



State Research Institute of Aviation Systems (GosNIIAS)

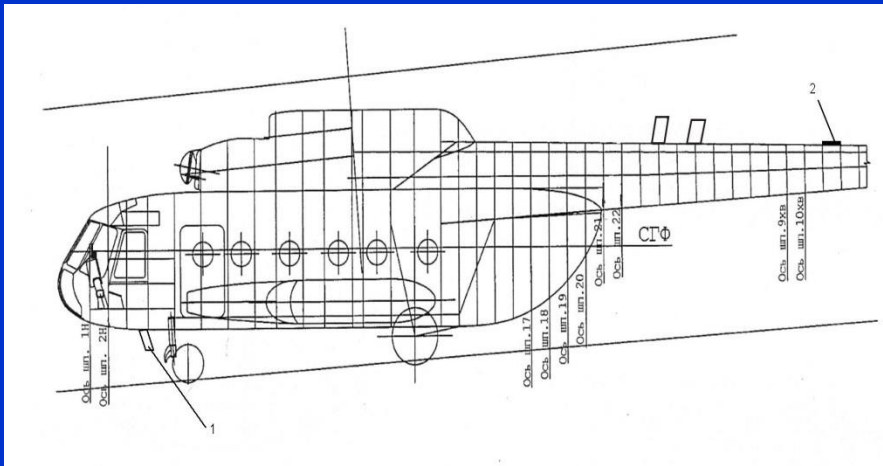
Experimental Flights of Utair Mi-8T
leading helicopters equipped with ADS-B
Mode 4 system for ADS-B service
evaluation on routes in Yamal peninsula



In the period of 18-21th of November and 8-12th of December 2011 at Utair Aviacompany LLC base there were performed refinement, debugging, and ground and flight tests of ADS-B on-board complex with a VHF Mode 4 digital line on Mi-8T Nos. RA 24105 и RA 24125 helicopters; these tests started from Mys Kamenny base airdrome on Yamal peninsula routes “Mys Kamenny – Yamburg” and “Mys Kamenny – Bovanenkovo”; the airdrome was equipped with ADS-B-N ground hardware/software in order to acquire the service evaluation in actual operating conditions.

The service evaluation was executed by an integrated team of specialists from FGUP GosNIAS, FGUP GosNII Aeronavigatsiya, LITs FGUP GosNII GA, NITA LLC, VNIIRA-Navigator CJSC, and AK Utairt JSC according to the *Program and Methodology of ADS-B service evaluation on Mi-8 helicopters and Supplements to the Operational and Technical Documentation (Maintenance Manual, Maintenance Guide, Flight Crew Operation Manual)*, approved by GosNII GA Flight Guidance Council on September 26, 2011, No. 17.

1. Results of ADS-B equipment installation on board of helicopters Nos. RA-24105 and № RA-24125:



Location of ADS-B antennas on Mi-8T helicopters

- 1 – Pulsar AMR-0.38 BV antenna;
- 2 – BMS-Indicator AT-1675-0 antenna

1. Range of “air-ground-air” and “air-air” robust communication on routes in Yamal peninsula at H=180 – 300 m:

- Mys Kamennyy – Yamburg – 95 km
- Yamburg - Mys Kamennyy – 95 km;
- Mys Kamennyy – Bovanenkovo – 58 km;
- Bovanenkovo – Mys Kamennyy – 75 km

2. Displayed information is representative and stable.

3. Electromagnetic compatibility of ADS-B and Mi-8T on-board equipment is provided

4. Right amount of Operational and Technical Documentation for ADS-B operation on board of Mi-8T helicopter.

ADS-B equipment installation on board of helicopters Nos. RA-24105 and RA-24125:

