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PREPARATORY ASSISTANCE-TEXTILE DYEING AND FINISHING INDUSTRY SERVICE CENTRE

DP/ROK/82/027

REPUBLIC OF KOREA

Technical report: The dyeing and finishing research center in Daejeon, Korea-proposed objectives and equipment needs*

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

Based on the work of Erik Kissa
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United Nations Industrial Development Organization
Vienna

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ABSTRACT

The first month of a planned six-month-long mission has been completed with the objective of assisting in establishing a Dyeing and Finishing Research Center at the Korea Research Institute of Chemical Technology, at Daejeon. The immediate need for the Center has been confirmed by visits to several textile companies and the Daegu Textile Technology Promotion Center. The primary function of the new Center in Daejeon(KRICT) is visualized as a problem solving research and development facility, for identifying, defining and solving technical problems of the dyeing and finishing industry. Routine testing of dyes and dyed fabrics is not considered the responsibility of this Center, although the development of test methods may be included in the Center's activities. A list of equipment needed has been finalized. The requirements of laboratory space for housing the equipment have been outlined.

The second month of the planned mission will follow when the equipment has been installed and the staff of the Center ready to start operations. Training of the staff to operate the equipment effectively and to develop the technical expertise needed for providing the Korea's dyeing and finishing industry with technical support is expected to be the critical period in the start up of the new Center.

TABLE OF CONTENTS

INTRODUCTION

The job description of the Post DP/ROK/82/027/11-52/ 31.7.B. gives the following background information:

During the past ten years Korea established itself as a reputable exporter of industrial and consumer products through the efforts of many technically and business oriented entrepreneurs assisted by the Government, domestic and foreign investors. The total exports of Korea increased during that period to a level of $12.7 billion in 1978, 31% of which almost $4.0 billion consisted of textile products(fibre, yarn, fabrics, finished clothing, etc.).

The Korean Ministry of Commerce and Industry has set a goal of attaining $10 billion in textile exports alone by the year 1986. This will require a continuing growth rate of about 12.3% per year, higher than the expected growth of the economy as a whole.

However, mainly caused by a lack of advanced technology and insufficient knowledge of the demand in the world market, the Korean textile industry, and the small to medium-size companies in particular, are operating in that part of the world market where the competition is growing stronger very fast: the market of low quality products. This trend of growing competition will extend itself in the future caused by a rapid industrialization that is taking place in other countries.

In order to raise the quality of the Korean textiles, so that the Korean textile industry can operate in the more profitable market of quality goods, it is important to improve the textile dyeing and finishing processes employed by domestic manufacturers.

The Korea Herald, May 4, 1986 reports that the textile exports are faced with strong protectionism abroad. Therefore, the textile industries in Korea are not expected to grow substantially in the future. The paper states that the dyeing and finishing industry is the most backward sector of the textile and clothing industry. Almost 75% of the total 7518 dyeing machines are over seven years old. Korea's dyeing and finishing industry employes 45,000 persons, who account for 6.3% of the total employment of the textile and clothing industries in Korea. A large volume of the dyes used(62%) is produced domestically.

In-depth information on the Korean textile industry can be found in a summarized report by A.S. Nasir, Project Manager and UNIDO Coordinator, April 1984.

CONCLUSIONS

The dyeing and finishing industry in Korea has technical problems it is not equipped to solve without outside technical assistance. The existing infrastructure of textile institutes and testing laboratories is apparently inadequate for solving all of the technical problems and providing sufficient technical assistance in the dyeing and finishing sector.

The Textile Technology Promotion Institute in Daegu does not conduct intensive research and development in the dyeing and finishing sector.

Although a substantial growth of the Korea's textile industry is unlikely in the near future, technical assistance to the dyeing and finishing industry, especially to the smaller companies, is essential for staying competitive and maintaining the existing market share and the value of textile exports.

