

Complex of radiomonitoring and
position location of HF band radio
emission sources

«**VOSTOK-M**»



COMPARATIVE TECHNICAL CHARACTERISTICS OF HF BAND COMPLEXES	«VOSTOK» (2005)	«VOSTOK-M» (2012)
Coverage range	up to 2000 km and more	up to 2000 km and more
Operating frequency band	1.0-30 MHz	1.0-30 MHz
Possibility to receive and take bearings of signals with vertical polarization and elevation angles of up to 87°	Absent	PRESENT
Round-the-clock registration of RES by panoramic recorder with summarized frequency bandwidth of 10 MHz	Absent	PRESENT
Sensitivity as for EM-field	1-5 $\mu\text{V}/\text{m}$	0.2-5 $\mu\text{V}/\text{m}$
Dynamic range with respect to intermodulation	> 80 dB	> 90 dB
Dynamic range of received signals	> 110 dB	> 130 dB
Resolution of frequency setting in receiving sections	1 Hz	1 Hz
Real time bandwidth	400 kHz	2400 kHz
Minimal rate of panoramic frequency scanning	15 MHz/sec	500 MHz/sec

COMPARATIVE TECHNICAL CHARACTERISTICS OF HF BAND COMPLEXES	«VOSTOK» (2005)	«VOSTOK-M» (2012)
Frequency resolution of detector finder	125; 250; 500; 1000 Hz	62,5; 125; 250; 500; 1000 Hz
Instrumental error of bearing taking	2° (RMS)	1° (RMS)
Minimal duration of signal which bearing is being taken	3 ms	1 ms
Signal bearing taking	Manual	Manual/Auto
Selection of correspondents in the process of bearing taking	Manual (table)	Auto
Position location of correspondents	Manual	Auto
Error of RES position location (triangulation)	5 % of distance	3 % of distance
Automatic registration, demodulation and signal classification	AM, ASK, SSB-tlph, FM, FM2, PSK2, PSK4	AM, ASK, SSB-tlph, FM, FM2, PSK2, PSK4
Detection and bearing taking of sources with frequency hopping	up to 300 hops/second	up to 1000 hops/second
Analyzed frequency band	0.3 - 8 kHz	0.03 - 12 kHz

General information

Complex «VOSTOK-M» provides continuous radio monitoring of RES by frequency and space as follows:

- Automatic search and detection of RES within preset sections of 1.0 – 30 MHz frequency band in real time mode at the background of radio station interference;
- Bearing taking of detected RES in automatic and command-executive modes;
- Monitoring of detected RES;
- Observation of signal shape of detected RES in spectral and time planes;
- Automatic registration, demodulation and classification of signals;
- Management DB files obtained in the process of detection and interception (radiograms, sheets, audio recording, etc.) with binding to DB of commands;
- Generating of DB of objects by the results of RES DB processing (binding of detected information and RES type to objects);
- Automated documenting of RES information to DB with printing and recording to the server;

- Automatic disclosure of RES operation modes and radionet composition, operating on fixed and hopped frequencies in real time mode;
- Computation of detected RES coordinates implementing triangulation method in spherical coordinate system accounting for Earth surface curvature and also SSL method – [single site location](#) implementing prognosis of Earth ionosphere parameters with displaying of coordinate information on electronic map;
- Panoramic receiving and registration of group signal of emissions with summarized registration frequency band of up to 10 MHz (with a possibility of independent selection of 10 bands by 1 MHz in HF band) in the form of files with recorded I/Q samples, with possible subsequent selection for viewing and analysis of recorded signals;
- Generating of Database (DB) of revealed RES;
- Applying of reference bearing taking method for specifying RES coordinates;
- Automatic analysis of real electromagnetic environment with the purpose of optimization of detection thresholds with displaying average noise level;

- Indication of amplitude-frequency, frequency-time (waterfall) and frequency-bearing panorama of air overloading;
- Managing of DB of issued commands, received bearings and additional messages arrived in the process of operation;
- Generating of reports and papers about REE in HF band, statistics calculation about operating RES over reporting period, analysis of operators work with automated estimation of their work efficiency, computation of network operation efficiency;
- Automated processing, accumulating and documenting (printing out and recording to CD) of RES;
- Issuing of commands for to mobile direction finders «Berkut» when searching of RES location;
- Flexible integration of Complex into Radiomonitoring structure of the Customer.

Composition

Complex of radiomonitoring and position location of HF band radio emission sources "Vostok-M" consists of territorially distributed Centers of Radio Monitoring (CRM), united by communication channels provided by the Customer.

To the composition of every CRM equipment for search, detection, direction finding, RES position location, recording, storage, signal classification and processing and also equipment for DB processing and storage are included.