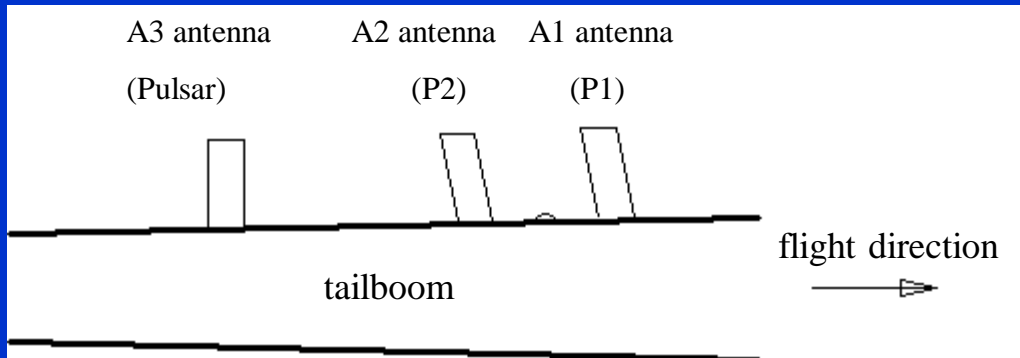


Location of AK-550 altimeter at the central console in the cockpit of Mi-8T RA-24105 and RA-24125 helicopters (looking aft).



Location of Pulsar radio on board of Mi-8T RA-24105 and RA-24125 helicopters (looking aft).

Ground works on measuring the VHF antenna cross talk (initial version of Pulsar antenna location)



Location of VHF radio antennas on the helicopter tailboom

Pulsar radio and regular radio antennas cross talk for R-863 command communications is within:

- A3 (Pulsar) – A1 (P-863 basic radio) – 17.3-31.8 dB;
- A3 (Pulsar) – A2 (P-863 back-up radio) – 14.7-19.0 dB.

Acquired values of the cross talk are much lower than 35 dB value, recommended by applicable Aviation Regulations (AP-20, Interim Supplement D29.2, part D29.2.5 Radio communication equipment, item 8.4.5.1.10).

HF generator sends a signal to AFT-X, emitted later by X antenna. Y antenna receives the signal, and FSL-3 spectral analyzer measures the signal at AFT-Y output.

Measurements were done in 118.0-137.0 MHz range. AC tracking generator (output power 0 dBm) and VXA-300 portable radio in VHF airband (output power +31 dBm) was used as the signal source.

Measuring cable losses were considered in the calculations of the antenna cross talk.

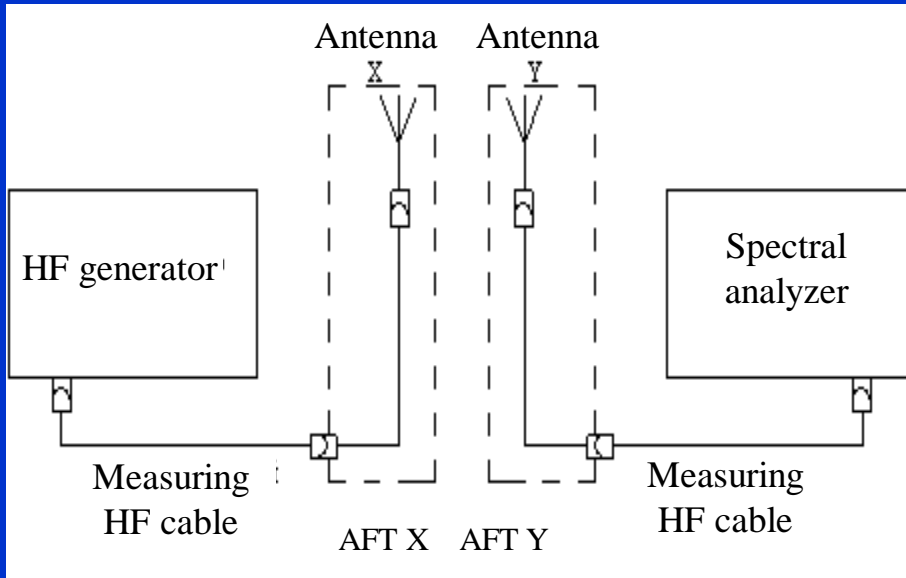
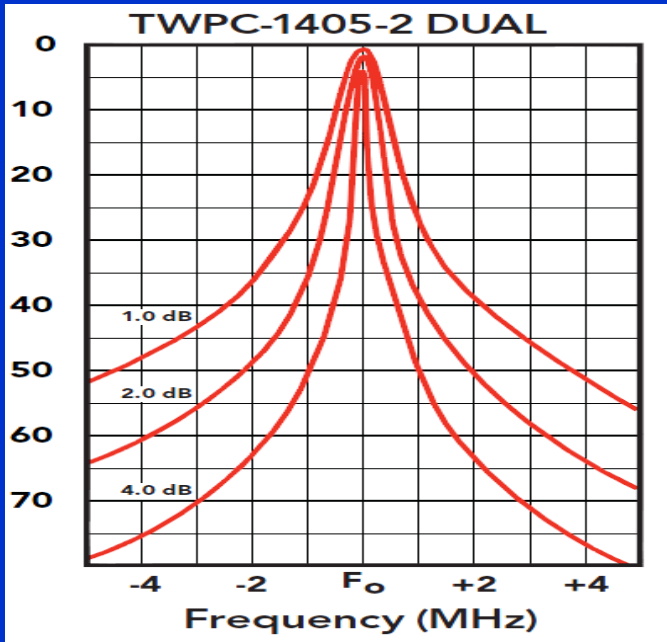


