Miscellaneous Report
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THE U.S.S.R. FOREST FIRE CONTROL OPERATION AS SEEN BY THE 1973 CANADIAN FIRE CONTROL DELEGATION

by

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Introduction

The Canadian Forestry Service, Department of the Environment, sponsored a two week, four-man (plus interpreter) delegation to tour the U.S.S.R. forest fire control facilities during August and September, 1973. The trip was the second of a continuing exchange of visits and was in specific response to the USSR's October 1972 fire delegation visit to Canada. The initial Canadian visit to the USSR (1967) studied their general forestry operations but few specific details regarding methods of fire control were obtained. The purpose of this recent visit was to obtain detailed information on their fire control operations including specifics on their organizational structure, helicopter initial attack system, communications system, fire line construction equipment and techniques, including use of explosives, cloud seeding for fire suppression, fire prevention program, and their forest fire research program.

The delegation consisted of: Mr. W.G. Cleaveley, Director, Field Services Division, Ministry of Natural Resources, Ontario; Mr. M. Vezina, Assistant Deputy Minister, Department of Lands and Forests, Quebec; Mr. S.M. Petrusewicz, Vice President, Wajax Manufacturing Ltd.; Dr. P.H. Kourtz, Researcher, Forest Fire Research Institute, Canadian Forestry Service, Department of the Environment; and Mr. W.D. Pierce, Interpreter, Secretary of State.

Throughout our entire two week stay in the USSR we received excellent treatment and the program that was planned by them met our full approval. All details concerning our personal comfort, meals, lodging, and transportation were looked after for us by our Soviet hosts.

Appendix II contains photographs of many of the items covered in the following report.

Trip Outline

Aug 20	4 pm	Depart from Ottawa for Montreal via Ontario Government Twin Otter
	8 pm	Depart Montreal for Moscow via Air Canada DC-8
Aug 21	3 pm	Arrive in Moscow at 3 pm and met by Forestry Deputy Minister O.I. Rozhkov, Mr. E.A. Shchetinskii[1], Chief Engineer, Pushkino, and Mr. N. Polyakov, Assistant to Mr. Rozhkov. The proposed trip plan was reviewed at this time and met our full approval. Checked into Ukraina Hotel[2]
Aug 22		Travel by mini-bus to Central Aviation Base, Pushkino (45 km from Moscow). Review of Base function and resources with Mr. N.A. Andreev, Chief of the Central Base; Mr. Shchetinskii, Deputy Chief (Engineering); Mr. Eduard Davydenko, Deputy Chief (Pilot Observers); Mr. Alexander Garkin, Chief of Foreign Relation, Ministry of Forestry; Mr. N. Polyakov, Assistant to Deputy Minister (RSFSR). Supper at "Georgian" style restaurant, Pushkino[3]. Return to Moscow and departure for Irkutsk, Siberia, (2 am) by commercial aircraft[4]
Aug 23		Arrived at Irkutsk (4 pm) after stopping twice en route including Omsk. Taken to Angara Hotel[5]. Visit to Irkutsk Central Air Base for briefing on responsibilities of base and resources. Supper at Angara Hotel dining room.

1 Mr. Shchetinskii remained with our group until Leningrad and proved to be an excellent guide. He visited Canada in 1967.

2 An elegant old, 29-floor hotel in downtown Moscow

3 Included fish dishes, chicken hearts, caviar, Georgian bread

4 TU-104 longrange twin-engined jet, 100 passengers, 6 crew and stewardess

5 Modern Hotel mentioned in Farley Mowat's Book "Sibir"

Aug 24	Trip to Bratsk, Siberia via Forestry IL-14[6] aircraft and demonstration of cloud seeding operation enroute. Visit with Bratsk District headquarters for briefing on responsibilities and available resources. Demonstration of fire control personnel and equipment. Visit to Bratsk Pioneer[7] program (with environment subgroup). Lodging and supper at Tiaga Hotel.
Aug 25	Tour of Bratsk Forestry Complex[8] and Hydro-electric station. Departure for Irkutsk via IL-14 at 3 pm. Lodging and supper at Angara Hotel.
Aug 26	Visit to Angarsk Forest Enterprise Headquarters and visit to a fire chemical station. Demonstration of fire line radio equipment and explosive line building technique. Visit to Baikal Limnology Institute and Museum. Boat trip on Baikal and picnic. Return to Angarsk Forestry Headquarters for supper and return to Irkutsk.
Aug 27	Return visit to Irkutsk Regional Air Base for continued technical discussions. Sightseeing in Irkutsk. Departure for Moscow via TU-104, 3 pm. Arrival in Moscow at 8 pm. Supper at National Hotel. Departure for Petrozavodsk 12 am by train.
Aug 28	Arrival at Petrozavodsk 3 pm. Visit to Karelian Ministry of Forestry for briefing on their fire problems.
Aug 29	Trip to forest and demonstration of smokejumpers, helicopter initial attack, explosive line building, fire pumps, and pressurized backpack pumps. Trip to Karelian Birch grove and visit to Mineral Water Museum.

6 Modern Convair type equipped with oxygen and cloud-seeding apparatus

7 USSR Youth Program similar to Cubs, Brownies, Scout, and Guide Programs

8 This complex cost 1 1/3 billion dollars and is still expanding. It processes about 2 million cords of wood per year into 40 products. In the future even stumps will be utilized. The mills are fully automated under the control of a single command centre.

Aug 30	Trip by fast hydrofoil (50 mph) to Kizhi Island on Lake Onega. Return to Petrozavodsk, supper and departure for Leningrad via train (11 pm).
Aug 31	Arrival at Leningrad (9 am). Visit to Leningrad Forestry Research Institute to discuss fire research program. Visit to Leningrad Academy of Forestry and briefing on foresty education in the USSR. Return to Hotel (Astoria) and afternoon discussion of research and equipment development program.
Sept 1	Visit to Czar's summer residence "Peterhoff", and a technical discussion regarding computer fire research with Dr. G.N. Korovin. Free time in Leningrad.
Sept 2	Arrival in Moscow (9 am), met by Mr. Davydenko, Mr. Polyakov and Mr. Andreev. Breakfast at the National Hotel, free time, and a visit to the Bolshoi Ballet.
Sept 3	Visit with USSR State Committee on Forestry for debriefing session. (See Appendix 1, for the names and positions of those present at the meeting). Trip to international forestry equipment exhibit Lesdrevmash including visit to USSR and Canadian fire control equipment displays. Farewell banquet at Georgian restaurant with Deputy Ministers Rozhkov and Pisarenko, Mr. Andreev, Mr. Davydenko, Mr. Polyakov.
Sept 4	Free time and departure for Canada via Air Canada (4 pm). Deputy Minister Rozhkov, Mr. Polyakov, Mr. Davydenko and Mr. Dobrotvorskii were present to bid us goodbye. Arrival in Montreal 9 pm. Flight to Ottawa by Ontario Government aircraft (10 pm).

The names and positions of most of the Soviet Forestry personnel that we met are listed in Appendix 1.

Operational Structure

The Ministry of Forestry, Forest Protection Branch is divided into two sub-sections - the aviation section and ground section. The main emphasis of the trip was with the air operation section because of our interest in air attack and because this section chiefly was responsible for protection of forest areas similar to those of Canada.

CENTRAL AIR BASE

The Central Air Base at Pushkino is ultimately responsible for the protection of most of the northern forests of the USSR. (The total forest area of the USSR is about 3 million square miles). There are 14 regional air bases that fall under the jurisdiction of the Central Air Base.

The Central Base has five divisions:

(a) Flying Operation Division is responsible for leasing, allocation, and maintenance scheduling of the approximately 500 aircraft (of these 300 are helicopters) that the Air Base control. These aircraft are leased from the civilian aircraft company Aeroflot on a seasonal basis. The lease arrangement is such that only the time in flight is charged. There are no standby charges.

At each airport visited (5) there appeared to be an ample supply of helicopters and fixed wing - forestry type aircraft. We were told that a region or district could obtain these aircraft, in addition to their leased aircraft under emergency conditions for transportation purposes only. This arrangement plus the leasing scheme reduced the necessity for inter-regional movement of transport aircraft. Aeroflot provides pilots, radios, and maintenance of all aircraft.

(b) Flying Production Division (7 people) is concerned with scheduling and routing of aircraft. The Central Base controls all inter-regional transfers of men and aircraft. Also, it was mentioned that considerable planning is involved in the initial regional and district allocation of fixed wing aircraft and helicopters. A computer routine is available to assist in this allocation. A computer routine is also available to assist in determining the patrol routes for each detection aircraft (on a seasonal basis).

(c) Smoke Jumper and Smoke Chaser Division. Smoke jumpers (parachutists) are used for initial attacks on fires in remote areas. Helicopter attack using "smoke chasers" are also commonly used. There are 2,300 smoke jumpers and 4,500 smoke chasers under the ultimate control of the Central Air Base. It requires 3 months to train a smoke jumper and 1 month to train a smoke chaser.

(d) Production Engineering Division (15 people). The purpose of this group is to introduce new fire fighting equipment and techniques to the field. It is a link between research and operations. This approach represents an important step forward in the application of research that might be considered for Canada.

(e) Supply Group is as its title suggests, concerned with logistics and supplies.

A major function of the central base is the interregional movement of manpower and equipment. Forty such moves were made during the 1973 season. In addition to this role there is a large training function that includes the training of 75 "pilot-observers" per year. The pilot-observer is a key man in the District operation. He makes most of the daily decisions regarding detection patrols, dispatching to fires, fire fighting strategy, and even inter-district resource movements. We might call him an airborne dispatcher - fire boss.

Included in the Base's function is the training of smoke jumpers and smoke chasers in the use of explosives. (There are 1,700 explosive experts among the jumpers). There is, also, training in navigation, communications, fire suppression, fire behaviour, and mechanical equipment operation. (1,750 personnel qualify as mechanical operators).

The Central Base is also in charge of all communication. Field communication to Pushkino is usually done by telephone or radio. Little use is currently being made of teletype.

REGIONAL AIR BASE

Fourteen regional air bases exist across the USSR. One of the regional bases that we visited was Irkutsk, Siberia. This region is about the size of the province of Ontario. The regional bases report to the central base at Pushkino and are responsible for the regional aerial fire control operation. In addition to manpower and equipment allocations within the region these bases are training centres for smoke jumpers and smoke chasers. The regional bases continually monitor the status of district resources and participate in inter-district movements when required. They serve as a communications centre and are responsible for disseminating daily weather and fire index data. They have the authority to shut down logging activity in the region if necessary.

DISTRICT OPERATION

The district is the lowest organizational level. Each region has about 25 districts and each district usually controls one or two aircraft and the appropriate number of smoke jumpers and smoke chasers. The key man in each district is the pilot-observer. Each day this man plans the day's detection program and dispatches to fires. If adjacent district resources are required he can request these directly from the district thus by-passing the regional base. However, he must keep the region informed of such requests. Large movements of resources are controlled by the Region.

The organizational structure, in theory, seems well suited for a high degree of central control. However, in practice there appears to be very little centralization of daily decision making and the majority of operational decisions are made by the chief "pilot-observers" of each district. It appears that the Central and Regional Bases become involved in daily resource allocation only when serious hazard conditions are present or when large fires are burning. The conditions for when regions and the central base dominate district decision making do not seem to be clearly laid out. In discussions with high forestry officials it was mentioned that a change toward more central control (similar to the change already taking place in several Canadian provinces) will likely be taking place in the future.

BUILDUP PROCESS TO COPE WITH LARGE FIRES

The existing air operation is primarily designed for early initial attack on small fires. When large fires develop a special communications group is dispatched from regional headquarters whose function is to provide all air and ground communications on the fires. The man in charge of the ground forces takes over command of the fire from the air operation. For very large fires a regional committee is formed to direct the fire control operations and this committee has the authority to recruit personnel from local populations. (This authority is usually not given to district chiefs). Mention was made of a civilian emergency measures organization that can be recruited for fire fighting if necessary.

Aircraft

The majority of fixed wing aircraft in use (200) are of the AN-2 type. This biplane is used for combined detection and initial attack and carries 6 smoke jumpers and their equipment. It appears to be slightly larger than our piston Otter and is capable of carrying 12 men on wheels or floats[9]. Its cruising speed is about 110 mph and its cost is $145.00 per hour. It slows to about 85 mph for the dispatch of jumpers. The L-200 Morawa aircraft is used for fire detection patrolling. Its speed is between 140 mph and 155 mph and its cost is about $100.00 per hour. Little mention was made of this aircraft and therefore it was concluded that few such aircraft are being used for pure detection work.

The MI-1 helicopter, a light 4-man helicopter has a speed of 75 mph, a cost of $155.00 per hour and appears similar to our Bell G 4 machine. It is used for general fire work and some detection patrolling.

