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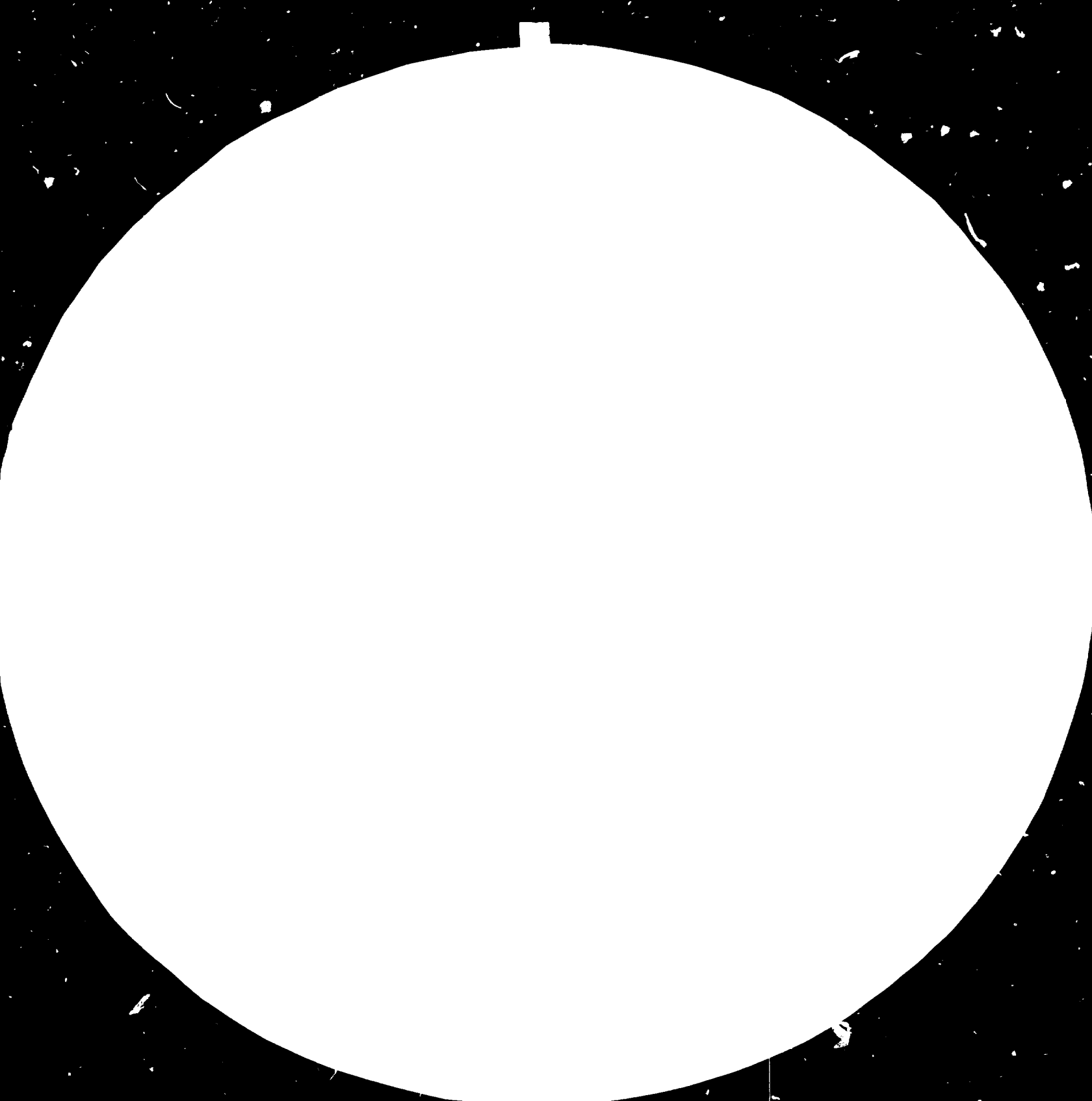

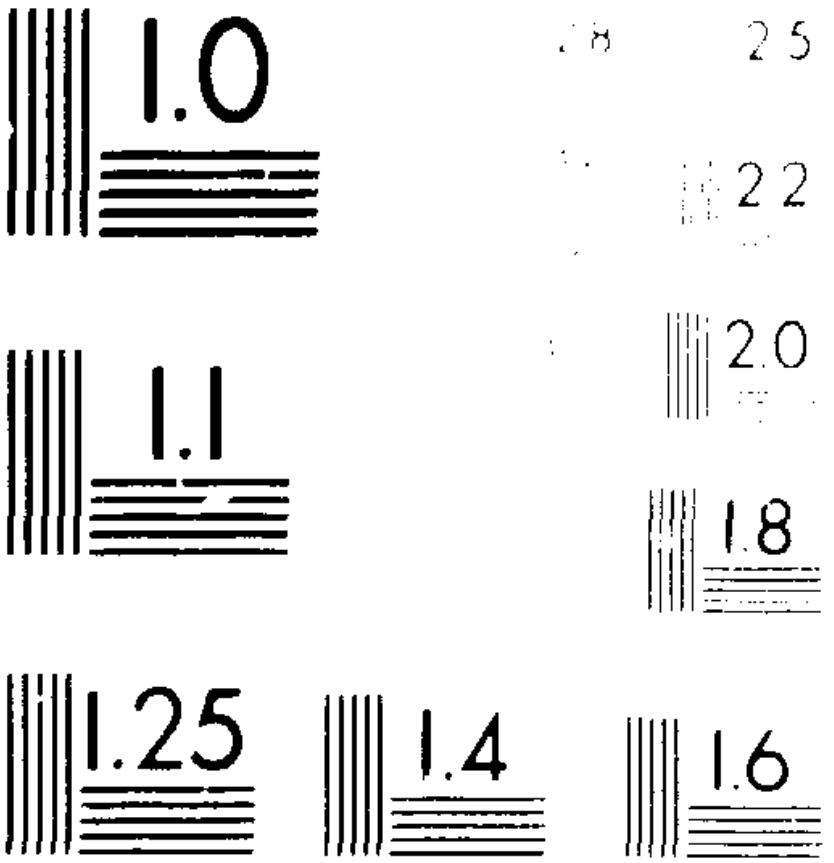
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English

PDR of Yemen.