Diagram of the antenna cross talk measurement

Check of VDL 4 radio operation impact on the performance of command voice radios



Amplitude-frequency response of TWPC-1405-2 filter

The impact of VDL 4 radio operation on the performance of command voice radios manifests itself as typical clicks which may be heard at the receiver output of voice radio with VDL 4 rate.

There were detected following specific features:

- Clicks at the command radio output depend on implemented designs;
- The antenna cross talk value significantly impacts the provision of the electromagnetic compatibility between the radios.

There is recommended an additional signal filtering at VDL 4 radio output allowing to decrease the frequency tuning-out value between operating frequencies of radios.

2. Results of the ground phase of the service evaluation



BMS-Indicator displays own aircraft mark (oriented on the grid center), mark of another aircraft with ADS-B on its board, showing relative barometric altitude, distance to the object, and mark of the base ground station (NITABASE)

Information from BMS-Indicator display on board of RA-24105 helicopter.

Results of the ground phase of the service evaluation



BMS-Indicator displays own aircraft mark (oriented on the grid center), mark of another aircraft with ADS-B on its board, with its call-sign, relative barometric altitude, distance to the object and mark of the base ground station (NITABASE)

Information from BMS-Indicator display on board of RA-24125 helicopter.

Results of the ground phase of the service evaluation



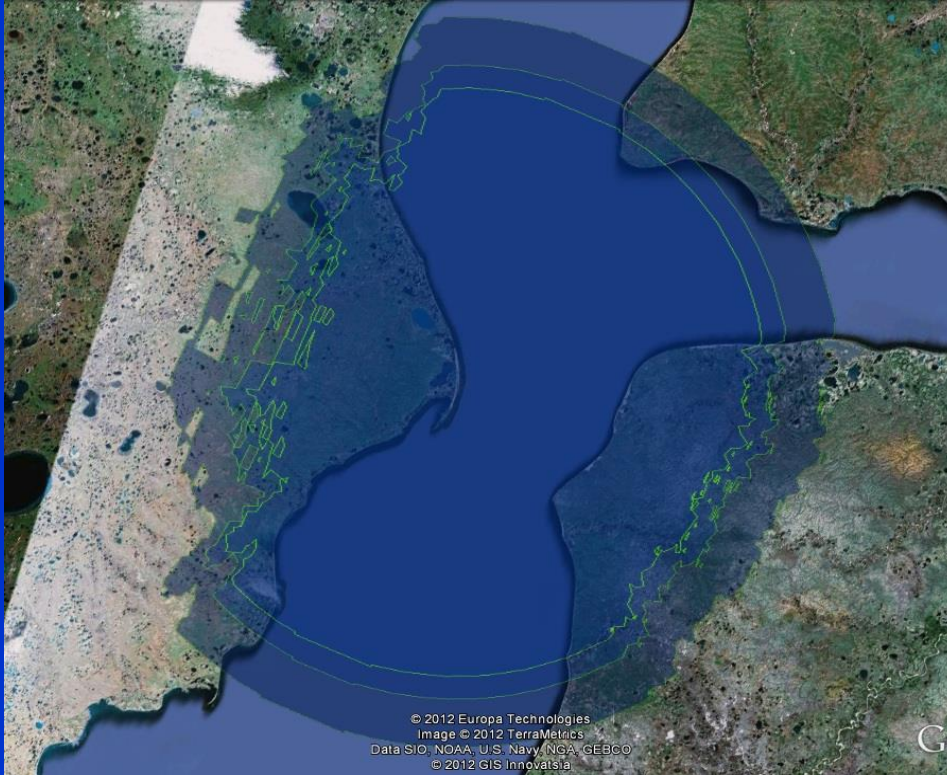
Photo from Alfa display

Alfa display demonstrates marks of observed aircraft in RLOS in real time.

The cursor selects an aircraft with RA 24105 call-sign.

Information box demonstrates aircraft performance data.

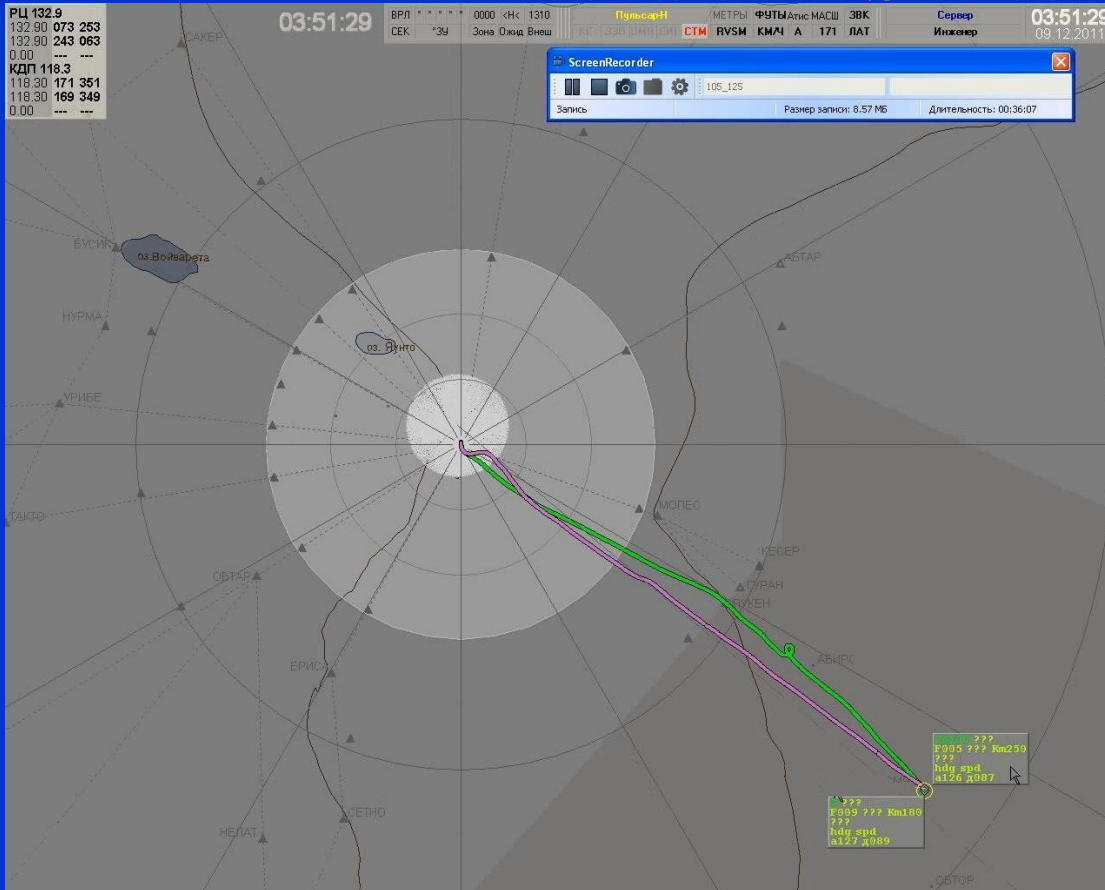
3. Results of the flight phase of the service evaluation on-board ADS-B complex



