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Status of the COSPAS-SARSAT Programme and Its Future Development

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Abstract. The first COSPAS-1 satellite launch 35 years ago opened a new era of rescue of people in distress when timely and exact determination of coordinates of maritime, aviation or any other accident became possible by means of spacecraft.

The project of a satellite system for search and rescue COSPAS-SARSAT was started in 1979 by four countries: the USSR, Canada, France, and the USA. At the beginning of the twenty first century, this project continues to remain a unique model of the international cooperation of 43 states and organizations, which provide means of satellite communication free of charge for the end user in distress in every spot on the globe.

Today, the Medium Earth Orbit Search and Rescue (MEOSAR) satellite system for distress alerting and positioning is beginning to operate and will eventually serve as a replacement of the existing LEOSAR system. As a reminder, 1998 was marked (after several years of testing) to strengthen the LEOSAR system with the introduction of the GEOSAR geostationary satellite system. The realization of the MEOSAR system will guarantee that the COSPAS-SARSAT Programme will continue its successful activities in the near future, providing improvements to the operational parameters of the System, including the accuracy of determination of the coordinates of an emergency beacon.

The status and major avenues of the Programme development are considered in this paper.

Keywords: COSPAS-SARSAT System, LEOSAR, GEOSAR, MEOSAR, MCC, LUT, beacon

Introduction

The beginning of implementation of the International satellite system of search and rescue COSPAS-SARSAT was a necessary start of the first Soviet COSPAS-1 satellite in 1982. For the last 35 years, by means of the COSPAS-SARSAT System more than 44 000 people have been saved, more than 1600 people out of this number are from the countries of the former USSR and Russia. This outstanding achievement has gained a big recognition among the world community of users of the aviation and maritime transport and also individual users on the land [1].

As one of the leaders of the COSPAS-SARSAT system and one of the Parties of the Agreement on the COSPAS-SARSAT International Programme, Russia assumed responsibility and obligations of the former USSR for an involvement in the Programme, including obligations for launch and maintenance of the satellites, installation of the stations for reception and processing of information, and also creation and maintenance of the center of the COSPAS System providing processing and routing of abnormal data.

The participants of the COSPAS-SARSAT Programme express huge gratitude to Joint Stock Company "Russian Space Systems" (the former scientific research institute of space device engineering) for the creation of the COSPAS System, its maintenance in an operational state, and improvement within the last 35 years.

The main concept and other fundamental information on the COSPAS-SARSAT system can be found in three working languages of the Programme (English, French, and Russian) [2].

1. The COSPAS-SARSAT mission

The COSPAS-SARSAT Programme renders assistance to search and rescue services around the world by timely giving precise and reliable data on disaster and its location to the world community on a non-discriminatory basis.

The purpose of the COSPAS-SARSAT System consists in decrease, as far as it is possible, delays in providing emergency messages to search and rescue services and time for a fixing of the disaster, and assistance that directly influences the probability of survival of the person at the sea and on the land.

To achieve this purpose, the Participants of COSPAS-SARSAT put into operation, maintain, coordinate, and operate a satellite system, which is capable to find emergency signals from the beacons that meet the specifications and standards. Moreover, the System can define the location of the beacons in every place on the globe. Disaster data and its location are transferred by the Participants of COSPAS-SARSAT to the relevant search and rescue services.

COSPAS-SARSAT cooperates with International Civil Aviation Organization (ICAO), International Maritime Organization (IMO), International Telecommunication Union (ITU), and other international organizations for the purpose of ensuring compliance of the COSPAS-SARSAT services in providing data on disaster with requirements, standards, and the corresponding recommendations of the world community.

2. The latest decisions of the COSPAS-SARSAT Council

One representative from each of four Parties of the International COSPAS-SARSAT Programme Agreement (ICSPA), namely Russia, Canada, France, and the USA is included in the COSPAS-SARSAT Council. The Council is convoked at least once a year to carry out the corresponding tasks and to coordinate the actions of the Parties, but to perform its functions it can be convoked as required and more often. The decisions of the Council are made unanimously by the Representatives of the Parties.

