



ICAO

International Civil Aviation Organization

**Twenty Sixth Meeting of the Communications/
Navigation and Surveillance Sub-group (CNS SG/26) of
APANPIRG**

Video Tele-Conference, 5 – 9 September 2022

Agenda Item 13: Discuss and share experience and application of new technologies, including big data analysis, artificial intelligence, Digital Tower, counter UAS detection and identification system, UTM, etc.

TRIAL FLIGHT AND STANDARD ESTABLISHMENT OF UAS-BASED FLIGHT INSPECTION IN CHINA

(Presented by China)

SUMMARY

This paper provides the trial flight information and standard establishment progress of UAS-based flight inspection in China.

The R&D team has been developing a leading and practical flight inspection technology based on the fixed-wing and hybrid-wing UAS, which was tested and validated in several trial flights. In 2021, based on the achievements obtained from R&D and trial flights, Civil Aviation Administration of China (CAAC) proposed a standard and regulation establishment plan covering UAS, mission payload, inspection specification, crew qualification, routine maintenance and operation, to guide and encourage UAS-based flight inspection development and application.

Action by the meeting is in paragraph 3.

1. INTRODUCTION

1.1 UAS-based flight inspection system (UFIS) R&D in China has been progressing since 2017. The feasibility and the creditability of UFIS are proven in actual NAVAIDS trail flights, compared with conventional airborne flight inspection system.

1.2 Through a series of R&D and trial flights, the R&D team has achieved remarkable progress, including the technical requirements of fixed-wing and hybrid-wing UAS platform, the design requirements of mission payload, and the standards and specifications for the flight inspection based-on UAS.

Agenda Item 13

05-09/09/22

1.3 Based on these achievements, CAAC published a standard and regulation establishment plan aiming UAS-based flight inspection, which covers equipment, crew and operation management. Two tentative technical specifications were reviewed and issued by CAAC, to direct the development of fixed-wing/hybrid-wing UAS-based flight inspection system (CAAC IB-TM-2020-005) and special air-ground data link for UAS-based mission data communication (CAAC IB-TM-2022-001), according to the establishment plan of standard and regulation.

2. DISCUSSION

2.1 The R&D team in China has adopted fixed-wing and hybrid-wing UAS as platforms for flight inspection research and flight verification. Compared with the UAV solution adopted by many research institutions, this technical solution can achieve operating beyond visual line of sight (BVLOS), have a larger mission payload and a longer endurance. While the UAV solution enriches the ground testing means, fixed-wing and hybrid-wing UAS platform can support the flight inspection for CNS facility.

2.2 Trial flight situations:

2.2.1 The team carried out several trial flights to test the UAS platform and payload's functions and performance, verify the mission module and integrated system. These flights were completed in different weather and day-night conditions. The latest flights were carried out at Shandong Dongying airport, at dawn, early morning and night in October 2020.

2.2.2 The detailed solution and result of the trail flights can be found in the attached slides.

2.3 Based on the trail flights, CAAC published the plan of standard and regulation establishment in November 2021.

2.3.1 According to the existing standard and regulation of flight inspection, the UAS-based flight inspection standards and regulations are developed with two modes:

a) New standards and regulations for UAS-based flight inspection

b) Revision for the current standards and regulations with the addition of the UAS-based cases.

2.3.2 The standard and regulation establishment plan is categorized into three parts:

a) Technical specifications of UAS platform for flight inspection mission and UAS-based flight inspection payload (system and special air-ground data link).

b) Flight inspection technical requirements for communication, navigation, surveillance radar, ATC automation system and ADS-B, NAVAIDS lighting system, GNSS, airport radio interference monitoring.

c) Regulations for crew qualification and mission operation: qualifications of pilot, inspector and maintenance personnel, mission organization, status monitoring for equipment, environment and UAS, the continued airworthiness, maintenance management, reliability monitoring and management, minimum operation condition.

3. ACTION BY THE MEETING

3.1 The meeting is invited to:

- a) discuss the trial flight solution and result, review the three parts of the standard and regulation establishment plan, and share any comments;
- b) discuss the verification for UAS-based flight inspection technology and promote its application.