Estimated radio coverage zones from Mys Kamenny airdrome taking into consideration the terrain (for altitudes of 160, 180, 300 m)

- A.** Pulsar range during flights from Pulsar-N Mys Kamenny at :
 - H = 300 m – 70 km.;
 - H = 500 m – 96 km.
- B.** BMS-Indicator allows to solve navigation tasks.
- B.** Mi-8T positioning error in hovering is about 30 m.

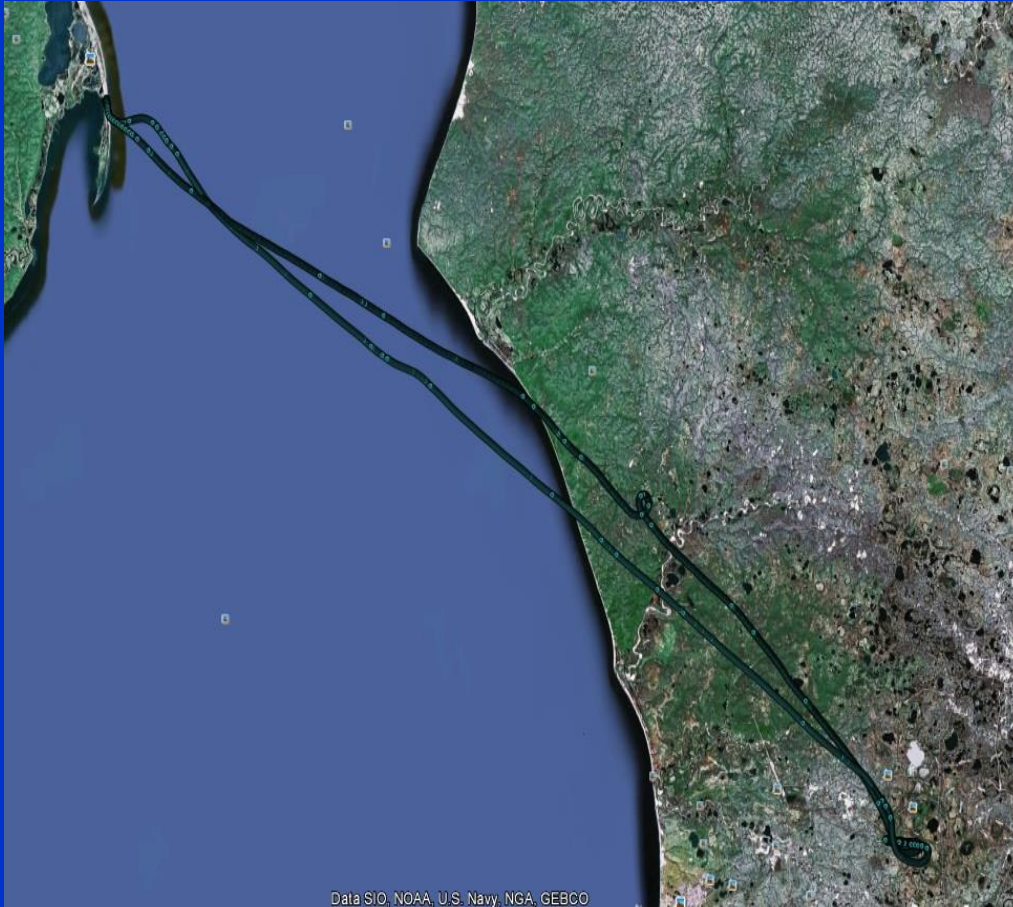
3. Results of the flight phase of the service evaluation on-board ADS-B complex



Completeness and reliability of transmit/receive of messages via air-ground-air link at various altitudes on parallel, intersecting and head-on courses is stable.

