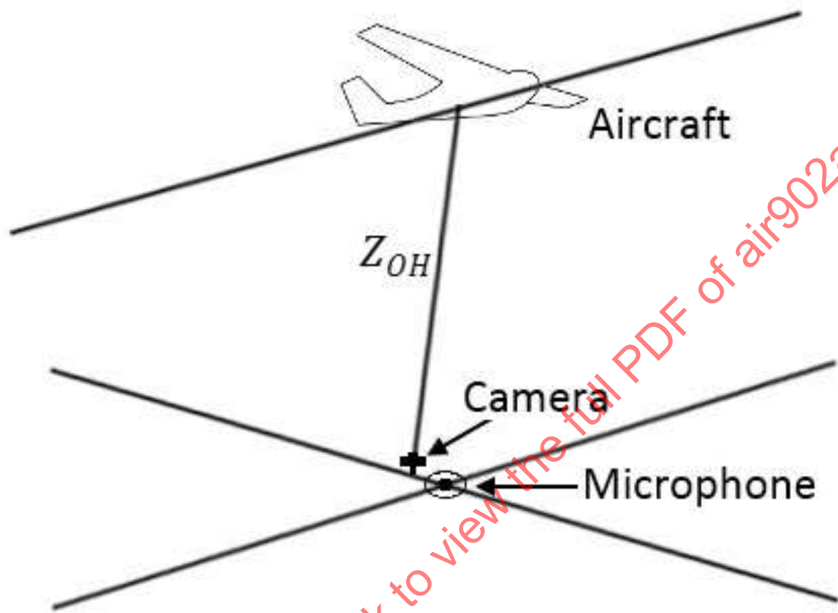

Figure 3 - Notional geometry for acoustic test

3.4 Components of the Image Scaling System

In order to properly perform the determination of distance between aircraft and observer using the method provided in this document, an image-scaling system comprised of hardware, software and specific procedures is required. The components of such an image scaling system are:

a. A digital camera with a fixed or locking focal length lens - fixed focal lengths are recommended;

b. Image-processing software that allows for identification of individual pixels in an image by row and column (XY) coordinates;

c. Calibration of the system using the method described in Section 4;

d. Procedures and methods described within this document; and

e. A conscientious operator or operators, to carefully execute the steps in the procedure.

4. CALIBRATION

The calibration of the image scaling system is used to determine the focal length of the digital camera/lens system. Equation 1 is used, but instead of an unknown distance from the observer to the object of interest, an object of known size at a known distance is used to solve for the focal length (f) in the equation by measuring the length of the recorded object in the image.

4.1 Setup

The image scaling system should be set up so that the image processing software can be used with images recorded on any and all digital camera/lens combinations that will be used as part of the system. The operator must ensure that each digital camera/lens system has been or will be calibrated. The user should ensure that the camera settings used during the calibration are the same as those used in the aircraft distance determination measurements. If possible, the user should set the camera to an un-compressed ("raw") image with the highest pixel count available for the camera. This minimizes possible issues with data compression and aliasing; these issues are discussed in 7.4. Note that the focal length *f* used in this context is *not* the focal length of the lens – skipping this calibration step and using the stated focal length of the lens *will* result in errors.

To calibrate a digital camera/lens system, the operator should choose as a calibration target an object that has a feature with a known dimension that can be captured in the camera image. This feature should be easily discernible from the image, and should be visually obvious, preferably with high-contrast compared to the image background. The target could also be a distance between easily discernable objects in the image. The camera should be placed at a known distance *perpendicular* to the target, far enough from the object to include the full known distance within the camera image, and to meet the requirement of an infinite focus setting. That is, the distance between camera and object should be large enough so that the image of the object is sharp with the lens set to infinite focus. If possible, the calibration image should be recorded using an object of approximately the same size and at the same distance as those expected during the test. An alternative to choosing an existing object of the proper size is to create one (e.g., high-visibility highway traffic safety cones placed a known distance apart). Once such a calibration target and camera location have been established, the operator should record several images of the target to ensure the process produces at least one satisfactory image. The calibration target should be centered in the recorded image. The calibration target should be in the same camera axis as the expected aircraft image during the flight test.

These calibrations can occur *after* the user records the images of interest. Before calibrating the operator must ensure that:

- The digital camera focus is set to infinity. As mentioned above, the operator should ensure that distance from the camera to the object provides a clear image with a focus setting of infinity.

- The digital camera system should employ a fixed focal length lens. Zoom lenses have variable focal lengths that may give unrepeatable results when processed. A zoom lens with a locking focal length could be used if the same focal length were used for the calibration and field measurements; however, a fixed focal length lens is recommended.

4.2 Processing

After recording images of the calibration target, these raw images from the digital camera should be downloaded to a processing computer. A stored image can be opened in the image processing software. The calibration image size in pixels (l'_n) should be determined. This pixel size can be determined as the hypotenuse of the right triangle defined by the pixels of the calibration image. That is, $l'_n = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$ where (x_1, y_1) are the pixel coordinates of one end of the calibration object and (x_2, y_2) are the other end. As discussed above, only the f variable in Equation 1 is still unknown at this point and can be found using the other three known values.

5. AIRCRAFT CPA DISTANCE DATA COLLECTION

The field setup of the image scaling system requires knowledge of the physical characteristics of the aircraft of interest (i.e. the length of the wings or fuselage), and properly setting up the features of the digital camera. As mentioned in 3.2, field measurements normally involve the user tracking the aircraft with the camera system to determine the CPA when the image should be recorded. This section describes the setup of a digital camera system and logging the data during the collection process.