At private meetings of the Council, there are only the Parties and, first of all, questions of the activity of the Secretariat and management of the Programme, including the relations with potential participants, users of the System, manufacturers, and the international organizations are considered.

The Council is also convoked at least once a year at an open meeting during which the associated countries and the organizations (COSPAS-SARSAT Participants) can discuss any problem concerning administration of the Programme and System management, which are of interest to the COSPAS-SARSAT Participants. The general expenses of the Programme, maintenance of the System and its development, the report and the recommendations of the Integrated committee (the organ of the Programme helping with preparation of decisions of the Council), and the relation with the international organizations belong to these questions.

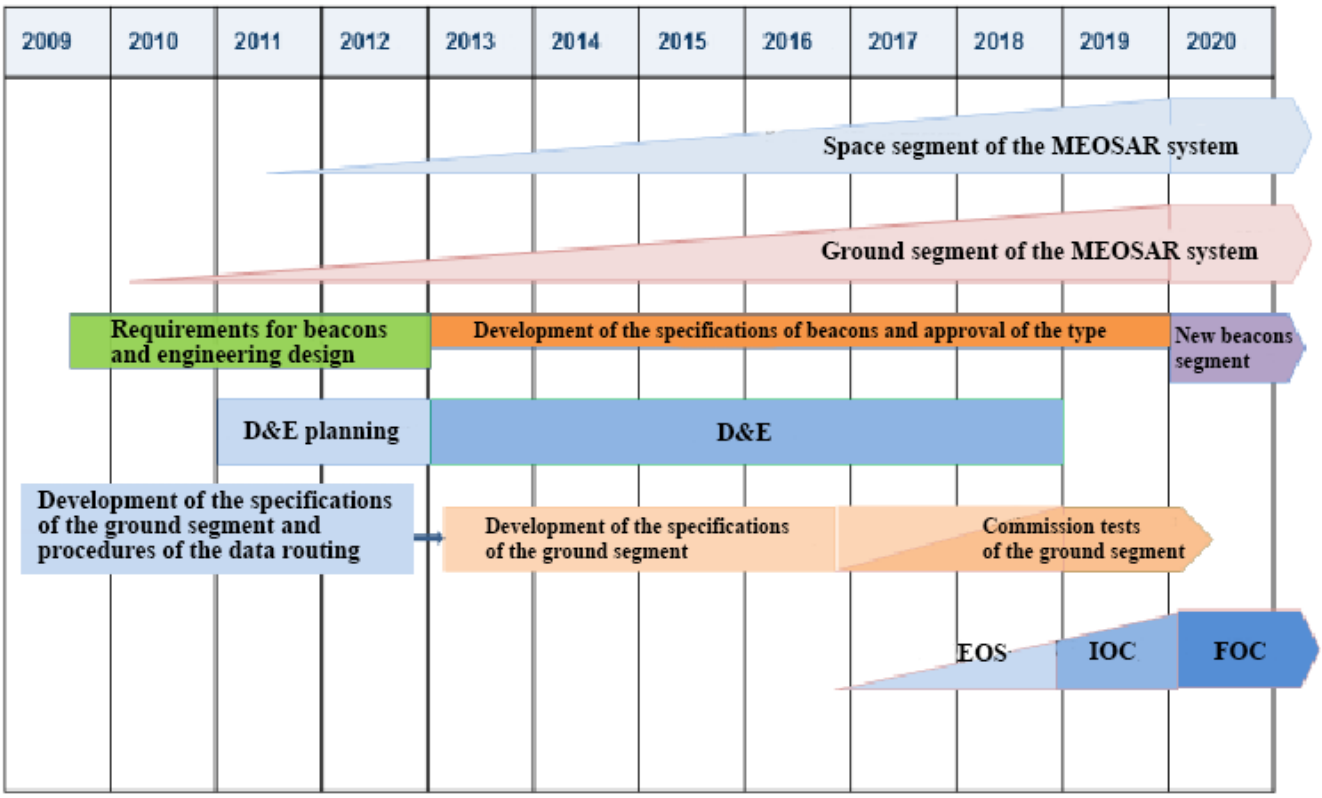

Fig. 1. Preliminary schedule of introduction of the MEOSAR system

At the closed and open meetings of the 57th session of the COSPAS-SARSAT Council (on December 1-8, 2016), key decisions concerned the beginning of routing of abnormal data of Medium Earth Orbit Search and Rescue satellite system (MEOSAR) at a stage of Early Operational Capability (EOC), and also advance on development of the specifications for second-generation beacons [3].