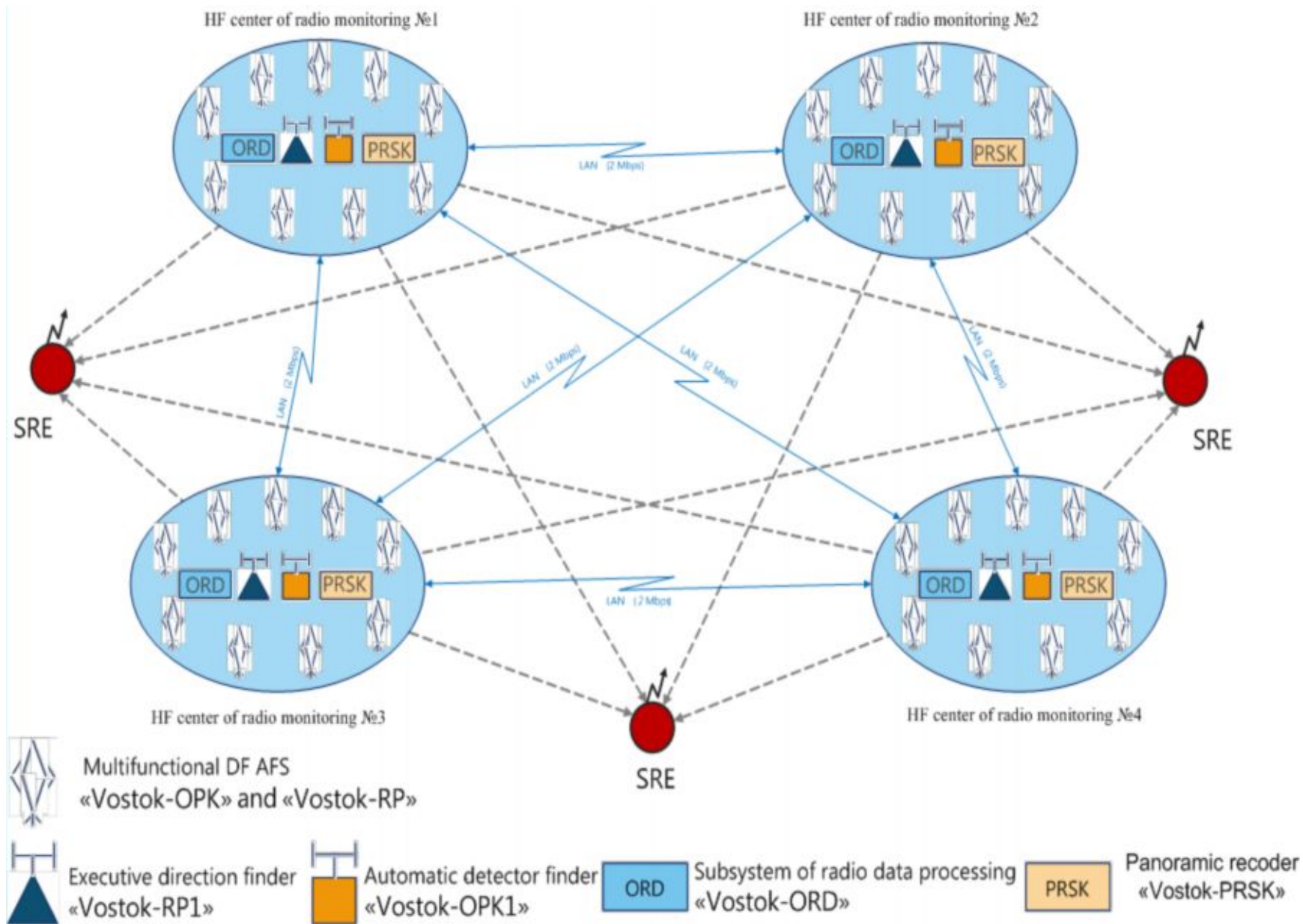
Depending on CRM complete set they can operate as a part of a complex or autonomously .

Number of CRM, nomenclature, composition and functions of posts of every CRM is defined by the Customer.

Mobile direction finding stations «Berkut» can be included into system composition

It is possible to reduce number of nomenclature of posts listed below combining their functions.

Structure of the «Vostok-M» complex consisting of four CRM



CRM of «VOSTOK-M» consists of:

Radio direction finding station:

- Multifunctional direction finding antenna-feeder system (AFS) AFS-OPK;
- Automatic detector finder of HF frequency band «Vostok-OPK» with operator posts «Vostok-ARM»;
- Executive direction finder «Vostok-RP»;
- Switching equipment that provides functioning of Local Computing Network (LCN).

