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14 March 1984

USSR REPORT

ENERGY

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OIL AND GAS

PROPOSED PLANS FOR INCREASING OIL OUTPUT IN CASPIAN SEA

Moscow PRAVDA in Russian 9 Dec 83 p 1

[Article by L. Tairov, PRAVDA Correspondent: "Neftyanyye Kamni Progresses"]

[Text] This year the gray Caspian has been beating all records for storms. It is not easy for the oil industry workers to function in the open ocean with waves coming like walls of water. Nevertheless, they are persistently struggling to increase their contribution to the fulfillment of the obligation undertaken by the workers of Azerbaijan--the extraction of 420 million cubic meters of natural gas and 60,000 tons of oil in excess of the annual plan.

Just the other day they struck a gusher--up to 300 tons per day. This is a great success which was rightly shared by the drillers of the brigade headed by the foremen and specialist-testers, V. Mamedov, and G. Isayev, and supervised by Sh. Aliyev. Four such wells are already producing oil on the platform, with a total of 12 wells designated to be drilled which will fan out under the sea floor. The expected production from this small artificial island will match the extraction from a large inland field.

The foregoing marked the beginning of the new Field imeni 28 Aprelya [April]. It is a symbolic name; after all, this is the date of the establishment of Soviet power in Azerbaijan. One more pipeline will be brought to the field which will assure the regular transportation of the raw material from here to Neftyaye Kamni and beyond, to the mainland.

Currently two additional metal islands are being constructed, one designed for the drilling of 12, and the other for 24 directional wells. The hydraulic equipment is being assembled in advance on shore and then transported by sea.

Meanwhile, at Neftyanyye Kamni, where mother earth no longer indulges us with gushers, competition is widening for the exemplary maintenance of the existing stock of wells, so as to optimize operations and increase oil extraction on older tracts. The leader here is brigade five under the foremen Sh. Gadzhialiyev and S. Abdyllyayev. Since the beginning of the year, their brigade has exceeded its annual production target by more than 20,000 tons of oil. Nor are the drillers of the brigade of S. Dzhafar-zade far behind, with several thousand meters of drilling in excess of the plan to their credit.

There was talk of something new at Neftyanyye Kamni: the final preoperation adjustments had begun on the largest automated oil collection station. This station will make it possible, without losses, to collect the entire production of the wells, and to separate the sand and the water from the oil without polluting the ocean. A city is growing on metal piles, and the workers and specialists who are attending the labor school here are helping to discover and to bring on line new deposits of oil and gas. In a word, Neftyanyye Kamni is progressing.

How do matters stand overall with the Azerbaijan oil workers? The comments of the First Deputy Chairman of the Council of Ministers of the Azerbaijan SSR, S. Tatliyev, follow:

"I have to admit that the extraction of black gold here has become more difficult and that the industry has been experiencing significant shortfalls in comparison with the objectives of the five year plan. The current year, however, may be considered a turning point. As participants in the implementation of the fuel and energy program, the workers of this republic are implementing a number of measures aimed at a fundamental improvement in the operations of the oil and gas extraction industry. Among the achievements have been the successful bringing on line of tens of new, high production wells, and the augmentation of oil, condensate and gas reserves. In the area between the Kura and Iori a gusher was recently obtained yielding oil from Eocene deposits.

But the main point to note is the accelerated development of the new Caspian fields, where today we are extracting almost 70 percent of Azerbaijan oil. We are placing great hopes as well in the Field imeni 28 Aprelya. Currently 8 wells are being worked from two of its platforms and five of which were brought on line this year, with total average daily production of more than 3,000 tons of oil. Progressive techniques for increasing oil recovery potential from formations are being more widely implemented on the existing stock of wells. Thanks to the application of secondary and tertiary oil extraction techniques, enhanced recovery accounts today for more than 30 percent of the overall volume of oil extracted in the republic.

This also made it possible, in the 3d year of the 11th Five Year Plan, to overcome longstanding shortfalls and to extract amounts of oil and gas considerably in excess of plan targets. Objectives for bringing new wells on line were also substantially overfulfilled. Collectives of the following organizations achieved exceptional results in the fulfillment of their adopted obligations: Industrial Association imeni 22nd CPSU Congress; Oil and Gas Extraction Directorates imeni H. Narimanov and 26 Baku Commissars; 'Karadagneft' and 'Sal'yanneft'. Outstanding worker awards to people such as A. Amanov, A. Mamedov, S. Dzhafar-zade, H. Kuliyeu, E. Aslanov, T. Bagirov, G. Guseynov, S. Nagiyev and many others attest to the existence of significant potential for increasing oil and gas extraction in the Aznaeft and Kaspmorneftegazprom Associations.

The marine oil workers are conducting prospecting and exploration operations at ever increasing depths. To assist them, it is necessary to speed up the start-up of the first section of the factory manufacturing support parts of

stationary deep water platforms, and upgrade the facilities for the overhauling and maintenance of floating drilling rigs. Several additional questions connected with the technical reequipping of this sector also await resolution.

The oil workers attribute their successes to the working of deep lying strata. There is experience in taming of great depths both on dry land and at sea, particularly during the last two five year periods. On the Bulla-more [Bulla-Sea] tract alone seven wells reached depths in excess of 6,000 meters. On land, eight wells have been drilled to a depth of more than 5,500 meters. The scientific and practical conclusions reached by the Azerbaijan oil workers based on the results of the drilling of super deep wells possess immense significance. Furthermore, it is my opinion that today it is no longer acceptable for drilling of this type to be still carried out with obsolete equipment.

9276

CSO: 1822/106

OIL AND GAS

EVALUATION OF SLANT HOLE DIRECTIONAL DRILLING METHOD

Baku BAKINSKIY RABOCHIY in Russian 30 Nov 83 p 3

[Article by A. Movsumov, deputy director of scientific work in the area of drilling at Gipromorneftegaz, the State Scientific Research and Design Institute, doctor of technical sciences, professor; and by S. Oganov, professor at the Azerbaijan Petroleum and Chemistry Institute imeni M. Azizbekov, doctor of technical sciences: "The Zigzags of Slant Role Drilling"]

[Text] Practically the entire volume of developmental well drilling for oil and gas in the Caspian Sea, at such high potential fields as Sangachaly-Duvanny-more, Bakhar-more, Neftyanyye Kamni and Field imeni 28 Aprelya is being carried out by the clustered, slant hole directional method.

In this article we would like to address the status of drilling technology for directional wells and the ways to increase the quality of their drilling of this type of well.

The volume of holes drilled using this technique will continually be increasing both on land and in the ocean. The use of slant hole drilling is also appropriate in those situations when sidetracking takes place to eliminate accidents and to reduce the zenith angle of naturally deviated vertical wells. In a word, this is a problem that is totally current and very serious.

The drilling of slant hole wells is very complicated. It is essential to deviate the hole from the vertical for the necessary distance and bring it in within a present circle in the field structure. For example it is often necessary to fall within a circle not more than 25 meters in diameter at a depth of more than five kilometers. With the exception of Neftyanyye Kamni, the usual deviation of the well hole at the fields in our republic is 400-600 meters. In addition, the drilling must be done so that the operation of one well will not influence another well being worked at the same time, in other words so as not to disrupt the operating grid of the field. Nor should it be forgotten that the drilling takes place under complex geological conditions. Generally speaking, special talent and experience are needed in order to carry out such tasks.

The drillers of Azerbaijan possess a full degree of both. They were the founders of the slant hole directional drilling technique, and pioneers in its mass application to the drilling of ocean gas and oil fields with cluster wells. The school of M.P. Gulizade, academician at the Academy of Sciences of the Azerbaijan SSR, and chairman of the department of drilling of AzINEFTEKHIM imeni M. Azizbekov, is famous throughout the country. The results of experiments carried out here have been successfully implemented not only in our republic but also in Western Siberia, Kazakhstan, Bashkiria, in the Crimea and in other regions. Drillers come from all corners of the country to study here. But nevertheless, the condition of slant hole directional drilling in Azerbaijan is cause for serious discontent. It is essential to do much to improve and develop it.

The Sangachalskiy MUBR [Marine Drilling Operations Administration] is the single marine enterprise in the country which conducts a substantial amount of deep drilling using this technique. Even so, the number of errors is still high. No more than half of the well holes fall within the designated target area. This extends the work timetable and reduces the technical and economic indicators. The main reason for this situation is the lack of availability to drillers of reliable equipment for controlling the path of the well hole. Even at the Sangachal'skiy UBR [Drilling Operations Administration] this is still done as it was two or three decades ago.

The principal difficulties in slant hole drilling are related for the most part to the precise orientation of the deflector. Also important is the correct choice of its setting angle in relation to the drift angle of the hole. In a majority of the oil regions of the country magnetic subs in combination with electrical inclinometers are widely utilized for this purpose. Unfortunately, the inertia among the older drilling enterprises in this country is still strong. For example, geophysicists refuse to place inclinometers inside the drill pipe. As a result the degree of control over the drilling process often amounts to zero, while already proven and reliable techniques do not find their way into our drilling practices. I might add that the use of an inclinometer not only yields a high level of precision but also sharply reduces the amount of orientation work.

During the development of the Peschanyy-more field a Grozneftegeofizik designed bottom-hole inclinometer with a mechanical operating principle was widely used, and received high marks from production workers. But even then, only a small batch of these instruments was produced, and their production was halted at a later date. Researchers at our institutes are diligently working on a design for instruments for the orientation of the deflector. Gipromorneftegaz has already developed a piece of equipment with hydraulic canal coupling which makes it possible to carry out this operation without starting up the apparatus. A method has been developed at the AzINEFTEKHIM imeni M. Azizbekov for utilizing a bottom-hole inclinometer with a magnetic sub.

The type of deflector and down hole motor chosen has a significant influence on controlling the path of the well hole. Many deflector designs are well known, and have proven themselves in various regions of the country. But the drillers of our republic use only the bent sub, even though this has proven to be effective in far from all situations. However, this is rather the misfortune of the drillers than their fault. The necessary instruments either

do not exist or enterprises are very poorly stocked with them. It is appropriate to mention that the drillers have no choice regarding the specifications of turbodrills. For instance, the industry has stopped production of 214 mm diameter turbodrills.

In the same vein, attention must be called to the generally inadequate level of technical sophistication in the drilling of slant hole wells. On the one hand, the lack of the necessary equipment makes it essential to seek out some kind of solution. Such as, for example, in relation to the turbodrill of the diameter we mentioned. Under such conditions losses are inevitable, as are sharp reductions in indicators. On the other hand, we are not prepared to implement new technology. Take for example the ways the drillers relate to a calibrator. It is well known that this piece of equipment has immense advantages. In part it makes it possible to get by without a deflector. To do this it is necessary to hook up the bit, the calibrator and the turbodrill, and this is enough to increase the zenith angle. At the same time the presence of a calibrator provides a guarantee that the well hole will be straight, smooth, and without shoulders, and that the casing will be run to the hole bottom. It serves the same purpose in relation to adaptation for primary sidetracking of a slant hole well from a vertical hole.

Are there other promising areas for increasing the effectiveness of slant hole drilling? Absolutely, many of them! In our country this type of drilling is performed with hydroturbine downhole motors. Abroad it is done by rotary drilling. The AzINEFTEKHIM imeni M. Azizbekov in conjunction with Kasporneftegazprom VPO [All-Union Production Association] have developed and successfully introduced a combined turbomotor-rotary technique that, in our opinion, is worthy of further application.

Another area with underutilized capacities is the drilling of slant hole wells with large deflections. Here the question often arises of whether it is necessary to achieve deflection records. In our view this should certainly be done, not for the sake of the record itself, but rather to resolve new questions of technical and technological character. It is now possible to pose the question of drilling a slant hole well with a deflection of the hole bottom from the vertical of 3-4 kilometers and more. The development of this technology will permit the solving of problems related to the bringing on stream of ocean fields where water depth does not permit the use of existing hydraulic equipment designs.

Given the current level of the technology for drilling slant hole wells, an optimal designed deflection should be one in which the central angle of the well hole fluctuates in the range of 8-10 degrees. This means that for a well to a depth of, let us say, 4,500 meters, the deviation must be increased to 650-750 m instead of the usual 400-600. Should such a standard be adopted, it would make it possible to introduce a nonorientational technique for drilling slant hole wells that has been developed by AzINEFTEKHIM imeni M. Azizbekov researchers. The key to this technique is to drive the first piece of casing into the bottom at an angle equal to the designed drift angle. This work can be done by the builders when they are preparing the base. It remains then for the drillers only to increase the zenith angle to the

projected level and to stabilize the drift angle. It is possible here to get by without an inclinometer. This method was successfully introduced on seven wells on the Black Sea, where deflections in the range of 1,000-1,500 meters were obtained for wells 3,000-4,000 meters in depth.

Prevention of and handling of emergencies, and the successful casing of wells are important problems. Gipromorneftegaz has developed and implemented inhibiting chlorinated potassium mud systems for increasing the integrity of the well walls, and the prevention of well hole restrictions and collapses. However, the absence of the necessary components for the preparation of these muds is slowing down their introduction.

The sticking of tools continues to be the most frequent type of accident even though the nature of this phenomenon and the means for preventing it are well enough known. The Gipromorneftegaz NIPI [Scientific Research and Design Institute] and the Kaspburnefetgazprom VPO have developed several fluid bath compounds for the freeing up of casing pipe that becomes stuck in a well hole. There are enough raw materials in our republic for this purpose. Some of the necessary components are available from the Baku Petroleum Processing Plant imeni Karayev.

It should be noted that when drilling to these low strata, where there is the danger that either the casing or the drill pipe may stick, it is possible to have at the drilling facility a supply of the fluids necessary for the baths. Unfortunately, even at the shore bases of the marine directorates of drilling work, there is rarely a supply of fluid baths already prepared for timely shipment to facilities in case of need.

Today, slant hole drilling is in need of a special approach, in view of the increasing depth of wells and the introduction of sophisticated technology. What is necessary above all is more strict technological discipline and the timely and precise controlling of the processes of well drilling. For instance, it appears to us to be expedient in the interest of achieving greater precision and reliability in [well] orientation work to take the control readings with an inclinometer twice as frequently, thereby reducing the corresponding intervals by 50 percent.

Particular attention should be paid to increasing driller qualifications. A special department for this is currently operational at the AzINEFTEKHIM imeni M. Azizbekov. Its students include representatives from all the oil producing regions of our country. But it is downright shameful that the drilling enterprises of our republic are very reluctant to send people to this department. It is clear that the managers of these enterprises do not fully comprehend the importance and seriousness of the demands now being made on those engaged in slant hole directional drilling. This technique has great possibilities and potential, and it is necessary to do everything possible to develop and improve it.

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OIL AND GAS

NIZHNEVARTOVSK ASSOCIATION ON SUBSTANDARD EQUIPMENT, PERSONNEL PROBLEMS

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 18 Nov 83 p 1

[Article by L. Kozodoy, oil and gas recovery operator of the Megionneft NGDU's [Administration for Oil and Gas Extraction] Nizhneartovskneftegaz Association, member of the Khanty-Mansiysk CPSU district committee: "The Gushers Have Become Silent".]

[Text] Since October of this year Tyumen's fields have been providing the nation with a million tons of fuel per day. Such a pace is unequalled in worldwide oil recovery.

In light of this achievement it seems strange that, since the beginning of the year, Glavtyumenneftegaz has had a debt of almost 2 million tons of fuel. Our association, Nizhneartovskneftegaz, is responsible for the bulk of this debt.

For several years now the Samotlor deposit has been operating at design capacity. A substantial supplement of fuel is now coming from the new northern deposits, which, although not as well known as Samotlor, have sufficient potential. However, for various reasons, which will be mentioned, more than 16 percent of our wells are unproductive. As a result, the above-plan tons of fuel recovered in Nefteyugansk and Surgut are used to pay the debt of the Nizhneartovsk oil workers. It is very painful to admit that we are subsidized by our comrades in socialist competition.

Just recently drillers contributed substantially to oil recovery by turning over mainly flow production wells to production workers. But at the start of the 11th Five-Year Plan only 30 percent of the fuel from the Nizhneartovsk fields' new wells was recovered by the flow production method, and 70 percent by the mechanized method. This year there is almost 7 times more mechanized recovery than natural flow recovery! And so the fate of the great Tyumen oil resources is henceforth in the hands of the production workers. What exactly hinders us from working better?

I will begin with the sore spot.--transport of shift teams to the work place. Is it right to brigades in one bus to different oil fields, separated sometimes by dozens of kilometers? Without this the long journey to work is

already taking 2-3 hours longer. Recently four brigades from the underground well repair shop of the Nizhnevartovskneft administration waited for the bus practically a whole shift and had to go home because there was no shift car for them. How could this happen here in Nizhnevartovsk, where from morning to night thousands of trucks and buses travel the roads?!

Well, let's suppose the commuter service was working normally. Even so, our shift teams rarely begin work on time, most often due to interruptions in the power supply. According to the incomplete data of the association's deputy chief power engineer, A. Vereshchagin, the electric power was cut off almost a thousand times in the fields over 10 months of this year. That is three emergency situations per day!

Today there is perhaps no more important task than supplying oil fields with engineering support. In Nizhnevartovsk this noticeably lags behind the level established in Nefteyugansk and Surgut. Here is an example. We have the most powerful central base for production supply of oil-field equipment, where lies the foundation of accident-free operation of the mechanized stock of wells. Nevertheless, the Nefteyugansk oil workers have managed to extend the between servicing period of operation of wells equipped with electric submersible equipment to 400 days. Ours comprises only 268 days.

The Nefteyugansk workers, having armed themselves increasingly better with oil workers from Tararia and Bashkiria, have established engineering groups within the underground repair shops, and are introducing a progressive, unranked pay system. However, on our fields there is still not much attention devoted to well operation and repair services.

Whose work is least equipped with machinery? Ours, the production workers. Who most of all experiences a need for housing, child care facilities and the simple blessings of daily social life? Again it is the production workers. And, our wages are much lower than, say, that of drillers. Hence the fluctuation of the cadres. This year, for example, our association hired about 300 underground repair operators and let go more than 200.

The cooperating ministries which provide the Tyumen fields with necessary materials and equipment are not responsive to our needs. The inspection department, specially created in the Main Administration for quality control of incoming technology, cannot keep up with compiling of statements about numerous the defects and even just plan shortages of installations provided by Minkhimmash [Ministry of Chemical and Petroleum-Related Machinebuilding] enterprises. There are especially many complaints about the Baku Machinebuilding Plant imeni Lieutenant Shmidt and the Moscow Borets Association. If we start-up a compressor here, for example, it immediately breaks down. It turns out that, after the gear casing is cast, the foundry sand was left in it. Another unit is nonfunctional because during assembly, someone "forgot" a piece of inside wire, the hermetic cooling chamber and it caused a short circuit.

Or another true-to-life picture, well know to oil workers. A train arrived at the train station with engineering salt needed for repair work. The salt must be packaged in jute sacks, which facilitates unloading of cares. However, the Novo-Solikama Potassium Plant and the Akhtubinsk Bassol Base, in Astrakhan oblast, load their product by the bulk.

To what tricks won't the brigades resort, in order to remove frozen blocks harder than granite from the cars! Neither crowbars nor mechanical picks work here. Local efficiency experts prepared a special scaffold and installed a drilling aggregate on it. It didn't work! The railcar fell apart from the strong vibration, but the snow-white monolith was unaffected. Now consider our losses if at Tyumen oil fields thousands of various repair operations are performed on wells annually, each of which requires about 16 tons of engineering salt.

We are glad of the successes of our competitive rivals, the Neftuyugansk workers, who in 10 months produced 646,500 tons of fuel. And, of course, we are acutely feeling our lag. I think it is time to at last bring order to the Nizhnevartovsk oil fields and to change the attitude toward the collectives of production workers, on whom today the fate of the nation's great oil resources primarily depends.

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CSO: 1822/107

ELECTRIC POWER OUTAGES DISRUPT OPERATIONS AT KARADAG OIL FIELD

Baku VYSHKA in Russian 3 Dec 83 p 3

[Article by S. Kyazimov, senior low-voltage network foreman, B. Abilov, oil and gas recovery foreman, I. Seliverstov, operator of the Karadagneft NGDU [Administration for Oil and Gas Extraction]: "Why Oil Wells are Idle."]

[Text] This year the collective of the Karadagneft NGDU achieved good results. In 3 quarters of the year several thousand tons of oil above the plan went into the reservoirs, and we achieved first place in the totals of socialist competition among the Azneft enterprises.

The oil workers showed great concern for their production facility also during preparation of the entire oil-field system for winter operations. At all our fields and in the shops we replaced defective pipelines and valves, heated air lines and water and fire-fighting risers and took measures to inspect electric equipment. In a word, we did everything necessary to complete this year successfully and create a good reserve for future work.

Nevertheless, there are disruptions in work. The fact is that in the last 2 months there have been power outages, blamed on the Korov electric network, in the NGDU system. Thus, on 26 October, there was a power outage from 5:30 to 9:40 at substation No 503, which supplies power to the first field's facilities. On the same day power was out for over 8 hours also at substation No 539. As a result, operations of compressor station No 5 and many of the oil wells located in the second and third fields were paralyzed.

These losses proved particularly frequent in November, when there were four outages (a "record" for the whole year!). For instance, on 23 November, a foul-weather day, three substations immediately lost power--No 503, 532, and 539. As a result, about 400 oil wells stopped operating in the first, second and part of the third fields. On the following day the outages were repeated. Substations No 503 and 539 lost power from 6:00 to 6:45.

What are the consequences of these outages? The majority of our region's wells are water flooded and operate under forced drive conditions. Therefore, even short-term disruptions in power supply cause long stoppages. It takes several days to restore them to their former production state.

Even more serious complications arise from stoppages of sand-forming wells. We perform flushing where possible. But still many wells must be turned over for overhaul. For example, such wells as No 416 with a yield of 8 tons of oil and No 246, which produced 5 tons of pipeline oil daily, and others, have still not been restored. For the whole administration in November alone, 1,000 tons of oil did not go to the storage tanks. Thus the shock work of the collectives of fields No 1, 2 and 3 went for nothing. True, they fulfilled their recovery plan, but did not manage to recover additional fuel as in preceding months, which is the fault of the workers of the Kirov electric network.

Let's note that the discussion is not about planned outages of the electric network. Usually in such cases the workers of the Kirov electric network inform the NGDU management of the planned routine maintenance of some facility. Service specialists of the Main Power Engineering Administration manage in that time to transfer the system of this or that field to reserve supply. But the fact is that the power outages which occurred are not in the same category as the planned outages. It is the general opinion that they are the result of untimely routine maintenance of the mentioned substations and the lack of proper control of this section's operation on the part of Azglavenergo.

Currently the oil workers of our administration are working with great enthusiasm. One would wish to finish up as quickly as possible with the consequences of the damaging power outages and honorably fulfill the increased obligations that have been assumed. But there is the feat that the power workers will again undermine us. In our view, the workers of the Kirov electric network would prevent similar disruptions in recovery by developing a set of measures to increase the reliability of all facilities, but the main thing is to implement the measures effectively.

12421

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OIL AND GAS

TURKMEN SSR'S NEW DOVLETABAD GAS FIELD PRODUCES NATURAL GAS, CONDENSATE

Ashkhabad TURKMENSKAYA ISKRA in Russian 10 Nov 83 p 1

[Article by N. Soboleva, director of the VPO [not further identified] department of Turkmengazprom; I. Khaydarov, engineer]

[Excerpt] The new Dovletabad gas deposit has reached design capacity. The entire engineering chain of preparing the fuel for transport is operating accurately and smoothly: the powerful separators, heat exchangers, dividers and fire evaporators. The reliability and efficiency of individual units and assemblies have increased. Saturation with automatic equipment and control-measuring instruments makes it possible to conduct engineering processes with high accuracy. Control is rendered from the main operator post. Measures have been taken to reduce harmful emissions into the air; the environment is being reliably protected.

The maximum in comfort was created for the service personnel. Air conditioners and ventilation equipment were installed in work areas. A settlement with all the day-to-day comforts was built not far from the field for the production workers.

The collective of the Dovletabad field administration achieved good production results: in 10 months they recovered more than 200 million cubic meters above the plan of inexpensive natural fuel and more than 6,000 tons of condensate. They contributed substantially to fulfillment of the program of the Shatlykgazdobycha Association.

The obtained results attest to the selfless labor of the diverse collective of the Red Banner association and widely unfolding competition under the motto: "Work effectively and with high quality".

12421

CSO: 1822/104

OIL AND GAS

UNDERWATER GAS PIPELINES LAID AT BLACK SEA GOLITSYNSK DEPOSIT

Riga SOVETSKAYA MOLODEZH' in Russian 11 Nov 83 p 3

[Article by M. Umanskiy: "Attack on the Shelf"]

[Text] The first to sail majestically from the port was the huge [vessel] Desna, gradually unwinding behind the stern, link after link, all 3,000 meters of the pipeline's steel length. pontoons kept this 600-ton length afloat and another ship carefully carried the end of the pipeline. In the company of a crane ship, dispatch ships and a diving boat, the Desna set sail for the open sea to where a colossal steel set of shelves with a drilling rig in the middle stood 72 km from the Crimean shore.

There is something unusual about gas from the bottom of the Black Sea. For more than a year the Sivash self-lifting floating drilling rig has methodically investigated the continental shelf of the Crimea and Caucasus. And finally success! The reserves of the discovered Golitsynsk deposit were so vast that the question was raised in earnest about its industrial use and laying of an underwater gas pipeline. However, the gas workers here have experienced great difficulties.

"Usually a special pipe-laying ship, which lays pipes like a caterpillar lays silk thread, is used to build underwater sea arteries", explains M. Petrosyan, director of the Chernomorneftegazprom Production Association for Oil and Gas Recovery. "It is an expensive method and inadvisable in the given case, since in the construction area for every nice-weather day there are three foul-weather days. Therefore, it was decided to use the method of "dagger" attacks on the elements--to weld the pipes to a length of a kilometer on land and haul it as a unit to the link-up spot."

The responsibility of the Black Sea workers was perhaps the highest of any of the nation's collectives of gas workers. To perform wide-scale industrial development of a gas deposit and preserve the water's original purity is not one of the easiest tasks. The gas workers perfected a technique for protecting the sea's flora and fauna. Bulk materials, such as clay and cement, are processed in closed units and waste water is forced through the wells at a depth of half a kilometer. Whereas earlier the drill cuttings were lowered again to the bottom after multiple washings with fresh water, now it was

decided to take them ashore all the same. Even the engines' exhaust manifolds were fitted with special traps to separate the smallest drops of oil and noncombustible fuel. The system of threefold automatic protection, like a vigilant physician, "holds a hand to the pulse" of the gas pipeline, preparing to work with lightning speed.

Today, having recovered the first gas in the Crimea, this collective is widening the scale of attack on the peninsula's continental shelf. They are building another underwater main which will tie the deposit to the land.

For the first time a gas river is running along the bottom of the Black Sea.

12421

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ALTERNATE FUELS

BELORUSSIAN PEAT INDUSTRY RESULTS FOR 1983 SUMMARIZED

Moscow TORFYANAYA PROMYSHLENNOST' in Russian No 11, Nov 83 pp 2-5

[Article by Ch. A. Kruglinskiy, first deputy minister of the BSSR Fuel Industry: "The Sector's Work Results for Peat Extraction in 1983"]

[Text] Implementing the decisions of the 26th CPSU Congress, the November (1982) and June (1983) CPSU Central Committee Plena and guided by the instructions of CPSU Central Committee General Secretary comrade Yu. V. Andropov, the BSSR Ministry of the Fuel Industry is successfully completing plan targets and socialist obligations for the 11th Five-Year Plan's main technoeconomic indicators.

Socialist competition directed towards finding reserves for increasing production efficiency, and the creative and conscientious labor of all workers have made it possible for the sector to obtain high indicators in the 11th Five-Year Plan. Above plan output since the beginning of the five-year plan amounts to 3.3 million tons of peat and 322,000 tons of peat briquets. Labor productivity is 105.1 percent of the planned target. The value of above plan industrial output is 25.8 million rubles. Production levels for 2.5 years of the current five year plan as percentages of the five-year plan targets are: for commercial output --54.2 percent; briquet production volume -- 51.3 percent; for peat extraction volume -- 58.7 percent.

