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UNITED NATIONS INDUSTRIAL
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ASSISTANCE IN THE ESTABLISHMENT AND OPERATION OF A LABORATORY FOR TESTING AND QUALITY CONTROL OF TOBACCO AND TOBACCO PRODUCTS,

TS/BUL/76/002

BULGARIA.

Project findings and recommendations

Prepared for the Government of Bulgaria
by the United Nations Industrial Development Organization

Based on the work of D. A. Jones, industrial chemist

id.77-6127

Explanatory notes

References to dollars ($) are to United States dollars, unless otherwise stated.

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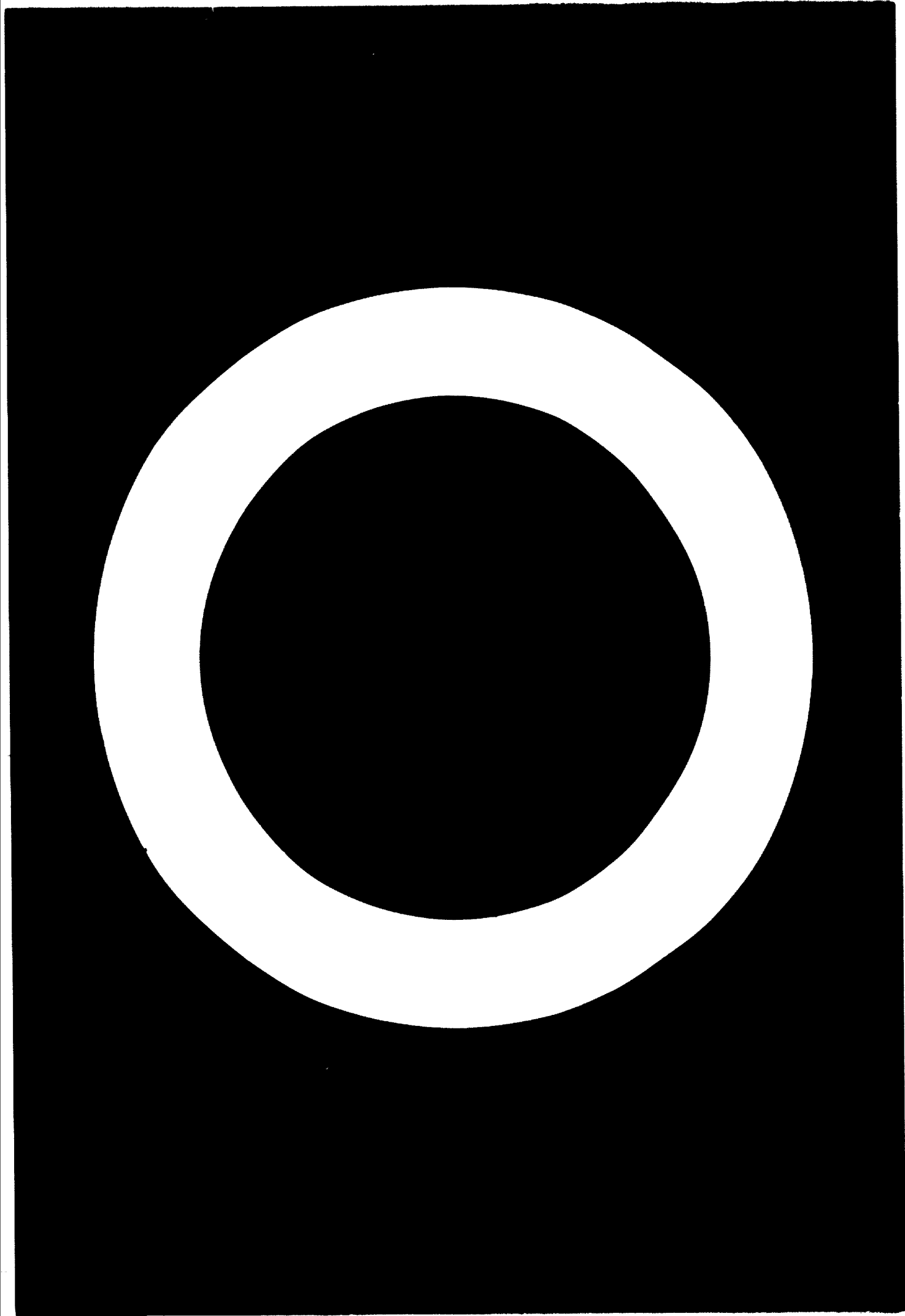
ABSTRACT

The report covers a three-week mission by an industrial chemist to advise the Government of Bulgaria on the establishment and operation of a laboratory for the testing and quality control of tobacco and tobacco products. The project (TS/BUL/76/002) was approved by the United Nations Industrial Development Organization (UNIDO) under the Special Industrial Services programme on 8 September 1976; the expert began work on 26 May 1977. The project budget was $US 3,000 and was financed from UNIDO trust funds for Special Industrial Services. The report describes the tests to which tobacco should be subjected and the equipment needed to carry out the tests. The expert recommends the introduction of a quality control scheme, if necessary by stages, and an early start on those parts of the scheme that do not require imported equipment.