Routes of 24195 and 24125 aircraft to Yamburg in flight on December 9, 2011 (altitude 180-250 m) acquired from air controller's electronic devices at Mys Kamennyy airdrome

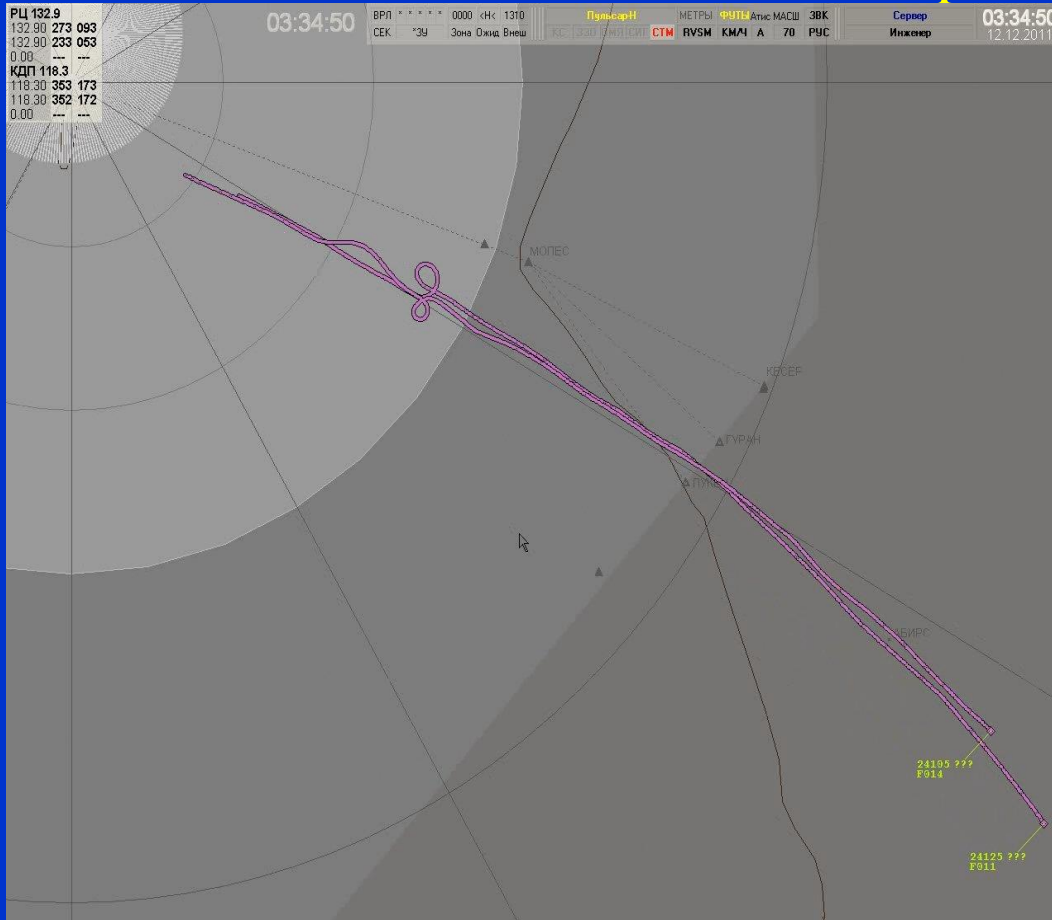
3. Results of the flight phase of the service evaluation on-board ADS-B complex



Routes of 24195 and 24125 aircraft to Yamburg in flight on December 9, 2011 (altitude 180-250 m) acquired from Log-files of Pulsar on-board radio

Completeness and reliability of transmit/receive of messages via air-to-air link at various altitudes and distances on parallel, intersecting and head-on courses is stable.

3. Results of the flight phase of the service evaluation on-board ADS-B complex



Routes of 24195 and 24125 aircraft to Yamburg in flight on December 12, 2011 (altitude 180-250 m) acquired from ground control station at Mys Kamenny

Mi-8T formation flight at 500-800 m altitude, Mys Kamenny – Yamburg.

There were practiced recommendation on the improvement of BMS – Indicator functioning insofar as display of air traffic participants who move away, converge, climb or descend at V_y exceeding 2.5 m/sec.

