L. C. Laporte, Esq. 25th April, 1958

something to your knowledge by analysis for tar and benzpyrene if you like to send us cigarettes made from the extracted tobacco.

I will keep you posted from time to time with a general appreciation of the work we have been doing and are intending to do, and I should be most grateful if you would do the same for me.

Mr. Wood was here yesterday and passed on messages from you and your colleagues. I should, in turn, like to be remembered to them and send you all my best wishes.

With kindest regards,

Yours sincerely,

C.c. D.J.F.Hobson, Esq.
Sir Charles Ellis,
Dr.D.G.Felton

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The effects of various casing and other materials upon the production of smoke condensables also comes into this project, the aim being to reduce these materials in mainstream smoke if possible.

We are very interested to learn of your experiments on extracting tobacco with hexane and should this prove to be worth pursuing, we would be grateful if you could make available to us some thousands of the cigarettes together with untreated controls, so that we might investigate the benzpyrene and tar contents of the smoke.

PROJECT 5

Although this is handled by the Smoke Group, it does not deal with the analysis of smoke in any way. It is an investigation of methods for the control of infestations of one sort or the other.

Project 9 - Smoke Evaluation of PCL

Excluding the organisation and interpreting of smoking tests by panels, PCL sample cigarettes are being evaluated for tar production and the correlation of this with changes in the formulation of the PCL. The aim is to try to ensure that PCL contributes less tar (at any rate, not more) to the smoke than does an equivalent weight of tobacco. Simultaneously, the formation of 3:4-benzpyrene during the burning of PCL is being investigated. When the analysis of the volatile fraction of smoke is established, the technique of Gas Chromatography will be applied to control and PCL-containing cigarettes of the "Viceroy" blend to investigate the nature of any "off-taste" which may be found.

We would very much like to discover the basic ways in which tar is formed in smoke production and as a start on this we are measuring the quantities of tar produced from the different parts of the leaf and from the different constituents of casing. To hazard a guess, the picture is probably complicated by these effects not being additive.

I think I have said enough to give you a general picture of what we are doing, and I understand it is not the intention that voluminous reports shall flow back and forth between us but rather that the general outline should be kept up to date. Where either of us finds the other's work to be of interest, we should ask for details of that particular subject. Therefore, I hope that you will ask for details from me of any part of the above about which you want to know more.

I should, as already mentioned, like to know more about your tobacco extraction when you have more to tell, and we might be able to add

ured in describing taste and flavour of smoke. e have collated a number of these from various parts of the world and have endeavoured to place them on a common basis which can be agreed and then used throughout the Organisation. Until this can be done, we feel little progress can be made.

Concurrently with that, we intend to apply the technique of Gas-Chromatography to the analysis of the volatile fraction of tobacco smoke in order to see whether we can correlate certain tastes and flavours with particular chemical entities in the smoke. e can then endeavour to trace these to particular types of leaf in a blend and see what can be done to modify them and so change the taste and flavour. We have just begun to receive our equipment and hope to learn a lot from it.

PROJECT 3 - How Smoke is Formed. Heat and Material Balance of a Cigarette.

At present this has been removed from our smoke programme but it is probable that a considerable amount of work will be carried out through T.M.S.C. at a London university.

We are intrigued by the fact that the CO_2/CO ratio of tobacco smoke varies with the airflow through a cigarette and, moreover, that there appears to be more CO_2 present than can be accounted for by the oxygen utilised in combustion. Where does the extra CO_2 come from? We also want to unravel how the basic combustion processes occur and to discover how much heat is made available for distillation processes. For example, what controls the maximum temperature reached in the coal and is this maximum value significant? What effects do the dimensions of a cigarette have on the combustion?

All we have done in the past is to investigate the measurement of temperature and to explore some of the effects which can be potential sources of error.

PROJECT 4 - Smoking and Health

This project deals with more specific investigation of smoke for particular compounds which might be indicted. In the first instance, we have set up, as a routine procedure, the assay of smoke for 3:4-benzpyrene by fluorescence microspectrophotometry. Having proved the consistency of the method by several assays, it was applied to smoke from various portions of the cigarette, when a considerable difference was found between the smoke from the first and second halves of the cigarette. It will also be applied to investigate any effects due to casings and other materials. We aim to keep this tool well-honed in readiness for a possible need.

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From the value of K^1 we find for a particular filter, we define a ~~Specific~~ Retention Coefficient, σ, such that

$$\sigma = \frac{KA}{\ell}$$

which we think may be a characteristic design constant for a particular filter and one which will enable us to compare the efficacy of different types of filter, which possess varying pressure drops etc.

At this point we should interpolate that we concern ourselves with Absolute Filtration Efficiencies, or as you describe them, Filtration Efficiencies vs. air. The filtration efficiency vs. an equivalent length of tobacco is dependent upon the amount of smoke presented to the plugs and constancy of filtration efficiency depends upon the assumption of constant weight of smoke constituent presented. We are still forming our views on this point and hope to design experiments to test them.