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INTRODUCTION

Project background

During the past thirty years the Bulgarian State Tobacco Monopoly has earned a reputation as a producer of high quality oriental tobaccos, despite early shortages of capital, engineers and technical personnel. In recent years the industry has also won recognition as a producer of Virginia and burley tobaccos. The various five-year plans have more than quadrupled the production of oriental tobacco, and Bulgaria now produces about 16% of the world's total oriental crop. The increase in production has been due largely to the expansion of crop areas, the use of more productive varieties, better cultivation methods, and the effective use of pesticides. Crop yields of Virginia and burley tobaccos have been encouraging in the past two years, as a result of the application of modern growing technology, and production of these two types of tobacco is expected to increase significantly in the future.

The cigarette manufacturing industry makes a valuable contribution to Bulgarian exports; in 1975 about 81% of total cigarette production was exported. Production under licence is also growing, with a number of popular American and Western European brands being manufactured at present.

A rapidly growing industry such as tobacco growing and cigarette manufacture clearly needs trained technical personnel. One of the chief functions of the Higher Institute for the Food Industry at Plovdiv is to give national and foreign students professional training to graduate and post graduate levels. The Institute also gives advice and technical assistance to industry, carries out testing and quality control for the Government, and does various research projects.

In order to be able to give students practical training in the use of the most modern equipment and techniques, and to be able to carry out advanced post-graduate research on the problems of the Bulgarian tobacco industry, the Plovdiv Institute asked the Committee for Science, Technical Progress and Higher Education for permission to set up the required laboratories. The Committee, through the Foreign Ministry, asked the United Nations Industrial Development Organization (UNIDO) for advice in setting up the facilities; the result was a three-week project at the Plovdiv Institute that was approved by UNIDO on 8 September 1976 and began on 26 May 1977. The project budget was $US 3,000 and was financed from UNIDO trust funds for Special Industrial Services.

I. FINDINGS

Very early in discussions with the Plovdiv Institute, it became clear that the exorbitant cost of highly automated scientific equipment, together with the near impossibility of arranging servicing in Bulgaria, ruled out such equipment. It was agreed, however, that any simpler manually operated equipment chosen should use exactly the same scientific principles as the most modern automated equipment, so that students would be familiar with the basic technology involved in all equipment which they would meet on entering the Bulgarian, or any other, tobacco industry. This principle will also enable any research project carried out for the Bulgarian tobacco industry to be completed in accordance with the best world standards of quality assessment.

In setting up a quality control facility for tobacco and tobacco products there are two aspects of quality:

(a) Tests carried out on tobacco and tobacco smoke to ensure that the demands of current or proposed health legislation are fulfilled;

(b) Tests carried out on tobacco products to ensure that smoking and other consumer-oriented properties are maintained.

It was decided that an effort would be made to keep the number of non-Bulgarian manufacturers recommended to a minimum, and preferably restricted to those already supplying equipment to the Bulgarian industry. This should ensure reliable delivery to Bulgaria and adequate after-sales service. Four main companies were recommended: Cigarette Components and Borgwaldt for smoking machines and general physical testing apparatus, Pye Unecam for spectrophotometers and chromatographic equipment, and Mitsui for small-scale manufacturing equipment. The various scientific terms used and the equipment recommended were readily understood by the Institute staff and need no further definitions. A summary quality control scheme covering health-oriented and consumer-oriented tests, is given in annex I.

A. Health-oriented tests

Pesticide residues

During the past three decades organic pesticides have been used widely to ensure a maximum yield of unblemished tobacco for a minimum expenditure of

labour. Owing to indiscriminate use, the levels of pesticide residues increased to a serious degree between 1956 and 1966, and various Governments took action either to ban certain pesticides or to set limits for their use on tobacco.

Some years ago the organochlorine pesticide residues were the main problem, but these have now been largely replaced by organophosphorus compounds, which are not persistent and hence leave little or no residue. The expert therefore feels that organochlorine residues need not be monitored, since these materials are banned in Bulgaria as well as in most other countries of the world. At present the main pesticide residue in many tobacco growths is Carbaryl, which is being widely used as a replacement for certain organochlorine pesticides. The monitoring of residues on imported tobaccos is necessary even when the degree of control over home-grown tobacco is sufficient to keep residues at levels that would pose no real health problem. In countries like Bulgaria, where blue mould (Peronospora tabacina) can be a serious problem, dithiocarbamates are used, and the pesticides sub-group of the Co-operative Centre for Scientific Research Relative to Tobacco (CORESTA) has developed a method for the determination of dithiocarbamate residues. The expert recommends that a simple, thin-layer chromatographic method for Carbaryl, and a simple spectrophotometric method for dithiocarbamates should be used as required; he has left full details of both methods with the staff of the Institute. The apparatus required is also needed for other quality control tests and recommendations for it will be given in later sections of this report.