Assistance to Al Gaadi Plastics Factory in the Establishment of Quality Control Laboratory, SI/YEM/83/801/11-01

People's Democratic Republic of Yemen

Technical Report : Testing and Quality Control

Prepared for the People's Democratic Republic of Yemen by the United National Development Organisations, acting as executing agency for the United Nations Development Programme

Based on the work of Dr. K. Ramamurthy - Expert in the Testing of Plastics

United Nations Industrial Development Organizations

Vienna - Austria

This report has not been cleared with the United Nations Industrial Development Organization, which does not therefore necessarily share the [illegible] presented.

E X P L A N A T O R Y N O T E S

The monitary unit of People's Democratic Republic of Yemen is the Dinar. During the period of the mission the value of local currency in terms of United Sates Dollar is , US$ 1 = Dinar 0.343.

ABBREVIATIONS

PDRY	-	People's Democratic Republic of Yemen
AGPF	-	Al Gundi Plastic Factory
HTD	-	Head of the Technical Department
ISO	-	International Standards Organization
ASTM	-	American Society of Testing Materials
BS	-	British Standard.
DIN	-	Deutsches Industrie Normung
IS	-	Indian Standard
ISI	-	Indian Standard Institution
NSI	-	National Standards Institution
CIPET	-	Central Institute of Plastics Engineering & Tools
RAPRA	-	Rubber and Plastics Research Association
TMI	-	Testing Machines Inc.
IPT	-	Institute Fur Prwf Technic
PVC	-	Poly (vinylcholoride)
PE	-	Polyethylene
PP	-	Polypropylene
PS	-	Polystyrene
LDPE	-	Low Density Polyethylene
HDPE	-	High Density Polyethylene
MFI	-	Melt Flow Index

ABSTRACT

The title of the post of the project No. SI/PDY/83/801/11-01 was Plastics Testing Expert with a purpose to assist AL Gundi Plastic Factory (AGPF) in the establishment of a quality control and testing laboratory in order to strengthen the expansion of Plastics Processing Industry in People's Democratic Republic of Yemen (PDRY) so that it may make a continuing contribution to the economic development of the country.

The duration of the mission was 8 weeks

The Main Objectives were to :-

1) assist and advise the AGPF in the setting up of a quality control laboratory in order to provide industry with a source of advice and service in plastics.

2) improving the ability of the staff to carry out quality control and laboratory testing work in the field of plastics.

Assistance has been given with enough background details and proposals for setting up of a quality control and testing laboratory in stages. The staff have been exposed to various aspects of quality control and testing and evaluation procedures. Recommendations for setting up of the laboratory with connected basic facilities, standardisation and training of staff have been proposed for action.

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I N T R O D U C T I O N

The assignment in the AL Gundi Plastic Factory (AGPF) at Aden was taken up on 11 April 1984 after briefing at Vienna and along with two other experts, Mr. RUESS - Matyas - Expert in moulding group , (GTI - Machine Industries Institute of Technology , Budapest).

A N D

Mr. ARUTJUNOV . S. - Expert in plastics processing (Chief of the Pilot plant, NPO Plastic , Moscow).

The mission was completed on 26.5.1984.

Mr.Hasson Mohmoud, the Director General of AGPF initially introduced the Head of the Technical Department (HTD) and his staff (Annex I) and brief the background details about AGPF. He subsequently arranged a meeting with Mr. Fadhle Hasson Yehia, Assistant Deputy Minister of Planning at the Ministry of Industry where the objectives and the implementation programme of the mission were discussed. The Honourable Minister stressed the need for expanding the plastics processing industry in PDRY and wanted specific proposals for achieving it. He was keen in initiating the standardization and testing activities in PDRY.

Weekly meetings were organized by the Director General along with HTD and counterpart staff in which the progress was reviewed and follow-up programme was discussed. Meetings with the Board of Directors and other ministry officials were also arranged now and then on the project matters. The Director General showed keen interest throughout the mission in the developmental activities of AGPF.

The main duties of the job description has been to :-

(a) advise and assist on the setting up of a quality control lab.

(b) advise to train the counterpart personnel in the methods of testing equipment, in quality control technique, use of statistics and recording procedures and

(c) advise in drawing a list of test procedures necessary to test procedures necessary to test the appropriate standards on plastics.

Keeping in mind the constraint, namely the lack of test equipment, the objective was marginally modified and instead of importing training on the test equipments the counterpart was aquainted and exposed to different aspects of plastic materials, test methods test procedures and equipments and methods of monitoring the quality control with particular reference to the requirements of AGPF and. were assisted in all other aspects of objectives. These were carried out through lectures, instructions specifically prepared for this purpose from books and background matters brought from India and through slides followed by discussions and also through proposals and recommendations. These were done in consultation with the Director General, HTD, and the progress was monitored .

The training, advice and assistance rendered have been well received by the staff. Since the mangement and the staff are keen in developing the factory it is hoped that the objectives will be easily realised.