The planned Dyeing and Finishing Research Center of the Korea Research Institute of Chemical Technology(KRICT) at Daejeon has a practical and useful purpose. With proper equipment, sufficient manpower and adequate funding the Center may become an important asset of the Korea's textile industry.

The Dyeing and Finishing Research Center at KRICT will need intensive technical input from the outside, mainly from experts of UNIDO, to expedite its development into a vital and effective technical research and development support organization for the dyeing and finishing industry.

The new Center should assume national responsibility for providing and coordinating technical support to the Korea's dyeing and finishing industry.

RECOMMENDATIONS

In view of the real need for a research and development oriented dyeing and finishing institute in Korea with problem solving capability the following is recommended:

- A Dyeing and Finishing Research Center, at the KRICT Institute in Daejeon, should be established, as planned
- The equipment and instruments listed in this report should be purchased as soon as possible.
- The Center should be provided with suitable laboratory rooms, one of these climate controlled.
- Training of the technical staff for the Center should start as soon as equipment is available. For training abroad, dye manufacturers supplying the Korean textile industry with dyes should be approached.
  The Textile Technology Promotion Institute in Daegu and the textile mills in Korea should also the be utilized for training purposes.
- Recommendations for purchasing equipment and organizing laboratory facilities have been made in this report and discussed in detail with Dr. Oh, Manager of the Dyeing and Finishing Research Center. Hence visits of UNIDO experts are unnecessary and should not take place before the equipment is installed and the staff of the Center ready to start operations.
- When the new Center has started ists operations, intensive input by UNIDO consultants will be needed to develop the technical expertise of the staff assigned to the Center.

- The new Center should be primarily a research and development facility with the objective of providing technical support to the dyeing and finishing industry. Routine testing and quality control of dyes and finishing agents should remain the responsibility of the producers and existing testing institutes.
- The Center should provide the dyeing and finishing industry with test methods for quality control.
- The Center should function as a technical information source for the dyeing and finishing industry and review regularly technical developments and international trends of textile industries.
- The Center should assist the dye producers in maintaining consistent dye quality by developing standardization procedures, if needed, and test methods.
- The Center should assist the dyeing industry in developing dyeing processes to improve dye utilization and the quality of dyeings, with the desired shade and fastness properties. For this purpose the Center should have the needed technical know-how and skills in color measurement, color matching and dye in fiber analysis.
- The Center should become thoroughly familiar with finishing technology, in order to recommend finishing agents to the finishing industry and develop processes for the application of finishes. The Center should perform analysis of finishing agents and finishes on fabric. Evaluation of durable-press finishes should include soil release testing and durability tests involving cyclic laundering and drying (a 50 cycle test is reasonable).

DISCUSSION

1. Background

The background of this project has been described in the UNDP Project Document DP/ROK/82/027/D/01/37 and in a Technical Report, entitled "Textile Dyeing and Finishing Industry", by Gert Bremhorst, DP/ID/SER.A/513, 4 May 1984. The report states that dyeing and finishing is one of the most important sectors determining the quality of textiles produced in Korea. The Project Document and the report by Gert Bremhorst conclude that a Dyeing and Finishing Research Center should be established to assist the Korean textile industry in raising the quality of textiles to a higher price level. The location at the KRICT(Korea Research Institute of Chemical Technology) in Daejeon was considered to be appropriate since it is situated in the most important dyeing and finishing industrial area(Seoul/Daegu). Lists of equipment needed for establishing a dyeing and finishing center at KRICT were compiled by Dr. Ahmed Hassan(17 March 1986, ref. ROK-82-027.3 and ROK-82-027,5) and Gert Bremhorst(see the reference of his report above).