Attachment:

Trail Flight of UAS-Based Flight Inspection in China (PowerPoint)

Trail Flight of UAS-Based FI in China

September 2022

Technical Solution: UFIS (UAS-based FI System)

Typical Structure of UFIS Solution (#1): Fixed-Wing



Inspection
Antennas



GNSS RTK Station



RPS+C3+Ground
Inspection Mission
Package



Surveillance and
Command Center

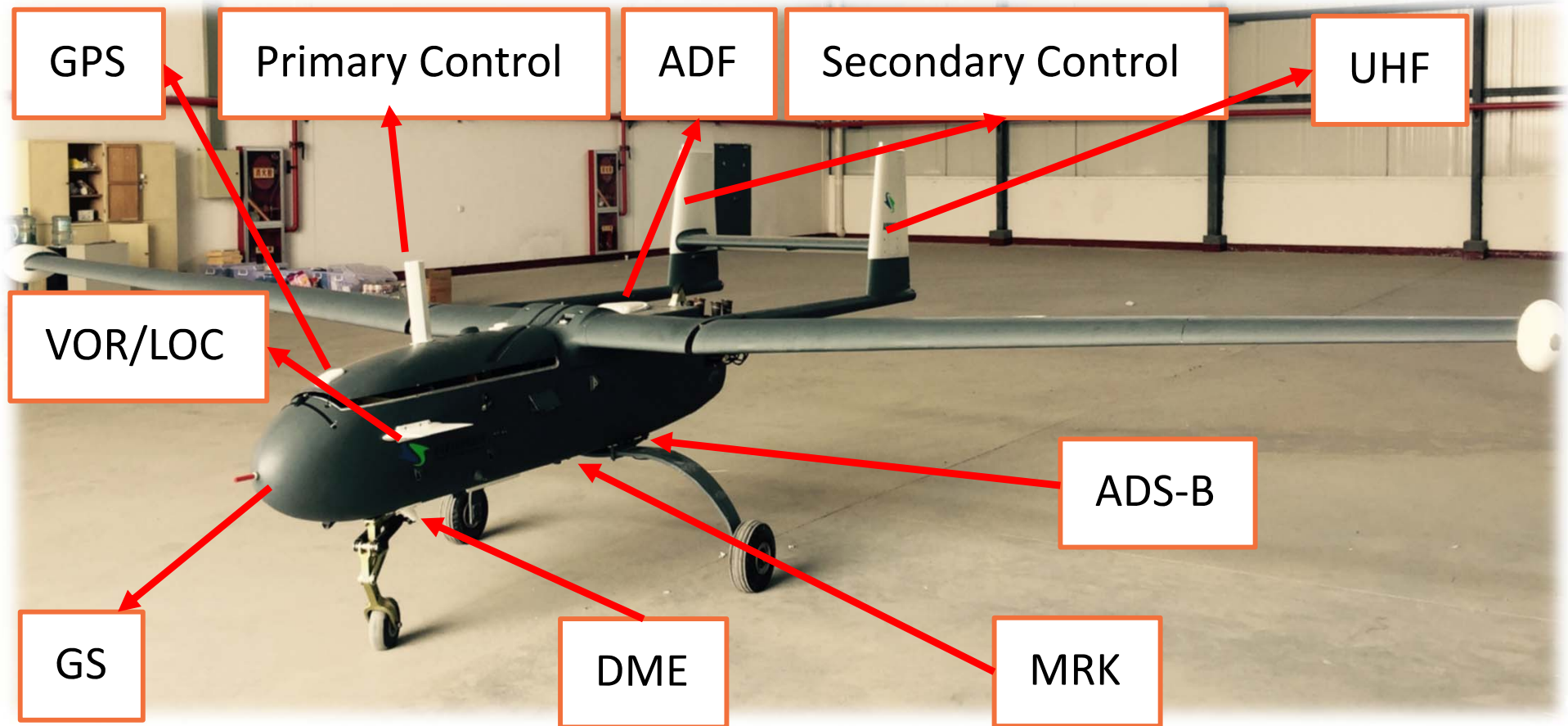
Optional



Logistics Vehicle

Technical Solution: UFIS

Fixed-Wing UFIS Solution: inspection antennas



Technical Solution: UFIS

Fixed-Wing UFIS Solution: mission payloads



Main mission payloads:

- FI Nav receiver
- GNSS receiver
- UHF datalink receiver
- Signal Acquisition Unit
- ADS-B transmitter