We feel that so far we are proving our methodology and sharpening our wits on the problem. There are a number of other features which require investigation, such as the dependence of filtration efficiency upon linear airflow of the aerosol through the filter; and we plan, at some time in the future, to initiate studies into the physics of filtration and the dependence upon all the physical characteristics.

In order to provide ourselves with suitably flexible apparatus possessing a number of desirable features, we have designed a new pattern smoking machine. It operates under constant volume conditions and besides enabling us to smoke cigarettes mechanically under reproducible conditions of constant puff profile, it will be adjustable to a wide range of puff conditions by suitable alteration in gears, cams etc. It will enable us to smoke "filter tipped" cigarettes with the filter separated from the cigarette and to measure and record by pen-recorder the pressure changes across the cigarettes and filters individually and on all six channels. We can then check that conditions are constant and see what changes in pressure occur on progressive deposition of smoke in the filter.

The machine is at present undergoing exhaustive testing to reveal design failures and necessary modifications.

So far, we have not touched on the question of unimpaired taste and flavour apart from exploring the effect of tobacco as an additive to conventional filters in restoring a modicum of tobacconess to the smoke. This aspect impinges on that of

PROJECT 6 - Taste and Flavour of Smoke.

Here, the first requirement is the systematisation of the terms

non-porous envelope (ensured by binding it with Sellotape - the filter tip on a cigarette has a cork tipping which effectively makes it non-porous) then draw resistance, defined as pressure drop per linear airflow, (the pressure drop is measured at an airflow of 1250 cc./min. and is then corrected for cross-sectional area) varies linearly with the length of the filter

$$\frac{P}{V} = \frac{\epsilon L}{A} \quad \text{or} \quad \frac{P}{v} = \epsilon L, \quad v \text{ being linear airflow.}$$

We call the constant, ϵ, the Impedance Coefficient for the filter.

When the envelope wrapping the filter is porous, as is usually the case, then the curve connecting $\left(\frac{P}{v}\right)$ with L is nearly linear for lengths up to 60 mm., but then curves away, and just at present we are proving the correctness of the expression we have derived, which includes the porosity of the paper. It has explained a number of curious small anomalies we encountered in the early stages.

We have progressed from this to a study of the variation of filtration efficiency with length for a particular filter. We have shown that filtration occurs exponentially, and the curve is a true exponential for lengths up to about 18-20 mm.

Thus, if S_o is the smoke presented to the filter, and S_1 is the smoke passing the filter

$$S_1 = S_o e^{-KL}$$

from which we derive

$$\text{Filtration efficiency } \theta = \frac{S_o - S_1}{S_o} = 1 - e^{-KL}$$

$$\text{whence } \log_{10}(1 - \theta) = K^1 L \quad (K = 0.4343K^1)$$

When we plot $\log_{10}(1 - \theta)$ against L, we get a straight line for the lengths up to 18-20 mm. After this, the filtration efficiency falls away, and we think this is probably due to the greater difficulty in filtering the remaining smaller particles from the smoke. Our ideas on this phase are just forming and we would prefer not to enlarge on them at present.

HDA/VC/46D

AIRMAIL

25th April, 1958

L. C. Laporte, Esq.,
Imperial Tobacco Company of Canada Ltd.,
P.O. Box 6500,
MONTREAL 30,
CANADA.

PRIVATE & CONFIDENTIAL

Dear Leo,

I understand from Sir Charles, and you will have seen from Mr. Hobson's letter to Mr. Keith of 2nd April, that there may now be a full exchange of information between us on the work being carried out on "Smoke" and its various health aspects.

I am starting the ball rolling by sending you the current programme for the Smoke Section of the laboratories here at R.& D. This has been cut down in amount from the full programme, which I showed you during my visit to Montreal, because of the lack of people to carry on all of the work therein detailed, and the current programme is accordingly cut down to what we can tackle. Even so, the smoke programme covers a number of projects which are to a lesser or greater degree inter-related and some are in abeyance or not started because of the pressure of work on the others.

An important feature of the programme concerns the health aspect. We feel that since no one substance or group of substances can be indicted it would be chasing a will-o'-the-wisp to concentrate on a particular class of smoke constituents. The overall reduction of the smoke constituents taken in by a smoker must reduce any danger proportionately, if danger there be. For this reason a considerable effort is being put into

PROJECT 2 - The study of the ways in which a filter acts, in order to produce filters of very high efficiency yet giving smoke with unimpaired taste and flavour. Our original task was to produce a filter which, while possessing a tolerable draw resistance, would remove ⅔rds tar from the smoke. Luckily, we nearly achieved this in our first shot using Supertex Cotton filters. We are not, however, working on an 'ad hoc' basis.

e have studied the variation of draw resistance of a filter rod with length. We have been able to show that when a filter has a

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