The purpose of the project DP/ROK/82/027/11-52/31.7.B. subject this report, is to assist and guide the development of the Korean textile industry through the introduction of advanced production methods with the objective of improving the quality and competitive position of Korea's textiles and

increasing textile exports. In accord with these objectives the author of this report is expected to :

1. Assist in starting up the operations of the testing laboratory;
2. Establish test procedures to be followed in order to raise the quality of dyeing and finishing processes in Korea to international high quality standards;
3. Assist the staff in the analysis of dyeing and finishing processes and suggest corrective measures in rejection rates;
4. Hold lectures and seminars on selected topics in the field of textile dyeing and finishing techniques;
5. Assist in selecting material for the library of the textile technical information centre;
6. Develop a methodology for effective use of the textile technical information centre by industrial firms;
7. Assist the inventory management section in setting up inspection and test procedures to be followed for the quality certification of imported and locally produced dyes and finishing agents;
8. Assist in the installation and commissioning of the testing laboratory equipment.

The consultant will also be expected to prepare upon completion of each split mission a technical report, setting out the findings of the mission and recommendations to the Government on further action which might be taken.

2. Textile Institutes and Testing Laboratories in Korea

According to the report by Gert Bremhorst the following institutes exist in Korea:

- Korea Yarn and Fabric Testing Institute, Seoul.
- Korea Textile Inspection and Testing Institute, Seoul.
- Korea Apparel Testing and Inspection Institute, Seoul.
- Textile Technology Promotion Institute, Daegu.

These institutes are mainly concerned with fastness testing of dyed or printed textiles.

The Daegu institute had made new investments in 1984 totaling about $220,000 and installed modern equipment, including a computer controlled color measurement and matching system. However, when Gert Bremhorst visited the Daegu institute he found that the instruments and equipment, especially the dyeing and finishing pilot plant, were not fully utilized. His observation was confirmed by the author of this report. This situation suggests that equipping a textile institute in Korea with modern instrumentation does not necessarily result in efficient utilization of the equipment installed and the hoped for enhancement of the quality of textiles. Although the concensus seems to be that state of art equipment is needed, the lack of equipment is not the only problem limiting the technical support of the Korean textile industry Personnel has to be trained to operate the equipment and technical expertise has to be

developed. The textile industry has to be convinced, with demonstrated useful results, that the new Dyeing and Finishing Research Center can provide essential technical assistance by solving problems and advancing dyeing and finishing technology. Once a working relationship with the textile industry is established, the financial support of the Dyeing and Finishing Research Center by the textile industry may be forthcoming.

3. Laboratory Facilities at KRICT

Since the main objective of the new Dyeing and Finishing Research Center at KRICT is to raise the quality of Korean textiles to a high international quality level, it should be obvious that research and development conducted at this center has to be of very high quality. The center has to be competent and efficient in solving technical problems of the textile dyeing and finishing industry and providing the technical support needed. This means that in addition to equipment, suitable laboratory facilities will be needed for housing the equipment in a proper environment. Trained technical personnel, familiar with dyeing and finishing operations, also is essential. Hence establishing the new Dyeing and Finishing Research Center is a major task requiring a very serious commitment by the supporting organications. A half hearted effort will not suffice.

A dyeing and finishing laboratory for research and development should consist of four sections which are not quite compatible and are better kept as separate areas:

- Dye"kitchen" for preparing dyebaths and formulations of finishes. A laboratory cabinet assembly with storage facilities, equipped with stirring hotplates, balances, and a sink with distilled water and process water faucets. A small fume hood with a cup sink would be useful.
- Area for applying dyes or finishes, including storage facilities for fabrics and table or cabinet for sorting and labeling dyeings. The dryer and steamer should

be ventilated to the outside.

- A room for evaluation dyeings and finished fabrics. This room should have facilities for controlling temperature and humidity and tables or cabinets laboratory benches for the equipment and storage.
- An analytical laboratory for analyzing dyes, determining dyes in solution or in fibers and for analyzing finishes on fibers. A fume hood is mandatory for chemical analysis.

The success of this project depends on the availability of suitable space at KRICT. At the time of writing this report the outlook seems to be favorable.
The space requirements of the Deying and Finishing Research Center are outlined in the Annex of this report.