5.1 Digital Camera Setup and Lens Choice

The approximate location and size of the objects of interest should be known in advance so that the operator can choose the proper camera/lens system to use. If the objects of interest are relatively large and the distances are small, a camera/lens system with a relatively small focal length (e.g., a fixed focal length lens of 50 mm) may be appropriate. If the objects of interest are relatively small and the distance is large, then a camera/lens system with a relatively large focal length (e.g., a fixed focal length of 200 mm) may be more appropriate. Lenses with large focal lengths may be difficult to use in the field as a larger lens is difficult to manually hold steady while panning for the aircraft and there may be difficulty finding a rapidly moving object in a small field of view (which is usual for a camera with a large focal length lens).

Each digital camera has its own settings for determining the quality of the stored image. *ALL* calibration images and field measurement images should use matching settings which retain the most information in the images. The operator should ensure the camera has sufficient image storage ability for the required amount of work in the field. Some cameras have the ability to capture multiple images per second – this feature may be advantageous for fast-moving aircraft.

5.2 Separate Data Logging

Often, different operators perform different tasks in the image scaling process; one operator may only be assigned to use the digital camera to capture the images in the field, while a different operator may use the software to find the slant distances. To allow the operators who process the images to perform their work correctly, the camera operator(s) should record information in a measurement log, including the digital camera settings and information associated with each image (e.g., image ID, aircraft type, approximate time of CPA or overflight, etc.). Appendix A includes an example of a field log sheet for the recommended information. An electronic text log may be convenient, but if a paper log is used, an image should be captured of the log sheet by the digital camera, so that other operators can coordinate the information on the log sheet with the recorded aircraft images during processing.

6. MEASUREMENT OF AIRCRAFT HEIGHT AT OVERHEAD

Acoustic flight tests require knowledge of the following information about the aircraft during the test:

- the distance from the aircraft to the microphone at the overhead point
- the lateral angle of the aircraft at the overhead point
- the speed of the aircraft along the flight path

The height and lateral position at any point along the flight track can also be found using the methods discussed in this section.

6.1 Distance and Lateral Angle from the Aircraft to the Microphone at the Overhead Point

Determining the distance from the aircraft to the microphone at the point where the aircraft passes over the microphone is similar to the determination of the distance at the CPA. A common method used to determine the aircraft's location relative to the microphone is to include a known visual reference in the image of the aircraft pass-by. For certification flight tests, this known visual reference is often a wire suspended parallel to the ground between two poles, in a direction perpendicular to the flight path of the aircraft. The poles should be high enough so that the wire is in focus when the aircraft is also in focus. With the camera directly under the wire, the known position of the aircraft occurs when the aircraft is in line with the wire, which occurs when the aircraft is directly overhead. The point directly under the wire can be determined by suspending a plumb bob from the wire. An example of a layout of this type is given in Figure 4. In this and the following figures, the subscript 'o' is used to denote the distance projected onto a horizontal plane at the height of the wire. Also, the suspended wire can include markings to either side of the center which will allow easy determination during the test of whether or not the lateral angle criterion for the flight test is met.

The 'o' plane mentioned in the prior paragraph is required to define the angles between the camera and the aircraft. These angles are used to provide position information in the X and Y directions. If this information is not required, then the slant distance from the aircraft to the camera can be found using the methods previously discussed.

Figures 4 through 6 use a right-hand coordinate system. The aircraft is shown traveling in the positive X direction (from a negative X position to a positive X position); the direction of the aircraft through the wire/camera system is independent of the direction of travel. The aircraft is arbitrarily shown with a negative Y position. The methods discussed here assume the aircraft has no roll component.