2.1. Medium Earth Orbit Search and Rescue satellite system (MEOSAR)

The MEOSAR system is created on the basis of the groups of the GLONASS navigation satellites (Russia), Galileo (European Union), and GPS (the USA).

The begun phase of the Early Operational Capability (EOR) already allows using operational data of the MEOSAR system. In the period of EOR, the MEOSAR system under development will allow one to improve the operational parameters of the System, including the accuracy of determination of coordinates of an emergency beacon in addition to the existing Low Earth Orbit Search and Rescue satellite system (LEOSAR) and the Geostationary Earth Orbit Search and Rescue satellite system (GEOSAR), and search and rescue services (SAR) should get acquainted with the MEOSAR system before the end of its Demonstration and Evaluation (D&E) Phase. By the present moment, commission tests within the MEOSAR system were passed through two Mission Control Centres (MCC) in France and the USA and also seven local user terminals (LUT) in Spain, Cyprus, Norway, the USA, Turkey, and France. Besides, now at the EOC phase, the MEOSAR system does not provide a global covering and not completely meet the expected requirements to its productivity, in particular concerning accuracy parameter.

The 57th session of the Council noted that all criteria, which allow one to begin the EOC phase of the MEOSAR system [4], were coordinated, and the beginning of this phase was announced. The letter notified all interested parties. The EOC phase began on December 13, 2016.

Each subsequent phase after EOC (that is Initial Operational Capability (IOC) and Full Operational Capability (FOC) provides improvement of operational parameters of the System.