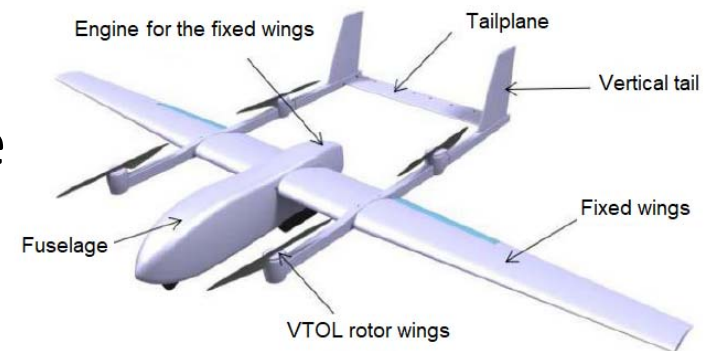
G.W: < 30 kg

Technical Solution: UFIS

Typical Structure of UFIS Solution (#2): Hybrid-Wing

Hybrid VTOL (Vertical Take-Off and Landing) Fixed-Wing UAS

- No runway occupied
- Portable remote operation suitcase
- Same mission payload
- Similar antenna layout



Technical Validation: Trial Flights

Sol #1: Fixed-Wing, June , 2019@Dongying airport, China





Technical Validation: Trial Flights

Sol #1: Fixed-Wing, June 2, 2019

➤ VOR/DME

ID: DYN
 Flight item: Radial
 Range: 5NM-10NM

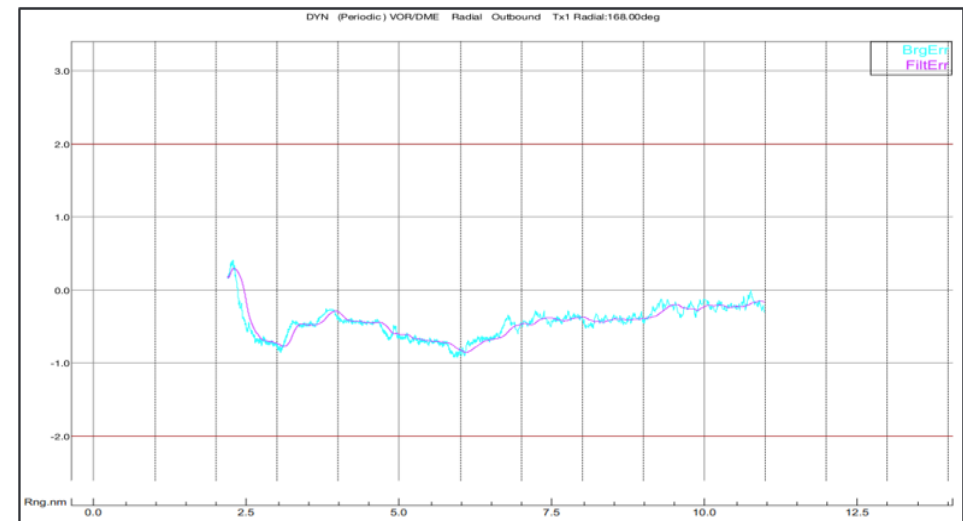
Inspection Para	Result	Latest	Tolerance
VOR bearing err	-0.41deg	-	± 2deg
VOR roughness	0.16deg	-	± 3.0deg
VOR bends	0.37deg	-	± 3.5deg
30Hz AM	30.22%	-	28~32%
30Hz FM	16.24	-	15~17
9960 AM	29.51%	-	28~32%
DME rang err	-0.06nm	-0.06nm	0.5nm

VOR/DME Radial_Result

Inspection				VOR Polarization						
Status	Inspection	ID	01	Facility ID	DYN	Mag Var	-6.00 deg	Left	Right	
Commission	No	Note		VOR ID	DYN	Direction	Inbound	Change	-	-
Standard	ICAO	Initial	No	VOR Rx	NAVA	Radial	20 deg	Roll	-	-
Type	VOR/DME	Final	No	DME ID	DYN	Start Ring		Range	-	-
Profile	Radial	TxNo.	1	DME Rx	NAVA	Stop Ring	10.21 nm			