Equipment of wideband signal registration and radio receiving devices of auditory control, including:

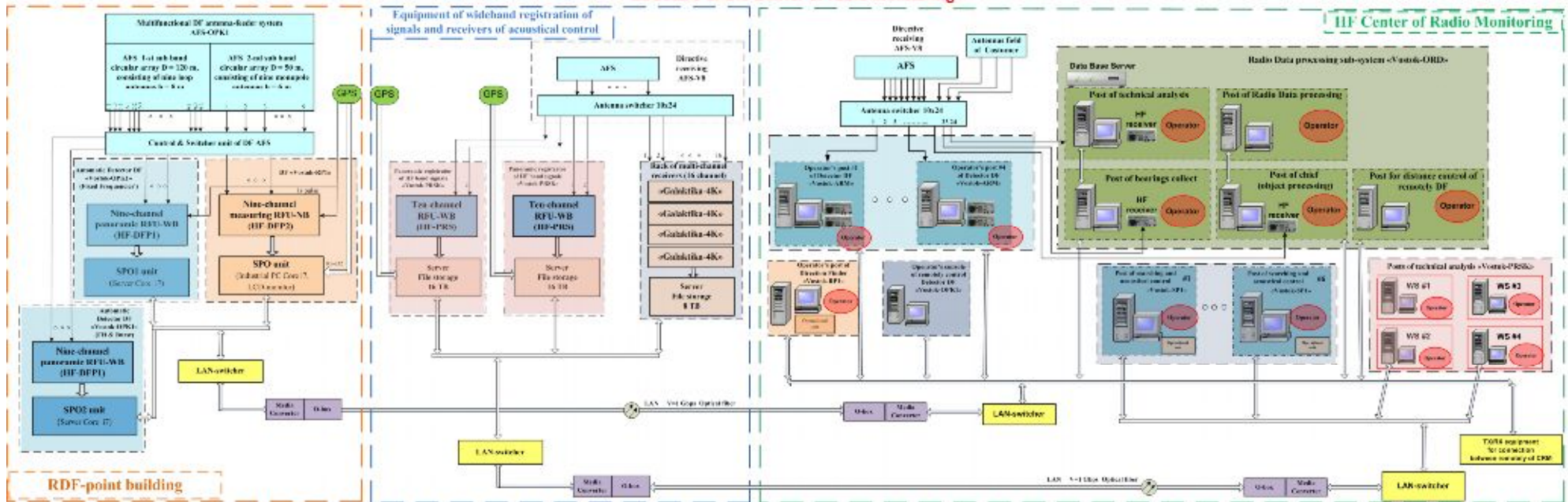
- Receiving directional sector AFS with antenna switch;
- Panoramic recorder of HF band signals «Vostok-PRSK»;
- Multifunctional recorder of auditory control;
- Switching equipment that provides functioning of LCN of registration post.

Receiving radio center including:

- Complete set of AFS of auditory control with antenna switch :
 - AFS of nondirectional/omnidirectional reception AFS-NNP;
 - AFS directional, sector AFS-NS;
 - Antenna field of the Customer;
- Posts of detector finder «Vostok-ARM»;
- Posts of searching and auditory control «Vostok-SP»;
- Posts of technical analysis of «Vostok-PRSK» product;
- Switching equipment for providing LCN functioning;
- Remote control board of detector finder «Vostok-OPK»;
- Operator post of direction finder «Vostok-RP»;

- Subsystem of radio data processing of receiving radio center «Vostok-ORD»:
 - Post of shift supervisor;
 - Post of bearing collection;
 - Post of technical analysis;
 - Post of radiograms;
 - Post of remote direction finding.

"Vostok-M"
Stationary complex for radio control and position location HF source of radio emissions
Structure of the Center of radio monitoring



MODES OF COMPLEX OPERATION

RADIOMONITORING

Before starting regular work session (shift beginning, change of daytime to nighttime etc.) complex staff configures operation of every CRM. Therefore, according priority information for search is done the following:

- parameters of detector finders operation are set;
- commands are issued for operator of intercept, search and auditory control post and posts of technical analysis and post of radiograms.

Initial parameters of operation of detector finders are set form control boards of detector finders, namely:

- parameters of detector finders operation are set;
- subbands of operating frequencies and lists of priority (special/extra) frequencies for serving;
- lists of prohibited and priority frequencies for serving are set (entering and editing is possible while scanning);
- frequency resolution and averaging parameters of signal being detected (duration of frame view, etc.);
- parameters of requests flow dissemination for serving detected RES are set by operators of detector finder "Vostok-ARM" posts.

List of fixed frequencies, transmission types, frequency band for wideband recording and other additional features for RES detection are given to operators of intercept system.

In accordance with preset parameters detector finders provide automatic detection and parameters measurement of signals (rate of signal emission, signal level, bearing on RES, elevation angle, time of detection, bearing accuracy (RMS)).

Detection of signals is carried out implementing statistic algorithms that allows for air overloading, station interference with subsequent spatial and spectral processing of received signals.

In a result of automatic operation of detector finders, queue of requests for serving fixed frequencies and parameters lists of active FH&Burst is formed and databases are generated. Distribution of requests for serving between automated operator posts of detector finder "Vostok-ARM" is done automatically in accordance with a preset rule. By means of estimating detected RES parameters with simultaneous listening to their audio signals, operators of detector finder posts "Vostok-ARM" detect operationally valuable RES. That is their main task.