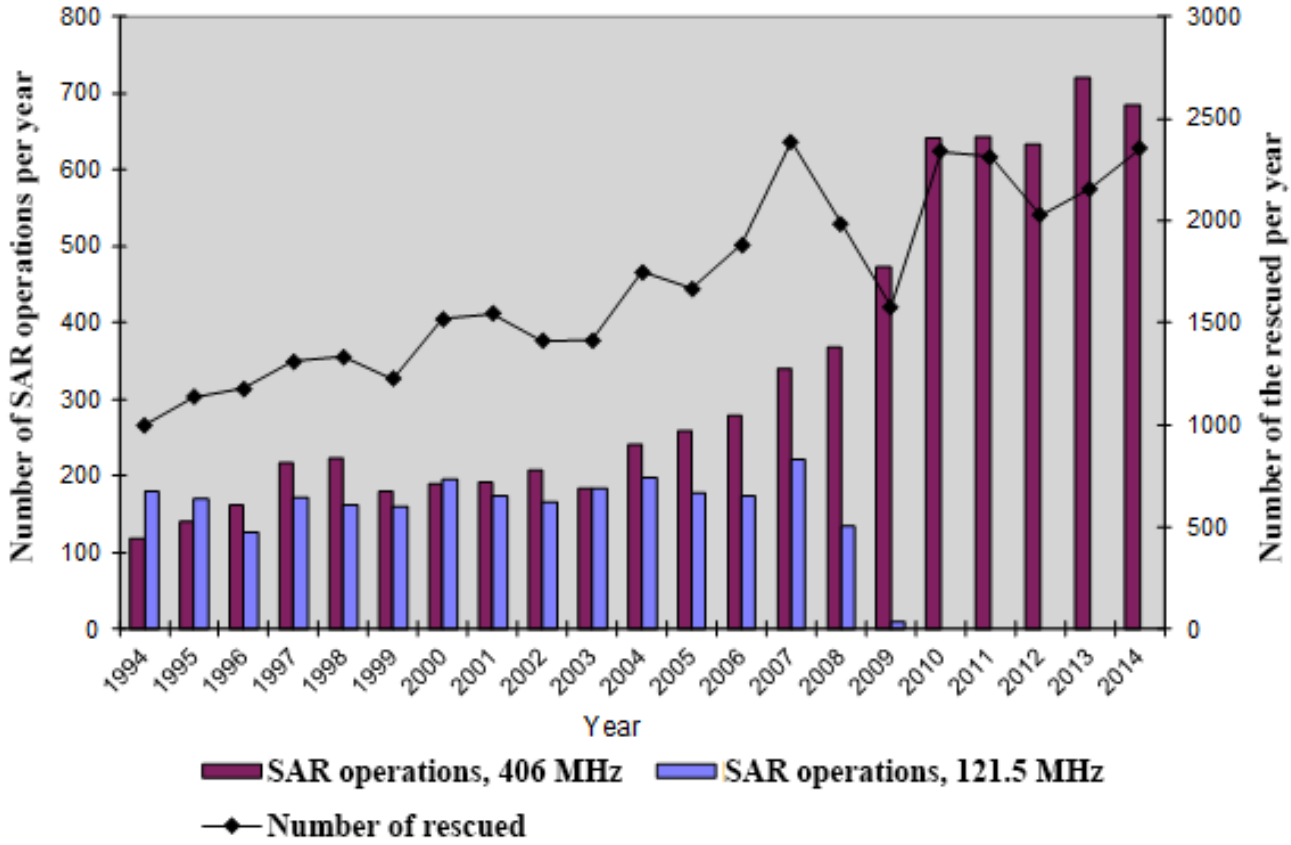

Fig. 2. Number of search and rescue operations and number of rescued people by means of the COSPAS-SARSAT emergency data (January 1994 – December 2015)

At the final stage of the IOC phase, all equipment of a ground segment of the MEOSAR system will conform to requirements for productivity without any restrictions.

At the FOC phase, the MEOSAR system will have already sufficient resources of a space segment and a possibility of providing a global service.

Transition to phases IOC and FOC is expected within the next several years. In Fig. 1, the preliminary schedule of introduction of the MEOSAR system is given.

As a result of a full introduction of the MEOSAR system, removal from operation of the existing LEOSAR system is supposed in course of years.

2.2. Second-generation beacons

Second-generation beacons will promote improvement of operational parameters of the System, meeting new more rigid requirements for probability of detection of a beacon, accuracy of determination of its location, and capacity of the System.

Second-generation beacons assume also realization of return link service (RLS) offered by some Global navigation satellite systems (GNSS), at which the notification is sent to an emergency beacon after it has been detected by the COSPAS-SARSAT System.

2.3. The COSPAS-SARSAT Secretary

The COSPAS-SARSAT Secretary is an administrative body of the COSPAS-SARSAT International Programme, which mission consists in assistance to the Council in realization of all its functions for management of the Programme, including holding meetings, administrative support, maintaining documentation of the System, and implementation of international relations.

The Staff of the Secretariat provides technical and operational support and examination for the participating countries/organizations and also users on such questions as the status of the System, the specification and performance data of the System, approval like emergency beacons, registration of beacons, work of the Space and Ground segments, and routing of emergency data.

