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PHYSICAL SCIENCES AND TECHNOLOGY

(FOUO 9/79)

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ELECTRONICS AND ELECTRICAL ENGINEERING

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DETERMINATION OF THE MOISTURE CONTENT OF SOIL BY MICROWAVE RADIOMETRY METHODS (REVIEW)

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian No 9, 1978 pp 1778-1791 manuscript received 15 Mar 78

[Article by A.Ye. Basharinov and A.M. Shutko]

[Text] A review is given of the status of theoretical and experimental work in the area of microwave radiometric investigations of soil and subsoil. A study is made of the physical principles of the interrelationship between radiation characteristics and moisture content and a number of other geophysical parameters of soil which is homogeneous and nonhomogeneous in terms of depth, in the absence and presence of vegetation. An estimate is made of the feasibility of determining moisture characteristics by microwave radiometry methods.

Introduction

A brief synopsis of the status of microwave radiometric investigations of soil and subsoil under conditions of moistening was given in [1,2,51,52].

The ability to estimate the moisture characteristics of soil by microwave radiometry methods is based on the dependence of the intensity, degree of polarization and penetrating capacity of the electromagnetic radiation of soil and subsoil on the dielectric properties of the latter, which are determined by the amount of moisture content and features of its vertical distribution.

Microwave radiometric investigations of moistened soil and subsoil include the following: studying the interrelationship between radiation characteristics in the UHF and SHF range and key geophysical parameters, such as the amount of moisture content, the density and lithology of the subsoil, and a number of other properties; determining the influence of the parameters of vertical profiles of moisture and temperature on the characteristics of the microwave radiation spectrum; obtaining estimates of the screening influence of vegetation covers; developing procedures for and estimating the accuracy of determining moisture characteristics in different hydrogeological situations.

Let us discuss the key results achieved in these areas.

1. Fundamental Radiation Relationships

Soil contains solid particles, ground water and air. The solid particles consist of mineral and organic matter. The major mass in the majority of soil consists of mineral matter: Particles measuring more than 3 mm in diameter are the rocky component of the soil, particles from 0.01 to 1 mm, "physical" sand, and particles finer than 0.01 mm, "physical" clay. Subsoil forming minerals consist chiefly of the oxides SiO_2 and Al_2O_3. The content of organic matter varies within the range of from one to 10 percent of the weight of the soil. The density of soil varies within the range of 1 to 2 g/cm^3, and in the arable layer, as a rule, from 1 to 1.5 g/cm^3 [3,4]. Soil moisture is non-identical with respect to its quality. The following categories of moisture are distinguished: securely bound, loosely bound, and free. The quantity of bound water varies from one percent in sand to 20 percent and more in some clay. In the majority of soil and subsoil this figure does not exceed five percent. During moistening, swelling of the ground takes place. For example, sand can change its volume by 30 percent with an increase in moisture from zero to 30 percent. This process depends on the salinity of the soil mixture and the presence of organic matter. Depending on the type of soil, the nature of its treatment, and features of the relief of the terrain, the ground surface is distinguished by the presence of irregularities, the characteristic dimensions of which vary from fractions of a millimeter and dozens of centimeters (fine-structure and gross-structure irregularities) to dozens of meters and more (topographical features).

The dielectric characteristics of soil and subsoil are determined to a different extent by the amount of moisture content, the density of the soil, features of lithology, the concentration and composition of salts in the soil mixture, and temperature.

The dielectric constant of dry ground, ε' , depends on density [9,10]. According to data of measurements for aluminosilicate rocks, the following relationship holds true:

$$\sqrt{\varepsilon'} \simeq 1+0{,}5\rho_c, \qquad (1)$$

where ρ_c represents density in g/cm^3. For ground consisting of sand and clay, $\varepsilon'_c = 3$ to 4, and the loss tangent, $\tan\delta$, equals 10^{-2} to 10^{-3}.

The dielectric constant of moistened soil and subsoil is estimated on the basis of equations from the theory of multicomponent mixtures [11-15]. These equations take into account the relative volume of components, their dielectric parameters, and the shape of inclusion elements. But the majority of equations from the theory of mixtures give highly approximate quantitative estimates of the dielectric properties of moistened soil and subsoil.

In this connection, of decisive importance in studying the dependence of dielectric properties on moisture are representative data from laboratory

measurements, for specimens of sandy and clayey soil with a density of about 1.75 g/cm^3, made in the waveband from 0.8 to 226 cm [17]; for specimens of loamy soil with a density of 1.2 to 1.8 g/cm^3, made in the waveband from 7.5 cm to 10 m [18]; for specimens of sandy, clayey and silty soil with a density of 1.2 to 1.7 g/cm^3, made in the 1.15 to 300 cm waveband [19]; as well as the data of other studies [20,26,30]. In fig 1 are represented data from these studies for a 20 cm wave, presented in the form of the dependence of ε' and ε'' on the specific weight of moisture.*

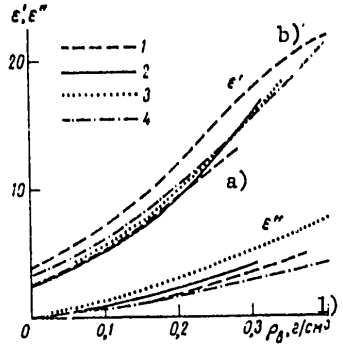

Figure 1. Dependence of the Real (ε') and Imaginary (ε'') Parts of the Dielectric Constant for a 20 cm Wave on the Value of the Specific Weight of Moisture in the Soil: 1-3--averaged experimental data: 1--from [18] (density of soil, ρ_s: (a)--1.4 g/cm^3; (b)--1.8 g/cm^3); 2--from [19] (ρ_s = 1.5 g/cm^3); 3--from [17] ($\rho_s \approx$ 1.7 g/cm^3); 4--calculated values from (4)

Key:
1. ρ_v, g/cm^3

The measurement data show an increase in the real and imaginary parts of ε with an increase in moisture content. The slight dependence of the dielectric constant on the degree of moistening with low moisture values (approximately five percent maximum) can be explained by the sorption capacity of soil when a certain part of the moisture is securely bound by the surface of soil particles.** With less than five percent of moisture the value of ε' practically does not depend on the wavelength.

*The specific weight of moisture, ρ_v (g/cm^3), is the weight of water in a unit volume of soil. The relative moisture content, m (%), is defined as the ratio of the weight of water to the weight of dry ground per unit volume of soil.

**According to the limited data available, the bound water has an anomalously low value of ε', equaling 1.06 to 2.2 [11].

According to the data of [17], sand and clay differ in absorption properties in the range of waves longer than 3 cm: The absorbing capacity of clayey soil is three- to fivefold greater than that of sandy soil. Furthermore, a considerable salt content has been observed in specimens of clayey soil. But according to the data of [19], no dependence of absorbing capacity on the type of soil is observed. These results show that the extent of absorption with waves longer than 3 cm depends not so much on the type of soil as on the level of ionic conduction of the soil mixture.

A slight temperature dependence of the dielectric constant has been observed with a moisture content greater than 10 percent--an increase in the real and a lowering of the imaginary part of ε [19].

An analysis of the applicability of the equations of the theory of mixtures and certain numerical calculation results are contained in [5, 11-16]. The criterion for the applicability of a specific equation for estimating the dielectric properties of soil and subsoil is its taking into account features of the relative distribution of solid and liquid phases of the mixture with different moisture content values, and also the agreement of calculation results with measurement data. For example, in the case of dry ground a "particle-air" mixture is close to a statistical type of component distribution. For the purpose of estimating the value of ε Odelevskiy's equation and Likhteneker's logarithmic equation are applicable. With a moisture content higher than a few percent the ground represents a three-phase matrix system (water forms the matrix). It is possible, however, to disregard the presence of one of the components (air) having the lowest value of ε .

Comparison with the data from experiments [17-19] has shown satisfactory agreement with them of the results of calculations by the following equations:

a) Odelevskiy's for matrix-type mixtures:

$$\varepsilon_{cM}=\varepsilon_s\left[1+\frac{1-W}{\frac{W}{3}+\frac{\varepsilon_s}{\varepsilon_0-\varepsilon_s}}\right], \tag{2}$$

where ε_{sm} , ε_v , and ε_s are the dielectric constants of the mixture, water and dry ground, and W is the relative specific concentration of water.

b) Wiener's equation, which is written differently but is equivalent to Odelevskiy's equation with not too high values of the specific concentration of water.*

*It is proven by expanding ε into a series of powers of W .

c) The Bruggeman-Khanai equation:

$$W = \frac{\varepsilon_0 - \varepsilon_{cM}}{\varepsilon_0 - \varepsilon_в} \sqrt[3]{\frac{\varepsilon_в}{\varepsilon_{cM}}}; \tag{3}$$

d) The Brown (refraction model):

$$\sqrt{\varepsilon_{cM}} = W\sqrt{\varepsilon_в} + (1-W)\sqrt{\varepsilon_c}. \tag{4}$$

Some calculation results are given in fig 1. Within the range of $0.05 \leq \rho_v \leq 0.35$ g/cm^3, the dependence of ε' and ε'' of the soil on the moisture content are close to linear with a slope constant of $\Delta\varepsilon/\Delta\rho_v \approx 0.7\varepsilon_v$. The influence of the type of soil is manifested chiefly in the form of an inverse relationship between the dimensions of particles (degree of dispersion) and the length of the range of moisture values in which ε_{sm} practically does not depend on the moisture content. It has been shown [1,2] that the density of the soil represents a parameter of the dependence of the dielectric constant on the degree of relative moisture content; at the same time the value of the density has a slight influence on the nature and slope of the curve for the dependence of the dielectric constant on the specific weight of moisture in the soil.

The data of [18,19] confirm the theoretical conclusions to the effect that the key parameter determining the value of ε is the specific moisture content.*

The brightness temperature, characterizing the intensity of radiation of a semi-infinite homogeneous medium with a random distribution of temperature, T(z), in terms of depth, is determined by the radiating power, κ, and the effective temperature, T_e:**

$$T_{в\lambda} = \varkappa_\lambda T_{э\lambda};\ \varkappa_\lambda = 1 - R_\lambda, \tag{5}$$

where R is the Fresnel reflection versus power coefficient, which is determined by the dielectric constant, the observation angle, θ, and the type of polarization.

*The dependence of the dielectric constant on the volume of organic inclusions has not been studied in detail. Approximate estimates according to (2) to (4) indicate a slight dependence of the soil's ε on this parameter.
**In (5) and below subscript λ below a symbol indicates wavelength.

In vertical observation:

$$\varkappa_\lambda = \frac{4\sqrt{|\varepsilon_\lambda|}\cos\frac{\delta_\lambda}{2}}{|\varepsilon_\lambda|+2\sqrt{|\varepsilon_\lambda|}\cos\frac{\delta_\lambda}{2}+1}, \quad \operatorname{tg}\delta_\lambda=\varepsilon_\lambda''/\varepsilon_\lambda'. \tag{6}$$

The equation for the effective value of the temperature has the form:

$$T_{e\lambda}=\int_0^\infty T(z)\gamma_{n\lambda}\sec\theta_\lambda' e^{-\tau_{n\lambda}'\sec\theta_\lambda'}dz, \tag{7}$$

where $\gamma_{p\lambda}$ is the absorption coefficient:

$$\gamma_{n\lambda}=2\sqrt{2}\pi\frac{\sqrt{\varepsilon_\lambda'}}{\lambda}\sqrt{\sqrt{1+\operatorname{tg}^2\delta_\lambda}-1}; \tag{8}$$

θ' is the value of the angle of observation, θ, in the ground; $\sin\theta/\sin\theta_\lambda' = \sqrt{\varepsilon_\lambda'}$.

In the case of an isothermal medium, $T(z) = T_0$,

$$T_e=T_0. \tag{7'}$$

The thickness of the effectively radiating layer (skin layer) is:

$$l_{e\lambda}=\frac{1}{\gamma_{n\lambda}}. \tag{9}$$

The radiation polarization factor is determined by the ratio of the difference in radioluminance temperatures with vertical and horizontal polarization to their sum.

An increase in dielectric constant with an increase in moisture content is accompanied by a reduction in radiating power and brightness temperature and an increase in the polarization factor [6-8]. Taking into account the data

in [17] on the values of ε with different moisture contents, estimates of the slope of the radiation versus moisture content curve equal minus 4 to 5°K per percent of moisture and 2 to 3°K per percent of moisture with a soil density of respectively 1.7 to 1.8 g/cm^3 and 1.2 to 1.4 g/cm^3, or about -0.2°K/g/dm^3 with slight dependence on the density of the soil [1,2].*

Relative variations in the polarization factor equal about 0.2%/g/dm^3 with an observation angle of about 60°.

The thickness of the skin layer of clayey soil, according to the data in [17], does not exceed the wavelength throughout the entire microwave range and equals from three to seven wavelengths in the case of dry (less than five percent moisture) sandy soil.