VOR Result				DME Result					
Min AGC	-58.00 dBm	Max RS	0.16 deg	Max Bend Align	0.86 deg	Min AGC	-56.89 dBm	Err Spread	0.06 nm
Min AGC	281.84 uV	Max RS Rng	9.86 nm	Max Bend Align Rng	5.96 nm	Min AGC	320.43 uV	Max +Rng Err	0.03 nm
Min AGC Rng	5.97 nm	Max Bend	0.37 deg	Max In Tol Bend	0.37 deg	Min AGC Rng	6.14 nm	Max+Rng Err Rng	4.18 nm
Mean Brg Err	-0.41 deg	Max Bend Rng	5.96 nm	Max Tol Bend Rng	5.96 nm	Mean Rng Err	0.01 nm	Max-Rng	-0.03 nm
Mean Fit Brg	-0.42 deg							Max-Rng Err Rng	5.06 nm

Segment	Mean Fit Brg Err	Max Abs Bend	Max Bend Rng	Max Bend Align	Max RS Rng	Max RS	Max RS Rng	VOR Min AGC	30AM Mod	30FM Mod	9960AM Mod	DME Min AGC	DME Max +Rng Err	DME Max +Rng Err Rng	DME Max -Rng Err	DME Max -Rng Err Rng
0-5	-0.52	0.25	3.03	0.77	3.03	0.12	4.92	-50.24	30.41	16.22	28.97	-53.05	0.03	4.18	-0.02	4.99
5-10	-0.49	0.37	5.96	0.86	5.96	0.16	9.86	-58.00	30.22	16.24	29.51	-56.89	0.02	7.35	-0.03	5.06
10-15	-0.24	0.05	10.19	0.29	10.19	0.09	10.00	-57.50	30.16	16.28	28.24	-50.21	0.02	10.04	-0.01	10.14





Technical Validation: Trial Flights

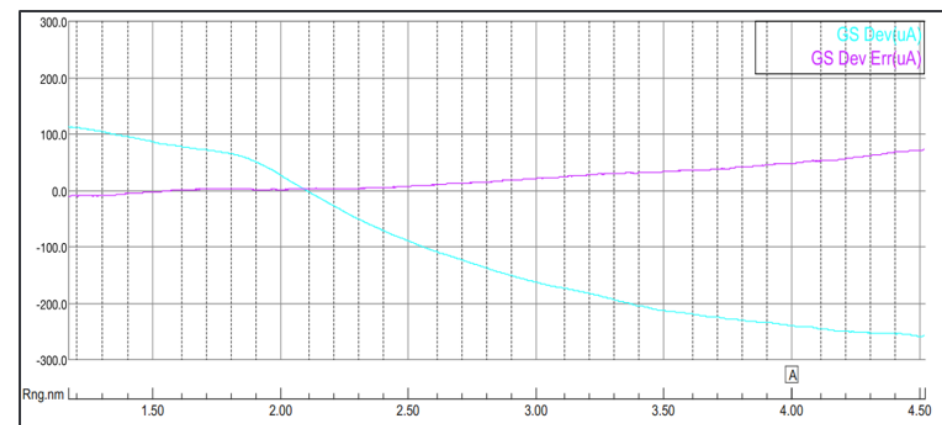
Sol #1: Fixed-Wing, June 2, 2019

➤ ILS GP Width/Symmetry

ID: IDY
 Flight item: Level Run
 Range: 4 NM- Threshold

Inspection Para	Result	Latest
GP width	0.74deg	0.71deg
GP symmetry	49.90%	46.90%
GP angle	2.98deg	2.97deg

Inspection						ILS2 Result					
Status	Inspection	ID	01	Facility ID	EKIDY						
Commission	No	Note		Facility Frequency	108.7	MHz					
Standard	ICAO	Rx	NAV A	Facility Category	1						
Type	ILS2	TxNo	1	Airport ID	ZSDY						
Profile	Normal	Runway ID	18	StartRange	4.20	nm					
Direction	Inbound	Received ID	IDY	StopRange	0.04	nm					
ILS2 Result											
Width	0.74	deg	Min Dev	-249.33	uA	0.3SetaDev	-	uA			
Angle	2.98	deg	Min Dev Range	4.20	nm	0.3SetaRng	-	nm			
90Hz Sym.	49.90	%	Max Dev	315.99	uA	0.45SetaDev	-	uA			
Struct Below Path	1.94	deg	Max Dev Range	0.05	nm	0.45SetaRng	-	nm			
Clear Above Path	Yes					0.3-0.45SetaDev	-	uA			
Clear Below Path	-238.78	uA				0.3-0.45SetaRng	-	nm			
Clear Below Path Rng	4.00	nm				0.45-1.0SetaDev	-	uA			
Min AGC	-83.57	dBm				0.45-1.0SetaRng	-	nm			
Min AGC	14.84	uV				1.0-1.75SetaDev	-	uA			
Min AGC Range	4.20	nm				1.0-1.75SetaRng	-	nm			