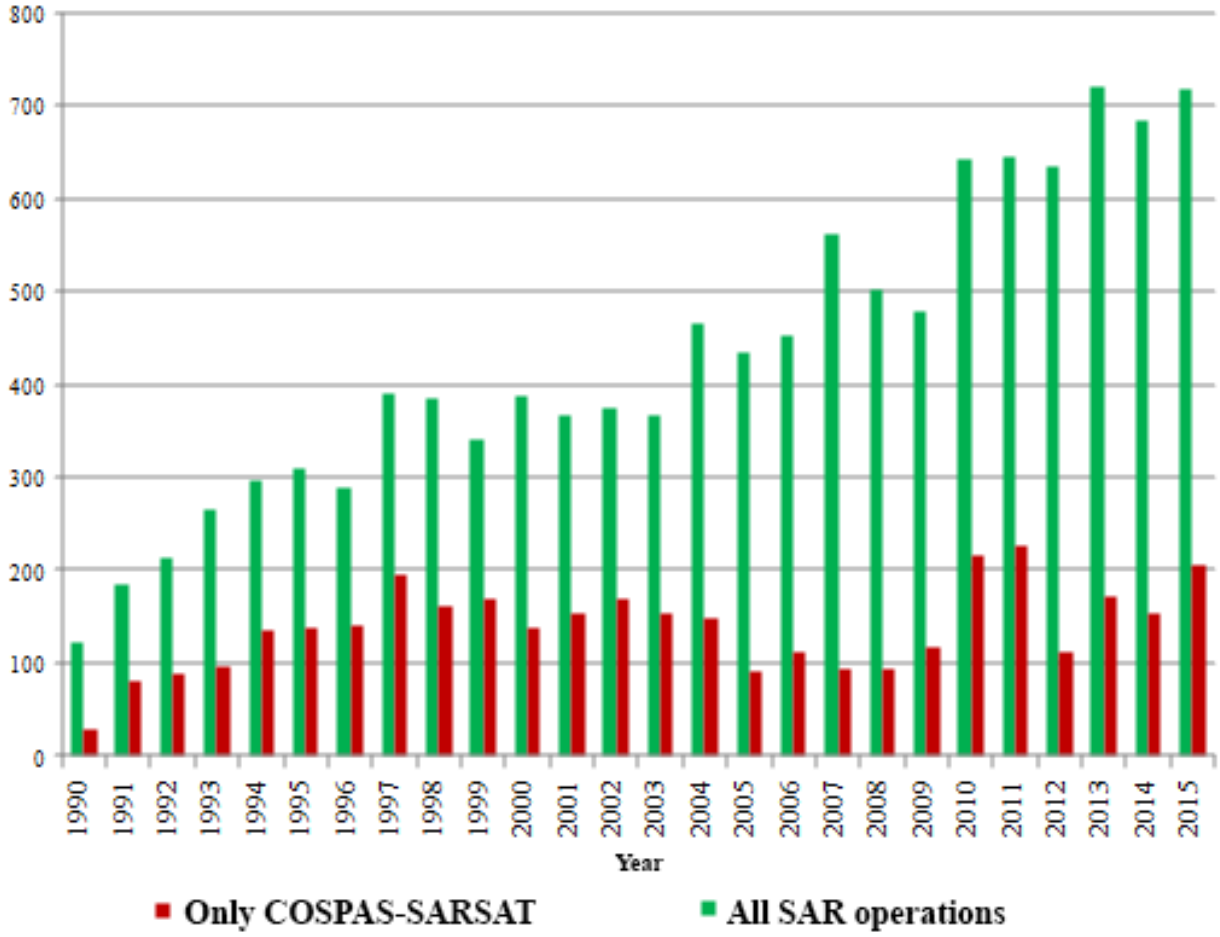

Fig. 3. Annual total number of SAR operations using the COSPAS-SARSAT emergency data and number of SAR operations when COSPAS-SARSAT was the only source of emergency information (1990-2015)

3. The COSPAS-SARSAT Participants

A total number of the Participants of the COSPAS-SARSAT Programme after accession of Malaysia in December 2016 has reached the number of 43 countries, among which 4 parties providing a space segment, 28 states providing a ground segment, 2 states-operators of a ground segment, and 9 states-users of the Programme [5].

4. The main operational statistics of the COSPAS-SARSAT System

In 2015 (processing of the statistics of 2016 has not been finished yet), the COSPAS-SARSAT emergency data were used in 718 incidents (in 2014 – 685), at the same time 2185 people were saved (in 2014 – 2354). Since September 1982 to December 2015, the COSPAS-SARSAT System provided help at rescue at least of 41 750 people in 11 788 incidents. Preliminary results show that in 2016, the COSPAS-SARSAT emergency data were used approximately in 885 incidents at rescue of 2 250 people.

Fig. 2 shows the number of search and rescue operations and number of saved people by means of the COSPAS-SARSAT emergency data from January 1994 until December 2015. [5].

As a component of the Quality Management System (QMS) [6] and for meeting the strategic plan of the COSPAS-SARSAT [7], a number of criteria of quality of work of the System has been developed. Fig. 3 depicts the annual total number of search and rescue operations (SAR) using the COSPAS-SARSAT emergency data, and a number of SAR operations when COSPAS-SARSAT was the only source of emergency information (1990-2015).