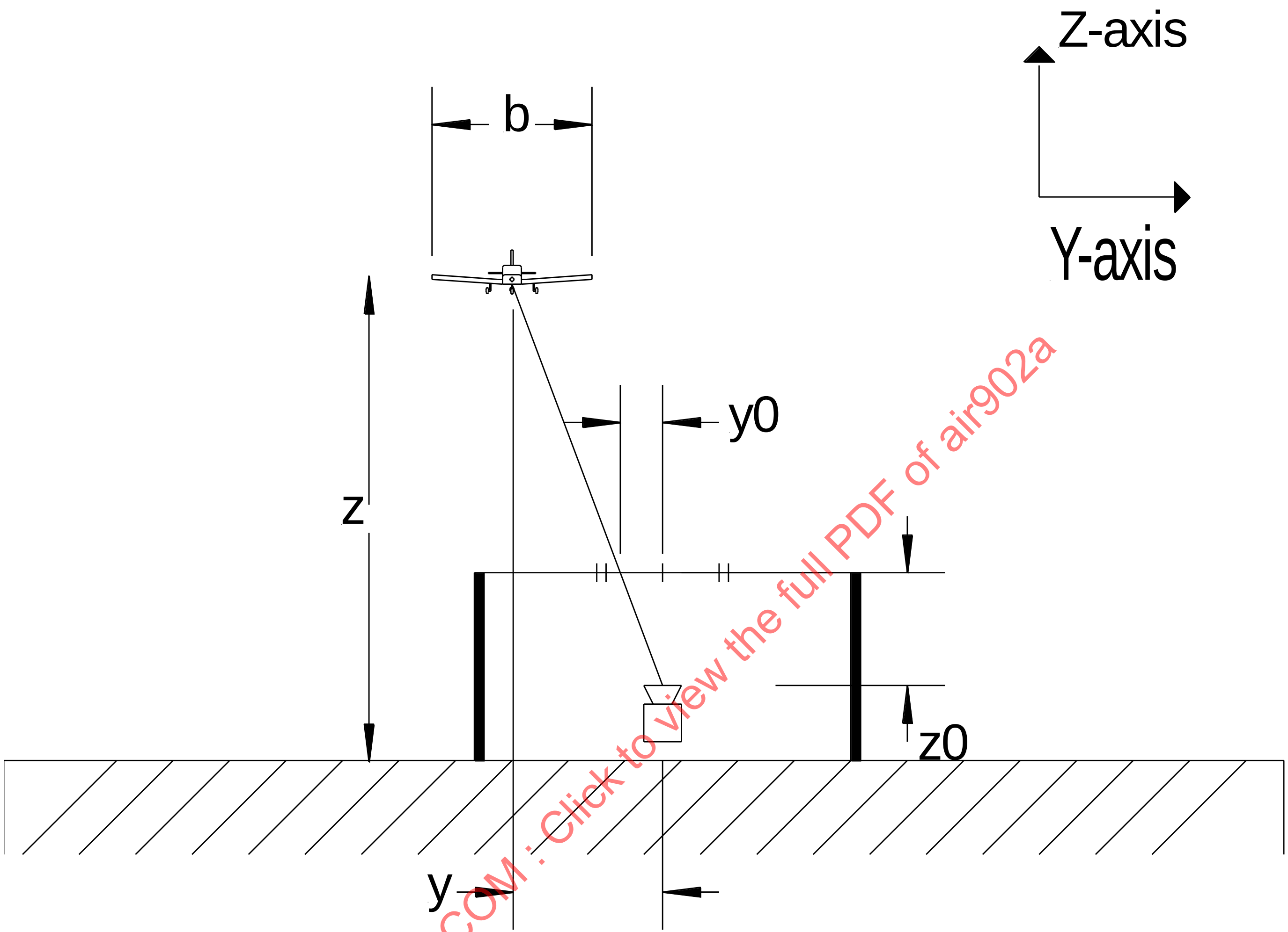

Figure 4 - Wire graphic for acoustic test, profile view schematic

In Figure 4, the following are the vertical dimensions:

h_p = height of the poles and wire above the ground (not shown for clarity)

h_c = height of the camera above the ground (not shown for clarity)

z_0 = height of the wire above the camera; $z_0 = h_p - h_c$

z = height of the aircraft above the ground

In Figure 4, the following are the horizontal dimensions:

b = aircraft wingspan

y = horizontal off-set distance of the aircraft from the camera

y_0 = horizontal off-set distance of the aircraft projected onto the horizontal plane at the wire

A plan view of the geometry given in Figure 4 is shown in Figure 5. Figure 5 is a schematic view from above both the camera and the aircraft.

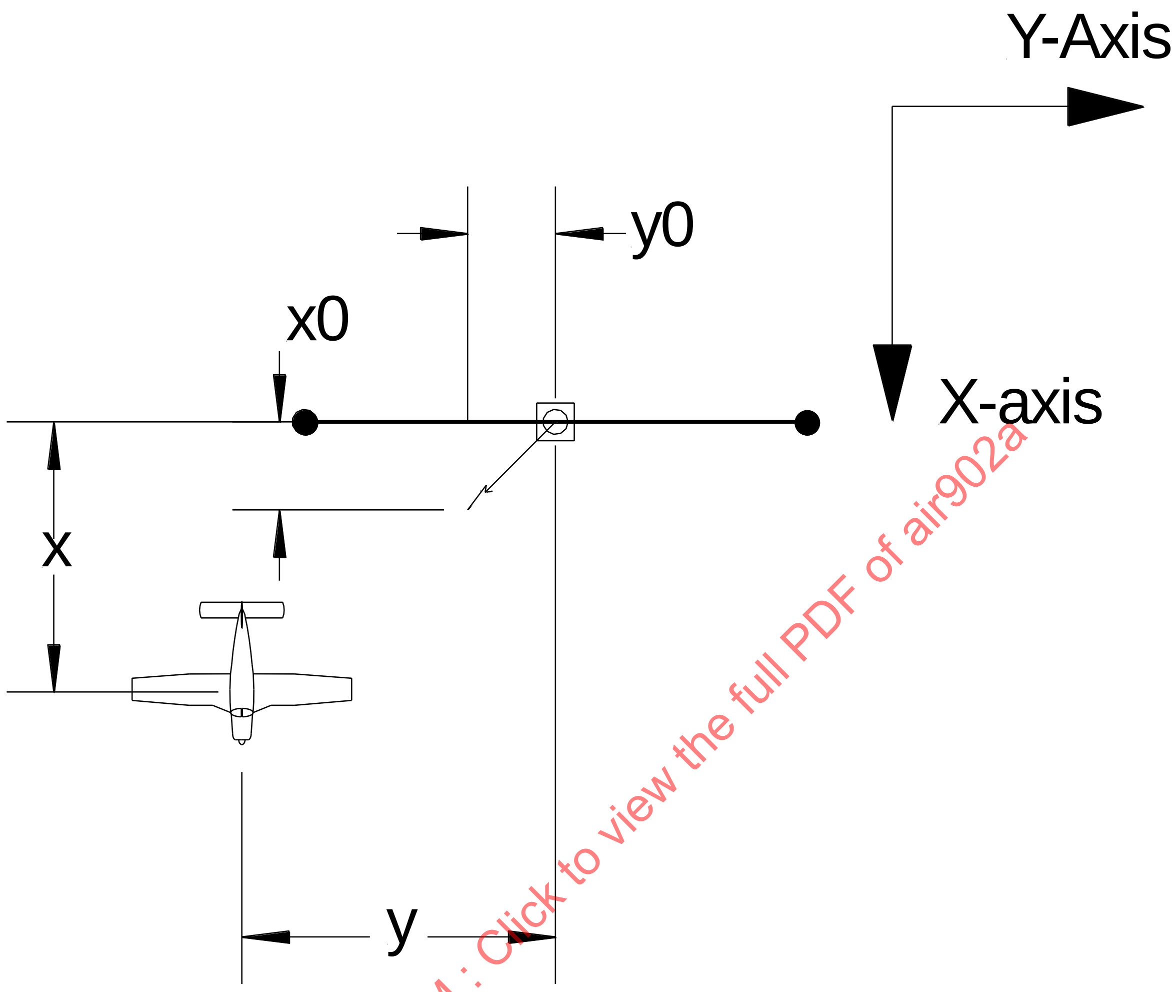

Figure 5 – Wire graphic for acoustic test, plan view schematic

In Figure 5, the following are the horizontal dimensions:

x = flight path off-set distance of the aircraft from the camera

y = horizontal off-set distance of the aircraft from the camera (also shown in Figure 4)

x_0 = horizontal flight path distance of aircraft projected onto the horizontal plane at the wire

y_0 = horizontal off-set distance of aircraft projected onto the horizontal plane at the wire (also shown in Figure 4)

