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UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
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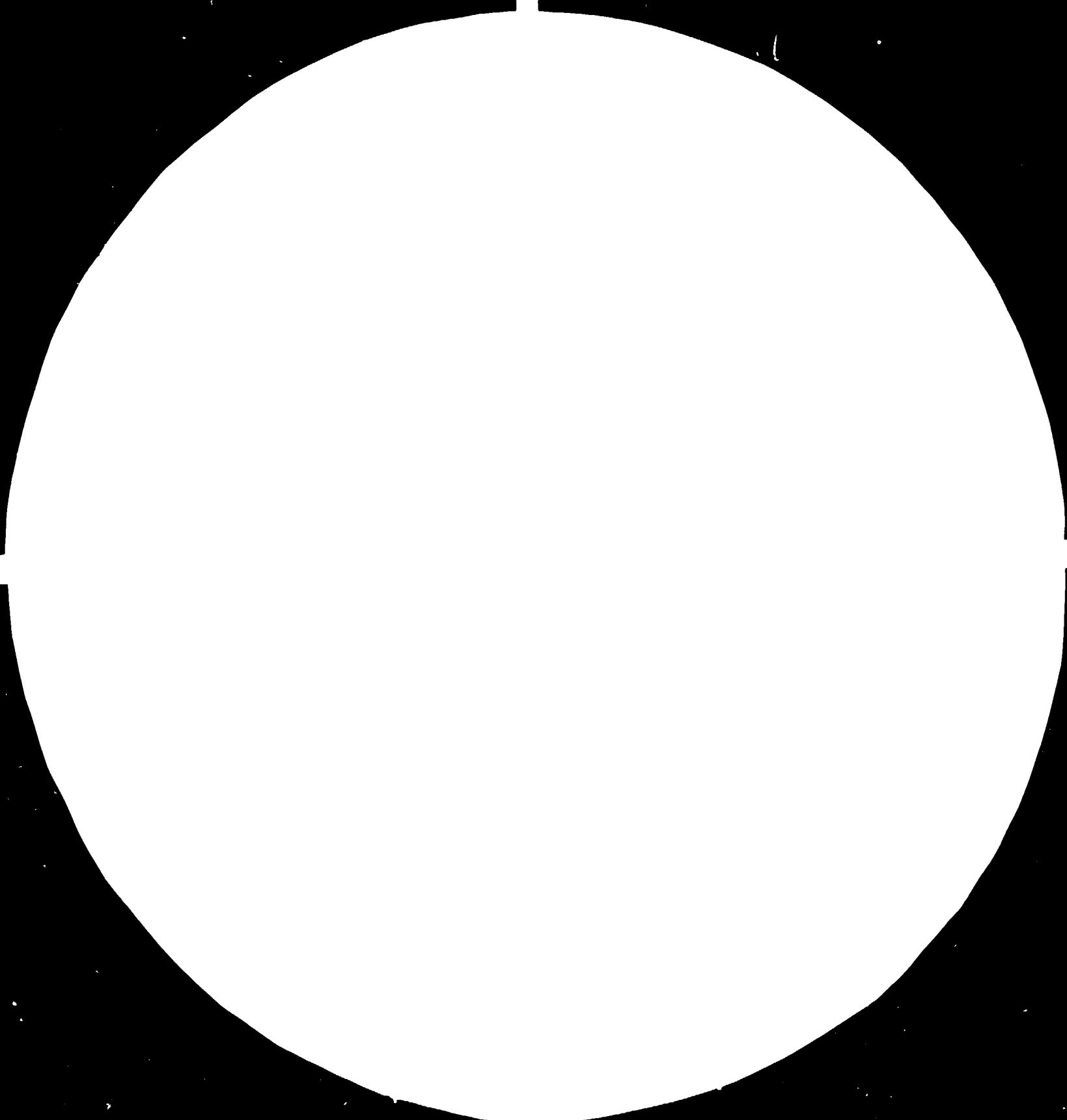