The MI-4 helicopter is a large 10-man or 1 ton helicopter similar to the Sikorsky S-58. It flies with 2 pilots and 1 pilot-observer and is used commonly for helicopter initial attack. Its cost is $285.00 an hour. The MI-6 helicopter is used under emergency conditions for carrying huge loads up to 12 tons. Bulldozers are occasionally carried with this machine. Its cost per hour was not given but must be over $2000.00 per hour.

The MI-8 is a 20-man or 3 ton helicopter that is commonly used in emergency conditions to carry water (in a heavy rubberized bag suspended beneath), small bulldozers or men to fires. Its cost is $740.00 per hour.

The K-26 helicopter is a new twin counter-rotor helicopter (no tail rotor) that has an estimated capacity of 6-10 people and has a speed of 87-100 mph. A water dropping bucket has been developed for this machine.

9 Floats are used in the Northwest USSR.

The AN-24 fixed wing aircraft is a new twin turbine pressurized aircraft similar to our Caribou. It can carry 50 men and is used for transportation of smoke jumpers. At least one of these aircraft is equipped for cloud seeding. The aircraft can fly to an altitude of at least 23,000 feet. It is currently being modified for amphibious use and also for use as an air tanker to carry 5-7 tons of water (1000-1400 gallons).

The IL-14 aircraft is a twin piston-engined aircraft used for general transport and cloud seeding. It has an estimated carrying capacity of 30-40 men and is equipped with oxygen.

In the Irkutsk region (270,000 square miles) 45 aircraft are in use including 16 AN-2, 10 MI-4, 9 MI-1 types. In the southern part of the region an aircraft is assigned to each million hectares and in the north one aircraft to each 2 million hectares. This region averages about 1,250 fires per season but can have in excess of 2,000 fires in a bad season.

The Karelian Republic is approximately 270,000 square miles and the Karelian Region within this Republic (60,000 square miles) has 11 aircraft of which 5 are helicopters of the MI-1, MI-4 and K-26 type and 6 are fixed wing aircraft[10]. There are 30 smoke jumpers and 110 smoke chasers in this region.

There are 650 pilot-observers for the 500 aircraft in the USSR. Aeroflot provides as many pilots as required. Officially pilots are to fly no more than 8 hours a day and only 5 days a week. There also are weekly and monthly maximums. It was mentioned that these limits are exceeded in some emergency conditions.

In 1961, tests with the AN-2 aircraft equipped for water dropping were carried out. It dropped about 260 Imperial gallons in a 5 second period. The pattern was about 200 feet by 45 feet with an average wetting of about 0.2 litres per square metre. In some areas concentration of up to 2 litres per square metre were obtained. The low capacity and poor pattern resulted in a discontinuation of this programme. It has only recently been reactivated with the proposed modification to the AN-24 aircraft.

10 Our notes were confused as to the sizes and number of regions within the Republic and to the operational area of the air fleet described.

The aircraft are used for other tasks when not required for forest protection work. Forest protection has priority over all other uses, however. As mentioned earlier, the aircraft fleet can be expanded quickly in times of emergency. There seemed to be an abundant supply of Aeroflot helicopters and AN-2 aircraft across the USSR.

Detection-Initial Attack

It was clear that the overriding philosophy was early detection and fast initial attack. Visual aircraft detection is the prime method of detection used in remote areas. For instance, in the Irkutsk region 80% of the area is patrolled by aircraft. The other 20% is covered by lookout towers of the forest enterprises. Most of the aircraft patrolling is carried out with the AN-2 aircraft carrying about 6 smoke jumpers. A limited amount of patrolling is carried out with the MI-1 helicopter carrying several smoke chasers. Some patrolling is carried out with lighter, faster aircraft without smoke jumpers - similar to our system.

The trend in detection appears to be toward more use of single function detection aircraft backed up by fast helicopter initial attack and away from the use of the combined detection, smoke jumper system. The high cost of training and supporting smoke jumpers will probably reduce this operation significantly in the next few years and likely eliminate it entirely in the next 5 to 10 years.

No infrared detection systems have been built although a satellite infrared system has been seriously considered. (There exists at least one infrared scanner for fire mapping). An experiment using remotely located and controlled tower-mounted television for detection is being carried out in western USSR. The results of this trial were not given. The television system used is similar to the one shown to us at the Bratsk Forestry Complex.

All normal forest protection activities, including detection routing and scheduling are under the control of the district chief. In general, his resources are assigned to him at the beginning of the season and remain with him. Up to recently this is the way that our larger agencies functioned. Lately, the trend has been toward more central control of these resources in an attempt to take advantage of the fact that usually only a few districts have a fire problem at any one time. Detection aircraft, for instance, on a daily basis can be concentrated where they are needed instead of being committed to districts without a fire problem. Hints were made that more centralized fire control decision making will be made in the USSR in the future and that the process of change may already have begun.

We learned that Dr. G.N. Korovin of the Institute[11], Leningrad has developed a computerized procedure for determining district patrol routes. Such routes are set at the beginning of the season and are based on fire occurrence patterns and on a criterion related to minimizing the elapsed time to detection. Little time was available to go into details on this procedure and consequently only a vague understanding of it was obtained.

The frequency of patrols is a function of the ignition index class for the district. No patrols are flown on class 1 days (0-300). On class 2 days (301-1000) one patrol is made every other day until a fire is detected and then every day thereafter. On class 3 days (1001-2500) one or two patrols are made. Two or more coverages are made on class 4 days and under severe hazard conditions as many as 4 patrols may be flown over an area.

The usual patrol altitude is 2,000 feet and the maximum distance that a small fire can be detected under ideal conditions is considered to be 6-10 miles.

The chief of the Bratsk district (Irkutsk Region) reported that the average fire area at detection in his district was 3/4 of an acre and the average area burned per fire was 6 acres (based on the last few years of data). This current year the average area at detection was 0.6 acres and the largest fire this year was 75 acres.

The equipment development section at Leningrad has developed a special tower structure that is used as a lookout. The advantage of this structure is that it is about 1/3 the cost of a comparable steel tower. There is a special lifting device which assists the observer to the top (37 metres high or 120 feet) of a guyed wooden[12] pole.

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11 Leningrad Scientific Research Institute of Forestry

12 Steel poles are now being used in place of wooden poles

Helicopter Initial Attack System

The commonly used large, 10-man, MI-4 helicopter was demonstrated in its initial attack role. Well trained, highly motivated "smoke chasers" were rapidly lowered through dense timber canopy from a hovering helicopter. This system, combined with early detection, presents a safe, relatively inexpensive, but effective means of achieving rapid initial attack. Such a system has often been proposed by Canadian fire control agencies, but in the USSR we were able to see it and study it in actual operation.

Each smoke chaser wore a heavy canvas uniform, heavy gloves, a large knife, and crash helmet (without a face mask). Attached to a parachute like harness, on the smoke chaser's chest was a lowering device. This device represents the key to success of their heli-attack operation. It consists of a circular, nearly flat enclosed reel of strong tape about 1 1/2 inches in width. At the top of the reel container was a frictional device through which the tape was threaded and a control lever. The control lever gave the man complete control of his rate of descent. Each reel appeared to contain about 250 feet of tape.

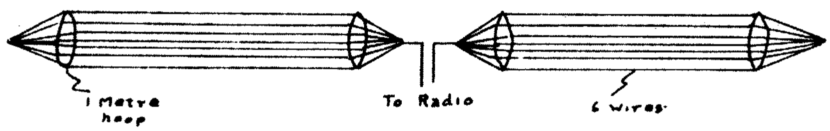
A special pipe frame structure was located in the doorway of the helicopter. It was swung inside the helicopter initially where the tape line was securely fastened to it by means of a simple snap device. Then it was swung outside the helicopter and locked into position. At that time the man stepped onto the wheel strut and began his descent. The jumpmaster unsnapped the line and dropped it as soon as it went slack. This procedure took slightly less than 1 minute per man through timber 100 feet tall. Each man carried a crank to rewind his tape once on the ground. The procedure could be reversed for cargo dropping. In this case the reel-friction device was fastened to the helicopter frame structure and the cargo master controlled its rate of descent. The estimated cost of the reel-frictional device is $50.00. Loads weighing between 100 and 200 pounds could be lowered.

Communications System

Communications between regions and the Central Base at Pushkino were usually by telephone although some mention was made of the use of teletype. A priority system existed such that emergency fire calls took priority over all others and could be rushed through the telephone network without delay.

The forest aviation radio communications system used throughout the USSR appeared to be standardized. We saw relatively few radio types in use but the function and method of use of each type appeared to be well-defined.

The largest radio complexes are located at regional air base headquarters. From these each district headquarters can be contacted. Each district in turn has the necessary radio equipment to communicate with aircraft and ground crews. Better success with radio communications was claimed than our North American experience. This possibly could be because of an unusual HF antenna design seen throughout the USSR



and most likely because of the common use of Morse Code. When radio noise became such that voice transmissions were poor, Morse Code was used - apparently quite successfully.

Long distance communication by radio is with a single-sideband system. UHF frequencies are used for short distances. All systems are AM and there is no direct use of microwave channels or satellites. There is no general field use of teletypes or facsimiles.

All reports of fires and district aircraft dispatches are reported to the region. The region has the authority to override the district dispatcher (each evening the district chief pilot-observer files the next day's proposed flight plan with the regional office). Complete details including photographs of the radio types in common forest protection use, their function, specifications, and antenna configurations are presented in a radio operators training manual (given to us).

There was a 3-man group at Irkutsk Regional Base to maintain the region's radios. The ground side of the forest protection organization has a radio system, identical to the aviation side. On large fires a special (Regional) communications group is set up to handle the fire communications.

Weather Data

The forest protection bases receive all their weather data from the Hydrological-Meteorological Service (completely separate from the Forestry Ministry). Each year Forestry and Hydro-Met negotiate a new contract for weather services. In our travels we passed by 3 of the Hydro-Met stations and these were heavily instrumented and well-maintained.

Each morning the Hydro-Met Service supplies the Regional Base with up-to-date satellite imagery of their region 24-hour forecasts, and long term fire weather forecasts. In addition the Hydro-Met Service calculates the forecasted (and presumed current) fire danger indexes for each District station (or weather point) within the region. These calculations are not done by computer.

The region is also supplied with a general forecast for the next month and a summary of the weather of the previous month. Previously forecasted and actual weather data are compared and adjustment factors are available for each forecast (based on past performance of the forecasters). The satellite data is found useful for front location and an overview of the general weather situation.

The Bratsk District (approximately 11,000 square miles in the Irkutsk Region) has 25 separate locations where weather data is taken (about every 20 miles across the District). Most of these are electronic (unmanned) remote stations that report to a Hydro-Met station via radio. Each Hydro-Met station has about 5 such "weather points". Forestry indirectly receives temperature, relative humidity, and precipitation from each weather point.

Single-sideband transmitters are used and maximum transmission distance from remote stations is 300 kilometres. The remote stations are powered by storage battery and have a gasoline-powered generator to recharge the batteries. They can operate unattended for at least 1 month. They can be interrogated at any time and use a different communications system than that used for forest protection.

We did not get to see any remote stations since they were not operated by the Forestry Ministry (others in AES have more details on these stations). It seems clear, however, that their Hydro-Met Service is serious about supplying Forestry with the needed weather data. Unfortunately, this does not seem to be the case in Canada.

Fire Danger Index

The only index in wide use is an ignition index that has the following form:

$$P = \sum_{i=1}^{W} (t_i - D_i) . t_i$$

Where P = Ignition index

W = Number of days since the start of the season

t = Temperature (centigrade)

D = Dew point temperature (centigrade)

The temperatures are measured each day at 1 pm local time. It is started the first day above 0^oC, after the snow leaves. A convenient form is used to make the calculation.

DAY

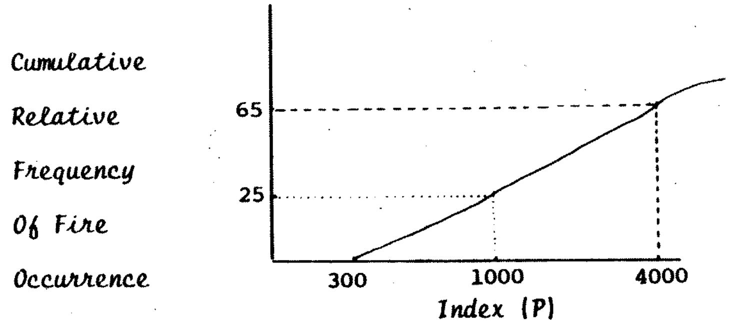
	1	2	3	4	
Precipitation Temperature (t) Dew point (D) (t-D)·t Sum					

The summation continues until more than 3 mm of precipitation. On such a day the sum is set to zero. The approximate class boundaries used are:

Class		P
Nil	.....	0-300
Moderate	.....	301-1000
High	.....	1001-4000
Extreme	.....	4001+

The boundaries are recalibrated for each local area using the following method:

A graph is plotted for fire occurrence versus the index based on 10 years of local fire and weather data.