• The following classification is developed for COSPAS-SARSAT emergency data, which is defined by SAR services:

Table 1. Percent of the detected activated beacons that were registered (2011–2015)

Year	EPIRB		ELT		PLB	
	Number of registered beacons / Number of activated beacons	Percent (%)	Number of registered beacons/ Number of activated beacons	Percent (%)	Number of registered beacons / Number of activated beacons	Percent (%)
2011	4.879/6.264	77.9	6.631/10.102	65.6	699/909	76.9
2012	5.383/6.699	80.4	6.616/10.056	65.8	952/1.242	76.6
2013	5.362/7.126	75.2	6.997/10.867	63.4	1.135/1.611	70.4
2014	4.933/6.414	76.9	7.007/10.451	67.0	1.179/1.582	74.5
2015	5.672/7.412	76.5	7.606/11.276	67.4	1.363/1.907	71.5

• Only COSPAS-SARSAT (Only Alert – COSPAS-SARSAT was the only source of information on the disaster);

• COSPAS-SARSAT the first (First Alert – SAR services received and used the first signal from COSPAS-SARSAT about the disaster);

• Support of COSPAS-SARSAT (Supporting Data – COSPAS-SARSAT data were used along with other sources of information on the disaster);

• COSPAS-SARSAT is not used (Data Not Used in SAR – COSPAS-SARSAT provided emergency data, but for various reasons they were not used by SAR services).

5. 406 MHz beacons

The information obtained from 177 national administrations specifies that nearly 2 million beacons were in operation at the end of 2015.

According to the estimates of the COSPAS-SARSAT Secretariat, at the end of 2015, the number of beacons in the world with the protocol of location (LP) reached 54.2% of all available park of beacons.

Since 2009, COSPAS-SARSAT began to estimate annually the percent of the registered beacons from the number of the detected activated beacons. These data are provided in Table 1.

The general assessment of the level of registration of all available park of all types of beacons (not only the detected activated beacons) from 2011 to 2015 was as follows: 2011 – 77.8%, 2012 – 78.4%, 2013 – 78.4%, 2014 – 77.8%, 2015 – 75.9%.

It is well-known that in case of registration of a beacon in the National Beacon Database or in the Interantional Beacon Registration Database (IBRD), SAR services have an opportunity, in addition to the coordinates of the disaster, to obtain information on object of the disaster and its possible route of movement that significantly facilitates and accelerates acceptance of countermeasures on a distress signal.

The current provisions on beacons in various countries can be found in the document [7].

COSPAS-SARSAT supports IBRD [8], to which a free access for the users who do not have national databases is organized. Allowing users of beacons to register their beacons in IBRD, administrations help to simplify appropriate registration of beacons by their owners and prevent administrative expenses and inconveniences to their governments.

Administrations can also load the national registration data of beacons into IBRD for a guarantee of the round-the-clock availability to them for other SAR services in the presence of information on activation of beacons in a zone of their SAR responsibility.

In the beginning of 2017, 67 237 beacons from about 140 national administrations were registered in IBRD. On average per month, more than 325 times SAR services address in IBRD to obtain information on the registered beacons.

6. LEOSAR and GEOSAR systems

As of April 1, 2017, five spacecraft of the LEOSAR system had been in operation: SARSAT-7, SARSAT-10, SARSAT-11, SARSAT-12, and SARSAT-13. The planned launches of the LEOSAR spacecraft include: four Russian Meteor-M SAR COSPAS payloads onboard. The launches

of Meteor-M No. 2-1, Meteor-M No. 2-2, Meteor-M No. 2-3, and Meteor-M No. 2-4 are planned in the 2nd quarter of 2017, the 4th quarter of 2017, and also in 2020 and 2021. The satellites of the Meteor-M No. 2 series are planed to operate in an orbit not less than for five years. According to the programme of the USA concerning the LEOSAR system, financing of the given LEOSAR satellite, which will be launched not earlier than 2021, is planned.