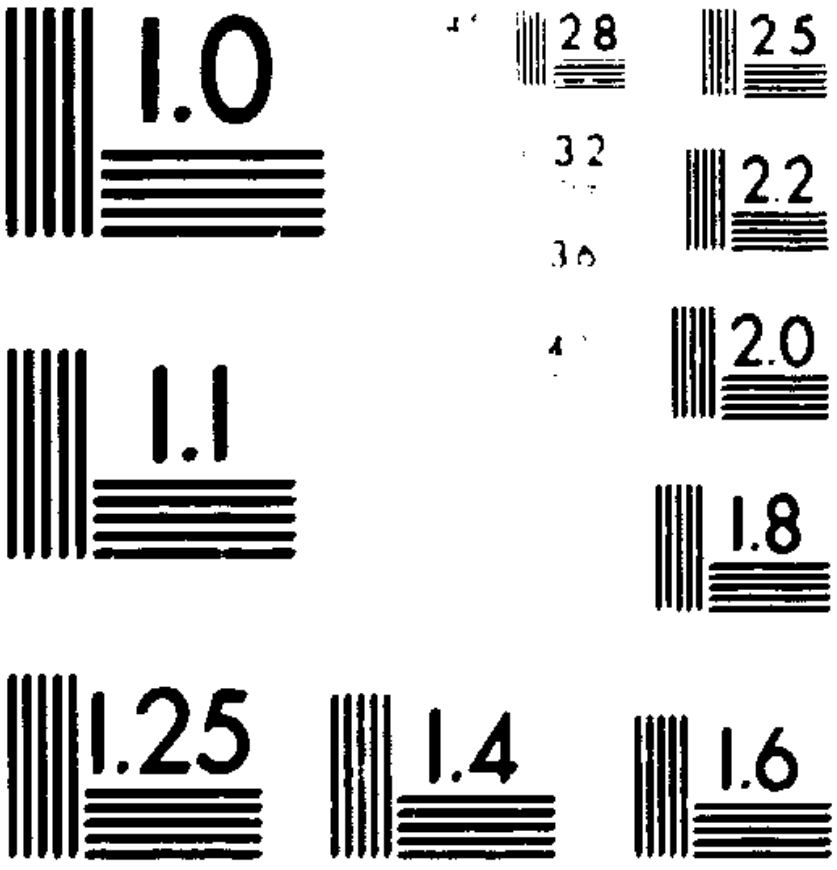

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5 December 1984
ENGLISH

CONSOLIDATION OF THE PACKAGING CENTRE AND ESTABLISHMENT OF A PLASTICS CENTRF AT THE JAMAICA BUREAU OF STANDARDS

DP/JAM/82/004
JAMAICA

Technical report: Laboratory Testing of Packaging and Plastic Materials and Plastic Products*

Prepared for the Government of Jamaica
by the United Nations Industrial Development Organization
acting as executing agency for the United Nations Development Programme

Based on the work of Joseph Miltz
Expert in Laboratory Testing of Packaging
and Plastic Materials and Plastic Products

United Nations Industrial Development Organization
Vienna

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CONTENTS

SUMMARY

This report summarizes the work performed by the expert during his stay with the Jamaica Bureau of Standards for the period July - August 1984.

The main purpose of this mission was to help in establishing a Plastics Laboratory in the Non-Metallic Section of the Jamaica Bureau of Standards and in training the local technical personnel in using properly, the equipment and in the interpretation of the results.

The different plastics testing techniques and instruments were discussed in detail. Actual tests were run and the interpretation of results as well as the significance and applications of the different test methods were outlined.

Video films describing the different test methods and the meaning of the results were prepared. Video films were also prepared discussing the structure, properties and applications of the most widely used commercial polymers.