Smoke analysis

The determination of nicotine and condensate in the smoke is of paramount importance in most countries, and the determination of carbon monoxide is rapidly becoming essential.

The piston-type smoking machine has gained world-wide acceptance as giving the puff profile closest to that of a human puff. It uses Cambridge filters for the collection of particulate matter. This system is already in use in the United Kingdom and the United States of America and was approved at the recent International Organization for Standardization (ISO) meeting in Ankara (ISO Dis 3308.2). Any type of restricted smoking machine capable of taking a two-second, 35 ml puff once a minute on each channel independently may be used; the expert recommends a twenty-channel piston smoking machine such as

the Cigarette Components Filtrona Model 300. Ancillary equipment such as smoking traps, volume indicators (bubble flowmeters), labyrinth seals, electric cigarette lighters, and draught screens has been discussed, and details are given in the section on equipment costs.

Nicotine should be measured by a manual spectrophotometric method, which uses the same scientific principles as more sophisticated methods. Various laboratories in the United Kingdom, including the Government Chemist's Laboratory, are fitting ATCOM attachments to the standard twenty-channel smoking machines, so that condensate, nicotine and carbon monoxide can be determined simultaneously. The ATCOM attachment is made by Cigarette Components and the system has the advantages that (a) it reduces sample handling with its possible associated errors, and (b) the three components are measured on the same sample. The expert recommends that this attachment be purchased eventually even if it is not incorporated into the system initially. Full details of all the above equipment have been given to the Institute and individual equipment details are given in the section on costs.

B. Consumer oriented tests

Tobacco leaf

Nicotine is probably the most important constituent of tobacco, although sugar is also extremely important because of its influence on the organoleptic qualities of nicotine. It is therefore recommended that both these constituents should be determined, using the same spectrophotometric method for nicotine as was recommended for nicotine in smoke. The sugar determination should also be made by a simple spectrophotometric method, so that one Pye Unicam spectrophotometer could be used for smoke and leaf tobacco analysis. Total nitrogen is important because of its influence on the pH of smoke, and should be determined by the normal Kjeldahl distillation method, which needs no special equipment other than laboratory distillation apparatus and a fume hood.

Leaf tobacco needs to be milled to a powder before chemical analysis, using a small rotary mill such as the Apex mill, and the moisture content will need to be determined in order to report all chemical analyses on a dry basis. The Brabender oven, which is already in use in Bulgaria, is

recommended for moisture determination. Finally, it is desirable to be able to assess the propensity of leaf tobacco to degrade under manufacturing conditions. This is usually expressed as a shatter index and should be determined by treating the strips of tobacco for a fixed time at a predetermined frequency of rotation in a Waring blender, and measuring the particle size by normal sieve analysis.

The Institute staff was very interested in correlating the results of objective tests with those of subjective tests, in order to train students to appreciate both aspects of quality, and to help the Bulgarian tobacco industry to set subjective indices for practical quality assessment that will guarantee certain minimum objective levels of quality. A project is already in progress to find the correlation between leaf colour and nicotine content; the expert recommends that a Hunter colour meter should be used for the objective measurement of colour.

Cut tobacco filler

Determinations of nicotine, total nitrogen, sugars and moisture will frequently be needed on cut tobacco filler and can be made using the methods already described for leaf tobacco. The filling power of cut tobacco is a critical physical property, since it determines the number of cigarettes of any required firmness that can be manufactured from unit weight of the tobacco. The expert recommends that this test be made using a Borgwaldt apparatus, which is already known in Bulgaria. The width of the shreds of cut filler is critical because of its influence on the filling power and rate of burn of the tobacco. It was agreed that this test should be conducted by magnifying the cut filler image through an overhead light projector and finding the width by comparison with wire strips of known diameter. The particle size of the filler should be determined by a normal sieve analysis, using the sieves already specified for the shatter test.

The amounts of the more common humectants used on cased blends should certainly be determined in order to check brand specifications. The staff of the Institute agreed that the more accurate method using a Pye Unicam gas-liquid chromatographic apparatus will be preferable to the semi-quantitative thin-layer chromatographic method for this purpose. The analytical balance and ancillary equipment needed is detailed in annex II.