Table 1. Calculated Values of Sensitivity of the Radioemission Field to Variations in Soil Parameters

λ [см]	$\frac{\overline{\Delta T_R}}{\Delta \rho_B}\left[\frac{°K}{г/см^3}\right]$	$\frac{\Delta T_R}{\Delta \rho_C}\left[\frac{°K}{г/см^3}\right]$	$\frac{\overline{\Delta T_R}}{\Delta S}\left[\frac{°K}{г/л}\right]$	$\frac{\overline{\Delta T_R}}{\Delta T}\left[\frac{°K}{°C}\right]$
3	-250	-14	+0,05	0,6
30	-350	-11	-0,5	0,1

Note: The values given in this table cover conditions of variations in moisture content within the range of 0.1 to 0.35 g/cm^3, variations in soil density within the range of 1 to 2 g/cm^3, and variations in salinity, S , of the soil mixture of 0 to 60 g/l and in air temperature of 10 to 30°C.

The influence of 24-hour variations in temperature, ΔT_s , at the soil's surface on variations in radioluminance is expressed in the inversely proportional relationship of the thickness of the skin layer to the depth of penetration of a heat wave, ℓ_{T_s} [5,40,49,50,58]. An estimate of variations in radioluminance at wavelength λ is determined approximately by the equation:

$$\Delta T_{R\lambda} = \varkappa_\lambda \Delta T_c \frac{\sec \theta'}{\frac{l_{s\lambda}}{l_{T_c}} + \sec \theta'} \quad (10)$$

*Model calculations according to (1) to (4) show the practical absence of an influence of soil density on the dependence of radiating power on the moisture content level expressed as a percentage of the total moisture capacity, which is explained by the relationship of the total moisture capacity to the porosity (density) of the soil.

In table 1 are given averaged calculated values, obtained at IRE AN SSSR [USSR Academy of Sciences Institute of Radio Engineering and Electronics], of the sensitivity of the emission strength to variations in soil parameters.

The results of experiments, laboratory [21,22], stationary ground [6,26,34,57], and from on board airplanes [6,23,24,27-30,36-39,54] and from ISZ's [artificial Earth satellites] [5,6,25,31,32,33,35,55,56,59,60] in the 0.8 to 30 cm waveband have confirmed the existence of a stable dependence of radiation characteristics on the moisture content of the surface layer. The quantitative values of the slope of radiation versus moisture content curves found experimentally are close to calculated estimates (fig 2). The differential in radio emission levels of dry soil and soil in the state of its full moisture capacity in vertical observation equals 60 to 90°K. With the most widespread density values under field conditions, 1 to 1.5 g/cm^3, the slope of the radiation versus moisture content curve is about minus 1.5 to 2.5°K per percentage of moisture content with 3 to 30 cm waves [24,36]. The curve for radioluminance versus specific weight of moisture is characterized by a slope of about minus 0.15 to 0.2°K/g/dm^3, agreeing with the calculated value. The influence of variations in soil density is observed chiefly with small moisture content values.

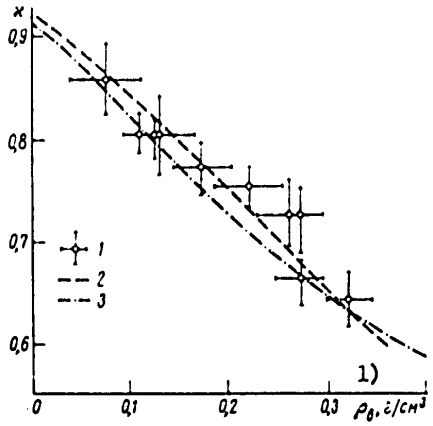

Figure 2. Dependence of Radiating Power with a 20 cm Wave on the Value of the Specific Weight of Moisture in the Soil: 1--local variations in κ and ρ_v from data of synchronous radiometric and contact ground measurements; 2--calculated dependence utilizing experimental data for ε in [17]; 3--utilizing calculated data for ε by using (4)

Key:
1. ρ_v, g/cm^3

Differences are observed in the slope of the radiation versus moisture content curves for vertical and horizontal polarization with an increase in observation angle. For example, according to data of measurements with 2.8 and 21 cm waves [27,29], with $\theta \sim 40$ to 45° the slope for vertical polarization is twofold smaller than in observing at the nadir. The radiation polarization factor increases with an increase in moisture content. The slope of the experimental curve has been shown, however, to be smaller than the calculated, which can be explained by the influence of irregularities and by the vertical inhomogeneity in moisture distribution. The radioluminance value correlates with the amount of moisture content in a layer (0.1 to 1.0)λ thick. No significant spectral differences have been observed in the values of the slope of radiation versus moisture content curves.

According to experimental data in [27,29,32], daily variations in temperature of 15 to 30°C result in variations in radioluminance, reaching 10 to 25°K with 1 to 3 cm waves and not exceeding 3 to 5°K with 20 to 30 cm waves.

In terms of its relationship to EHF, SHF and UHF waves, the ground surface can be represented as rough and locally smooth. The results of model estimates of the influence of fine-structure irregularities according to the slight perturbation method [2,40,45] have shown that the value of radiating power in the presence of slight perturbations,

$$\varkappa_{\sim} = 1 - A_{\sim} = 1 - [(R_{-} - \Delta R) + D_J] \tag{11}$$

(where $A_{\sim}$ represents the albedo of the perturbed surface, ΔR is the degree of reduction of the specular component, R_{-}, and D_J is the dispersion of the stray field), differs from the value of $\varkappa_{-} = 1 - R_{-}$ for a flat surface by no more than 0.01 to 0.02(3 to 6°K) in the observation angle range of 0 to 60°. Gross-structure irregularities, whose influence is taken into account in the Kirchhoff approximation, result in considerable depolarization of the radiation [2,45] and in a considerable increase in radioluminance of 10°K and more, chiefly for horizontal polarization with glancing observation angles. Features of the topography cause variations in the mean value of the brightness temperature reaching 10°K for horizontal polarization with $\theta \geq 40°$ and $\Delta\theta = 20°$.

It has been confirmed experimentally [26] that the influence of surface irregularities (tilled fields) is manifested chiefly with 1 to 3 cm waves, primarily for horizontal polarization, in the form of a reduction in the slope of radiation versus moisture content curves.

The data obtained demonstrate the feasibility of determining moisture content for as many as 10 gradations by the microwave radiometry method.*

*The data of radiometric measurements make it possible to determine directly the specific moisture content or moisture content as a percentage of total moisture capacity. For comparison of the data of radiometric estimates with the results of field measurements of relative moisture content, values of the content of moisture by weight must be scaled to allow for the density of the soil.

2. Radiation Characteristics of Non-Uniformly Moistened Soil and Subsoil

The nature of the distribution of moisture content is determined by the type of soil and subsoil, by the level of ground waters, and, in irrigated land, by the irrigation and evaporation cycle: the amount of water poured on, the irrigation period, and weather conditions.

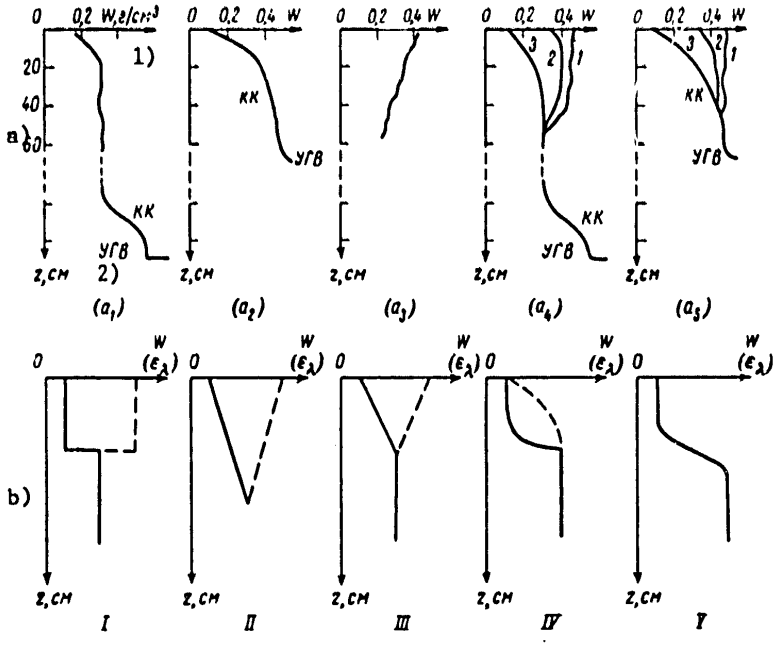

Figure 3. Types of Vertical Profiles of Moisture Content in Soil and Subsoil (a) and Approximation Functions Used (b): (a_1) to (a_3)--dry-farming land; (a_4) and (a_5)--irrigated land; (a_2) and (a_5)--high level of ground water (UGV); 1,2,3--days after watering; KK--capillary fringe layer

Key:
1. W, g/cm^3
2. UGV

In fig 3a are given examples of typical profiles with deep ((a_1), (a_3) and (a_4)) and not so deep ((a_2) and (a_5)) levels of ground water beds in dry-farming (unwatered) ((a_1) to (a_3)) and irrigated ((a_4) and (a_5)) land. The height of the ground water rise zone (capillary fringe, KK, zone) depends on the size of soil particles and varies from a few centimeters in coarse-grained soil to

5 to 10 m in clayey and loess soil. Profile (a_3), according to the data in [53], is characteristic of dry-farming land in Kazakhstan in the springtime.

The existence of vertical inhomogeneity of the dielectric constant on account of modification of the moisture content with the medium's depth results in the appearance of distinctive features in the radiation spectrum--the dependence of $T_{ya\lambda}$ on the parameters characterizing the $\varepsilon_\lambda(z)$ profile:

$$T_{a\lambda}=\varkappa_{a\lambda}[\varepsilon_\lambda(z)]T_{a\lambda}[T(z),\varepsilon_\lambda(z)],$$

$$T_{a\lambda}=\int_0^\infty T(z)\gamma_{a\lambda}(z)\sec\theta' e^{-\int_0^z \gamma_{a\lambda}(l)\sec\theta' dl}dz. \tag{12}$$

For the purpose of determining the interrelationship between the effective values of the radiating power and temperature, $\varkappa_e$ and T_e, and parameters of the moisture content profile, various model approximations are employed. Real media are represented in the form of flat-layer structures with values of ε which are constant within the limits of each layer; in the form of structures including layers with smooth regular and random variations in dielectric properties; etc. Approximation functions are employed for the purpose of describing profiles of moisture content (and of the dielectric constant) in these models. Some of them are illustrated in fig 3b: a step function (I), a linear (II), a broken-line (III), an exponential polynomial (IV) and an Epstein function (V) [1,2,41-49,53]. It has been shown [1,42] that the radiation contrast caused by the presence of inhomogeneity at depth ℓ with a profile of type I is determined by the approximate equation:

$$\Delta\varkappa_\lambda\simeq(1-R_{1\lambda})^2R_{2\lambda}e^{-2\tau_\lambda}, \tag{13}$$

where $\tau_\lambda=\gamma_{a\lambda}\ell$; R_1 is the reflection coefficient at the upper limit; and R_2 is the reflection coefficient for the inhomogeneity.

The existence of smooth transitions on $\varepsilon(z)$ exerts an adjusting effect, which results in a reduction of reflections at the limits. According to [2,42,44,45], reflection from smooth transition layers at the "upper layer - uniform half-space" limit which are described by functions of type IV and V is considerable only with a relative thickness of the layer equaling $\ell/\lambda \gtrsim 0.1$ to 0.3. Estimates of the influence of a smooth transition layer at one of the limits of model I (cf., e.g., model V) can be obtained in an impedance approximation: For the transition layer a determination is made of the effective value of the reflection coefficient, R_{ef}, reduced for the mean level of $\bar{\ell}$. The values of R_{ef} and $\bar{\ell}$ are used in (13) to estimate the amount of radioluminance contrast.

As follows form (13), the influence of the moisture content of the lower layers can be felt when the depth at which they lie does not exceed the thickness of the skin layer in the upper ground level.

The individual sounding depths with the values of ε from [17] equal from 5 to 50 cm with 10 to 30 cm waves for clayey soil, and from 10 to 200 cm for sandy soil, with a variation in the moisture content of the upper layer of from four to 12 percent.

It has been shown [41,58] that the influence of vertical inhomogeneity in $\varepsilon(z)$ is felt chiefly with an increase in moisture content with depth.

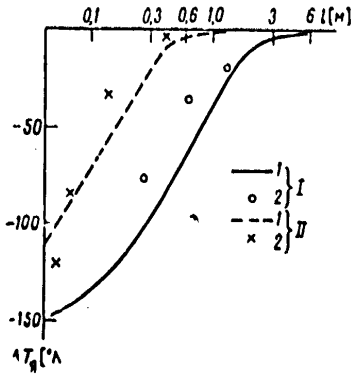

Figure 4. Relationship of Radiation Contrast with a Wave of Approx. 30 cm to Depth of the Ground Water Level. Types of Subsoil: I--sandy loam; II--loam. 1--calculated values for model I; 2--data of measurements in Central Asia and the Crimea

The nature of the spectrum relationship of the radioluminance of vertically polarized radiation when observing at angles close to the Brewster angle is determined by the sign of the temperature profile gradient [58].

The analytical solution to the problem of reconstructing the moisture content profile with the kernel of integral equation (12) is not known. Approximate estimates of parameters of the profile can be gotten on the basis of the relationship between the thickness of the skin layer and the moisture content and the radiation's wavelength.

For example, for the model of a two-layer medium (model I) a separate estimate is made of the moisture content of the top and bottom layers. Here the number of differentiable gradations of moisture content in the bottom layer is several times less than the number of differentiable gradations of moisture content in the top layer.