Great successes in fulfilling five-year plan targets were attained by collectives of peat enterprises and peat briquet plants in Ditva (director, A. N. Bos'ko) and Dneprovskiy (director, I. M. Bereyshik), which were awarded the Red Challenge Banners of the CPSU Central Committee, the USSR Council of Ministers, the AUCCTU and the Komsomol Central Committee; at Vitebsk (director, M. S. Peshchur) and Usyash (director, K. V. Avin) awarded Red Challenge Banners of the Belorussian CP Central Committee, the BSSR Council of Ministers, the Belorussian Trade Union Council and the Belorussian Komsomol Central Committee; at Lyakovichi (former director, V. Ye. Litvinov) and Berezinskiy (director, B. I. Gavris); the Order of the Red Labor Banner was awarded to the Peat Enterprise "40 Years of the BSSR" (director, K. K. Korda) and the Gantsevichi enterprise (director I. O. Matviyenko). There were also successes at Braslavskiy (director, M. Ye. Doronin), Kolpenitsa (director, N. A. Vakolyuk), "Krasnaya Zvezda" (director, A. I. Kulesh), Smolevichi (director, A. S. Kostyukov) and at other enterprises.

The successful operation of enterprises and the sector in general is to a great extent determined by the fulfillment of peat extraction plans. Peat is the main and definitive component of the sector's work.

The planned conduct of work in the preparation and restoration of cutting areas, the introduction of highly productive equipment, the improvement of skills of key personnel and the scientific organization of labor all make it possible for collectives in the BSSR Ministry of the Fuel Industry to constantly meet annual peat extraction targets.

The high quality preparation of new and upkeep of existing areas lay a firm foundation for the unconditional fulfillment of peat extraction targets. The use of MTP-26 and MTP-81 machines for uprooting fields, and the MP-3M, MTP-29, PPV-0 and MTT-12 for loading and hauling has made it possible to completely eliminate manual labor and to ensure high quality preparation of the deposit strata for the seasonal work depth.

Special attention is given to the drainage of areas and to attaining the required drainage norms during the season at all areas worked. Sixty six percent of the area at enterprises is drained by 51 pump stations. The sector's results depend to a great extent upon their technical condition and operating qualities. Highly productive axial pumps equipped with automatic control systems are finding ever greater use in drainage work.

Excavators have an important role in land drainage work. Constant supervision of their work on the part of enterprise managers and ministry departments has increased output per excavator to 82,000 cubic meters. The volume of earth moved per ton of peat extracted has been made the indicator for drainage work efficiency. At the better enterprises (Ditva, "40 years of the BSSR", Dneprovskiy, Berezhinskiy and others) this indicator is 1.9 - 3.8 cubic meters per ton of extracted peat.

In preparing for the work season great attention is given to the certification of areas, making it possible to determine their suitability for mechanization and readiness for the extraction season. Thus, in the 1983 season 52 percent of the area reached 9 points and higher on a 10 point scale and only 5 percent was less than 8 points. The higher quality areas were awarded the plant mark of quality.

Improvements in the qualifications of key personnel have a definitive role in improving production efficiency, especially in peat extraction.

This is done at a republic intersector institute for improving the qualifications of managerial workers and specialists, at courses for the management of the national economy at the Belorussian State Institute for the National Economy imeni Kuybyshev and in courses organized at ministries and departments. Just in the 2.5 years of the current five-year plan 34 percent of the engineering and technical personnel improved their qualifications. In 1982 15 percent of the workers improved their qualifications.

Prior to the beginning of the peat extraction season there were seminars on progressive experience, including preparation work, the maintenance of water

engineering installations and drainage networks and a seminar on the brigade form of work organization and payment.

By the beginning of the 1983 season 126 comprehensive brigades for peat extraction had been set up, 15 percent more than in 1982. Even during 1981-1982 the transition to the new forms of work organization and incentives had shown their high efficiency. The final stage in preparations for the 1983 season was an inspection of production section readiness held on 15 April. This made it possible to determine the quality of repairs and the readiness of equipment, field production bases, fuel and lubricant storage areas, the complete staffing of sections with machine operators and mechanics the organization of hot meals, etc. The shortcomings revealed during the inspection were quickly corrected.

Organizational and technical work has made it possible for collectives at many enterprises to begin the peat extraction season considerably earlier than the deadlines. The republic's season begins when weather conditions permit. An earlier beginning to the season has positive results even in the initial stages of work: there are tests of equipment and production areas and, most importantly, a psychological restructuring of work collectives. Many years' experience shows that enterprises which are among the first to begin the season as a rule complete it before the deadlines. In 1983 39 of 47 enterprises in the sector began the season earlier than the deadlines. These include the Berezinskiy, Ganchevichi, Vitebsk, Lyakhovichi, Ditva and others beginning work 10 and more days early.

Competing for the successful fulfillment and overfulfillment of plan targets and socialist obligations for the 11th Five-Year Plan's third year, the BSSR Ministry of the Fuel industry was ahead of schedule, reaching the annual target for peat extraction on 17 August. By 1 September all enterprises in the sector had met plan targets. Above plan extraction reached 1.2 million tons.

Collectives at the following enterprises and peat briquet plants made a worthy contribution to meeting the ministry's plan targets and socialist obligations: the Berezinskiy, which met annual targets by 12 July, the "40 Years of the BSSR" (16 July), Vitebsk (19 July), Lyakhovichi (20 July), "Krasnaya Zvezda" (24 July), Ditva (28 July) and many others.

Among the first in the sector to report meeting annual peat extraction targets were the collectives of production section No 2 at the Lyakhovichi Peat Briquet Plant and No 4 at the Vitebsk Peat Briquet Plant.

Section No 2, led by K. A. Leonovich, completed the season ahead of time on 20 July and extracted 203,000 tons; the plan was 172,000 tons. Section No 4 (V. A. Yaltsevich) completed the season work plan in July and extracted 127,000 tons; the plan was 120,000.

These collectives of these leaders' comprehensive brigades met their annual targets and socialist obligations: Ye. N. Lazovskiy ("Krasnaya Zvezda Peat Enterprise), S. M. Pashkovskiy (Berezinskiy Peat Briquet Plant), S. V. Smolin (Ditva Peat Briquet Plant), Ch. V. Supren ("40 years of the BSSR" Plant) and others.

The following peat extraction machinery operators attained high results in meeting plan targets and socialist obligations: M. F. Mel'nikov (Belitsk Peat Enterprise), A. V. Fedorov (Khoyniki Peat Briquet Plant), P. I. Baranchuk (Braslav Peat Briquet Plant) and many others.

The highly productive and high quality labor of all workers has been stimulated by the following: competition for attaining the highest labor productivity, comprehensive brigades' starting and completing seasonal targets ahead of schedule, competition with peat enterprise workers in the LiSSR, awarding the victors testimonials from the BSSR Ministry of the Fuel Industry and the Trade Union for Workers at Electric Power Stations and the Electrical Engineering Industry, honorary pendants, monetary awards and other material and moral incentives. The distribution of material incentives funds during the extraction season played a positive role. During the first half of the season it was planned to award bonuses up to 50 - 60 percent and in the second half up to 40 percent.

The 1983 season is additional proof of the advantages of comprehensive brigades, into which 58 percent of all peat extraction workers have been organized. Such units extracted 75 percent of the ministry's peat. They have better discipline and labor productivity and make better use of equipment and new technology.

Belorussian peat enterprises are constantly being supplied with highly productive equipment: MTF-43A peat collectors, 9.5 meter wide cutting drums, MTF-22 agitators, MTF-33A swathers and MTF-71 stackers. Existing equipment is being modernized: the MTF-21 agitator, MTF-31 swather, MTF-13 cutting drum and MTF-41 collector. At better enterprises 70-90 percent of the equipment is highly productive units. Thirty five percent of the sector's equipment is such highly productive units.

The scientific organization of work and the use of highly productive equipment made it possible to reduce extraction labor intensity by 3 percent in 1983 compared to 1982. Seasonal output per hectare increased by 1 percent. The ministry's average output per collection machine was 18,000 tons.

The majority of enterprises in BSSR Mintopprom [Ministry of the Fuel Industry] produce peat briquets. The stable operation of briquet plants depends to a considerable extent upon the quality of the extracted raw material. Directing their efforts towards the unconditional and ahead of schedule fulfillment of annual peat extraction plans, enterprise and ministry workers are not lessening their attention to raw material quality. Every enterprise and sector was given targets for peat quality which were supervised by OTK [Technical control department] services at enterprises. Peat quality has a substantial influence upon bonuses. All this made it possible to extract high quality peat. This is shown by the work results of briquet plants. By August 1983 they had produced 20,000 tons of briquets above the plan. All plants have been supplied with high quality raw material to last until August 1984.

The fulfillment of plan targets ahead of time has been assisted by the reliable work of equipment during the season and the improving quality of its repair and servicing. Units for organizational technical supply and for tractor diagnostics

have been introduced at the sector's enterprises and equipment reliability has been improved. There are 13 organizational technical units for repairing cutting drums, 5 for collection machines, and 4 stationary diagnostic centers for tractors. There has been stable performance by cutting drums modernized at the Smolevichi Peat Enterprise and dump trailers on rubber inflatable tires, the production of which is planned at the Dneprovskiy Peat Briquet Plant.

Improvements in production efficiency and growing scientific-technical potential are helping to solve the problems facing the BSSR Mintopprom. Peat briquet plants and enterprises are being modernized, the technical standards and qualities of output are being improved and the production of new types of output mastered. In 1983 the industrial production of the "Dvina" peat mixture began and there were experimental batches of the "Charaunitsa" micro planting rows [mikrogyadka] and "Grantorf" soil. Belniitoproyekt [Possibly: Belorussian Scientific Research Institute for Fuel] has developed processes for the production of new types of products.

Work is under way to mechanize manual labor and automate peat briquet production. In 1983 Belniitoproyekt will deliver to the departmental commission a machine for measuring peat stacks and the production of a hydraulic controlled rotary grubber has been organized. Automated systems for emergency water supply to driers, for starting and stopping briquet presses and for drying peat have been introduced at the Zhitkovichi Peat Briquet Plant.

Work is under way to increase the production of lumpy peat. The production of machines for lumpy peat extraction has been mastered and a set of machines created for its separate collection.

Collectives at the sector's enterprises and organizations face new tasks in the successful completion of the third year and the 11th Five-Year Plan as a whole.

Constant attention must be given to improving production efficiency and product quality. Work will continue on the sector's reequipment and production mechanization and automation. New forms of work organization and pay will be further improved. Preparation for the 1984 season has begun.

The sector's work results for nine months of this year have been totalled: the sales plan was 109.2 percent completed, the marketed output volume plan 108.4 percent and the labor productivity plan -- 109 percent. There were 105,400 tons of above plan briquets produced.

The republic's fuel industry workers are exerting every effort to fulfill plan targets and socialist obligations for 1983 and targets for the 11th Five-Year Plan.

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ALTERNATE FUELS

NEW EQUIPMENT DEVELOPED FOR PREPARATION OF PEAT BEDS

Moscow TORFYANAYA PROMYSHLENNOST' in Russian No 11, Nov 83 pp 10-13

[Article by V. V. Pokamestov, candidate of technical science, A. K. Kochedykov, V. I. Pavlov and I. A. Feduñov, engineers (Kalinin Affiliate, VNIITP [All Union Scientific Research Institute for the Fuel Industry]: "The Development of Technological Processes and Equipment for the Preparation of Peat Deposits for Peat Extraction"]

[Text] The preparation of production areas at peat deposits precedes the peat extraction process and is one of the decisive factors in the reliable operation of equipment and the successful completion of the program for product output and quality.

In the development of peat deposits under agricultural land, the high quality working of the area is a contribution to raising good harvests. Preparatory work (after preliminary drainage) includes: the removal of woody vegetation, the removal of stumps and other wood residues from the preparatory layer, land leveling and grading.

During the maintenance of peat extraction areas, in addition to the construction of drainage systems, stumps are removed from the production layer and the land is leveled and graded.

All preparatory and maintenance work is mechanized.

The deep continuous cutting method is the most widespread in the preparation of production areas, while the stump grubbing and cutting method is used for maintenance. Stump grubbing is carried out separately from loading, or there is the simultaneous separation and loading of stumps into transport equipment.

The MTP-42A machine for deep continuous cutting does not sufficiently break up wood. Consequently, in some cases wood in the finished product exceeds the normed value.¹ The wood residue is high because of the unsatisfactory working of areas by MTP-42A machines. Because of this the "Sel'khoz mashina" SKB [Agricultural Machinery Special Design Office] is developing a set of machines for picking up this wood. The PV-1.5 swather and loader for picking up chunks of wood from swaths has been created. It has the additional operations of swathing, loading and hauling.

The low quality of wood mulching by the MTP-42A machine is due to the following: the cutters rotate at too low a speed (8 meters per second) for cutting unattached wood, the high positioning of the knife above the cutter frame and the clearance between the carry-off plate and the cutting chin.

Stump grubbing during preparation of an area is ineffective because in the process of extracting stumps a plant layer is also removed. This increases the transportation volume 14-16 fold compared to the volume of the stump and root ball, sharply raising work costs and labor intensity.²

The use of MTP-26, MTP-29 and MTP-24B machines for improving production areas lengthens the repair cycle 2-3 fold. When the MTP-81 and MTP-25B machines are used for combined root grubbing the degree of breakdown at deposits is less than 15 percent and peat "haul-off" with stumps is up to 74 percent.

In order to perfect the process of preparing and improving production areas, the VNIITP and the Kalinin Affiliate are creating new processes and equipment.

Production area preparation and improvement methods based on deep continuous cutting have been developed and widely tested under production condition.

The first method is deep continuous cutting with low volume feeds to the cutter, the mulching of wood into chips smaller than 25 mm and stacking by a special device. Unmulched pieces of wood are randomly scattered on the cut layer. It prepares and improves the area in one pass. Inspections of work quality have shown that when deposits with 2-3.5 percent wood are prepared, the share of wood chips in the worked area exceeding 25 mm is not over 2.5 percent (by weight), while after area improvements it is not greater than 1.5 percent. This is 2-3 fold less than at areas worked by the MTP-42A. Consequently, this process meets technological requirements and can be used for preparing areas for the extraction of peat for fuel, fertilizer, compost and other purposes, where the amount of wood in the preparatory layer does not exceed 3.5 percent by volume. It is also advisable to use this method in developing peat deposits under row crops.

The second method, deep thorough cutting, the simultaneous mulching of wood into comparatively large pieces, its shaping into swaths and subsequent removal, cleans the area 3-4 fold better than after working the area by an MTP-42A. The ground is cut in large sweeps and less energy intensively. Therefore equipment productivity increases 1.5-1.6 fold over the first method even using tractors with the same power. Depending upon the volume of wood, one or two swaths can be obtained from a 20 meter wide strip. The wood chip swaths are loaded into trailers by a PP-1 tractor loader³ or a MTP-29 machine.⁴

A qualitative feature of this method is the improved separation through the breakup of soil and wood. This reduces the inclusion of plant layers and roots and separates the raw material from the wood. This, in its turn means a 2-2.5 fold reduction in the unit consumption of energy compared to the breakup of dry wood. Transportation costs and labor intensity are reduced through the denser stacking (the stacking coefficient is 2.5-3 instead of 8-12 for unseparated stumps). In addition, it is possible to use the wood for fuel, fuel briquets and

as a raw material for the manufacture of siding --arbobeton. This is the prerequisite for the development of waste free technology, ensuring the rational use of natural resources.⁴ This method is recommended for the preparation and improvement of areas for the extraction of peat to be used for briquets, bedding and for export. It can be used if there are pieces of wood up to 15 cm and the wood volume in the cut layer does not exceed 4 percent.

The third method is deep continuous cutting in large passes to the required depth and the stacking of the mulch under the cut layer. This cleans 50-70 percent of the worked layer. Equipment productivity is 1.5-1.6 fold greater than the first method -- cutting in small fractions. Deep continuous cutting in large passes is recommended for unforested peat deposits in the Northwest and West Siberia and in the replanting of grass on worked out peat areas.

Inspections of this method have shown that with wood volumes in the cutting layer of up to 2.5 percent, the amount of wood residues larger than 25 mm in the upper 30 centimeter layer does not exceed 0.7-0.8 percent (by mass) when the total depth of working is 50 cm. Thus, production areas are prepared in one operation and one pass.

This method can be carried out by RAPP equipment with changeable units, reducing capital and operating outlays.

This unit is a semi-trailer mounted machine pulled by the swamp modification of the T-130BG1 tractor or the T-100MZBGS. It comes with or without the swath separator and is equipped with rotor cutters or L shaped blades. The cutting depth is changed by readjusting the carry-off plate over a range of 0.25-0.5 meters.

The machine can be hooked up to a K-701 tractor with coupled wheels, reversible power take-off, a T-130BG1 type tractor hitch and a drive reducing gear.

If the K-701 tractor is used, equipment productivity increases 1.5-2 fold over its use with the T-130BG-1 tractor. The K-701's lower cross country capabilities in poorly drained areas are a restriction on its use for preparing peat deposits.

Table 1. Technical Characteristics of RAPP Equipment

Type of machine	Semi-mounted
Width of cutter sweep mm	2,240
Maximum cutting depth, mm	500
Productivity per 1 hour of net time at a cutting depth of 400 mm, in hectares per hour is not less than:	
Cutter with cup knives	0.1
L shaped knives	0.15
Machine weight without tractor (with reducing gear and shaft), in kilograms, does not exceed;	
Without swath separator	6,250
With swath separator	8.350
Roller pressure on ground in transport position, in kPa does not exceed	30

The simplification of the production process through the elimination of individual operations, the improvement in work quality and increased productivity through greater power and the selection of the appropriate cutters and working conditions have resulted in a calculated economic effect from the introduction of one machine without a swath separator totalling 4,900 rubles, while with the swath separator the figure is 14,700 rubles, without taking wood sales into account.

Labor intensity for preparation work is reduced 1.9-3.3 fold and metal intensity 1.2-1.9 fold compared to the MTP-42A machine, while for improvement of production areas labor and metal intensity are reduced 2-3 fold compared to the MTP-81 grubber.

The coefficient of equipment use in tests was 0.89 (the planned magnitude was 0.8), affirming the equipment's reliability.

The quality of prepared and improved areas meets technical requirements. The amount of wood in prepared and improved layers is reduced 2-4 fold compared to working with the MTP-42A machine, depending upon the type of cutter used.

Equipped with L shaped blades, the machine can be used to open up areas for crop improvement work on mixed soils.

Thus, these processes and equipment are progressive and meet the peat sector's demands. The task is to accelerate the production of experimental models and organize their series production.

FOOTNOTES

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11574
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NON-NUCLEAR POWER

NERYUGRINSKAYA GRES STARTS UP FIRST POWER UNIT, WILL POWER BAM CENTER

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 23 Dec 83 p 1

[Article by L. Rybakovskiy and V. Antipin, Serebryanyy Bor settlement:
"The Energy Heart of BAM"]

[Excerpt] Yesterday the State Commission took over the operation of the first energy generation unit of the Neryungrinskaya GRES [State Regional Electric Power Station]. The station is being built in South of Yakutia and will become the energy generation center for the territorial-industrial complex that is taking shape here--the first along the right of way of the Baykal-Amur Main Line [BAM].

The power industry builders and assemblers had to overcome more than a few difficulties. It was necessary, for instance, to find ways of dealing with "wilting" permafrost while at the same time securely protecting the station in a very seismically active area. In addition, the Neryungrinskaya GRES is a facility at which prototypes have been installed of powerful steam boilers which as yet have no equivalents and which are adapted for the use of specific fuels. They will be served by the so-called industrial output of the largest coking coal enrichment facility in the country which is under construction here. In addition to this, the assembly schedules for the first unit were compressed as much as possible.

...Equipment for the second unit of the station is already making its way to the construction site. The second unit is slated to begin operations next year. With the startup of the third unit towards the end of the five year plan, the entire first phase of the Neryungrinskaya GRES will be on line, with a capacity of 740 megawatts. Providing reliable energy supplies not only to meet the needs of the South Yakutian territorial-industrial complex but also the entire BAM Central, the station will become a major link in a unified far eastern energy generation system.

The rapid development of a new industrial region, the further development not only of the coal but also of the richer iron ore deposits of South Yakutia, and the prospects for the formation here of a huge metallurgical production operation raise the question of the further expansion of the Neryungrinskaya GRES. At present serious consideration is being given to a two- or three-fold expansion of its capacity in the 12th or 13th five year plans. And one of the primary supports for this argument is the presence of a monolithic, highly qualified, multi-thousand member collective of power industry workers and assemblers capable of implementing the most complex of assignments.

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NON-NUCLEAR POWER

THIRD POWER UNIT BEGINS OPERATION AT AZERBAIJANSKAYA GRES

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 29 Nov 83 p 1

[Article by Fizuli Mamedov, brigade leader of the builders of the Construction Administration of the Azerbaijanskaya GRES: "High Tension"]

[Excerpt] The assembly of the boiler unit was completed in 5 months instead of the 8 months prescribed by existing norms. I might mention that we installed a unique, gas-tight boiler unit manufactured at the Krasnyy Kotel' shchik Plant in Taganrog. This is an open type unit and assembling it requires adherence to very close tolerances. The metalworker-assembler brigades of Agazay Aliyev, Viktor Sapunkov, Israfil Gumbatov and others decided to carry out the assembly with modular units. They gathered the individual components on the ground in groups, and then hoisted entire units weighing up to 100 tons to a height of 50 meters, putting them together there.

A number of the facilities at our GRES [State Regional Electric Power Station] may be considered unique. A 330-meter smokestack assures that the air above the Mingechaur and the village with the construction workers will remain clean. A deep water intake for cooling the station turbines is an example of the originality of engineering design. The water is drawn from the bottom of the Mingechaur reservoir which lies right next door. To accomplish this it was necessary to bore through a mountain and lay a kilometer-long tunnel through which bottom water with constant temperature of 14 degrees centigrade is drawn in winter and summer. The low temperature of the cooling water plays a role in one of the most important indicators of the work of a thermal power station--economical fuel use. A total of 325 grams of fuel is expended to generate one kilowatt hour of electrical energy at the Azerbaijanskaya GRES, a figure that is much lower than any other operating thermal power plant of the Transcaucasus region.

Optimal station operations are determined by a computer built into the control system of the station.

Thus, the third energy generation unit is in operation. The lead time which we were able to develop due to its ahead of schedule startup date will make it possible to generate additional tens of millions of kilowatt hours of electricity which is so essential to the national economy of our republic and the fraternal republics of the Transcaucasus region.

NON-NUCLEAR POWER

CENTRAL YENISEY HYDROELECTRIC PROJECT PLANS DESCRIBED

Leningrad LENINGRADSKAYA PRAVDA in Russian 1 Nov 83 p 1

[Article by Yevgeniy Smirnov, deputy chief engineer, Hidroproyekt Institute, chief project engineer, Central Yenisey GES: "The Energy Giant"]

[Text] The technoeconomic feasibility studies for the construction of the six million kW Central Yenisey GES in Siberia have been developed. The Hidroproyekt Institute and other organizations are designing the hydroelectric project and the facilities in the reservoir area.

The planned mastery of the hydroelectric resources in the Yenisey and Angara basins began in the 1950's. The Krasnoyarsk GES, the nation's most powerful facility (6 million kW) is on the Yenisey, while on the Angara there is a cascade of 3 hydroelectric stations (Irkutsk -- 660,000 kW, Ust'-Ilim -- 3.8 million kW, and Bratsk -- 4.5 million kW). They became the cores for the formation of territorial-production complexes.

On the Yenisey, the construction of the Sayano-Shushenskaya GES (6.4 million kW) is under way, and the Boguchanskaya GES (3 million kW) is being built on the Angara. The development of the Central Yenisey and Lower Angara is next.

The Central Yenisey water project now being planned is a multipurpose facility. The large GES, a source of low cost energy, will be the basis for the development of a territorial-production complex in the Central Yenisey and Lower Angara. The project's construction will make it possible to create a deep water route over a wide area of the reservoir, and, what is especially important, through the existing shallows caused by rapids and rocky sections ['shivera'] on the Angara and its tributaries. The project's construction will create a highway and rail crossing over the Yenisey, making it possible to develop transportation on the right banks of the Yenisey and Angara.

The basic components of the project include: a hydroelectric station, a spillway dam, water transport installations, an earth-fill dam and levees.

The project is to be located below the confluence of the Angara and the Yenisey. The Central Yenisey GES is designed for a capacity of 6 million kW and in the

* Shivera -- a stony, shallow, rapidly flowing section of a river channel.

long term this can be increased to 7 - 7.5 million kW. Average annual electric power output will reach 31 billion kWh. During the first stage it is planned to install 16 turbine units with a capacity of 375,000 kW each. These will have runners with 10 meter diameter adjustable blades.

The concrete spillway dam is intended for releasing low frequency floodwaters. Its maximum capacity is 31,400 cubic meters per second. Its length is 230 meters, height -- 75 meters and width -- 58 meters.

The water transport facilities are intended for the passage of ships up and downstream and for the movement of log rafts from the reservoir to the afterbay. They are two stage, that is, they consist of two locks separated by an intermediate canal. It is a two channel facility, each stage having two chambers through which ships and log rafts can be simultaneously passed in the same or in different directions.

Figures will help in better understanding the scales of construction which will take place on the Yenisey. The total volume of earth moving work is more than 70 million cubic meters, and concrete and ferroconcrete work - 3.7 million cubic meters. It will be necessary to install 88,000 tons of metal structures and mechanical equipment and 55,000 tons of equipment.

Homes, industrial and agricultural installations will be removed from the zone to be flooded and relocated.

Forests in the future reservoir will be cut down. The total volume of commercial timber in this zone amounts to 19 million cubic meters, of which about two-thirds is coniferous.

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CSO:1822/109

NON-NUCLEAR POWER

EXPERIMENTAL MODEL OF BOGUCHANSK DAM CORE BUILT AT BRATSK

Moscow STROITEL'NAYA GAZETA in Russian 2 Dec 83 p 4

[Article by L. Danilenko: "Boguchanskiy Experiment"]

[Text] A fragment of the dam at the Boguchanskaya GES, part of its asphalt concrete core, has been built in an old stone quarry in the afterbay of the Bratsk Hydroelectric Station.

A sizable section of the dam for the fourth power station in the Angara cascade will be rock-fill. It is planned to use concrete only on the bank face pavement and the powerhouse section. Such a solution will cut in half the use of concrete, reinforcement steel and other materials which must be hauled in from outside. This is very important in this still uninhabited region. The total calculated savings exceed 80 million rubles.

The asphalt concrete core is only 1 meter thick. It will be in the center of the rock-fill dam and will hold back the 56 billion cubic meter Boguchanskoye reservoir. Design calculations were based on the viscosity of asphalt concrete. Under its own weight it will flow and seal up cracks, thus ensuring the dam's impermeability.

For the sake of convenience of the hydro-engineering experiment at Bratsk the builders made it in the form of a closed rectangle. There are four walls, no windows, doors nor any sort of entrance into this unusual asphalt concrete building erected on rocky soil. It is eight meters high and one-tenth the size of the future core to the Boguchansk dam. The experiment is being conducted by a group of specialists from the Gidroyekt Institute imeni S. Ya. Zhuk led by D. Ragozin, leader of the hydro-engineering department.

It is intended to apply other economical decisions to the construction of the Boguchanskaya GES. For example, the production base, which includes a concrete plant, a rock crusher and gravel sorter, a test area for ferroconcrete elements, a motor vehicle shop and other facilities, will have general warehouses for cement and metals, repair shops and service facilities. This will help reduce the material intensity of the base and its construction costs. What is more, these projects are being built not only so that they can be used by the dam builders, but because later enterprises in the new energy and industrial region will find such buildings very useful.

The dam's fundamentally new design is very important. The widespread use of local materials will make possible its rapid construction. Hidroproyekt has worked out two design alternatives for putting powerhouse turbines on line using temporary intakes before the dam has been built to full height. This will make it possible to produce billions of kilowatt hours of electric power.

The construction of a rock-fill river bed dam with an asphalt concrete core requires considerable preparatory work, especially on the core itself. Testing at Bratsk will help find the correct composition for the asphalt concrete, develop technology for pouring it the year around and clarify many other questions upon which the pace and quality of engineering work depends.

At the Boguchanskaya GES foundation pit work is already under way on the construction of the powerhouse. Water project builders are making preparations to cover the Angara.