The upper limit of the Nil class is set at the index value below which no fires occurred in the past. The upper bound of the Moderate class is that index value that includes 25% of all fires that occurred. The upper bound of the High class is the 65% value and Extreme is the remainder.

In some areas up to 3 such graphs are prepared for spring, summer, and fall. These calculations are made for each weather point in a district and are considered to be valid at most, to a radius of 30 km. Detection patrol frequency for a day depends on the index of the highest station in the patrol territory. The index is aimed at fine fuel, at or near the ground. No multiple index system is used. In the Eastern regions the index class is raised by 1 class if the wind is over a specific speed.

The index is used strictly as an ignition index to give the chance of a fire occurring. Fire rates of spread equations have been developed for research purposes but are not used in the field.

Use of Explosives for Line Building

Explosives are the major line building tools in remote areas where bulldozers and ground tankers cannot reach. (Most of the Siberian area that we saw had deep, well-drained, sandy loam soils and consequently there was little opportunity to use motorized fire pumps). Explosives are carried in a wooden crate by either helicopter or aircraft and are either lowered or para-dropped to the line building crew on the ground. A technique has been developed to deposit sufficient explosives ahead of the line building crew by helicopter. We learned that there are 1,700 personnel trained in the use of explosives - most of these are smoke jumpers or smoke chasers.

Two explosive methods are available. One method is used in heavier soils and peat and where heavy underbrush is present. It consists of placing explosive charges in small holes separated by several metres and joined together by blasting cord. The depth of the holes, the amount of charge placed in them, and the hole spacing determine the depth and width of the resulting line.

At the demonstration at Petrozavodsk we were able to see the complete operation using this method. First the AN-2 aircraft dropped six smoke jumpers; a light, motorized hole-drilling machine; and a sufficient quantity of explosive. Holes 2 1/2 inches in diameter, spaced several metres apart[13] were drilled (3 feet deep) in a line several hundred metres long. Two charges of "amonite" explosive, each 1 1/2 inches in diameter, and 10 inches in length, were dropped down each hole. A single detonating cord joined each of the hole charges together. This was accomplished by a simple knot of the cord around the top charge in each hole. A blasting cap with a 1-minute fuse was used to set off the chain of charges.

Two hundred metres of line were prepared in about 30 minutes by four men. (The average time to drill a hole was about 4 seconds). A maximum of 300 metres of fireline could be built with this technique. The safety zone for detonation was 50 metres. Electric detonators once were used but this was abandoned because of the difficulty of handling the wire in the forest. Detonators are carried in an explosive proof vessel that has about 10 separate compartments. The resulting explosion produced a continuous trench, 2 feet deep producing an excellent fireline about 10 feet wide from which backfires are lit.

The cost for this type of line is as follows:

42¢ / Kilogram of explosive "Amonite"

6¢ / metre of fuse

5¢ / blasting cap

19¢ / metre of detonating cord

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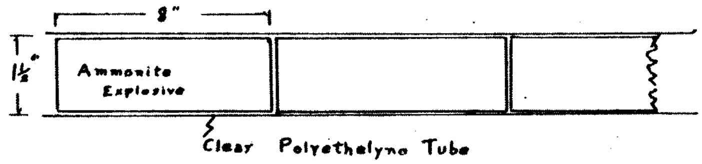
13 A 4-foot trench is made if the spacing is 1 metre

Each charge unit weighed about 1/4 of a kilogram. The average explosive cost per metre for this type of line construction is 40¢.

This technique produced a fireline far superior to any that could be made by hand and equivalent to that made by a dozer-flail combination.

The second explosive line building technique and by far the most widely used is suitable in lighter, shallow soils, and litter. It involves the laying of a continuous length of "amonite" explosive where the line is to be constructed. The same charge units as described previously are placed end wise in a light, flexible, transparent, polyethelyne tube.



The explosive tube may either be laid on the forest litter or buried about 6-8 inches in the soil. The best results are obtained by burying it in a small slit trench constructed by hand. The explosive units must be adjacent to each other to guarantee that the explosion will be carried along. A blasting cap and a 1 minute fuse are used to set off the explosive.

Before the tube is buried a man inspects the tube to ensure that it will all explode. A whistle signal is given when the fuse is lit and the personnel go at least 100 yards away. Two minutes after the blast the original inspector must walk the line to ensure that all the explosive has been detonated. Once the line is safe the crew usually starts a backfire using fusees.

One kilogram of explosive is used each metre and the approximate cost is $1.20 per metre. Only several hundred metres of line can be made with a single explosion. The explosive line must be built 100 metres from the fire's edge although the explosive will not detonate if the fire burns to it. Apparently, it merely burns and will only explode if a concentration of 3 tons or more is set on fire. The explosive is carried in wooden crates in helicopters and enough explosive is lowered about every 100 metres to construct the line.

Experiments have been conducted to test the safety of the explosive. Bundles dropped from a helicopter onto rock did not explode.

A new type of explosive resembling a fire hose is being developed. With this type, lines up to 400 metres can be built with one explosion.

The fireline can be built even faster if the tube is not buried but the results are not quite as good. We were told that explosives are used on about 600 fires each year.

Other Line Building Equipment

Heavy and light line building equipment were shown to us. These included bulldozers, tracked fire plows, tracked flails, tankers, and conventional hand tools and pumps. The soils of many of the USSR sections that we visited were deep sandy loams[14] and we could see the usefulness of the heavy equipment. But such equipment would have a very limited role in our shallow soils. With regard to hand tools, our tools (specifically made for fire control) appeared superior. Their fire pumps were of the low pressure-high volume type that did not seem to compare to our types, however, in much of the area that we visited the use of pumps (as we use them) was out of the question. There were few streams running through their well-drained soils. Such pumps were probably used to load ground tankers and helicopter water bags (made of rubberized canvas) that are carried to firelines for backpack pump use.

Conventional backpack pumps and pressurized backpack pumps were shown to us. The pressurized type consisted to two cylindrical tanks joined together holding 16 litres of water. Premeasured plastic bags were used to carry the chemical compounds that were added to the water. These chemicals were oxalic acid (110 grams), potassium permanganate menture (30 grams) and sodium bicarbonate (50 grams). It required 2 minutes to reach full pressure. A good pressure (5 atmospheres) lasted for about 5 minutes and spray distances of 15-20 feet could be attained. The spray could be shut off at any time and each pump has a variable nozzle. Other types of line building equipment either shown to us or on photographs were:

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14 Like much of Canada might have been had it not been for glaciation

(a) TDP-53 fire plow
- mounted on a "J-5" type tracked vehicle
- 2 tanks (1000 litres total) and pump

(b) All terrain tracked, amphibious vehicle
- equipped with a fire plow
- mainly for personnel transportation

(c) Slip-on tank for a 2 ton truck
- 1000 litre capacity
- discharge rate of 600 to 800 litres/minute
- 8 to 10 atmospheres pressure
- 1000 of these units exist

(d) Firefighting boat
- jet drive
- for equipment and personnel transport

(e) Small line building bulldozers
- flail and trenching tool
- 1.5 tons (carried by MI-8 helicopter)
- 1.1 metres wide
- 50 hp engine

(f) Portable manual flail
- 4.5 hp engine
- for light and sandy loams

(g) Heavy flail
- tracked vehicle
- 110 hp engine
- throws up to 125 metres
- 100 in use

(h) Motorized fire extinguisher
- based on solo mist blower
- uses water and softener
- 12 litre capacity
- 2.5 hp engine
- 22 kilograms in weight
- pressure of 4 to 5 atmospheres
- pump time of 2 minutes

(i) Peat bog fire fighter
- 1 metre probe with handle

(j) Pressurized ignition pump
- hand operated
- kerosene fuel

A series of 10 large training posters were given to us. These contain pictures and specifications of the major line building equipment, cargo dropping procedures, smoke jumper and smoke chaser operation, and fire fighting techniques. (See Appendix 2).

Cloud Seeding for Fire Suppression

A simple technique involving the use of cloud seeding for fire suppression has been developed by the fire research section of the Leningrad Forestry Institute. The production unit is currently in the process of introducing the technique to the operations side. We flew from Irkutsk to Bratsk, Siberia, in an IL-14 aircraft equipped for cloud seeding and on the way the complete cloud seeding procedure was demonstrated.

The purpose of the seeding is to produce rain on or near burning fires. A "wide-area" approach is used where all suitable clouds in the vicinity of fires are seeded. The regional meteorological service informs the production unit of the days when atmospheric moisture and stability conditions are suitable for seeding (computerized convective models apparently are not used for this). During the last four years the areas around two hundred fires have been seeded and rain has resulted on 80 of these fires. It has been estimated with the aid of a crude fire model that 300,000 hectares (1,100 square miles) have been saved from fire in the last 4 years by the cloud seeding program. Five aircraft are available for cloud seeding.

A study has been made of the frequency of fire occurrence and corresponding cloud seeding chance for all fire areas across the USSR. Based on this, areas have been delineated for operational trials. The Irkutsk region was found to have adequate seeding conditions present often enough when fires were burning to justify an operational cloud seeding unit.

The method consists of firing 12.5 grams of silver iodide or lead oxide into every 10 cubic kilometres of cloud. This is accomplished by using a conventional 10 gauge flare pistol, a specially constructed small window opening in the back of the aircraft, and a timing device under the control of the pilot to indicate the time at which each charge should be fired. The aircraft must be capable of flying to an altitude of 7,000 metres.

During seeding trials, smoke jumpers were dropped into recently seeded areas to observe the effects. Usually within 25 minutes rain would begin to fall and occasionally rapid and violent cloud buildups were reported immediately after seeding.

Unsuccessful attempts have been made to seed the convection columns of nine larger fires with this same technique. Lack of sufficient water content in the column was given as the reason for these failures; such an approach has been proposed for use in Canada. Further discussions on this point indicated that the fire columns on which seeding was tried were not the massive thunderstorm-like forms present with some of our large Canadian fires (the fire type on which such an approach would be first used). Also, the "dynamic" seeding technique[15] rather than the "wide-area" technique would be used on these convection caps. The dynamic technique has never been tried for forest fire control work in the USSR. However, considerable interest was expressed in this technique and in the convection column seeding approach. We were asked to keep them informed of our work in this area.

An automatic flare-firing system has been constructed and fitted to the back porthole of the AN-24 aircraft. It consists of a cassette in the form of a metal wheel capable of holding 16 cartridges. An electric firing mechanism is used to fire the cartridges singly or in salvo. The same cartridges are used in this system as with the flare pistol system of the IL-14 aircraft.

A cartridge of silver iodide costs about 12 dollars. Lead oxide cartridges cost about 1.35 dollars. Lead oxide is most commonly used because of this lower price in spite of slightly lower effectiveness. A rocket system is being developed to launch the reagent into the clouds

15 Dynamic seeding involves a rapid and massive injection of silver iodide into a single cell.

from low altitude aircraft (such as the AN-2). Also photographs of a large 82 mm rocket launcher was shown to us that is being used in experiments involving ground-to-air rocket transport of the reagent into clouds. It is capable of reaching an altitude of 4.2 km. It is electrically fired and had a 7 second fuse that turns on an active cloud seeding generator in the rocket's head. It has a self-destruct system that is employed either after 25 seconds or 40 seconds (at least 1 km above the ground).

The cloud seeding technique is used only in areas where fires are burning but these fires can be very small. It seems clear that this type of seeding operation could be used as an effective prevention tool to wet fuels in high hazard areas. The distinction between the use of seeding as a prevention tool and as a suppression tool becomes quite vague when only very small fires are involved. Political implications of preventative seeding may be the reason for the condition that fires must be burning in the area to be seeded. Also, it was mentioned that some cloud conservation must be considered. Rain dropped in one area is rain that is not available to adjacent areas.

In general, the USSR fire suppression work with cloud seeding appears excellent and definitely should be tried in Canada. Cloud seeding offers the only method known to suppress large, high-energy fires that cause most of Canada's losses and suppression costs. Also, it has the added advantage as we have seen in the USSR that the technique is very inexpensive.

Detailed literature describing the atmospheric conditions necessary and complete operational procedure and results to date were given to us. These are now being translated.

We related the Quebec experiences in public reactions to cloud seeding to various USSR forestry officials. The reply received varied from one extreme to the other. At least one person said that it was not necessary to consider public opinion while others said the public was in favour of it because it put out fires. Others indicated that public opinion was very important and indicated that it should not be neglected. A story was told to us of how Dr. Artsybashev was recently conducting ground-launched cloud seeding experiments in the vicinity of a small town.

The mayor of the town received a large number of letters from the local population that could be filed into two baskets. The letters of one basket blamed the experiments for removing the rain and causing the drought and the letters of the other basket blamed the experiment for causing too much rain. Needless to say we came away with the impressions that local public opinion indeed influenced their cloud seeding operations. Also, they seemed to understand why we would be conducting our future cloud seeding experiments only in the areas immediately in front of large fires.