RECOMMENDATIONS

(1) A proposal has been put forward after identifying the necessity of training the technical staff of AGPF in the wider areas of plastic mould design, mould repair and maintenance, processing and testing in CIPET where all such facilities are available under one roof, through a programme of technical cooperation between India and PDRY. The Government of PDRY should give top priority to this proposal and accord approval. The UNIDO should favourably consider this proposal and arrange assistance through TCDC or suitable otherchannel. As a preliminary step to this the Director General and an Engineer of AGPF should be deputed to CIPET for a week in order to acquaint with the available facilities and draft out the details of suitable training programme needed for AGPF.

(2) The basic facilities and infrastructure needed for setting up of a quality control and testing laboratory in AGPF is recommended. This may be considered by the Government for necessary approval and action. The UNIDO should extend assistance through a second phase of this project in which technical assistance needed in mould design, repair and maintenance and processing included with other components such as training fellowships, study tour, experts and so on.

(3) The Director General and the HTD should be deputed to international plastics exhibition/study tour often in order to get acquainted with the latest developments useful for the development programme of AGPF . Some centres useful for such study tours are given in Annex 5.

(4) It is necessary to train AGPF technical staff including technicians in other centres on specific areas for widening their knowledge.

(5) Formation of a National Standards Institution should be immediately considered by the Government for standardization purpose so that the adoptation and formulation of standards for plastics may be initiated in PDRY. The Director General of AGPF and a senior official of the Ministry should be sent on a study tour to ISO/USA, ISI/India for acquaintance and follow-up. UNIDO may provide necessary assistance for this purpose.

(6) For the sound growth of AGPF a technical library with international standards, reference books, journals and other literatures is essential and the list given in Annex 9 and 10 together with volumes recommended by other experts and Director General should be arranged for purchase. Necessary audio visual aids, Arabic translated materials should also be considered taking into consideration the inplant training. Provisions may be made in UNIDO assistance for this component also.

I. ACTIVITIES AND RESULTS

The AGPF started in 1972 under the Ministry of Industry, is the biggest Government owned Plastic Factory in PDRY besides a privately owned Middle East Facto y. The production programme of AGPF is at present based on an injection moulding process. There are 6 injection moulding machines now and they produced about 366 tons in 1983. An extrusion blown film and bag making plant based on the knowhow of M/S Reifen Hauser of West Germany is under erection now at a cost of about 1 million US Dollar and will go into production in June 1984. Proposals are under consideration by the Government for putting up a:-

- Blow moulding plant.
- Pipe extrusion plant;
- Woven Sack plant.

based on the report of Dr. A.D. Clark and feasibility study of WMW export-import team on the expansion of processing industry.

These diversifications call for creation of more facilities.

The factory employs about 50 production staff at present. The bag making plant envisages about 32 production staff and an equal number in each of other plants which are under proposals now.

The factory has been facing certain difficulties due to lack of quality control of the products, shortage of trained personnel, the lack of good mould design and mould making facilities, which are to be seriously considered in the present context.

Ways & means of achieving the objectives are therefore being identified for action.

A. Setting up of a quality control and testing Laboratory at AGPF

Evaluation of plastics are needed for control of quality or acceptance testing against specification or establishment of data for engineering and design. Quality control on quality assurance is carried out for maintaining the quality of the products to set standards which embraces the quality of incoming raw materials, the control of manufacturing process to help to identify and thus rectify faults at the earliest possible stage and the inspection and

testing of final products considering the present production programme of AGPF and the priority the Government has given to this biggest Govt. owned factory in diversifying its processing activities, a comprehensive programme of setting up a quality control and testing laboratory in stages is necessary and accordingly a proposal is outlined so that after initially fullfilling it's own requirements, it can spread its activities in serving other processing industries in the country, and ultimately grow to the size of a National test house on behalf of the Government for certification and other standardization purposes.

1. Quality Control and Test Equipments

Taking into consideration the present requirements of the injection moulding plants and the blown film bag making plant for which M/S Reifen Hauser is supplying few control apparatus (Annex ?), the details of facilities proposed for a central laboratory in stages is given in Annex 3 in the order of priorities. It is recommended that stage 1 of Annex 3, which includes general test equipments, specimen preparation and miscellaneous testers and apparatus that may be considered immediately and the stages II & III may be scrutinised at a later stage when further expansion programme is realised.

The general test equipment is needed for quality control and testing of materials and products.

The specimen preparation facilities are essential when product testing, specification checking etc. are undertaken. Besides the equipment suggested, one of the existing injection moulding machines itself can be used for preparing standard test specimens for which moulds are to be described and fabricated on being procured.

The miscellaneous testers and apparatus are useful for quality control of raw materials, identification and chemical testing purposes.

2. Building and Basic Facilities:

A laboratory area of about 500 square meter, part of which should be airconditioned is suggested for housing the test equipment.

Other facilities like lab. lables, water connection, power connection, drain system etc are also to be properly provided.

3. Technical staff and training

Technical staff pattern for the quality control & testing laboratory are suggested as follows :

Quality	Beginning of the Project	End of the Project
Quality Engineer (Degree in chemical Engineering)	1	2
Quality Assistant /Inspector (Basic degree in science)	2	5
Lab attendant	1	2

It is necessary that the quality engineers are trained initially in a testing laboratory where practical test facilities are available for a minimum of 6 months in all aspects of quality control & testing as per syllabus given in Annex 4 and later depending upon any specific requirements in centres given in Annex 5.

The Engineers after their training should initially train all the quality assistants in the NRL laboratory it-self. The technical assistants should be given later opportunities for exposures in centres outside the country.

Assistance of an expert for installation, operation & training may be sought.

4. Conclusion :

The Government should therefore give due consideration in proposing a project incorporating the necessary requirements for setting up of a quality control and testing lab and the UNIDO may support the proposal and extend all the necessary assistance.