R_C = Slant distance between camera and object

R_0 = $\sqrt{x_0{}^2 + y_0{}^2}$ (not labeled for clarity)

The notional image captured by the camera for the geometry presented in Figure 4 and Figure 5 is given in Figure 6. Note that the right and left wings are reversed from Figure 5, since the image is of the underside of the aircraft.

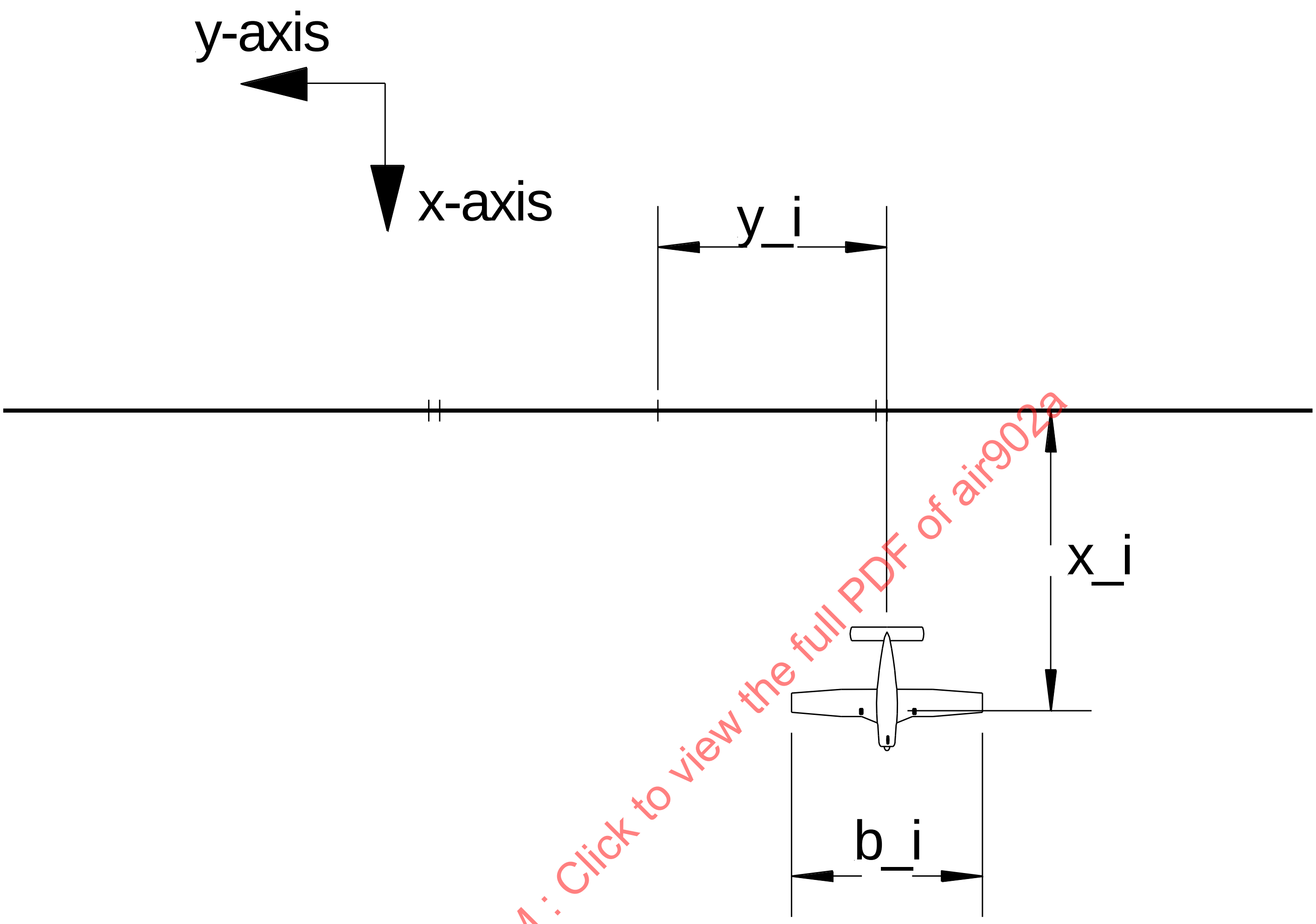

Figure 6 – Camera image schematic for acoustic test

In Figure 6, the subscript 'i' indicates 'image'. The following are the image dimensions in units of pixels:

x_i = horizontal flight path distance of aircraft in the image from the wire

y_i = horizontal off-set distance of aircraft in the image from the origin

b_i = wingspan of the aircraft in the image

The distances x_o and y_o(and therefore R_o) are found using the photo-scaling methods discussed in this document. The angle from the camera to the aircraft is:

$$\gamma = \tan^{-1}\left(\frac{R_0}{z_0}\right) \qquad \text{(Eq. 2)}$$

The equation above uses the distances from the projected system; the angle from the camera to the aircraft is the same in the projected system and the actual test. The slant distance from the camera to the aircraft, R_c, is:

$$R_c = f\frac{b}{b_i \cos\gamma} \qquad \text{(Eq. 3)}$$

The focal length f is found from the calibration methods discussed in Section 4. The ground projection of the slant distance is:

$$r = R_c \sin\gamma \tag{Eq. 4}$$

The actual distance to the aircraft from the camera in the x-direction is given by:

$$x = \frac{R_c \cos\gamma}{f} x_i \tag{Eq. 5}$$

The actual distance to the aircraft from the camera in the y-direction is given by:

$$y = \sqrt{r^2 - x^2} \tag{Eq. 6}$$

The height of the aircraft above the ground can be determined:

$$z = R_c \cos\gamma + h_c \tag{Eq. 7}$$

The slant distance from the origin to the aircraft can be determined:

$$R = \sqrt{x^2 + y^2 + z^2} \tag{Eq. 8}$$

Note that if $h_c = 0$, then $R = R_c$.

7. ACCURACY

The image scaling technique can be reliable and accurate when conscientiously and properly performed. However, if an image is captured incorrectly (for example, too early or too late relative to CPA or overflight), uncertainty as discussed in this section may occur. Note that this section discusses accuracy, but the methods discussed in this section will generally not be sufficient to provide corrections to a poorly captured image – the methods of this section rely on angles which will generally not be known to the user. This section is only intended to provide the users with an understanding of the issues associated with uncertainty of the process.

7.1 Measurement of Recorded Object in Image

Errors made in measuring the size of the aircraft in the recorded image are usually a result of haste or situations where visual interference occurs by some portion of the aircraft obscuring another portion of the aircraft that requires measuring. Such errors affect calculated distance, but unless they exceed 6% the error in normalized sound pressure level (SPL) remains less than 0.5 dB.

NOTE This error estimate is based solely on consideration of the inverse square law, where a doubling or halving of distance results in a change in SPL of 6 dB. Atmospheric and other sound attenuation effects are not considered.

The calibration method discussed in 3.1 assumes that the calibration image and the recorded image of the aircraft are in the same axis of the camera. If the pixels in the camera system are not square, then the calibration image and the recorded image *must* use the same axis for the methods of 3.1 to work.

7.2 Issues during Field Measurements

7.2.1 Orientation of Aircraft

An image taken when the aircraft is not perpendicular to the line of sight, i.e., taken too soon or too late, will give an inaccurate CPA distance. This section discusses the magnitude of this type of uncertainty. Figure 7 presents a schematic illustrating the terms used in this section.

If the aircraft is not perpendicular to the line of sight, the aircraft will have a non-zero orientation angle (θ), which is the angle by which the actual position of the fuselage differs from being normal to the line of sight. The formulas for range based on measurements when the orientation angle is known is shown in Equations 9 to 11.

$$l_n = l_o \cos\theta;\ r = \frac{f\ l_o \cos\theta}{l'_n} \qquad \text{(Eq. 9)}$$

where:

l_o = length of fuselage or wing of aircraft

θ = orientation angle

Correcting this to the minimum slant range gives Equation 10.

$$r_{min} = r\cos\varphi = \frac{f\ l_o \cos\theta\cos\varphi}{l'_n} \qquad \text{(Eq. 10)}$$

where:

r_{min}= minimum slant range – the distance between the camera and the aircraft at the CPA point

φ = angle between the line of sight and the normal vector from the observer to the flight path

If an assumption is made that the fuselage axis is oriented along the flight path (i.e., the aircraft is not yawing) and the aircraft is centered in the image, the two angles, θ and φ, are equal and the relationship is shown in Equation 11.

$$r_{min} = \frac{f\ l_o \cos^2\theta}{l'_n} \qquad \text{(Eq. 11)}$$

It is unlikely that θ would ever be as large as 20° for which the range correction would be approximately 12% or around 1 dB in SPL by the inverse square law. Therefore, only negligible errors in field data should result from a failure to take small values of θ into account.

Note that the relationship between the length of the fuselage projected onto a plane which is normal to the line of sight (l_n) and the actual length of the fuselage (l_o) is given by Equation 12.

$$l_n = \frac{2l_o \sec\frac{\alpha}{2}}{\sec\left(\theta + \frac{\alpha}{2}\right) + \sec\left(\theta - \frac{\alpha}{2}\right)} \approx l_o\cos\theta \qquad \text{(Eq. 12)}$$

NOTE: For all cases mentioned in this section, the possible inclination of the fuselage to the flight path, even at low speed with modern high-lift devices the angle rarely exceeds a few degrees during steady flight. This small inclination of the fuselage should not have a substantial effect on the results.