The Fire Problem

Considerable time was spent by the group in trying to understand the seriousness of the fire problem in each of the regions visited. North of the 60th parallel lightning is an important cause of fire. In some areas the limit of Northern protection is the Arctic Ocean. In the far north reindeer pastures are protected. The intensity of protection in the eastern USSR is a function of the value present.

The Irkutsk Region is 760,000 square kilometres in area (293,000 square miles) and is about the size of Ontario. Seventy-two per cent of this area is forested with pine (pinus sylvestres, pinus siberia), larch (larex siberica), birch (betula vericosa), and aspen (populus tremuloides). The most severe fire conditions in the USSR occur in this region. Maximum temperatures reach 35°C (95°F) with very low relative humidities (below 20%). The soils are deep and appeared to be mostly well drained. There are a great many logging operations throughout the region.

The region averages 1,250 fires a season but more than 2,000 have occurred some years. The Bratsk District (11,000 square miles) averages 80-90 fires per year but in 1969 it had 719 fires. The largest of these was 865 acres. The chief of the Bratsk District reported that only 5% of his fires were caused by lightning and the remainder by people. There were no railway or power saw fires (their saws have a much different design than ours and probably can't start fires). The average multiple-occurrence day in the Bratsk District has 4 fires with a maximum of 7.

While we were at Bratsk we observed large even-aged, mature, and overmature pine stands. To us, these suggested large, destructive fires in the past. However, the Bratsk officials indicated that crown fires rarely occurred and certainly the fire statistics of the last 5 years confirmed this[16].

Before leaving Bratsk we could not help commenting on the apparent lack of fire protection for the town and forestry complex[17]. The large, mature pine forests came up to the town's buildings. Mr. Shchetinskii pointed out that much of the underbrush had been removed under these stands for a large area around the town and once again pointed out the lack of crown fires in the District.

Detailed fire reports are filled out for all fires over 25 hectares in European USSR and for fires over 200 hectares in Eastern USSR. Only limited data are recorded for fires below these limits including location, occurrence time, and final area. All fire reports are forwarded to the regional base and then on to the central base. A computer program has been written to summarize and update the monthly fire statistics for the USSR. At Pushkino we were shown the June computer report.

In the Karelian Republic the regional air base at Petrozavodsk was responsible for a 70 million hectare area (270,000 square mile area). The forest and lakes of this area reminded us of Northern Ontario and Quebec. There are 52 aircraft distributed among 42 Districts within 2 Regions in the Republic. The average number of fires per season for the Republic is 750 although 1,600 occurred this year and last year. The average area burned per fire is 4 hectares and in the last 2 years there were only 3 crown fires. The minimum relative humidity for this area was reported to be above 40% which explains the lack of large fires. Once again lightning was reported to have started only 5% of the fires although in 1972 this figure was 13%. (15.6% of the 1972 fires had unexplained causes).

In the Republic there are 33 fire chemical stations (ground fire stations) and 1,500 fire wardens. The 40 main weather stations also have weather "points" supporting them. Some of these are electronic and others are manned.

16 Later Mr. Dobrotvorskii indicated that very large fires had occurred in the past in this Region. It may be that there is a 20 year + cycle of bad fire years and such a season is yet to be experienced by the Bratsk organization.

17 The forestry complex alone represents an investment of 1 1/3 billion dollars.

It was interesting to note that the field people did not accept lightning as an important cause of their fires. It was pointed out both at Pushkino and again at Leningrad that lightning was probably responsible for a much larger proportion of their fires than their official field statistics indicated. A study in the 1960's indicated that in one area of Siberia lightning accounted for about 80% of the fires and it was said that overall lightning in Siberia probably starts 40% of the fires - not the 5% suggested by the field people.

Prevention Program

The prevention program appears to be better organized and better financed than those found in Canada. Apart from their numerous and attractive roadside poster program and radio and TV programs they appeared to be successfully recruiting children to actively pass the fire prevention message to adults. One such group of enthusiastic children (ages 8-14) were shown to us. They wore uniforms copied after the adult forest protection uniform and each was assigned a rank similar to that in the adult organization. Part of their work involved distributing fire prevention literature to vehicle operators and forest travellers. Another phase dealt with helping to run a tree nursery and tree planting in burned areas.

We were shown a large and powerful loudspeaker system that was attached to many fixed wing aircraft and helicopters. This system was demonstrated to us. From an aircraft at an altitude approaching 2,000 feet we could clearly hear a 30 second message while standing in heavy timber. The system is not only used to direct fire fighters but widely used to inform forest travellers during high hazard periods of the fire prevention message. The system can be mounted on fixed wing aircraft or helicopters.

As mentioned previously their fire control personnel are paid year-round by the forest protection organization. Most crew workers apparently are given winter work on the logging or related forestry operations. However, the pilot-observers spend much of the winter working in fire prevention. They visit schools and other community groups spreading the fire prevention message.

In Siberia, between Lake Baikal and Irkutsk we were shown a network of well maintained fire breaks. These were about a chain wide and also served as access roads. They were spaced every few kilometres along the main road. Every three or four kilometres along this same road was a small shelter that not only served as a waiting spot for buses but also was the only place in the forest where a traveller was allowed to smoke.

Each spring before the fire season began an extensive burning program was carried out to remove fuels in high hazard areas. These included right-of-ways along roads and railroads and areas adjacent to timber landings and agriculture lands.

It is interesting to note that there appeared to be a clear policy on the method of slash disposal. Prescribed fire was not to be used but rather the slash was to be chipped and spread at the time of logging. It was recognized that this policy involved a change in harvesting technology but they pointed out the benefits related to soil protection and enrichment, lack of smoke, and elimination of the risk of escaped fires.

Regional officials had the authority to stop logging operations in their region during times of high hazard. Also, cloud seeding, although officially not used as a prevention tool, its use over high hazard areas when small fires were burning amounted to using it for prevention. No work has been done on prevention or reduction of lightning with cloud seeding to date.

Personnel

The fire control personnel with whom we visited were highly trained and highly motivated. All fire control personnel were full-time employees paid year round by forest protection. In winter, many worked at other forestry activities such as logging. We concluded that their personnel were a very professional group quite serious about protecting forests from fire.

The average monthly wage of a smoke jumper in Siberia (subject to approximately 100% regional and northern allowances) is about $270.00. The minimum wage for all workers in the USSR is $95.00. Engineers in the Bratsk area made about $540.00. A smoke jumper can retire after 18 years if he makes over 15 jumps per year. At retirement they can get another job and earn up to a maximum of $405.00 a month including the retirement pay. A job is guaranteed in the air service to retired jumpers.

Budgeting

It appeared that budgeting for fire control in the USSR was done in a similar manner as in Canada. Each year a plan and corresponding budget must be prepared. An emergency fund similar to "EFF" fund exists from which additional moneys may be obtained. It was mentioned that the air service already has spent this year about 7 million dollars over its planned budget on the large fires of the far East and West. It was mentioned that they hoped to use computers to define more accurate desired protection goals, and these in turn could be used to stabilize the budgeting situation.

Fire Retardants

Water softeners (detergents) and freons appear to be in common usage by ground forces in ground tankers and backpack pumps. Little, if any, use is made of long term retardants. However, the impression was given to us that di-ammonium phosphate was being studied and future use may be forthcoming.

Forest Enterprises

Each region is divided into forest administrative districts and in some of these active logging may be carried out by forest enterprises. Each forest enterprise is responsible for forest protection in its timber limits and consequently they operate lookout towers and ground fire stations.

The complete operation of one such enterprise was described to us at Angarsk. The timber limit area was 280,000 acres and the current harvest is 70,000 cu. metres/year (20,000 cords). They operate two lookouts and have a good prevention program involving the use of school-aged children. Their fire station has one modern tracked personnel carrier, one tanker truck, five motorized pumps, and a variety of hand tools and radios. If a severe fire situation develops the air service is notified and extra protection is supplied.

Research in Fire Control

While in Leningrad we visited the Leningrad Scientific Research Institute of Forestry. It was founded in 1918 and at that time had a staff of 18 people. Today is has a staff of 330 people, approximately 7 regional experimental stations, a demonstration forest, and an experimental production factory. The Institute at Leningrad is divided into Laboratories and Sections and each works in a specific problem area in forestry that has application to the whole USSR. (Note that similarity between this structure and that of the Canadian Forestry Service). The specific problem areas in which the Leningrad Institute currently is working are:

(a) Mechanization of forestry operations including fire control
(b) Use of chemistry in forestry
(c) Soil drainage and mechanization
(d) Forest management and use of aerial methods
(e) Economics of labour
(f) Forest renewal

Sections and Laboratories conduct research into these problems including:

(a) Silviculture section
(b) Artificial forest section
(c) Economics of forest reorganization section
(d) Genetics section
(e) Fire research section
(f) Mathematical methods laboratory
(g) Forest renewal mechanical development section
(h) General equipment development section
(List not complete)

The fire research section has 20 workers. Four are candidates of Science, three are laboratory specialists, and the remaining are either engineers or clerical assistants. The fire research is aimed at five specific areas.

a) Fire behaviour (7 workers - much of this work is going on in the regions but it is coordinated by the Institute). The work includes the study of the interaction of weather and fires. Experimental and natural fires are observed. Mathematical methods are used to process the data.

b) Search for chemical means of fire suppression and corresponding delivery systems (3 workers). Current emphasis is on use of softeners, thickeners and foam. Also much work is being done with freon emulsions and it was claimed that these increase the efficiency of water by 3-5 times. Work is also being completed on high expansion foams (ratio of 1:250) and a foam line apparently has been used successfully as a base for burning-out.

c) Development of Radio Engineering Equipment. This section developed the aircraft loud hailer and infrared fire mapping equipment that is now in use in the Far East. Currently experiments are being conducted with the Barnes infrared fire spotter. A study is going on to identify the infrared signatures of forest vegetation and terrain.

d) Development of aerial suppression methods. Currently, this group is working on the design of easily detachable fire equipment for their aircraft. For example, they have developed a 470 litre (103 gal.) water dropping bucket for the K-26 helicopter. It has been nick-named the "Canadian Barrel".

e) Weather modification for fire control. Recently this group has finished work on the aerial cloud seeding techniques and are now working on a method of launching seeding generators from both the low flying AN-2 aircraft and the ground. Also, some thought is being given to the use of seeding for the reduction of lightning.

Crown fires are not currently being researched. A fuel typing system has recently been completed that should appear in the literature. Next year experiments will be carried out using directional spherics equipment and weather radar[18]. No work is being done on spontaneous combustion. Work is continuing on fire danger rating (at least 3 workers).

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18 We were quick to point out the Canadian solution to this problem which would probably be ideal in the USSR based on the density of weather points.

A set of equations giving rates of spread and fuel inputs has been developed.

Dr. Korovin, Chief of the Laboratory of Computing Methods outlined the fire related work in which he was involved. Up until recently the emphasis has been in the application of computers to the organization of the forest protection effort. Specifically the Laboratory has been working on long term planning aids for the air and ground sections. This year the work has taken a new direction - involving fire protection management and aircraft dispatching (presumably related to shorter term decision-making aids).

Some of the Labs' work is concerned with building an information bank including the fire and weather data for the last five to six years, the road transportation network, and an inventory of the available resources. These data will be used initially in a study to determine the suitable goals for forest protection. Work has been done using Monte-Carlo methods on the number of initial attack crews required in each region for each season and an optimal allocation of stations for these crews. Here a function of travel time was the criterion used to allocate crews and stations. It was claimed that the computer manpower - station allocation was 1 1/2 times more effective than the existing procedure. Also, optimal routes for detection patrols have been calculated for certain areas after considering hazard, values and fire occurrence patterns. Results from both these projects are now being applied in the field. Work has been done on alternatives for servicing large fires and the best combination of ground and air initial attack forces in an area. Results from the latter work are being field tested and will be used by forestry establishments and regions for long term planning purposes.

The computer facilities available to the lab is an "in house" computer approximately the size of an IBM 360 Model 30. In 1974 they expect to get a Minsk-22 system that is about equivalent to the IBM 360 Model 40.

Mention was made of an automatic position location experiment that is going on this season. Apparently, position location devices are on some of their "heavier" aircraft. We asked if these used the "Loran" principle and the answer was yes. However, it's not clear that the question was properly understood.

While at Pushkino, we were shown an up-to-date computer listing of the fire situation up to the end of June. This report was based on fire report data from the regions and the system appeared quite similar to the computerized fire report system of Quebec.

Conclusions

In conclusion we have seen that the USSR is more advanced than Canada in several areas of fire control such as:

(a) The general use of a large helicopter initial attack system including the descent mechanism, and highly trained and motivated smoke chasers.

(b) The use of explosives for line building in remote areas where water or bulldozers are not available.

(c) The forest protection organization is being supported by a large meteorological organization apparently serious about supplying the necessary weather data.

(d) A standard communications system across the country (although some Canadian fire control agencies operate superior systems - there is no standardization as in the USSR).

(e) The cloud seeding operation is nearly operational and likely represents a significant new tool for large fire suppression.