B. Visits & study tour of senior managerial staff.

The setting up of a quality control lab and the future diversification programme demands that the top management staff should be constantly exposed to developments in the various fields of plastics.

It is therefore proposed that the Director General and HMD are deputed often to various conferences international plastics exhibitions like inter plast, Japan plast, kunststoffe fair and so on , the exact details of which can be obtained from the forth coming events column of the journals like Plastics and Rubber International. Study tour should also be undertaken by them to various raw material manufacturers, processors fabricators and laboratories. Addresses of few centres useful for such purposes is given in Annex 5.

C. TRAINING OF COUNTERPART PERSONNEL

1. Test Methods and Equipment

The counterpart was initially given exposure on basic aspects in plastics since the staff was found to be lacking in such background information. The chemistry of polymer formation , the polymer structure that affects the properties, the plastics materials & properties, the identification of plastics by simple methods were some of the topics initially covered through lectures and supply of literature specifically prepared for study and discussion.

The AGPF consumes raw materials like PE, PP and PS for its production. The properties of these raw materials and the method to be followed in selecting the right grade of material for evaluation & specific application reforming the material specification data sheet and the procedures for procurement based on various factors were also briefed. The staff was also acquainted with trade names for identification of plastic materials with the aid of literature like kunststoff taschenbuch.

Basic concepts regarding test methods and test equipment available for quality control and testing of plastics were covered in detail.

This included

- The quality control of incoming raw materials
- The testing of materials and products
- Testing and quality control in injection moulding industries.
- The quality control & testing of plastics film .

The simple raw material tests like density, moisture content, viscosity & I.V. and the material and product testing methods & equipments, covering standards and specifications, preconditioning and test atmospheres, methods of fabrications and preparation of test specimen, mechanical, Thermal, processing & flow , optical , Electrical & permanence properties were also dealt with.

Importance of quality control for checking certificate of conformance, integrity check of new suppliers and monitoring the quality when the recycle of scrap is employed was also briefed.

Though test specimen utilises specimen of standard dimensions and shapes prepared specifically for this purpose, commercial articles even if cut to standard specimens are rarely comparable with results . It is therefore necessary to design suitable methods of test in such occasions so that result of performance tests correlate perfectly with the actual performance of the article in service . Their importance were stressed.

Quality cannot be simply achieved by inspection and testing. In order to attain quality it is necessary that it is built into the product in stages. Careful choice of materials proper design & fabrication, correct moulding process and operation, necessary pre and post production procedures are important . The co-operation of all the concerned design& production staff is essential in order to achieve quality. Therefore all the concerned technical staff of ACC were briefed regarding the various steps to be observed in quality control and procedures to be followed at various stages of production starting, from raw material as outlined in Annex 6. The quality control procedures to be followed in ACC were also briefed using virgin material and also with recycle. The responsibilities of individuals to become a part of the quality team were also stressed. The technical staff were also given exposures on the general methods of quality control & testing.

The counterpart staff was also briefed regarding simple chemical lab tests and experiments that may be conducted in ACC for control purposes when basic miscellaneous testers are made available . These covered the measurement of density, viscosity, K-value + so on.

2. Test Procedures to Test the Appropriate Standards

The counterpart staff was acquainted with testing procedures. In the absence of test equipment , the main purpose of doing so being, by possessing such background knowledge there should be no difficulty in the future when test equipment is procured to go ahead with adoption of such procedures with/or modifications. The procedures adopted by ISO in some instances and ASTM in certain other instances were taken as examples for discussions. Model test procedures were also prepared and discussed which included details of scope, definition significance test specimen, conditioning , observation chart, recording procedures calculation of results and interpretation. The personnel was also given guidelines in the design of observation chart preparation, test reports and presentation and interpretation of test results and scientific understanding of the reports and their usefulness and limitation in practice . Specific attention was given to the procedures whichhave direct application to ICAF. The test procedures drawn up and discussed in this connection are given in Annex 7.

3. Quality Control Techniques use of Statistics and Recording Procedures.

The staff were briefed in simple terms the concept of statistics & the use of statistics in the interpretation of test results. Collection of data during processing at various stages and the procedures adopted for recording the data and the techniques of quality control were also discussed. These included variability measurement through normal distribution aver average / mean value, standard deviation & coefficient of variation and confidence limits.
The production capability through use of normal distribution curve and estimation of total range , monitoring procedure by quality control charts and sample gauging and finished goods inspection through accepted quality limits and random sample checking were also discussed.
Brief write up and background materials regarding various above mentioned topics were left with the counterpart for further study of use .

4. Conclusion

The staff has responded to the training quite well. However they should be exposed to a practical oriented training before responsibilities are given in the quality control lab.

D. Establishment of a National Standards Institution

Standards are yet to be adopted or formulated for plastics in PDRY. Standardisation requires immediate attention.

The growth of industrial sector to produce quality goods ultimately lies with standardisation. Standardisation and quality control in production are regarded as important tools for industrialisation. Standardisation contributes extensively to higher productivity. Every country that plans industrialisation and rapid economic growth through introduction of standardisation and quality control must consider establishing a central national standards body.

In country like PDRY standardisation activity may be handled as a part of a larger composite organisation encompassing industrial research development and testing activities. Small national unit may be set up for the purpose of implementing standards, certification marking and quality control.

The efficient operation of a national standards is not feasible without laboratory facilities in the country. The plastics industry is one of the most important developing sectors in PDRY. The ADC which is now considering to set up a quality control and testing laboratory should be given full encouragement and support so that it can ultimately grow as a national test house for standardisation in plastics.

The introduction and adoptation of standards for Plastics would help to ensure the development of Plastics industries in this country. It is therefore necessary that a national standards institute is formed at the earliest so that adoptation & formulation of standards for plastics may be initiated.