Cigarettes

The amounts of nicotine, total nitrogen, sugars, humectants and moisture in the filler tobacco from a cigarette are often required. They can be determined by the methods already described for cut tobacco filler. The physical properties of the filler (particle size and width of strands) can similarly be determined by the methods already described for cut tobacco filler. The delivery of nicotine in the smoke, noted under health-related determinations, is also important for controlling organoleptic smoking quality, and the pH value of the smoke can be monitored using the smoking machine recommended for the health-related tests.

The dimensions of the cigarette are determined, together with the weight of the filler tobacco, on a dry basis, so as to calculate the dry density of the tobacco rod. This latter property is critical because it affects draw resistance (pressure drop), smoke deliveries, firmness and profit margins. The firmness of a cigarette is important for consumer acceptability and should be determined by means of the Borgwaldt firmness gauge. The pressure drop of a cigarette must be also controlled: it can be measured by means of the Borgwaldt pressure drop tester. The manual sorting of a large number of cigarettes into preselected weight groups is a very tedious job and a Borgwaldt automatic weight sorter is normally used. Most of the physical tests carried out on cigarettes require that the cigarette should be brought into equilibrium with an atmosphere of controlled relative humidity beforehand, and the Borgwaldt conditioning chamber, which is already in use in Bulgaria, is ideal for this purpose. The presence of a large number of small particles of tobacco in the bottom of the packet harms consumer acceptability of a brand and should be determined by collecting the particles and weighing them on an analytical balance.

Cigarette paper

The cigarette paper has an important effect on various properties that determine consumer acceptability. The amount of calcium carbonate loading in a paper can affect porosity and burning quality and should be monitored by direct titration with dilute acid. The usual salts used as burn controllers should be measured. These include lactates, citrates, tartrates, phosphates and nitrates, together with impurities of chlorides, and should be determined

by means of a simple thin-layer chromatographic technique. This method needs no elaborate equipment and full details have been given to the Institute staff. Titanium dioxide is widely used as a whitening agent in cigarette paper and should be determined by a spectrophotometric technique. Yellow spots sometimes appear on the paper of cigarettes which have been stored under warm, humid conditions, and the presence of these spots should be noted when found by visual examination.

The introduction of highly porous cigarette paper has made the monitoring of paper porosity an essential quality control test. The Borgwaldt meter is recommended for this purpose, since it uses the principle approved by ISO of passing air through a sample of the paper at constant pressure and finding the flow rate.

The ever increasing speeds of modern cigarette making machines make stringent demands upon the mechanical properties of cigarette paper, especially in the case of the more porous papers. The expert recommends that the elasticity of the paper should be measured using the Borgwaldt apparatus.

Cigarette filters

The pressure drop of a filter is one of its most important properties and should be measured using the Borgwaldt pressure drop tester, already recommended for use with the whole cigarette. The retention of a particular filter for various smoke components can be determined by means of the techniques described for smoke analysis under health oriented tests, and a copy of the manual describing all such test procedures, published by the Tobacco Research Council of Great Britain, has been given to the Institute. The measurement of filter retention for smoke constituents other than nicotine and condensate will probably not be required by undergraduate students, but could be of considerable interest to post-graduate research workers engaged in studies of the effects of various tobacco treatments on the constituents of smoke. These latter methods are described in the above manual.

The firmness of filters is an important property for consumer acceptability and can be determined by means of the Borgwaldt Firmness Gauge, already recommended for the determination of cigarette firmness.

Organoleptic tests

The final test for a cigarette is whether the smoking public will find its smoking properties desirable. Each of the foregoing objective tests can give an optimum result, but the adequacy of the blending of the various factors can be assessed only by a panel of trained smokers. The Institute staff members were familiar with the principles of paired comparison and triangular testing normally used in organoleptic studies and were familiar with the procedures of statistical analysis necessary to interpret the results. A number of discussions were held on more advanced indices of smoking quality and how to train smokers to measure them. The staff agreed with the expert's recommendation that they should study the techniques, as published in various technical journals, and try to apply them at the Institute. The provision of reliable smoking panel facilities will enable undergraduates to gain experience in using them for later work when they enter industry, and will also be of use to post-graduate research workers in assessing the value of some of their projects to the tobacco industry.

A subject which aroused much interest was the concept of an objective index for the aromatic quality of oriental tobacco. The expert left details at the Institute of a method that he had developed and recommended that it should be used for training students and for assessing aromatic quality in some of the projects on fermentation. The method needs no equipment other than normal laboratory glassware.

C. Laboratory cigarette-making facilities

The expert endorsed the strong opinion of the Institute staff that small-scale cigarette-making facilities will be essential in any quality control laboratory. The facilities are necessary for training students in the principles of commercial production, for the manufacture of good-quality cigarettes for further testing, and for assessing the quality of tobacco as part of various research projects being investigated for the industry.