The data in fig 4, obtained at IRE AN SSSR, illustrate the experimental and calculated values of radiation contrast with a wave of about 30 cm, with various depths at which water-bearing layers lie under a layer of sandy and clayey soil. Examples of the realization of radioluminance profiles for sections with a high ground water level are shown in figs 5 and 6.

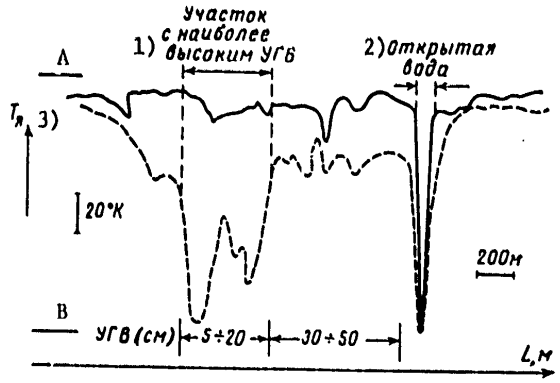

Figure 5. Example of Recording of Variations in Radioluminance Over Sections with Different Ground Water Levels (Moldavian SSR): solid curve--λ = 2.25 cm; dotted-line curve--λ = 30 cm; radio emission levels: A--for dry land; B--for open water

Key:
1. Section with highest UGV
2. Open water
3. T_{ya}

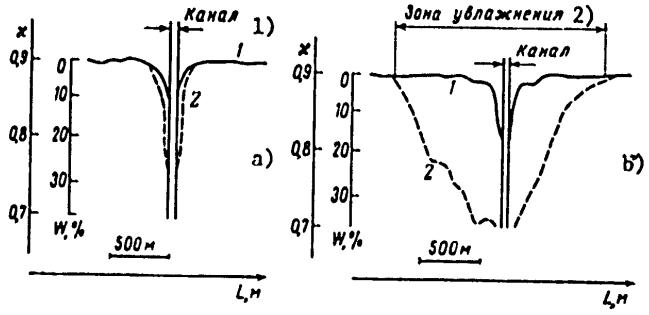

Figure 6. Examples of Recording of Variations in Radioluminance Over Canals Without Loss (a) and With Loss (b) of Water (Uzbek SSR). Waves: 1--2.25 cm; 2--18 cm.

[Key on following page]

Key:
1. Canal
2. Moistening zone

Experiments conducted at IRE AN SSSR have revealed considerable radiation contrast with UHF waves, reaching 10 to 30°K and more with the ground water level lying at depths of 30 to 70 cm.*

Spectrum measurements of the polarization factor have made it possible to obtain estimates of parameters of the moisture content profile within the limits of depths of $\ell \leq \lambda/2$ [6].

In modeling the ground with profile I (fig 3b) the possibility has been demonstrated of getting estimates of the moisture content of the top layer and of its thickness by measuring radiation characteristics at several observation angles [45].

In [53] for model II (fig 3b) a technique has been developed for estimating the moisture supply of the top layer of soil up to several decimeters thick by determining the moisture content at the surface and utilizing data on the slope of the moisture content profile, corresponding to values of the lowest moisture capacity of the soil.

In [26], for the purpose of estimating parameters of the profile, a technique is suggested for tying in the value of the "equivalent moisture content" obtained from radiometric estimates with the depth of the skin layer from the data of measurements with different waves.

Changes in moisture content in the process of drying of the soil are accompanied by changes in radioluminance (figs 7 and 8). In fig 7 is given an example of a change in the intensity of the soil's radiation from the data of measurements with an 18 cm wave, made from on board the AN-2 laboratory airplane of IRE AN SSSR. An observation has been made of the spectrum relationship of the rate of variation in radioluminance (cf. fig 9), occasioned by features of the change in moisture content at different depths.

3. Screening Influence of the Vegetation Cover

For the purpose of obtaining quantitative estimates of the moisture content characteristics of soil and subsoil in the presence of a vegetation cover, it is necessary to know the screening influence of different types of vegetation at various stages in the vegetation cycle. The parameters determining the intensity of radiation of the underlying surface when covered with vegetation are: the radiating power of the ground surface; the radiation transmission and

*These results testify first to the considerable role of the capillary fringe, which rises above the ground water level, and, secondly, to the possible existence within the limits of the fringe of slight sudden changes in moisture content.

reflection coefficients of the vegetation; and the extent to which the ground surface is covered with vegetation [5]. The following types of vegetation cover can be differentiated, the influence of which is considerably different: agricultural crops at early stages of vegetation and cereal and grass covers; "broad-leaved" agricultural crops (sunflowers, maize, beets and the like); and undergrowth and forest vegetation.

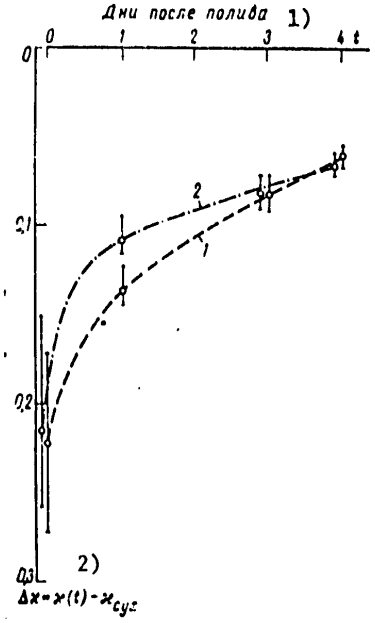

Figure 7. Change in Radiation Contrast with an 18 cm Wave During Drying of the Soil (Central Asia): 1 and 2--different sections of fields

Key:

1. Days after watering
2. κ_{sukh} [κ_{dry}]

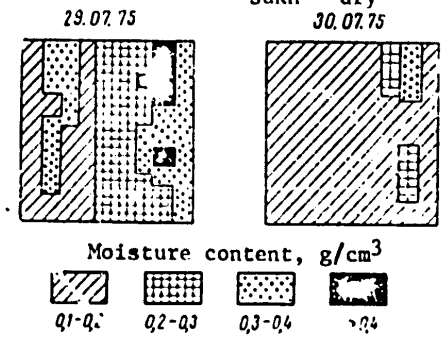

Figure 8. Examples of Moisture Content Charts from Data of Radiometric Estimates with a 3 cm Wave (Crimea)

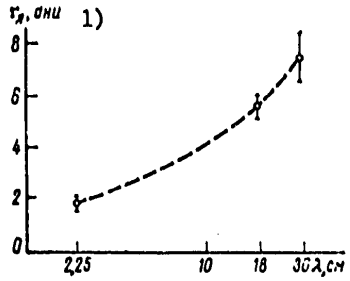

Figure 9. Spectral Relationship of Rate of Change in Radioluminance During Drying of Soil (Ukrainian SSR): τ_{ya} --time interval during which radioluminance contrast is reduced e-fold

Key:
1. τ_{ya}, days

At IRE AN SSSR experimental investigations were made of the screening influence of these types of vegetation cover. Some data from experimental investigations in the 3 to 30 cm waveband are shown in fig 10. The value of the reduction factor, β , for the slope of the radiation versus moisture content curve, $\kappa(W)$, on account of the influence of vegetation is determined by the equation:

$$\beta = \frac{\varkappa_p(W_1) - \varkappa_p(W_2)}{\varkappa(W_1) - \varkappa(W_2)}, \tag{14}$$

where κ_r and κ are the radiating power of the soil when covered with vegetation and in the absence of vegetation, with soil moisture content values of W_1 and W_2 .

It has been demonstrated that crops of rye, barley and clover represent a semi-transmissive medium in the SHF wave band and are practically transmissive with UHF waves. Estimates of the amount of integral absorption in the 3 to 30 cm range are characterized by values of 0.05 to 0.3 nepers.

Broad-leaved crops of the maize and cotton plant type at the ripening stage screen as much as 70 to 80 percent of the radiation with waves shorter than 10 cm and reduce by 20 to 50 percent the slope of the radiation versus moisture content curve with a 30 cm wave.

From data of experiments over forest areas and dense undergrowth, complete screening of the soil's radiation has been observed with waves shorter than 10 cm. This conclusion follows also from the results of model estimates.

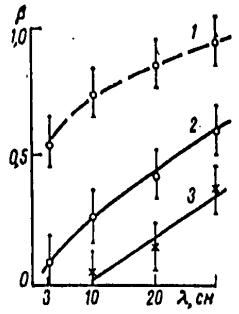

Figure 10. Spectral Relationship of Reduction Factor for Slope of the Radiation Versus Moisture Content Curve on Account of the Screening Influence of the Vegetation Cover: 1--rye, barley, wheat, grass (July-August); 2--maize (August); 3--hybrid forest (July)

Conclusion

Experimental research conducted has demonstrated the promise of utilizing microwave instruments for the purpose of determining the moisture content characteristics of soil and subsoil in solving problems relating to land reclamation and the hydrological cycle of soil, agriculture, hydrogeology, etc.

The USSR Council of Ministers Central Administration of the Hydrometeorological Service Central Geophysical Observatory imeni A.I. Voyeykov has conducted research and obtained positive results from remote readings of the moisture supply in dry-farming lands in Kazakhstan from the data of microwave radiometry measurements from on board an IL-18 laboratory airplane [53].

At the IRE AN SSSR Special Design Bureau airborne microwave radiometric hygrometers have been developed, utilizing the 2.25, 18 and 30 cm wavebands, for IL-18 and AN-2 laboratory airplanes.

Tests of these instruments in different climate zones--in Central Asia, in the North Caucasus, the Ukraine and Moldavia--have revealed the effectiveness of utilizing them for the purpose of determining the degree of non-uniformity in watering and the rate of drying of soil, for determining times for adding fertilizers and for sowing, and for prescribing additional water supply irrigation procedures, for determining zones with a high ground water level (up to 0.5 to 1 m), and for monitoring the condition of water engineering structures.

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CSO: 8144/0552

PUBLICATIONS

APPLICATION OF MULTI-USER COMPUTER CENTERS

Minsk ORGANIZATSIYA ASU NA BAZE VYCHISLITEL'NYKH TSENTROV KOLLEKTIVNOGO POL'ZOVANIYA (Organzations of Automated Control Systems on the Basis of Collective-Use Computer Centers) in Russian 1978 signed to press 30 Jan 78 pp 2, 3-4, 64-73, 104-;08, 120-123, 125-127

[Annotation, excerpt from introduction, table of contents, bibliography, and excerpts from book by Stefan Borisovich Mikhalev and Anatoliy Nikolayevich Zazharskiy, Belarus', 2000 copies, 127 pages]

[Text] The book reviews one of the directions for improving and increasing the efficiency of automated control systems (ASU) by means of collective use of computer technology. There are descriptions of the principles for creating ASU on the basis of collective-use computer centers and computer networks, the structure of the hardware for such systems, and the requirements for information, software, and programming are presented. Recommendations are given on designing the structure and staffing of collective-use computer centers.

The book is intended for engineering and technical workers of enterprises and scientific and technical planning institutes who are involved in the design, operation, and problems of development of ASU, and also may be used by those studying computer technology.

Introduction

[Excerpt] It is the task of the present work to define the basic principles and describe existing experience in creating ASU of various classes and levels on the basis of multi-user computer-information networks and to formulate the requirements for their organization and functioning, the hardware basis, and various forms of service (organizational, information, software, and programming). As a foundation it uses the experience of the Central Scientific Research and Design-Technological Institute for the Organization and Technology of Control (TsNIITU) and a number of other organizations which have created an ASUP [automated enterprise management system] and have taken part in developing methodological materials for the creation of multi-user computer centers [MUCC] and ASU for enterprises being served by MUCC.

The work does not claim to be a complete exposition of such a complex topic as a result of a lack of sufficient practical testing of the methodological materials which have been developed. Many questions still have not been finally settled. The task which the authors set for themselves was to attract the attention of organizations which are designing ASU and of ministries to the problem of creating collective-use computer centers and computer networks which will make it possible to increase the efficiency of automated control systems.

Table of Contents

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MUCC Technological Basis

[Text] The structure of a MUCC technological complex is determined by the specifics of the collective use of resources and the work regime of the MUCC hardware and should be multi-machine (at least two machines). The necessity of having at least two machines in the MUCC hardware complex structure is determined above all by the requirements for reliability of data processing. When one of the machines of the complex is down, the most important jobs (with the highest priority) are performed on the other machine.

Arising from the experience of collective use of computer technology in other countries and from analysis of the tasks performed in MUCC, first of all financial accounting and statistical accountability (tasks with large-volume files, run less than daily, and complexity of 200-500 command bytes), technical-economic planning (tasks with large-volume files, run more than ten days apart, and complexity of 1000-5000 command bytes), and operational planning and regulation (real-time tasks, with small-volume files, run at least one time a day, shifts, complexity of 500-1000 command bytes), it is essential to provide for computer work in MUCC in the following regimes:

time-sharing (for running and testing moderate-sized engineering and scientific research jobs, as well as debugging all other kinds of jobs);

batch multi-programming (for running both engineering and economic large-scale jobs);

multiprocessing (for large-scale jobs).

One must note that a multiprocessing regime requires the solution of complex problems in linking computers, special programming of the jobs being run, and control of performance of jobs.

In the MUCC both local (traditional for information-computer centers) and remote data processing is done.