COORDINATION FROM ALL COUNTRIES

In this connection it may be mentioned that India has acquired a vast experience and expertise in recent times in the formulation of national standards in plastics and since the climatic conditions and other regional characteristics have similarities with PDRY it will be more advantageous to study the functioning of BIS and adopt suitable policies and procedures that will be more realistic for PDRY.

The PDRY should adopt ISO standards in plastics to start with for standardisation purposes and make an effort to formulate national standards by consulting Indian standards and other national standards once the standards Institution is formed. In this connection the compilation of all the available BS and ISO standards on plastics together with a specimen copy on an Indian standard is left with AGPP for reference and use.

2. Propositions :

It is considered essential that the Director General of AGPP and a serious official from Ministry should visit the Indian standards Institution at Delhi and ISO at New York for understanding their function and activities in order to propose further follow up action in starting a BSI for P.D.R.Y.

E. A proposal of technical assistance for training staff

1. Necessity

In the light of the expansion and diversification programme that is being planned in AGPF, it has become essential that supervisory technical staff are trained in phases to the wider areas of plastics mould design, mould repair and maintenance and fabrication, processing and testing. This, in addition to specific training they might receive from the plant suppliers that will be installed in AGPF, will enable them to organize inplant training for otherstaff and also give confidence to manage plants efficiently to produce quality products. It is therefore emphasized that a practically based and application oriented effective training programme be organized for the staff of AGPF.

2. Training at CIPET

Through this can be realized in many ways it is felt appropriate that this type of training is arranged in a place like CIPET / India where all such facilities are available under one roof.

The Central Institute of Plastics Engineering and Tools at Madras established by the Government of India and assisted by UNDP offers highly specialized and practical oriented training matching international standards in the field of mould design, fabrication, processing and testing. The courses, the details of which are given in Annex 8 are particularly designed to ensure exposure of the candidates to the practical intricacies/problems involved in the relevant areas of study. Many international agencies including UNIDO have trained their fellows there.

The AGPF may also train their staff in batches for few years choosing suitable courses from the regular programme or a more realistic practical oriented training may be sought for a shorter duration together with specific factory visits which will be more appropriate for them.

CIPET Madras may be more suitable for training personnel from AGPF because:-

- any specific training suitable to AGPF can be requested.
- there are many climatic and regional similarities between these two places.
- Training and Technology adoptation will be similar.
- the expertise and experience gained through all these years under similar circumstances may be advantageously and realistically adopted.

3. Proposals

It is therefore proposed that a cooperation between CIPET and AGPF for technical assistance be developed which will be beneficial to the industrial growth of the plastic industry in PDRY. As per this proposal the Director General and the head of the technical department should visit CIPET and familiarize with the training facilities available there. From CIPET, the Director General and Senior Technical Staff should then visit AGPF, finalize the field of training content, duration etc. and select the first batch of trainees in consultation with the Director General of the AGPF. The training may be planned to start in 1985 and continued for subsequent periods till the needs are met.

Keeping the proposed plan of expansion of AGPF a minimum of 5 technical staff each year for training covering the four areas is recommended.

4. Conclusion

It is therefore strongly recommended that the proposal of technical cooperation between AGPF and CIPET be given top priority and accorded approval by the Government of PDRY. The UNIDO should consider this proposal favourably and provide necessary assistance and funding through TCDC or any other channel.

F. Library

The setting up of a library and audio visual facilities are essential for the technological growth and training potential for the AGPF.

There is a lot of scientific information available on plastics in general and quality control in particular. The AGPF technical staff should be in a position to get themselves exposed to these literatures constantly for uplifting their technical knowledge. It is therefore essential that a good library is build up in AGPF, so that, books, journals, international standards and other technical data are available for their use. Few of such important references are given in Annexes 9 and 10 for procurement. Arabic translations of some important materials should also be made available for inplant training.

Also some of the ISO and ISI standards which are to be immediately ordered are given in Annexes 11 & 12.

Besides particulars of additional books the useful for the library and also lists of compiled ISO and IS standards for future consideration were left with the Director.

Also the expert has given the following literature to the library for the use + benefit of the staff :-

(a) Quality Control and Testing of Plastics - CIPET Training Course material.

(b) Refresher Course in Extrusion Blown Film - CIPET Training Course. material.

(c) Compiled List of ISO Standards.

(d) Compiled List of Indian Standards.

G. Miscellaneous :-

(1) During the reporting period the experts had an opportunity to visit/meet few companies/ personnel in connection with certain consultations. They are

(a) Visit to M/S Yemen Rubber Manufacturing Company, on 16/4/1984 where Mr. Hasson A. Haddad, General Manager and Mr. Ali Abdulla Yamani, Chief Engineer were met.

They are facing problem of slipiness in their EVA/rubber sandales produced. Suggestions were given for slight modification in the mould and in the compound receipe for possible improvements.

They are planning to put up a tyre rebuilt plant for which two quotations were scrutinized and technical advice was given:-

(2) Mr. Shade of GDR working in the Ministry of Education visited us on 5/5/1984 and discussed regarding the possibility of making educational aids out of plastics.

(3) The possibility of producing food serving plastic items for Alyemda indigeneously was discussed by the Director General of AGPF and the Alyemda staff including the identifical and material selection on 8/5/1984.

(4) Visit to National Bottling Organization on 25/4/1984 along with Mr. Nasser of AGPF and Mr. Habib and Ali Noman of Ministry of Industry. This firm is buying bottle crates from AGPF. They face problem of breakage and short life. One cause traced was because of mishandling, through the basic production technology at AGPF found to be alright, some suggestions were given in moulds & materials for possible improvement.