The simplest arrangement consists of a small wetting unit, a spray chamber and toaster for treating cased burley tobacco, a stem press roller for treating stem, a rotary cutter, a drying oven, a Itanin Baby cigarette making machine and a Mannella tipping machine. All except the last two items are made by Mitsui.

D. Equipment and laboratories

The cost of the recommended equipment is summarized in annex II. Prices are given in United States dollars and, for equipment to be purchased outside Bulgaria, are for delivery in Western European countries. This is because the manufacturers approached could not quote for delivery in Bulgaria owing to complicated purchasing formalities.

The apparatus recommended should be capable of testing up to fifteen complete samples per day; if only selected tests are required, this number could be considerably increased. Some of the items required are already installed in the Institute and are marked "existing".

The size and number of laboratories required are shown in annex II, although the Institute staff stated that they had new laboratories under construction and laboratory space would therefore not be included in the establishment costs.

Internal organization of the laboratory

The laboratory will need one graduate chemist and one graduate physicist for supervision and teaching duties, and three technicians. One technician should be experienced in chemical analysis involving chromatography and spectrophotometric work, another should be experienced in electronics, and the third should be an instrument mechanic. These technicians are solely to keep the quipment in good working order; the actual chemical and physical measurements will generally be carried out by students as part of their undergraduate course of practical instruction.

It would be preferable if the graduate physicist also had experience in the statistical procedures necessary for handling data.

Training of professional staff

The Institute staff agreed that the graduate chemist and the graduate physicist supervisers should have a thorough training for four months in the laboratories of the main equipment manufacturers or, failing that, in some other laboratory where training facilities on the type of equipment to be used are available.

The electronics technician and the instrument mechanic should be trained also for four months in similar laboratories to those chosen for the graduates. The chemical technician can be trained at the Plovdiv Institute by the graduate chemist appointed and also by other scientists in the department.

II. RECOMMENDATIONS

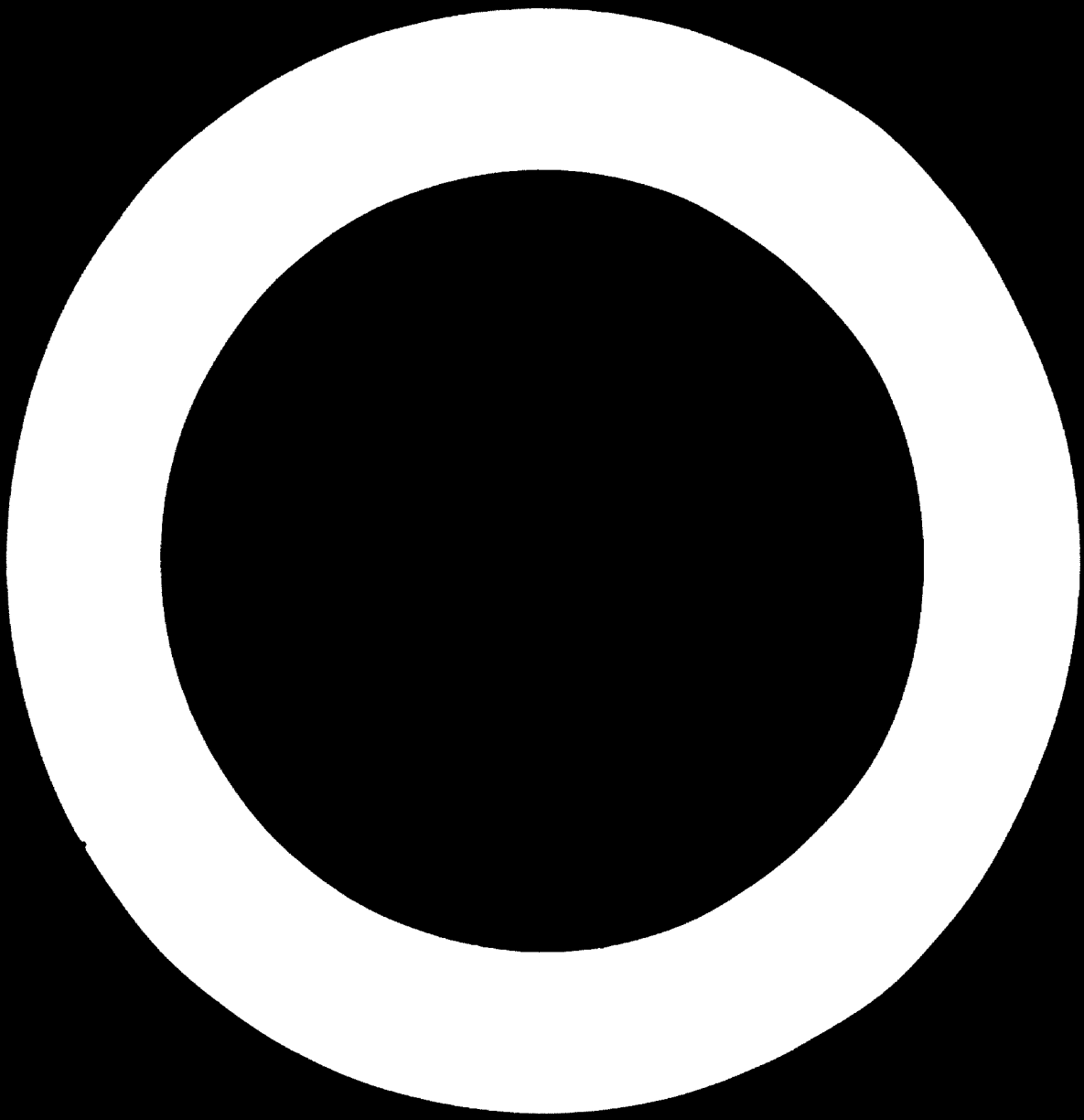
1. The quality control scheme described in this report should be established at the Plovdiv Higher Institute for the Food Industry so as to provide comprehensive training for undergraduate students receiving professional training for entry into the tobacco industry. This scheme will also provide facilities for post-graduate research workers to conduct investigations into technological problems posed by the Bulgarian tobacco industry, using the most modern criteria of quality assessment.