Processing of information in a MUCC does not in principal differ from its processing in an ASU with its own computer center and therefore it can be

carried out in accordance with the recommendations (1, 6, 12, etc.). It is appropriate to run jobs in a local mode of data processing in an MUCC for users for whom it is economically more profitable to transmit information by courier than by communications lines.

In cases where use of a courier for data transmission is impossible (it does not provide for, for example, timeliness requirements) or is economically unprofitable, processing of data in the MUCC must be done with a system for teleprocessing of data (STD).

The system for teleprocessing of data must provide for all stages of the technological process of data processing, from collection and transmission to return to the user.

According to the assumptions of the MUICN structure and the tendencies for use of the MUCC computer resources, they can be divided into three types:

MUCC for processing information to coordinate the work of a group of subscriber enterprises, unconnected with tasks for managing individual enterprices (MUCC of the first type).

It is assumed that subscribers to the MUCC-ASUP will have their own computer centers for running enterprise management jobs;

MUCC with a combination of the functions of processing information connected with management of main subscriber enterprise and coordinating the work of all enterprises served by the multi-user computer center (MUCC of the second type). It is expected that subscriber enterprises, except for the main one, will have an ASUP with their own computer centers for handling their management tasks, while the ASUP of the main enterprise will subscribe to the computer capabilities of the MUCC (a MUCC some of whose subscribers have their own computer centers while others do not can also be associated with this type);

MUCC for processing information on the management of individual subscriber enterprises (MUCC of the third type). It is assumed that enterprises served by the multi-user computer center do not have their own computer centers and running of management jobs for individual ones of them will be done by subscribing to the computer capabilities of the MUCC.

It is natural that the computing power of the MUCC hardware complex is dependent on the number of subscribing objects and their flows of information being processed in the MUCC.

On the basis of an analysis of the experience of creating an ASUP on the basis of a MUCC it is possible to recommend three classes according to capability in creating MUCC:

Class 1 MUCC--the number of ASUP attached to one MUCC is from five to seven (the capability of the computer complex is more than 0,8 million operations per second);

Class 2 MUCC--the number of ASUP attached to one MUCC is from three to five (the capability of the computer complex is from 0,3 to 0,8 million operations per second);

Class 3 MUCC--the number of ASUP attached to one MUCC is three.

The recommended MUCC hardware complex configurations are presented in table 2, and their types and classes in table 3.

The MUCC hardware complex structures presented in table 2 can be used as approximate in designing the technical tasks in MUCC planning. Along with this the required MUCC computing capability is tentatively determined as a result of the totality of the size of the computer jobs of potential subscribers (1).

Table 2. Hardware Complex Variations for Multi-User Computer Centers

(1) Устройство	Тип технических средств (2)	1	2	3	4	5
ЭВМ (базовые комплекты) (3)	ЕС-1060* (4)	1	—	—	—	—
	ЕС-1050 (5)	—	1	1	—	—
(6)	ЕС-1033* (ЕС-1040)	—	—	—	2	2
	ЕС-1035 (7)	—	—	—	—	—
(8)	ЕС-1022	2	2	3	2	1
	М-4030 (9)	—	—	—	—	—
	М-5010 (10)	—	—	—	—	1
	(11) Дополнительное					
НМЛ (12) (13)	ЕС-5017 (ЕС-5012)	4	4	10	10	4
НМД (14)	ЕС-5061	8	8	6	8	4
(15)	ЕС-5056 (ЕС-5052)	8	8	12	8	4
УУНМД (16)	ЕС-5561 (17)	1	1	1	—	—
УВпК (18)	ЕС-6012 (19)	2	2	2	2	2
УВвЛ (20)	ЕС-6022 (21)	1	1	1	1	1
АЦПУ (22)	ЕС-7032 (23)	3	3	2	3	2
УЭРГ (24)	А5231 (25)	—	—	—	—	—
УВК (26)	ЕС-7012 (27)	1	1	1	1	1
УПДК (28)	ЕС-9001 (29)	—	—	—	—	—
УПДМЛ (30)	ЕС-9001 (31)	—	—	—	—	—
(32) Пишущая машинка (33)	«Консул-260»	2	2	2	3	2
Пакеты сменных дисков (34)	ЕС-5033 (7,25 Мб)	60	60	40	40	30
	(29 Мб) (35)	40	40	40	40	20
Пакеты сменных дисков (36)	Р412, Р421 (37)	—	—	—	—	15
(38) Селекторный канал	ЕС-4035 (39)	1	1	1	—	—
Адаптер «канал — канал» (40)	ЕС-4060 (А7131) (41)	1	1	1	1	1
Система подготовки данных (42)	СПД-9000 (43)	1	1	1	1	1
Устройство дистанционного сбора (44)	РИ-8901 (45)	—	1	—	—	—

[Table continued on following page]

[Table 2. Continued]

МПД (46)	(47) ЕС-8403	—	—	—	—	—
	(48) ЕС-8410(ЕС-8402)	—	1	1	1	1
	ЕС-8401 (49)	1	—	—	—	—
	(50) УВТЛ-М (УВТЛ-Т) (51)	—	—	—	—	—
Устройство группового управления выносными пультами (52)	ЕС-7566 (53)	—	1	2	—	—
	ЕС-7064 (54)	—	—	2	—	—
	ЭП-4030 (55)	—	—	—	—	—
	ЕС-7051 (56)	—	1	—	—	—

* Предполагается, что в состав базового комплекта ЭВМ входят диски емкостью 29 Мб (НМД ЕС-5061, УУНМД ЕС-5561). (57)

Количество технических средств (58)

6	7	8	9	10	11	12	13	14	15	16	17	18
—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—
1	—	1	—	—	—	—	—	—	—	—	—	—
—	—	—	—	2	1	2	—	—	—	—	—	—
—	1	1	3	—	1	—	1	—	—	—	—	—
2	2	—	—	—	—	—	—	—	—	—	2	2
—	—	2	—	1	—	1	1	1	—	—	—	—
оборудование												
4	4	4	6	4	8	5	2	8	4	8	4	—
4	—	6	—	8	—	6	3	—	—	—	—	—
8	12	4	12	—	8	—	4	8	8	8	8	8
—	—	—	—	—	—	—	—	—	—	—	—	—
2	2	1	2	1	1	1	1	1	1	2	1	1
1	1	1	1	1	1	1	1	1	1	1	—	—
1	1	2	2	2	2	2	2	2	2	2	—	—
2	2	—	—	—	—	—	—	—	—	—	2	2
1	1	1	1	1	1	1	1	1	1	1	1	1
—	—	2	—	2	2	2	2	2	2	2	2	2
—	—	4	—	4	4	4	4	4	4	4	4	4
2	2	2	2	2	2	2	2	1	1	2	2	1
30	40	20	40	—	20	—	20	30	30	30	30	30
20	—	10	—	40	—	40	12	—	—	—	—	—
—	—	30	—	15	—	15	15	15	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—
1	1	1	1	1	1	1	1	1	1	1	1	1
1	1	—	1	—	—	—	—	—	—	—	—	—
1	—	1	—	1	1	—	1	—	1	—	—	—
—	—	—	—	1	—	—	—	—	1	1	—	—
—	—	1	1	—	1	1	1	1	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—
1	1	—	—	—	—	—	—	—	—	—	1	1
—	—	—	—	1	1	—	1	—	—	—	—	—
—	—	2	—	—	—	—	—	—	—	—	—	—
2	2	—	—	—	—	—	—	—	—	—	—	2
—	—	—	—	—	—	—	—	—	—	—	—	—

[Key on following page]

Key:

1. Device
2. Type of Hardware
3. Computer (basic assembly)
4. YeS-1060
5. YeS-1050
6. YeS-1033 (YeS-1040)
7. YeS-1035
8. YeS-1022
9. M-4030
10. M-5010
11. Auxiliary equipment
12. Magnetic tape storage
13. YeS-5017 (YeS-5012)
14. Magnetic disk storage
15. YeS-5061
    YeS-5056 (YeS-5052)
16. Magnetic disk storage control unit
17. YeS-5561
18. Punched card input device
19. YeS-6012
20. Punched tape input device
21. YeS-6022
22. Alphanumeric printer
23. YeS-7032
24. Electrographic graphic data display device
25. A5231
26. Card punch
27. YeS-7012
28. Punched card data entry device
29. YeS-9011
30. Magnetic tape data entry device
31. YeS-9001
32. Typewriter
33. Konsul-260
34. Removable disk packs
35. YeS-5033 (7.25 megabytes (29 m-bytes))
36. Removable disk packs
37. R412, R421
38. Selector channel
39. YeS-4035
40. "Channel-channel" adapter
41. YeS-4060 (A7131)
42. Data entry system
43. SPD-9000
44. Remote data collection device
45. RI-8901
46. Multiplexors for data transmission
47. YeS-8403
48. YeS-8410 (YeS-8402)
49. YeS-8401
50. UVTL-M
51. (UVTL-T)
52. External display group control unit
53. YeS-7566
54. YeS-7064
55. EP-4030
56. YeS-7051
57. It is planned that the base computer assembly will include disks with a capacity of 29 megabytes (magnetic disk storage YeS-5061, magnetic disk storage control unit YeS-5561).
58. Number of hardware items

Table 3. Correspondence of Hardware Complex Structures Presented in Table 2. to Various Types and Classes of MUCC

Тип КВЦ (1)	Класс КВЦ (2)	Номер структуры КТС КВЦ (3)
1-А	1-А	1
1-А	2-А	4
1-А	3-А	7,9
2-А	1-А	2
2-А	2-А	6, 8, 13
2-А	3-А	10, 11, 15,18
3-А	1-А	1
3-А	2-А	3,5
3-А	3-А	12, 14, 16, 17

[Key on following page]

Key:
1. Type of MUCC
2. Class of MUCC
3. Number of MUCC hardware complex structure

The foundation of the MUCC hardware complex is made up of models of YeS computers and ASVT [modular system of computer technology], while to meet all the requirements for information processing in the MUICN the base models must be supplemented by peripheral equipment (in particular, memory and printing devices), teleprocessing equipment, etc.

The components of the hardware complex are determined at the technical planning stage (1).

The hardware complex structures presented reflect the peculiarities of information processing in MUCC of various classes and types with different purposes and characteristics of tasks and are oriented (in composition of devices) toward use of batches of applications programs. MUCC differ one from another in productivity, capability of organizing work with the type of basic hardware carrier used for primary and intermediate data, the capability of operating in batch processing and real-time modes, and orientation toward specific means of transmitting data.

To provide direct access to the computer for a large number of remote users of subscriber points, in structures 1-5 and 8-16 various types of subassemblies of data transmission multiplexors (MPD) from the YeS series of computers are used, depending on the power of the subscriber net of users. The remaining structures (6, 7, 17, 18) are provided with UVTL-M (UVTL-T [device for input/output of telegraph information]) to attach CRT units from the ASVT-M series (Ekran-M system).

Structures 2, 6, 8, 10, 13, and 18, intended for MUCC of the second type, are able to provide for production control in real time, which is attained by using devices for remote collection, exchange, and distribution of data RI-8901 (P-2311), linked to series YeS and M4030 computers. The RI-8901 makes it possible to organize a multiplexor work regime within a radius of 10 km of automatic data acquisition devices of type RI-7701, RI-7501 from the ASPI series placed directly in the work places, shop, and plant services of the main enterprise. When the computer is down, the RI-8901 puts data out on punched tape, which permits data collection to be carried out while the computer is down or during preventive maintenance. Remote collection of data at distance greater than ten km is possible with teleprocessing equipment from the YeS series.

In structures 2, 10, 11, 13 a YeS-7566 external alphanumeric display group control unit is used; in structures 3 and 8, the YeS-7064 graphic display; in structures 6, 7, 18, EP-4030 CRT's. The devices used are intended for a dialogue connection of the subscriber with the system for real-time data processing, with display of information on a cathode-ray tube.

For handling planning automation tasks in variation 2, plotters are provided for. For this purpose in structures 6, 7, 17, 18 UERG A5231 devices for electrographic display of graphic information can be used with an M4030 base computer. These devices additionally can be used for their primary functions as alphanumeric printers of the ATsPU YeS-7033 type.

The most powerful systems (variations 1-7, 9) are provided with the SPD-9000 machine control system for centralized preparation of a large volume of data.

The area of application of the small M5010 computer in a MUCC will be rather varied--from subscriber computer centers for smaller enterprises to auxiliary computers in large hierarchical systems.

Use of the SK channel matcher for YeS computers, intended for attaching the M5010 computer to the central computer (models YeS-1022, YeS-1033, YeS-1035, YeS-1050, M4030), makes it possible to employ the small computer in a multi-processor system.

The presence of "channel-channel" adapters in the structures presented provides for the possibility of running a multi-processor system with shared external memory.

For organizing multi-processing of data it is essential to have a dual-access main memory in the types of computers used.

The MUCC hardware complex structures presented in table 2 may be modified, for example, by substituting equivalent models of computers. One must keep this in mind, since, for example, certain ministries are oriented toward a specific type of hardware (e.g., only YeS computers).

In addition to the computer hardware presented in table 2, MUCC must be provided with desk calculators and adding machines for numeric checking operations and simple calculations, copying machines, and also laboratory instruments and auxiliary equipment (oscilloscopes, volt meters, amp meters, generators, constant current sources, transformers, ohm meters, meters for measuring semiconductor devices, turning-milling equipment, fitting equipment and instruments, etc.).