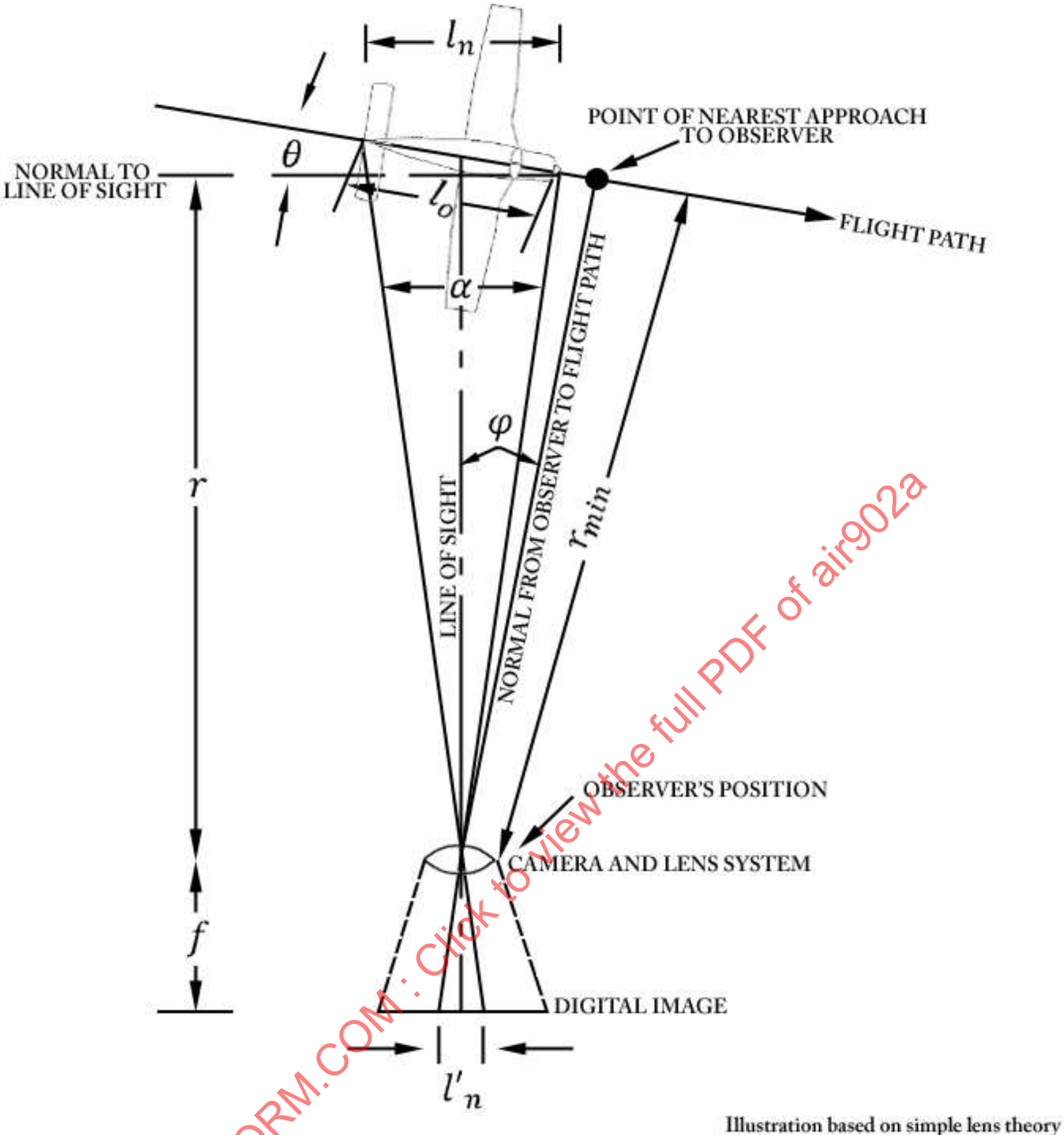

Figure 7 – Plan view schematic of range determination during field measurements

7.2.2 Aircraft Off-Center in Image

The camera should be pointed so that its axis coincides with the line of sight. If it is not aimed properly (see Figure 8), the aircraft will be off center in the recorded image by a distance d and will therefore be slightly longer, due to the increase in projected distance.