By valuable detected RES operators of posts of interception of detected RES «Vostok-ARM» can do the following:

- 1) issue command "C1/C2" for executive direction finding of RES (operator of post of bearing collection);
- 2) issue command "ANALISYS" for post of technical analysis;
- 3) issue command "ACQUISITION" for more detailed tracking over RES (to operators of search and auditory control post "Vostok-SP")

More profound analysis of operationally valuable RES is done by operators of search and auditory control post "Vostok-SP" in accordance with preset task, and also when serving control requests (requests queue, formed by received commands "ACQUISITION").

Search and auditory control post "Vostok-SP" can issue command "C3" for conducting off-line bearing taking of RES by parameters of DB of panoramic direction finders "Vostok-OPK".

Main modes of operation of operators of search and auditory control posts "Vostok-SP":

- *manual mode*: setting of two recorders "Galaktika-M" manually to the frequency according received command, decision making as for received frequency following results of signal spectrum observation, its ACF shape, auditory control;
- *serving of requests queue and observation*- serving order of control requests from "Vostok-M" posts is provided from the queue, decision making as for received frequency following results of signal spectrum observation, its ACF shape, auditory control;
- *scanning by the list or frequency band (work by command)* – setting of scanning parameters according received command, decision making as for received frequency following results of signal spectrum observation, its ACF shape, auditory control;
- *registration* – signals recording from two RRD of tracking in *.ifs format (I/Q – samples of complex envelope).

By the results of working with RES operators of search and auditory control post "Vostok-SP" can do the following:

- issue commands "C1/C2" for executive direction finding of RES (operator of post of bearing collection);
- issue command "C3" for conducting off-line bearing taking of RES by parameters of DB of panoramic direction finders "Vostok-OPK";
- issue command "ANALISYS" for post of technical analysis;
- issue command "REGISTRATION" of intercepted data (to operator of post of radiograms).

Profound technical analysis of especially interesting RES is carried out by operator of post of technical analysis following commands from post of shift supervisor or from queue of commands "ANALYSIS".

Operator of post of technical analysis carries out technical analysis of signals by files registered at the posts of detector finder "Vostok-ARM", working places of search and auditory control "Vostok-SP" post, equipment of panoramic registration and technical analysis of HF band signals post "Barhan-PRSK", and also by signal received directly from the outputs of recorder "Galaktika-M". For signals that need additional analysis and bearing taking operator has a possibility to send command "ACQUISITION" to operators of search and auditory control "Vostok-SP" post. Technical analysis is provided using hardware and software of our own production along with WAVECOM ELEKTRONIK AG software (or HOKA), that is installed to the equipment of the post.

Intercept data (radiograms and datasheets) are recorded at the post of radiograms by the command received from post of shift supervisor or from the queue of requests for "REGISTRATION". Registration is performed as a binding of radiogram/datasheet to the RES and recording of this information to the DB. All records by radiograms and datasheets for any date, and also full text of radiogram/datasheet of interest are displayed at the post of shift supervisor.

Also at the post of radiograms possibility of viewing issued commands, bearing taking results and registered files of RES is available.

All information about RES and commands issued by them are saved to the DB and are sent to post of shift supervisor. Operator of post of shift supervisor processes RES information, provides RES classification, prepares reports about obtained results over selected period of time. Detailed description of purpose and operators' work of posts of subsystem of radio data processing of receiving center "Vostok-ORD" is presented in Attachment .

Informational interaction of working places of operators between themselves and with working places of operators of component parts of "Vostok-M" complex is carried out through LCN Ethernet on the basis of TCP/IP protocol with rate of 1 Gb/sec .

RES position location

CRM of the complex of radio monitoring and position location of radio emission sources of HF band "Vostok-M" can be either equal, or one of them – Master, other – Slave.

Radio direction finder station "Vostok-RP" joined with CRM through communication channels form direction finding network. Two modes of operation are possible: classic command-executive mode (commands C1 and C2 with manual signal bearing taking) and mode of remote bearing taking (commands C1 and C2 with automatic signal bearing taking).

In "Vostok-M" complex panoramic bearing taking of all detected RES simultaneously at detector finders of "Vostok-OPK" of every CRM (commands C3) is also present.

C3 – is a command for taking bearings in postponed mode (off-line) data of frame information, registered by detector finder "Vostok-OPK".

Command-executive mode of operation of direction finding network

In command-executive mode of operation bearing taking is carried out by operators at every executive direction finder "Vostok-RP".

Operators of automated working places of "Vostok-ARM" post, of search and auditory control "Vostok-SP" posts and post of shift supervisor "Vostok-ORD" send "C1/C2" commands for bearing taking of RES to operator of "Vostok-ORD" post of bearing collection of Master CRM:

C1 – command for bearing taking of ultra short transmissions including special transmissions in real time mode;

C2 – command for bearing taking in real time mode (for traditional continuous transmissions);

Commands are given according to their priority. Commands C1 and C2 can be sent by operators of automated working places "Vostok-ARM", of search and auditory control "Vostok-SP" posts and post of shift supervisor "Vostok-ORD". Command C3 can be sent by operators of every post of CRM.