(f) The prevention program appears to be broader in scope and making much better use of young people than our program.

(g) In general, the personnel appear to have a high degree of training and motivation and relatively low staff turnover. Their permanent year-round employment policy likely has some bearing on the state of their personnel.

Canada is more advanced in other areas such as:

(a) At least in some Provinces there is a higher degree of centralized control that, in theory, should enable better use of existing aircraft and manpower resources by taking advantage of new mobility and broad-based, well-informed decision-making. In the USSR we saw that aircraft and crews were controlled by local forest protection officials - although it was made clear to us that this situation was changing rapidly.

(b) In fire detection, the Canadian use of single-purpose, high-speed, aircraft for detection appears superior at least cost-wise to the AN-2 smoke jumper approach. But the Canadian detection system requires something like the USSR heli-attack operation to back it up while the USSR heli-attack system probably should be complemented with a single purpose detection system.

(c) Canadian portable fire pump-hose systems are much superior to those of the USSR. Again there is a good reason for this difference. Canada has a great deal of poorly drained forests while in the USSR's forests water for fire pumps is very scarce. Certainly in the Siberian and Karelian areas that we visited portable fire pump-hose could only be used rarely.

(d) Canada has well established air tanker fleets some of which have been using long term retardants for many years. No operational air tankers were seen in the USSR.

(e) The Canadian Fire Weather Index system is much more comprehensive than the Ignition Index in use in the USSR. In theory Canadian fire control officials in the field should be better informed as to the expected behaviour of new fires.

We have come back with a great deal of knowledge - not only about the fire control system of the USSR, but about specific aspects of it that should benefit Canada. Future exchanges of limited numbers of specialists on a long term basis will help to fill in the many missing details. The forest fire problems of Canada and the USSR are surprisingly similar and both countries have developed in ways that will complement each others total system.

APPENDIX I

Names and positions of people met during the trip

APPENDIX I

List by Place and Date of Soviet Personalities Encountered

Moscow, Tuesday 21 August

Shchetinskii, Evgenii Antonovich: Chief Engineer, Central Air Base, Pushkino. Met the delegation at Sheremet'evo Airport and was our chief escorting officer until Friday, 31 August.

Polyakov, Nikolai: A junior assistant to Rozhkov, Deputy Minister of Forestry, RSFSR. Met the delegation along with Shchetinskii at Sheremet'evo and handled our accommodation and travel at Moscow.

Rozhkov, Oleg Ivanovich: Deputy Minister of Forestry, Russian Socialist Federated Soviet Republic (RSFSR). Met us at Sheremet'evo Airport. Accompanied Peter Kourtz and Bill Pierce by car to the Ukraina Hotel and briefed us on our itinerary in the USSR.

Moscow/Pushkino (Central Air Base), Wednesday 22 August

Andreev, Nikolai Alekseevich: Chief, Central Air Base, Pushkino. Briefed us on the role of the Central Air Base and was our host at lunch at a local restaurant.

Davydenko, Eduard Pavlovich: Believed to be Chief Pilot-Observer at Pushkino. His speciality is aircraft navigation as related to fire detection.

Gar'kin, Aleksandr Alekseevich: Chief, Foreign Relations, Ministry of Forestry, RSFSR.

Pryakhin, Petr Nikolaevich: Chief, Engineering and Production Laboratory, Central Air Base; in charge of exhibit at Lesdrevmash Trade Fair.

Irkutsk, Thursday 23 August

Butskikh, Aleksei Petrovich: Chief, Irkutsk Air Base.

Panasenko, Nikolai Yakovlevich: Deputy Chief, Forestry Directorate, Irkutsk Oblast.

Akhtyrskii, Eduard Ivanovich: Chief, Experimental Production Unit, Irkutsk Air Base.

Podderyogin, Aleksandr Erofeevich: Chief Engineer, Irkutsk Air Base.

Gordeev, Fedor Nikiforovich: Chief, Radio Station, Irkutsk Air Base.

Samarkin, Gennadii Alekseevich: Operator, Radio Station, Irkuts Air Base.

Biryulya, Mikhail Ivanovich: Technician/Engineer, Radio Station, Irkutsk Air Base.

Gubar', Irina: Intourist guide.

Bratsk, Friday 24 August and Saturday 25 August

Starodubtsev, Anatolii Danielovich: Administrative and Technical Chief, Bratsk Operational Division of Irkutsk Air Base.

Galitskii, Adam Fedotovich: Chief Engineer, Timber Exchange, Bratsk Forest Industry Complex.

Dyatchenko, Aleksei Konstantinovich: Deputy Head, Finance, Irkutsk Forestry Directorate.

Vostretsova, Al'bina Fedotovna: Intourist guide.

Angarsk Forestry Establishment, Sunday 26 August

Zychenkov, Vasilii Semenovich: Director, Angarsk Forestry Establishment (Leskhoz). Address: Irkutsk, Bol'shaya Rechka, Ulitsa Oktyabr'skaya, No. 18.

Shvaibovich, Vasilii Sergeevich: Forest Protection Engineer (fire and pests).

Kopylov, Mikhail Vasil'evich: Head of explosives team, Angarsk.

Note address of Irkutsk Air Base:
Tsentral'naya Aviabaza,
Irkutskaya baza aviatsionnoi okhrany lesov i
obespecheniya lesnogo khozyaistva
No. 85, Ulitsa Deputatskaya,
Irkutskaya Oblast',
USSR

Petrozavodsk, Tuesday 28 August

Ryabinin, Yurii Alekseevich: Deputy Minister of Forestry, Karelian ASSR. (ASSR = Autonomous Soviet Socialist Republic).

Sizyomin, Leonid Ivanovich: Chief of Northern Base, Forest Fire Protection.

Shikhanov, Serafim Kirilovich: Senior Pilot-Observer, Karelian Region, Northern Base, Forest Air Protection.

Leningrad, Friday 31 August

Barsukov, Petr Fedorovich: Deputy Chief, Leningrad Directorate of Forestry.

Nekrasov, Nikolai Sergeevich: same rank as above.

Artsybashev, Evgenii Stepanovich: Head of Forest Protection Division, Leningrad Scientific Research Institute of Forestry.

Korovin, Georgii Nikolaevich: Chief, Laboratory of Computer Methods, Leningrad Scientific Research Institute of Forestry.

Smirnov, Sergei Dmitrievich: Chief, Leningrad Directorate of Forestry.

Stolyarov, D.P.: Director, Leningrad Scientific Research Institute of Forestry.

Dobrotvorskii, Mikhail Mikhailovich: Commander of Experimental Production Unit, Central Air Base (Pushkino). Took over escort of Canadian delegation when Shchetinskii was called away to Moscow.

Shchuchin, (spelling approximate): Head of Mechnical Equipment Division, Leningrad Scientific Research Institute of Forestry.

Moscow, Monday 3 September

Final meeting at State Committee for Forestry:

Nikolayuk, Vladimir Andreevich: First Deputy Chairman of the State Committee for Forestry, Council of Ministers, USSR.

Tishchenko, Anatolii Ivanovich: Chief, Division of Mechanization and New Equipment, State Committee for Forestry, Council of Ministers, USSR.

Moiseev, Nikolai Aleksandrovich: Chief, Directorate of Science, Introduction of Advanced Methods and Foreign Relations, State Committee for Forestry, Council of Ministers, USSR.

Khramtsov, Nikolai Nikolaevich: Chief, Forest Production Division (insects, fire and diseases), State Committee for Forestry, Council of Ministers, USSR.

Kopolov, (surname only available): Chief of Division for Cooperation with other countries, State Committee for Forestry, Council of Ministers, USSR.

Shishkov, Evgenii Vasil'evich: Chief, Foreign Division, State Committee for Forestry, Council of Ministers, USSR.

Pisarenko, Anatolii Ivanovich: Deputy Minister of Forestry of the RSFSR. First introduced to the Canadian delegation at the farewell banquet held at Moscow on the evening of Monday 3 September.

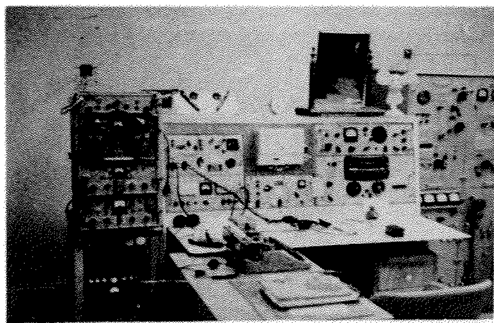
Note address to which pertinent literature should be sent:

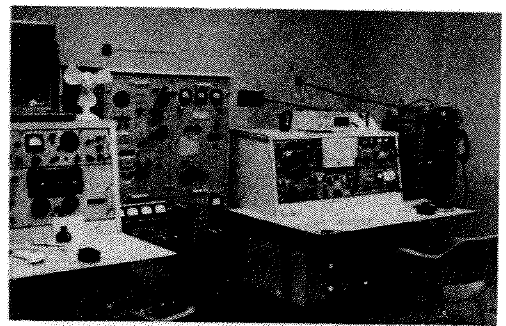
USSR
Moskva M-162,
Ulitsa Lesteva, 18
Gosudarstvennyi komitet lesnogo
khozyaistva Soveta Ministrov
SSSR,
Shishkovu, E.V.

APPENDIX II

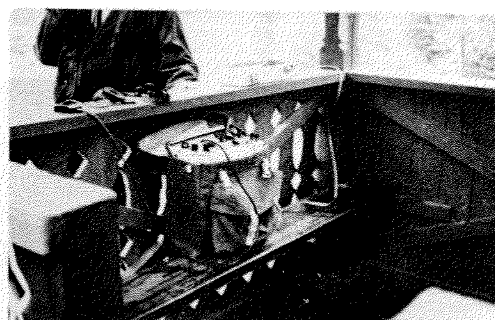
Photographs of Items Mentioned

in the Report

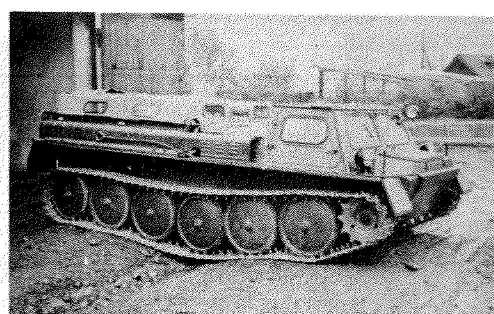




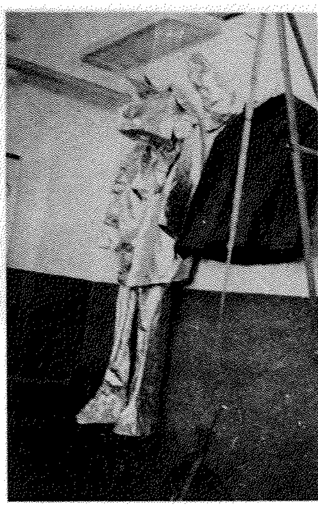
Right and left halves of Irkutsk Region's Central Base Communication Room



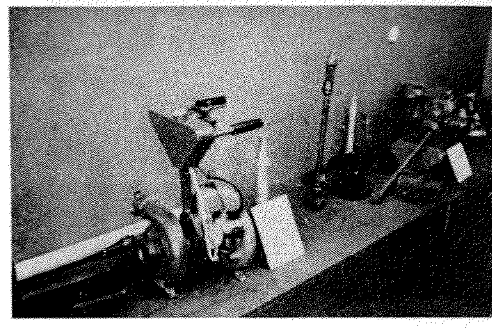
Portable fire-line, 5-watt HF Single side band radio (Angarsk)



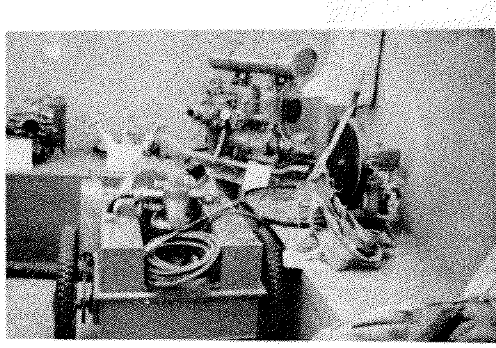
All Terrain, Amphibious Personnel and Equipment Carrier (Angarsk)



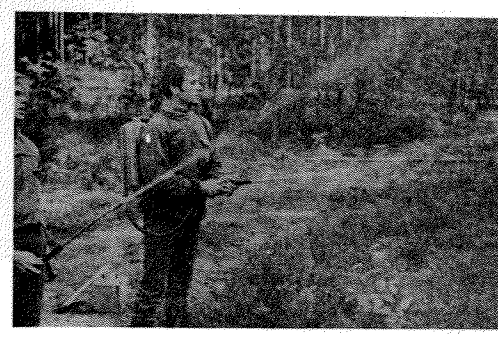
Fire Proof Suit
(Pushkino)



Commonly used light, high-volume, low-pressure fire pump (demonstrated at Petrozavodsk)