During my stay in Daejeon I met with Dr. Yung Bog Chae, President of KRICT, and Dr. Suh Bong Rhee, Senior Research Manager of KRICT. I discussed the technical aspects of creating the new Dyeing and Finishing Center in detail with Dr. Oh, Manager of the Dyestuff, Dyeing and Finishing Center of KRICT. Dr. Oh is quite enthusiastic about the project and convinced that the Center will have a very useful and important function of providing the dyeing and finishing industry with much needed technical assistance. Dr. Oh has a thorough knowledge of dyes and dye intermediates and should find it relatively easy to extend her responsibilities to the dyeing and finishing sector.

The management of KRICT was very cooperative and made my mission a pleasant task for which I am very grateful. My special appreciation is extended to Dr. Oh, who arranged visits to the textile companies and provided transportation.

4. Equipment

Since the Dyeing and Finishing Research Center is expected to function as a research and development facility with emphasis on problem solving, the equipment needs of the Center differ from those of a typical dye test laboratory. In addition, equipment is needed for development work and problem solving in the area of finishing. The purchase of equipment for the Center has bben suggested in the Project Document and listed in reports by Gert Bremhorst and Ahmed Assan. Some of the equipment has been ordered, but meanwhile the needs of equipment have changed somewhat as a result of redefining and pinpointing the objectives of the Center. Limitations of funds necessitate setting priorities for purchasing equipment. However, the equipment listed in Table I of this report is the bare minimum needed for the Center to function.

In Table I the status of equipment availability is indicated by the following code:

A - Equipment, or equivalent equipment, is available

L - Equipment can be purchased or constructed locally.

K - Purchase orders being processed with government funds

U - Purchase orders being processed with UNDP funds

P - Equipment to be purchased in the near future

F - To be purchased at a later date

Table II lists the equipment to be purchased with UNIDO funds. The total cost is estimated to be $150.000.

The padder should be equipped, in tandem, with an infrared dryer(Fostoria) to control dye migration and simulate continuous dyeing. Drying of the padded fabric facilitates handling of padded fabric swatches for curing in the steamer/heater. Laboratory scale infrared dryers are commercially available (Fostoria). Alternatively, an infrared drying unit could be constructed locally, if sufficient funds are not available.

Once the equipment is in place, training, a more difficult task, has to be completed to assure an efficient utilization of the equipment. I have observed during my previous UNIDO missions that newly purchased equipment is left sometimes idle because the utility of the equipment in research and development is not fully recognized, although the staff may have the necessary skills to operate the equipment. Hence the staff of the new Center should be trained, not only to operate the equipment, but to utilize the equipment for identifying, defining and solving technical problems.

5. Training Program

One of the major problems in establishing the new Dyeing and Finishing Research Center is lack of trained personnel, experienced in dyeing and finishing technology. Training is envisaged by UNDP experts, fellowships for training abroad, and study tours for the research staff. A workplan for training, suggested by Gert Bremhorst, remains to be implemented. Language requirements seem to have been one reason of the delay.

The author of this report arrived with about 150 slides, prepared for minicourses in fundamentals of dye utilization, analysis of dyes in solution, analysis of dyes in fibers, fundamentals of dye coloristics and soil release finishing. It seemed, however, that the appropriate time for these minicourses had not arrived. A need for such training courses will come after equipment has been installed and manpower assigned.

Dye suppliers may be the best source for training abroad because of their vested business interest in Korea's textile industry. It is unlikely that foreign textile mills, sensitive to competition by Korea's textile industry, would open their doors for trainees from Korea.