After receiving requests for bearing taking "C1/C2", command for bearing taking is sent from post of bearing collection "Vostok-ORD" of Master CRM to operators of executive radio direction finding stations "Vostok-RP".

Operators of posts of executive radio direction finding stations and direction finding post of Master CRM provide bearing taking of all correspondents (RES) and transmit bearings to the "Vostok-ORD" post of bearing collection of Master CRM according code table or automatically.

Remote control bearing taking mode

Bearing taking at every executive direction finder "Vostok-RP" involves one operator – operator of post of CRM remote control. In this mode commands for bearing taking of RES "C1/C2" are sent to operator of "Vostok-ORD" post of bearing collection of Master CRM as it was described above.

After receiving requests command for bearing taking is sent from post of bearing collection to the post of remote direction finding.

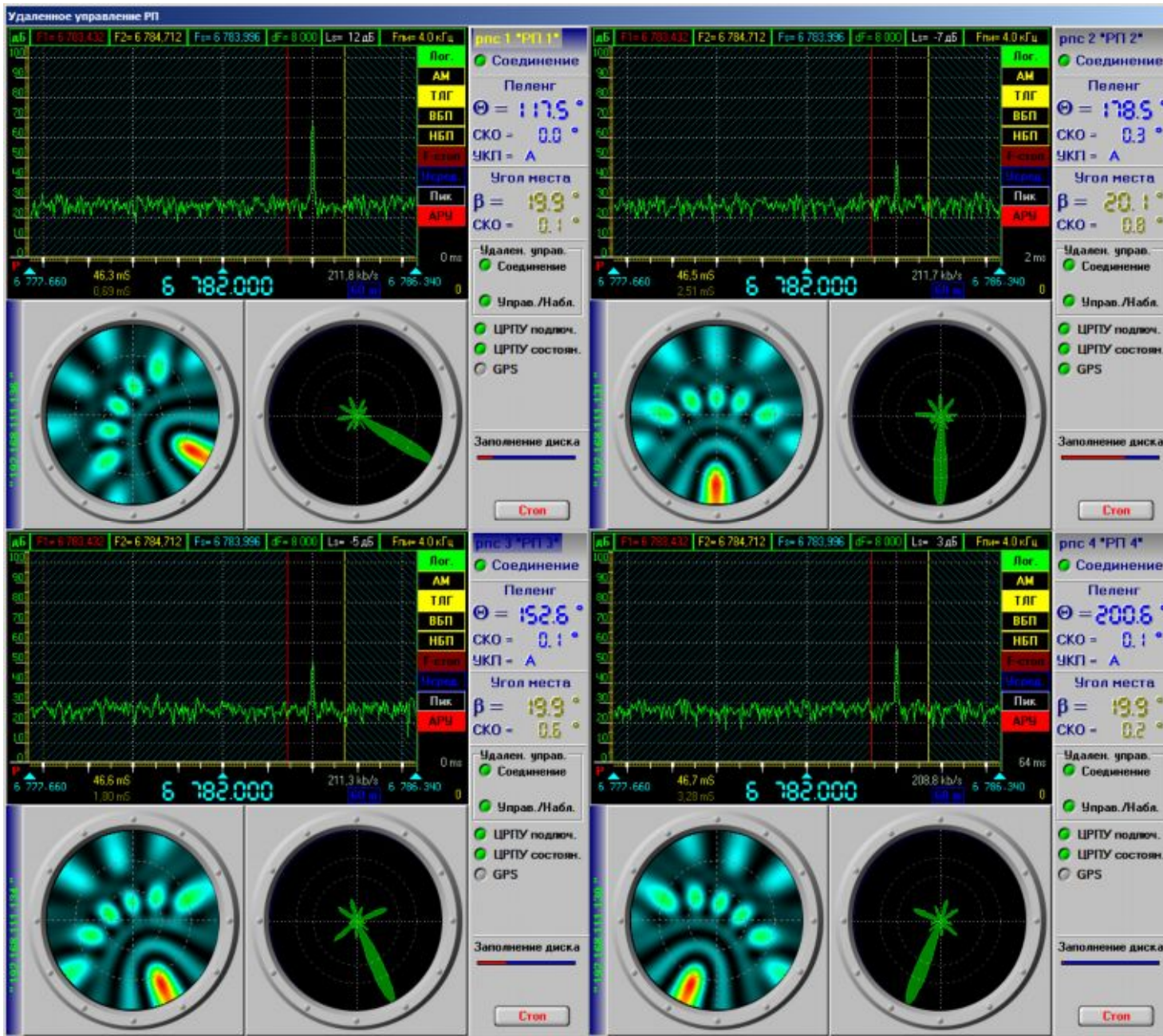
Operator of post of remote direction finding provides remote bearing taking of RES in real time mode. For this purpose through high-speed communication channels at post of remote direction finding virtual control panels of all executive direction finders is displayed. These panels display in real time mode the same bearing information that is displayed at the post of respective executive direction finder "Vostok-RP".