The MUCC must also be supplied with office equipment. The calculation of office equipment, organization and equipment of archives of machine data carriers and documents, job slots for personnel, development of the technical assignment for designing the building (facilities) for the MUCC, calculation of the size of the facility, matters of communications, installation of broadcast networks, timing facilities, and signalling equipment in the MUCC, as well as selection of auxiliary equipment are carried out just as for any information-computer center and may be done in accordance with the recommendations presented in works (1, 6, 12, etc.).

Table 4. Model Planning Chart for Installation of a MUCC Hardware Complex

Measure	Performer	Stage of MUCC planning at which measure is implemented		Document confirming completion of work
		start	end	
1	2	3	4	5
1. Preliminary acquaintance of customer with questions connected with creation of MUCC and aid in selecting site	Organization-designer	PS*	PS	Protocol
2. Assignment of site for MUCC	Customer	"	PS TP**	Decision of object managmment on site assignment
3. Investigation of site assigned for MUCC	Organization-designer, customer	"	"	Act of inspection
4. Submission to organization-designer of structural plans of site with indication of supporting power of roof for layout of MUCC	Customer	"	"	Transmission of blueprints, plans of site assigned
5. Submission to customer of technical assignment for development of architectural-building and engineering portions of design	Organization	TP	TP	Technical assign-
6. Development of plan for installing and adjusting the hardware complex	Customer, organization-designer	"	"	Plan of action
7. Completion of contract for design of project of remodeling (constructing) MUCC facility, sanitary and power engineering	Customer	"	"	Contract
8. Order for building materials for remodeling (constructing) facility for MUCC	"	PP	"	Confirmation of receipt of order

*Pre-planning stage
**Technical planning stage

9. Order for auxiliary equipment (air conditioners, air filters, automatic fire extinguishing system equipment)	Customer	TP	TP	Confirmation of receipt of order
10. Acquisition of building materials for remodeling (constructing) facility for MUCC	"	"	"	Presence of materials
11. Acquisition of auxiliary equipment (air conditioners, air filters, automatic fire extinguishing equipment)	"	"	"	Presence of equipment
12. Freeing of area for remodeling of facility for MUCC	"	PP	"	Presence of free area and work front for remodeling
13. Remodeling (construction) of facility for MUCC and its handing over for placing of hardware	"	TP	"	Act of completion of work
14. Determination of customer's possession of hardware	Customer, Organization-designer	PP	PP	Report of inspection of object
15. Submission of preliminary requisition list for initiation of financing and subsequent ordering of hardware, auxiliary equipment, special furniture, and office equipment	"	"	"	Preliminary inventory of hardware
16. Composition of order documentation for basic equipment	Customer	"	TP	Order documentation
17. Composition of order documentation for auxiliary physical equipment according to product list of union republic Glavsnab [Main Administration for Material and Technical Supply]	"	"	"	Order documentation
18. Dispatch to union republic Glavsnab of order documentation for auxiliary equipment	"	"	"	Order documentation

31. Sending of MUCC specialists to courses to train programmers	Customer	PP	TP	Act of completion of planned measures
32. Organization of instruction of personnel in receipt, delivery, and recording of data	"	TP	WP	"
33. Organization of instruction for operators of data recording devices	Customer, producing plant and special courses	"	"	"
34. Organization of instruction for employees involved in installation and operation of standards-reference work in object	Customer	PP	TP	"
35. Organization of instruction for employees of subdivision of computer maintenance	"	PP	TP	"

Requirements for MUCC Facilities

[Excerpt] In accordance with ORMM [Industry-Wide Master Methodological Materials] (8), the form, contents, and order of developing planning estimates and performing construction and installation work is regulated by the documents on construction from USSR Gosstroy, the Instruction on Developing Plans and Estimates for Industrial Construction (SN-202-76) and other normative documentation which is in effect.

The architectural and construction part of the MUCC plan should be developed by a specialized planning organization (as a rule, by industry-wide state planning institutes) on the basis of an assignment for planning and direct contracts with the customer.

The order of developing a MUCC and also its composition depend on in what kind of building the multi-user computer center will be installed--a new one or an already existing one.

In planning a new special building for installing the MUCC the object technical-work (technological) plan is developed in its full form in accordance with SN-202-76.

When installing the MUCC in an already existing building, as a rule, the technological, construction, sanitary and electrical engineering portions and estimates are developed in the plan. In this case the construction portion of the plan envisages only the equipping of the site in accordance

with the technological requirements and construction norms. Along with this special attention is given to pre-planning work: inspection of the building with the aim of determining the possibility of installing a multi-user computer center in it from the standpoint of meeting the requirements of the technological, construction, sanitary engineering and fire-prevention norms. At the same time the soundness of the structures (roofs, walls, beams, columns, etc.) must be determined according to their load-bearing capability and rigidity.

The requirements for the facilities and the technical assignment are developed on the basis of the hardware complex selected, special requirements for its installation and standards in effect, the structure and personnel schedule of the MUCC, the space set aside, requirements in the architectural and construction and sanitary engineering aspects, electrical power supply, lighting, fire and explosion safety, vibrations, communications, radiofication, and civil defense. The general requirements for computer center facilities (presented, for example, in "ASUP Standard Planning Decisions," "Hardware," part 1) (12) may be used, while modifications are made according to the concrete situation of the MUCC.

In constructing buildings for multi-user computer centers special attention must be paid to machine rooms. When using YeS or ASVT model computers, the machine rooms must meet the following basic conditions: height of the room must be at least 3 meters; height of doors, 2 meters, with a width of at least 1.5 meters; illumination at a height of 1 meter from the floor, 190-200 lux; temperature when equipment is working in the range of +5 - +40° C; atmospheric pressure, 760 ± 30 mm Hg; load on the floor, up to 700 kg per square meter; dust should not exceed 75 nanokg per cubic meter with particle size no greater than 3 microns.

The most favorable working conditions are provided with a temperature of 22 ± 2°C and a humidity of 65 ± 5%. To attain them, it is recommended that the facility be sealed and air conditioned, while magnetic tape and disk devices should be set up in separate facilities with maximum possible freedom from dust.

The technical assignment, as a rule, does not consider requirements for the facilities which contain air conditioning equipment, ventilating equipment, and the main switchboard, the cloakroom, conference room, and supplementary services, since they are not related to the technological subdivision of the multi-user computer center. The planning organization selects the site and equipment for the indicated subdivisions and plans all MUCC facilities in accordance with the standards and requirements which are in effect.

In computing and allocating space among the subdivisions it is essential to take into account the type and quantity of equipment, the number of employees in them, interconnections between them, and the flow routes for movement of technical documentation and recording media.

For machine rooms according to the producing plant's technical conditions and taking into account the requirements of the technological process of processing information it is essential to have areas (in square meters) for the computer:

YeS-1033 -- 110-120
YeS-1030 -- 90-110
YeS-1022 -- 100-110
YeS-1025 -- 75- 90
YeS-1035 -- 100-120
YeS-1045 -- 140-150
M-5000 -- 50- 60.

Areas for subdivisions of the multi-user computer center and the subscriber information point (SIP) are computed in accordance with personnel schedules, equipment selected, and space standards recommended by standard plans for working spaces (1, 12).

For locating the management staff an area of 16-18 square meters is accepted; for technical engineering personnel, 4.0-4.5 square meters for one workspace; for operators and aids working with small computing machinery and date preparation equipment an area of at least 6-10 square meters is essential, and in some cases even more.

In computing the areas of the MUCC and SIP, selecting standard workspaces, and supplying them with equipment at various stages of the development one can use the recommendations presented in the literature (1, 12).

In developing the technical assignment for construction of the MUCC building, as well as facilities for the SIP, it is essential to take into account the prospect of development of multi-user information-computer network, the possibility of expansion and replacement of equipment, etc.

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PUBLICATIONS

OPERATION AND MAINTENANCE OF PUNCH COMPUTERS, PART 1, TEXTBOOK FOR TECHNICAL HIGH SCHOOLS

Moscow EKSPLUATATSIYA PERFORATSIONNYKH VYCHISLITEL'NYKH MASHIN, CHAST' 1, UCHEB. DLYA TEKHNIKUMOV (Operation and Maintenance of Punch Computers, Part 1, Textbook for Technical High Schools) in Russian 1978 signed to press 26 May 78 p 2-4, 278-279

[Annotation, excerpt and table of contents from book by N. M. Surin and T. N. Yakupova, Statistika, 15,000 copies, 279 pages]

[Text] The first part of this textbook is designed for students at the technical high schools in the specialty of the "organization of machine processing of economic data," and was written in accordance with the program for the course in "punch computers."

In the textbook primary attention has been given to describing the operating capabilities of these machines and the methods of programming economic data processing problems.

In addition to the students at the technical high schools, the book can be useful to computer installation people and students in the various advanced training courses.

[Excerpt] The functioning of various levels of automated control systems is based on the effect of applying a set of technical means, the principal ones of which are the digital computers. Depending on the operating capabilities, the digital computers are broken down into keyboard computers, punch computers and electronic computers.

The keyboard computers are the simplest in use. They are used when it is necessary to perform mathematical operations, and the choice of the sequence of these operations is left to the operator. The table-model keyboard computers have become widespread, many of which are executed from electronic elements and permit the performance of all of the arithmetic operations. They include the automated invoice and bookkeeping machines with program control. Data processing on these machines includes a set of man-machine operations coupled by a defined algorithm. The automated execution of the operations built into the machine in a defined sequence is realized by a

program which has been set up in advance for each specific operation separately. A distinguished feature and the primary deficiency of the keyboard computer for processing economic data is the manual input of the initial data. Therefore when solving problems with a large number of initial data and when grouping of this data with respect to defined attributes is required, it is more efficient to use the punch computer to compile the various summary tables.

The punch computers include a set of defined machines designed for successive execution of interrelated operations with respect to preparing the machine carriers of the initial data--the punch cards--from which these data are read by automatic machines during mathematical and logical processing. These automatic machines have complex program control. Therefore when designing the technological processing of economic data using a punch computer the necessity arises for programming the automatic solution of the problems on specific automated machines. This is a very tedious operation requiring special knowledge. The quality of the compiled programs and consequently, the efficient application of the machines depends to a high degree on the depth of knowledge of the specialists with respect to the operating principles and operating capabilities of the punch computer.

The study of the basic units and operating capabilities of the machines, the procedures for working with them and programming techniques for solving various economic problems is the subject of the course on "operation and maintenance of punch computers." But, however deep the knowledge of the machines and their operating capabilities, this is still insufficient for successful development of the most efficient programs. Each student must have a creative approach to the search for the optimal solutions when creating specific programs for the punch computers.

At the present time thousands of sets of punch computers are in operation on which a significant proportion of all of the economic data processing problems are solved. The plan for the development of the national economy provides for production of them also during the Tenth Five-Year Plan. The punch computers are being continuously improved, and machines are being built in new versions with improved operating capabilities and electronic elements.

This textbook is designed for the students at the technical high schools to study the operating capabilities of punch computers. It was written as applied to the existing training program and consists of two parts. The first part includes general information on the punch computers and an investigation of the operating capabilities of punch machines, controllers, sorting machines and the T-5MB tabulator.

Chapters 1-2 were written by T. N. Yakupova, and the foreword, general information and Chapters 3-14, by N. M. Surin.

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PUBLICATIONS

COMPUTERIZED DATA PROCESSING (INTERDEPARTMENTAL SCIENTIFIC COLLECTION, NO 24)

Kiev MASHINNAYA OBRABOTKA INFORMATSII (MEZHVEDOMSTVENNYY NAUCHNYY SBORNIK, VYPUSK 24) (Computerized Data Processing (Interdepartmental Scientific Collection, No 24)) in Russian 1977 signed to press 18 Mar 77 p 2, 134-139

[Annotation and abstracts from book edited by N. G. Tverdokhleb et al., Cishcha shkola, 1,000 copies, 142 pages]

[Text] This collection contains a discussion of the problems of improving computerized data processing in automated control systems for industrial enterprise and production associations, hardware, information support and software for automated enterprise and association controls systems based on the integrated system of computers. A number of articles are devoted to the computer processing of data at the agricultural enterprises and branch control agencies and also the investigation of the control of the activity of the collective-use computer centers.

The collection is designed for workers at the computer centers and scientific research institutes and also specialists dealing with the investigation and introduction of computer engineering means and mathematical economic methods in various branches of the national economy.

UDC 330.115:338

USE OF COMPUTERS TO COMPARE INDUSTRIAL PRODUCTION OF THE CEMA COUNTRIES

[Abstract of article by Sis'kov, V. I., Mashikhin, Ye. A., Starostina, A. V., and Mikheyeva, G. N., p 3-13]

[Text] A study is made of the most important procedural prerequisites of the international comparison of industrial production levels of the member countries of the CEMA. A mathematical economic statement of the problem of comparing a given unit is presented, and the technological process of solution on the computer is discussed. A description is present of determining the group and individual price indexes and dispersion coefficients. A computer recalculation of the valuation volumes of gross industrial product from national currency to comparable. There are 12 references.