6. Technical Information

One of the important functions of the Dyeing and Finishing Research Center will be to provide textile industry with technical information by surveying scientific and technical publications, patents and trade reports. The cost of the journals needed can be reduced by subscribing to the World Textile Abstracts and ordering reprints of useful articles directly from the authors. However, the following journals are essential and should be available at the Dyeing and Finishing Research Center:

Textile Chemist and Colorist

Textile Research Journal*

Journal of the Society of Dyers and Colourists

Melliand Textilberichte(the English edition is useless without the German edition, because illustrations and tables are not reproduced in the English edition)

Analytical Chemistry

Textiles in Asia*

Textilveredlung(optional)*

Chemical Abstracts

The journals indicated with an asterisk(*) are not available in the library and subscription is recommended.

Textile mills can be supplied with technical information by defining the particular interests and needs of each

company and selecting abstracts of pertinent publications. The selection and delivery of information could be greatly facilitated by a computer program operated at the new Dyeing and Finishing Research Center.

7. Textile Technology Promotion Center at Daegu

Since the Textile Technology Promotion Center at Daegu is well equipped with testing instruments and pilot plant equipment the question had to be answered why another dyeing and finishing center is needed in Korea. To find an answer to this question Dr. Oh and I visited the Daegu Center and met with Mr. Sam-Ju Yum, Director, and Young-Il Lee, Manager, of the Center. I found that the Center was indeed well equipped with a variety of testing equipment and analytical instruments, but I observed, like Gert Bremhorst had noticed in 1984, that most of the equipment is not used. I also arrived at two significant conclusions. Firstly, the Center did not seem to have a sufficiently large laboratory staff for an efficient use of the equipment. Secondly, some of the instruments did not have the supplies and accessories needed for their practical use. For example, liquid chromatography(HPLC) and the UV/visible spectrography require a variety of solvents, chemicals and glassware, but the customary supplies were not in sight. This indicated that the equipment was not set up for efficient practical use, but was installed mainly for display purposes, perhaps for the benefit of the training courses given by the Center.

The visit left me with the impression that the Center in Daegu is not engaged in solving technical problems of the Korean dyeing and finishing industry, for whatever the reasons may be, but functioning mainly as a training facility for the

textile industry. Consequently, the planned Dyeing and Finishing Research Center in Daejeon(KRICT) has indeed a useful and necessary purpose. Since it is improbable that equipment from the Daegu Center can be transferred to Daejeon, the instruments and equipment needed for the new Center in Daejeon have to be purchased as soon as possible and installed in a suitable location.

8. Examples of Technical Problems

In order to find out how the new Dyeing and Finishing Research Center in Daejeon could serve the Korean Textile Industry I visited, accompanied by Dr. Oh, several textile companies and engaged in technical discussions. I concluded that

- The textile industry in Korea has technical problems it cannot solve because of limited research and development capanilities
- A Dyeing and Finishing Research Center, such as the one planned for Daejeon, could be very useful in solving these problems
- The textile industry would welcome and appreciate the technical help they may get.
- A cooperation of the Center with the industry should present no problems if technical assistance can be provided at a reasonable cost.

Some examples of technical problems discussed during the visits are listed below.

Dae Young Industryal Co, Ltd., Seoul

Mr. Moon Whi Jeon, President, and Mr. Myung-Jin Park, Managing Director, would like to switch their disperse dye production from liquid dyes to powder form dyes. They could use technical assistance in drying, milling and standardizing dyes in dustfree powder form.