Weekly lectures to the technical personnel of the Plastics Laboratory and the Packaging Centre were held reviewing structure-property-application relationships of plastics, common test methods, specifications and standards. The subject of plastic bottles and containers was also discussed.

A four and a half day seminar was presented to the people of the local industry.

A list of recommended testing equipment for the Plastics Laboratory and a list of recommended books on Plastics structure and properties for the Bureau's library were prepared.

1. INTRODUCTION

1.1 General

This report summarizes the work performed during the period of July - August 1984 in the recently established Plastics Laboratory at the Jamaica Bureau of Standards.

1.2 Job Description

The objectives of the present post were to help in establishing a Plastics Testing Laboratory in the Non-Metallic Section of the Jamaica Bureau of Standards in general and in particular:

(a) Advise on the methods of use of the Plastics Laboratory testing equipment already in place and on additional equipment that may be considered essential. The equipment is principally related to testing the physical properties of plastics.

(b) Advise on the interpretation of the results from the above equipment and on their application to typical problems faced by plastics converter factories and users of plastic containers and other plastic products.

(b) Assist the project manager in preparing the script for a series of video training films that will record the key points made by the expert during his mission.

(d) Assist the Plastics Laboratory staff in preparing testing schedules for typical problems associated with plastic containers and components.

(e) Advise on the nature of standards that would be helpful to the export industries and on the preparation of buying specifications.

(f) Present six one-hour talks to the Bureau's staff concerned with such topics as plastic types and their principle properties, plastics manufacture, the principle methods of test, plastics and the environment and future developments.

(g) Present three-hour seminars on plastics laboratory testing techniques for participants from local industry.

1.3 Background

The Jamaica Bureau of Standards was established in 1969 and is presently run under the Ministry of Science, Technology and Environment. It consists of the following departments in alphabetic order:

(a) Administration
(b) Chemistry
(c) Engineering
(d) Food Science and Agricultural Commodities
(e) Information
(f) Materials Science
(g) Packaging
(h) Regulations and Compliance
(i) Standards.

The Packaging Department which deals with different aspects of packaging (including plastic packages) was established in 1979. The Non-Metallic Section which belongs to the Materials Science Department was established in 1972 and only in 1981 it was decided to form a Plastics Laboratory in this section.

Most of the technical personnel in the Non-Metallic Section are young graduates and technicians of very limited experience in Plastics. The graduates received their education and training in the West Indies where to the best of the author's knowledge, no programme exists dealing with plastics technology, structure-properties relationships and processing and applications of plastics. None of the people in the Non-Metallic Section and in the Packaging Centre have an advanced degree and definitely not in Plastics or Packaging Technology.

The Jamaican Plastics industry consists of a small number of big manufacturers (one of them - "Thermoplastics Co Ltd" - is big even on an international scale) and many small companies. The big companies have some facilities for quality control and testing. On the other hand, most of the small companies have no testing facilities.

The number of plastics used in Jamaica is limited primarily to the more common and cheaper ones. Almost no advanced polymers like Polyethyleneterephthalete (PET), Nylons, Polycarbonate, Ionomers, etc are presently being used. It is however the opinion of the expert that they should and will be introduced to Jamaica in the future.

The expert finds the technical personnel in the Plastics Laboratory very capable (although inexperienced) and willing to learn and acquire knowledge and experience. Some of the technical people working with the big companies were trained abroad and have experience in Plastics Technology. On the other hand they do not have all the equipment that will be available in the Plastics Laboratory nor experts in the field that come for training of the technical personnel.

Therefore a close co-operation between the people of the Plastics Laboratory and the technical people from industry could be beneficial to both sides. It is the opinion of the expert that the Plastics Laboratory of the Jamaica Bureau of Standards has the potential to become a very good facility for helping the local industry in testing of raw materials and finished products, for involvement in trouble-shooting in industry and for preparation of specifications and standards.