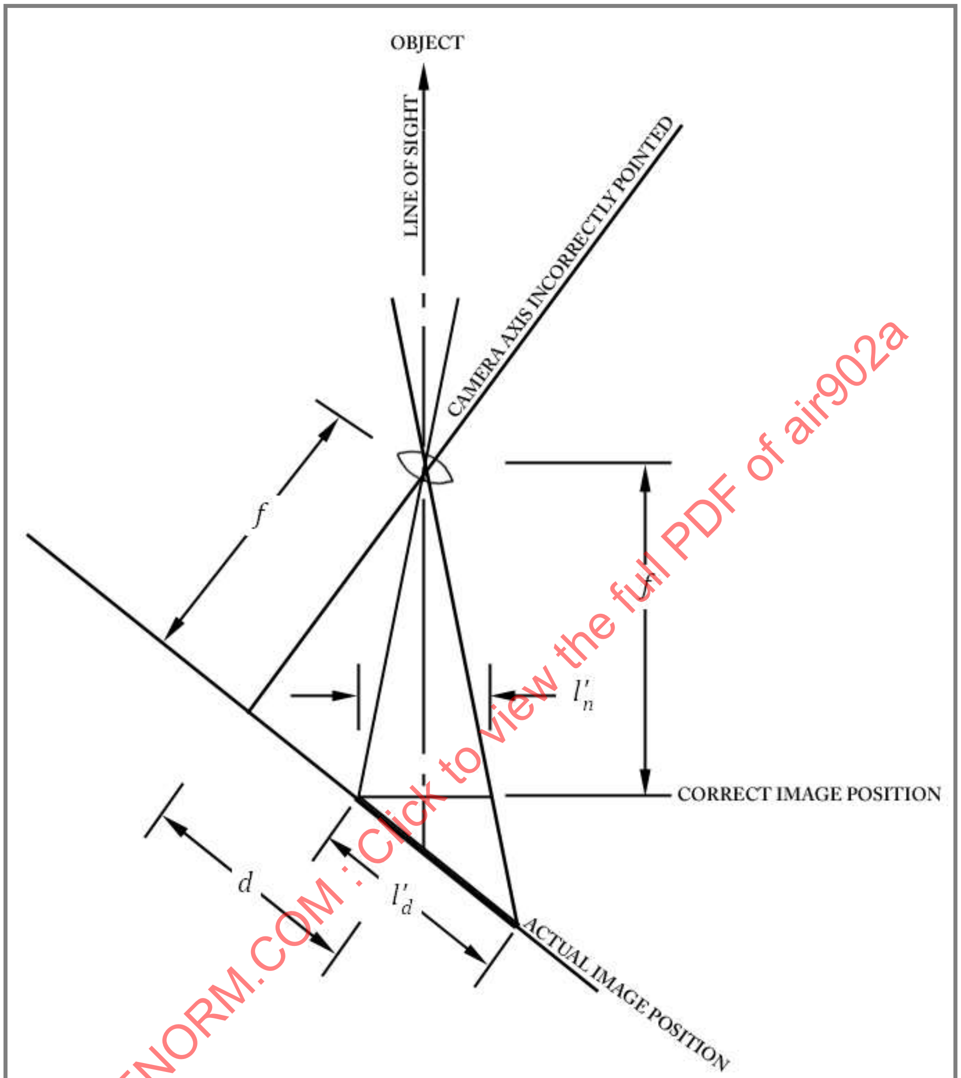

Figure 8 – Effect of aiming camera incorrectly

A range formula (Equation 13) quantifying this effect can be derived using the small angle assumption that the cosine of a right triangle is approximately equal to the long leg of the triangle divided by the hypotenuse of the triangle.

$$r \approx \frac{f\, l_n \left(1 + \frac{d^2}{f^2}\right)^{1/2}}{l'_d} = \frac{f\, l_o \cos\theta \left(1 + \frac{d^2}{f^2}\right)^{1/2}}{l'_d} \quad \text{(Eq. 13)}$$

where:

l'_d = length of the off center aircraft in the image

d = displacement of the center of the recorded aircraft from the center of the image

The amount of offset is limited by the pixel size of the digital camera's image in the axis of the direction of the recorded object. The off center distance *d* can be expressed as a fraction n of the focal length *f*, which allows a determination of the effect on the sound level to be made, as shown in Equation 14.

$$\Delta SPL = 20\log_{10}\left[\left(1+\frac{d^2}{f^2}\right)^{1/2}\right] = 20\log_{10}\left[(1+n^2)^{1/2}\right] \qquad \text{(Eq. 14)}$$

where:

n = off center distance expressed as a fraction of the focal length

An image 10% (where n = 0.1) off center relative to the focal length would give a difference in SPL of about 0.04 dB.

7.3 Issues during Acoustic Tests

Capturing an image of an aircraft flying overhead in an acoustic test is similar in theory to the prior discussion of determining minimum distance in a field test. Despite basic theoretical similarities, there are practical differences. In the field test, the user is usually panning with the aircraft in the viewfinder of the camera; in an acoustic test, the camera is typically fixed and the user must pick the instant at overhead to capture the image. Users should consider using a remote trigger for capturing the image during the acoustic tests to avoid unnecessary movement of the camera.

7.3.1 Aircraft Offset from Overhead

An image taken before or after overhead will give errors similar to those discussed in 7.2.1, with the added issues that the rate of climb or descent of the aircraft is unknown and so contributes to the uncertainty of the measurement.

If the aircraft is offset to the side, and the camera is aligned so that it is in the expected alignment of pointing vertically up at the overhead point, then the offset of the aircraft lateral does not affect the range estimation. The triangle formed by the aircraft wingspan and the camera-to-overhead distance is similar to the triangle formed by the focal length and the recorded image. An example schematic is shown in Figure 9. A different way to consider this situation is that the line from each wingtip to its respective image is half of the isosceles triangle shown in Figure 1. If the aircraft has a roll component, the effect is similar to the yaw component effect in the field measurement case.

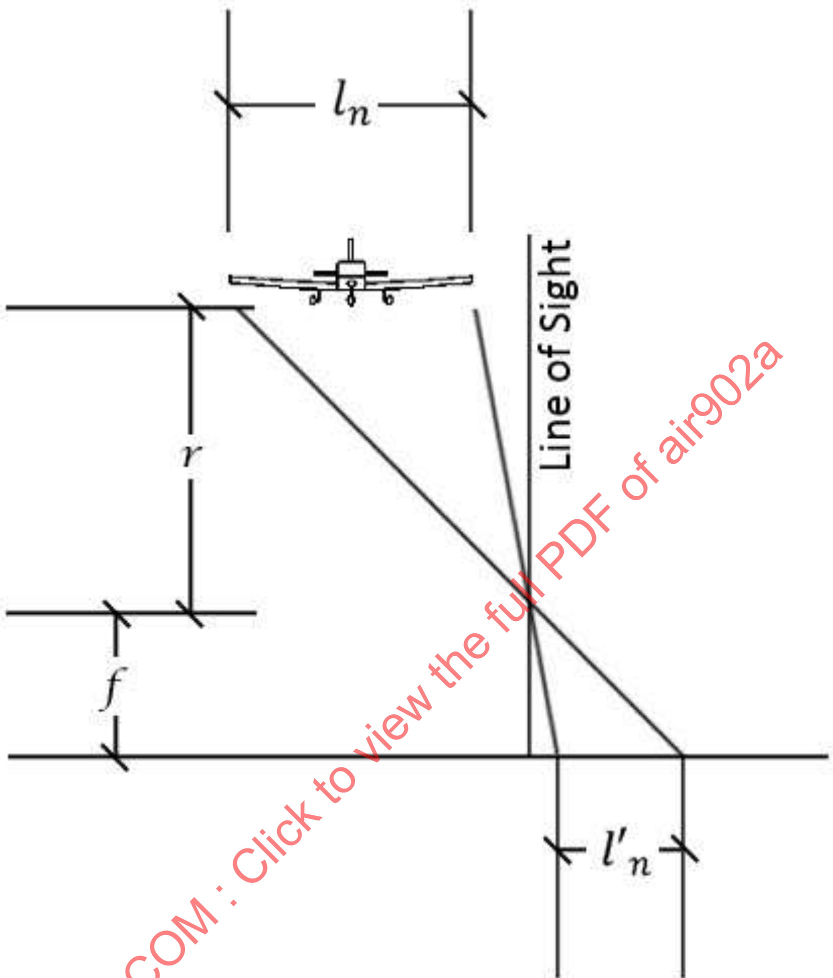

Figure 9 – Schematic of offset aircraft during an acoustic test

7.3.2 Camera Offset from Vertical

The acoustic test camera should be aligned so that it is pointing vertically up. If the camera is not vertically aligned, the errors are similar to the effects discussed in 7.2.2 and shown in Figure 8, where the camera is aimed incorrectly. In the acoustic test case, the aircraft is assumed to be in the correct overhead position, but the recorded image is incorrect due to the increase in the projected distance.