3. Results of the flight phase of the service evaluation on-board ADS-B complex



Displayed ADS-B flight information is sufficient to improve the air traffic situational awareness (two Mi-8T and Pulsar-N helicopters). Graphical presentation of the air situation corresponds with the digital information of both air traffic participants (right part of the display).

ADS-B page at BMS-Indicator display ($t = T_1$)

3. Results of the flight phase of the service evaluation on-board ADS-B complex



ADS-B page at BMS-Indicator display ($t = T_2$)



ADS-B page at BMS-Indicator display ($t = T_3$)

Photos of a one-way flight of two aircraft in pair from Mys Kamennyy to Bovanenkovo with T_2 exceeding T_3 , at different velocities and altitudes.

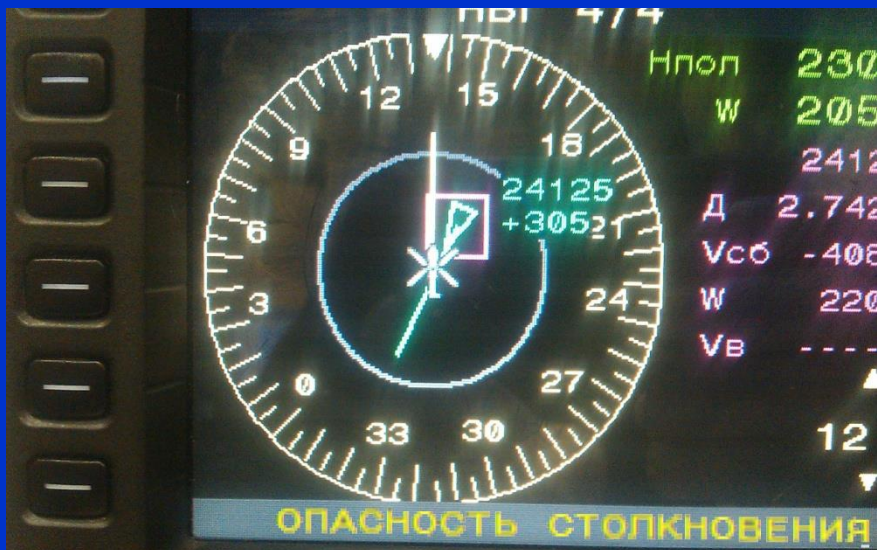
3. Results of the flight phase of the service evaluation on-board ADS-B complex



Graphic ADS-B and digital information in the right part of the display complement each other. Ranges, closing velocities, vertical separation of two helicopters provide for complete air situation awareness.

ADS-B page at BMS-Indicator display showing 24105 and 24125 aircraft opposing flight

3. Results of the flight phase of the service evaluation on-board ADS-B complex



ADS-B pages at BMS-Indicator display showing dangerous convergence and divergence of aircraft

The two helicopters on converging routes with closing velocity of 400 km/h managed to pass head on, having avoided a collision (CD enclosure from DO-289/RTCA). It was found necessary to send a sound signal to pilot.



4. Conclusion on the results of the service evaluation of ADS-B equipment on board of Utair Aviacompany JSC Mi-8T helicopters

While investigating the capabilities and operational prospects of ADS-B for the management of helicopter flights on Gasprom LLC production tasks it should be mentioned that ADS-B complex has demonstrated its full functional validity.

Higher level of flight safety back-up becomes possible due to the transition of on-board equipment to another level of solution of navigation and traffic management tasks.

Development of legal and normative documents regulating the civil aviation operation should contain rules and procedures of ADS-B technology application.

Conclusions:

The results of performed works may form the basis for future actions on the carriage of the Decision No. 3 of the Air Navigation Council (Panel) of the Federal Air Transport Agency named *Problems of the implementation of automatic dependent surveillance systems in the air traffic organization in the Russian Federation* of October 2, 2009; first of all it concerns the implementation of **Yamal-ADS**, **Baltika-ADS** pilot projects of ADS-B deployment as well as future development of **Moscow-ADS** system .