2. DESCRIPTION OF WORK PERFORMED

2.1 General

The Non-Metallic Section in the Jamaica Bureau of Standards was involved until recently, (1982), in testing materials like leather, fibers, paints, paper and rubber that are not considered to be plastics (although polymers). Therefore, most of the equipment existing in this laboratory is designed for testing these materials. Only since the forming of the Plastics Laboratory at the end of 1982, the acquisition of equipment for testing plastics begun. The author of this report was consulted about the appropriate equipment even before the beginning of the mission when it became clear that he was the candidate for this post. The completion of the list of necessary equipment was carried out during the mission.

2.2 Testing Equipment for the Plastics Laboratory

Upon the arrival at the post, the following instruments designed for plastics testing were available at the Plastics Laboratory:

(a) A Davenport Melt Flow Indexer

(b) A Lorentzen and Wettre Elmendorf Tear Tester (belongs to Packaging)

(c) A Davenport Falling Dart Impact Tester

(d) A Zwick Universal Tester (just arrived, not yet assembled)

(e) A Sentinel Impulse Heat Sealer

(f) A Coefficient of Friction Tester.

Other related instruments exist in the Packaging Centre, (a Hot Bar Sealer, a Rub Tester, a Compression Tester, a Drop Tester, Water Vapor Transmission Rate Cells) and in the Chemistry Laboratory, (Infrared Spectrometer) and may become available to the people of the Plastics Laboratory when required. Additional pieces of equipment were recommended by the author of this report some of which were already ordered. The list of these equipment is given in Appendix 1.

The expert finds one instrument that was not ordered, of utmost importance. This is a Gas Chromatograph equipped with a dual flame ionization and thermal conductivity detectors. With the increase in the regulatory requirements and consumer sensitivity (all over the world), to off tastes and off odours, the determination of residual solvents and monomers in plastic packages and their migration to the contained foods and drugs is of very great importance. However, neither the Packaging nor the Plastics Laboratories in the Jamaica Bureau of Standards has a gas chromatograph required for the performing of such tests. Such a gas chromatograph will also enable different gases permeability measurements.

Although a gas chromatograph exists in the Chemistry Laboratory, the author was told that this chromatograph is very busy and it is therefore very unlikely that it will become available to the people from the Plastics Laboratory or Packaging Centre.

It is the opinion of this expert that if the gas chromatograph in the Chemistry Laboratory will not be available, upon need, to the technical personnel of the above mentioned two groups every effort should be made to find the appropriate resources to acquire such an instrument in order to enable the two Departments in the Jamaica Bureau of Standards to properly fulfil their task and needs of the present and future.

2.3 Video Films on Test Methods

A list of priorities for the different test methods as applied to the Plastics Laboratory of the Jamaica Bureau of Standards was prepared together with the UNIDO Project Manager, Mr. John Salisbury. This list is given in Appendix 2.

The Melt Flow Rate (Melt Flow Indexer) apparatus, its composition and functions were explained in detail to the technical staff of the Packaging Centre and the Non-Metallic Section. Several runs of the instrument were carried out and the test method, the interpretation of the results and the possible applications of this test were also explained. A video film describing in detail the test method, interpretation of results and applications of the Melt Flow Rate test was prepared.

The Elmendorf Tear Tester its applications and the interpretation of results were explained and demonstrated to the technical personnel. A video film showing the test method, explaining the way of reporting the results and possible applications of the test was prepared.

The Zwick Tensile - Compression Tester was assembled. The different functions of the machine and primarily the importance of the tensile test, probably the most important test for plastics, the kind and shapes of test specimen, the meaning of the different parts in the Force - Extension (Stress - Strain) curve, the effect of test rate and temperature on the results were explained in detail. Tensile tests on films and dog-bone shaped sheet specimen, especially ordered from the author's laboratory in Israel, were carried out and the results analyzed. A video film showing all the features of tensile testing was prepared.

The Sentinel Heat Sealer and the principle of its operation were outlined. A video film explaining the functions of the instrument and its applications to actual Heat-sealing problems was prepared.