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NON-NUCLEAR POWER

MISMANAGEMENT DELAYS CONSTRUCTION AT EKIBASTUZ POWER PLANTS

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 25 Nov 83 p 2

[Article by V. Tyrinov, chairman of people's control group and chief of chemical shop, Ekibastuz GRES-2: "We Tally...the Errors"]

[Excerpt] The other day the latest--next to the last--unit in GRES-1 went into operation. Construction is now under way on GRES-2. The pace and volume of the work are rising.

In the course of them a number of errors and mistakes are coming to light. One would think they should be eliminated and then not repeated. Unfortunately, it doesn't always happen that way.

Our people's control group has been functioning about a year now; it was set up in association with the directorate of the GRES-2 under construction. During this time we have managed to conduct a number of checkups. The results have been discussed in the labor collectives. Some of the shortcomings have been liquidated. But only a few. How about the others? Judge for yourself.

How, for example, can we avoid low-quality housing construction if we continue to erect five-story buildings of the 467 series, which were banned by USSR Gosstroy? Stroybank finances the construction, and the USSR Ministry of Power and Electrification's ferroconcrete plants continue to "push" components for these buildings.

At present the necessary conditions do not exist for conducting planning work on the construction site of GRES-2. Construction of the heating boiler and fuel oil storage tank, treatment facilities, water pipeline, and service lines is lagging. This in turn delays the concrete pouring for the smoke stack and equipment footings. All our directorate's efforts to speed things up lack the support of the construction and installation organizations. Nor is the USSR Ministry of Power and Electrification in any hurry. It has not even designated the plants which are to produce for us the boiler and auxiliary equipment, pipelines, and hoisting machinery.

A housing settlement is to be built in conjunction with GRES-2 and GRES-3. It should already have been started but we lack project documentation, and when it is to be ready is unknown.

More and more freight is being delivered to GRES-2, but there is no machinery to unload and transport it. You have to go begging to Ekibastuzenergo Association in hopes of getting badly needed equipment. And although we are part of this association they treat us like poor relations. It is indicative that ever since our directorate has been in existence no one in the association's management has deigned to meet with the collective or look into our problems.

And, I repeat, we have plenty. One of the most alarming is the cadre problem. We are supposed to form a collective of thousands of highly skilled specialists, yet so far there have been only three applications. How are we supposed to attract people? The matter of the rayon wage factor has yet to be decided, and the business of housing, kindergartens and schools is quite uncertain.

In short, the same mistakes and oversights are being repeated as in the construction of GRES-1. It cannot be said that no one knows about this in the ministry. There is no shortage of orders, commands, and directives coming from there. The trouble is that no one carries them out.

The first power block of GRES-2 is supposed to go into operation in 2 years. We must make up for lost time and regain normal rhythm. The possibility to start up on time has not yet been lost.

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NON-NUCLEAR POWER

GOMEL ELECTRICAL EQUIPMENT PLANT COPEs SUCCESSFULLY WITH SUPPLIER PROBLEMS

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 18 Nov 83 p 1

[Article by A. Muchnik, Elektrotehnika Press Center correspondent:
"Reliable Partner"]

[Text] The Gomel Elektroapparaturna Plant is fulfilling the plan of deliveries to customers for the third year now. By the results of All-Union Socialist Competition in honor of the 60th anniversary of the formation of the USSR the collective was awarded the challenge Red Banner of the Ministry of Electrical Equipment Industry and the Central Committee of the Trade Union of Workers of Power Plants and Electrical Equipment Industry. The plant's collective has held on to the banner four quarters in a row. Having pledged to ship all products ahead of schedule, on the eve of the celebration of the 66th anniversary of October the workers of Elektroapparaturna completed the monthly target for deliveries of thermal relays to the Riga Electrical Machine-Building Plant--their biggest customer.

It is not easy to be a reliable partner. After all, materials and components come to Gomel from 160 enterprises in the country, and the plant has to supply products--1,000 different items--to 875 customers. With such an elaborate network of technological and marketing ties, the failure of just one link can hamper completion of the main task.

To prevent this it has been necessary to substantially improve in-plant planning, enhance labor organization, and find effective forms of incentive. Just a few years ago Elektroapparaturna willingly utilized the tried and true method of "assortment shift"--in which it produced goods advantageous to the enterprise but not what the customer wanted. It was working on the principle "The main thing is to produce as much as possible, but just what to produce is a secondary issue." This continued until 1978, when a procedure was established for rewarding the production collectives on the basis of completion of targets and obligations with respect to product deliveries. Norms governing permissible underdeliveries were toughened. Restructuring became necessary.

First of all they carefully examined the order portfolio by the year, half-year, quarter and month. Then they plotted the production schedule in accordance with it. As the basis of operational planning they took the day layout [sutkokomplekt] daily requirements for components and parts manufactured in a particular shop for subsequent assembly on the conveyor.

Now each brigade (and all workers in the basic operation are included in brigades) is notified of the appropriate daily target. The major plus in this form of operational planning is that by the end of one day any worker knows about tomorrow's assignment. To prevent "backsliding"--that is, the possibility of covering nonfulfillment of the plan for some items through unnecessary production of others--at the end of the month only those items included in the layout [komplekt] are paid for. This makes it possible strictly to monitor compliance with product list plans. Another incentive to normal rhythm is an additional bonus for each day worked without lagging behind schedule in the first two 10-day periods. So that now, for most workers the proportion of bonuses paid for the end result of the work constitutes almost four-tenths of average monthly earnings.

But not everything depends on the work of the plant itself. The complexity of modern-day production and expanded cooperative ties make the enterprise increasingly dependent on its suppliers. What if they let it down? What if materials come in late? What if tool and equipment orders are incompletely filled? Is the finely tuned plant mechanism going to break down?

"Of course not!" says Director N. Markov. "First of all, and this is the main thing, we have managed to build up a reserve stock of materials, supplies and components in case of possible disruptions. It took a long time to build up a 15-day reserve stock, and it is difficult to maintain it at the necessary level, but it does permit us to maintain our production rhythm even in the event of unforeseen circumstances. Secondly, with many of our suppliers we have established relations of trust on the basis of long-term business contacts."

For almost 15 years now, for example, the Gomel workers have been getting rolled brass from the Artemovskiy Nonferrous Metals Processing Plant. They have never let us down. Elektroapparatūra has also collaborated for a long time with the Borisovskiy Plastic Products Plant. Things didn't go smooth there at first: deliveries were very late, and in less than complete amounts. It turned out that the plastics plant did not have enough press forms. Gomel's toolmakers manufactured some. Now the Borisovskiy plant is a very reliable supplier.

In the third quarter of this year the workers of the billet-making shops and the assemblers of Elektroapparatūra worked rhythmically and on a high-quality level, as always. As a result, the production plan was fully completed. But it is not enough to produce goods on time, they also have to be delivered to the customer on time. The plant's personnel set themselves the task of shipping all consigned products ahead of schedule. But how to do this?

"By the plan we are supposed to get 154 containers per month, but the Ministry of Railroads doesn't deliver more than 120," says A. Rakusevich, head of the plant's marketing department. "We tried to ship the goods right in the boxes, in packets on pallets, but this caused a substantial rise in the labor-intensiveness of loading operations as well as additional expenses for wood and wire. Moreover, our products are rather fragile. But we found a way. We purchased 228 special containers that are considerably smaller in volume than those of the Ministry of Railroads but just as convenient

and rugged. Now we ship the smaller consignments in them. The customer is obliged to return the containers to the plant, in good condition, in the shortest possible time. Otherwise he is subject to a stiff fine. At present we are shipping about 20 percent of our products this way."

Orientation toward the customer has confronted many services in the plant with new and very difficult problems, the successful handling of which would be impossible without computers. The enterprise's data-computer center is responsible for compiling order portfolios, calculating delivery plans, keeping day-to-day track of the movement of finished products in the warehouses, and monitoring the shipment of products to the customers--that is, all the most labor-intensive and vital tasks.

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NON-NUCLEAR POWER

AZERBAIJAN ENERGY PROGRAM REQUIRES TECHNICAL RETOOLING

Baku VYSHKA in Russian 22 Dec 83 p 3

[Article by M. Imanov, head of the Azerbaijan SSR Main Production Administration of Power and Electrification: "The Course--Technical Progress"]

[Excerpts] The principle of priority development of power was disrupted in the 1970s, and the pace of renovation of fixed productive capital was slowed. The Severnaya GRES and the GRES imeni L. Krasin, the Baku Krasnaya Zvezda TETs-1, and the Sumgait TETs-1 continue to run obsolete and worn-out equipment that has been in service 30 to 50 years. Keeping in operation worn-out medium-pressure thermal power equipment, plus the low level of operation of our power plants, is leading to a situation in which we are lagging behind the all-union level in terms of the main technical-economic indicator--fuel consumption per kilowatt hour. We are considerably behind in the construction of compensators to maintain the voltage level in power networks. For this reason, the republic's power system is near last place in terms of electricity consumption and transport.

To ensure scientific-technical progress in the republic's economy we see our task primarily as that of accelerating and prioritizing the development of the power base and increasing new generating capacity on the basis of up-to-date, economical, and reliable power equipment.

Such a course has been undertaken since the start of the 11th Five-Year Plan. Thanks to the constant help of the Azerbaijan party organization and the republic's government as well as the selfless labor of the power construction workers and operators, in the first 3 years of the five-year plan three 300,000-kilowatt power units have gone into operation ahead of schedule in the Azerbaijan GRES and two 190,000-kilowatt hydro units in the Shamkhor GES.

When the fourth power block goes into operation in 1984, the Azerbaijan GRES will reach projected capacity, and the total start-up of generating capacity in the republic will add up to 1.6 million kilowatts in the 11th Five-Year Plan. The system's installed power plant capacity will increase by 1.5 times in the 5-year period, thus ensuring completion of the five-year program ahead of schedule.

The power units of the Azerbaijan GRES not only reduce the capacity deficit but also mark a qualitatively new direction in the republic's power system. The highly economical units of the GRES will help to improve the system's

technical-economic indicators, boost labor productivity, and enhance production effectiveness.

What are the prospects of development of the republic's power system? The Azerbaijan CP Central Committee and the republic's Council of Ministers raised a number of principled questions regarding development of the energy base, which were resolved in the affirmative by the USSR Ministry of Power and Electrification. In 1985 work will begin on expanding the Azerbaijan GRES to 1.8 million kilowatts with the installation of two more 300,000 kilowatt units. Over the long term the ministry has proposed drawing up substantiation next year for expanding the plant to 3 million kilowatts.

The 1980 capital construction plan includes preparatory work on the construction of a large-capacity Novo-Bakinskaya TETs which will, when operational, signal technical progress in power engineering and in the Azerbaijan capital's municipal economy. The TETs will make it possible to dismantle low-efficiency equipment in the existing Baku TETs's and do away with 400 small-scale, uneconomical boiler units, release human resources, save considerable amounts of organic fuel, and clean up the air in the Baku basin.

Another big milestone in scientific-technical progress will be the construction of Azerbaijan's first 250,000-kilowatt steam-gas unit in the Severnaya GRES, the plant's worn-out and uneconomical equipment to be dismantled. Construction is scheduled to start in 1985. Farther in the future, plans call for building another such unit. Other plans call for technical retooling of the Ali-Bayramly GRES by replacing four 150,000-kilowatt units with two 300,000 kilowatt units.

By a special project, all obsolete thermal power equipment in the power system is to be dismantled.

Finally, the republic will build a number of GESes adding up to about 1 million kilowatts' capacity. This is also in conformity with the general thrust toward reducing in the total generated electricity output the share of thermal power plants running on mineral fuel.

Scientific-technical progress entails the adoption of computer technology. Successfully functioning in Azglavenergo is one of the ministry's most advanced automated control systems. Ten computers are used to handle more than 200 tasks, including such important ones as operational-dispatcher control, optimal planning, tallying and analysis of technical-economic indicators, accounting transactions, monitoring of execution, and so on. The Azerbaijan GRES has put into operation an automated control system monitoring technological processes of two power units. Similar control systems have also been developed in a number of network enterprises.

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NON-NUCLEAR POWER

MOBILE GAS-TURBINE POWER PLANT DEVELOPED FOR REMOTE AREAS

Riga SOVETSKAYA MOLODEZH' in Russian 21 Sep 83 p 1

[Article by S. Red'kin (APN): "Power Plants on Wheels"]

[Text] Soviet specialists have developed 2500-kilowatt mobile gas-turbine power plants based on aircraft engines that have outlived their service life. They are for use in remote areas that are difficult to get to, where there are no permanent power plants and power lines have not yet been built.

The PAES-2500 mobile gas-turbine power plant is installed in a vehicle van and can be transported easily to remote projects. It is reliable in operation, and its service life runs as high as 8,000 to 9,000 hours even in the severe climate of Western Siberia.

The power plant is remote-controlled: commands are sent over communications lines from a control panel, while control signals concerning the unit's operation are sent back.

The design of the turboprop aircraft engine is such that it can run on liquid fuel like kerosene or (after some modifications) on gas fuel. In gas-producing regions, therefore, the new unit can make use of that fuel.

The PAES-2500 is already in use in remote regions of Siberia and the Far North, for example in geological prospecting and the extractive industry. These plants, of course, are not the sole source of energy: diesel drive is also used. But mobile diesel plants are low-capacity, while under many conditions permanent plants are uneconomical. They are justified only where it is easy and inexpensive to deliver fuel.

In the Far North, where drilling is going on, fuel can be brought in by water only during the short summertime, and transport costs are considerable. It is possible, therefore, to utilize the gas produced there. It is true that there are also permanent plants running on this fuel, but it is necessary to build power lines from them to constantly changing drilling sites dozens of kilometers away. The mobile gas-turbine plants themselves "come to" the consumer. The same advantages apply to gas-turbine power trains, but they are unwieldy and require considerable time and outlays to install.

Incidentally, the new mobile power plants can serve drilling sites in a radius of 12 kilometers. This distance is fully adequate for "cluster" drilling.

The welding of pipes in the construction of trunk gas pipelines requires large power plants capable of reliable operation in rough terrain with a list and trim of 15 to 20 degrees. Successful use is being made of mobile plants running on kerosene.

One way to enhance the effectiveness of oil recovery is to increase reservoir pressure by injecting water into the well. This makes it possible to reduce the number of operational wells and thereby substantially cut down on capital investment. In this case, however, powerful pumping units are needed: the amount of water must be twice the volume of the oil pumped out. Such units receive their power from the PAES-2500.

Since the capacity of the mobile gas-turbine power plants is rather large, they can be used as well to supply electricity to remote population centers, even cities.

The operation of the gas turbine releases large amounts of heat. To save it from being wasted, the heat of the exhaust gases can be recovered by special units and used to heat production facilities and living quarters. The units are provided with mufflers to reduce the noise level from the aircraft engine to acceptable norms.

The prime cost of the electricity generated by PAES-2500 units operating in Western Siberia is only half that which is generated by gas-turbine power trains and diesel power plants.

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NON-NUCLEAR POWER

BRIEFS

NEW GES -- Krasnoyarsk -- The Angara - Yenisey cascade energy family is being reinforced by another member -- the Central Yenisey GES. In accordance with the recently approved technoeconomic feasibility study, its dam will be located near the town of Lesosibirsk, and near the confluence of two mighty rivers -- the Angara and the Yenisey. The new giant's initial capacity is 6 million kW and it will later be increased to 7.5 million kW. Sixteen turbines of 375,000 kW each will be installed here. Average annual electric power output will exceed 30 billion kWh, that is, it will reach the highest level of GES's now operating in the nation. [By P. Zinkev] [Text] [Moscow SEL'SKAYA ZHIZN' in Russian 30 Oct 83 p 1] 11574

TASH-KUMYRSKAYA GES WORK -- Kara-Kul' (Kirghiz SSR) -- Builders of the Tash-Kumyrskaya GES fulfilled high obligations in honor of the Great October Revolution. Finishing preparation of the construction site and a powerful industrial base ahead of time, they opened a work front for the installation of the basic projects. Yesterday in the core of the dam they poured the first cubic meter of concrete. Work is rapidly under way on other sections of the project. A tunnel is being driven under difficult mining geological conditions to divert the Naryn from the main project site. The 120 meter mark, more than one-fourth of the distance -- has already been passed. [Text] [Moscow TRUD in Russian 5 Nov 83 p 1] 11574

POWER PROJECTS -- The first unit of the thermal electric station in Tobolsk has begun operation. Its capacity is 135,000 kW. Builders at the Khudonskaya GES in Georgia were ahead of time in completing a tunnel to divert the Ingura River to a new channel. [Text] [Moscow EKONOMICHESKAYA GAZETA in Russian No 18, Apr 83 p 2] 11574

TAJIK GES--Dushanbe -- The first stone was laid at the seventh hydroelectric station on the Vakhsh River. It is called the Sangtudinskaya and is being built between the existing Golovnaya GES and the Baypazinskaya GES, now under construction. A construction workers' settlement is being built right near the station. The future 1 million kW GES will not only produce low cost electric power, but will also make possible the irrigation of about 20,000 hectares of arid land. Power engineering workers in Tajikistan are working at pace setting rates in the 11th Five-Year Plan. Taken together, all the hydroelectric stations in the mountain region produce more than 10 billion kWh annually. [By. S. Smirnov] [Text] [Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 26 Nov 83 p 2] 11574

NEW TURBINE FOR GES -- Sayanogorsk (Krasnoyarsk Kray) -- The 150 ton runner for the tenth turbine at the Sayano-Shushenskaya GES was delivered from Leningrad to the Karlov site. The unusual load was shipped on the Northern Sea Route from the Baltic to the mouth of the Yenisey on the "Pomor'ye", a diesel ship. It was hauled from the port of Dudinsk to the dam at the Krasnoyarskaya GES on a special barge pulled by the tug "Voskresensk". After passing the barge through the ship lift at the dam, the tug passed the baton to the diesel ship "Akademik Korolev". [By P. Zinkev] [Text] [Moscow SEL'SKAYA ZHIZN' in Russian 5 Nov 83 p 1] 11574

NEW DAM -- The center of work has shifted from the excavation pit to the dam at one of the largest water resources engineering projects in western Kazakhstan -- the Aktyubinskoye reservoir on the Ilek River. Construction is entering the decisive phase -- the building of the high earthen dam. Aktyubvodstroy workers must move almost 1.5 million cubic meters of earth. [By TASS] [Text] [Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 11 Nov 83 p 2] 11574

NEW GENERATOR ON LINE -- Cheboksary -- The eleventh generator unit at the Cheboksarskaya GES has been put on line. The new unit is the fourth since the beginning of the year. Its start-up was the subject of a report on the ahead of schedule fulfillment of 1983 obligations by water project builders. The side of an oil tank on the new unit was decorated with the Komsomol insignia. Komsomol members, projects and enterprises supplying lumber, cement and metal assumed patronage over the eleventh unit. As a result, its installation took 23 days instead of the 45 called for by norms. One after another, the numerous instruments on the new unit indicated that everything was working normally. Assembly and adjustments were excellently done. You should have seen the joy in the faces of V. Akulov, I. Isayev, D. Lyubayev and other water project builders. They are obligated to put another four units on line in 1984. [By U. Bogdalov] [Text] [Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 27 Dec 83 p 2] 11574

SANGTUDINSKAYA GES -- The Sangtudinskaya GES, another pearl on the string of the cascade on the Vakhsh River, has been put on the map of hydroprojects in Tajikistan. Near the mountain village of Sangtuda the first stone was laid in the foundation of the future dam for the GES, which will have a capacity of about 1 million kW. Specialists and designers found an interesting engineering solution. In order not to flood the fertile mountain valley, two dams are being built on the Vakhsh. The twin stations will produce about 4 billion kWh annually. This power will go to developing projects in the Southern Tajik Territorial Production Complex and to enterprises in neighboring republics. The Sangtuda Valley is now being irrigated with the help of pump stations. When the GES is introduced water will flow on its own to the fields, saving electrical energy. A meeting was held on the bank of the Vakhsh when the first stone was laid. [Text] [By TASS] [Moscow STROITEL'NAYA GAZETA in Russian 12 Oct 83 p 1] 11574

KOLYMSKAYA GES -- Sinegor'ye (Magadan Oblast) -- Installation work has begun on the next turbine generator unit at the Kolymskaya GES, now under construction. Work here is done by the consolidated assembly method. For example, workers assembled the scroll casing at a special site. Then, using a powerful crane, they installed the 200 ton unit in the turbine housing. This saved about two months. Even though the station is already operating, the echos of blasting rumble through the ravines of the Cherskiy Range. It is from tunnel drivers storming the cliffs on the river's left bank. Here, in permafrost, a canal for year-round water supply and a tunnel are being built. During this five-year plan the water from the Kolymskoye reservoir will flow through them to the new powerhouse. [By TASS] [Text] [Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 22 Nov 83 p 2] 11574

NERYUGRINSKAYA GRES CONSTRUCTION PROGRESSES--Serebryanny Bor, Yankutsk ASSR (TASS)--Assembly has been successfully completed on the basic units of the Neryungrinskaya GRES [State Regional Electric Power Station]. Pre-startup adjustment operations have begun at the station. The operators are carrying out these procedures along with the builders. The operators previously underwent special training for this at other electric power stations in the country. The multithousand member collective of GRES builders has committed itself to having the first energy generation unit in full scale operation at the end of November, 1 month prior to the scheduled deadline. [Text] [Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 11 Nov 83 p 1] 9276

COMPUTERS MONITOR POWER USE--(TASS)--The Proizvodstvo ASU [automatic control system] has begun to operate at Armglavenergo [Main Administration for Automated Power Monitoring]. The electronic systems installed here are capable of solving not only problems related to operational-dispatching control, but also those of technico-economic planning. The computer makes it possible to receive any kind of information concerning the availability of resources in a shorter period of time, electrical energy distribution, and its generation. The economic impact of the introduction of this ASU amounts to more than 1 million rubles annually. [Text] [Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 4 Oct 83 p 2] 9276

POWER PLANT OPERATOR TRAINING--Kiev--The computer presented the program, the operating conditions and also the emergency situation. Each of the 130 electric power plant operators who had come to the Ukraine from the many corners of the country was timed when choosing the best operational solution from among the possibilities presented. Teams from 26 electric power stations from throughout the country took part in the first All-Union competition for operators of power generation units which was held in the study-training center of the Tripol'skaya GRES. On a special simulator they took turns solving complex control problems using contemporary equipment. The manager-operators of the Tripol'skaya GRES took first place, with second and third place going to foremen from Kashir and Uglegorsk. [By Zh. Tkachenko] [Text] [Moscow SOTSIALISTICHESKAYA INDUSTRIYA 9 Oct 83 p 2] 9276

MAGNETOHYDRODYNAMIC POWER GENERATION--Scientists and experts include increasing the effectiveness of the fuel used to generate electrical energy among the problems the solution to which will have a significant impact on the economies not only of individual countries but also of entire continents. Particularly promising in this regard is the technique of directly transforming heat into electrical energy on the basis of the magnetohydrodynamic principle (MGD). On 12 September, the Eighth International Conference on MGD Transformation of Energy opened in Moscow. Famous scientists and designers from more than 20 countries are participating in it. In his speech at the conference, the president of the USSR Academy of Sciences, Academician A. P. Aleksandrov, emphasized that in the Soviet Union great attention is being devoted to the development of promising research in the area of MGD transformation of energy. The success of Soviet science and technology in this regard is attested to by the construction at the Ryazanskaya GRES of the first industrial MGD energy generating unit in the world, with a capacity of 500,000 kilowatts. Conference participants will provide overviews of their national programs for the MGD transformation of energy and discuss the scientific and engineering aspects of designs for electric power stations of this type. [Text] [Moscow IZVESTIYA in Russian 13 Sep 83 p 2] 9276

NERYUNGRI GRES TESTS TURBINE--Neryungri--The turbine in the first energy generation unit as the Neryungrinskaya GRES has been tested under no-load conditions. This station is being built for the South Yakutian TPK [Territorial Industrial Complex] along the BAM [Baykal-Amur Main Line] right of way. In order to meet their obligations for the scheduled startup of this powerful thermal electric power station, the assemblers of the Neryungri Vostokenergomontazh Directorate have contracted for all the basic components and sub-assemblies of the unit. Shock-work levels were achieved by the brigades of N. Savvateyev and I. Sviridov, thereby assuring high quality of the final assembly work. [By. A. Antipin] [Text] [Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 18 Nov 83 p 1] 9276

YAKUTSKAYA GRES NEARS STARTUP--Serebryanny Bor (Yakutskaya ASSR)--Assembly has successfully been completed on the basic units of the Neryungrinskaya GRES. Pre-startup adjustment operations have begun at the power station. These operations are being conducted by the builders along with the operators, who have previously undergone special training at electric power plants throughout the country. The multi-thousand member collective of GRES builders committed itself to making the first energy generation unit of the station fully operational by the end of November, 1 month earlier than the projected schedule. [Text] [Moscow SLE'SKAYA ZHIZN' in Russian 11 Nov 83 p 1] 9276

CSO: 1822/110

COMPRESSOR STATIONS

CHELIABINSK-PETROVSK GAS LINE'S SOKOVKA COMPRESSOR STATION COMPLETED

Moscow STROITEL'STVO TRUBOPROVODOV in Russian No 11, Nov 83 p 22

[Article by Ye.T. Popov and N.P. Gavrilov, Tatkomplektmontazh Trust, Al'met'yevsk: "Construction of Sokovka Compressor Station on the Chelyabinsk-Petrovsk Pipeline"]

[Text] The Sokovka compressor station (CS) is essentially different from stations built earlier by the trust, both in design and in volume of work. The Sara and Saraktash compressor stations on the Dombarovka-Orenburg pipeline were built for around 3-4 million rubles, while over 7 million rubles were spent at Sokovka.

The latest design features were incorporated into the construction of the compressor station: utility lines were installed above ground, the heating system was protected by waterproof insulation, walkways were made from sidewalk plates, and building and equipment foundations were made by prefabricated reinforced concrete. The work production plan for the Sokovka CS was developed by the Orgtekhstroi Trust. Its staff developed the network schedule, the unit passport and process charts for different types of work and installation operations.

When work began, a fully-equipped town was ready for construction workers, working by the expedition method.

The compressor station construction site was located 500 meters from a highway. This allowed an access road to be built in a minimum of time and it expedited the completion of the project as a whole.

The complete-modular construction method was widely used on the Sokovka project. Modular boxes of various kinds, shelters and container modules (process modules), which are small sewage pumps, arrived at the site. Eighty-four modules and modular boxes were installed, as were 25 factory-built modular building units. This comprised 60 percent of the total construction work.

The movement toward greater efficiency was broadly developed at the construction site. The MU-2 Construction Administration workers alone suggested and implemented nine efficiency proposals with a total savings of over 7,000 rubles.

The construction staff played no small role in the accelerated completion of the project. The staff included the management of the general contractor and sub-contractors and representatives of the buyer. Construction reports were given at the staff meetings, new assignments were made, the causes of delays were ascertained and measures taken to resolve them.

All construction organizations on the project actively participated in a competition operating on a "workers' relay-race" principle. The "relay-race" helped coordinate the builders' efforts and direct them toward the completion of the main task--the timely completion of the first phase of the compressor station. Competition results were totaled every day. Wide publicity helped ensure the success of the competition. Bulletins were dispatched as soon as the results were totaled.

The construction supervisors efficiently organized the work. Great attention was paid to the introduction of brigade cost accounting, on the basis of which about 80 percent of all work was performed. The brigades of N. Chaganov, A. Zhidkov, N. Yevlakhin and D. Khasanshina of MU-2 operated exclusively on the cost accounting method, based on issued piecework orders. The cost accounting method fully justified itself, as these brigades were the most productive. The general contractor organized two- and three-shift work at the compressor station site while barely increasing the number of workers.

A carefully considered work plan, strict controls on materials and equipment, skillful allocation of manpower and equipment, active sociality competition and organization of the workers' amenities and leisure permitted the compressor station to be commissioned 10 months after work was started. The normal construction period was cut by 14 months. Over 200,000 rubles were saved.

Utilizing the experience gained in the construction of the Sokovka compressor station, the Trust took part in the construction of the Pomary compressor station on the Urengoi-Pomary-Uzhgorod pipeline.