UDC 002.513.5

PROBLEMS OF INFORMATION SUPPORT OF AUTOMATED CONTROL SYSTEMS

[Abstract of article by Kutsenko, S. P., and Marinchenkov, B. V., pp 13-21]

[Text] A study is made of the problems of determining redundant information arising as a result of the existing statistical relations between documents and individual indexes. An analysis is made of the methods permitting a decrease in redundancy of the input flow, and a method is proposed for statistical encoding of the information set. For automation of the data encoding and decoding process by a proposed code, algorithms are described in the article which can be executed on a computer. There are 3 illustrations and 11 references.

UDC 657.2:658.5

OPERATIVE ACCOUNTING AT AN INDUSTRIAL ENTERPRISE UNDER AUTOMATED CONTROL SYSTEM CONDITIONS

[Abstract of article by Godun, V. M., pp 21-27]

[Text] A grouping of problems of operative accounting at an industrial enterprise is presented with respect to production objects such as labor, objects of labor and means of labor. With respect to each of the problems solved in the automated production control system, the list and content of the machinograms formulated on the computer and required for operative control of the course of production in the control level section are discussed.

The subdivisions of the enterprise to which the machinograms are transmitted for making administrative decisions during the course of production are indicated. There is one illustration.

UDC 330.115:658.5

PROBLEMS OF IMPROVING THE COMPUTER DATA PROCESSING WITH RESPECT TO THE CONTROL OF MATERIAL RESOURCES UNDER AUTOMATED PRODUCTION CONTROL SYSTEM CONDITIONS

[Abstract of article by Pinchuk, N. S., pp 28-33]

[Text] The necessity for creating a control subsystem for material resources concentrating the solution of all of the problems with respect to the control of this type of resource within the framework of the automated production control system is substantiated. The goals and problems of the functioning of the subsystem are defined. The basic means of improving computer data processing with respect to the control of material resources under automated production control system conditions are planned on the basis of the systems approach. There are seven references.

UDC 658.5

PROBLEM OF CREATING A COMMUNICATIONS NETWORK IN THE BRANCH AUTOMATED CONTROL SYSTEM

[Abstract of article by Vesnovskiy, Yu. A., and Galitsyn, V, K., pp 33-38]

[Text] A study is made of the problems of creating an information network in the branch automated control system, in particular, factors influencing the calculation of the required number of terminals and communication channels in the systems with rering signals. An analysis is presented of the existing methods of calculating the demand for equipment. The necessity for considering the flow of rering signals in determining the information loads of the objects of the branch automated control system and the use of the automated telephone network is demonstrated. A method is proposed for determining the probability of losing a call as a function of the probabilities of failure in the connection, the number of servicing units and the interval between rering signals. There are 10 references.

UDC 641.14

SOME PROBLEMS OF DETERMINING THE COMPOSITION OF TECHNICAL MEANS FOR THE ORGANIZATION OF COMPUTER INSTALLATIONS (UNDER AUTOMATED CONTROL SYSTEM CONDITIONS)

[Abstract of article by Nikolenko, A. G., pp 39-44]

[Text] This article investigated the urgent problems of improving calculations with respect to determining technical means when organizing computer installations. A procedure is proposed for determining the optimal composition of the technical means for the functioning of the automated control system. The factors influencing the composition of the technical means and the automated control system conditions are investigated. There are seven references.

UDC 330.115:658.5

TYPES AND STRUCTURAL PRINCIPLE OF MULTILEVEL TRANSPORT PROBLEMS UNDER AUTOMATED CONTROL SYSTEM CONDITIONS

[Abstract of article by Koretskiy, S. L., pp 45-52]

[Text] A study is made of the principles of simulating complex economic systems--branches or groups of branches--using the multilevel transport problems. On the basis of analyzing the economic meaning of the models three possible types of structure of the models are distinguished. The general statement of the multilevel problem is presented. Accordingly, a study is made of the problem of the possibility of solving all three possible special cases. It was established that the most general case cannot be realized using the available methods of solving the transport problem.

Accordingly, the conclusion is drawn of the necessity for modifying the existing methods or development of new ones. Requirements are also presented to which (the new method) must correspond. There are three illustrations and seven references.

UDC 338:330.115

ORGANIZATION OF COMPUTER DATA PROCESSING WITH RESPECT TO THE TECHNOLOGICAL PREPARATION OF PRODUCTION

[Abstract of article by Sendzyuk, M. A., pp 52-59]

[Text] An analysis is made of the existing methods of mechanization and automation of the processes of technological preparation of production. A discussion is presented of the basic areas of improvement of the organization of computer data processing when assimilating new equipment. An approach to determining the cost of products introduced into production in the technological process planning stages is investigated. Recommendations are made with respect to selecting the procedure for automatic solution of the problems of technological preparation of production as applied to the use of the integrated system of computers. There are six references.

UDC 338:330.115

PROCESSING OF ECONOMIC DATA WITH RESPECT TO THE TECHNICAL-ECONOMIC PLANNING OF REPAIR PRODUCTION IN THE AUTOMATED CONTROL SYSTEM

[Abstract of article by Pisarevskaya, T. A., pp 59-66]

[Text] A study is made of some of the basic problems of technical-economic planning of repair production in an instrument making enterprise. The procedure and algorithms for determining the equipment subject to repair, the demand for spare parts, the size of the lot of spare parts, the labor consumption of the production program and loading of the equipment, the demand for material and power resources are discussed. Files and resultant machinograms used in the process of solving the problems of technical-economic planning of repair production on the computer under the conditions of the automated production control system are presented. There are two references.

UDC 658.50

ONE OF THE METHODS OF EQUALIZING THE MACHINE SHOP LOAD BY COMPUTER

[Abstract of article by Dedkov, V. I., pp 66-73]

[Text] A study is made of one of the possible methods of equalizing the labor involved in manufacturing parts by the machineshops with respect to months of the year. The equalization takes place by shifting the times for release of the parts. The determination of the labor required for displacement

of the parts is made without tying it to specific parts and products, which greatly simplifies the algorithm of the problem. The data obtained make it possible to determine the required magnitude of unfinished production at the beginning of the planned period and the possible magnitude of it for the next year's plan. There are four illustrations and two references.

UDC 330.115

PROBLEMS OF ORGANIZING INFORMATION FILES ON MAGNETIC DISCS

[Abstract of article by Kurkina, I. V., pp 73-78]

[Text] A discussion is presented of the problems of formulation, storage and use of information files on magnetic discs. A comparative characteristic is presented for magnetic tape and magnetic disc storage. An analysis is made of the organization of the files on magnetic tape and under the conditions of the application of direct-access memory. The advantages of using direct-access memory are analyzed under the conditions of an economic data processing system. There are five references.

UDC 681.14

ALGORITHM FOR CALCULATING THE STAFF OF COMPUTER SYSTEMS FOR AUTOMATED CONTROL SYSTEMS

[Abstract of article by Krivonosov, Yu. G., Skopen', N. M., and Vybornov, Yu. B., pp 78-84]

[Text] An important area in the design and organization of automated control systems is automation of planning and design which will permit elimination of routine operations of planning the organizational support of the systems. A study is made of the statement of the problem of calculating the staffs with respect to the functions of the computer centers of various classes of automated control systems and the algorithm for solving it. It is noted that the algorithm for calculating the staffs is a component part of the automated system for designing automated control systems developed by the TsNIITU Institute. There are two illustrations and three references.

UDC 681.142.72

IMPROVING THE EFFICIENCY OF THE CONTROL OF THE PRODUCTION ACTIVITY OF COMPUTER CENTERS

[Abstract of article by Kulagina, V. P., pp 84-90]

[Text] A study is made of the problems of improving the operative-calendar planning and control of the production subdivisions of computer centers. An analysis is made of the modern state of the art with respect to production activity of computer centers, the existing methods of improving operating efficiency of its subdivisions, and, accordingly, the construction of a

standard system for operative-calendar planning in the control of the production processes of computer centers processing economic data is proposed which will permit the solution of the problems of optimal loading of the equipment and personnel, the construction of an efficient data processing sequence such that the computation capabilities of the computer centers will be matched to the maximum to the requirements of the users for resultant information. There are seven references.

UDC 681.14:330.115

STUDY OF THE COLLECTIVE-USE COMPUTER CENTER LOAD BY A PROBABILITY MODEL

[Abstract of article by Skripnik, P. M., and Tkachenko, I. S., pp 90-94]

[Text] The collective-use computer center is investigated as a queueing system with arbitrary distribution laws of the random independent variables characterizing the process of the arrival of data and the intensity of processing it by each group of computers. The simulation of the operation of the collective-use computer center is carried out using a probability-automatic model made up of a number of groups of computers. The model is used to determine the optimal number of groups of computers and their number in each group for restrictions on the length of queue awaiting the beginning of data processing for each of them and loading of the computers as a whole throughout the computer center.

The possibility of using the model to determine the production indexes of the operation of the collective-use computer center in the interrogation-response mode is illustrated in a specific example. There are two illustrations and three references.

UDC 681.142.33.330.115

THEORETICAL PRINCIPLES OF THE SIMULATION METHOD

[Abstract of article by Sharapov, A. D., and Soyka, I., pp 94-101]

[Text] A characteristic of the peculiarities of the simulation method in scientific research in the field of economics is presented. Logical principles are formulated for it including the logical classification and models, the forms of outputs by analogy as generalizations of the concept of similarity, the necessary and sufficient conditions of similarity. The possibility of using similarity theorems when constructing simulation models of economic phenomena which are executed on a computer is demonstrated. A classification of economic models is presented. There are nine references.

UDC 338.4:330.115

APPLICATION OF MATHEMATICAL ECONOMIC METHODS WHEN DEVELOPING THE ANNUAL PRODUCTION PLANS OF A PRODUCTION ASSOCIATION

[Abstract of article by Kostenko, V. I., pp 101-110]

[Text] The further growth of production volumes will complicate the planning of the production-economic activity of the production associations. We have investigated the necessity for applying mathematical economic methods and computer engineering in practice when formulating the planning assignments. By using mathematical economic models, varying the different "planning requirements" and "playing" them on the model it is possible to obtain a version of the most stressed, but at the same time realistic production plan and a set of corresponding recommendations.

UDC 658.5

CONTROL OF RESERVES AT THE WAREHOUSES WITH RANDOM INPUT AND OUTPUT

[Abstract of article by Nasirova, T. I., Akhmedova, Kh. M., and Teymurov, Sh. Kh., pp 110-114]

[Text] A procedure is presented for calculating the amount of current reserve at the warehouses ensuring given reliability of the operation of the warehouse for various combinations of input and output random variables. As an example a study is made of an oil base providing for the acceptance of petroleum products, the placement and supply of the users of the national economy. There are two references.

UDC 338.1:330.115

MACHINE PROCESSING OF ZOOTECHNICAL PLANNING INFORMATION IN DAIRY FARMING

[Abstract of article by Teslenko, G. S., pp 114-120]

[Text] A discussion is presented of the results of the investigation and practical implementation of these results in the machine compilation of planning documents connected with natural reproduction and productivity of the dairy herd. A description is presented of the calculation algorithm, the contents of the initial data files, the contents and forms of the output machinograms, the purpose of peculiarities of their use.

For the mechanization of planning calculations in animal husbandry it is recommended that the computer engineering widespread in agriculture be used, which even on the basis of the punch computers and using the proposed procedure permits significant facilitation of the labor of the zootechnical workers on the farms, acceleration and significant deepening of the planning calculations in dairy farming. There is one table and one reference.

UDC 330.115:338.1

USE OF RDCS INFORMATION TO IMPROVE THE ECONOMIC STANDARDS ON THE KOLKHOZES

[Abstract of article by Trokhimenko, L. N., pp 120-126]

[Text] A discussion is presented of some of the problems of creating classified economic data for operative analysis of the formation of production expenses at the kolkhozes based on the computer processing of accounting data. A study is also made of the possibility of using the RDCS data for production planning, in particular, for improving the standards for expenditures of labor and the wages for the production of individual types of products. In order to obtain the necessary information, summary tabulagrams are proposed with respect to the figures of the production expenditures in the national economic subdivision section with respect to individual periods of the operations. This will offer the possibility of finding the planning normatives ties to the actual expenditure normatives. There are two tables.

UDC 681.14

IMPLEMENTATION OF COMMUNICATIONS BETWEEN PROGRAMS IN THE DISC SYSTEM OF OPERATIONS OF THE INTEGRATED SYSTEM OF COMPUTERS

[Abstract of article by Smetanyuk, V. P., pp 126-133]

[Text] The use of the module principle both in the third generation hardware and software advances the necessity for coupling the modules into an integrated system. In this article a study is made of the ASSEMBLERA DOS/YeS language capabilities providing for the possibility of breaking down large, complex programs into functional modules and establishing standardized communications between them. Specific recommendations are made, and examples are presented of the implementation of symbolic and interprogram communications, the transfer of parameters and data between modules. There are two references.

10845
CSO:1870

PUBLICATIONS

CALCULATIONS ON ISKRA SERIES OF KEYBOARD COMPUTERS

Moscow VYCHISLENIYA NA ELEKTRONNYKH KLAVISHNYKH VYCHISLITEL'NYKH MASHINAKH RYADA "ISKRA" (Calculations on Iskra Series of Keyboard Computers) in Russian 1978 signed to press 28 Feb 78 p 2, 160

[Annotation and table of contents from book by B. A. Baklan, A. I. Bukhshtab, M. Ye. Levit, V. A. Murzin, and L. M. Khokhlov, Statistika, 37,000 copies, 160 pages]

[Text] This book describes the operating capabilities of the most widespread models of the Iskra series keyboard computers. The fundamentals of the input language of these machines are classified in it, and a detailed description is presented of the instruction systems for specific models of the series. Methods of solving typical problems and also the problems of using keyboard computers with programmed control are investigated.