The Falling Dart Impact test was discussed. The significance of this test and its application to actual problems were outlined. The differences between the applicability of this test as compared to the Tear Test were clarified.
A video film describing the test methods and the interpretation of results was prepared.

The meaning of coefficient of friction was discussed with Mr. John Salisbury, UNIDO Project Manager and with Mr. Joseph McCarthy from the Bureau of Standards.

2.4 Video Films on Structure - Property - Applications of Plastics

At the beginning of the mission, it was learned that most of the technical personnel in the Non-Metallic Section and in the Packaging Centre were not familiar with plastic technology and with the structure -property -application relationship of the polymers commercially used in the plastics and packaging industry.

The main reason for this lack of knowledge stems from the fact that Jamaica does not have a School of Engineering and even the University of the West Indies does not have a programme on polymers and plastic materials technology. For this reason a series of video films were prepared explaining:

(a) The chemical structure of additions polymers.
(b) The chemical structure of condensation polymers.
(c) The molecular structure of polymers (molecular weight distribution and molecular weight averages)
(d) Methods for molecular weight averages and molecular weight distribution determination
(e) The relation between structure, properties and applications of the different commercial plastics.

2.5 Lectures

Weekly, one - one and a half hours of lectures and discussions were held with the technical personnel of the Non-Metallic Section and the Packaging Centre. The structure of the different plastics and their properties and applications were discussed. The different methods of testing plastic materials and products and primarily plastic containers were outlined. The difference between specifications and standards was explained and the importance to distinguish between simple tests that can be carried out in industry and more complicated ones that the Plastics or Packaging Laboratories will have to take care of, was stressed. The view of the present expert was stressed that at the beginning industry should be asked to perform only a limited number of tests. The number and complexity of tests can be increased gradually when they become more accustomed to the idea of quality control and performance testing.

Otherwise, if the industry and primarily the smaller companies are requested to perform many (including complicated) tests from the beginning, they will not bother performing any tests.

Discussions were also held with people from the Packaging Centre related to container specifications. The subject of critical, major and minor defects was elaborated.

2.6 Visits to Industry

The two biggest plastic products manufacturers in Jamaica were visited. These are

(a) Thermoplastics Company Ltd and
(b) West Indies Synthetics Ltd.

The summary of the visits is given in Appendix 3.

2.7 Seminar to Industry

Although a three hour seminar to the local industry was scheduled in the assignment, in reality a four day seminar, three hours each day, was presented, discussing structure, properties, applications and laboratory testing of plastics. From the response of the participants it was learned that the seminar was very successful.

2.8 List of Books

Upon the arrival at the mission, it was learned that very few books on plastic structure, property and technology existed in the library of the Bureau.

A preliminary list of recommended books (given in Appendix 4) from the expert's memory, was prepared. A more comprehensive list will be sent to the UNIDO Project Manager from the expert's home.

3. RECOMMENDATIONS

3.1 It is highly recommended that most of the technical people in the Plastics Laboratory of the Non-Metallic Section are thoroughly trained in using properly, the different instruments in this laboratory. The importance of this recommendation stems from the fact that the technical personnel belonging to this laboratory is a small group.

3.2 It is recommended that all of the technical personnel in the Non-Metallic Section and the Packaging Centre view more than once all the video films that were prepared and make sure that everything in them is clear.

3.3 It is highly recommended that every effort should be made to find the resources for purchasing a gas chromatograph for the Plastics Laboratory or Packaging Centre in the case that the technical personnel of these groups will have no access to this instrument in the Chemistry Laboratory. The people in these two groups have to be thoroughly trained in the use of this instrument as well as in the analysis of residual solvents and monomers in plastic materials. The expert has recently acquired a Varian 3700 Gas Chromatograph for his laboratory and finds it to be a very good instrument.