2. If the whole scheme cannot be approved initially, the sections on tobacco leaf, cigarettes, cigarette paper, and cigarette filters should have first priority. Smoke analysis and organoleptic testing should have second priority, followed by the section on pesticide residues.

3. The provision of laboratory-scale equipment to model all the stages of modern tobacco treatment and cigarette manufacture should have a high priority.

4. While the laboratories are being equipped, approval should be sought for starting those parts of the scheme which do not require imported equipment, in order to give the staff experience in teaching elements of quality control.

5. Eventually, possibly during a second visit of one month in the latter half of 1978, recommended by the expert, more advanced organoleptic techniques should be examined, and further targets should be set for the correlation of objective and subjective indices of quality, both in leaf tobacco and in smoke.



Annex I

QUALITY CONTROL

A. Recommended scheme for quality control to ensure compliance with health requirements

Tobacco. Determination of the amounts of the main pesticide residues present in the tobacco.

Tobacco smoke. Determination of the amounts of nicotine, condensate and carbon monoxide in the smoke.

B. Recommended scheme for quality control to ensure maintenance of smoking and other consumer oriented properties

Tobacco leaf. Determination of nicotine, total nitrogen, total reducing sugars, moisture and propensity to degrade. Training for students in correlating the results of objective and subjective tests.

Cut tobacco filler. Determination of nicotine, total nitrogen, total reducing sugars, moisture, filling power, width of strands, and particle size. For blended cigarettes, the amounts of humectants in the filler is also a necessary determination.

Cigarettes. Determination of nicotine, total nitrogen, total reducing sugars, moisture and humectants by the same methods as for filler tobacco. Determination of dimensions, moisture, weight, density of the tobacco rod, firmness, particle size, width of strand cut, pressure drop, and quantity of particles loose in each packet. The determination of nicotine delivery as noted under smoke analysis and the pH of the smoke.

Cigarette paper. The determination of calcium carbonate loading, and the amounts of burn controllers such as lactates, citrates, tartrates, phosphates, nitrates and chlorides. Titanium dioxide should be determined. The porosity of the paper should be determined together with its elasticity and other mechanical properties that would determine its suitability for use in modern high-speed cigarette making machines. The whiteness of the paper is important; with cigarettes that have been stored for any length of time it is essential to examine the cigarette paper for the presence of yellow spots due to transfer of solute material from the tobacco.

Cigarette filters. Pressure drop and firmness are essential tests. Retention for nicotine and condensate will be required. The retention of filters for other constituents such as acrolein and phenols could be required for post-graduate projects.

Organoleptic tests. Panels of smokers should be trained to carry out simple paired comparison and triangular smoking tests. At a later date more sophisticated training to detect and score discreet elements of smoke quality. Objective measurement of aromaticity in oriental tobacco.

Training on laboratory-scale equipment. Students should be trained in all aspects of tobacco processing and cigarette manufacture on laboratory-scale equipment.