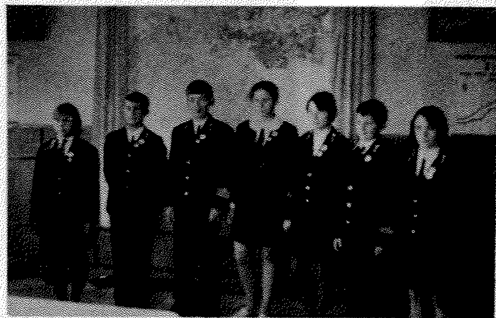
Heavy, large volume pumps
(Pushkino)



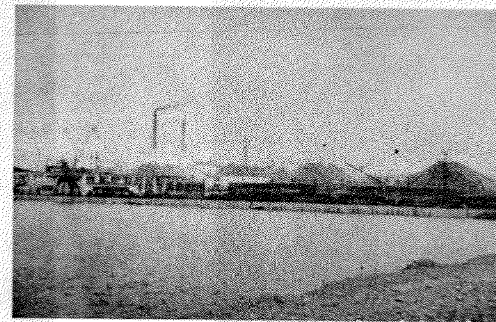
Pressurized backpack pumps
(demonstrated at Petrozavodsk)

Airborne loudhailer and amplifier
(demonstrated at Petrozavodsk)

Prevention Poster and Smoking
Hut (Angarsk)



Fire Prevention Club at Angarsk (Uniforms parallel those of the adult fire control organization



Part of Bratsk Forestry Complex

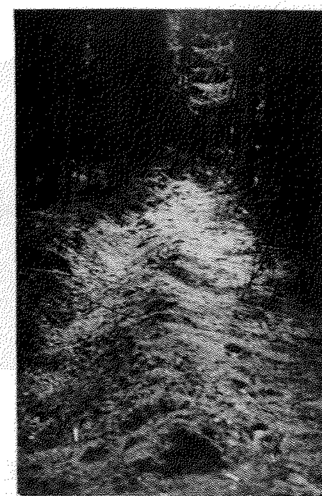
Smoke jumper landing in forest near Petrozavodsk

Smoke jumper radioing jump-master of his safe descent

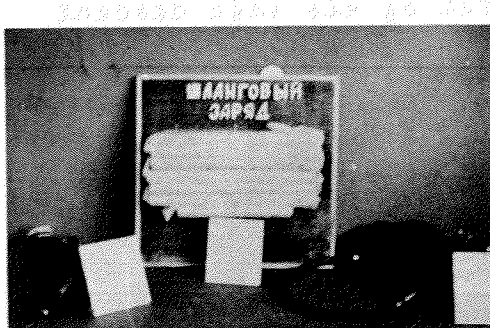
MI-4 helicopter commonly used for initial attack (Petrozavodsk)

Smoke jumper and smoke chaser protective clothing (Bratsk)

Drilling holes for
Explosives (Petrozavodsk)



Resulting fire line from
the hole technique

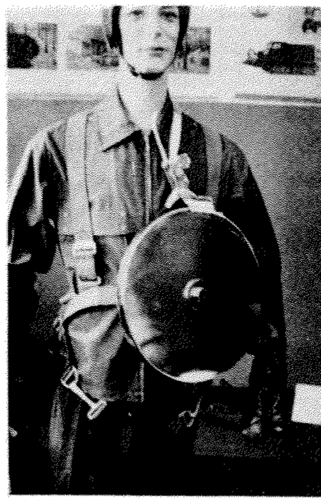


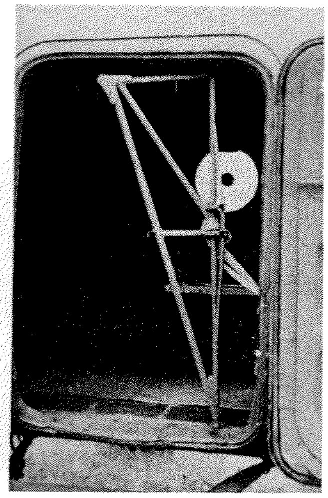
Commonly used explosive encased
in plastic hose (Pushkino)

Placing the hose type
explosive in a shallow
trench (Angarsk)

"Hose" type blast (Angarsk)
(capable of extinguishing crown fires)

Deep trench resulting from
"hose" type blast





Smokechaser lowering device harness and clothing

MI-4 helicopter frame mount for dropping smokechasers

Smokechaser descending into forest from MI-4 helicopter (Petrozavodsk)

Smokechaser demonstration crew at Petrozavodsk

APPENDIX III

Photographs of Soviet Fire Control Training Posters Given to the Delegation

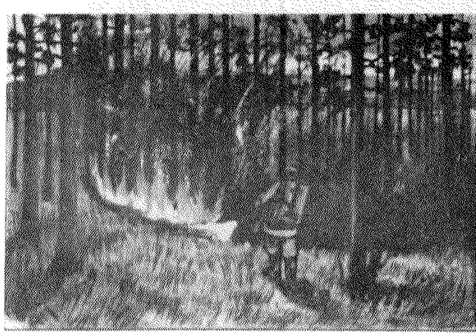
ВИДЫ ЛЕСНЫХ ПОЖАРОВ

НИЗОВОЙ. Скорость распространения огня при низовом пожаре (м/мин): сильном 3 и более, среднем 1—3, слабом до 1.
Огонь распространяется только по напочвенному покрову, обжигая подрост, подлесок, нижние части стволов деревьев и выступающие на поверхности почвы корни

ВЕРХОВОЙ. Скорость распространения огня при верховом пожаре (м/мин): сильном 100 и более, среднем 3—100, слабом до 3.
Огонь охватывает кроны деревьев, при этом сгорают хвоя, листья, мелкие, а иногда и крупные ветки. Пламя распространяется как по кронам деревьев, так и по напочвенному покрову

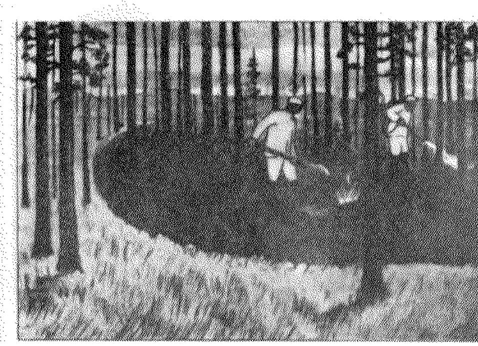
ПОДЗЕМНЫЙ. Глубина прогорания при подземном пожаре (м): сильном 0,5 и более, среднем 0,25—0,5, слабом до 0,25.
При подземных пожарах сгорает частично или полностью до минерального слоя почвы нижний разложившийся слой горючего материала; древостой вываливается и сгорает частично или полностью

ПОСЛЕДОВАТЕЛЬНОСТЬ ТУШЕНИЯ ЛЕСНЫХ ПОЖАРОВ



ОСТАНОВКА ПОЖАРА. Прекращается распространение пламени по лесной площади

ЛОКАЛИЗАЦИЯ ПОЖАРА. Переброска огня за барьер, устроенный вокруг пожарища, исключается. Пожарный барьер создается в виде минерализованной полосы или поливкой кромки пожарища водой или растворами химикатов

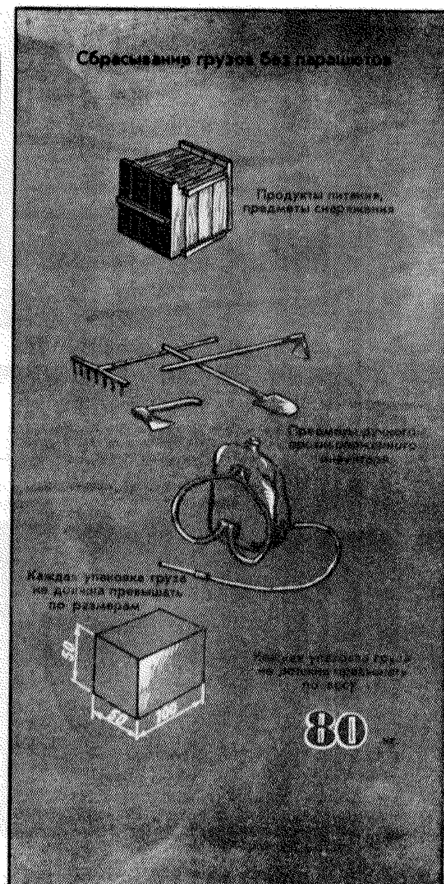


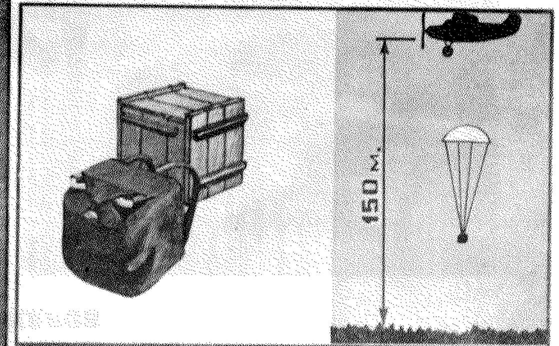
ДОТУШИВАНИЕ ПОЖАРА. Заключается в ликвидации видимых очагов горения внутри пожарища. После дотушивания пожара производится окараулившие его до тех пор, пока возобновление скрытых очагов огня будет исключено

ДОСТАВКА ГРУЗОВ К МЕСТАМ ПОЖАРОВ НА САМОЛЕТАХ И ВЕРТОЛЕТАХ

Для выброски груза выбираются по возможности открытые места. Если имеется опасение длительных поисков сброшенного груза, к нему перед выброской прицепляется звуковой извещатель

Патроны с аммонитом и средства взрывания в раздельных упаковках размещаются в фюзеляже самолета или вертолета. Сбрасываются взрывчатые материалы с парашютами

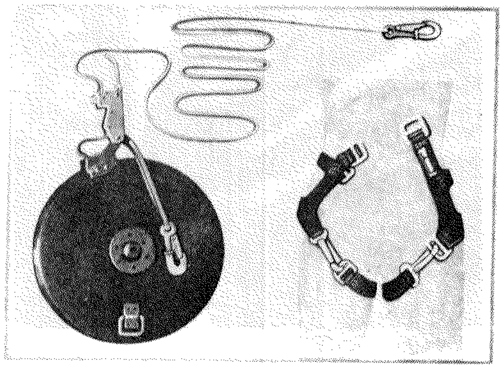




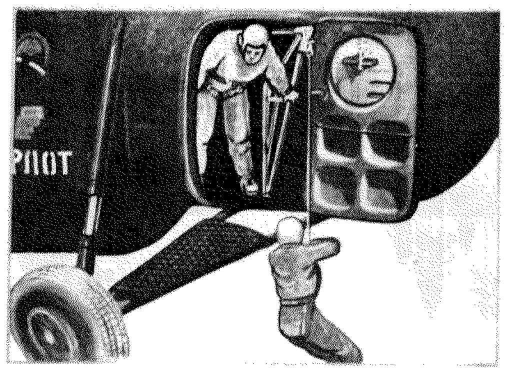
Противопожарные механизмы (мотобур, мотопила «Дружба», мотопомпа ПМП-Л и др.) сбрасываются с парашютом в специальных контейнерах и деревянных ящиках. Высота сбрасывания — 150 м. Эти контейнеры служат для переноски механизмов в лесу

При невозможности посадки выгрузка с вертолета производится с висения на высоте 1—2 м. Вес и габарит грузов не должны препятствовать выгрузке их вручную

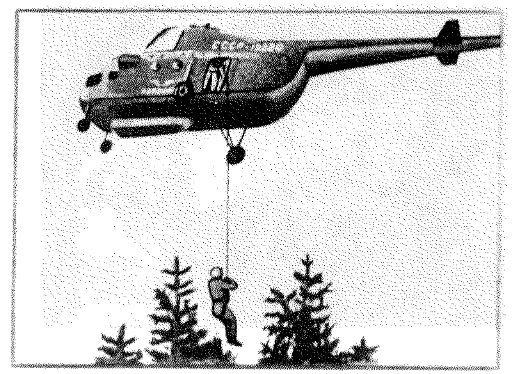
СПУСК ЛЮДЕЙ И ГРУЗОВ С ВЕРТОЛЕТА В ЛЕС



Спусковое устройство включает капроновую ленту (длина 40 м, прочность на разрыв 700 кг), металлический барабан для намотки капроновой ленты, заклинивающий замок, подвесную систему и карабины для присоединения спускового устройства к подвесной системе и узлу на вертолете

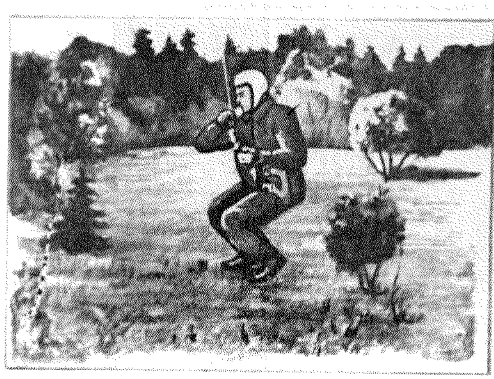


После сигнала на спуск, десантник пожарный выходит на подножку шасси вертолета, сходит с нее и зависает на спусковой ленте