3.4 It is recommended that a close co-operation between the Plastics Laboratory and the local plastics manufacturing companies is formed for the purpose of exchanging ideas, information and experience. The two sides can benefit from such a co-operation.

3.5 As no programme on Plastics Technology exists in the West Indies Universities, consideration should be taken to send, not in the far future, key persons (group leaders, for instance), in each of the Non-Metallic Sections and the Packaging Centre, for an advanced degree training abroad in this field.

3.6 More training abroad of the technical personnel of the Plastics Laboratory, is recommended.

3.7 Although there is almost no use in Jamaica for the more advanced polymers, like polyethylene-terephthalate (PET), nylons, polycarbonate, ionomers etc, the technical personnel of the Plastics Laboratory and the Packaging Laboratory should become well familiar with their structure and behaviour because they are widely used in developed countries and it is only a matter of time before they will be introduced to Jamaica.

APPENDIX 1

List of recommended equipment for the Plastics Laboratory of the Jamaica Bureau of Standards

INSTRUMENT	TYPE
1. Melting Point Apparatus	Fisher-Johns Catalogue No. 12 - 144
2. Viscometry	Ubbelohde Fisher Catalogue No: 13 - 614 (A + E)
3. Tank for viscometry and Environmental Stress Cracking	Bird and Tatlock Catalogue No: 304 - 2035
4. Jaws for 5KN Tensile Testing	Zwick
5. Gas Chromatograph with 1 channel suitable recorder	Varian 3700
6. Syringes, Vials, Septa, Columns (Molecular Sieve 5A Poropack Q, Apizon or Carbowax or equivalent), Gas Flow Meter	Outlined to the project manager, Mr. J. Salisbury
7. Carver Press	Model M with heated plates Catalogue No. 2108 - 1 Model 12-10-2T
8. Punches	H.W. Wall ASTM D638 Types I & IV
9. Tensile Cut	Information to be sent from Israel
10. Environmental Stress Cracking Devices	Toyoseiki Catalogue No. 539 or Custom Scientific Instruments Catalogue No. C592S, C592, C592T
11. Pendulum Impact Tester Hammers IZOD and Charpy 0-2, 0-10 ft. lb Pendulums 1-2, 10 ft. lb	Custom Scientific Model 137 TMI Model 43-1-1 Toyoseiki No. 505
12. Notch Cutter	TMI Model 43-15-2
13. Heat Deflection/Vicat Softening Point	Custom Scientific Model CS-107 (1 Place, Manual) or TMI Model 46-11

No Hardness Testers were recommended as three different Hardness Testers exist in the Non-Metallic Section. It is recommended to contact the three manufacturers for the purpose of exploring their suitability (even with some modifications) for plastics testing.

APPENDIX 2

LIST OF PRIORITY TESTS

NOTES ON DISCUSSION WITH DR. JOSEPH MILTZ CONCERNING PRIORITIES AND A PLANNING BASIS FOR HIS VISIT

A meeting was held to discuss the many methods which have been isolated and documented by the lab with a view to giving them priority based on their importance to the Bureau of Standards' role. Attached is a summary of those comments.

Reference No.	Subject	Yes/No	Priority
1a	Plastic Yield	Yes	3
1b	Vicat Softening Point	Yes	5
1c	Deflection Temperature	Yes	4
1d	Deformation under Heat	Yes	5
1e	Melting Point (Fischer Melting Point)recommended)	Yes	1
1f	Stability Thermal	Yes	5
1g	Crush Resistance after Heating	Yes	5
1	Blister Temperature	Yes	5
1j	Flammability	Yes	2
1k	Oxygen Index	No	
1ℓ	Stiffness	No	
1m	Low Temperature Effects	?	
1n	Film Forming Temperature	No	
1o	Sealability	Yes	1
1p	Expansion	No	
1q	Heat of Fusion	Yes	5
1r	Thermal Flow	Yes	5
1s	Thermal Conductivity	Yes	3

Reference No.	Subject	Yes/No	Priority
1t	White Point Temperature	No	
1u	Film Forming Temperature	Yes	5
1v	Heat Seal Strength	?	