ANNEXES

Annex I

Senior Staff , Their Names and Specialization

HASSAN	MAHMOUD ABDUL RHMAN	- Chairman of the Board of Directors and Director General.

Counterpart Staff

NASSER	HUSSEIN ALALAH	- Mechnical Engineer - Head of the Technical Department.
HISHAM	ABDUL RAHMAN MOHAMED	- Chemical Engineer
AHMED	YASIN GAZI	- Electrical Engineer
NASER	ALI BADRS	- Maintenance Engineer.
ASHRAF	RUSTUM KHAN	- Mechnical Engineer.
AHMAD	AHMED RAMADAN	- Moulding Technician.

Main Counterpart - Mr. Hishan

After completing his secondary school and one year teaching work, he was sent by the Government to Soviet Union to the Institute of Oil and Chemistry Baku for 6 years where he underwent a one year Russian language course and a five years chemical engineering course specialised in petrochemical Engineering. He has basic knowledge in chemistry and production of plastic materials and limited exposure in the other fields of plastic. He is good with Arabic and Russian and is average in English,

He joined AGFF in January 1984.

Annex 2.

Test equipments to be provided by M/S Reifen Hauser

(1)	Hand operated thickness measuring devices (special micrometer)	-	4 Nos.
(2)	Stationary Micrometers	-	1 No.
(3)	M F I Test Equipment	-	1 No.
(4)	Sample punching device	-	1 No.
(5)	Precision balance	-	1 No.
(6)	Quadrant balance with circular cutter	-	1 No.
(7)	Rapid thermometer	-	1 No.

Annex 3

List of test equipment recommended

Stage 1

A. General test equipment

Equipment	Supplier	Approx cost US$
(1) Condition Chamber (Temperature & Humidity)	Fisons Ltd/ UK. Daven test Ltd/UK.	$ 10,000
(2) Temperature - Humidity Indicator/ Recorder	Testing Machines Inc./USA Daven Test Ltd/UK	$ 500
(3) Density Gradient Column (Two Column apparatus)	Daven Test Ltd/UK	$ 3,500
(4) Polariscope	Gardner Lab/USA	$ 1,000
(5) Viscometers (U - tube and Ubbohlode)	Gardner Lab/USA	$ 1,000
(6) Melting point - apparatus (Capillary Method)	TMI / USA Daventest/UK	$ 1,000
(7) Large Air circulating oven	TMI/ USA Engelmann & Buckham Ltd. /UK	5000
(8) Impact testing with notcher	Zwick GMBH/West Germany Ceast - Spa /Italy	$ 10,000
(9) Durometer (Shore)	H.W. Wallace & Co. Ltd/UK	$ 1,000
(10) Rockwell hardness tester	Zwick GmbH/W.Germany	$ 3,000
(11) Environmental stress apparatus (with 5L reagent)	Daven test Ltd/UK Yarsley Technical Centre/UK	$ 5,000
(12) Falling Weight Impact Tester (Pipes, plates and moulded articles)	TMI/USA Daventest/UK	$ 15,000
(13) Universal Tester (100 KN) (For Tensile, Compression & Flexural)	. Instron /UK Zwick GmbH /W.Germany	$ 50,000

Cont'd.... Annex 5.....

(14)	Heat distortion) Vicat Softening) point Apparatus) (3 station model)	H.W. Wallace & Co./UK Daventest Ltd/UK	$	5,000
(15)	Elemendorf tear tester	Daventest Ltd/UK	$	5,000
(16)	Dart Impact tester	Daventest Ltd/UK	$	6,000
(17)	Burst Strength Tester	Daventest Ltd/UK	$	3,000
(18)	Gloss/Haze/Clarity Meter	GARDNER Lab/USA	$	10,000
(19)	Folding Endurance tester	TMI/USA	$	7,500
(20)	Elipsoid Fraction Tester	Gardnen Lab/USA	$	5,000
(21)	Blocking apparatus (to suit universal tester)	Daventest Ltd/USA	$	3,000
(22)	Electrostatic Field Meter	Daventest Ltd/UK	$	3,000
(23)	Gas permeability apparatus	" " "	$	6,000
(24)	Water Vapour permeability apparatus	" " " H.W. Wallace & Co./UK	$	5,000
(25)	Flammability Tester	TMI/USA Ceast SPA/Italy Stanton Redcraft/UK	$	7,500
(26)	Stereo Microscope	Olympus /Japan	$	5,000
(27)	Volume and Surface resistivity apparatus with electrodes	Beckmann / USA	$	5,000
(28)	Low temperature brittleness tester	Tinus Olsen/USA Daventest /UK	$	6,000

(B) Test Specimen Preparation

Hydraulic press Clamping force 50T/20T Platen Size minimum 150 X 130 MM Heating & Covering - Temp up to 300°C	Daventest Ltd/UK	£ 15,000
Two roll mill 200°C Speed contave, Heating & Cooling - roll size approx 100 X 360 mm	Engelman & Buckham Ltd/UK	£ 25,000
Stamping press/ Cutting press	H.W. Wallace & Co./UK Daventest Ltd/UK	
Precision Contour Cutter/ copying machine	Gottfert Feinwesk Technik/ W.Germany CEAST SPA/Italy	£ 15,000
Strip Cutter for Films	TMI/ U S A	£ 2,000
Standard Moulds	-	£ 20,000
		US$ 35,000
		U.S.$... 300,000

(C) Miscellaneous Testers/Apparatus 1 Set

Stop Watch/ Timer
Digital Temperature Indication with thermocouples
Calculator (Scientific and Statistical)
Low Temperature Circulator
Glasswares like glass tubes, heaters, conical, glasses, flasks
Standard Flasks, burettes, pipettes, dessicator, distillation flasks hydrometers
Water distillation unit, thermometers, Bunsen burners, hot plates, heating mantles, water baths and stirrers
ITG cupboards
Chemical reagents and solvents
Plain paper copier, Dia projector, overhead projection