Technical Validation: Trial Flights

Sol #1: Fixed-Wing, June 2, 2019

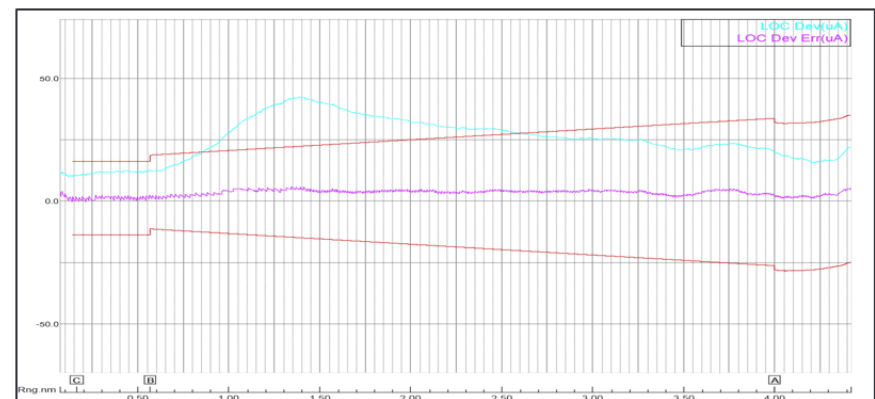
➤ ILS Alignment, Modulation, Structure

ID: IDY
 Flight item: Approach
 Range: 4.2NM- Threshold

Inspection Para	Result	Latest
Alignment	-0.02/1.47R	-0.01/1.08R
modulation	39.2%	39.9%
Structure (Zone 1)	1 /4.34	1 /8.67
Structure (Zone 2)	3 /0.64	1 /2.31
Structure (Zone 3)	1 /0.21	1 /0.25

Inspection				MARKER			
Status	Inspection ID	01	Facility ID	EKDY	Outer	-	m
Commission	No	Note	Facility Frequency	108.7	Range	-	nm
Standard	ICAO	Rx	NAV A	Facility Category	1	Middle	154.4 m
Type	ILS3	Txllo	1	Airport ID	ZSDY	Range	0.7 nm
Profile	Center	StartRng	4.43 nm	Received ID	IDY	Inner	107.7 m
Direction	Inbound	StopRng	0.04 nm	Runway ID	18	Range	0.2 nm

Localizer Result										
Course Alignment			Structure			Polarization				
Angle75L	-	deg	deg	uA	Zone1	Dev Err	Ring toTH	Change	Left	Right
Angle75R	-	deg	Above Path	-	Zone2	1.2	4.34	-	-	uA
1/2Width	-	deg	On Path	-0.02	-1.47	3.1	0.64	Roll	-	-
90Hz Sym	-	%	Below Path	-	Zone3	1.6	0.21	Range	-	-
TolMod	39.2	%			Zone4	-	-			
TolMod Rng	5.00	nm			Zone5	-	-	Localizer	Structure	PASS!



Technical Validation: Trial Flights

Sol #2: Hybrid-Wing, December 2019-October 2020



Technical Validation: Trial Flights

Sol #2: Hybrid-Wing, December 2019~October 2020

Inspection Para	Result	Latest	Tolerance
LOC Alignment	0.01/1.10R	0.00/0.41R	$\pm 15\mu\text{A}$
LOC Modulation	40.4%	39.9%	36%~44%
LOC Structure (Zone 1)	0/6.96	1 /7.79	$\pm 30\mu\text{A}$
LOC Structure (Zone 2)	2/1.23	2 /1.24	$\pm 15\sim\pm 30$
LOC Structure (Zone 3)	4/0.15	1 /0.50	$\pm 15\mu\text{A}$
LOC Width	3.14	-	-
GS Angle	3.02	3.02	2.78-3.3
Threshold Height	17.4	17.1	15-18
GS Modulation	79.9%	79.5%	75%-85%
GS Structure (Zone 1)	3/11.48	1 /9.64	$\pm 30\mu\text{A}$
GS Structure (Zone 2)	10/0.57	10 /0.57	$\pm 30\mu\text{A}$
GS Structure (Zone 3)	18/0.31	9 /0.55	$\pm 30\mu\text{A}$

