Measurement Method Research on Calibration Error of Radio Compass for Some Type Aircraft

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Abstract—This electronic document is a "live" template. The various components of your paper [title, text, heads, etc.] are already defined on the style sheet, as illustrated by the portions given in this document. DO NOT USE SPECIAL CHARACTERS, SYMBOLS, OR MATH IN YOUR TITLE OR ABSTRACT.

Keywords- *radio compass; error analysis;Aircraft;Measurement Method*

I. INTRODUCTION

Implementation of not pushing the aircraft for correction compass error is: using the analog signal source to replace navigation units work, by changing the analog signal source feeding direction to replace pushing aircraft rotation. Analog signals source system is made up of high frequency signal source, antenna signal splitter and corner antennas and other components. When corrected compass error, high-frequency signal source via antenna signal splitter transmits the high-frequency signal output to the corner antenna which is placed above compass loop antenna. Without pushing the plane, only by rotating corner of antenna analog signal source could obtain the relationship between antenna corner angle and compass goniometer indicated value 0c, heading indicator value 0z. However, the loop antenna of the compass is under the non-uniform field effect of corner antenna, and the resulting different values of the difference between a and 0c, and the difference between loop antenna and compass error compensator; therefore, when correcting compass error without manually pushing the aircraft must give law between corner antenna angle a between compass goniometer instructions value 0c.

II. QUASI-COMPENSATION OF FIXED LOOP ANTENNA IN NON-UNIFORM FIELD

Fixed loop antenna and the goniometer consisting of a loop antenna system of radio compass.

In a homogeneous field of vertically polarized waves, coil EMF of the fixed loop antenna transverse (b), vertical (a), respectively are

$$e_a = E_{om} h_a \cos\theta \cos\omega t \quad (1)$$

$$e_b = E_{om} h_b \sin\theta \cos\omega t \quad (2)$$

Where, Eom as the maxima of a given type electric field intensity in the center of the loop antenna ; ha, hb are rms of vertical, transverse coil; 0 is the clockwise angle from the longitudinal plane of the coil to the waves, when Longitudinal plane of the coil is parallel to the longitudinal axis of the aircraft, 0 is the radio relative azimuth; ea, eb formed transverse and longitudinal magnetic field in stator goniometer; synthetise synthetic magnetic field Hm and transverse magnetic field Ham with angle 0, and this angle is goniometer indicated value 0c .

Assumed fixed loop antenna vertical, transverse coil have same electrical parameters, that is ha = hb; in the radio compass, the goniometer 0ccan track changes in the rotor angle 0, indicating the relative azimuth station. However, due to the presence of the aircraft compass error, 0c is not equal to 0 but:

$$\theta_c = \theta + \theta_i$$

Where, 0i is aircraft compass error.

In order to have a compensation effect for the fixed loop antenna on the compass error produced by aircraft body , ha, hb are not equal, so that the resultant magnetic field 0 in the goniometer plus a desired angle. For example, a certain type of compass antenna ha / hb = 0. 852 (reference), the difference between the maximum compensation for compass error is +7.50, each of the other angles 0B compass error compensation value can be calculated via

$$\theta_B = \theta_c - \theta \quad .$$

Similarly, when the largest compass error compensation value is known, the ratio ha / hb can be calculated, that is law of compass error compensation . If loop antenna structure in Uniform Field is certain,then EMF of vertical, horizontal scaling factor is constant,

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regardless of the DOA, compass error compensation is only decided by fixed loop antenna structure.

When the fixed loop antenna is at a non-uniform field formed by angle antenna, the longitudinal and transverse induction depends not only on the potential ha, hb, but also depends on the non-uniform field distribution, i.e., a fixed structure of the loop antenna, the proportion of the longitudinal and transverse induction is also related to corner antenna size and angle a; in this case, the difference between goniometer value 0 and angle a is not compass error compensation value of fixed loop antenna . To differ from the uniform field, the difference a ' this time is called "quasi-compensation" value of compass error.

Fixed loop antenna with he maximum compass error compensation value +7.5 , according to the measured difference to calculate and "quasi- compensation" , in 0° , 90° , 180° , 270° , the angle antenna is placed in fixed loop antenna center , "quasi- compensation" values are 0° . Research shows that factors affecting the "quasi-compensation" values are: parameters compass error compensation device (loop antenna , compass error compensator) , the angle of the antenna near- field distribution (depending on the angle antenna structure and the relative position of the antenna in the test) ; goniometer compass and automatic synchronizer circuit parameters. Under the same conditions, the "quasi-compensation" value is reproducible, "quasi-compensation" value is not affected by the site; due to the compass system (such as a loop antenna and compass error compensation, goniometer parameters changes) lead to compensation value changes, " quasi- compensation" value will change as well. Therefore, the "quasi- compensation" value could be used as compass error difference compensation value change basis. When compensation value characteristic is known, we can record "quasi-compensation" features, and to determine the difference between the remaining compass error by reviewing the "quasi- compensation " feature, enabling to find the compass error without manually pushing the aircraft.