Annex II

ESTIMATED EQUIPMENT COSTS
(All prices in United States dollars for delivery in Western European countries)

Item No.	Quantity		Cost ($US)
		(a) Health orientated tests - pesticide residues	
1.	1	Ultra-violet spectrophotometer (Pye Unicam)	8,700
2.	1	Analytical balance (0.1 mg) (Hungary)	1,400
3.		Thin-layer chromatographic equipment (United Kingdom)	2,200
4.		Miscellaneous glassware, syringes, flasks (German Democratic Republic)	1,200
		(b) Health orientated tests - smoke analysis	
5.	1	Filtrona 20-channel smoking machine (United Kingdom)	18,000
6.	1	Gas liquid chromatograph with katharometer detector for water determination in smoke (Pye Unicam)	6,500
7.	1	Recorder for above (Pye Unicam)	4,000
8.	4	Banks of Markham stills with ancillary equipment (United Kingdom)	2,000
9.	1	Ultra-violet spectrophotometer (Pye Unicam)	see item 1
		Miscellaneous equipment for smoking machine operation and cigarette selection (United Kingdom)	11,000
10.		ATCOM attachment and NDIR instrument for carbon monoxide determination (Cigarette Components)	12,000
11.	1	Vacuum pump (United Kingdom)	800
		(c) Leaf tobacco	
12.	1	Drying cabinet	existing
13.	1	Rotary mill (Pass 0.2 mm) (Apex, United Kingdom)	900
14.	1	Analytical balance (0.1 mg)	see item 2

Item No.	Quantity		Cost ($US)
15.	1	Analytical balance for sample weighing (1 mg)	existing
16.	1	Ultra-violet spectrophotometer (Pye Unicam)	see item 1
17.		Markham stills and ancillary equipment (United Kingdom)	see item 8
18.	1	Vacuum pump (United Kingdom)	see item 11
19.	1	Steam bath	existing
20.	2	Water baths	existing
21.	1	Oven for drying glassware	existing
22.		Miscellaneous glassware	existing
23.	6	Kjeldahl flasks and hood	existing
24.	1	Brabender oven for moisture determination	existing
25.	1	Waring blender and bank of sieves for shatter test (United Kingdom)	1,000
26.	1	Hunter colour meter (MOMCOLOR)	7,000
		(d) Cut tobacco filler	
27.		Equipment for nicotine, total nitrogen, sugars, moisture	see (a), (b) and (c)
28.		Cutting machine for preparation of filler	existing
29.		Filling power apparatus (Borgwaldt)	existing
30.		Overhead projector for width of cut	existing
31.		Sieves for particle size determination	see item 25
32.	1	Centrifuge	existing
33.	1	Laboratory oven	existing
34.	1	Mechanical shaker	existing
35.	1	Rotary evaporator	existing
36.	1	Analytical balance (0.1 mg)	see item 2
37.	1	Electronic thermometer (Borgwaldt)	800
		(e) Cigarettes	
38.		Equipment for nicotine, total nitrogen, sugars humectants and moisture determination	see (a),(b), (c) and (d)
39.		Equipment for particle size and width of cut	see (c)

Item No.	Quantity		Cost ($US)
40.		Apparatus for nicotine in smoke	see (a)
41.		Conventional pH meter for smoke pH (Pye)	6,000
42.	1	Analytical balance (0.1 mg)	see item 2
43.	1	Firmness gauge (Borgwaldt)	existing
44.	1	Pressure drop tester (Borgwaldt)	existing
45.	1	Automatic weight sorter (Borgwaldt)	6,000
46.	2	Conditioning chambers (Borgwaldt)	8,500
		(f) Cigarette paper	
47.		Thin-layer chromatographic equipment	see item 3
48.	1	Ultra-violet spectrophotometer	see item 1
49.	1	Porosity meter (Borgwaldt)	existing
50.	1	Elasticity measurement apparatus (Borgwaldt)	5,000
		(g) Cigarette filters	
51.	1	Pressure-drop tester (Borgwaldt)	existing
52.		Determination of filter retention	see (b)
53.	1	Firmness gauge (Borgwaldt)	existing
		(h) Laboratory cigarette-making facility	
54.	1	Wetting unit (Mitsui)	4,000
55.	1	Spray chamber (Mitsui)	4,000
56.	1	Toaster (Mitsui)	5,000
57.	1	Stem press roller (Mitsui)	6,000
58.	1	Rotary cutter (Mitsui)	4,000
59.	1	Drying oven (Mitsui)	3,500
60.	1	Hanni Baby cigarette making machine	30,000
61.	1	Mannella tipping machine	6,000

Estimate of laboratory sizes	Dimensions (metres)
Sample room and stores	3 x 3
Sample preparation room	8 x 4
Milling room	3 x 3
General chemical laboratory	8 x 6

	Dimensions (metres)
Pesticide and humectant laboratory	8 x 6
Physics laboratory	6 x 4
Smoking-machine room	8 x 4
Office for supervisers and records filing	

The total laboratory floor area is 202 m^2, excluding the records office.