Moreover, as of April 1, 2017, there had been five devices of the GEOSAR system: GOES-13 and GOES-15 (the USA), INSAT-3D (India), MSG-2, and MSG-3 (EUMETSAT) in operation.

The Russian SAR payloads on the Electro-l No. 1, Electro-l No. 2, Louch-5A, and Louch-5B, have been undergoing the necessary tests.

The ground segment of the LEOSAR and GEOSAR systems includes 30 Mission Control Centres (MCC), 53 LEOLUTs in the LEOSAR system, and 21 Station of GEOLUT the GEOSAR.

7. Trends of perspective development of the COSPAS-SARSAT Programme

7.1. ICAO: GADSS (Global Aeronautical Distress and Safety System) and ELT(DT) emergency locator transmitter

In response to recent aviation incidents, ICAO has begun to realize Global Aeronautical Distress and Safety System (GADSS) to increase the efficiency of global search and rescue. It is supposed that routing of emergency data of the COSPAS-SARSAT from ELT(DT) (emergency locator transmitter), will be directly carried out in MRCC.

Additional requirements will be applied however: ("alarms" have to be delivered immediately in MRCCs, and "data on tracing of the disaster" have to be available to the parties concerned (air transport security units (ATSU), operators of airlines, investigating authorities, MRCC, etc.).

Appendices 11 and 12 to the Convention of ICAO, which describe delivery of "emergency messages" in the rescue coordination centers (RCC), have not been changed. However, the Appendix 6, which is agreed with GADSS, has undergone changes in that the operator of airline provided available data of autonomous disaster tracking (ADT) in, at least, ATSU, and MRCC.

The Appendix 6 also gives the chance to operators of airlines to allow the third parties, for example COSPAS-SARSAT or other suppliers, to perform this function according to the scheme.

For this reason, COSPAS-SARSAT considers the development of means for ATSU to get access to data on disaster tracking, at the same time continuing to send emergency data directly to MRCC.

The deadline of ICAO on readiness of ELT(DT) is January 1, 2021. From the point of view of COSPAS-SARSAT, the readiness of documentation on ELT(DT) is January 1, 2019.

It is considered preferable that COSPAS-SARSAT became the only storage of all data of ADT.

7.2. Global Maritime Distress and Safety System (GMDCC) (IMO)

The COSPAS-SARSAT system is a component of the GMDCC (IMO) system. Considering the inquiry of the 3rd session (2016) of a subcommittee of Navigation, Communications, and Search and Rescue Sub-Committee (ICAO-IMO) (NCSR) about a possibility of distribution of digital emergency data of the GMDCC system in addition to the routing in the existing COSPAS-SARSAT ground network from 406 MHz beacons, COSPAS-SARSAT carries out the analysis and assessment of this offer.

Conclusion

Development and introduction in practice of the essentially new method of search and in distress through the COSPAS-SARSAT Satellite System became the phenomenon of the end of the 20th century.

The former USSR, the USA, France, and Canada became initiators of creation of this international organization. Now the System unites 43 states, provides emergency information and location of disaster on a non-discriminatory basis and free of charge to any end user without any exception. There is only one condition: beacon (maritime, aviation, or personal) should be available for giving a distress signal. A beacon should be registered to know the owner. In total, in the world, there are already more than 2 million COSPAS-SARSAT beacons working at frequency of 406 MHz.

From the moment of the creation, more than 1 600 citizens (at first the USSR and then Russia) have been rescued when using the data of global system of search and

rescue. By the present moment, the System has provided the emergency information and location of disaster for rescue of more than 44 000 people when carrying out more than 12 600 search and rescue operations.

Persistent improvement and advance of the COSPAS-SARSAT System begins with introduction of the MEOSAR system today. Parameters of compatibility of three constellations of System – LEOSAR, GEOSAR, and MEOSAR are coordinated. Upon completion of the FOC phase of the MEOSAR system, its space and ground segments will guarantee the implementation of the requirements of a global covering, productivity, and accuracy. In the same way, technical requirements for 406 MHz beacons of the second generation will allow one to provide further improvement of the COSPAS-SARSAT System.

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