Woo Il Textile Co, Ltd., Kyungki-Do

Mr. Ok-Kyun Choi, President, and his staff described problems in dyeing polyester fabric for automotive upholstery. Polyester fabric is dyed with disperse dyes, but the flame retarders impair light fastness of the dyes. Antistatic and soil resistant finishes also are needed. For styling purposes fabrics are constructed with polyester yarn, dyeable with disperse dyes, and with modified polyester yarn, dyeable with cationic dyes. However, the cationic dyes were found to change their shade at a temperature(130^{o}C) needed to dye the fibers. The dyes they were using were imported and expected to have adequate thermal stability in normal use. It appeared therefore that the problem was related to the dyeing process or the fiber properties. The diffusion of the dye into the fibers could be inadequate resulting in ringdyed fibers where the amount of dye in the outer perimeter of the fiber exceeds the number of dyesites available and does not have the expected shade of the dye cation associated with the dyesite. Hydrolytic decomposition of the dye could be another reason for the unwanted shade change. If the dyeing rate is too slow, the dyes remain for a longer than the usual time in the heated dyebath. The dyeing rate could be slow because of unfavorable dyeing conditions, improper pretreatment of the fabric, or the fibers may be intrinsically difficult to dye. The causes of the problem could be elucidated by measuring the dyeing rate and examining the cross-sections of dyed fibers for the extent of dye diffusion. A comparison of the dyeing rate of the fiber made in Korea with that of a reference fiber(Du Pont's

Dacron Type 64) with the same dye would show whether or not the problem is related to the physical properties of the fiber itself. This example illustrates the complexity of dyeing problems that the new Dyeing and Finishing Research Center will have to face once it is in operation.

Gyeong Il Dyeing, Ihyeon Plant, Daegu

Jin Jung Lee, President, and Pal Yong Kim, Laboratory Manager, described problems associated with dyeing of rayon fabics with reactive dyes. Because of equipment limitations the pad-bath pick-up is very high(about 90%). Evaporation of the excessive amount of water during drying causes dye migration that results in two-sidedness of the dyed fabric. Migration control by the infrared predryer or antimigration agents could solve the problem. Another problem the plant was experiencing was unequal reactive dye distribution between cotton and rayon in a patterned fabric, dyed by an exhaust process. The problem may be caused by an optical effect, an unequal dye substantivity on the different fibers or by different dyeing rates. Dye exhaustion and dye fixation measurements by the new Center could pinpoint the problem and provide information for developing a exhaust dyeing program that produces the desired dye distribution.

Table I. Equipment Needed for the Dyeing and Finishing Research Center.

Dye "kitchen"

A - Electronic balance - 160g range

A - Electronic balance - 1600g range

P - Pipetters, 1 to 5 mL capacity, with disposable tips

A - Stirring hotplates

Application Area

U - 2-roll laboratory padder(Mathis Model HF)

U - Laboratory steaming, curing and heat setting unit (Mathis Model DHE)

U - High temperature dyeing unit(Launder-O-meter, model L-P1, Dyeing System, Atlas Electric Co)

U - Dyeing apparatus for exhaust dyeing, adaptable to cone dyeing, microprocessor controlled(Ahiba Turbocolor)

F - Dyeing apparatus for exhaust dyeing of piece goods, permitting visual observation of the dyeing process. (Ahiba Texomat)

L - Washing unit with three trays, preferably steam heated, if steam is available)

L - Electric dryer(home appliance type).

L - Washing machine(automatic washer, home appliance type)

Evaluation of Dyeings (Climate controlled "dry" area).

K - Color measurement system for color matching and color difference measurement, computer controlled, Applied Color System, Model 3100 or 4500.

U - Color assessment cabinet

P - Microtome for cutting cross-sections of dyeings

K - Microscope, equipped with a 35mm camera,

U - Crock(rubbing) fastness tester

U - Crease recovery tester

U - Abrasion tester

U - Lightfastness tester(Atlas Xenotest 450 LF)

U - Scorch tester for testing fastness of dyeings to heat (sublimation and shade change)
Note: for washfastness tests - the Launder-o-meter, Model L-P1, is used located in the Application Area

P - Tensile strength tester

F - Softness(hand)tester, electronic

P - Eppendorf repeater pipet, with 2.5 mL combitip, for oily soil application(Fisher Scientific Co).

L - Test equipment for oil repellency testing

U - Water repellency test equipment, spray type, AATCC specifications

Equipment for Dye and Finish Analyses

L - Constant temperature heating bath, temperature range from ambient to 150°C, with a rack for holding extraction flasks (as shown in Fig. 19.2, of "The Analytical Chemistry of Synthetic Dyes", edited by K. Venkataraman, Wiley-Interscience, New York, 1977).