A possibility to display spectrum of received beatings, 3D directivity diagrams of antenna system, 2D directivity diagrams of antenna system, current bearing value and elevation angle of received signal of the RES which bearing is being taken of every direction finder is realized at the working place of operator of post of remote direction finding of executive direction finder (fig. 3, 4).

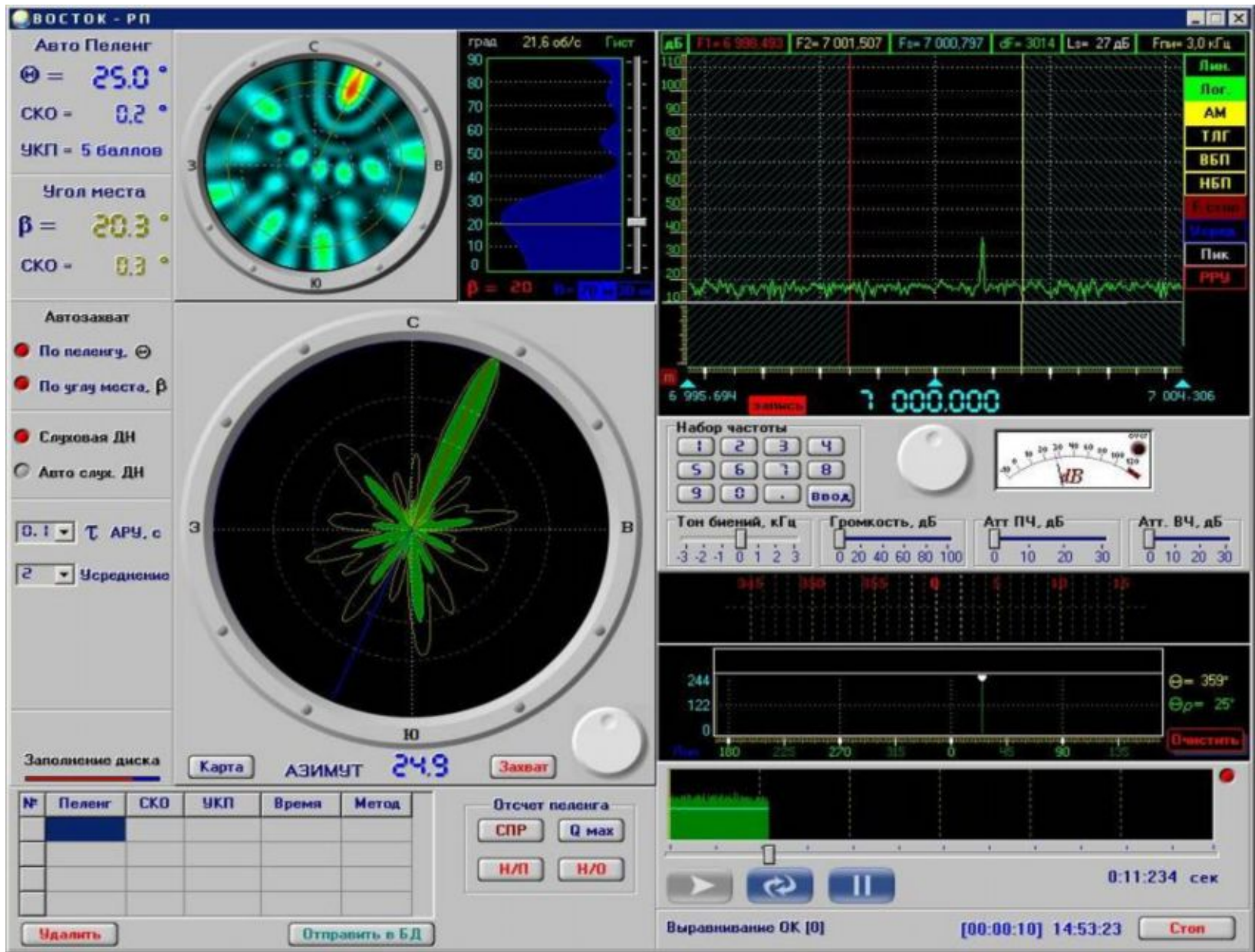
Implementing of remote bearing finding mode allows improving of direction finding quality due to exact time (GPS) of bearings from all correspondents of the network and reducing of stuff at remote direction finders

Complex architecture provides possibility of combining two modes of direction finding, when one part is operating in mode of remote bearing taking, another one – in command-executive mode .