The milling room will need an efficient dust extractor, and the smoking machine room will need venting to remove the side-stream smoke. It was agreed that the physics laboratory will need an ILKA - KT 2 air-conditioning unit costing $US 2,000.

Annex III

ADDRESSES OF EQUIPMENT MANUFACTURERS

Heinrich Borgwaldt, 2000 Hamburg 50, Federal Republic of Germany

Cigarette Components Ltd., Friendly House, 21-24 Chiswell Street, London EC1Y 4 UD, United Kingdom

Mitsui and Co. Ltd., General Merchandise Division, Tokyo, Japan

Pye Unicam Ltd., York Street, Cambridge, United Kingdom

Technicon GmbH, Linke Wienzeile 236, A-1150 Vienna, Austria

Technika, 10 Graf Ignatiev Street, P.O. Box 672, Sofia, Bulgaria

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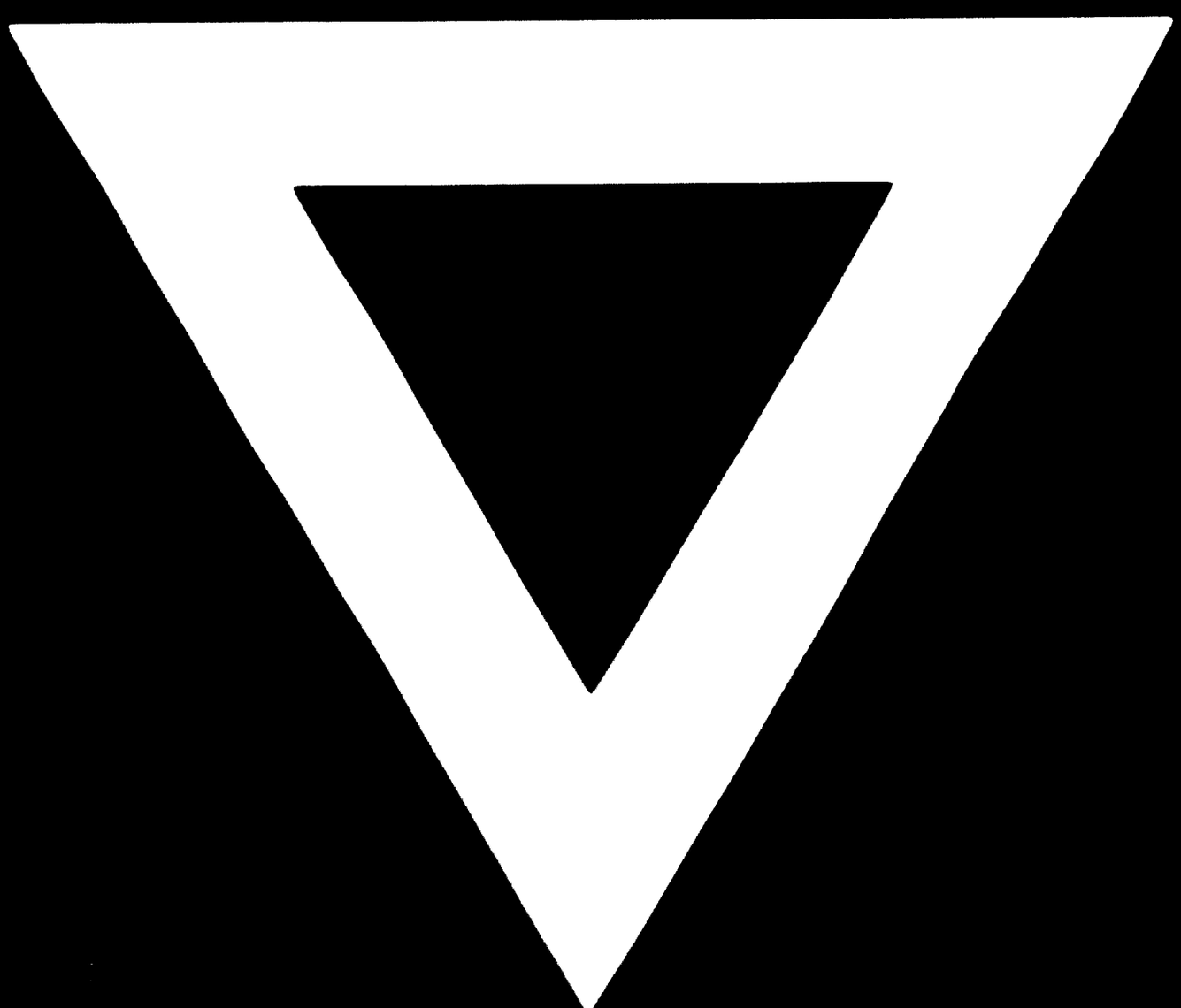

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