A - Refrigerator

A - Centrifuge, IEC Clinical Model

U - Flammability tester

A - Scanning electron microscope

A - Equipment for elemental analysis: C,H,N,S,Cl,Br,P,F (if water/oil repellent finishes are analyzed), alkali metals, alkaline earth metals, Fe,Al, Also in trace quantities.

A - Gas chromatograph, equipped with a flame ionization detector and preferably, with a wide bore(0.75mm) capillary column, 30m or 60m long.

A - High performance liquid chromatograph(HPLC), with ion chromatography capability

A - Equipment for acid/base and redox titrations, manual or automatic

A - Spectrophotometer, UV/visible spectral range

U - Infrared spectrophotometer(FTIR)

A - Nuclear magnetic resonance(NMR)spectrograph

A - Mass spectrometer (GC/MS)

A - Thin layer chromatography equipment

L - A die, about 12mm diameter, and a plastic covered block, for cutting disks from dyed fabrics for analysis.

Table II. Equipment to be Purchased with UNIDO Funds

Padder, Mathis Model HF

Steamer. Model Mathis DHE

Launder-o-meter L-Pl Dyeing System(Atlas Electric Co, USA)

Dyeing aparatus, AHIBA Turbocolor, with one dyeing position

Color evaluation cabinet,(Macbeth Division, Kollmorgen Corp., UAS)

Lightfastness tester, Atlas Weather-o-meter, Model 25-18-WT (Atlas Electric Co, USA)

Crock(rubbing)fastness tester(Tokyo Testing Machine MFG, Co, Ltd)

Crease recovery tester(Tokyo Testing Machine MFG, CO, Ltd)

Abrasion fastness tester(Shirley Developments Ltd, Manchester, England)

Scorch(thermo)fastness tester (Tokyo Testing Machine MFG Co, Ltd)

Perspiration fastness tester(James H. Heal & Co, Ltd, Halifax, England)

Flammability tester, Custom Scientific Instroments, Inc. Model CS-186

Electrical resistance tester, Custom Scientific Instruments, Inc. Model CS-51

Water repellency(spray) tester(James H. Heal & Co, Ltd. Halifax England)