Annex 3

STAGE II

	Equipment	Supplier
1)	Short term hydraulic life tester	IPT/W.G.
2)	Long term hydraulic life tester	TMI/USA
3)	Opacity tester	
4)	Large Oven	Devon Test Ltd/UK
5)	Torque Rheometer	Brabender O H G/WG Haake / USA
6)	Bulk Density funnel	Devon test Ltd/UK
7)	High Speed mixer	Henschel Work AG/WG
8)	Creep tester	Karl Frank GmbH/WG
9)	Clash & berg apparatus	Tinius Olsen/USA
10)	Fatigue tester	Zwick Co/WG
11)	Colour Comparator	Gardner /USA

STAGE III

1)	High pressure Rheometer	Instron/UK Gott-fert/W.G.
2)	Dielectric break down tester)	Lehmann/Holland
3)	Dielectric tester (Hi loss char Dielectric constant.	
4)	Arc resistance tester	
5)	Tracking index tester	
6)	Weatherometer	Atlas Electric co/USA
7)	Sophisticated instruments for identification & characterization. (Like IR, UV photometer, Thermal analyser, Gas chromatograph, gelpermeation chromatograph & so on).	Heraeus GmbH/W.G.

Annex 4

Syllabus For Training

Theory and Practicals

Introduction to Polymer Chemistry

Plastics Materials, properties structure and applications.

Identification and analysis of plastics

Standards and specifications

Preparation of Test pieces

Preconditioning and Test atmospheres

Polymer Charaterisation

Testing of materials before moulding

Short Term Mechanical Properties

Thermal Properties

Processing and Flow Properties

Optical properties

Electrical properties

Permanance properties

Testing of Products

Influence of processing variables on the quality of the products

Quality Control and Testing in Plastic Industries.

ANNEX I

LIST OF CENTRES FOR STUDY TOUR AND TRAINING

	Name of the Centre	Field
1)	Central Institute of Plastic Engineering of tools (CIPET) India.	Mould Design Fabrication, Processing and Testing.
2)	Rubber and Plastic Research Institute (RAPRA) Shrewsbury/UK	Processing and Testing
3)	Wolverley Technical Centre Ltd/ UK.	Design, Processing and Testing
4)	Laboratorium fur Kunststoff Technik/ (KTI) Vienna/Austria.	Design, Processing
5)	Rubber & Plastics Institute (NIRO)/ Delft/Holland	Processing and Testing
6)	Institute für Kunststoff Prufung (IKP) Stuttgart/W. Germany.	Testing
7)	Deutsches Kunststoff Institute (DKI) Darmstadt/ W. Germany	Processing and Testing
8)	Sud Deutsches Kunststoff zentrum Wurzburg/ W. Germany (SKZ)	Processing and Testing
9)	Institute für Kunststoff Verarbeitung (IKV) Aachen/W. Germany (IKV)	Processing
10)	ATO Chemie Paris/France	Materials Testing
11)	ICI Plastics Division Welwyn/UK.	Materials, Processing Testing
12)	Indian Petrochemical Corporation Ltd. (IPCL) Baroda/India	Materials, Processing and Testing

[illegible] 6

QUALITY CONTROL AND TESTING PROCEDURES

MOULDING QUALITY PARTS

PRE PRODUCTION PROCEDURES FOR CONTROLLING QUALITY		Specification detailing qualification approval tests Acceptance quality levels [illegible] to lemcos
Specimen preparation Control Charts Short-Term/Long Term testing.	CONTROL OF RAW MATERIAL AND INTEGRITY CHECK	Certificate of Conformance Integrity Check Specification testing Recycle control
[illegible]		Checks on Process-Parts Press Cycle Card.
[illegible]		[illegible] Inspection Report [illegible] Procedure Card Quality Standard.
[illegible]		[illegible] of relevant cards JOB Operation Card.
[illegible]		Random Sampling Acceptance Quality level Inspection level Final Inspection Clearance.

[illegible]	[illegible]	[illegible]
and Testing	Normal Distribution Curve	Inspection
Limitation of Test	Total Range	Acceptable quality limit
Mid-and Finish	Monitoring Production	Random Sampling
inspection	Quality Control Charts	Total inspection
Component testing	Sample Gauging	

Annex I

LIST OF TEST PROGRAMMES

1) Identification of Plastics using simple methods
2) Determination of Plastics Density
3) Determination of the melt-flow index of thermoplastics
4) Determination of dilute solution viscosity of polymers
5) Test specimen preparation
6) Standard atmosphere for conditioning and testing of plastics
7) Determination of tensile properties of plastics.
8) Determination of flexural properties of plastics
9) Determination of the Izod impact resistance of rigid Plastics
10) Determination of the charpy impact resistance of rigid Plastics.
11) Rockwell hardness of Plastics :
12) Determination of Vicat softening temperature of Plastics.
13) Determination of temperature deflection under load of Plastics.
14) Environmental stress cracking of Polythene Plastics.
15) Determination of tear resistance of film & sheeting.
16) Determination of Haze , Glass & Clarity of Plastics.
17) Determination of impact resistance of Polyethylene film by the free falling dart method.

[illegible]

DETAILS OF TRAINING COURSES CARRIED ON AT CENTRE

LONG TERM COURSES

Ser.No.	Title of the Course	Duration	Min.Qualification
1.	Plastics Mould Technology	3 Years	Matriculation with Science & Maths.
2.	Plastics Mould Design	1 Year	Diploma in Mechanical Engineering.
3	Plastics Processing Technology	1 Year	Degree in Science with physics or Chemistry.
4.	Plastics Engineering	1 Year	Degree in Chemical Mechanical Engineering
5)	Quality control and Testing	1 Year (From 1984)	Degree in Science

Specific training as per individual requirements are offered to trainees sponsored by UNIDO and other international agencies.