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PIPELINE CONSTRUCTION

UDC 621.643:621.791+62.001.7

WAYS OF RAISING TECHNICAL LEVEL OF WELDING WORK IN PIPELINE CONSTRUCTION

Moscow STROITEL'STVO TRUBOPROVODOV in Russian No 9, Sep 83 pp 2-5

[Article by V.G. Chirskov, USSR first deputy minister of construction of oil and gas industry enterprises]

[Text] Workers of organizations and enterprises of the Ministry of Construction of Oil and Gas Industry Enterprises (Minneftegazstroy), as is the entire Soviet nation, are directing their efforts toward implementation of the decisions of the 26th CPSU Congress and of the November 1982 and June 1983 plenums of the CPSU Central Committee, and toward ahead-of-schedule fulfillment of State plans and socialist obligations for 1983. The industry's workers have coped successfully with the program of the first half year. Construction of the Urengoy-Pomary-Uzhgorod export trunk line has been completed much earlier than the appointed deadline, and construction of the next Urengoy-Center gas pipeline has been launched. New limits have been designated for ahead-of-schedule fulfillment of the quotas of the five-year plan period.

The pipeline construction program for the 11th Five-Year Plan period calls for the construction of more than 56,000 km of trunk pipelines, and of pipes with a diameter of 1420 mm more than 20,000 km will be laid, or two times more than in the 10th Five-Year Plan period. The amount of construction of field pipelines at oil and gas fields will be doubled as compared with the preceding five-year plan period. Plans have been made for the construction of a new class of gas pipelines designed for pressure of 10 MPa. Here it is necessary to solve a number of complicated scientific and engineering and organization problems.

With the constantly increasing pace of construction of pipelines, the quality of construction and assembly work has acquired first-level importance, especially in the nearly inaccessible regions of Western Siberia and the Extreme North, where the cost of each failure of a pipeline in the process of testing and especially of using it is exceedingly high.

At the present time more than 50 percent of butt joints are welded manually in the construction of pipelines. About 8000 highly skilled welders are occupied with this work in the industry. An analysis has shown that the principal reason for failures of welded joints of pipelines in the process of

testing and utilization is manual arc welding defects. Therefore, the basic direction for improving the quality of welding work as well as for increasing the labor productivity of welders is the total mechanization of these operations and expansion of the use of automatic methods of welding and, primarily, resistance welding.

In recent years organizations of the Ministry of Construction of Oil and Gas Industry Enterprises in cooperation with the Institute of Electric Welding imeni Ye.O. Paton of the Ukrainian SSR Academy of Sciences, the Ministry of the Electrical Equipment Industry and Power Machine Building and other ministries have done a great amount of work on the creation and introduction of a number of machines and devices making it possible to raise drastically the level of the mechanization and automation of welding. Here principal attention has been directed at the development of equipment for welding large-diameter pipes, in which the greatest number of workers are occupied.

Fundamentally new systems have been created--the "Sever" [North] for resistance welding of large-diameter pipes, and the "Styk" [Butt Joint] for automatic welding of fixed joints using a powder wire--and highly mechanized BTS bases for automatic two-way submerged arc welding of two- and three-pipe sections, mobile and self-propelled multiple welding units for manual arc welding, new welding materials, facilities for controlling the quality of welded joints, and other equipment. The series production of this equipment and these materials has begun at the industry's plants and at enterprises of other ministries.

New welding equipment has already arrived on routes and is being introduced by builders of pipelines. The industry is faced with the task, in the next few years, of accomplishing retooling of welding production in pipeline construction. The following data testify to the scale of this retooling: In 1985 on routes of pipelines under construction the number of "Sever" complexes being used will increase 10-fold, of "Styk" units almost 3-fold, of BTS pipe welding bases 5.5-fold, and of PLT [plow-type trencher] and TKUS [general-purpose trencher] units 2-fold. The active inventory of this equipment will increase even more in 1990.

For the successful introduction and efficient utilization of advanced equipment, it is necessary to master the technology of welding pipes by new methods, to improve the forms of organization of welding and assembly work, to put in order the preventive maintenance and repair of welding equipment, and to perform a combination of scientific research studies. It is necessary to improve the system for training and improving the skills of welders and flaw detection personnel, to train and retrain engineering and technical personnel and to develop new advanced norm-setting documents.

Accomplishment of this set of measures will make it possible to raise considerably the technical level of welding work, chiefly on account of the extensive application of resistance welding of pipelines. As early as the beginning of 1986 the amount of manual welding in the construction of large-diameter pipelines will be reduced by a factor of 2.5 to 3.

The introduction of new equipment has always been a matter involving much trouble and requiring a special approach and creative initiative at all levels--from worker to manager. New machines sometimes have "bugs," which for some managers is an occasion for justifying disruption of the introduction plan. But whoever, if not the builders themselves, must give a new machine a start in life must create the conditions for its successful operation. And in fact wherever enthusiasts are enlisted for this job and creatively thinking workers and engineering and technical personnel, and wherever the necessary conditions are created and psychological and material incentives are provided, new equipment is being introduced successfully, being improved, and in the final analysis producing a great saving. A positive example in this respect is the work of the Severtruboprovodstroy, Samotlortruboprovodstroy, Ukrtruboprovodstroy, Krasnodartruboprovodstroy, Tatnefteprovodstroy and Tatspetsstroy trusts. Poor work on the introduction of new equipment is being done in Glavtruboprovodstroy [Directorate for Gas Pipelines Under Construction]. "Styk" and "Sever-2" systems are being put into service slowly in the Kuybyshevtruboprovodstroy, Sredazneftegazstroy and Ryazan'truboprovodstroy trusts. The directors of some central administrations and trusts must reconsider their attitude toward this important job.

At the same time it is necessary to develop an improved system for the introduction of new equipment providing for interest in its utilization both on the part of production personnel and developers, and it is necessary to create conditions under which it would be disadvantageous to operate according to the old technology. As noted in the speech by CPSU Central Committee General Secretary Comrade Yu.V. Andropov at the June 1983 Plenum of the CPSU Central Committee, the problem is to develop a system of organization, economic and psychological measures which would interest both managers and workers and, finally, scientists and designers in the renewal of equipment and which would make working in the old way unprofitable.

With the present-day high level of power availability per worker in welding production in the industry, the problem of startup and debugging work and of maintaining and repairing welding equipment is becoming very important.

At the present time in several trusts a considerable portion of welding equipment is standing idle because of malfunctions and a lack of the required spare parts. The system for servicing and repairing equipment in the majority of construction subdivisions has been poorly organized, and a centralized system on the scale of central administrations has not been created.

In order to solve this problem, it is necessary to go the route of organizing the debugging, servicing and repair of equipment by the manpower of specialized cost-accounting subdivisions of pipeline construction central administrations, associations and trusts, and of using existing, and of creating in central administrations new, enterprises for the centralized major overhauling of welding equipment and for making spare parts, as well as of enlisting for these purposes the repair plants of ministries and other departments.

In order to carry out startup and debugging operations and the servicing and routine repair of "Sever" and "Styk" systems, units for resistance welding of

small-diameter pipes, BTS pipe welding bases and other welding equipment, it is necessary to create in each pipe construction central administration and association startup and debugging administrations or cost-accounting sections.

The Gazstroy Mashina SKB [Special Design Bureau] must develop catalogues and norms for the consumption of spare parts for repair and utilization needs of key welding equipment, and Glavneftegazstroy mekhanizatsiya [expansion unknown] must determine the volume of their production at the industry's plants and enterprises of the Ministry of the Electrical Equipment Industry.

Observance of the welding and assembly operation procedure is one of the most important conditions for ensuring high quality.

However, in recent times instances of violation of the welding procedure and of quality control of welded joints have been established by tests in individual construction and assembly organizations. Violations of welding parameters have taken place, as well as unsatisfactory storage and preparation of electrodes, welding wire and flux, insufficient cleaning of pipes and non-observance of established tolerances in the assembly of joints.

All this was the result of poor technological discipline, poor operation-by-operation control and insufficiently exacting demands on performers on the part of foremen, people in charge and personnel of production testing laboratories. Sometimes poorly trained welders and flaw detection personnel were enlisted for welding and controlling the quality of welded joints. Incidents of gross violation of technological discipline in the production of welding and assembly work and in testing welding joints have been established in the Soyuzgazspetsstroy, Tyumengazmontazh and Tsentrukomplektmontazh trusts.

It is necessary to take additional measures to improve technological discipline and the responsibility of foremen, producers of the work and services for controlling the quality of welding operations. It is necessary to create a situation of intolerance of bad workers and to severely punish people violating technological discipline. In each production line there must be a welding process engineer responsible for high-quality fulfillment of process specifications by assemblers and welders, and in long process lines this specialist should be a chief engineer or deputy line superior (of the construction and assembly administration).

Analysis of cases of failure of welded joints testifies to the fact that it is necessary to improve considerably the quality of the welding of special joints--wraparounds, "coils," fitting insets, patches and butt joints subjected to repair. VNIIST [All-Union Scientific Research Institute of Construction of Trunk Pipelines] must speed the development of more advanced technological alternatives for making these joints (taking into account the use of new welding materials and automation of the welding process), and must also find new design and technological solutions.

An important role in providing for the required technology is being assigned to production process charts on which all specifications for assembly,

welding and testing of welded joints must be recorded. VNIIST, NIPIorgneftegazstroy [expansion unknown] and the Orgtekhstroy trusts must in the immediate future complete the development of unified process operation charts for welding and assembly work, taking into account the use of new welding equipment and testing equipment and ensure their introduction in conjunction with production organizations. It is necessary to reach the situation whereby welding operations are not performed in pipeline construction without process operation charts.

An important goal facing the industry's scientific research and production organizations is the improvement of existing, and the investigation of new, forms of organization of welding operations.

The creative search for optimal organization structures has been under way at the industry's construction sites for the last 10 years.

Since 1974 in Western Siberia the disjoint straight-line flow method of welding by means of combined crews has been used, whereby welding and insulating and laying operations are performed by the manpower of a single construction administration. Experience gained has made it possible to draw the conclusion that the most optimal variant of organizing welding operations in the construction of 1420-mm-diameter pipelines is the disjoint straight-line flow method of welding by means of large crews in which there are no fewer than 16 welders (per shift). In spite of this, a considerable portion of welding and assembly crews working on the construction of large-diameter pipelines in Glavtruboprovodstroy, Glavyuzhtruboprovodstroy [expansion unknown] and Glavukrneftegazstroy [expansion unknown] are outfitted with only 10 to 12 welders. In these crews, as a rule, the pace of construction is slow and equipment is used less efficiently. Welding operations must be performed only by large crews in the construction of large-diameter pipelines.

A considerable portion of the industry's construction organizations perform welding on small-diameter pipelines, on whose routes the use of large crews is not justified economically. Here specialization of welding operations at the level of the construction and assembly administration is more expedient. A further creative search for new, and the improvement of existing, forms for organizing the performance of welding operations are required.

In the practice of constructing pipelines cases exist when work is begun without the proper technical training, which has a negative effect, primarily on construction quality. This is a wanton practice and it is necessary to put an end to it.

NIPIorgneftegazstroy must speed development of, and central administrations and associations must establish, a unified procedure for checking the readiness of production lines and crews for beginning work. It is necessary to generalize and expand available know-how on certification of construction and specialized organizations for the right to perform welding and assembly work.

In the job of improving the reliability and life of pipelines under construction a major role has been assigned to the welding quality control service.

Definite successes have been achieved in recent years in the area of the creation of new inspection facilities. Efficient self-propelled intrapipe units for panoramic radiographic inspection of welded joints, roll-type x-ray film, automatic units for photographic processing of radiographs and other equipment have been introduced and are being used in pipeline construction. The change has been made to radiographic inspection utilizing iridium-192 isotopes, which has improved the quality and reliability of inspection. On the other hand, the system for controlling welding quality which exists in the industry does not conform to the pace of construction and the increased amount of inspection of welded joints.

The effectiveness of the work of the quality control service is determined today by its efficiency and high pace of controlling welding quality. It is necessary to create in all pipeline construction trusts specialized cost-accounting sections for production checking of construction work. This will make it possible to concentrate resources of materials and equipment and the necessary number of flaw detection specialists at the most important construction sites and to enable high efficiency and the required pace and objectivity of control. The practical working experience of the specialized administration for controlling the quality of construction in Glavtyumentruboprovodstroy has confirmed the correctness of the direction chosen.

At the same time it is necessary to expand at the industry's plants and at enterprises of other ministries the production of instruments, equipment and materials for control being produced and to organize the manufacture of new ones. It is also necessary to review the procedure and the organization of work for controlling the quality of welded joints, to create and introduce a disjoint straight-line flow method of control, and to introduce periodic certification in specialized cost-accounting subdivisions for the right to control construction quality.

Experience in organizing 100-percent control of the welding quality of 1420-mm-diameter pipelines by the radiography method testifies to the need to create special teams of flaw detection personnel able at the same time to test and, prior to the start of the welding team's work, to produce the results of the inspection of joints welded by the preceding shift. Such organization of control makes it possible efficiently to eliminate flaws discovered in joints, as well as to take timely measures to prohibit them.

It is necessary to expand the training of flaw detection personnel and to improve their skills. VNIIST must develop and implement in practice in conjunction with construction organizations procedural instructions for performing radiographic inspection, taking into account the use of existing x-ray equipment, isotopes, x-ray films, shields, etc. Further study and scientific substantiation of criteria for evaluating the quality of welded pipeline joints are required, as well as improvement of the procedure for interpreting

radiographs. The institute with the involvement of scientific research organizations of other departments must make a statistical evaluation of the quality of welded joints performed by various welding methods and develop a procedure for determining the optimal level of welding quality in pipeline construction.

Scientific research and planning and design organizations of the industry are solving big and complicated problems. These organizations in creative cooperation with leading scientific institutes of the country in the field of welding (IES [Institute of Electric Welding] imeni Ye.O. Paton, VNIIESO [All-Union Scientific Research Institute of Electric Welding Equipment], MVTU [Moscow Advanced Technical School] imeni N.E. Bauman) have achieved considerable success in solving problems relating to the automation of welding processes and controlling the quality of welded joints. A large group of designers and personnel of scientific and production organizations of Minneftegazstroy was awarded the USSR Council of Ministers Prize in 1983 for the study entitled "Combination of Investigations, Planning and Design and Technological Studies on Creation and Introduction of an Advanced Arc Welding Technology and Equipment ("Styk" System) for Welding Work in Construction of Trunk Pipelines."

On the other hand, a quantity of research and development on welding of pipelines which is of great practical importance is being performed exceedingly slowly.

Requiring further intensified research are questions relating to the quality of welded joints performed by various methods and to improving the reliability and serviceability of joints under real conditions of construction and the use of pipelines. It is necessary to intensify work on determining scientifically substantiated criteria for permissible flaws in welded joints and on the use of modern flaw detection equipment based on the use of low-silver-content materials and the x-ray television method of inspection.

It is necessary to speed work on automating welding of the root layer of a weld and special pipe joints, on the creation of portable systems for resistance welding of pipes of the field class, on development of a procedure and equipment for repairing welded joints under route conditions, and on total mechanization of welding operations with pipe welding bases.

It is necessary to concentrate the efforts of the industry's scientists on the development of a technology for welding field pipelines, including for transporting corrosive oil and gas.

At the same time it is necessary to activate work on the creation of promising methods of connecting pipes, including brazing, and of welding units based on inverter power supplies, and on designing robot manipulators for welding pipelines.

During the period of retooling of the industry's welding production, with special urgency the question will arise of training and retraining specialists in welding production, i.e., electric welders, operators of welding

systems, flaw detection personnel and engineering and technical personnel. In this important task it is necessary first of all to achieve high quality in the training of specialists.

Unfortunately, cases still exist where some welders, having completed the training course, have poor skills, have unsatisfactorily mastered the technique of welding a weld root, and have an insufficiently good knowledge of the welding procedure and welding equipment. Newly trained flaw detection personnel are poorly able to interpret radiographs.

It is necessary to concentrate the training of working personnel for welding production in the best educational institutions of the ministry and to review training plans and programs, taking into account the introduction in the industry of new welding equipment and advanced technology and stricter requirements for the quality of welding and assembly work.

For further improving the professional mastery of welders and flaw detection personnel it is necessary regularly to hold industry competitions for the title of best welder and best flaw detector and schools for advanced know-how in organization of welding work.

It is especially necessary to turn attention to improving the training and increasing the skills of welding production engineering and technical personnel. For this it is necessary to organize the training and retraining of engineers, taking into account the peculiarities of the ministry's work, in the areas of specialization of "Welding Production Equipment and Technology" and "Physical Methods and Instruments for Non-Destructive Testing." In pipeline construction central administrations, associations, trusts and administrations it is necessary to strengthen the chief welder's service, and to carry out measures for improving the skills of management personnel of these subdivisions with obligatory certification for the right to manage welding and assembly work.

Attaching special significance to raising the technical level of welding work in pipeline construction, the board of Minneftegazstroy has discussed the status of this question and has approved special measures. These measures, aimed at further raising the technical level of welding based on the extensive use of automatic methods and advanced technology and improvement of the system for controlling the quality of welded joints, call for specific goals for the development and production of new welding equipment, welding quality control equipment and advanced welding materials. Measures have been specified for improving the technology of welding work and organizing startup and debugging and repair work, improving the working conditions and environment of electric welders, training working personnel and engineering and technical personnel, holding training courses for advanced working methods, and producing norm-setting documents and technical and welding literature on welding of pipelines.

Central administrations, associations, trusts, and scientific research and planning and design organizations of the industry are confronted with an important goal--ensuring implementation of the measures designated.

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PIPELINE CONSTRUCTION

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AUTOMATIC WELDING—IMPORTANT POTENTIAL FOR RAISING QUALITY OF CONSTRUCTION

Moscow STROITEL'STVO TRUBOPROVODOV in Russian No 9, Sep 83 pp 6-10

[Article by A.G. Mazel', VNIIST [All-Union Scientific Research Institute of Construction of Trunk Pipelines]]

[Text] The automation, mechanization and robotization of welding and assembly work make it possible to reduce considerably the presence of flaws in welds.

Analysis of welding quality in the Urengoi-Pomary-Uzhgorod gas pipeline in the 0 to 60 km region showed that the extent of the presence of flaws in welds (the mean number of impermissible flaws which can be corrected per single joint) is 1.9-fold lower when using SST-PAU [automatic field welding units] units than in manual arc welding of fixed joints.

The structure of the presence of flaws in welds (mean distribution as a percentage for kinds of impermissible flaws which are correctible) in welding with SST-PAU units and in manual arc welding of fixed joints looks as follows:

<u>Flaws</u>	<u>Manual arc welding of fixed groove joints</u>	<u>Submerged-arc welding using bases</u>
Pores	53.6	54
Slag	12.4	12.5
Poor penetration	13.6	16.1
Cracks	0	1.6
External flaws (shrinkage cavities, gashes, burn-throughs)	20.4	15.8

In determining the degree and the structure of the presence of flaws an analysis was made of 242 groove joints welded at pipe welding stations by the submerged arc method, and of 134 groove joints performed by manual arc welding in the fixed position. Pipes 1420 mm in diameter with a wall thickness of 15.7 and 18.7 mm were welded.

The close structure of the presence of flaws in welds made at pipe welding stations and on-site at the route, with a considerable difference in the extent of the presence of flaws, makes it possible to assume that flaws in both cases belong basically to manual arc welding and the backing run of a root and are typical of welding with electrodes. Filling welds made by submerged arc welding are of high quality, which is responsible for the lower general extent of the presence of flaws in non-fixed groove joints.

In manual welding on a route somewhat more external flaws were noted, and in welding by using bases individual cases of the formation of cracks in welds were recorded, which is probably associated with violation of the conditions for slowed cooling of welds called for by the technology. The main flaw is porosity.

Of course, the main reasons for porosity in welds are insufficient calcining of the electrodes and flux and the presence of moisture and rust in the welding zone. Of great importance are the storage conditions for welding materials in warehouses; the rusting of electrode rods and irreversible changes in their coating during wetting can make calcination prior to welding ineffective, i.e., such that it does not prevent porosity. Non-observance of the welding technology, e.g., insufficient heating of edges prior to welding and excessively high welding current which causes destruction of electrode coatings also can cause porosity in welds.

Pores with elevated humidity cause damage to welds, chiefly in the form of accumulations and chains. In overhead welding accumulations and chains constitute 86 percent of the entire impermissible pore content, and 88 percent in non-fixed welding.

Of course, failure of groove joints is caused most often by poor penetration, which is potentially more dangerous than pores.

The concentration of stresses is usually more significant at points of poor penetration. Incomplete root penetration and poor penetration (incomplete fusion) within welds between layers and with edges are encountered both in non-fixed and in overhead welding.

For the purpose of improving the quality of welding of annular groove joints in pipelines it is necessary to direct very serious attention to improving the storage and preparation of welding materials under route conditions; to ensure strict observance of the welding technology used, in particular, heating parameters and cleaning snow from the cavities of pipes and rust and moisture from edges; and to make maximum use of mechanized methods of welding, and, in the future, of robotized systems, too.

Certain trends in the use of mechanized methods of welding have been designated already at the present time (fig 1). The introduction of new methods will make it possible to raise considerably the level of the mechanization of welding in the industry. Whereas in 1983 the level of the mechanization of welding operations (for welded-on metal) equaled 53 percent, in 1985 it will reach 74 percent. In the future the level of mechanization will continue to increase, chiefly on account of the use of continuous flash-butt resistance welding, which should in the future to a considerable extent displace manual arc welding.

Continuous flash-butt welding does not have the types of flaws characteristic of arc welding. The presence of flaws in resistance welding, which are of a fundamentally different nature, requires separate discussion.

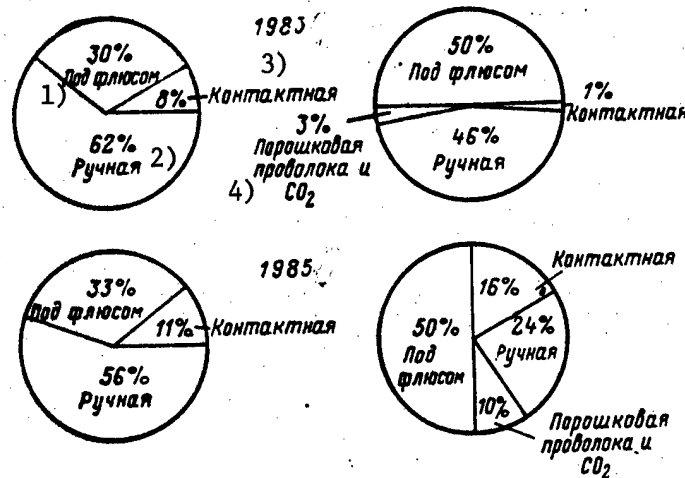


Figure 1. Use of Various Methods of Welding Pipelines: left--for diameters of 114 to 820 mm; right--for diameters of 820 to 1420 mm

Key:

- | | |
|------------------|------------------------------------|
| 1. Submerged arc | 3. Resistance |
| 2. Manual | 4. Powder wire and CO ₂ |

Practical experience in using this welding method demonstrated the need to solve a number of problems: to create intrapipe units which are capable of passing through the turning angles; to develop and introduce post-welding inspection of groove joints; to automate control of the welding process, including by means of robotized units with feedback; and to make a more complete estimate of the degree of the influence of the welding's thermal deformation cycle on the properties of welded joints and to find ways of further improving them.

Specialists at the Institute of Electric Welding imeni Ye.O. Paton, VNIIST, MVTU [Moscow Advanced Technical School] imeni N.E. Bauman, etc., are working on solving these problems.

Submerged arc welding will also receive considerable application in the future.

In connection with the fact that welding with a preliminary backing run does not eliminate the presence of flaws in welds, in the future in the development of this process the use of pipe welding bases of the BTS type with shuttle movement of pipes will be expanded, as well as of bases of the single-pass type with two-sided automatic welding. The volume of welded-on metal is reduced substantially when using these bases because of the change from single-sided welding to two-sided with pretreatment of edges by means of machine tools of the SPK type. For example, for pipes measuring 1420 x 20 mm the amount of welded-on metal in welding a single groove joint is reduced from 13 to 5.5 kg, or 2.4-fold. Accordingly, productivity must be increased and the probability of the formation of pores and slag inclusions reduced.

It must be mentioned that pipe welding bases of the single-pass type can be robotized in the future.

Comparative technical and economic indicators of pipe welding bases of different types follow:

<u>Indicators</u>	<u>PAU-1001V</u>	<u>BTS-142V</u>	<u>BTS-143</u>	<u>Robotized system</u>
Productivity:				
Groove joints per hour	2	3	6	8
km/year	100	225	450	600
km/shift	0.6	0.9	1.8	2.5
Number of workers in crew	12	7	14	4
Including welders	6	2	2	-
Need to inspect finished groove joints	Yes	Yes	Yes	No
Assumed number of groove joints requiring repair per each 100 joints (flaw presence level, %)	10	2	2	0.2

The shift from manual welding to mechanized will make it possible to improve the quality and increase the productivity of arc welding for fixed groove joints also.

Units of two kinds have been developed at the present time: of the "Duga" [Arc] type for welding in an environment of protective gases, and of the "Styk" [Groove Joint] type for welding with a powder wire with forced formation of the weld.

The "Duga" type unit developed by VNIIST, VNIIESO [All-Union Scientific Research Institute of Electric Welding Equipment] and the Gazstroy Mashina SKB [Special Design Bureau] KF [Kiev Branch] is distinguished by slight injection of heat into the zone around the weld as compared with other welding methods.

Heat Injection (in J/cm) with Various Methods of Welding Pipelines

In units of "Duga" type	5.5 to 7
In units of "Styk" type	20 to 40
Submerged arc welding using pipe welding bases	25 to 30
With pulp-coated electrodes "downhill"	6 to 9
With base-coated electrodes "uphill"	30 to 40

The "Duga" unit, in addition to low injection of heat characteristic also of welding with electrodes with a pulp coating, unlike the latter, enables a low hydrogen content in welds, which has a positive effect on the quality of welded joints and in particular eliminates the formation of cold cracks.

Reduction of injection of heat in welding is of fundamental importance for pipelines made of heat-hardened steel and designed for corrosive gases, since the required quality of the zone around the weld is achieved by this. Therefore, the automatic method of welding in a medium of carbon dioxide, in spite of some complexity of the process and equipment, should be part of builders' equipment.

An important plus feature of units of the "Duga" type is the possibility of high-productivity automatic welding inside the pipe, which guarantees the elimination of incomplete root penetration.

The opinions which have appeared in recent times regarding the total interchangeability of units of the "Duga" and "Styk" type for these reasons are not to be regarded as sufficiently justified. Each of them must have its own area of application.

Welding with "Styk" units has an advantage over gas-arc welding: It is not necessary to use cylinders with a protective gas medium, the delivery of which to a route is usually difficult.

In "Styk" units the pool is confined to the forming bar, which makes it possible to use considerable current (300 to 400 A) exceeding twofold the current in gas-arc welding.

A disadvantage of welding with powder wire is the need to do it with a preliminary backing run by means of electrodes in several layers, which creates conditions for increasing the presence of flaws in welds. Attempts have been made to use special releasing backing rings. However, with this technology the pace of construction of a pipeline is reduced considerably.

Of considerable interest is a combination of highly productive welding inside the pipeline in a medium of CO₂ with welding by means of "Styk" type units

on the outside of the pipe. This technical solution, based on already tested designs, successfully combines a high rate of progress of the welding column and guaranteed root penetration with high productivity and high-quality welding of the filling layers of the weld.

In the future it will be possible to create a similar high-productivity robotized welding system with a small number of attending personnel (fig 2).