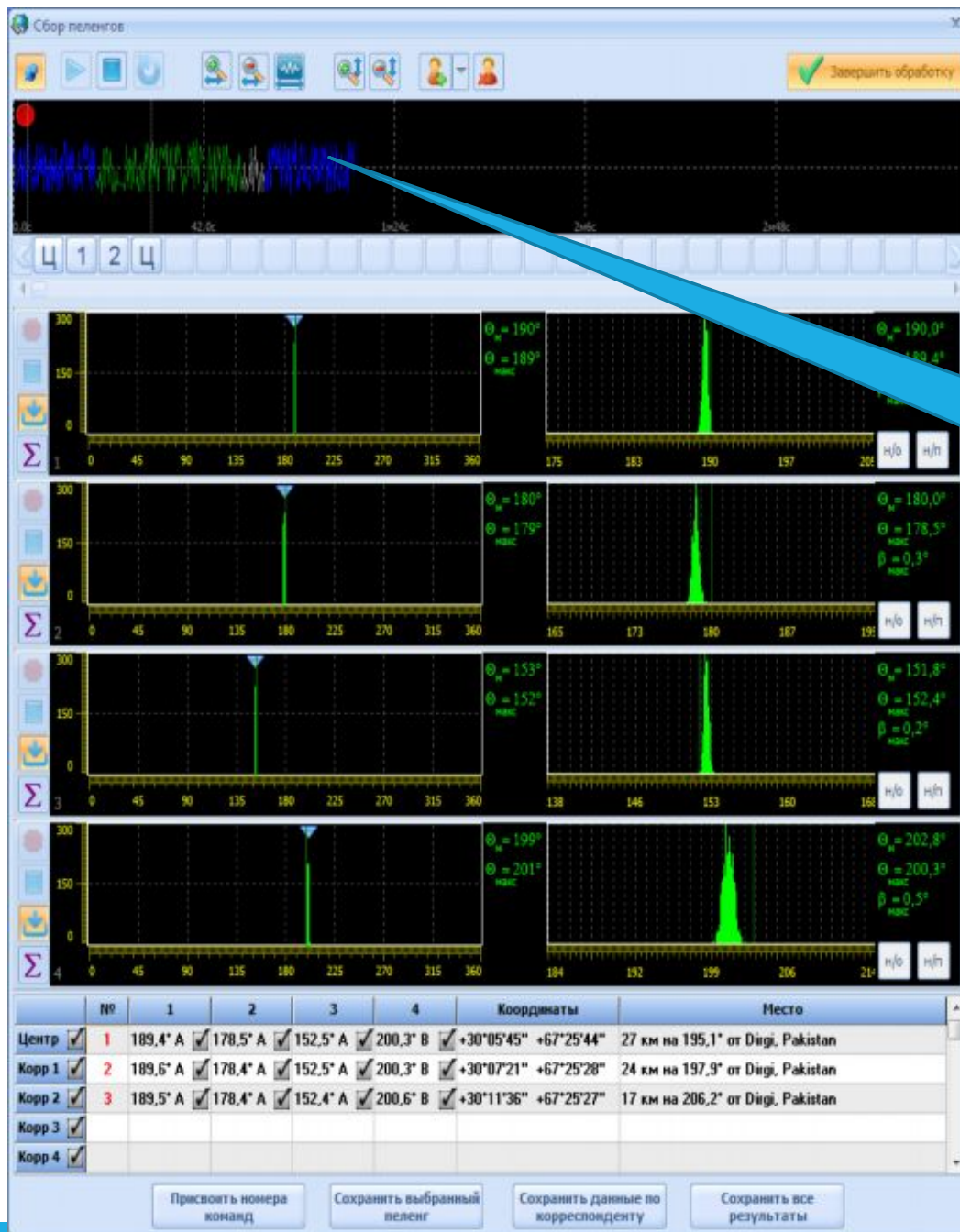
As far as the DB of RES and worked-out semantic information are getting filled operator of post of shift supervisor generates DB of objects (provides binding of the object to radionet storing result of classification to DB of objects, at the same time coordinates of RES and object are saved to the DB). At this post DB of radionets is being managed. All files of interest registered by commands operator saves in file archive (DB archive of files) at the special server for providing further analysis.



Panel of remote direction finding for four RPs



Panel of receiving and measuring direction finder «VOSTOK-RP»



Panel of post of bearing collection «Vostok-ORD»

Time synchronization of correspondents of the radio net which bearing is being taken by the signals of GPS time signals

Panoramic direction finding mode

In "Vostok-M" a possibility of sending C3 command by any post connected to local network is implemented for short time signals that were detected only or for previously non-processed signals. At the same time signal selection is provided depending on frequency and time for all simultaneously detected RES by detector finders "Vostok-OPK" of every CRM. Result in form of line of bearing ellipse is displayed on the map on computer of the post that sent command "C3"

Panoramic registration

Equipment for panoramic registration and technical analysis of HF band signals "Vostok-PRSK" in the composition of complex contains panoramic recorder and post of technical analysis and provides round-the-clock registration of emissions in summarized bandwidth of 10 MHz (10 independently selected frequency bands of 1 MHz).