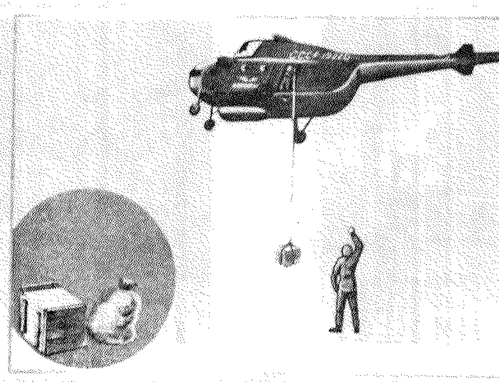


Для спуска людей вблизи пожара выбирается место с наименьшей полнотой леса и высотой деревьев. Максимальная высота спуска 35 м, скорость спуска не свыше 3 м/сек

Перед входом в кроны деревьев необходимо приостановить спуск и осмотреться, чтобы не попасть на вершины деревьев и сухие сучья



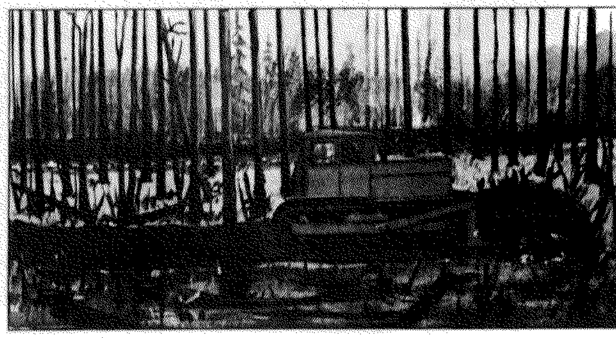
После приземления десантник-пожарный должен присесть, чтобы ослабить натяжение спусковой ленты. Выпускающий отсоединяет карабин спусковой ленты и бросает его вниз



Грузы спускают в тюках, ящиках, мешках или в другой упаковке. Вес каждой упаковки не должен превышать при спуске с вертолета МИ-4 100 кг, с вертолета МИ-1 50 кг. Груз на земле принимает ранее спущенный десантник-пожарный

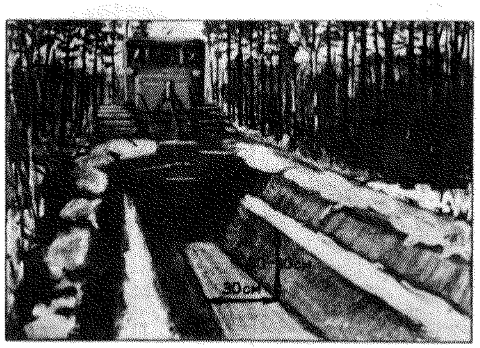
После приземления груза десантник пожарный отсоединяет от него карабин со спусковой лентой, а выпускающий быстро втягивает эту ленту в вертолет

МАШИНЫ И МЕХАНИЗМЫ ДЛЯ СОЗДАНИЯ ПРОТИВОПОЖАРНЫХ ЗАГРАДИТЕЛЬНЫХ ПОЛОС И КАНАВ

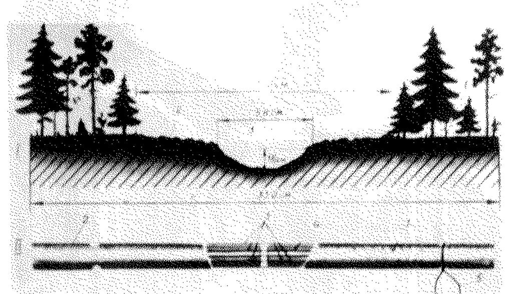


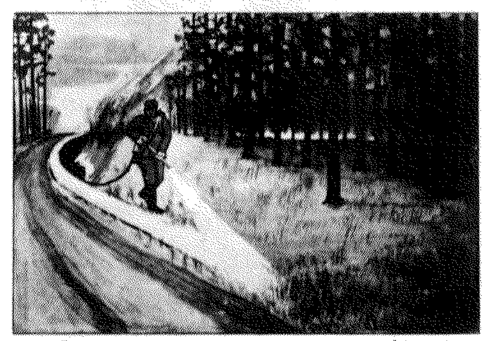
Бульдозером можно прокладывать заградительные полосы на тяжелых, задернелых почвах. Производительность бульдозера за смену до 4 *км*, ширина создаваемой полосы до 3 *м*

Тракторный лесной плуг ПКЛ-70 применяется на легких и средних почвах. Его производительность на создании заградительных полос до 11 *км* за смену при ширине полосы (с отвалами) до 1,4 *м*



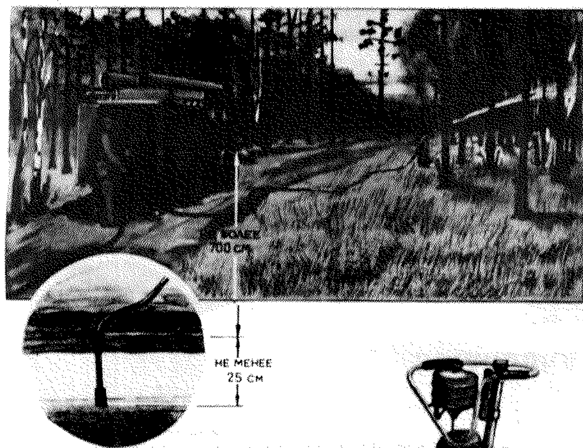
Лесной плуг-канавокопатель ПКНЛ-50А позволяет прокладывать заградительные канавы глубиной 300—500 *мм* и шириной по дну 300 *мм*. Его производительность до 1 *км/ч*. Канавокопатель должны обслуживать не менее 3 человек





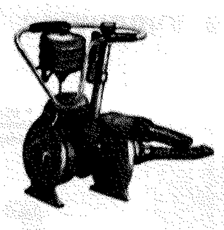
Отжиг для остановки пожаров проводится от опорной полосы, созданной почвообрабатывающими орудиями, взрывчатыми материалами или химикатами. Для быстрейшего загорания напочвенного покрова пользуются зажигательными аппаратами на смеси бензина и автола. При отжиге запрещается переходить за линию отжига. К работе с зажигательными аппаратами допускаются лица, прошедшие специальный инструктаж

МАШИНЫ И МЕХАНИЗМЫ ДЛЯ ТУШЕНИЯ ЛЕСНЫХ ПОЖАРОВ



Серийные пожарные автоцистерны имеют цистерну для воды, насос производительностью 1200 л/мин и закрытую кабину для команды рабочих. Подача воды для тушения производится как из цистерны, так и из водоема.

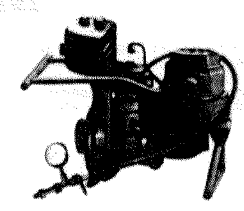
Для лесных условий создана пожарная автоцистерна АЦЛ-147 высокой проходимости на базе шасси ГАЗ-66. Кроме бака для воды (1000 л) и пожарного насоса, эта автоцистерна имеет навесной плуг для прокладки минерализованных полос.



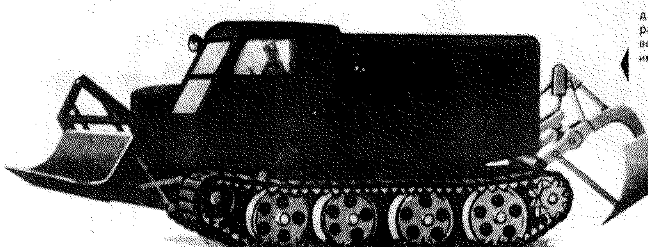
Малогабаритные лесные пожарные мотопомпы ПМП-Л и МЛ-100 служат для подачи воды из водоема или емкости к месту пожара

Техническая характеристика мотопомп

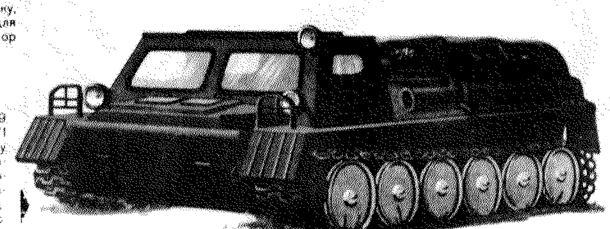
ПМП-Л	Показатели	МЛ-100
14	Вес, кг	22 (с всасывающим рукавом)
До 400	Производительность, л/мин	До 100
До 4	Давление, атм	До 12
65	Диаметр всасывающего рукава, мм	50
51	Диаметр напорного рукава, мм	26 и 51



Лесопожарный агрегат на тракторе ЛХТ-55 для тушения пожаров имеет насосную установку, работающую при движении трактора, бак для воды (1000 л) и ранцевые опрыскиватели. Трактор имеет бульдозерную навеску и навесной плуг.



Пожарный вездеход ВПЛ-149 на шасси трактора ГАЗ-71 имеет бак для воды, мотопомпу МЛ-100, ранцевые опрыскиватели, ручной пожарный инвентарь и навесное почвообрабатывающее орудие для прокладки минерализованных полос.



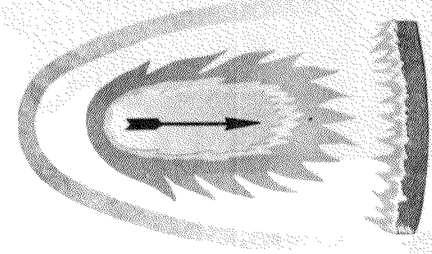
На ровной местности пожарный насос, в зависимости от развиваемого давления, может подавать воду на расстояние 300—1000 м. С повышением рельефа местности и уменьшением диаметра пожарных рукавов дальность подачи воды уменьшается.

Запрещается производить заправку работающих моторов горючим, оставлять механизмы вблизи пожара без надзора. К работе с механизмами допускаются только обученные рабочие

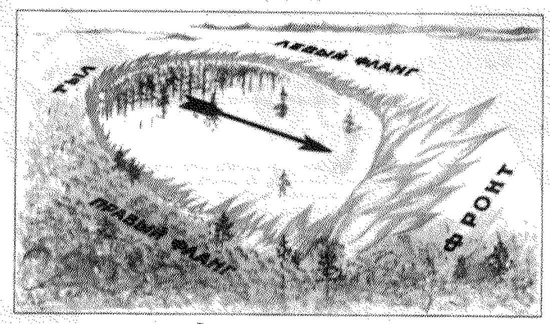
ПРИЕМЫ ОСТАНОВКИ ЛЕСНЫХ ПОЖАРОВ

Перед тушением пожара все рабочие должны быть ознакомлены с порядком проведения работы и правилами техники безопасности при тушении пожара

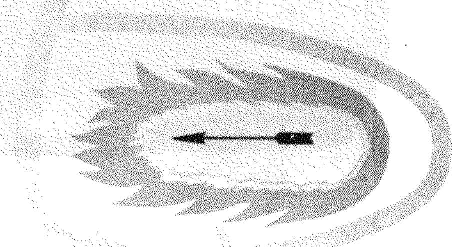
К тушению пожаров не допускаются инвалиды, подростки, не достигшие 18-летнего возраста, беременные и кормящие грудью женщины, глухие



Остановка пожара отжигом применяется при верховых и сильных низовых пожарах. Ширина отожженной полосы должна быть при верховых пожарах 80—150 м, при низовых — не менее 15 м

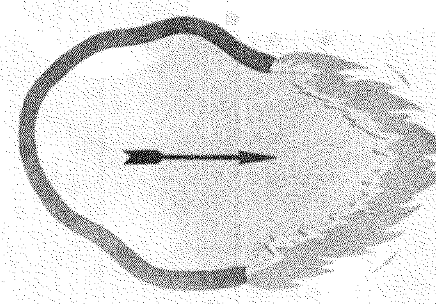


Стороны лесного пожара

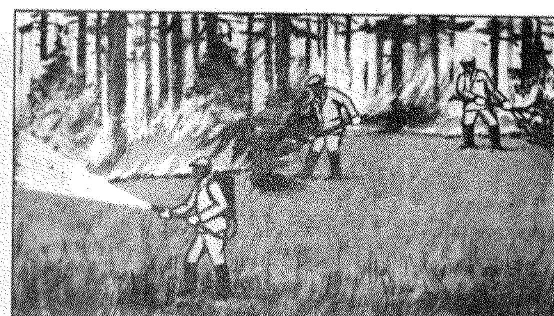


Для остановки слабых и средних низовых пожаров создаются заградительные минерализованные полосы шириной не менее 1 м. Для остановки подземных пожаров создаются заградительные канавы глубиной до минерального слоя почвы или уровня грунтовых вод