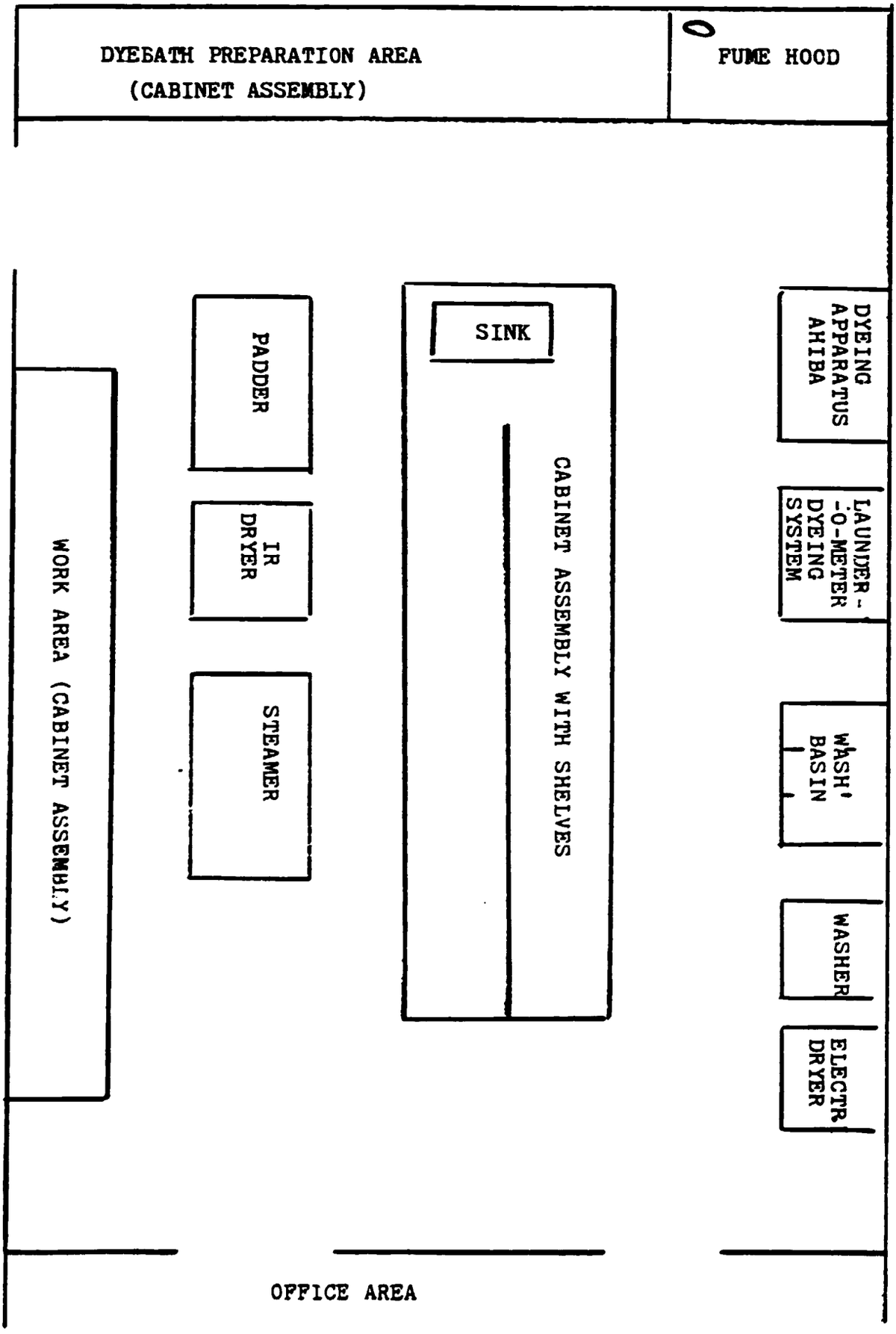
Infrared(FTIR)spectrograph, Analect Instruments, Model FX-6160

* This list of equipment was compiled before the author's mission. The equipment specifications have not been changed by the author of this report.

Laboratory Space Requirements of the Dyeing & Finishing Research Center.

Room	Area(m^2)
Application laboratory	100
Climate controlled laboratory for evaluation of dyeings	60
Analytical laboratory	65
Laboratory for the application and study of finishes	65
Storage area	50
Offices	250
Total minimum area	590

LAYOUT OF THE DYE APPLICATION LABORATORY



List of Persons Contacted in Korea

Korea Research Institute of Chemical Technology, Daejeon

Dr. Yung Bog Chae, President

Dr. Suh Bong Rhee, Senior Research Manager

Dr. Sea Wha Oh, Manager of the Dyeing and Finishing Research Center

Dae Young Industrial Co, Ltd., Seoul

Mr. Moon Whi Jeon, President

Mr. Myung-Jin Park, Managing Director

Woo Il Textiles Co, Ltd., Kyungki-Do

Mr. Ok-Kyun Choi, president

Gyeong Il Dyeing Ihyeon Plant, Daegu

Mr. Jin Jung Lee, President

Mr. Pal Yong Kim, Laboratory Manager

Textile Technology Promotion Institute, Daegu

Mr. Sam-Ju Yum, Director

Mr. Young-Il Lee, Manager

Korea Explosives Co, Ltd. Daejeon

Mr. S. H. Lee, Chief Chemist

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Kyungin Corpo Co, Ltd

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