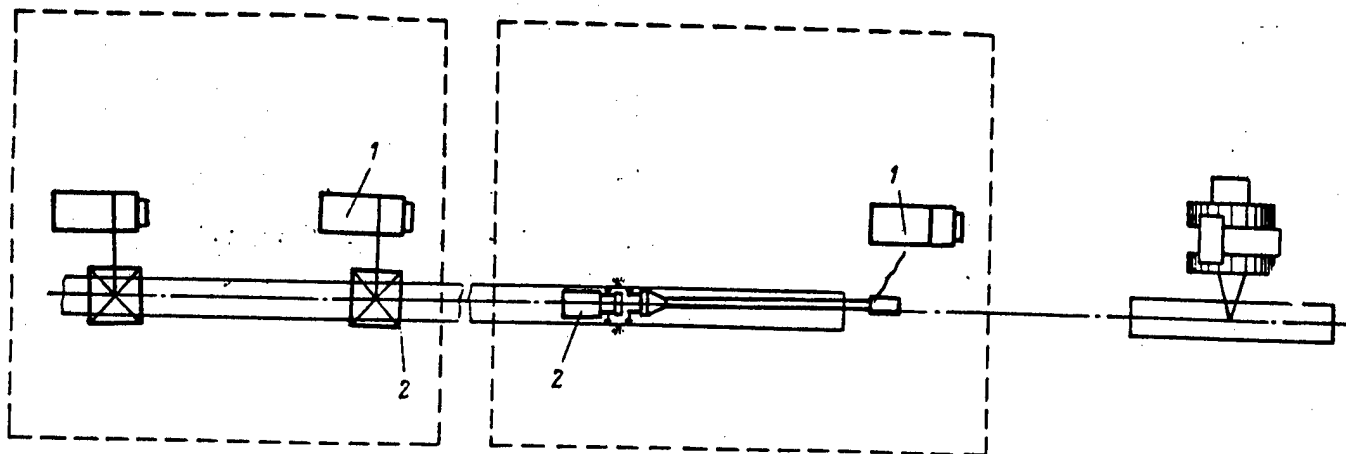


Figure 2. Diagram of Robotized System for Welding Fixed Groove Joints of Large-Diameter Pipelines: a--"Styk-Avto" unit for welding outside weld; b--"Avangard" [Vanguard] unit for welding root; 1--self-propelled power-generating unit; 2--automatic welding and on-line gauging unit

It can be assumed that the level of the presence of flaws in the case of automatic welding of the root, as in the case of using units of the BTS type, will not exceed two percent. The use of a robotized complex will make it possible to reduce the presence of flaws even more considerably.

One type of operation urgently requiring mechanization is special welding operations (welding collars, welding-in spools, fittings and connecting parts). These operations, which constitute no more than four to five percent of the total amount of welding in pipelines, in 40 to 50 percent of cases are the reason for their failure. This is associated with insufficient accuracy of marking, cutting and assembly and with a considerable concentration of stresses in the rigid loop in welding fillet welds and lap welds, as well as patches.

In connection with the special form of special welded joints, inspection is difficult in many instances. The reliability of these joints can be improved considerably on account of more precise machining of the edges of collars and spools. It is necessary to employ mechanized methods of gas or plasma cutting with subsequent mechanized machining of the edges with add-on machine tools of the SPK type. The cutting out of holes in pipes under offsets and connections must also be mechanized.

For welding the root of collars, spools and connections it is necessary to create self-propelled welding systems (capsules) with a life support system and a welding power supply which would transport inside pipelines 1020 to 1420 mm in diameter an electric welder and a helper for a distance of up to 2 km. These systems can also be used for repairing groove joints from inside a pipeline. The operation of these units can be oriented in the future toward using not only manual, but also mechanized welding methods.

Ensuring high quality of welding of the root, especially in small-diameter pipes of compressor and pumping stations, where the inside of the pipeline is not accessible, is possible by employing argon-arc welding with a tungsten electrode while feeding the filler wire into the arc. Argon 99.9-percent pure is necessary for welding carbon steel. The process can be accomplished manually or by using automatic machines which are already produced by industry. Good alignment of edges on the inside of the pipe is necessary for high-quality execution of the root by means of argon-arc welding. This alignment is made possible, for example, in the construction of electric power stations, by turning the ends of pipes or by using steel sizers which can expand the inside diameter of pipes. For example, with hot sizing of pipes made of carbon steel up to 300 mm in diameter with a wall thickness of up to 20 mm it is allowable to increase the inside diameter at the end of a pipe up to 10 percent. The argon-arc welding process must be introduced primarily in pipelines with a corrosive gas containing hydrogen sulfide.

New more up-to-date technical solutions are also required in the area of repairing flaws discovered in inspecting groove joints. In terms of its importance, the repair of welded joints is similar to special welding operations and trained welders must be permitted to perform it.

The development of more precise methods of determining the location of repairable flaws (in terms of perimeter and depth of occurrence) is necessary, as well as the creation of mechanized highly productive methods of eliminating them.

The amount of repair work is determined by the level of the presence of flaws, which depends on a number of factors, such as the welding technological process used, the skills of welders or operators, seasonal fluctuation and climatic conditions, the amount of inspection and inspection standards, and the like.

In domestic and world practice ideas have already been formed regarding the acceptable level of the presence of flaws with 100-percent inspection of groove joints for the case when the welding technological process has already been sufficiently debugged.

A level of the presence of flaws of four to six percent is satisfactory for manual methods of welding pipelines, and two to three percent for mechanized and automatic methods, and for robotized processes it will apparently equal not greater than 0.5 percent. Exceeding this level of presence of flaws testifies to trouble in the welding process. A considerable lowering of the level of the presence of flaws speaks of violations in the area of inspection.

By a decree of the board of Minneftegazstroy [Ministry of Construction of Oil and Gas Industry Enterprises], ways have been designated for further improving welding work in pipeline construction. Measures are being taken to raise the technical level of welding based on the extensive use of automation and advanced technology and improvement of the system for controlling the quality of welded joints.

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CSO: 1822/61

PIPELINE CONSTRUCTION

UDC 621.643.002.2+331.876.4

URENGOY-CENTER PIPELINE AHEAD OF SCHEDULE

Moscow STROITEL'STVO TRUBOPROVODOV in Russian No 9, Sep 83 pp 8-9

[Article by L.N. Sokolova: "Ahead of Schedule"]

[Text] Included among the leading subdivisions of the industry is the combined production line from the Mosgazprovodstroy [Moscow Trust for Gas Pipeline Construction] trust headed by A.K. Buyankin. This team, formed in August 1982, successfully worked on the route of the Urengoy-Pomary-Uzhgorod export gas pipeline. Here the line constructed a 100-km section from the Sura River to Pochinkovskiy Rayon in Gorkiy Oblast.

The experience gained on the route of the export trunk pipeline is being used extensively in construction of the new Urengoy-Center gas trunk pipeline. The work is proceeding considerably ahead of schedule. The high pace is being achieved because of the use of advanced technology and the introduction of effective suggestions by efficiency experts.

The disjoint straight-line flow method of welding is being used extensively. Up to 800 m of pipeline per day are being welded by the crew of USSR State Prize Winner V.I. Satarov. Furthermore, it is providing work of high quality.

Assigned to the crew is a railway mobile power plant which includes a tractor with an electric power station and a machine with a modernized welding rectifier, which makes it possible for four welders to operate simultaneously. For the purpose of speeding up the work, an elongated boom is being employed, by means of which the zone for preliminary heating of the joint is removed from the welding zone by a length of pipe. Both the railway mobile power plant and the boom are the crew's own invention.

V.I. Satarov's crew came out with the initiative of laying 120 km of the pipeline per year. This initiative was supported by the earthmoving and fixed welding crews, pipelayer machinists and pipe-length hauler drivers. The momentum provided by the leading workers brought the entire production chain of the line into action.

High production figures are being achieved by the insulation-laying column of Hero of Socialist Labor V.P. Tsvetkov and the crew of earthmovers from SUZR-4 [expansion unknown] headed by S.V. Babkin.

Not inferior in high proficiency to V.I. Satarov's crew is the crew of V.V. Navozov, who has been leading welders already for 30 years. The shock work of V.V. Navozov has been honored with government awards. He has been awarded orders of the Friendship of Nations and the Red Banner of Labor and the "Medal of Honor." Also working here is V.V. Navozov's teacher--mentor N.S. Martynyuk, who has devoted more than three decades to pipeline routes. Crews headed by V.V. Tumanov and S.V. Teplov are doing excellent work at welding bases.

The team of A.K. Buyankin's combined production line has assumed the obligation of completing construction of the straight-line section of the trunk line by the holiday of the Great October Revolution, two months before the planned deadline, and it is planned to increase labor productivity by 0.6 percent and to gain an above-plan profit of 10,000 rubles and 12,000 rubles from the introduction of efficiency expert suggestions.

The pace adopted by the production line testifies to the real possibility of successfully reaching the limits designated.

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PIPELINE CONSTRUCTION

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RESISTANCE WELDING OF FIXED GROOVE JOINTS

Moscow STROITEL'STVO TRUBOPROVODOV in Russian No 9, Sep 83 pp 10-13

[Article by S.T. Kuchuk-Yatsenko, Institute of Electric Welding imeni Ye.O. Paton, Kiev]

[Text] The key advantages of resistance welding, in particular, the possibility of total automation of the process, high productivity, and elimination of welding materials, are especially perceptible in welding fixed groove joints. With an increase in the diameter of pipes, the effectiveness of this method increases as compared with arc methods of welding. The labor intensiveness of the latter increases in proportion to an increase in the diameter and thickness of the wall, but with resistance welding these factors do not exert an important influence on the productivity of the process.

In the last decade the efforts of scientists and designers of the teams of IES [Institute of Electric Welding] imeni Ye.O. Paton, the Gazstroy Mashina Special Design Bureau Kiev Branch and VNIIST [All-Union Scientific Research Institute of Construction of Trunk Pipelines] have been directed toward the creation of a range of machines for resistance welding of fixed groove joints in pipelines of primarily large diameter. For this it was necessary to solve complex scientific and engineering problems relating to improving the welding technology and to systems for automatically controlling the design of key units of welding equipment.

In welding fixed groove joints of pipes under field conditions the number of unfavorable factors influencing the stability of the flashing process and the stability of the quality of joints increases considerably (insufficient accuracy of assembly of pipes prior to welding, worsening of quality in scraping pipes clean, and effect of atmospheric conditions on the process). This makes it unacceptable to utilize the principles of strict programming of the flashing process used in traditional methods of resistance welding. In addition, in welding such large cross sections (up to 100,000 mm²), in view of the limited power of power supplies it is difficult to ensure a stable flashing process at its various stages.

With an increase in the diameter and area of the cross section of pipes there is a drastic increase in the power requirement and the weight of machines,

and there are heightened requirements for the relative precision of alignment devices.

A no less complex problem is ensuring failure-free operation of complex electrical and hydraulic systems for controlling welding machines under the extreme conditions of the Extreme North.

These problems were solved by developing a new welding technology and fundamentally new units of machines, such as welding transformers having very low short-circuit impedance, systems for controlling welding parameters and programming, machine drives, and new devices for scraping clean and removing burrs.

The new welding technology is based on the results of studies of the heating of metal with intermittent flashing and new principles for programming and controlling the flashing process. In particular, it was demonstrated that in welding pipes of various diameters (114 to 1420 mm) the welding process can be controlled according to a single standard program (Fig 1) including three basic periods. During the first period, when fusion of the edges of pipes and irregularities on their ends takes place, the feed rate, v_p , is automatically adjusted as a function of the size of the welding current and the no-load voltage of the welding transformer, U_{2khkh} , is kept constant. During the second period, the feed rate remains constant, but the voltage can vary according to an assigned program depending on the thickness of the pipe's walls. During period III an increase in the rate takes place with variable acceleration up to an assigned value, and the duration of this period is reduced to a strictly defined minimum value. The voltage remains constant at the controlled level.

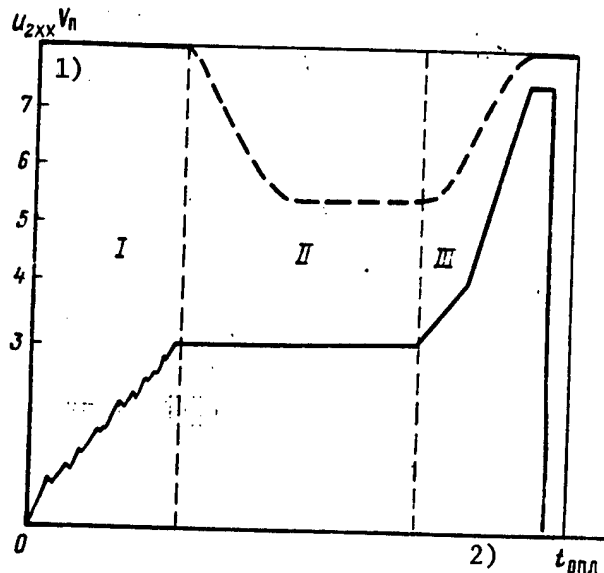


Figure 1. Standard Program for Changing Key Parameters in Welding of Pipes

Key: 1. No-load voltage, feed rate 2. Flashing time

At the concluding stage of the process compression of the parts being welded--upsetting--takes place. The amount and rate of deformation of the heated metal in upsetting exert an important influence on the quality of welded joints. Regardless of the conditions for the operation of machines, it is necessary to provide deformation amounts and rates specified by the program. One of the distinctive features of the programming system described is the difference in criteria for controlling the welding process at its various stages. For example, at the initial stage of the process the presence of interruptions and short circuiting is permitted, but at the final stage these deviations are completely impermissible. At the second stage the feed rate is held constant, but variation of the voltage over a wide range is possible. Because of this, stable heating and formation of joints are achieved with a fairly wide range of permissible deviations of certain parameters influencing welding quality (inaccurate assembly of pipes prior to welding, poor scraping clean of pipe surfaces at pipeline sites, excessive resistance of the machine's welding circuit as the result of its overheating and contamination of two-way make-before-break contacts).

The programming system used makes it possible to efficiently control and predict the quality of welded joints, since it makes it possible to isolate clearly the influence of each parameter determining welding conditions on the quality of joints. Therefore, the analysis of deviations of these parameters from the values specified by the programs at various stages of the process makes it possible to evaluate the quality of joints immediately after the performance of welding.

Implementation of the processes suggested for programming the process and controlling it is possible if the systems for providing power to and controlling the welding machines enable stable flashing with fairly low no-load voltages of the welding transformer (6 to 8 V). With higher voltage the stability of the quality of joints is reduced. In order to fulfill this condition, fairly low impedance of the welding circuit and the power supply is necessary. It is more difficult to solve this problem the greater the cross-sectional area. Designs developed for welding ring transformers used in K700 machines make it possible to lower the short-circuit impedance by a factor of six to eight as compared with certain steady-state machines, which makes possible stable flashing of pipes with a cross section of up to 100,000 mm² with average power requirements of 6 to 8 W/mm². Here standard mobile electric power stations with a capacity of up to 1000 kW are used.

The employment of high-speed speed controls based on a hydraulic servo-mechanism made it possible to solve the problem of precise reproduction of assigned programs for varying the speed and controlling it as a function of the welding current, as well as the amount of deformation in upsetting, regardless of a change in operating conditions (which is especially important under conditions of the Extreme North).

It must be mentioned that the necessity of operation of all control systems of resistance welding machines under field conditions required a radical change in the design of their key units. High reliability of the hydraulic and electrical systems of machines was achieved on account of their modular

design in combination with the creation of a microclimate for individual modules especially sensitive to a change in temperature and humidity of the environment.

These features of the technology and design of systems for controlling the resistance welding process formed the basis of the creation of second-generation machines for pipes 114 to 1420 mm in diameter.

The K584 machine for resistance welding of pipes 114 to 325 mm in diameter with a wall thickness of 6 to 20 mm has a weight of 2.5 tons. Its productivity is 12 to 15 groove joints per hour. In the machine maximum use is made of unified units tested in K355 rail welding machines, which have been series produced since 1970 (transformers, hydraulic pump units, hydraulic cylinders, rods, etc.). Unified modules were used for the programming device and the speed control, enabling execution of the programs specified. The series production of these machines has been mastered since 1982.

The K700 machine for welding pipes 1420 mm in diameter has an intrapipe design (fig 2 [photograph not reproduced]). It can move inside a pipe by means of a self-propulsion drive. It solves the problem of rapidly rebaseing of the machine from groove joint to groove joint and accurate placement of it at the point where pipes are joined. With an intrapipe design for the machine it becomes possible to reduce its weight and dimensions to the maximum, which is one of the main conditions for the creation of highly mobile resistance welding machines suitable for use under field conditions. The weight of the machine is 26 tons, i.e., the maximum for a mechanism containing two power presses. The time it takes to weld pipes 1420 mm in diameter with a wall thickness of up to 20 mm is 180 to 200 s.

Up to the present time more than 50,000 groove joints have been welded with K584 machines, primarily in field pipelines, and about 10,000 groove joints with K700 machines. All these groove joints are performing successfully.

Welding Technology

The principles of programming and controlling key parameters forming the basis of welding technology ensure high and stable quality of welded joints. This has been confirmed by the results of mechanical tests of more than 500 test groove joints in 114- to 315-mm-diameter pipes and 100 groove joints in 1420-mm-diameter pipes. The greater part of groove joints in 1420-mm-diameter pipes were welded during the winter at temperatures of -30 to -45° C, actually without restrictions with regard to weather conditions. Deviations were observed in assembly of the pipes prior to welding and in the accuracy of trimming the ends and cleaning, and various power supplies were used. In spite of this, the control systems enabled execution of the assigned programs for variation in parameters. In recent years a technology for welding pipes made of enhanced-strength steel of the Kh67 and Kh70 types has been mastered successfully. Single pipes and sections up to 36 m long have been welded. Variation in the lengths of pipes over this range did not exert a negative influence on the performance of the machine's drive and the stability of the flashing process. Nevertheless, in

a number of cases it was necessary to impose stricter requirements on the assembly of pipes. In particular, the need was established of limiting the variation in the thickness of pipes welded by the resistance method to not more than 10 percent of their thickness.

Control of Quality of Welded Joints

On-line checking of key parameters by recording them with a multichannel recorder and comparing them with standard programs was used as the basic form of control. Much statistical data testifying to the high efficiency of this method and relating to the control of tens of thousands of groove joints have been accumulated. Since the majority of groove joints, in addition to on-line testing, were subjected to non-destructive ultrasonic testing, including the control groove joints cut from a pipeline for mechanical tests, it is possible to compare the results of testing by both methods. In practically 100 percent of groove joints rejected by on-line testing, impermissible flaws were discovered, whereas the results of ultrasonic testing were confirmed in 80 to 85 percent of cases.

The American firm MacDermott made a study of more than 300 groove joints in pipes 920 to 1020 mm in diameter with a wall thickness of up to 25 mm, welded on a K775 machine designed by IES imeni Ye.O. Paton and sent to the firm in accordance with a licensing agreement. In welding groove joints, conditions were created for violating the welding technology for the purpose of producing flaws in joints. All joints were subjected in various laboratories to ultrasonic testing and high-resolution radiographic inspection. As follows from the firm's report, there are no cases of the detection of flaws by these non-destructive methods with the absence of impermissible deviations recorded by on-line checking. Good correlation was found in processing groove joints by the three methods. These data also confirm the high effectiveness of the on-line checking system employed.

In addition to on-line checking, it is necessary to make measurements of geometrical deviations of the height of the weld and of displacements of edges. Up to the present time these operations have been performed visually, which reduces their efficiency. Therefore, the creation of systems for mechanized measurement of the geometrical dimensions of welds with subsequent recording of measurement results is a first-priority goal.

Organization of Work in Resistance Welding of Pipes

In welding pipes with K584 machines under field conditions the following system for organizing the work is used. The welding head is set by means of the pipelayer at the ends of the prejoined pipes. Final alignment of the pipes takes place when their ends are pressed. A standard 200-kW electric power station, which is transported on the pipelayer's trailer, is used to supply electric power to the machine.

Prior to welding, the ends of the pipes are cleaned by means of a hand tool. For the purpose of removing inside burrs, heads with cutters are used, installed on a boom which is inserted into the pipe. Internal

burrs are cut off in the hot state. The boom is moved by means of a tractor. External burrs are cut off in the hot state immediately after welding by means of blades installed in gripping devices on the welding machine. The system is attended to by a crew of eight men.

At the present time enterprises of Minneftegazstroy [Ministry of Construction of Petroleum and Gas Industry Enterprises] are making highly mobile systems based on swamp vehicles.

The system for organizing the work in welding pipes 1420 mm in diameter up to 12 m long by means of the "Sever-1" system is presented in Fig 3. The pipes are scraped clean prior to welding by means of unit 2, which is suspended on the boom of the pipelayer, 1.

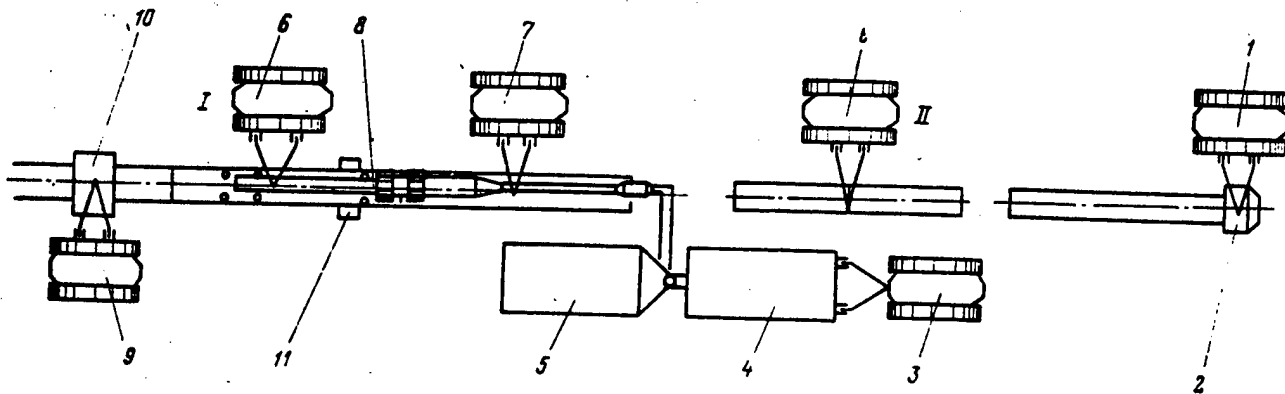


Figure 3. Diagram of Organization of Work in Welding Fixed Groove Joints in Pipes 1420 mm in Diameter by Means of K700 Machines

The length of pipe to be welded, of the pipelayer with the welding machine, 8, on it, is held by the pipelayer, 6, which is at position I. The pipe to be welded is held by pipelayer 7. The welding machine, via a boom and electrical connectors on its end, is connected by means of a flexible cable to electric power station 4 and the control equipment, placed in car 5. The electric power station and car are transported by means of truck tractor 3. After the welding, the pipelayer, 6, releases the pipe length and moves to position II, where it "makes fast" the new pipe. The pipe length is held by pipelayer 7 and the welding machine moves to the edge of the length, and the electric power station is rebased with it at the same time. After welding every four groove joints, the length is lowered onto a prepared support, 11. The connectors are disconnected from the boom and the pipe to be welded is put by pipelayer 6 onto the boom and the front part of the machine, after which the cables are again connected to the boom. Alignment and pressing of the pipes and welding are performed. Internal burrs are removed in withdrawal of the machine after welding, and external burrs by means of a separate burr remover, 10, which is transported by pipelayer 9. The system is attended to by a crew of 12 people. The calculated productivity of the system is eight groove joints per hour.

Lower productivity is achieved under actual conditions. The basic potential for increasing it is the use of mobile supports, preparation of the work front and elimination of pipe cleaning operations.

Experience gained in using resistance welding testifies to the possibility of the extensive introduction of this method in the construction of various pipelines. Minneftegazstroy and Mingazprom [Ministry of the Gas Industry] in conjunction with IES imeni Ye.O. Paton have specified first-priority goals for the next few years which will make it possible to implement designated plans for the extensive employment of resistance welding.

IES imeni Ye.O. Paton in cooperation with the Gazstroy Mashina Special Design Bureau Kiev Branch, VNIIST [All-Union Scientific Research Institute of Construction of Trunk Pipelines] and other organizations have developed a third generation of welding machines. In the manufacturing stage are a new external pipe machine for pipes 377 to 530 mm in diameter, as well as the K800 intrapipe machine for pipes 1020 to 1420 mm in diameter, which is able to perform welding in bending sections of pipelines. Mastery of the series production of these machines will make it possible to use resistance welding in practically all pipelines under construction. Development and testing have begun on devices for measuring and recording the amount of gain and displacement of the edges of the weld immediately after welding. Their use will make it possible to automate inspection completely and to eliminate the influence on it of subjective factors.

Devices for the automatic rejection of groove joints from the results of on-line inspection in the process of performing welding have passed tests. With the presence of deviations of welding parameters from the assigned at any stage of the process, welding is automatically interrupted and pipes are moved to the starting position. Work is under way on the creation of systems for automatically interpreting recorded parameters with the output of information in digital code suitable for entry into a computer memory.

Several types of new experimental burr removers making it possible to cut off internal burrs with great accuracy have been developed and manufactured and have passed tests.

Studies are being conducted on the weldability by the resistance method of a wide range of different types of steel. It has been found to be possible in principle to join pipes 1420 mm in diameter with a wall thickness of up to 20 mm in 1.5 to 2 min. For this it is necessary to impose stricter requirements on the accuracy of the assembly of pipes and to create special-purpose power supplies for welding machines.

In recent years the problem of welding small-diameter pipes (57 to 80 mm) under field conditions has become quite urgent. In Minneftegazstroy alone the extent of welding of such pipes numbers many hundreds of kilometers. For the purpose of resistance-welding them, the K255L mobile rail welding machine has been re-equipped and on its basis a high-productivity mobile system has been made. The time for welding pipes by the resistance method, including the operation of cutting off burrs, equals a total of 15 to 20 s.

In addition to this unit, at IES imeni Ye.O. Paton special-purpose miniature heads are being developed for resistance welding of pipes 30 to 114 mm in diameter. It is planned to manufacture the first models of these machines in 1984.

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INTRODUCTION OF 'STYK' AUTOMATIC WELDING SYSTEM

Moscow STROITEL'STVO TRUBOPROVODOV in Russian No 9, Sep 83 pp 13-14

[Article by M.G. Lerman, Ukrtruboprovodstroy [Ukrainian Pipeline Construction] Trust, Kiev]

[Text] The Ukrtruboprovodstroy trust is annually introducing about 400 km of 1220- to 1420-mm-diameter gas pipelines. Three hundred and fifty electric welders are employed in four subdivisions performing welding and assembly work. Taking into account the cramped time period for laying the Urengoy-Uzhgorod gas pipeline and the change to the straight-line flow method of construction, the trust was faced with the problem of increasing the pace of welding work by automating the welding of pipe sections into a line.

Paying attention to the features of construction in the territory of the Ukrainian SSR (ramified network of transport lines; considerable number of rivers, lakes, drowned estuaries and irrigation systems; swampy sections; rugged terrain; and, most important, the high value of fertile soil), the management of the trust decided to use automatic arc welding of sections into a line by means of a powder wire with forced formation of the weld. The essence of this process consists in the following: The powder wire is supplied to the melting chamber bounded by the edges to be welded and the surfaces of the root layer and forming block. After excitation of the arc, a weld pool is formed, consisting of the molten base and electrode metal, which is protected from the surrounding atmosphere by slag and gas formed in melting of the core of the powder wire.

At the present time "Styk 04" systems are being manufactured for automatic welding of pipes with a powder wire with forced formation of the weld. The system consists of three units and an engineer's shop and is designed for welding filling and facing layers on pipes 1420 mm in diameter. Since 1983 the system has been furnished with two removable clamps for welding pipes 1220 mm in diameter.

Technical Data of "Styk 04" System

Welding current, A	300 to 450
Arc voltage, V	24 to 26
Welding rate, m/s	1.4×10^{-3}

Wire feed rate, m/s	4.2×10^{-2}
Diameter of wire, m	2.3×10^{-3} to 3.0×10^{-3}
Overall dimensions of unit, m:	
Length	4.0
Width	2.6
Height	3.5
Weight, kg	16,500

The power unit (self-propelled and based on a TT-4 tractor) is outfitted with a DEA-100G-M1 electric power station, three VDU-504 rectifiers, a unit for feeding and cooling water and control cabinets.

The mobile non-self-propelled engineer's shop is designed for heat treating the powder wire and coiling it and is outfitted with a drilling machine, a vise and the required tools. The dimensions of the workshop are 2.41 x 5 x 2.9 m and it weighs 6 t.

In constructing the Urengoy-Uzhgorod gas pipeline two "Styk 04" systems were used in two subdivisions of the trust. Welding by employing the "Styk 04" system was performed in the following manner.

The fixed-welding crew consisted of four units.

The first unit made up of a tractor crane operator and a rigger unloaded sections of pipe and laid them out and carried out the rejection process. The second unit took care of assembly and manual welding. Here the root was welded and the "hot pass" by means of electrodes with an organic coating, and one filling layer was executed by means of electrodes of the "Shvarts IIIk" type. An AS-81 welding unit was used as the welding source. The second unit was made up of a tractor crane operator, a rigger, a bulldozer operator, a crew leader, a fitter-pipelayer, a welding unit operator and five electric welders.