III. KEY POINT OF IMPLEMENTATION NOT PUSHING THE AIRCRAFT TO CORRECT COMPASS ERROR

On the basis of "quasi-compensation" theory, the key points of using analog sources to achieve compass error without pushing aircraft are: ① to keep the test conditions remain unchanged, so reviewing compass error has a certain reproducibility; ② should give "quasi compensation " 1° in the corresponding changes of degree .

A. Test conditions remain unchanged

If the corner of the antenna structure is certain, to ensure the distribution law of antenna near-field corner on a constant loop antenna is unchanged, we should pay attention to the following points:

1) the mounting position of angle antenna relative to the loop antenna should be consistent for each trial;
2) angle antenna can be reversed 180 ° and be mounted on a turntable; it has a ground terminal,so as to prevent the impact of ground terminal changes on the near-field distribution; when the test status is determined, mark in the end corner of the antenna to ensure Corner Antenna installation of repeatability ;
3) distribution of corner antenna field is also related to the frequency;during test, select radio navigation station in the vicinity of 500 kHz as the operating frequency of the analog signal frequency; use this frequency for each test.

   In order to maintain the influence consistency of the compass and the clearance of angle antenna rotation in the system, during the test the corner antenna should rotate in one direction; if rotate more than the required value, reverse it in the opposite direction and then add value to as large as desired.

B. Relationship between "quasi-compensation" value and compass error compensation value

1) the implementation principle of loop antenna and compass error compensation. Adjust the longitudinal or transverse coil output, turn an angle more or less in the resultant magnetic field goniometer, so near the coming waves 45 ° the largest compass error point will be compensated, remaining points are roughly compensated as well.

   Given the relative azimuth between loop antenna, error Compensator and radio is 0, hence wefind 0c, 0B, and a loop antenna and compass error compensator total compensation, 0'B. When we select a long loop antenna and + 4 ° error compensator , the parameter values will have changes, the total compensation value 0'B will change as well.

2) Law of compass error "quasi-compensation" value. "Quasi-compensation" law is obtained by the measurements. Based on aircraft radio aberration correction and meeting the requirements, we use the analog signal source to measure "quasi-compensation" value.

3) From a "quasi-compensation" value difference we could find error compensation value changes. Near 0° , 45° , 90° , 135° , 180° , 225° , 270° , 315° , "quasi-compensation" value changes with the antenna angle relatively slowly; in order to improve "Compensation "value sensitivity and accuracy in response to the compass error compensation value changes, now we choose range of angles in a fundamentally linear relationship between "quasi-compensation ", compass error:15 ° ~ 30° , 60. ~ 85° , 95° ~ .. 120, 150° ~ 165, 195° ~: 210° , 240° ~ 265° , 275 ° ~ 300 ° , 330 ° ~ 345 ° , to compare"

quasi-compensation "value and compass error compensation value; hence we derive 1 ° corresponding to compensation value in this range, and take it as a judge when not pushing the aircraft to correct compass error. When reviewed, we could calculate compensation value changes by "quasi-compensation" amount of change.

IV. When review "quasi-compensation" value, analyze the accidental error caused by changing test conditions

A. supply voltage variations. When corrected compass error, analog signal source of corner antenna input should be greater than 12000uV, compass is oriented in its strong field; the test shows that when 27 V DC and 115 V, 400 Hz AC power supply voltage variation is within the rated range, there is no effect on the indication value.

B. Tune the difference. In a strong field effect, after repeated experiments, it has indicated that compass tuned slightly difference does not affect the indicated value.

C. Changes in the corner antenna mounting angle. Corner antenna is placed above loop antenna (of the top-mounted), the error of the alignment markings is easier to control in the range of less than ± 0.5 mm. Standard corner antenna base line has a length 300 mm, semi length 150 mm , installation angle accidental error is less than ± 0.19° ; when installing the bottom of the big ring line, corner antenna requires to be fixed by screws, with the gap of mounting holes less than 0 5 mm. , accidental error of installation angle less than +0.19° .

D. Goniometer, the indicator reading errors. After the experiment, under the strong field, the goniometer, indicator indicates stably (for some models, if the instructions swing in individual angles o, it is because the modulation is too large; we can adjust the antenna signal splitter input resistance to eliminate the swing). Accidental error of reading should be less than ± 0. 50° ; for small indicator with coarse scale indexing , in order to reduce reading errors, during the test we can place the antenna wire angle be based on the scale indicator pointer.In summary, when reviewing quasi compensation value, we could measure it by simplifying the generalized rms, hence the uncertainty causal factors will be less than ± 0. 6° .

V. Conclusion

In the case of correcting compass error to measure compensation values by manually pushing the aircraft, we could use analog signal source to find quasi- compensation law without pushing the aircraft. By reviewing changes in the quasi-compensation law changes we could also determine the changes in the compass error. When measuring Quasi compensation value, it is important to maintain the consistency of the measurement conditions; in addition, we should also note the accuracy of the reading. As for 1° changes of compass corresponding to quasi-compensation amount, we should determine it by the aforementioned method and determine whether there are changes in compass error compensation. During the preceding calculation, when compass error compensator type is consistent to loop antenna model, it can be considered as the same compass error compensation law; prospective compensation value of each aircraft shall be decided by the measurement.

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