ELECTRICAL PROPERTIES

It was unlikely that electrical properties would be the concern of the Plastics Lab since we had a well equipped Electrical and Electronics Section. At least for the time being this would be rated as no.

MECHANICAL PROPERTIES

Reference No.	Subject	Yes/No	Priority
3a	Tensile Strength & Elongation	Yes	1
3b	Stiffness 3 point bending	Yes	3
3c	Flexural Properties	?	
3d	Deflection under bend	Yes	5
3e	Shear Strength	Yes	3
3f			
3g	Compressive properties	Yes	2
3h & 3i	Impact Resistance by Sharpy and Falling Weight	No IZOD/Zwick preferred	2
3j	Dynamic Cushioning	Yes	3
3k	Tear	Yes	1
3l	Softness	Yes	5
3m	Hardness	Yes	3
3n	"	Yes	5
3o	IZOD	Yes	2
3p	Tortion	?	5
3q	Stress Cracking	Yes	1
3r	Fatique	Yes	5

MECHANICAL PROPERTIES CONT'D.

Reference No.	Subject	Yes/No	Priority
3s	Mar Resistance	Yes	5
3t	Abrasion	Yes	2
3u	Bond Strength (as 3e.)		
3v	Bearing Strength	Yes	5
3w	Puncture	Yes	5
3x	Friction	Yes	3
3y	Creep	Yes	3
3z	Pourability	Yes	5
3ab	IZOD (see 3h.)		

CHEMICAL PROPERTIES

Reference No.	Subject	Yes/No	Priority
4a	Loss of Plasticizer	?	
4b	Extractable Materials	?	
4c	Wetting Tension	Yes	3
4d	Resistance to Chemicals	Yes	2
4e	Epoxide Equivalent	No Chemistry Lab	
4f-4g	Bleeding of Colourant	Yes	5
4h	Acidity	Yes	5
4i	Gas Transmission	Not for Plastics Lab. important for Packaging; check on Chemistry Lab equipment	
4j	Gas Chromotagraphy	Yes, but Chemistry Lab	
4k	Ash	No	
4	Volatile Matter	No	
4m	Plasticizer Absorption	No	

CHEMICAL PROPERTIES CONT'D.

Reference No.	Subject	Yes/No	Priority
4n	Water Vapour Transmission Rate	Yes, Packaging already equipped	1
4o	Stain Resistance	No	
4p	Reactivity	No	
4q	Phenol	No	
4r	Chlorine Content	No	
4s	Vinyl Acetate Content	No	
4t	Purity & Toxicity	Yes	2
4u	Hydroxile Value	No	
4v	Bromine Number	No	
4w	Ammonia & Compounds	No	
4x	Styrene & Polystyrene	No (Chemistry Lab if required in future	
4y	Acetic Acid	No	
4z	Acid Value	No	

OPTICAL PROPERTIES

5a	Yellowness Index	?	5
5b	Colour	No	
5c	Resistance to Change under glass	?	
5d	Exposure to light	Yes	2
5e	Colour/Water Resistance	Yes	5
5f	Weathering	Yes	2
5g	Damp heat, water & salt	No	
5h	Colour light resistance	Yes	5
5i	Haze and light transmission	No but consider use of Chemical Lab equipment for light absorption.	

CHEMICAL PROPERTIES CONT'D.

