GEORGIA INSTITUTE OF TECHNOLOGY
ENGINEERING EXPERIMENT STATION
ATLANTA, GEORGIA 30332

October 15, 1965

Scripto, Incorporated
P. O. Box 4847
Atlanta, Georgia 30302

Attention: Mr. Charles A. Lovejoy
Vice President, New Product Development

Subject: Final Technical Report, Project A-884
Investigation of Butane Lighter

Gentlemen:

The objectives of this investigation were to determine the properties of the reservoir and fill valve of the Scripto butane lighter. Measurements were taken of the following:

Reservoir

1. Normal fuel fill at temperatures up to 150 F.
2. 100 per cent fuel fill at temperatures up to 150 F.

Fill Valve

1. Maximum fill in consumer use
2. Fill control in normal use

Procedures

1. Filling

Ten lighters were provided by the sponsor for this study. These were emptied of their charge and weighed. They were reweighed after filling, the filling being conducted according to three schedules:

(a) Normal fuel fill

A group of individuals was selected at random, including laboratory personnel, secretaries, and maintenance personnel. Each was provided with the ten lighters and a supply of fuel and instructed merely to "fill each lighter." The meaning of "full" was left to the individual.

(b) Maximum fill in consumer use

These fillings were made by laboratory personnel and consisted primarily in keeping the injector in position until the fuel escaped freely around the injection port.

(c) 100 per cent fuel fill

In order to fill the reservoir completely, eliminating void space above the liquid, fuel was injected in several successive stages, and the vapors were bled off through the burner valve between stages.

2. Reservoir

The reservoir was tested for resistance to leakage and pressure distortion over a period of 24 hours at temperatures of 100 F, 125 F, and 150 F and at each of the fillings described above.

3. Fill Valve

The method of determining maximum fill in consumer use is described above. Fill control in normal use is indicated by the deviation from average of the multiple replications.

Results

Table I shows the average load and the deviation for each of five individuals selected at random to fill ten lighters each.*

TABLE I

NORMAL CONSUMER FILL

"Consumer No."	Average Load, g	Average Deviation, g
1	3.7780	0.2529
2	2.9756	0.7001
3	3.8592	0.2131
4	2.1412	0.4925
5	3.9501	0.0966
Average for 5:	3.3408	0.3510

*In two instances lighters failed during testing. Those results were discarded.

Table II shows the average load and average deviation of three tests, each of which comprised ten lighters filled by laboratory personnel, as described in (b) above.*

TABLE II

MAXIMUM FILL IN CONSUMER USE

Test No.	Average Load, g	Average Deviation, g
1	3.8176	0.1053
2	3.9670	0.0716
3	4.0864	0.0117
Average of 3:	3.9570	0.0962

Table III shows the average load and deviation for a single test consisting of six lighters filled to 100 per cent capacity, as described in (c) above.

TABLE III

100 PER CENT FILL

	Average Load, g	Average Deviation, g
Average of 6:	4.2571	0.0659

Table IV shows the weight loss for each mode of filling at temperatures of 100 F, 125 F, and 150 F.

Conclusions

1. Normal consumer fill differs from maximum consumer fill by approximately 0.5 grams. The loss of fuel encountered in obtaining maximum consumer fill is sufficiently noticeable that it will generally be avoided. An average fill of 3.34 ± 0.35 grams may be expected in consumer use.

*Two measurements showed abnormally low loads and were discarded as attributable to leaks. A hinge broke on one lighter during testing, and that test was discarded.

6. Since even at normal consumer fill and 100 F there is small leakage over a 24 hour period, there is indication that lighters should not be filled to this extent for shipment. A nominal charge of about 1 gram would probably suffice for a factory fill, if the lighters are not to be shipped empty.

Remarks

The lighter appears to be a well engineered product and performs well even under the rather severe conditions of laboratory testing. There were several features that came to light during the testing, although not intentionally included in the program. These are mentioned for whatever value they may have.

Of the ten lighters included in these tests, there were several whose burner valves were very difficult to close completely. It is recognized that these valves are intended for regulation, rather than for shut-off; but in this program it was necessary to use them for shut-off as a part of the test procedure.

One of the tops came loose from its hinge at the spot weld connection.

Wind guards proved to be not too effective in a moderately strong wind.

Mating of cannister spout and injection port on the lighter is often imperfect, resulting in excessive spillage during filling.

Respectfully submitted,

[redacted]

W. H. Burrows
Project Director

Approved:

[redacted]

Frederick Bellinger, Chief
Chemical Sciences and Materials Division

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TABLE IV

WEIGHT LOSS OF LOAD UPON HEATING

Temperature, °F	Fill	Av. Wt. of Butane, g	Weight Loss Upon Heating	
			g	%
100	Av. Consumer	3.2863	.6738	2.05
	Max. Consumer	4.0866	1.0462	2.56
	100% Fill	4.2757	.9574	22.39
125	Av. Consumer	3.3588	.1586	4.72
	Max. Consumer	3.9945	.1948	4.88
	100% Fill	4.1928	1.7439	41.59
150	Av. Consumer	3.3332	.2090	6.27
	Max. Consumer	4.0468	.2760	6.82
	100% Fill	4.3219	4.3219	100.00*

2. Normal consumer fill is approximately 78 per cent of the maximum possible fill (100 per cent fill). Some 22 per cent of the volume of the reservoir is normally void space.

3. Weight losses upon heating are not greatly different for average consumer fill and maximum consumer fill, but increase greatly with 100 per cent fill. At 100 F the weight loss for 100 per cent fill is 22.39 per cent, which corresponds very closely to the normal void space of the reservoir. At 125 F this loss is almost doubled; at 150 F it is complete, due to failure of the reservoir.

4. The vapor pressure of isobutane at 150 F is approximately 145 psi. Apparently, the pressure that developed in the reservoirs at 150 F was slightly under this value, as there was sufficient loss of fuel to indicate some leakage. The reservoirs showed sufficient strength to contain this pressure without distortion.

5. At 100 per cent fill there was a considerable increase in weight loss at all three temperatures, and distortion at 150 F. This is attributed to thermal expansion of the liquid butane, forcing it out of the burner valve. Apparently, at 150 F, leakage was insufficient to accommodate the thermal expansion, and the reservoir walls were bulged by liquid expansion.

*The sides of the reservoir bulged out, and the valve failed, resulting in complete loss of fuel.

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