7.4 Digitization Issues

A digital image contains a finite amount of information. At the edges of the aircraft image this limitation can introduce ambiguity in the pixel-based measurement. This ambiguity arises due to the pixels at the edges of the image not having enough resolution to unambiguously determine which pixels define the end of the aircraft image. An example of this is shown in Figures 10 and 11. Figure 10 shows an image of an aircraft where the fuselage (not the wings) is perpendicular to the camera and so would be used for a CPA calculation. Figure 11 shows a detail of the tail of the aircraft.

Figure 10 – Sample digital image from field measurement

In Figure 11, the trailing edge of the horizontal stabilizer shows this digitization effect (the same effect can be seen on the vertical tail and the fuselage). Even though the image has high contrast between the aircraft and the background sky, identifying which pixel defines the back of the horizontal stabilizer along the centerline of the aircraft is ambiguous. In this case, the ambiguity is only a single pixel; however, if the contrast between the aircraft image and the background is low, the ambiguity of which pixel defines the measurement point becomes greater.

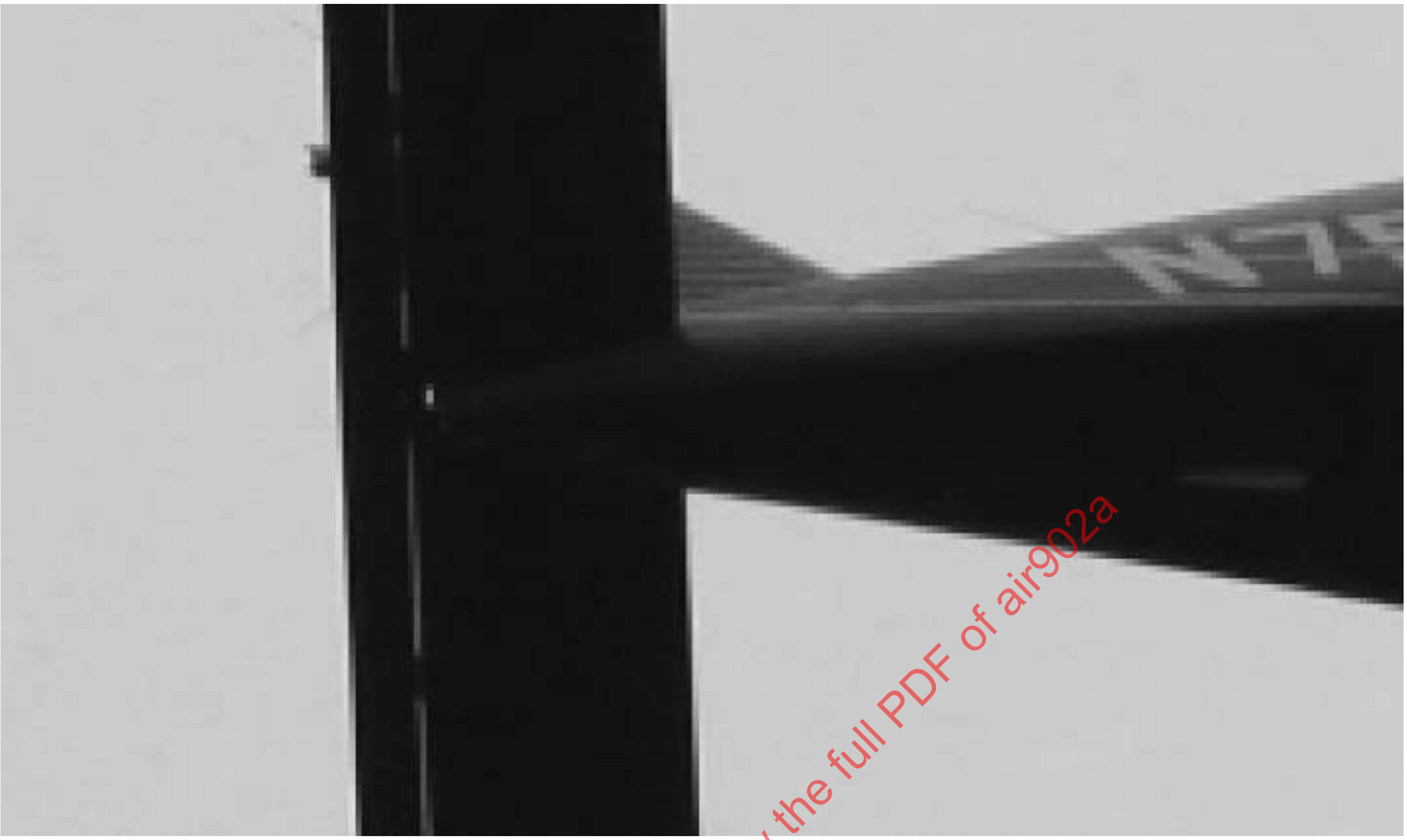

Figure 11 – Detail of prior image

8. NOTES

8.1 Revision Indicator

A change bar (l) located in the left margin is for the convenience of the user in locating areas where technical revisions, not editorial changes, have been made to the previous issue of this document. An (R) symbol to the left of the document title indicates a complete revision of the document, including technical revisions. Change bars and (R) are not used in original publications, nor in documents that contain editorial changes only.

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