The book is designed for specialists connected with the operation and technical servicing of keyboard computers at the computer centers, the machine accounting stations and offices. It can be useful for engineering and technical workers who use computers in the daily activities.

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PUBLICATIONS

MODELS AND METHODS OF PLANNING THE INFORMATION SUPPORT OF AUTOMATED CONTROL SYSTEMS

Moscow MODELI I METODY PROYEKTIROVANIYA INFORMATSIONNOGO OBESPECHENIYA ASU (Models and Methods of Planning the Information Support of Automated Control Systems) in Russian 1978 signed to press 17 Jan 78 p 223, 220-221

[Annotation and table of contents from book by A. G. Mamikonov, A. N. Piskunov, A. D. Tsvirkun, Statistika, 17,000 copies 224 pages]

[Text] A study is made of the principles, models and methods of formalizing and algorithmizing the problems of planning the information files, the procedures for conversion of the input files to the required files at the output and also the problems for determining the best versions of implementing individual subsystems and the information support system of automated control systems. Some examples of using the investigated models and techniques to solve practical problems are presented.

The book is designed for developers of automated control systems, scientific coworkers, postgraduates and students at the institutions of higher learning studying the problems of building information systems.

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PUBLICATIONS

UDC 553.9.12

DESIGN, APPLICATION OF INTENSE ELECTRON BEAM SOURCES

Novosibirsk RAZRABOTKA I PRIMENENIYE ISTOCHNIKOV INTENSIVNYKH ELEKTRONNYKH PUCHKOV in Russian 1976 signed to press 12 Jul 76, pp 1-5, 182-183

[Annotation, table of contents and editor's comments from the book edited by G.A. Mesyats, Siberian Department of Nauka Publishers, 1,650 copies, 191 pages]

[Text] A series of materials are presented in the collection which generalize the research and developmental experience with generators of intense relativistic electron beams, methods of designing the individual components of such generators are given, and inductive storage devices as well as diodes with plasma cathodes with a large emission area are described. Studies of the interaction offintense electron beams with condensed media and gases are described, as well as the application of intense electron beams to the creation of a low temperature plasma.

The book is of interest to specialists in physical electronics and the physics of high energy density fluxes.

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Editor's Comments

The results of research in high current electronics, carried out at the Institute of Atmospheric Optics of the Siberian Department of the USSR Academy of Sciences, at Tomsk Polytechnical Institute and at the Tomsk Institute for Automated Control Systems and Radioelectronics, are given in the book.

The collection contains articles on techniques of obtaining high power, nanosecond pulses, which are of independent interest for those engaged with nanosecond pulse engineering. In this section, we would especially like to note the work of the group of Yu.A. Kotov on the utilization of an LC network with current cutoff to obtain high power, nanosecond pulses. This method, in which an inductance is used as the intermediate energy storage device, permits the development of high power nanosecond and microsecond electron accelarators. Such accelarators differ from the traditional ones in the significantly smaller dimensions and the capability of simple control of pulse width.

Studies of the behavior of exploding wires in an LC network on the basis of the application of similitude theory and dimensional analysis, which were begun in the earlier works of this group, are continued in this work. Similitude theory permits a reduction in the number of independent factors and substantially facilitates the interpretation of the experimental data. In analyzing the various hypotheses concerning the mechanism of wire explosion, it is shown that the hypothesis of magnetohydrodynamic instabilities contradicts the similitude criteria, which have been confirmed experimentally, while the hypothesis of F.D. Bennet concerning a vaporization wave, although it is in agreement with the similitude criteria, nonetheless does not reflect the experimental relationships.

If in the initial periods of the development of high current electronics, basic attention was devoted only to the generation of nanosecond, relativistic electron beams with a high current density, now the range of requisite beam parameters has expanded. For example, to create high power gas lasers, both nanosecond and microsecond beam with current densities from 10^4 a/cm^2 to 1 a/cm^2 are necessary. In this case, beams with a low current density have a large aperture (up to 1 m^2 and greater). The wide beams are also necessary for plasma chemistry, for the design of injection thyratrons, high power switchers, etc.

For this reason, considerable attention has been devoted in the first section of the collection to electron sources with a large cross-section using explosive emission and emission from a plasma. In the papers given in the second part, it is shown that by using explosive emission of electrons, one can now generate pulsed electron beams with pulse widths from fractions of a nanosecond to several microseconds. Where cathodes with explosive emission are employed, questions of cathode stability and the structure of the electron beams are important. These questions are also covered in this collection.

Plasma electron sources can be employed to increase the pulse widths. Several articles are devoted to a treatment of the special features of sources in which the electrons are extracted from a plasma of low voltage discharges into a vacuum and a rarified gas. The expediency of using reflective discharge from cold cathodes in a magnetic field in electron sources is demonstrated, as a result of which it becomes possible to design pulse plasma emitters with a large emitting surface by virtue of expanding the plasma, which penetrates into the vacuum from an arc derived discharge with a cold cathode. These researches provide the basis for the development of electron guns, which are effective in electron beam technology, quantum electronics and other fields. Such sources have substantial advantages over guns with a hot cathode, since incandescent components are not employed in them, there is no ion bombardment influence on the parameters of the beam, and there exists the possibility of realizing pulse emission through the use of pulse discharge.

The book contains three papers on the action of electron beams on metals, gases and solid dielectrics. The process of heating the surface of a metal with an electron beam having a duration on the order of 10^8 s [sic] and with a power density of 10^7 -- $5 \cdot 10^8$ w/cm^2 plays an important part during electrical discharge in a vacuum and in the diodes of nanosecond electron accelerators. The article devoted to this question in essence represents a continuation of the research started as early as 1967.

In the article concerning the action of an electron beam on gases in the presence of an electric field, the possibility of obtaining a low temperature plasma with high density of neutral particles is demonstrated. This method of obtaining a low temperature plasma has advantages over the well-known ones, since in the first place, it makes it possible to obtain a plasma at practically unlimited pressures and gas volumes, and secondly, makes it possible to separatly regulate the main parameters of the plasma: the electron temperature and the concentration of discharge particles.

In the article by D.I. Vaysburd, et al., a cycle of work is continued on the action of the nanosecond pulses radiated by high current electron beams on wide band dielectrics and semiconductors. The first work on the action of high power beams on ion crystal dielectrics and glass has been accomplished thanks to the fact that as early as 1969, a series of high current, nanosecond accelerators were used which were designed in the IOA [expnsion unknown] of the Siberian Department of the USSR Academy of Sciences. These investigations have allowed for the detection of a number of phenomena which are interesting in both as regards scientific and practical applications: brittle fracture of ionic crystals, semiconductors and glasses; fundamental plasma luminescence, which possesses temperature indiependence and subnanosecond flash times; a picosecond component of electron-hole conductivity of dielectrics. One can now say that a new direction has arisen in the radiation physics of dielectrics, which is related to the study of degenerate electron-hole plasma, the density of which is 10^4 -- 10^9 greater than in the case of steady-state irradiation using conventional accelerators. The question of

the transformation of electron-hole plasma bunches into bunches of radiation defects is treated for the first time: defects such as vacancies, internodal atoms and ions. These bunches are treated as a new, "heavy" component of a solid plasma, which can have a substantial influence on the mechanism of the observed phenomena.

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CSO:1870

PUBLICATIONS

UDC 535.36

THE SCATTERING OF LIGHT IN GASES, LIQUID AND SOLUTIONS

Leningrad RASSEYANIYE SVETA V GAZAKH, ZHIDKOSTYAKH I RASTVORAKH in Russian 1977 signed to press 18 Aug 77 pp 1-2, 5-6, 319-320

[Annotation, table of contents and introduction fromthe book by M.F. Vuks Leningrad University Publishing House, 2,160 copies, 320 pages]

[Text] The monograph is devoted to the basic questions of the molecular scattering of light. The determination of the anisotropic polarizabilities of C-H, C-C, C-O and other chemical bonds is treated on the basis of data from light scattering, something which is extremely important in the calculations of the optical properties of macromolecules. The theory of light scattering in liquid and solutions is presented, and the results of studying the intensity of light scattering and its spectral distribution are given. It is shown how based on the results of such research, one can obtain data on the various properties and the structure of liquids and solutions.

The book is useful to physicists, physical chemists, biophysicists, as well as graduate students and students in the senior courses in the appropriate specialities.

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Introduction

The study of light scattering has considerably enriched our knowledge of both the structure of molecules and the structure of liquids and solids.

At the present time, the phenomenon of molecular scattering of light is widely used to study the structure and properties of the molecules of compounds of low and high molecular weight. The method of light scattering is employed to determine the velocity and absorption factor of sound in amedium, and to study their disperion at very high frequencies. This procedure finds application for the study of the thermodynamic properties and structure of solutions.

It has also come to be used in recent years for the determination of the diffusion coefficient.

This book acquaints the reader with the basic questions of the phenomenon of the Rayleigh scattering of light. It is written to a considerable extent on the basis of material derived in the physics faculty of Leningrad University and contains a number of new theoretical and experimental data, which have not appeared in other publications or review articles.

The valency and optical polarization relationship of the polarizability of molecules is treated in detail, by means of which, on the basis of experimental data, the main polarizabilities of many simple, double and triple bonds are calculated. The resulting numerical values are used to find the polarizability tensor and thestructure of complex molecules.

More precise formulas are derived for the intensity of light scattering in liquid and solutions, in which, along with the fluctuations in the dielectric permittivity, fluctuations of the exciting field are also taken into account. Experimental data derived in the laboratory of the author and in other laboratories are given, which attest to the good agreement between these data and the new formulas.

Attention is turned to the relationship between the intensity of light scattering and the thermodynamic properties of a solution. It is shown how the partial pressures of solution somponents can be determined from the experimental data on light scattering in solutions.

Results of studying the small frequency spectrum of molecular crystals are given, and the relationship between the small frequency spectrum of crystals and anisotropic light scattering in liquids is indicated.

Naturally, the book does not encompass all of the questions of the molecular scattering of light. Many important questions remain outside the scope of the book or are treated extremely briefly.

The author is extremely grateful to F.M. Kun' for reading through the manuscript and his numerous useful remarks and advice. The author is also grateful to L.I. Lisnyarskiy, V.P. Romanov and A.V. Tulub for reviewing and discussing individual sections of the book. The author would to thank A.K. Atakhodzhayev, N.Yu. Golubovskiy, N.B. Rozhdestvenskiy, G.P. Roshchin and F.Kh. Tukhvatullin for presenting new data and discussing a number of questions.

8225
CSO:1870

PUBLICATIONS

UDC 550.344

REFLECTED WAVES IN THIN STRATIFIED MEDIA

Moscow OTRAZHENNYYE VOLNY V TONKOSLOISTYKH SREDAKH in Russian 1976 signed to press 15 Nov 76 pp 2-9, 190

[Annotation, introduction and table of contents from the book by O.K. Kondrat'yev, Nauka Publishers, 1,300 copies, 192 pages]

[Text] The structure of an actual medium and the specific features of the wave field in the reflected wave procedure are analyzed using the conditions of the Russian platform. A procedure is developed for the formulation of thin stratified models based on the data of acoustical logging. New and existing methods of theoretical calculations of seismograms on computers are described and discussed. Methods are developed for the experimental analysis of the wave field at the surface and at internal points in the medium. The nature of the waves is specified more precisely and a new classification of the waves is made, where the waves are recorded using the reflected wave method in platform regions. The causes of a reduction in the efficiency of the common depth point method in thin stratified real media are ascertained. An optimum set of methods for suppressing noise of various types is discussed and examples of its use in Nizhnoye Povolzh'ye are given.

The work is intended for the further development of the physical principles of seismic surveying methods. It is of interest to seismic surveying engineers, scientific associates, students and geophysicists.

Some 65 illustrations, 15 tables, 164 bibliographic citations.

Introduction

Seismic methods are the basic methods for studying the internal structure of the earth. In terms of the volume of work which is being done, its scientific and technical level and the theoretical development work, the leading role among all of these methods belongs to seismic surveying. It is of considerable national economic importance, especially in the field of searching for and surveying petroleum and gas deposits. The overwhelming portion of the work in this direction is being done by the reflected wave method (MOV).

In the last decade, reflected wave seismic surveying has been living through a period of rapid scientific and engineering progress. The introduction of multiple coverage and digital processing systems for seismic recordings, and the use of new methods of analyzing and interpreting the wave fields on electronic computers have promoted an increase in the depth and confidence level of the results of seismic studies in all regions of our country.