The third unit took care of welding of the filling and facing layers in a single pass by means of the "Styk 04" system. Two units were used, which worked through a groove joint; the third unit was a standby unit. Unit No 3 included two welding unit drivers, a fitter-pipelayer, an electrician and four welder operators. The fourth unit, consisting of an ADD-305 welding unit operator and an electric welder, corrected flaws which were found.

Flaw areas were eliminated by grinding them out, followed by welding up.

A crew with the structure indicated makes possible a rate per shift of 700 m of 1420-mm-diameter pipeline (20 to 22 groove joints) prepared with insulation. Working in a crew are six welders and four operators. A similar rate is provided by a crew performing manual welding of pipe sections into a line and consisting of 18 to 20 electric welders.

Thus, utilization of the "Styk 04" system makes it possible to increase two-fold labor productivity in welding operations.

By means of the first "Styk 04" system 120 km of a section of the Urengoy-Uzhgorod gas pipeline were welded and 40 km by means of the second. The third system is now being used in construction of the Krasnopol'ye-Radushnoye gas pipeline. Automatic welding of the 1220-mm-diameter gas pipeline is also being performed in a single pass with a "hot pass" (it is not necessary to weld a filling layer).

Here welding of a gas pipeline consisting of single pipes is being tested. Three units are working in a crew with three units of the system, and one unit is working on repairs. The crew's labor productivity per shift is 500 to 600 m of a gas pipeline consisting of individual pipes. With the absence of a pipe welding base (in case of the elimination of seasonal fluctuation in the work) the removal of pipe sections is facilitated, the possibility of poisoning crops is reduced, and the control of welding and assembly operations is simplified.

Thus, the extensive use of automatic welding by means of a powder wire has become an important element of the welding process in the Ukrtruboprovodstroy trust. On the other hand, introduction of the "Styk" system has involved several difficulties. The system is mastered in two to three months as a rule. This is due to the time needed for assembly, debugging and achieving high quality of welding work, which to a considerable degree depends on the skills of operators. Usually young welders having the desire to master the new welding technique are used in the job of operator. On the other hand, the length of their training at the Ufa school for welders is inadequate. It must be taken into account that preparation of a welded joint for welding by means of the "Styk" system has several peculiarities. For example, the gap is set with minimal tolerance, e.g., for pipes 1420 mm in diameter it equals 1.5 mm (when welding the root by means of electrodes with an organic coating); the substrate for automatic welding must be uniform without rolls and flaws. It is necessary that the depth of the melting chamber (a single pass) not exceed 8 mm, and of the upper semicircle in the 11 to 1 section (clock face), 7 mm.

In the process of mastering automatic welding with a powder wire, which, as a rule, is performed on spools and only with the presence of on-line inspection, reasons for the formation of flaws have been discovered (incomplete fusion, pores and burn-throughs) and methods have been determined for eliminating them.

A flaw in the form of incomplete fusion is associated not only with a change in the angle of attack of the wire (in the overhead position the wire is set along a tangent to the surface of the pipe and in the welding process the slope of the wire in the upper quarter equals 30 to 40 degrees relative to the tangent to the surface of the pipe).

In welding pipes with a wall thickness of 15 mm and more, because of reduction of the volume of the melting chamber of the weld pool, incomplete fusion can form along edges, as well as incomplete fusion between layers. Removal of heat to the base metal from the pool increases with an increase in the thickness of the wall. Its intense peripheral overcooling takes place.

This process occurs especially intensely with a negative temperature of the environment, when the base metal of the pipe is cooled to a temperature below -12°C . The blocks (cooled in the winter time by means of "Tossol") also have the temperature of the environment prior to welding. This is one of the reasons for incomplete penetration of initial sections of the weld and the upper semicircle, where the weld pool under the effect of gravitational forces increases the area of contact with the base metal and block.

For the purpose of stabilizing the distribution of heat in the weld pool and for achieving a relatively uniform temperature in it, the trust in conjunction with IES imeni Ye.O. Paton has developed and introduced an original-design oscillator which provides an oscillating frequency of up to 4 Hz. The oscillator present in the system provides an oscillation frequency of 1 Hz, which is clearly insufficient.

The elimination of burn-throughs (in the majority of cases in the overhead section) consists in performing an internal backing run of the root layer in the section between numbers 5 and 7 (of the clock face).

It is advisable that the manufacturing plant supply powder wire in 10- to 12-kg reels. This eliminates rewinding of wire under route conditions and reduces spilling of powder.

Utilization of the "Styk 04" system is possible only with on-line quality control. This means that the interval between the completion of welding and issuance of a conclusion regarding quality of the welded joint should not exceed 24 h, and the analysis of flaws makes it possible to reveal the reason for their formation. The entire extent of welding by using the "Styk 04" system is being checked by gamma ray inspection.

Tests performed in the construction section of the Urengoy-Uzhgorod gas pipeline demonstrated the high reliability of welded joints performed by automatic welding with a powder wire.

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ULTRASONIC QUALITY CONTROL OF WELDED JOINTS IN GAS PIPELINES

Moscow STROITEL'STVO TRUBOPROVODOV in Russian No 9, Sep 83 p 15

[Article by G.A. Nikolayev and N.P. Aleshin, MVTU [Moscow Advanced Technical School] imeni N.E. Bauman]

[Text] In connection with the intense mastery of gas fields in regions of West Siberia and the Extreme North, plans have been made to speed the pace of the introduction of large-capacity gas trunk pipelines with high-quality construction. Welding is one of the key production processes and the reliability of operation of the gas trunk pipeline as a whole depends to a considerable extent on the quality of its execution.

The quality of welding is determined by a number of organization and technical factors, the main one of which is the level of technology achieved.

As a result of the work of IES [Institute of Electric Welding] imeni Ye.O. Paton, as well as of VNIIST [All-Union Scientific Research Institute of Construction of Trunk Pipelines] and other organizations, modern equipment has been created and a technology has been developed whose use with the appropriate organization of labor makes possible high welding quality.

Nevertheless, in spite of the high level of welding technology, flaws, impermissible for operation, which can become the reason for an emergency situation, for a number of reasons originate in groove welds in pipelines. Therefore, the timely detection and elimination of flaws is an important problem of pipeline construction. Up until recently the only method of inspecting annular welded joints in 1420-mm-diameter gas pipelines was the radiographic. But the radiographic method, in addition to advantages, possesses a number of important disadvantages as compared with the ultrasonic. In the radiographic method of inspection the guarantee of detecting cracklike flaws (drawn-together cases of incomplete fusion, cracks, and the like), which often form in welds and as a rule are responsible for subsequent emergency situations, is poor. The ultrasonic method of inspection reveals flaws in the form of pores, cracks and incomplete penetration in items made of low-alloy carbon steel with a thickness of 5 mm and more. Ultrasonic inspection considerably surpasses radiography in terms of productivity—by a factor of two to three with manual inspection and five to six with automated.

The use of ultrasonic inspection in the entire world has reached 75 to 80 percent in terms of volume, whereas the volume of radiography is 10 to 12 percent. Guided by these considerations, MVTU imeni N.E. Bauman in conjunction with VNIIST since 1980 has been doing work on the creation of equipment and a technology for ultrasonic inspection of welded groove joints in 1420-mm-diameter pipelines.

A manual method of inspection was introduced at the first stage. For its implementation special wear-resistant transducers with improved characteristics were developed. Inclined transducers with a prism angle of 45 degrees, made of acrylic plastic and a reject level for a 6-mm² corner reflector were recommended.

By the improved inspection procedure, from 1980 through 1982 more than 6000 fixed-welded groove joints were inspected at bases by the manpower of MVTU and VNIIST. Sample comparisons of the results of ultrasonic testing with the data of fractographic analysis demonstrated the high reliability of ultrasonic flaw detection.

For the purpose of enabling the performance of work under winter conditions and obtaining an objective inspection document, MVTU imeni N.E. Bauman in conjunction with VNIIST did a combination of work on the creation of equipment for automated inspection of 28- to 1420-mm-diameter pipelines.

An operating model of a unit has been created at the present time and tested under production conditions, a distinctive feature of which is high informativeness, sensitivity and productivity and relatively low weight (about 35 kg). Not only the range and relative extent, but also the type and orientation of flaws in a weld are recorded on an ultrasonograph. The unit makes it possible to reveal volumetric flaws measuring 0.6 mm and more and plane flaws 0.5 mm² in area. Identification of the nature of flaws in thin-walled joints is made possible on account of the employment of specially developed acoustical systems. It takes 10 to 11 min to inspect a single 1420-mm-diameter groove joint. For the purpose of enabling acoustical contact at a temperature down to -40 °C, a magnetic fluid is used which is contained by means of magnets specially built into the body of the transducer. The employment of automated ultrasonic inspection will make it possible to reduce considerably the cost of inspection because of an increase in productivity and dispensing with expensive x-ray film, and, the most important thing, will increase the accident-free performance of gas pipelines on account of more reliable and efficient detection of impermissible flaws.

The introduction and mastery of ultrasonic inspection in fixed-welding sections of trusts of Glavsibtruboprovodstroy [Main Administration for Construction of Pipelines in Siberia] confirmed the high efficiency of this kind of inspection and because of this the ability to control the quality of welding work. For example, in three days from the beginning of the introduction of ultrasonic inspection the level of rejects for a number of administrations was reduced from 30 to 40 percent to 1 to 3 percent.

Preliminary results obtained at a number of sites of Minneftegazstroy [Ministry of Construction of Petroleum and Gas Industry Enterprises] doubtlessly testify to the high effectiveness of the application of ultrasonic flaw detection. The introduction of this method on the scale of the entire industry will make it possible to solve a major problem--to improve the reliability of gas trunk pipelines. For the fastest solution of this major problem the efforts not only of MVTU and VNIIST are required, but also of a number of other leading organizations such as IES imeni Ye.O. Paton, the Volna [Wave] NPO [Scientific Production Association] and TsNIITmash [Central Scientific Research Institute of Machine Building Technology].

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DEVELOPMENT PROSPECTS FOR NON-DESTRUCTIVE TESTING EQUIPMENT

Moscow STROITEL'STVO TRUBOPROVODOV in Russian No 9, Sep 83 pp 15-18

[Article by N.M. Yegorychev, R.R. Khakim'yanov, M.Kh. Khusanov and S.A. Fal'kevich, VNIIST [All-Union Scientific Research Institute of Construction of Trunk Pipelines]]

[Text] Non-destructive control of the quality of welded joints in the industry is, as a rule, of a complex nature--radiographic, magnetographic and ultrasonic flaw detection methods are used in an intelligent combination and to an intelligent extent depending on territorial and climatic conditions for construction and the category of individual pipeline sections. Practical implementation of the advantages of physical methods of non-destructive testing is thereby achieved. Radiography is characterized by high sensitivity and clear representation. Magnetographic testing is highly productive and economical. It is safe for servicing personnel and is sensitive for the revelation of extended flaws of the plane type most dangerous for the serviceability of pipelines, such as cracks, incomplete penetration, chains of slag inclusions, etc.

Ultrasonic testing is highly efficient. It is effective in revealing plane flaws with a small opening (cracks, incomplete penetration and the like), and makes it possible to make sonic tests of both groove welds performed by fusion welding and resistance welding and angular, lap and other shaped joints.

It must be mentioned that the ultrasonic method of testing with the hitherto traditional manual scanning of a groove weld is rather poorly productive and does not enable clear representation and documentation of testing results, and its use is restricted by climatic conditions. Therefore, this method is employed to an insignificant extent basically for testing welded joints of complex configuration (T-joints, insets and the like) and groove joints performed by resistance welding, where other methods are poorly suited.

Radiography and magnetography are employed to a greater extent for inspecting ordinary groove joints in trunk pipelines.

According to the existing norm-setting documentation (SNiP [Construction Standards and Regulations]), the most important rejection feature is the

depth of the flaw, i.e., its size relative to the thickness of the pipe wall. This dimension is fairly strictly limited (e.g., the depth of incomplete penetration should not exceed 10 percent of the thickness of the pipe's wall, but not greater than 1 mm). But the other two dimensions--the length and width of the flaw--have a practically arbitrary limit. This method of rejecting welded joints considerably simplifies and speeds the process of the interpretation of radiographs and magnetographs and at the same time ensures, as demonstrated by many years of experience, the required reliability of welded joints of pipelines in utilization.

One of the most important problems in non-destructive control of the quality of welding is increasing its efficiency with the high reliability of results. The 24-hour pace of welding and erection work in construction of 1220- and 1420-mm-diameter pipelines now equals not less than 1 km of a finished section and requires the efficient issuing of a conclusion regarding the quality of welded joints. This problem is being solved by maximum mechanization and automation of all testing production processes.

At the present time, in particular, for inspecting fixed groove joints the method of panoramic radiographic inspection is used, by means of automated systems including intrapipe self-propelled units with an iridium-192 radiation source with intensity of 120 Ci and higher. In inspection, roll-type x-ray film is used in RT-SSh lightproof packaging in combination with elastic shields based on salts of heavy elements, which make it possible to shorten the exposure time to the minimally acceptable limits without worsening the quality of a radiograph of a welded groove joint. A feature of this film is its triacetate-cellulose base, which possesses enhanced deformability and better adhesion of emulsion layers [1].

Photographic processing of x-ray films is accomplished in automatic developing machines of the roll type according to an approved technology which enables daily processing productivity of up to 100 groove joints in a 1420-mm-diameter pipeline with high quality of the radiographs produced.

The use of the LPM-K high-productivity mobile laboratory with a mechanized ring-type magnetizing unit [2, 3] has begun for magnetographic inspection of welded groove joints in 1220- and 1420-mm-diameter pipelines. This laboratory, designed on the basis of a TDT-55A highly passable logging tractor with a system of hydraulic drives used for controlling the ring-type magnetizing unit is suitable for various conditions of construction. The hourly productivity of magnetographic inspection is up to 8 to 10 welded groove joints in pipes 1420 mm in diameter with sensitivity of up to 5 percent. An experimental model of the LPM-K laboratory was recommended for series production and was used from August 1982 by the Mosgazprovodstroy [Moscow Trust for Gas Pipeline Construction] trust in the section of construction of the Urengoy Pomary-Uzhgorod gas pipeline in Gorkiy Oblast (settlement of Sechenovo), where it demonstrated high results in terms of productivity and reliability of inspection. For the purpose of reproducing magnetographs of welded groove joints, MD-20G magnetographic flaw detectors are used with multiparametric recording of testing results on electrochemical paper film.

The multichannel trace obtained with an image of magnetic imprints of the scattering field of flaws in the plane and a diagram of the peak values of signals characterizing the variation in the depth of flaws along the weld is a clear document of testing results and considerably facilitates the interpretation process.

Highly skilled specialists or flaw detectors (not below category 6) must interpret the results of radiographic and magnetographic inspection. The closest attention must be paid to the training of flaw detectors and to systematic improvement of their skills.

Experience has demonstrated that ensurance of the required quality of inspection and the correctness of the evaluation of welded joints is guaranteed by a multistage check of inspection results. The correctness of the conclusions of flaw detection personnel is evaluated by a field laboratory engineer (PIL) and a representative of the State Inspectorate for Construction Quality. This to a considerable extent eliminates subjectivity and improves the reliability of inspection results.

At the present time VNIIST in cooperation with institutes of the USSR Academy of Sciences and organizations of other departments is doing research and experimental design work on further improvement and development of non-destructive testing methods.

In the Area of Radiography

Precise determination of the depth of flaws from the degree of blackening of their images on radiographs involves certain difficulties.

At VNIIST studies and analyses have been made of relationships between the degree of blackening of images of flaws and their dimensions for various types of x-ray film, radiation energies of sources and inspected thicknesses of pipe walls. Based on the results of studies, a portable instrument has been developed which makes it possible to determine the depth of a flaw from the value of the optical density of its image on a radiograph with an error of not greater than 20 percent. In working with this instrument the optical density of the radiograph is measured at three points: on the base metal, on a sensitivity standard (or a simulator of one) and directly on the image of the flaw. From the data obtained a determination is made of the suitability of the radiograph for drawing a conclusion and of the depth of flaws. The scale of the pointer indicator in the instrument is graduated in absolute units--in millimeters or fractions of one [4]. The use of radiometric control is conducive to improving the efficiency of testing.

Studies have shown that by using a beam-scanning x-ray tube, as well as a tubular collimator and an x-ray detector of a special design it is possible to inspect annular welds at a rate of up to 3 m/min with sensitivity of not worse than 1 percent. With this method an image of welding flaws is reproduced on the screen of a video monitor by means of synchronized raster scanning. At the same time signals from flaws are recorded on paper tape, used as the document. Thus, the need for x-ray film is eliminated.

Another direction for improving the efficiency of testing is the creation of special diffusion photopacks for paste photographic processing of radiographs. Work done on determining the possibility of using diffusion photopacks has still not presented a clear picture. This is associated with the fact that the x-ray film of the diffusion photopack sharply lowers the contrast of images with an increase in the hardness (reduction of the wavelength) of the radiation.

In radiography of welds extensive use is made of ionizing radiation sources with energy of $3.2 \cdot 10^{-14}$ to $4.8 \cdot 10^{-14}$ J (200 to 300 keV), and the optimal radiation energy for a diffusion photopack is in the range of $1.3 \cdot 10^{-14}$ to $1.9 \cdot 10^{-14}$ J (80 to 120 keV). But this problem, in our opinion, can be solved by further improvement of the diffusion photopack (development of photopack film for energy of $3.2 \cdot 10^{-14}$ to $4.8 \cdot 10^{-14}$ J, i.e., 200 to 300 keV) or by creating low-energy ($1.3 \cdot 10^{-14}$ to $2.4 \cdot 10^{-14}$ or 80 to 150 keV) sources of ionizing radiation.

In the Area of Magnetography

With magnetic methods of flaw detection and, in particular, with magnetographic inspection, flaws lying closer to the surface of the metal than flaws of the same size but located at a considerable depth and even more so at the end of a welded groove joint are revealed much more easily and produce a stronger signal. The nature of this phenomenon is associated with the features of the formation of magnetic scattering fields from flaws and the conditions for recording them on magnetic tape.

In existing magnetographic flaw detectors it is not possible to adjust the amplitude of signals as a function of the depth of occurrence of flaws in the thickness of the metal. This to a considerable extent reduces the accuracy of the results of magnetographic inspection.

The existence of a definite interrelationship between the depth of occurrence of flaws and the parameters of signals from them has been established by studies. Some results of these studies are presented in fig 1. As the depth of occurrence of flaws increases the amplitude of signals is lowered and their duration increases monotonically. If the entire range of the durations of signals is divided, e.g., into three equal subbands (I, II and III), then they will belong to flaws occurring in the upper, middle and lower sections of the thickness of the groove weld. Now if the flaw detector's playback amplifier is divided into three parallel channels with specific bandwidths of their amplitude-frequency characteristics (Fig.2) corresponding to these subbands of durations, and the recording electrode of a multichannel recorder is connected to the output of each of these selective channels, then the signal from the flaw, passing through one of the selective channels depending on the depth of occurrence, will be recorded on the corresponding track of the trace. The sensitivity of selective channels can be tuned from standard magnetographs recorded from control samples with identical flaws occurring in the upper, middle and lower zones of the thickness of the groove weld. Thus, the possibility appears of determining the depth of occurrence of flaws and their sizes independently of their depth of occurrence [5, 6].

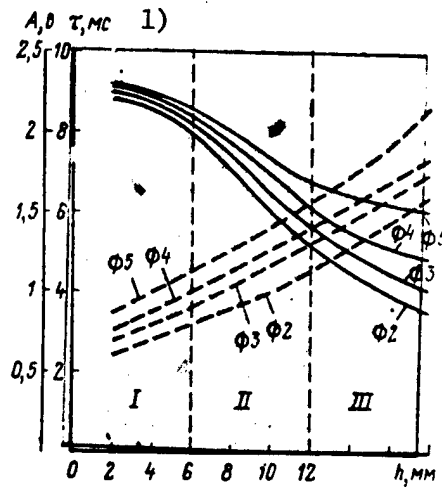


Figure 1. Dependence of Amplitude, A (Solid-Line Curves), and Duration, τ (Dotted-Line Curves), of Signals on Depth of Occurrence and Size of Flaws

Key:

1. ms

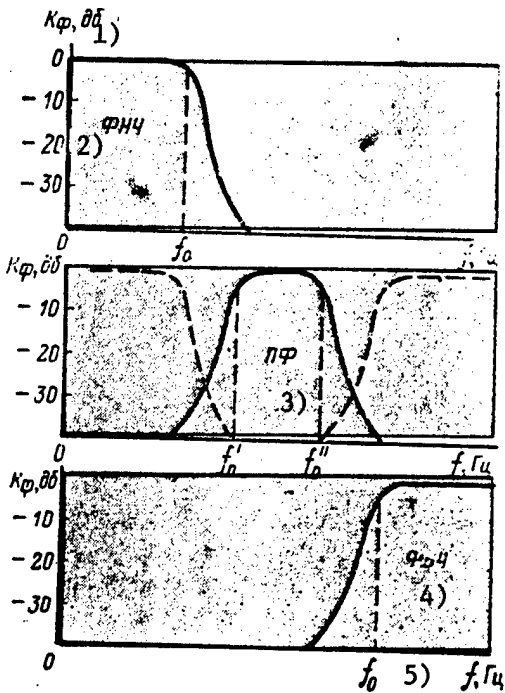


Figure 2. Amplitude-Frequency Characteristics (AChKh's) of Selective Channels of Playback Section in MD-40G Flaw Detector: K_f --filter's gain; f_0 --AChKh cutoff frequency; FNCh--low-frequency filter; PF--band filter; FVCh--high-frequency filter

Key:

- | | |
|---------------|---------|
| 1. K_f , dB | 4. FVCh |
| 2. FNCh | 5. Hz |
| 3. PF | |

VNIIST in conjunction with the Institute of Introscopy (NIIIN [Scientific Research Institute of Introscopy]) of the Spektr [Spectrum] MNPO [expansion unknown] has developed the new MD-40G magnetographic flaw detector in which the above-indicated ideas have been implemented.

As a reading sensor in the new flaw detector a magnetosensitive microferroprobe transducer is employed, which has considerably higher sensitivity (approximately 10-fold) than the induction-type playback head used in existing magnetographic flaw detectors and extensive possibilities for selective playback of a magnetic recording from flaws which differ in terms of size and depth of occurrence. An experimental model of the MD-40G flaw detector has passed interdepartmental acceptance tests and has been recommended for series production. The sensitivity and reliability of the magnetographic method of inspection will be increased considerably with the employment of these flaw detectors.

In the current year NIIIN in conjunction with VNIIST has begun research work on the creation of a method and equipment for automated interpretation of the results of magnetographic inspection using an amplitude-to-digit converter of playback signals and a microcomputer. The first series of experiments has been conducted on computer processing of signals from flaws. The printouts of playback signals obtained contain multielement information and can be used as a clear-representation document.

In the Area of Ultrasonic Inspection

The basic direction of the development of ultrasonic testing in the USSR and abroad is the creation of automated complexes making it possible not only to carry out on-line testing, but also to accomplish multiparameter registration of its results.

At the present time VNIIST, the Volna NPO and the Proyektneftegazspetsmontazh [expansion unknown] SPKB [Special Planning and Design Bureau] with the participation of MVTU [Moscow Advanced Technical School] imeni N.E. Bauman are developing a system of equipment for automated ultrasonic inspection of welded joints in 25- to 1420-mm-diameter pipelines with a wall thickness of 3 to 24 mm.

The elements of this system are acoustical and electronic systems, a device for moving the acoustical system and a recorder. A unified multichannel electronics unit is used for the purpose of inspecting welded joints of the entire range of diameters and thicknesses. The use in the acoustical system of a combination of separate and combined finders and an X-type sonic test system make it possible to determine the position of a flaw over the cross section of the weld (bottom, middle, top), as well as to classify flaws according to three types: volumetric and plane along and across the weld.

The reliability of acoustical contact is increased because of the use in the acoustical system of a low-consumption magnetic fluid. Synchronization of the motion of the device for moving the acoustical system and the tape of the recording device make it possible to determine the position and length

of a flaw along the weld. The system's recorder enables multilevel recording of the amplitude of an echo signal, the type of flaw and its position over the cross section of the weld and markers for the path traveled by the acoustical system along the weld. Various movement devices are being developed, depending on the diameter of the joint being inspected: of the clip-on type, on magnetic wheels, and of the belt type. For the purpose of inspecting welds in pipes of medium and large diameters the most promising is the variant of a dolly on magnetic wheels furnished with a device for tracking the weld. The time for inspecting a single groove joint 1420 mm in diameter by means of this system is 3 to 4 min. Experimental models of the system will be made in 1984.

The next stage in the development of ultrasonic inspection will be a shift from flaw detection to flaw measurement--measurement of the dimensions of flaws. Here in addition to pulse representation (type A) it is necessary to use raster representation also (type B and C). The first step in this direction is the creation of an ultrasonic flaw detector with electrical scanning. The ultrasonic converter in this flaw detector is a phased array of piezoelectric elements making it possible to implement the method of electronic scanning by means of the converter's ultrasonic beam [7, 8]. The use of this method will make it possible to increase the productivity of inspection by a factor of three to four as compared with traditional methods and to obtain an image of the flaw along the vertical cross section of the welded joint. In a mockup of the flaw detector which has been created the sector for electrical scanning in the metal is from 40 to 60 degrees and the number of lines in the raster is 100. Laboratory tests which have been conducted on the mockup of the flaw detector confirmed the correctness of the key technical decisions on which it is based. It is planned to make and test experimental models of a flaw detector with electrical scanning in 1986.

Employment of the method of electrical scanning will also contribute to solving the problem of obtaining a 3-dimensional image of flaws. The amplitudes and phases of echo signals will serve as the source information for a computer in constructing a holographic picture of the flaws detected.

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PIPELINE CONSTRUCTION

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AUTOMATED X-RAY FILM PROCESSING FOR WELD QUALITY CONTROL

Moscow STROITEL'STVO TRUBOPROVODOV in Russian No 9, Sep 83 pp 18-20

[Article by V.T. Kalinichenko and V.P. Soltys, Gazstroy Mashina SKB [Special Design Bureau] Kiev Branch]

[Text] With an increase in the extent of construction of trunk pipelines and heightening of requirements for their quality there has been an increase in the amount of work on inspection of groove welds, including by the radiographic method.

For the purpose of inspecting welding under route conditions, at the present time mobile and semistationary laboratories (the RML2V, LKS2-76, LKK1, etc.) are being produced, as well as automated inspection systems (AKP's). These laboratories in addition to other equipment have apparatus and equipment making it possible to perform the entire combination of work in radiographic control of welding quality (including photographic processing of exposed radiographs and formation of conclusions regarding quality), making possible under field (route) conditions on-line 100-percent or random non-destructive testing of the continuity of welds.

In preparing for performing an inspection and in processing the results of gamma raying or x-ray inspection a number of operations are performed. The most labor intensive and longest of them is photochemical processing of radiographs. Photographic processing of film on routes is performed in the bodies of laboratories with blacked-out windows (the RML2V, LKK1 and AKP's); there is a set of special equipment.

In the LKS2-76 semistationary laboratory there is a compartment (photographic section) with a set of equipment for tray processing, as well as a cabinet for drying film. This considerably improves the quality of radiographs and the speed of drying, but because of manual piece-by-piece photographic processing in trays labor productivity remains low.

Tray processing of film does not satisfy the requirements of field laboratories, especially when using high-productivity equipment, e.g., automated systems of the AKP type in which productivity in the inspection of 1420-mm-diameter pipes equals 8.5 groove joints per hour (about 100 radiographs/hour).

In laboratories of the "light-duty" and "medium-duty" type produced by Bulgaria, tank processing of film is performed. Special devices are employed for maintaining photographic solutions at constant temperature. There is also a cabinet for drying radiographic film. Water is stored in a tank with a capacity of about 60 liters. The photographic laboratory's productivity is more than 20 films per hour, measuring 100 x 720 mm.

For the purpose of satisfying all requirements imposed on the quality of radiographs, it is necessary to observe carefully the conditions for photographic processing of exposed x-ray film. Photographic processing includes development, intermediate rinsing, fixing, washing and drying. In mobile laboratories the developer and fixer are prepared in advance and are transported to the construction site in special containers.

For the purpose of achieving a high-quality radiograph it is also necessary to observe rather strict requirements for the temperature of photographic solutions and their purity and the lighttightness of the room, which is fairly complicated to provide in mobile laboratories (RML2V and LKK1) when separated from bases, especially during the winter.