Processing of this information simultaneously with registration in postponed mode allows operator to return to those parts of operatively valuable information that were not processed during the time of the signal being present in air.

Processing of radio data

Operator of post of shift supervisor generates samples according results of direction finding network operation over necessary period of time:

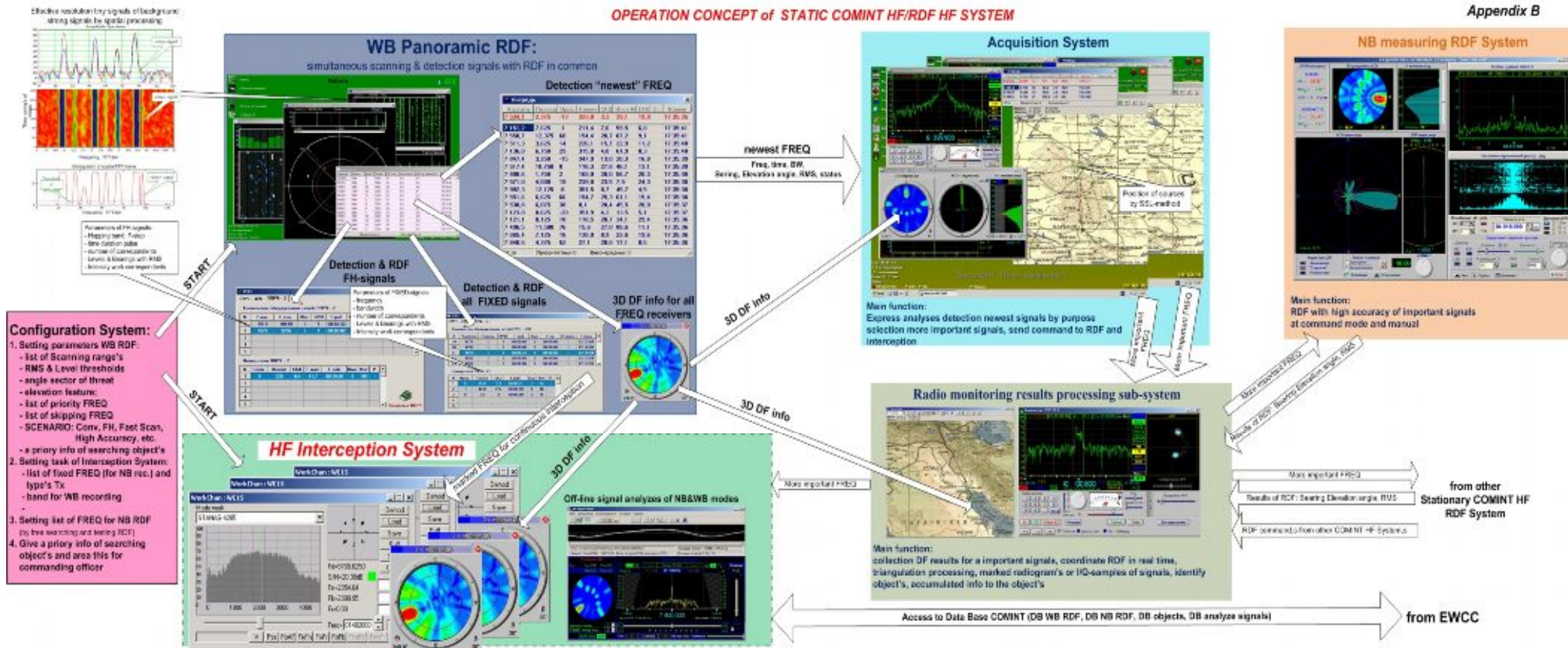
Primary DB: DB of commands, DB of bearings, DB of material, DB of sources.

Secondary DB: Db of radionets, DB of objects, DB of objects' coordinates.

Set of informational fields, included into the sample and order of fields is determined by operator. There exists a possibility to save selected field set in order to prevent from necessity of generating the same sample configuration every time. Operator of post of shift supervisor can generate three kinds of reports for primary DB (quantity of material by operators, quantity of material by nets, efficiency of network operation). Sample and reports are saved in Excel format. For sample and reports generating special autonomous program is used (without interaction with post of shift supervisor). To the composition of the post of shift supervisor printer is included for printing out reports and samples, and DVD for recording information to optical discs. Schematic algorithms of operation of the Complex of radiomonitoring and position location of HF band radio emission sources "Vostok-M" is presented on figures below.

Detailed description of purpose, composition, modes of operation, main indication modes and main technical parameters of complex elements are given in Attachments No. 1-6.

OPERATION CONCEPT of STATIC COMINT HF/RDF HF SYSTEM



Principle of Learning & Training Subsystem (LTS) HF RDF «Vostok» operation