SHORT TERM COURSES

1) Quality control and testing
2) Plastics mould fabrication
3) Plastics product Design
4) Injection moulding of Plastics
5) Blow moulding of Plastics and so on .

[illegible]

LIST OF IMPORTANT REFERENCE BOOKS

1) Hand book of Plastics test methods, Edited by R.P. Brown, George Godwin Ltd.,

2) Testing of Polymers Edited by J.V. Schmitz-Vol.1 to 4, Interscience .

3) Flow properties of polymermelts, Brydson, J.A., George Godwin Ltd.

4) The identification of Plastics and Rubbers, K.J. Saunders, chapman & Hall Ltd.

5) Identification and analysis of Plastics, J. Haslam and H.A. Willis,

6) Quality control for Plastics Engineers, Lawrence H. Duping, Reinhold

7) Quality control Handbook, Jurana, J.M. McGraw Hill.

8) Plastics Technology , Robert V. Milby, McGraw Hill .

9) Experiments in polymer science , Billmeyer F.W., Interscience.

10) Plastics Materials , Brydson, J.A. Butter Worth.

11) Polymer Handbook , Brandrup, J. etal. Wiley.

12) Plastics Engineering Handbook, Joel Frados, Van Nostrand.

13) A concise guide to Plastics, simonds. R, Reinhold.

14) Industrial Plastics, David, R.J. Reinhold.

15) Plastics Films, Briston, J.H, Iliffe.

16) Plastics Piping system, David A. Chasis, Industrial press inc.

17) Thermoplastics, Effects of Processing, Ogorkiewicz, R.M, Iliffe.

18) Plastics Technology, W.J. Patton, Reston Publishing Co.

ANNEX 10

LIST OF SOME IMPORTANT STANDARDS AND JOURNALS

1) ISO Standards for Plastics	American National Standards Institute 1430, Broadway. New York N.Y. 10018 - U.S.A.
2) Annual Book of ASTM Standards. Vol.34,35 36, 37 & 38 (1984)	American Society for Testing Materials 1916, Race Street, Philadelphia, PA 19103 USA.
3) British Standards for Plastics	British Standards Institute 2, Park Street London W. 42 BS U.K.
4) DIN Standards for Plastics	Deutsches Institute fur Normung Burg gafen strass 4-10 Post-fach 1107, Di000. Berlin 30.
5) Indian Standards for Plastics	Indian Standards Institution Manak Bhavan, 9 Bahdur Shah Safar Marg, N. Delhi-11001
6) Polymer testing	RAPRA Shawbury, Shrewsbury Salop SY4 4NR England
7) Plastics and Rubber International	The Plastics & Rubber Institute 11 Robert place London SW1 WOHL
8) Modern Plastics International	50 - avenue de la gare CH - 1003 Lausanne Switzerland.
9) Kunststoffe German Plastics	Carl Hanser verlag Kolberger Strasse 22 D 8000 Munchen 80 W. Germany

ANNEX II

LIST OF A FEW INDIAN INTERNATIONAL STANDARDS (ISO)

1) ISO 291 - Standard atmosphere for conditioning and testing.
2) ISO 294 - Injection moulding test specimens of thermoplastics materials.

3) ISO 2818 - Preparation of test specimen by machining
4) ISO 1872 - Polyethylene thermoplastic materials
5) ISO 1622 - Requirements of polystyrene moulding and extrusion materials.

6) ISO R 1183 - Methods of determining the density and relative density

7) ISO R 1628 Directivies for the standardisation of methods for the determination of dilute solution viscosity of polymers.

8) ISO R 1184 - Determination of Tensile properties of films
9) ISO 292 - Determination of the melt flow index of polyethylene and polyethylene compounds.
10) ISO 1133 - Determination of melt flow rate of thermoplastics
11) ISO 178 - Determination of Flexural properties of rigid plastics.
12) ISO 179 - Determination of charpy impact resistance of rigid plastics.
13) ISO R 180 - Determination of Izod input resistance of rigid plastics.
14) ISO R 527 - Determination of Tensile properties
15) ISO 868 - Determination of indentation of hardness of plastics by means of Durometer.
16) ISO 306 - Determination of vicat softening point of thermo Plastics.
17) ISO 2039 - Determination of Rossewell hardness
18) ISO - 4600 - Determination of Environmental stress cracking resistance.

Annex 12

List of a few useful Indian Standards

(1) Is 196 - Atmosphere condition for testing
(2) Is 2267 - Polystyrene moulding material
(3) Is 2530 - Methods of test for PE Material and PE Compoured
(4) Is 3395 - LDPE material for moulding and Extension
(5) Is 4669 - Method of test for PVC resins
(6) Is 7328 - HDPE materials for moulding and Extension
(7) Is 8543 - Methods of testing plastics part I, II & III
(8) Is 2508 - LDPE Film
(9) Is 2798 - Methods of test for PE containers
(10) Is 3730 - PE Buckets
(11) Is 5322 - PE Wash bowls
(12) Is 7403 - Blown Polyolifins plastic containers
(13) Is 8686 - PE Portable water bottles
(14) Is 3076 - LDPE Pipes for portable water supplies
(15) Is 4984 - HDPE pipes for portable water supplies
(16) Is 4985 - Unplasticised. PVC for portable water supplies
(17) Is 7834 - Specification for injection moulded PVC Socket fittings with solvent cements for water pipes
(18) Is 6340 - HDPE Woven Sacks.

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