In a ventilated space film hung on clips usually dries in 3 to 6 h at room temperature. The use of table fans somewhat speeds drying; however, it does not eliminate the possibility of dust falling on the wet radiograph.

For the purpose of shortening the drying time and improving its quality, special cabinets are used, where the film, stretched out on racks, is placed in a drying chamber. Here drying is accomplished by means of air which passes through a heater and is driven by a fan through rows of racks with film. These cabinets, as indicated, have been installed in laboratories of the LKS2-76 type, as well as in the Bulgarian-made laboratories. In these cabinets drying takes 20 to 40 min, depending on the air temperature.

At the present time drying of film in cabinets of the roll-type is becoming ever more widespread. However, the equipment of these cabinets cannot be used without restriction for any film produced. In principle it is possible to dry RT-1D, RT-5D, etc., film in cabinets of the roll type.

The UP41 unit for developing film and the ShS1 drying cabinet have been developed at the Gazstroy Mashina SKB Kiev Branch.

The UP41 unit (fig 1) makes it possible to perform so-called tank processing of sheet and roll film.

Technical Data of UP41 Unit

Size of film which can be processed, cm:	
Sheet	7.5 x 40, 8 x 30
Roll	7 x 460
Number of films processed simultaneously:	
Sheet	50
Roll	4

Capacity of tanks, liters:	
Developing	30
Intermediate rinsing	30
Fixing	40
Final wash	80
Working temperature range of solutions, °C	18 to 25
Supply voltage, V	220
Power requirement, W	2500
Weight with set of accessories, kg	160
Overall dimensions, mm:	
Length	1204
Width	615
Height	950

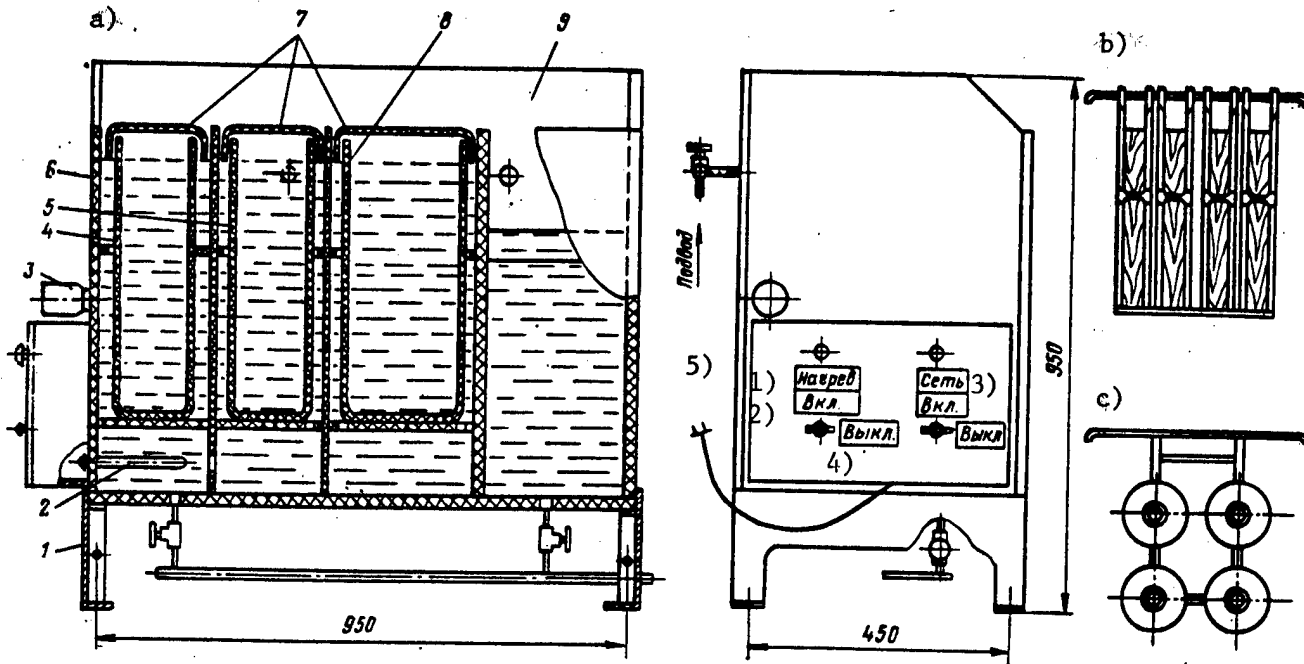


Figure 1. UP41 Photographic Processing Unit: a--general appearance; b--sheet film rack; c--hanger with reels

Key:

- | | |
|------------|-----------|
| 1. Heating | 4. Off |
| 2. On | 5. Supply |
| 3. Main | |

The unit (fig 1a) is in the form of a tank, 6, representing the unit's constant-temperature cabinet, made of welded rigid PVC sheets and fastened to a base, 1. It is divided into two sections. Each section has independent supply and drainage of water by means of valves. In the first section there are three tanks (4--for the developer, 5--for intermediate rinsing, and 8--

for fixing) with lids, 7. The second section, 9, isolated from the section with the tanks, is designed for final washing of radiographs.

In the tank of the constant-temperature compartment are installed three electric heaters, 2, for heating the water in the compartment, and a sensor—a temperature relay, 3—making it possible to set the required temperature, which is automatically maintained with accuracy of ± 2 °C. On the side wall of the compartment there is a control console on whose panel there are controls—switches and lamps. There is also safety equipment on the control panel. The unit is connected to a water supply line, and when there is none it can be filled with water from other sources.

The unit's set includes accessories for winding roll film onto reels and for loading film into tanks. X-ray sheet film is loaded into the unit by means of racks (fig 1b). The rack has four sections to accommodate the film. Fifty films can be placed in one tank with a photographic solution. X-ray roll film wound onto special reels is loaded into tanks on a hanger (fig 1c). Photoprocessing consists in the fact that the film on the racks (sheet) or on the reels (roll) is placed by the operator successively in the tanks with the photo solutions and is held for a specific time. After final washing, the film is dried.

The ShS1 cabinet is designed for drying film (fig 2).

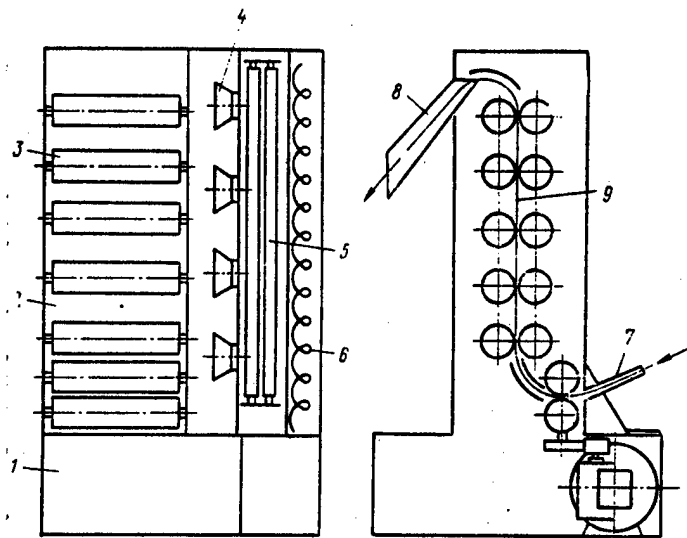


Figure 2. ShS1 Drying Cabinet

Technical Data of ShS1 Drying Cabinet

Size of film which can be processed, cm	8 x 30, 7.5 x 40
Number of films processed simultaneously	2
Drying rate, m/h	18
Drying temperature, °C	30 to 60

Supply voltage, V	380
Overall size, not greater than, mm:	
Length	720
Width	650
Height	950
Weight, kg	80

The drying cabinet is in the form of a case, 1, in which there are a drying section, 2, a block of fans, 4, heating elements, 5, and a filter, 6. The film, 9, is placed into a receiver, 7, and is then, being gripped by each pair of rollers, 3, in the drying chamber, successively pulled through the drying chamber. The rollers are designed with a rigid base onto which is put an elastic cover which enables uniform pressure on the film. Air from the room is collected by a block of fans into the drying chamber and is uniformly distributed over the surface of the film. The dried film is collected in a receiving chute, 8, in the upper part of the cabinet. The cabinet can be placed on the table alongside the developing machine.

According to preliminary data, the savings from the introduction of one UP41 unit equals 4500 rubles per year, and 13,000 rubles per year for the drying cabinet. Experimental models of the UP41 and ShS1 were made at the Kiev Experimental Mechanical Plant.

This equipment can be used in laboratories of the LKS2-76 type, as well as in any heated area adapted for photoprocessing.

The introduction of equipment for mechanized processing of film will considerably reduce input of manual labor and increase productivity and the quality of the work.

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USE OF PHOTOGRAPHIC PAPER FOR RADIOGRAPHIC INSPECTION OF WELDED JOINTS

Moscow STROITEL'STVO TRUBOPROVODOV in Russian No 9, Sep 83 pp 20-22

[Article by A.A. Adamenko, Institute of Electric Welding imeni Ye.O. Paton, Kiev]

[Text] X-ray film is used extensively at the present time in radiographic inspection. It has high sensitivity, but it is too expensive--a considerable amount of silver is used to make it. In a number of areas of industrial radiography photographic paper is used in place of x-ray film, which makes it possible to lower the cost of inspection, to observe radiographs in reflected light, and to shorten the time for processing radiographs (to 10 s for some types of paper).

Radiographic paper is insufficiently sensitive to direct x-rays. The fluorescent intensifying screens used produce considerable shortening of exposure time. For example, if instead of Kodak Indicatrix A x-ray film, Kodak Indicatrix 620 radiographic paper is used with an R7 screen, then the exposure time is shortened by a factor of 50. Then it becomes possible to lower the voltage in the x-ray tube, because of which the contrast of the radiographic image is increased. This makes it possible to compensate the lowering of the quality of radiographic inspection caused by introduction of the screen. As a result, the quality level of inspection is preserved.

The use of radiographic paper is advisable in the following cases: the productivity of inspection or its cost are of first-level importance; and providing for radiation safety involves certain difficulties, which can be overcome by lowering the dose or lowering the voltage in the tube. The use of radiographic paper is most effective in inspecting entities characterized by relatively slight attenuation of radiation (low atomic number or small thickness).

Densitometric Properties of Radiographic Paper

The operator obtains the information contained on radiographic paper by observing the radiograph in reflected light. This process is described by means of a densitometric curve, which is plotted by measuring the optical density in reflected light (fig 1). For the purpose of standardizing measurements, the following specifications are satisfied: The angle of illumination

is 45 degrees; measurement is performed in the direction perpendicular to the surface, although under real conditions the primary flux consists of directed and scattered light. It must be stressed that the argument of the densitometric curve is the surface density of the silver, unlike the characteristic curve, where the argument is the radiation exposure dose. The densitometric curve for x-ray film is given in fig 1 for the sake of comparison. This curve is linear, which corresponds to an exponential law for attenuation of the transmitted light:

$$I_2 = I_0 e^{-\mu\rho},$$

where I_0 and I_2 are the incident and transmitted light flux, respectively; μ is the mass attenuation factor for the light in the silver layer. Since the blackening density is defined as a logarithmic quantity ($D = \log(I_0/I_2)$), the dependence indicated in fig 1 by the black curve is in the form of a straight line, $D = 0.43\mu\rho$. From an experimental curve it is possible to find the value of the mass attenuation factor for the light in the silver.

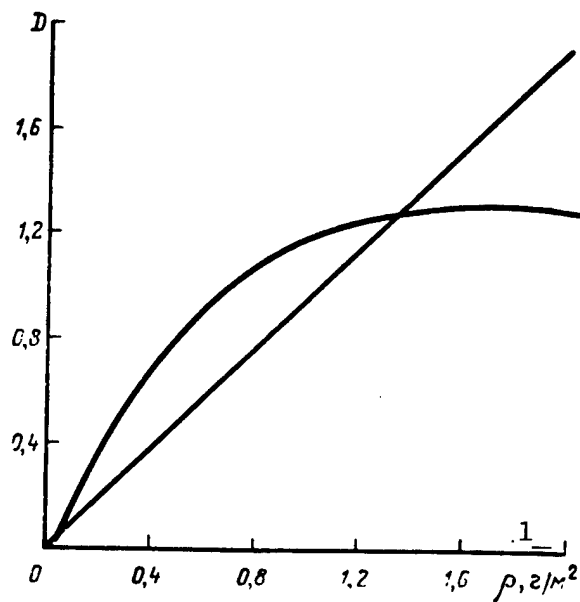


Figure 1. Dependence of Optical Density of Radiograph, D , on Surface Density of Silver, ρ , Measured in Reflected Light for Photographic Paper (Curved Line) and in Transmitted Light for X-Ray Film

Key:
1. g/m^2

In observing a radiograph in reflected light the blackening density is described by a more complicated relationship. The reflected flux registered by the operator consists of the sum of two fluxes: that reflected from the

surface of the silver and passing through the silver layer and reflected from the baryta layer and again passing through the silver layer. The expression for the reflected flux has the following formula:

$$I_1 = I_0 [K_1 + (K_2 - K_1) e^{-2.4\mu\rho}], \quad (1)$$

where K_1 and K_2 are the reflection factors for the light from the silver layer and baryta layer, respectively. Dependence (1) is presented graphically in fig 2. With the absence of a silver layer the value of the reflected flux is determined by the reflection factor for the light from the substrate, and with an increase in the surface density of the layer the reflected flux tends asymptotically to the limiting value, which depends on the reflecting properties of the silver.

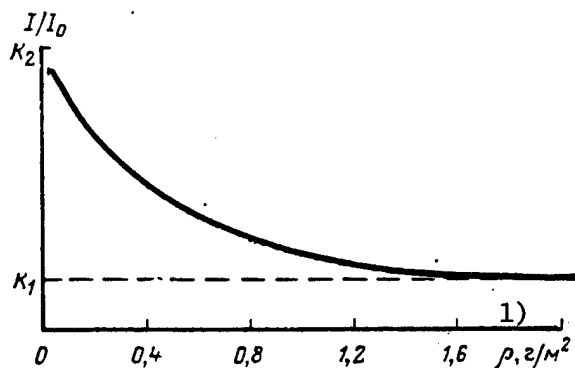


Figure 2. Dependence of Reflected Light Flux on Surface Density of Silver Layer

Key:

1. g/m^2

The densitometric curve for photographic paper is described by $D = \log \log (I_0/I_1)$, where I_1 is determined from equation (1). When employing photographic paper in flaw detection for welded joints the following range of blackening density values is employed: $D = 0.5$ to 1.2 , whereby the recommended value is $D = 1$. The width of the operating range depends on the difference $K_2 - K_1$, and a shift of the operating range in the direction of higher values of blackening density can be achieved by lowering K_1 . Thus, in the development of new kinds of radiographic paper not containing silver and not requiring wet processing it is necessary to take into account the fact that the sensitive layer must have sufficiently low light reflectance.

It should be mentioned that the description presented of the densitometric properties of radiographic paper can be used in electroradiography, where radiographs are also observed in reflected light.

Intensifying Screens

The effectiveness of the use of a specific screen - photographic paper pair depends on to what extent two spectral characteristics agree: the radiation spectrum of the screen and the sensitivity spectrum of the photographic paper. In making certain photographic papers, for the purpose of facilitating their processing in the darkroom lowering of their sensitivity to blue light is provided, which causes insufficient sensitivity of these papers when using screens. Most widespread at the present time are screens in which the fluorescent material includes calcium tungstate. In addition, screens made on the basis of rare earth elements have found application.

The screen's intensification factor increases with an increase in the thickness of the fluorescent layer. With specific thickness the intensification factor depends on the energy of the x-radiation (Fig. 3). When using screens, it is necessary to stabilize the voltage, since a small change in radiation energy exerts a considerable influence on the value of the intensification factor, as the result of which the blackening density of the radiograph deviates from the required optimal value. The highest requirements for stabilization of the radiation energy are imposed when using rare earth element screens in the range of 75 to 100 kV, where a drastic change in the intensification factor takes place.

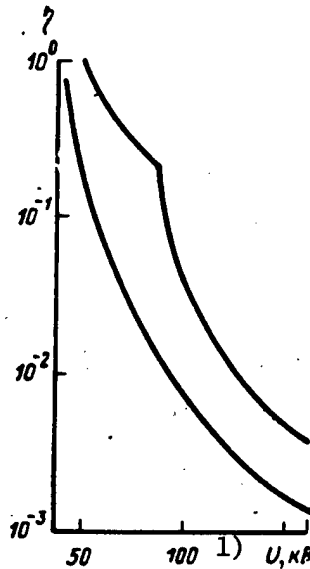


Figure 3. Relative Change in Intensification Factor, η , as Function of Energy of X-Radiation (U) for Fluorescent Screens Based on Calcium Tungstate and Rare Earth Elements

Key:

1. kV

Fluorescent screens make it possible to shorten the exposure time. But with this some lowering of the quality of radiographic inspection is usually observed. When fluorometallic screens are used shortening of the exposure time can be achieved without reducing the quality of inspection. A fluorometallic screen consists of a polycrystalline layer of tungstate applied to a thin lead foil placed on a substrate. Here the fluorescent layer is under the influence of the x-radiation and the stream of electrons emitted by the lead foil. A feature of fluorometallic screens is the uniform fine-grained structure of the fluorescent layers, because of which high quality of the radiograph is provided. The screens are fairly flexible and can be bent around pipes 80 mm in diameter without damage. The ranges of application of fluorometallic screens of various types are indicated in the table. The thickness of the fluorescent layer is about 0.1 mm for high-resolution screens and 0.2 mm for high-productivity screens. The thickness of the lead foil varies from 0.04 mm for type 08 to 0.4 mm for type 01.

Ranges of Application of Various Fluorometallic Screens of the SMP Type

<u>Energy range</u>	<u>Number of screen</u>	
	<u>High-resolution screens</u>	<u>High-productivity screens</u>
80 to 20 kV	108	308
200 to 400 kV, ^{192}Ir		
^{137}Cs	103	303
^{60}Co	101	301

When fluorescent screens are used, deviation from the reciprocity rule is observed, which imposes a limitation on the use of exposure curves arrived at in determining the value of the tube current (Fig. 4). This deviation becomes more noticeable for fluorometallic screens. At the same time these screens are characterized by a less abrupt drop in the intensification factor with an increase in the radiation energy. A temperature dependence of the intensification factor is characteristic of fluorometallic screens: with a rise in temperature from 20 to 50 °C the intensification factor is reduced 80 percent and with a drop in temperature to -50 °C it increases by a factor of 2.5; the quality of inspection is not changed with this.

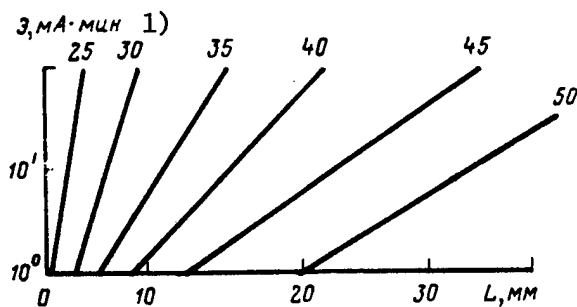


Figure 4. Dependence of Exposure, E , on Thickness of Aluminum for Various Voltage Values When Using Kodak Indica-trix Instant 620 Radiographic Paper with F1 Screen. Focal Length of 1 m, Tube Current of 20 mA)

Key:
1. E , mA·min

Industrial Application of Radiographic Paper

Radiographic paper can be used for detecting inclusions which differ in atomic number from the welded metal.

Radiographic paper can be used most extensively in the inspection of welded joints in pipelines passing through a territory of population centers. Radiographic safety and high productivity in inspection are made possible. In addition, its cost is lowered. The gain with respect to inspection cost increases with an increase in the diameter of the pipe being tested.

When laying pipelines which pass through residential buildings it is necessary to provide for the inspection of soldered connections. When radiographic paper is used radiographic inspection of these joints is performed by means of a portable x-ray unit with voltage of 80 kV, and the relative detection threshold equals 2 percent in terms of the wire standard.

The use of series-produced rolled photographic paper of the "Fototelegrafnaya BS" type in conjunction with a "Standart" intensifying screen is recommended. Also suitable are screens made of the phosphor CaWO_4 . Panoramic inspection is made possible because of the rolled design. The series-produced photodeveloping machines available make it possible to automate the photodevelopment process.

The level of the quality of radiographic inspection is being evaluated according to a procedure developed at IES [Institute of Electric Welding] imeni Ye.O. Paton and based on the use of a set of statistical standards.

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PIPELINE CONSTRUCTION

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ROBOTICS IN PIPELINE CONSTRUCTION

Moscow STROITEL'STVO TRUBOPROVODOV in Russian No 9, Sep 83 pp 22-23

[Article in "The Scientific and Technical Council of Minneftegazstroy [Ministry of Construction of Petroleum and Gas Industry Enterprises]" section, "Fulfilling the Program for Creation and Introduction of Robotics"]

[Text] The problem of the use of robotics (automatic manipulators) in line construction was discussed at a joint meeting of the section for the organization and technology of construction of trunk pipelines and the section for mechanization of construction and special construction machines of the Scientific and Technical Council of Minneftegazstroy.

At VNIIST [All-Union Scientific Research Institute of Construction of Trunk Pipelines] an analysis was made of robots and manipulators used in the USSR and abroad. In conjunction with interested organizations, a program was prepared for the creation and introduction of robotics (automatic manipulators) in the industry to 1990, including robotic facilities for line construction, welding production, welding inspection and laying pipelines under field conditions.

Working on completion of the robotization program are the Central Technical Administration, Glavneftegazstroy mekhanizatsiya and Glavneftegazpromstroymaterialy [expansion unknown], the Soyuzneftegazstroy konstruktsiya VPO [expansion unknown], VNIIST, the Gazstroymashina SKB [Special Design Bureau], the Proyektneftegazspetsmontazh [expansion unknown] SPKB [Special Planning and Design Bureau] and VNIIPitranstprogress [expansion unknown]. Plans have also been made to involve institutes, design organizations and plants of Minstankoprom [Ministry of the Machine Tool Building and Tool Industry], Minpribor [Ministry of Instrument Making, Automation Equipment and Control Systems], Minelektrotekhprom [Ministry of the Electrical Equipment Industry and Power Machine Building], Minstroydormash [Ministry of Construction, Road and Municipal Machine Building] and Minvuz [Ministry of Higher and Specialized Secondary Education] of the USSR and Ukrainian SSR Academy of Sciences.

The program for the creation and introduction of robotics (automatic manipulators) in the Minneftegazstroy system for the next few years was approved at the section meeting. It was decided to consider the basic direction for

the application of robotics to be the employment of series-produced robots and manipulators at machine building and equipment repair enterprises, in the construction industry and the building materials industry.

Serious problems calling for the direct participation of organizations of Minneftegazstroy in the development of technical documentation, the making of models and the testing and series manufacture of robotic facilities can be solved in expansion and strengthening of the industry's experimental production base. The Central Technical Administration, Glavneftegazstroymekhanizatsiya, Glavneftegazpromstroyaterialy, the Soyuzneftegazstroykonstruktsiya VPO, VNIIST, the Gazstroy Mashina SKB, the Proyektneftegazspetsmontazh SPKB and VNIIPITransprogress have been entrusted with taking the necessary measures for this. It was recommended that the control of management personnel and educational institutes of the ministry be provided for by organization specialists working on the creation and introduction of robotics into production.

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PLANNING INSPECTION CONTROL OF QUALITY OF PIPELINE CONSTRUCTION

Moscow STROITEL'STVO TRUBOPROVODOV in Russian No 9, Sep 83 pp 23-24

[Article by V.I. Orekhov, Nadym Territorial Inspectorate for Quality of Construction]

[Text] Two trends are most pronounced at the present time in the mathematical theory of design of experiments: the design of extremum experiments for revealing general principles, and for studying the mechanism of competing events.

As applied to inspection control, experimental design of the first type is suitable in choosing and validating a control program, as well as in studying the conditions which make it possible to arrive at quality indicators meeting optimal criteria for the informativeness of control. Design of the second type must be used in cases when in the control process it is necessary to establish the relationship between the level of construction quality and various design, technological, organization and other factors.

Design of the first type makes it possible to determine the sequence for the performance of control operations which makes it possible to reach the goal set with minimum input. Let us assume that in the process of inspection control it is necessary to provide an estimate of parameter L_j , characterizing the level of the quality of a specific type of building and erection work. Let us assume arbitrarily that L_j depends linearly on a certain set of factors,

$$\sum_{i=1}^n X_i.$$

The problem consists in estimating the extent of the influence of each of factors X_i on the total factor variance, Y_j . This problem generally can be solved by the methods of sensitivity theory. However, in practice there is not always a mathematical model establishing with the required accuracy the relationship between Y_j and X_i , which impedes the computation of sensitivity functions by analytical methods. In this case factor analysis

is performed, which makes it possible to determine the control factors of the regression

$$Y_j = b_0 + \sum_{i=1}^n b_{ij}X_i, \quad (1)$$

which establishes the relationships between influencing factors X_i and the controlled parameter. Under real conditions of construction influencing factors X_i are, as a rule, of a random nature and, besides, appear in various combinations. In this connection, most preferable is an inspection control plan (for revealing the influence of various factors on the quality of construction) with which a multifactor experiment is performed in random order (a so-called completely randomized control plan).

In planning inspection quality control an important factor is a thorough analysis of factors X_i , since the choice of the planning method and the method of processing control results depends to a great extent on their nature. An especially important step is screening of non-essential factors. This achieved by ranking factors in the formalized processing of control results or by performing screening experiments.

A search for optimal methods of inspection control of the quality of construction production made it possible for the Nadym territorial inspectorate to create and introduce in the experimental procedure a system of tests based on unified "inspection control charts." The chart is in the form of a table in which the first column includes the set of quality parameters determined experimentally. By the same method a determination is made of weight factors for each quality parameter controlled, placed in the second column. The third column is filled in in the process of an inspection check of the quality of construction production, by means of the alternative indicators "Yes" and "No" for each controlled parameter, which testifies to the fulfillment or violation of the specifications of norm-setting and instructional documents.

An inspection control chart is created for a specific kind of work (operation) of the organization or enterprise.

The total value of the weight factors of all controlled parameters, according to the calculation procedure, equals one. With this approach the total value of the weight factors of the group of parameters with violations represents the presence-of-defects factor, and without violations, the indicator of the quality of the kind of production, work, and the like being checked, expressed in relative units.

Having quantitative indicators of quality, the inspectorate can trace the dynamics of the level of quality, introduce the required control actions into the process of the formation of quality, and concentrate efforts on the biggest "bottlenecks."

Generalization and graphic representation of the data of inspection control charts makes it possible to perform longterm planning and forecasting of the quality level, which are totally necessary in taking into account one of the most important properties of the process of the formation of the quality of construction production--its sluggishness. If only a qualitative estimate of the influence of factors is required, then for the formalized processing of data it is suitable to employ analysis of variance. For a more precise quantitative estimate of the influence of factors it is possible to employ methods of correlation or confluence analysis, as well as the method of major components. In this case the response function of type (1) is approximated by the terms of polynomial expansion of it into a Taylor series:

$$Y_j = b_0 + \sum_{i=1}^n b_{ij}X_i + \sum_{i=1}^n \sum_{j=1}^n b_{ij}X_iY_j. \quad (2)$$

The inspection control system must always be planned in such a manner that the necessary conclusions regarding the quality of the entity being checked are made with the required reliability with the minimum possible set of measurements. From this viewpoint the measured (controlled) parameters will be the most informative. At the present time the basic procedural tool for finding informative parameters is the sensitivity method. According to this theory under the heading of the most informative parameters are those to whose variations the criterion for evaluating the quality of construction and erection work (SMR) is most sensitive. However, a disadvantage of this theory as applied to problems of inspection control is the impossibility of taking into account the probabilistic nature of errors in measuring and estimating, their ranges of variation and correlations between various factors and errors in estimating them.

Of major methodological importance is planning of inspection control according to economic criteria. Let us designate by C_1 the average cost of a single inspection test, and by C_2 (rubles/hour) specific losses from SMR spoilage normalized for the time of an emergency state of the entity resulting from this spoilage. Then spoilage originating at any moment of construction between a certain K -th and $(K + 1)$ -th test, in counting, can cause potential operating losses on the average equal to

$$\int_{t_K}^{t_{K+1}} [(K+1)C_1 + C_2(t_{K+1} - x)] dF(x), \quad (3)$$

where $F(x)$ is the distribution function for the time of the manifestation of spoilage.