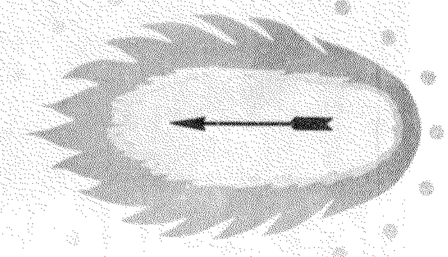
ОСТАНОВКА ПОЖАРА ТУШЕНИЕМ ОГНЯ ПО КРОМКЕ



Тушение пожара сведением на „клин" применяется в том случае, если из-за большой захламленности и сильного пламени тушение с фронта невозможно



При остановке пожара тушением огня по кромке пламя тушат водой, растворами химикатов, засыпкой грунтом, захлестыванием ветвями. Тушение огня по кромке применяется при слабых низовых и подземных пожарах. Тушение пожара с фронта позволяет быстро остановить пожар

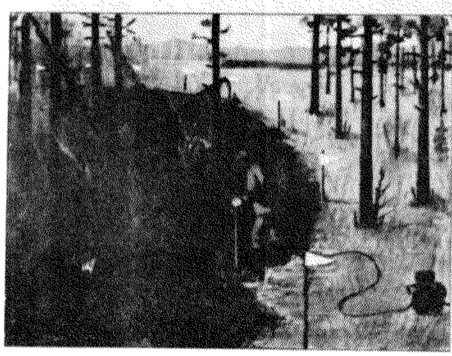


Тушение пожара окружением применяется для ликвидации небольших по площади пожаров и при наличии достаточного числа рабочих

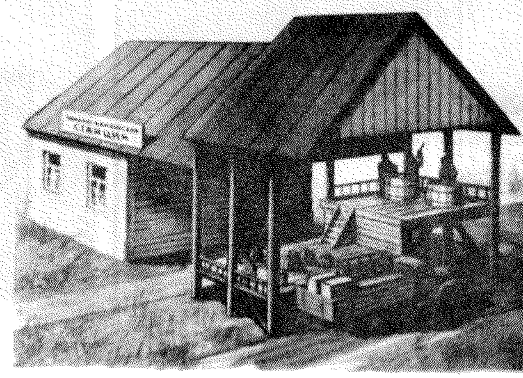
ТУШЕНИЕ ЛЕСНЫХ ПОЖАРОВ ВОДОЙ И ХИМИКАТАМИ

Огнетушащие химические средства применяются для тушения огня по кромке средних и слабых низовых пожаров. При тушении пламени лицо и руки работающих должны быть защищены от теплового воздействия.

Опорную полосу для отжига создают опрыскиванием напочвенного покрова раствором химиката. Полоса прокладывается по не захламленным, задернелым местам. Расход химиката 0,3 л на 1 пог. м полосы.



Торфяные стволы ТС-1 при тушении подземных пожаров применяются в комплекте с мотопомпой, при этом ускоряется тушение и экономится вода; к воде добавляют 0,2—0,3% смачивателя НП-1 (сульфанола). При тушении подземных пожаров предварительно разведывают и обозначают кромку пожара.

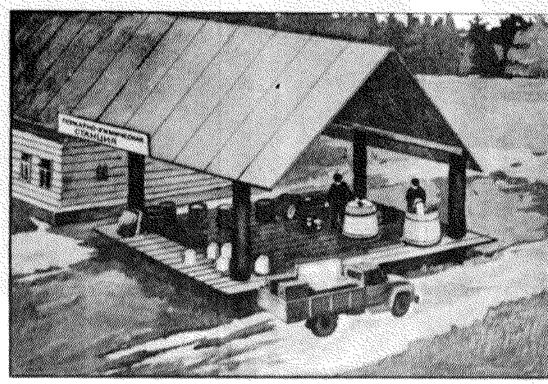


В качестве огнетушащих химических средств применяют 20%-ные водные растворы хлористого кальция, сульфата и фосфата аммония, а также фреоновую эмульсию. К работе с химикатами и ранцевой аппаратурой допускаются лица, прошедшие специальную подготовку.

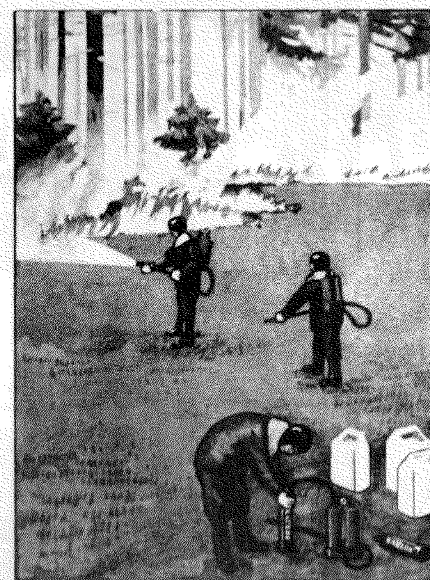
Работа с химикатами проводится в спецодежде, а при высыпании твердых химикатов и в защитных очках.

Емкости или цистерны с привозной водой в целях ее экономии должны быть приближены к пожару, так как только для заполнения рукавной линии протяженностью 100 м требуется при рукавах диаметром 51 мм 200 л воды, а при рукавах диаметром 66 мм—до 300 л. При тушении пламени следует использовать стволы-распылители.

ТУШЕНИЕ ЛЕСНЫХ ПОЖАРОВ С ПОМОЩЬЮ ХИМИЧЕСКИХ ВЕЩЕСТВ



Для тушения лесных пожаров применяют 20—25 -ные водные растворы хлористого кальция или сульфата аммония, а также огнетушащую смесь ЭС-1. В состав смеси входят: водный раствор хлористого кальция или сульфата аммония (70), четыреххлористый углерод (30) и смачиватель ОП-7

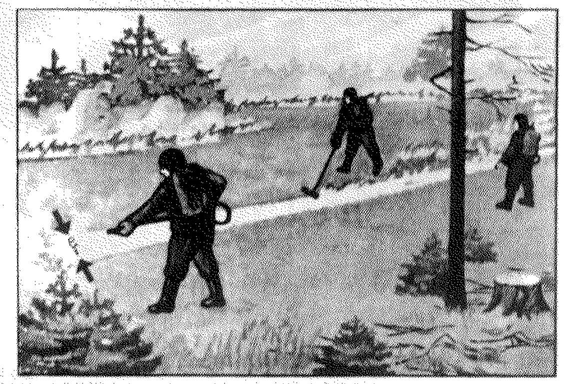


Растворы химических веществ используются для тушения пламени по кромке пожара и создания заградительных полос путем опрыскивания напочвенного покрова.

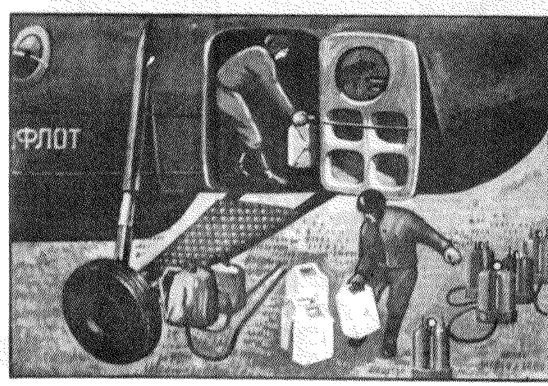
При тушении огня распыленная струя раствора направляется в нижнюю часть пламени до полного прекращения горения. На 1 пог. м кромки пожара расходуется 75—100 см³ раствора

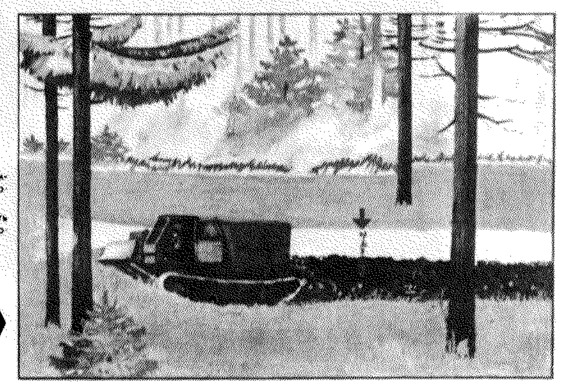
К месту пожара растворы химических веществ доставляются вертолетами в ранцевых опрыскивателях и полиэтиленовых канистрах. Наземным транспортом раствор доставляется в цистернах и железных бочках

Низовой лесной пожар можно остановить заградительной полосой, созданной путем опрыскивания напочвенного покрова раствором химического вещества. В зависимости от интенсивности пожара и мощности напочвенного покрова полосу делают шириной до 4 м с расходом раствора 0,5—0,75 л на 1 м полосы. Такая полоса сдерживает огонь в течение 16—23 часов



Опорную полосу для отжига создают путем опрыскивания напочвенного покрова раствором химического вещества. Такая полоса прокладывается по мало захламленным и задерненным местам. Ширина полосы 0,4—0,5 м, расход раствора до 0,3 л на 1 пог. м полосы

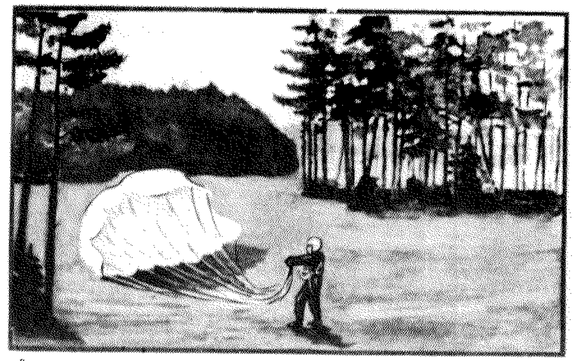




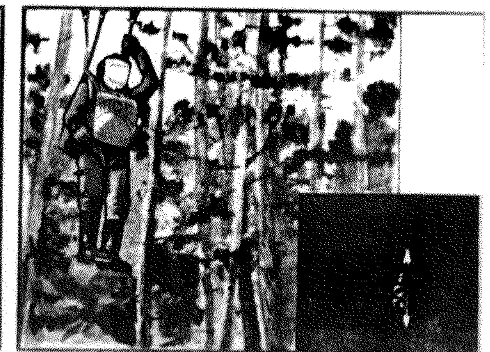
ПАРАШЮТИСТЫ-ПОЖАРНЫЕ НА ОХРАНЕ ЛЕСОВ ОТ ПОЖАРОВ

Для обеспечения свободы движения, помимо парашюта и радиостанции, брать с собой при прыжке в костюме какое-либо снаряжение не разрешается

Защитный костюм для прыжков на лес должен быть подогнан по размеру для каждого парашютиста

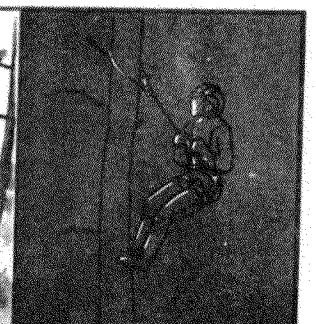


Высадка парашютистов-пожарных без защитных костюмов производится на открытые сухие площадки. Площадки должны быть свободны от пней, камней, валежин и канав. При прыжках с парашютами ПД-47 и Д-1 размер площадки должен быть не менее 150×150 м, с парашютами Т-2 и Т-4—75×75 м

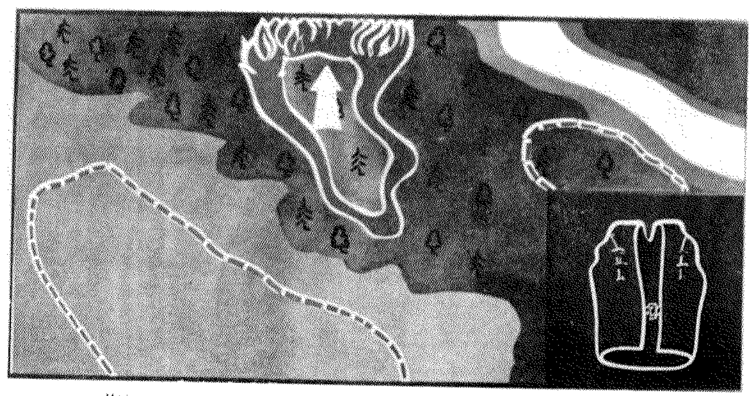


Прыжки в защитных костюмах на сосновые, еловые, кедровые, лиственничные и березовые насаждения (без сухостойных деревьев) разрешаются при ветре не свыше 10 м/сек. При высоте деревьев свыше 20 м полнота древостоя должна быть не менее 0,8

Для снятия зависших на деревьях парашютов пользуются лазами, которые входят в комплект спускового устройства



При зависании парашютист-пожарный зацепляет конец спусковой ленты с карабином на дереве и, регулируя заклинивающим замком, плавно спускается на землю



Место приземления парашютистов-пожарных выбирается с тыловой или фланговой стороны пожара. При необходимости приземления вблизи водоема парашютист пожарный перед прыжком должен надеть спасательный жилет