The common depth point method (OGT) [156, 157] which came into being in the beginning of the 1960's, at the present time has actually replaced for production work all of the remaining variants of reflected wave surveying. The works of V.I. Meshbey, Ye.A. Kozlov, P.G. Gil'bershteyn, B.L. Lerner, G.G. Tabakov, V.B. Levyant and many other researchers [71, 91-93, 96-98, 128, 140] have promoted its successful aplication in the USSR. The contents of this procedure rapidly passed beyond the simple summing of paths using the common depth point method with the introduction of kinematic and static corrections. It now includes diverse complexes of programs for the velocity analysis of the wave field and preliminary improvement of the input data: fan and inverse filters, several methods for subtracting noise, etc. [44, 64, 68-74, 85, 98, 106, 108, 119, 128, 148, 155, 160]. Based on multiple coverage systems, methods are being developed for determining the stratum velocities and the lithologic composition of rocks, automatic plotting of depth sections, bypassing their time analogs [96, 97, 128, 130, 145, 151, 153, 158, 161, 162]. The works of Yu.V. Timoshin on the diffraction conversions of seismic recordings [133] has won considerable recognition here at home and abroad. The first articles on the use of the principles of holography in seismic surveying have appeared [20]. G.I. Petrashen and S.A. Nakhamkin have worked out the plotting of seismic sections using the method of converted wave prolongation [24].

It must be noted that the common depth point method was not anything findamentally new for seismic surveying. The grouping of seismographs has been used for a long time in this regard [25, 27, 52, 118, 139]. L.A. Ryabinkin and his students have treated the extremely effective method of variable directional reception (RNP) [119, 125, 126]. S.A. Nakhamkin proposed the procedure for subtracting wave interference, which comes well recommended [107, 109].

The theory of interference reception of regular waves is used to describe all of these methods, which was worked out as applied to tasks of seismic survey ing by F.M. Gol'tsman [45]. Also being developed by him and his coworkers are statistical approaches to signal separation (optimum reception) and the interpretation of geophysical data [46-48, 67, 88, 136]. S.A. Kats has come up with a rather well put together theory for multichannel filters and has tested several of them while working in Nizhnoye Povolzh'ye [64-66].

Acoustical logging (AK) of deep wells yields detailed information on the velocity parameters of a section [60-63, 87]. Initially, discrete variants of acoustical logging were employed, and later continuous variants. At the

present time, acoustical logging equipment - LAK, SPAK, "Zvuk" [19] - exists in all geophysical trusts, but acoustical logging is primarily used for commercial on-site geophysics. It illuminates individual intervals of a section which are not extensive. Obtaining data throughout the entire depth range should be simplified with introduction of acoustic studies in cased wells [87]. Articles are devoted to the development of a procedure for the use of acoustic logging materials for seismic surveying [39, 41, 63, 77, 86, 127].

Direct representations of the structure of a medium, which acoustic logging yields, are extremely valuable. The primary conclusion drawn concerning the thin stratification of actual media, which has an enormous influence on the development of new physical viewpoints, was based specifically on acoustical logging data [9, 11, 39, 60, 77, 137].

A vertical seismic profiling (VSP) [26] method was developed by Ye.I. Gal'perin at the Institute of Geophysics of the USSR Academy of Sciences, where this method has earned great recognition among geophysicists. It possesses specific survey capabilities for studying the space near a bore hole: the inverse hodograph procedure (OG) [131, 132], the nonlongitudinal vertical profiling procedure (NVP) [124], etc. However, its main applications area is the analysis of the wave field and the derivation of the seismic parameters of the structure of a medium at reference points. Vertical seismic profiling observations involve specific technical difficulties, but fundamental limitations on its capabilities are related only to the sparseness of the grid of reference wells. Multichannel vertical seismic profiling equipment has been designed, and considerable work has been done to refine the observation procedure and process the analog recordings. By means of directional summing and subtracting, the field at internal points in a medium is broken down into descending and ascending waves [22, 31, 32, 137].

The main result of vertical seismic profiling in platform regions can be considered the visible confirmation of the reality of the formation of one-time reflections throughout all intervals of the sedimentary cover [27, 137]. The presence of intense multiple waves has likewise been established. Special procedures have been worked out for estimating the intensity of multiple waves in media, where the main (strictly speaking, the only) multiple forming boundary is the upper surface of the medium [103-105]. However, extracting useful information from such rich materials remains limited due to the weak implementation of methods for digital processing and analysis of vertical seismic profiling data.

Even greater services have been rendered by domestic seismic surveying in the field of the theoretical development and the development of physical concepts of the formation and propagation of waves. The direct and inverse kinematic problems of the reflected wave method are based on the integration of systems of ordinary differential beam equations. They have been solved sufficiently completely for a broad class of media in the fundamental papers of

G.A. Gamburtsev, I.S. Berzon, N.N. Puzyrev, Yu.V. Riznichenko, I.I. Gurvich, A.I. Bogdanov et al. [7, 10, 17, 28, 29, 50, 52, 117, 121].

In the 1950's and 1960's, a group of associates of the Leningrad Branch of the Mathematics Institute imeni V.A. Steklov and Leningrad State University under the supervision of G.I. Petrashen worked out a beam method for calculating the amplitude of individual waves as applied to seismic investigations [1-5, 33, 110-113, 146]. The correctness of the beam method was justified by means of comparisons with exact solutions for the simplest homogeneous stratified axially symmetric media. It has also been used successfully for inhomogeneous media with small vertical or horizontal velocity gradiants [2-4, 5, 36, 80] and for media with curvilinear separation boundaries [4, 95]. A zero approximation of this method is also widely used for calculating the intensities of one-time and multiple waves in thick stratified sections [10, 54].

The beam method of calculation in a conceptual sense corresponds to representations of the geometric seismic behavior of thick stratified media. This is reflected, in particular, in the fact that the divergence function, which controls the change in wave amplitudes, can be derived by means of simple differentiation of their hodographs [34, 80]. The physical limitations of such concepts are obvious. A further development of the theoretical methods for calculating the wave fields was related to the introduction of computers, and went in two directions. In the first, the thick stratified model remained as the basic model, but its parameters have an adequate degree of freedom and can vary so that the results of the theoretical calculations agree with experiment. The author of this model, B.Ya. Gelchinskiy, called it the L-model [33, 35]. For the case of determined parameters, it degenerates into an "effective seismic model" (ESM).

In the other approach, being developed at the Institute of Geophysics of the USSR Academy of Sciences [12, 13, 77, 137], more complex models of the medium are constructed from the directly measured parameters of a section, without bringing the results of the interpretation of the observed seismograms into the first stage. The comparability of the theoretical and experimental data (if this is possible) is the criterion here for the correctness of the representation of the medium and the correctness of the conclusions reached. The inital data for such models can only be obtained with a sufficient degree of detail by acoustic logging.

The idea of complete preservation of the velocity characteristic of a seciton is the most consistent one and is found in the procedure for calculating synthetic seismograms for unidimensional, ideally elastic media. The calculation routines employ an algorithm of V. Baranov and G. Kyunets [6]. The first computations of synthetic seismograms in the USSR were performed by B.S. Parlyskiy and N.G. Mikhaylova [100, 101]. The work of G.N. Gogonenkov, which is generalized by him in monograph [39], has promoted their wide introduction into seismic surveying practice. Considerable research in this field

has also been performed at the Institute of Geophysics of the USSR Academy of Sciences and a number of other organizations [79, 82-84, 94, 123, 128].

Individual attempts have been undertaken to extend the range of applications of synthetic seismograms by means of bringing into consideration the absorption or by making a transition to two-dimensional models of the medium [37, 38, 43, 81, 135, 164]. However, they have not left the stage of the design of the individual trial programs and several illustrative calculations, something which is related to the inadequate capacity of second generation computers with which the geophysical enterprises are equipped.

In synthetics seismograms, the overall field of all waves close to the explosion point is computed. Rought estimates of the structural configuration of the medium are recorded in practice here, but on the other hand, substantial simplifications are intorduced intothe wave process (failure to take divergence and absorption). For this reason, along with these methods, L.I. Ratnikovaya has expanded work at the Institute of Geophysics of the USSR Academy of Sciences to refine the beam method of calculating the dynamic characteristics of individual waves in media which contain thin stratified rock benches [120]. This approach is based on the notion that certain sharply pronounced reference horizons are of the main importance in a section, and that the influence of thin stratification of the medium plays a large part in the formation of the reflected wave and has little effect on its passage. As a result, there appears the possibility of replacing the thin stratified intermediate portions of a section with thick homogeneous or gradiant layers. In calculations of individual waves by the beam method, it is not difficult to introduce the absorption and divergence, and for this reason, such a method can be used to obtain characteristics of reflected waves at different distances from the explosion point which are extremely important to us. However, in this case, we can study only a part of the wave field, related to the reference levels, while drawing up the overall recording path is an extremely labor intensive process as regards the sorting out and subsequent summing of the individual reflected waves, which are both one-time and multiple waves.

The basic feature of the seismic field in stratified media is the enormous number of individual multiply reflected waves. In the words of the graphic expression of Ye.A. Losovskiy, with 150 boundaries in a section, "the number of multiples waves which accumulate per one-time depth reflection will exceed the total number of protons in the universe ($N > 10^{79}$)." Analytical expressions for the amplitudes of the total field of all reflected waves (for the case of normal incidence) have been derived in his papers [94] in the most finite form. This has proved possible only with an extremely idealized structural configuration of the medium: a periodic structure with reflection factors equal in terms of their absolute value. For this reason, only the most general laws governing the wave field have been derived in this manner.

When using a procedure for calculating individual reflected waves, the problem of the large number of them becomes an urgent one from the viewpoint of the

possibility of sorting out all of these waves, as well as selecting their individual, sufficiently significant representatives. Such problems are solved for horizontally stratified media by combinatorial methods, which were coupled with the beam methods of T.I. Vavilovaya [20, 21, 113]. She advanced the extremely fruitful idea of "enlarging" multiple waves by grouping them into a family of kinematic and dynamic analogs. This has permitted calculations based on only one representative of each family. However, the number of families remains rather large. Considered in papers [49, 76] were some algorithms for the analysis of a wave field and the selection of the most representative total multiple waves, based on a limited number of which one can successfully put together an idea of the field as a whole.

Methods of calculating synthetic seismograms, individual reflected waves and their combinatorial selection successfully complements one another. For this reason, they are all used in solving various problems in the theoretical analysis of a wave field.

The possibilities for the general solution of inverse dynamic problems have been studied by A.N. Tikhonov [134], M.M. Lavrent'yev [89] and A.S. Alekseyev [1]. As is well known, they are not correct. Although the mathematical tools for their solution have been developed, they can hardly be applied to the conditions of the seismic surveying of actual strongly inhomogeneous, thin stratified media. It is as yet possible to use only the dynamic parameters of individual reflected waves.

At the same time, increasingly complex problems are facing seismic surveying. Despite the increase noted here in the effectiveness of the reflected wave method, in a number of regions there has as yet been no success in reliably segregating and tracing the reflecting levels at great depth. Included among are the most promising terrigenous deposits of the lower portion of the sedimentary sheath of the Russian platform. These are regions with a highly developed industry, and for this reason, the problem of creating the requisite power engineering and raw materials resources is a particlularly urgent one here.

A further increase in reflected wave method effectiveness is possible only as the result of developing the physical principles of this method.

At the present time, the complexity and dynamics of the physical processes are taken into account to only a certain degree in the analysis of the wave field. The interpretation of seismic data though is, as before, entirely based on their kinematic characteristics and notions of geometric seismicity. From these viewpoints, one cannot explain the causes of the inadequate effectiveness of the reflected wave method in complex regions and outline approaches to refining the working procedure. With the introduction of digital processing procedures using computers, seismic surveying is mastering at a rapid pace and widely using the new approaches of the formal logic of computer methods, probability estimates and the statistical theory of signal separation against a background of noise. Under these conditions, it is particularly necessary to work out the physical principles of a method, which would be

in accordance with its new technical capabilities. Otherwise, the geophysical contents of a problem can simply be lost in the formalized procedures for solving it.

The results of developing the physical principles of the reflected wave method for media with comparatively tranquil occurrence of the rock in platform regions is described in this work. In this case, a complex of research methods was used [9, 137], including:

1) Study of the detail velocity structure of actual media by means of acoustical logging of deep wells;

2) Theoretical calculations of wave fields on computers for models designed around acoustical logging data;

3) Special experimental and procedural work on the surface and using the vertical seismic profiling method for the experimentally studying the wave field;

4) The analysis and generalization of materials derived in the processing of ground magnetograms of experimental and production batches.

The work was closely tied to production observations in the Nizhnoye Povolzh'ye regions. We considered and made use of all of the actual data obtained in the geophysical organizations of Saratov and Volgograd [16, 53, 58, 59]. The physical conclusions were checked directly in the processing of the mass of material.

The basic features of the structure of an actual medium are treated in Chapter I, and the most suitable model for it is selected. The second and third chapters are devoted to ways of studying the reflected waves: to theoretical calculations and some experimental approaches. Among the latter, primary attention is devoted to the method of vertical seismic profiling, which possesses considerable fundamental capabilities, but as yet lags ground observations in the field of the utilization of digital methods of analyzing and interpreting seismic data. Results of a theoretical and experimental study of the field of reflected waves in thin stratified media are presented in the fourth chapter. The conclusions drawn here have permitted not only the explanation of the basic features of the wave picture, but also the outlining of the ap proaches to boosting the effectiveness of reflected wave seismic surveying on the platform. To check them, the new methods of suppressing noise and segregating deep, one-time reflections were developed and tested operationally under production conditions. The fifth and final chapter is devoted to these questions.

The seismogeologic characteristics of the regions of the papers are typical for platform regions, and for this reason the results obtained here can be extended to the entire Russian platform and other similar regions.

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