Reference No	Subject	Yes/No	Priority
5i	Gloss	No	
5j	Surface irregularities	No	
5l	Refractive Index	No	

DIMENSIONAL PROPERTIES

6a	Density	Yes	1
6b	Density of liquids	No	
6c	Thickness, length and breadth	Yes	1
6d	Thickness gravimetric	Yes	1
6e -6f	Shrinkage	No	
6g	Shrinkage of film	Yes, Packaging	1
6h	Open and closed cell volumes	No	
6i	Plastics containers dimensions & tolerances	Yes	1
6k	Dimensional Stability	No	
6l	Sieve Analysis	No	
6m	Flatness	No	

OTHER POINTS

1. It is essential that we are equipped for preparing special size and shape samples for testing. Urgent requirement for cutting device (tensile kut) must be acquired.

2. It is essential that we have press and mold for preparing sheet samples from plastic resins. Small laboratory press, e.g. carver press.

3. Special sample cutters required for the Wallace Hand Press suitable for thin plastic film samples.

4. A power punch and die for cutting samples from sheets of semi, flexible materials. We may need to purchase this, but first we will look at equipment available in the laboratory.

5. Compression moulding. Not considered worth buying the expensive equipment required at this stage.

6. Identification of plastics in the laboratory considered a number one priority too.

APPENDIX 3

VISITS TO JAMAICA PLASTICS INDUSTRY

REPORT ON VISIT TO THERMOPLASTICS CO. LTD
AND WEST INDIES SYNTHETICS LTD (WISYNCo)
DATE JULY 19, 1984

1. INTRODUCTION

The tour was made by Dr. Joseph Miltz, a United Nations Consultant to the Bureau of Standards and Joseph McCarthy, an employee of the Bureau of Standards with a view to exposing Mr. McCarthy to the technical operations involved in plastics processing as well as enlightening Dr. Miltz of the operations of the plastics industry in Jamaica.

At Thermoplastics the tour was conducted by Mr. Amitirigala, Technical Works Manager of the company and at WISYNCo the tour was conducted by Ms. Lovina Henry, Quality Control Supervisor of that company.

The tour lasted a period of six hours, from 8.30 a.m. to 2.30 p.m.

2. TOUR OF THERMOPLASTICS

The tour of Thermoplastics covered the Compression Moulding Division, the Injection Moulding Division, the Blow Moulding Division and the Extrusion Division. Discussions were held with Mr. John M. Desulme General Manager of Thermoplastics Ltd and Mr. Amitirigala. Talks surrounding the general problem areas experienced in the company ensued after lunch and arrangements were made as to how the Bureau could help in solving these problems.

3. TOUR OF WEST INDIES SYNTHETICS

At West Indies Synthetics a general tour was made of the plant after which discussions were held with the General Manager, Mr. Joseph M. Mahfood. Areas were looked at where the Bureau could be of assistance to the development of the company. A rundown of the operations in the Plastics Laboratory of the Bureau of Standards was also given.

4. GENERAL

At the two companies Dr. Miltz gave a rundown of the areas in which he in colloboration with the Plastics Laboratory can offer competent help to the manufacturers. It is hoped that both companies will make maximum use of the expertise available from Dr. Miltz in the two months that he is here.

Submitted by: J. McCarthy
July 23, 1984

APPENDIX 4

PRELIMINARY LIST OF RECOMMENDED BOOKS ON PLASTICS
FOR THE LIBRARY OF THE JAMAICA BUREAU OF STANDARDS

Authors	Title	Publisher	Date
RAFF, R.A.V & DOAK, K.W.	"Crystalline Olefin Polymeters" Parts 1 & 2	Wiley-Interscience	(1964-65)
BRANDRUP, J. & IMMERGUT, E.H.	"Polymer Handbook" 2nd Ed.	Wiley-Interscience	(1975)
NIELSEN, E.	"Mechanical Properties of Polymers & Composities" Vol. 1 & 2	Dekker	(1974)
BAER, E	"Engineering Design for Plastics"	Krieger	(1975)
BENNING, J.	"Plastic Foams", Vol, 1 & 2	Wiley-Interscience	(1969)
BILLMEYER, W. Jr.	"Textbook of Polymer Science" 2nd Ed.	Wiley-Interscience	(1971)