Since spoilage can originate after any test in the count, then, for arriving at the total expected losses from spoilage, we have

$$M(\Pi_0) = \sum_{K=0}^n \int_{t_K}^{t_{K+1}} [C_1(K+1) + C_2(t_{K+1} - x)] dF(x). \quad (4)$$

The optimal plan for inspection quality control represents a sequence of tests (control operations) which minimizes total expected losses of type (4), i.e.,

$$\frac{\partial}{\partial t_K} M(\Pi_0) = 0, \text{ for all } K. \quad (5)$$

From expressions (4) and (5) comes the recurrence relation

$$t_{K+1} - t_K = \frac{F(t_K) - F(t_K - 1)}{f(t_K)} - \frac{C_1}{C_2},$$

where $f(t_K) = \left. \frac{dF(t)}{dt} \right|_{t=t_K}.$

(6)

By means of recurrence relation (6) a determination is made successively of the optimal values of the moments of tests, t_k (with the initially assigned value of the first test, t_1).

The minimax strategy of inspection tests reduces to selecting the number of tests, n , as the highest whole number satisfying the inequality

$$C_1 n^2 + C_1 n + 2(C_1 - C_2 T) < 0. \quad (7)$$

and the moments of the successive tests themselves, t_k , are determined from the expression

$$t_K = K \left[\frac{T}{n+1} + \frac{C_1}{2C_2} \left(\frac{n(n-3)}{n+1} - (K+1) \right) \right]. \quad (8)$$

Calculation formulas (7) and (8) make it possible to solve the problem of planning inspection control in the case when at final interval of time (0, T) it is necessary to determine the number of tests and intervals between them in order to reach a minimum of maximum possible losses of type (4) with any distribution, $F(t)$, of the manifestation of spoilage. Since T has a finite value, then the class of strategies sought is made up of serially periodic strategies with a period of T .

The susceptibility of the process of the formation of quality to the influence of numerous factors makes it necessary to take into account all factors in

their interrelationship and in planning the job of inspection to concentrate efforts on controlling important factors and reducing the influence of unimportant ones.

The cyclicity of the process of the formation of the quality of construction production has imposed the requirement on inspection control of gathering and systematizing information on quality taking into account the creation of control actions preventing the repetition of committed violations. In practice, a considerable number of inspections of the quality of construction makes it possible to obtain data which is a good basis for the development of scientifically validated suggestions for improving the quality of production and preventing typical violations and cases of spoilage.

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PIPELINE CONSTRUCTION

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COST-ACCOUNTING WORK QUALITY UNITS PROMOTED AT PIPELINE TRUST

Moscow STROITEL'STVO TRUBOPROVODOV in Russian No 9, Sep 83 pp 24-26

[Article by S.S. Zinovoy and A.G. Kovalev, NIPIorgneftegazstroy [Scientific Research and Planning Institute of Organization of Oil and Gas Pipeline Construction]]

[Text] The requirements of today and the foreseeable prospects for scientific and technical progress in the area of the construction of trunk pipelines are responsible for a fundamentally different approach to the question of designing a production control system in the key production-economic structures of the industry--combined pipeline construction trusts.

This approach is due to a number of objective causes and factors: aggregated specialization of primary production subdivisions according to stages and combinations of pipeline construction production jobs, and the steady increase in the pace of construction of trunk pipelines; the intense introduction of new kinds of pipes and welding methods; and the preparation for the use of pipes of even larger diameters and with high operating pressure.

The production control service which has been in operation up to the present time, accomplished by the manpower of production test laboratories (PIL's) subordinate to construction subdivisions (SU's [construction administrations] and SMU's [construction and erection administrations]), under the leadership of central laboratories (TsPIL's) has not provided the prerequisites for its further improvement. As a result, a proper solution has not been found to such problems as carrying out a unified technical policy in the area of controlling production quality, increasing the maneuverability of the service and improving the utilization of specialists, the creation of a powerful technical and standards base, the improvement of metrological control and radiation safety, strengthening of orientation of the system of economic incentives and material responsibility for work results in correlation with the results of the work of production subdivisions, improving the reliability of accounting and analysis, etc.

For example, the outfitting of construction organizations with measuring equipment equals about 65 percent on average for the industry, and part of the

total number of instruments has been acknowledged to be metrologically unsuitable. Furthermore, the actual expenditure for production control and its metrological support with an average norm of 3 to 4.5 percent of the amount of construction and erection work equals 0.7 percent.

One of the most important kinds of control is control of the quality of welded joints. However, the creation within the structure of pipeline construction trusts of combined production lines (KTP's) and mobile mechanized road transportation work and engineering and process preparation systems (PMK-1's and PMK-2's) was supported by a corresponding increase in the potential of control services, which caused disproportions between the pipeline construction paces reached and the extent of the control of the quality of welded groove joints. Meanwhile it is obvious that a further increase in the pace of construction by means of the manpower of KTP's, PMK-1's and PMK-2's is responsible for a considerable increase in the amount of quality control, primarily of welding and erection work.

The search for an effective form of reorganization of the existing service under conditions of a progressive growth in the pace of pipeline construction production with an insignificant increase in the number of personnel for it has been responsible primarily for essential changing of the idea of the economic and legal content of the machinery for the functioning of production control subdivisions. This made it possible to provide grounds for and point out ways of designing it according to cost accounting principles.

In this connection, in preparing for carrying out in the industry an experiment on the combined introduction of new economic methods aimed at the creation of an organization economics, sociopsychological and legal situation in pipeline construction trusts enabling uniformity in the entry into service and improvement of the quality of the construction of pipelines, the laboratory for the improvement of the economic machinery (SKhM) of NIPiorgneftegazstroy has developed the theoretical fundamentals and a procedure for organizing production control by the manpower of a special-purpose production subdivision--the cost-accounting work quality section (UKR). In it, in addition to measures of an organization nature, specially developed systems are implemented in a combined fashion, i.e., systems of planning and estimating indicators, pricing, accounting, for providing labor incentives and for responsibility for results of labor.

For the purpose of norm-setting and procedural support for functioning of the new production subdivision, the SKhM laboratory of NIPiorgneftegazstroy in conjunction with the Chief Welder's Administration and the State Inspectorate for Quality of Construction of Minneftegazstroy [Ministry of Construction of Petroleum and Gas Industry Enterprises] has prepared the "Provisional Statute for a Cost-Accounting Work Quality Section in a Pipeline Construction Trust."

The cost-accounting work quality section is entrusted with ensuring high-quality performance of the combination of pipeline construction production work, i.e., supervising observance of the technology and making tests by

destructive and non-destructive methods in strict agreement with control work schedules and at times ensuring continuity of high-speed flowline construction of trunk pipelines. On the basis of the goal set, the UKR must solve a wide range of problems associated with perfecting and improving control. However, at the first stage, the stage of organization and establishment of the section, its attention must be concentrated on the following problems: preventing rejects in the production of construction and erection work; timely revelation of nonconformity of the quality of materials and work performed to the requirements of the standards, SNiP [construction standards and regulations], departmental instructions and planning, technological and other norm-setting documentation; increasing the efficiency of the utilization and improvement of facilities and methods for production control; and reinforcing technological discipline and increasing responsibility for the quality of work by issuing conclusions to the performer (crew) before the start of the shift with the reflection in special journals of reasons for flaws and rejects with an indication of the specific people who permitted the flaws and rejects.

The basic functions of the section are as follows. The planned volume of work on controlling the quality of construction by destructive and non-destructive methods (visually, by physical and chemical methods, by mechanical tests, by instrument monitoring, etc.) is performed, including incoming control of materials. An evaluation is made of the quality of work by kinds and stages (groups) of construction production with the formation of documents for payment of bonuses, test reports, acceptance of concealed work, etc. Analytical work and preventive measures are performed, aimed at preventing low-quality work and flaws and rejects. The fulfillment of measures developed by the trust for raising the level of the quality of construction is controlled. Furthermore, the most economic and effective means and methods must be used for controlling quality by destructive and non-destructive methods and it is necessary to provide unity and the required accuracy of measurements, debugging, and repair of control facilities, as well as radiation safety, including radiation monitoring and a self-check.

Representatives of the UKR participate in State and working acceptance commissions, the certification and qualifications commissions of the trust and its subdivisions (including the preparation of appropriate performance documentation) and in certifying electric welders for the right to perform important work, and participate in inspection tests performed by other inspection services, and in supervising fulfillment of their instructions; and in investigating each instance of the failure of an entity under construction or having been introduced. Its important functions include halting, and in necessary cases prohibiting, construction and in issuing to the performers of work and the management of structural subdivisions of the trust instructions which it is obligatory to carry out, as well as the proper control of performance and accounting documentation for the UKR's work (journals for recording the results of inspection, instructions, conclusions and the like) with an obligatory indication of the reasons for rejects and the people permitting them.

The work quality section is formed chiefly from the personnel of TsPIL's and PIL's and organizations subordinate to the trust within the limits of the established limits for the number of personnel. The structure and staff of the UKR are worked out and approved by the trust by agreement with the central administration on the basis of the typical staff schedule and structure of a cost-accounting UKR in a pipeline construction trust.

The section is assigned special equipment, apparatus and other control equipment at the disposal of production (construction) subdivisions of the trust.

For the purpose of centralizing the engineering, norm-setting and technical support of production units for accomplishing control at sites, under the auspices of the section a production group for incoming control and laboratory tests and a production group for repair and debugging of instruments, radiation monitoring and radiation safety are being created.

The incoming control and laboratory test group checks the quality of materials arriving at the trust (welding, insulation and construction materials and inspection facilities), and of pipes, building structures and parts. Samples are taken, technological testing is performed, and physicomachanical tests of samples of building materials, welding of control groove joints in pipes is provided, a determination is made of the correspondence of the technological characteristics of materials to certificate data, etc. The same group checks and accumulates technical documentation for the building materials arriving and in conjunction with the trust organizes work on unsatisfactory equipment reports with enterprises supplying products. It controls the observance by subdivisions of the trust of norms and rules for transporting, storing and using construction structures and materials. It provides control by means of physical methods of groove joints to tolerances.

The group for repairing and debugging instruments, radiation monitoring and radiation safety performs the preventive inspection and tuning of ultrasonic and magnetographic flaw detectors, x-ray equipment and instruments for controlling the quality of insulation, as well as routine and medium repair of this equipment, and debugs new testing and measuring instruments before sending them to production sections. Its functions also include organization of the welding of standard and tolerance groove joints.

In conjunction with scientific research and design organizations, the repair and debugging group participates in tests of new equipment and materials for quality control, gives recommendations on their use, develops plans for the introduction of new control equipment and is involved in the introduction of improved instruments for controlling the quality of building and erection work. An important part of this work is the development and performance of measures for economizing on fuel and energy resources, materials and control facilities and for collecting silver-containing waste. It performs the servicing and routine repair of the fleet of machine tools for machining samples of tolerance and control groove welds, and tensile testing and other testing machines (when necessary, mobile laboratories, too) and organizes an annual State inspection of testing machines and instruments.

This group supervises the proper use of gamma-ray inspection instruments and x-ray apparatus, keeps records of individual radiation doses of flaw detection personnel, supervises the timely medical examination of people involved in working with sources of radioactive emission and takes measures to guarantee safe working conditions.

In the management apparatus of the UKR are concentrated on-line checking, record keeping and statistical analysis of the performance of control work, as well as a number of functions relating to controlling the quality of construction production.

The basis of interrelations between the cost-accounting quality control section and subdivisions and the trust is schedules for the performance of control work and business contracts concluded by the trust and the UKR. After approval by the trust of quarterly schedules, on-line interaction between the section and production subdivisions is accomplished by them independently via a system of monthly schedules and weekly and 24-hour planning.

The UKR with the rights of a subcontractor performs construction and erection work as part of production control at all stages of the production process of pipeline construction. The general contractor is the trust, which provides the conditions necessary for fulfillment by the section of its plan quotas.

The UKR's production program includes the amount of work on controlling the quality of construction and erection work to be performed by the trust's production subdivisions (enlisted by outside performers) and on controlling the quality of materials arriving for this work, and other work. The production program is expressed in in-kind and cost units of measurement.

In keeping with the production economics plan (construction financing plan) of the pipeline construction trust, the UKR approves for a year (with a breakdown by quarter) plan indicators, the most important among which are the volume of standard conventional net output (NUChP) to be produced by internal manpower; the amount of construction production agreed to be completed to be performed by internal manpower in NUChP units; the cost of quality control work; planning and estimating costs; and growth in labor productivity and the wage fund standard per ruble of NUChP. An evaluation is made of the UKR's work in terms of these indicators. Indicators such as output, the amount of work on servicing and repairing control equipment and measuring equipment performed by internal manpower, the percentage of the presence of flaws, the wage fund per category of workers, and fulfillment of norms for the delivery of silver-containing waste are estimated.

It is suggested that the work of section workers be compensated chiefly according to the team form of payment for work according to the site schedule for the production of work, employing the standards for wages per one ruble of standard conventional net output. With the completion of standard quotas (stages) of control work on time (according to the work production schedule), workers and line engineering and technical personnel are given a bonus of up to 40 percent of the collective-scale wage fund. For fulfillment of

standardized quotas by a smaller number of UKR personnel, additional payments are provided--up to 20 percent of scale within the limits of the established wage fund. With non-fulfillment of the work schedule, payment is made according to scale and job salaries.

Bonuses for the entry of sites into service, for savings achieved and bonuses from the material incentive fund, etc., have been extended to UKR personnel. These measures are keyed to specific quotas and have been enlisted to provide incentives for unconditional completion with high quality of key construction and erection work in keeping with the production schedule.

For the purpose of strengthening the responsibility of UKR personnel for timely and high-quality performance of their functions, they can be deprived of bonuses completely or partially. For example, with non-fulfillment of standard quotas and for permitting flaws and for too-high estimates of the quality of work discovered by the State commission, the amount of the bonus is reduced up to 50 percent. Personnel are completely deprived of the bonus for failures discovered in testing or delivery of the pipeline.

The conditions for (total or partial) depriving or increasing the size of bonuses for kinds of functions and jobs are indicated in the job instructions of the performers, approved by the director of the UKR, and when necessary are in addition agreed upon in the special stipulations for business contracts (including the size of the bonus reserve).

Preliminary economic estimates defining the possible effects of the work of a cost-accounting work quality section on the results of the work of production subdivisions have shown that in the first few years of the functioning of a cost-accounting quality section an increase in the amount of production rejects revealed (more than twofold) and a considerable growth in the cost of eliminating them (twofold and more) will be the rule. This should direct the technical services and management of the trust toward behaving with special attention to the preparation and organization of a cost-accounting work quality section, which in the future must perform the role of a powerful and effective key factor in improving the quality of construction control and improving the efficiency of pipeline construction production.

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PIPELINE CONSTRUCTION

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SUGGESTIONS ON IMPROVING LONGITUDINAL STABILITY OF GAS TRUNK PIPELINES

Moscow STROITEL'STVO TRUBOPROVODOV in Russian No 9, Sep 83 pp 27-29

[Article by O.M. Ivantsov, Central Technical Administration, Minneftegazstroy [Ministry of Construction of Petroleum and Gas Industry Enterprises]]

[Text] Ensuring the longitudinal stability of 1420-mm-diameter gas trunk pipelines with an operating pressure of 7.5 MPa laid in swampy and flooded areas of West Siberia and other areas with poorly supporting and loosely bound soil has become one of the central problems relating to the reliability of their use.

In recent years this problem has been discussed at all scientific levels, but its solution has progressed little.

Specialists interpret variously the indicators for the temperature for closure of the design diagram. They present all the new arguments in defense of their positions, but up to now no changes have been introduced either in calculation procedures or in equipment design solutions. From our viewpoint there is an important potential for ensuring longitudinal stability which must be realized.

As we know, the thickness of the wall of a trunk pipeline is determined by calculation for hoop tension from internal pressure without taking into account longitudinal stresses, on the basis of the relationship

$$\sigma_{\text{hoop}} = \frac{npD_{\text{in}}}{2\delta} \leq R_1, \quad (1)$$

where n is the pressure overload factor; p is the pressure; D_{in} is the inside diameter; δ is the thickness of the wall; and R_1 is the standard resistance of pipe steel to uniaxial tension.

However, in a gas pipeline longitudinal stresses also develop from the pressure and temperature difference, equal to the difference of the

temperatures of the pipeline when used in the hottest days of the summer and closure of the design diagram during construction in the coldest time of the winter.

In order to provide for the condition for calculation of the wall's thickness, i.e., to not change its thickness determined according to relationship (1), the longitudinal stresses from the combined effect of pressure and the temperature difference must meet the condition

$$\sigma_{np} \geq 0. \quad (2)$$

In observance of this condition, longitudinal compressive stresses cannot develop in the wall of the pipe. In determining the permissible temperature difference we start from the relationship

$$\sigma_{np} = \mu \sigma_{кн} - \Delta t \alpha E \quad (3)$$

with

$$\sigma_{np} = 0, \Delta t = \frac{\mu \sigma_{кн}}{\alpha E}, \quad (4)$$

where μ is the lateral deformation coefficient; Δt is the temperature difference; α is the coefficient of temperature elongation; and E is the modulus of elasticity.

If condition (2) is not observed, then it is necessary to increase the thickness of the pipe wall as compared with that determined by calculation only for hoop tension from internal pressure. This involves the additional consumption of steel and additional input of materials for constructing the pipeline.

It is theoretically and technically possible to achieve an increase in the calculated temperature difference on account of increasing the thickness of the pipe wall and ballasting, as indicated in table 1.

Table 1. Increase in Calculated Δt on account of Increase in Thickness of Wall and Ballasting

$\Delta t, ^\circ\text{C}$	1) Толщина стенки δ		2) Балластировка, %
	мм	%	
58	19,5	100,0	100,0
63	20,1	103,0	108,8
68	20,8	106,7	117,6
73	21,7	111,3	126,4
78	22,8	116,9	135,3
83	24,1	123,6	144,0
0	19,5	100,0	45

Key:

1. Wall thickness

2. Ballasting

[Continued on following page]

Note: Diameter of gas pipeline—1420 mm, operating pressure—7.5 MPa, $\sigma_{vr} = 600$ MPa, $\sigma_t = 470$ MPa . Flooded sections (swamp) of category II.

The minus sign in equation (3) corresponds to compression. According to the SNiP [construction standards and regulations] coefficient μ is assumed to equal 0.5, which corresponds to a plastic state of the pipeline's wall.

Here there is a theoretical contradiction in the calculation procedure. Why is the calculation designed for the limiting extremal state, when plastic deformations arise? The pipeline is restrained in the ground, and where it is not restrained it is ballasted. In such cases a plastic state of the pipeline's wall is an extremely rare phenomenon coming under the heading of random events. Therefore, the pipeline should be calculated for strength for the elastic stage with $\mu = 0.3$. The calculated strength safety factors should "protect" the elements of the pipeline's wall from the appearance of limiting states in them, including plastic deformations, with a scientifically validated degree of reliability.

In this analysis we will begin from pipeline parameters calculated according to the standard procedure, in particular, with $\mu = 0.5$, but we will determine actual stresses and safety factors under various conditions for the elastic stage of functioning with $\mu = 0.3$.

For a "standard" gas pipeline 1420 mm in diameter with pressure of 7.5 MPa in sections of categories I and II, the calculated thickness of the wall of a pipe made of steel with $\sigma_v = 600$ MPa equals 19.5 mm, and the permissible temperature difference according to equation (3) with $\mu = 0.5$ equals 58 °C. The calculated thickness of the pipe's wall for sections of categories III and IV is 16.2 mm (16.5 mm according to gauge), i.e., 20 percent less than for sections of categories I and II, but the permissible temperature difference equals 70 °C, because of the higher value and influence of the hoop stress, σ_{kts} , according to relationship (4).

The temperature difference, equal to 58 °C, is assumed in designing to be the maximum permissible calculated difference in the entire section between KS's [compressor stations], as well as for the entire length of the gas pipeline. With this the temperature compensation capacity for approximately 80 to 85 percent of the length of the gas pipeline consisting of sections of categories III and IV remains underutilized with $\Delta t = 70$ °C , i.e., the temperature difference potential of 12 °C is not realized in the overwhelming length of the route.

The increase in the thickness of the wall of sections of categories I and II is associated with reduction of the operating conditions factor, m , from 0.9 to 0.75, since the category of the complexity and importance of sections is increased. The thickness of the wall, determined from relationship (1), will be great for sections of categories I and II, since the calculated resistance will get a lower value:

$$R_1 = \frac{R_{1m}}{K_1 K_n}, \quad (5)$$

where R_{1m} is the standard resistance of pipe steel; K_1 is a factor reflecting the level of the technology of the production of pipe steel and pipes; and K_n is the reliability factor.

It was assumed that with an increase in the thickness of the wall there is a substantial lowering of the level of the stressed state, and there is an increase in the safety margin and the reliability of the performance of the pipeline in sections with the highest probability of failure and with special severity of possible consequences.

However, a calculated comparison of the levels of the stressed state of sections of categories I and II and sections of categories III and IV for the elastic stage of working demonstrates that an increase in the thickness of the pipes does not produce a substantial effect.

The point is that according to the energy theory of strength (used in the SNiP) the criterion for the general level of the biaxial compressed state is the equivalent stress, which for a pipeline is assumed with sufficient accuracy to equal

$$\sigma_{\text{эKB}} = \sqrt{\sigma_{\text{ку}}^2 + \sigma_{\text{т}}^2 - \sigma_{\text{ку}} \sigma_{\text{np}}}. \quad (6)$$

The equivalent stress depends substantially on the longitudinal compression stress, $\sigma_{\text{пр}}$. It exceeds the hoop stress (always tensile) when it has a negative sign, i.e., is compressive (then the third term under the root has a plus sign). An increase in the thickness of the pipe's wall results in a proportional lowering of the hoop stress, but the longitudinal compressive stress is thereby according to equation (3) progressively increased, which results in an increase in the equivalent stress and makes it close to the equivalent stress of a non-thickened wall.

Accordingly, with an increase in the temperature difference the additional safety margin of thickened pipes, defined as the ratio of the ultimate strength to the equivalent stress, decreases considerably and approaches the safety margin of pipes of ordinary sections of categories III and IV. For example, with $\Delta t = 70^\circ\text{C}$, the difference in safety margins equals 12 percent, and with $\Delta t = 80^\circ\text{C}$, only 9 percent. Taking into account the universal extent of elastic bending of design and technological origin, the difference in the safety margin factors of thickened and ordinary pipes is even smaller.

A study of the statistics of failure in northern gas pipelines 1420 mm in diameter during 1977 to 1981 has demonstrated that in sections of thickened

pipes (sections of categories I and II) the mean number of failures per 100 km of the route is 1.5-fold higher than in sections of categories III and IV. This can be explained by the following. An increase in the thickness of the wall of the pipes does not produce a considerable lowering of the level of the stressed state, especially with actual temperature differences of 70 to 80 °C. It is obvious that for this reason the relative accident rate is higher in sections of categories I and II with complex working conditions.

The effectiveness of the use of thickened pipes is reduced also because of the fact that they require stronger total additional loading against loss of stability and against buoyancy. The longitudinal compressive force from the effect of the temperature difference is proportional to the cross-sectional area of the pipeline and is less in pipes of sections of categories III and IV. The longitudinal compressive force equals 17,600 kN for sections of categories I and II, whereas it equals 15,700 kN for sections of categories III and IV. The mass of pipes of sections of categories I and II is 20 percent greater, which reduces the amount of ballasting against buoyancy, but this does not alter the overall additional loading balance in the direction of an increase for pipes of sections of categories I and II. The total additional load required for compensation of the effect of the longitudinal force and buoyancy forces with different safety factors is greater for sections of categories I and II than for sections of categories III and IV, by approximately 3 percent. For example, for the example considered, total ballasting with ferroconcrete additional loads with $t = 58$ °C in sections of categories I and II equals 3.39 t/m versus 3.28 t/m in sections of categories III and IV. Comparative data on ballasting of elastically bent sections of a gas pipeline in flooded terrain or a swamp according to SNiP and VSN [expansion unknown] for the restraining design diagram with $\Delta t = 58$ °C, as well as for $\Delta t = 70$ °C, are presented in table 2. The analysis made is the basis for the following conclusions and suggestions.

1. For the purpose of extending the temperature range (difference) and lowering the permissible temperature for winter construction, it is necessary to make calculations of stability and strength for the permissible temperature difference for sections of categories III and IV instead of for sections of categories I and II, which will produce a gain of 12 °C for winter construction.

The change to a calculated difference of 70 °C for the entire gas pipeline requires an increase of approximately 7.5 percent in ballasting in sections of categories III and IV. For the example considered, this equals 3.53 t/m, i.e., increases by 0.25 t/m.

2. Thickening of pipes of sections of categories I and II does not yield advantages in solving the problem of longitudinal stability, but with an increase in the actual temperature difference and laying with the universal extent of elastic bending for design and technological purposes the difference in the safety margin factors for pipes with an increased wall thickness and ordinary pipes of sections of categories III and IV is insignificant.

Table 2. Ballasting of Elastically Bent Sections of Gas Pipelines 1420 mm in Diameter for Pressure of 7.5 MPa

Category of section	Wall thickness, mm	Elastic bending radius, m	Ballasting, t/m		Total
			From buoyancy and for initial bending, $n = 1.1$	From loss of stability,	
III-IV	16.5	3000	1.53	1.75	3.28
I-II	19.5	3000	1.44	1.95	3.39
			$K = 1.05$	$K_b = 1.25$	$K = 1.05$
			$\frac{K_n}{(\text{ferrocon-crete})}$	$\frac{K_n}{(\text{soil})}$	$\frac{K_n}{(\text{ferrocon-crete})}$
			$K_n = 1.2$		$K_n = 1.2$
			$\frac{K_n}{(\text{ferrocon-crete})}$		$\frac{K_n}{(\text{soil})}$
			<u>Temperature difference of 58 °C</u>		
III-IV	16.5	3000	1.53	1.75	3.28
I-II	19.5	3000	1.44	1.95	3.39
			<u>Temperature difference of 70 °C</u>		
III-IV	16.5	3000	1.53	2.00	3.53
I-II	19.5	3000	1.44	2.25	3.69

Increasing the thickness of the wall results in lessening not only of hoop, but also of longitudinal stresses from pressure and the temperature difference, whereby the total longitudinal stresses must equal zero. Therefore, the permissible temperature difference for thick-walled pipes is less than for pipes of sections of categories III and IV.

In spite of established ideas, it is necessary to refrain from laying, in swampy and flooded areas with poorly supporting and loosely bound soil, especially in convex curves, thickened pipes designed for sections of categories I and II, but to use pipes intended for sections of categories III and IV. In this case more favorable conditions for ensuring longitudinal stability will be observed.

3. It is necessary to reduce to a reasonable limit the use of pipes with a thickened wall, limiting their use to sections of intersection with engineering structures, highways and railroads, as well as to sections in crossings through water obstacles and near residences.

If the extent of the use of thickened pipes is reduced from 20 to 10 percent, which is more than sufficient for preserving sections of category I, then in 1000 km of the length of a gas pipeline 1420 mm in diameter the saving of pipe steel will equal about 10,000 tons.

The temperature difference for sections of categories I and II must remain equal to 58 °C and must not be brought to 70 °C, as this has been done for the entire gas pipeline. In this case it is not necessary to increase the thickness of the wall by 1.6 mm and ballasting by 9 percent in sections of categories I and II. Then it will be necessary to construct these short sections (only these sections) according to temperature curves applied at the present time to design documentation.

4. In the new edition of SNiP for designing trunk pipelines it is necessary to replace the four categories for sections by two: a first and second. Under the heading of the first category with pipes of increased thickness come only sections of the intersection of a gas pipeline with engineering structures, as well as sections of crossings across rivers and near residences. Of course, standardization of the extent of inspection of welded groove joints has been changed and is not referenced to categories. Preliminary testing by means of elevated pressure is certainly necessary for sections of category I. Therefore, there cannot be objections to the use of two categories of sections in place of four.

The suggestions presented, while preserving the high level of structural reliability and ensurance of the longitudinal stability of gas pipelines, will make it possible to expand considerably the range of permissible temperatures for winter construction under conditions of the north, as well as to save a considerable amount of metal.

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