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SYRIAN INTERMEDIATE TECHNICAL INSTITUTE

TECHNICAL ASSISTANCE PROJECT

FINAL REPORT

October 1977

Prepared by

William S. Reynolds, Team Leader

John D. Cowan, Jr.

Michael J. Danehy

John J. Foody

Theodore Georgian

Elwood J. Nicholson, Jr.

Bruce A. Reinhart

This report has been prepared by the Academy for Educational Development, Inc., for USAID/Syria and NE/TECH/HRST, AID/Washington, under Contract No. AID/afr-C-1131, Work Order No. 15.

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PROPOSED SYLLABI AND EQUIPMENT LIST

Air Conditioning Ventilation and Refrigeration	AC-1
Building Construction Technology and Surveying	BC-1
Chemical Engineering Technology	CT-1
Control Systems and Transducers	CST-1
Mechanical Power Technology	MPT-1
Mechanical Materials Handling Technology	MMH-1
Audiovisual Equipment for Intermediate Technical Institutes at Dier-ez-Zor, Hama, and Latakia	AV-1

SYRIAN INTERMEDIATE TECHNICAL INSTITUTE

TECHNICAL ASSISTANCE PROJECT

FINAL REPORT

The purpose of this Final Report is to summarize the activities and procedures of the technical team and to present the products required by the contract.

Recommendations are included aimed at insuring that equipment, trained teaching staff and program are in place for the first classes in September of 1980.

1. INTRODUCTION

1.1. Project Goals

The goals of the project were set forth in the Contract No. AID/afr-C-1131, Work Order No. 15, between the Near East Bureau of the Agency for International Development and the Academy for Educational Development. Simply stated, the contract called for a team leader and a five-man team of specialists representing the following technologies: air-conditioning, building construction, chemical, instrumentation and port materials handling. The team was to identify the equipment needs and write specifications for three Intermediate Technical Institutes located at Homs, Latakia, and Deir-ez-Zor, Syria. Specifications were to follow procedures set forth by the IBRD (International Bank for Reconstruction and Development) for international bidding and procurement. The equipment selection was to be based on existing syllabi, but if these had not been completed, the team was required to assist the Syrians in their development.

1.2. Recruitment of Team

The team leader, Dr. William S. Reynolds, was recruited by AED with the first contact being made on April 28, 1977. Dr. Reynolds then recruited the candidates for each of the five technical areas and

recommended final selection during a meeting at AED/Washington.

The team members were:

- Control Systems and Transducers

John D. Cowan, Jr., Professor, Department of Electrical Engineering, The Ohio State University, Columbus, Ohio.

- Building Construction Technology and Surveying

Michael J. Danehy, Dean, Engineering Technology Division, State University of New York Agricultural and Technical College, Canton, New York.

- Mechanical Materials Handling Technology Mechanical Power Technology

John J. Foody, PE, Consulting Engineer, Professor Emeritus, State University of New York Maritime College, New York, New York.

- Chemical Technology

Theodore Georgian, Associate Professor of Organic Chemistry, Niagara County Community College at Sanborn, New York.

- Air-Conditioning, Ventilation and Refrigeration

Elwood J. Nicholson, Jr., Professor, Engineering Technology Division, State University of New York Agricultural and Technical College, Canton, New York.

- Team Leader

William S. Reynolds, Ed.D., Professor and Coordinator, Vocational Technical Education, State University of New York College at Buffalo, New York.

Note: Audio-visual equipment and specifications were prepared for all three institutes by the team leader.

1.3. Operations Schedule

The team arrived in Washington on Tuesday, June 28th for a two-day briefing at AED. The program included a background briefing on Syria at AID and an orientation from IBRD concerning writing equipment specifications for the intermediate institutes. AED provided briefing on the individual technician's contracts, support and management systems. In addition, they provided for all the usual

preparations required for foreign travel.

The planned departure for Syria was delayed due to the lack of country clearance and then the lack of available flight space on U.S. carriers. The team finally arrived in Damascus on Sunday, July 3rd.

Dr. Bruce Reinhart of the Center for Vocational Education at The Ohio State University preceded the team to Syria to arrange for accommodations and other support. His previous knowledge of the country facilitated the team's arrival and adjustment to the surroundings.

Following a discussion with Syrian officials, team members and Acting Director Dennis Chandler of USIAD/Syria, we decided to work a six-day week as this was the schedule at the Ministry of Education. Since the Ministry closed at 2 p.m. for the day, we arranged our schedule so that we worked at the MOE from 8:15 a.m. to 1 p.m. We then returned to the hotel for lunch and worked in our rooms until about 5 p.m. Most of the team worked well beyond this time as dinner was not served until 8 p.m. The daily move to the hotel from MOE involved the transfer of catalogs, books, files, and a typewriter.

The team's in-country work was completed by August 18th when the team leader departed. Additional work in the U.S. was scheduled for completion by the end of October.

2. INFORMATION GATHERING AND PLANNING

The first activity of the team was to gather required information so that a work plan could be developed. Preliminary to this was the in-country orientation identified below.

2.1. Orientation

Our orientation included discussions with the following key people

of the Syrian Arab Republic:

- Mr. Sharifuddin Mohammed, Director of Technical Education, Ministry of Education, S.A.R.
- Mr. Munir Azzam, Senior Advisor and Director, World Bank Project, Directorate of Planning, Ministry of Education, S.A.R.
- Mr. Mustafa Kazziha, Inspector, Technical Education Directorate, Ministry of Education, S.A.R.
- Mr. Aymen Muwakki, Engineer, School Building Institute, Damascus, S.A.R.

In addition to these people, a number of other technical specialists in various fields were consulted as noted in the reports of individual team members.

We were briefed on the Syrian school system with emphasis on the vocational-technical program, and the role of the intermediate institutes. The team was especially interested in the preparation of the students who would be entering the institutes.

A briefing on the functions of USAID in Syria was provided by Mr. Herbert Roberts, Technical Specialist, and Mr. Dennis Chandler, Acting Director.

2.2. Field Trips

Field visits were made to:

- Intermediate Technical Institutes in Damascus and Homs.
- University of Homs Engineering and Chemical Departments.
- Port facilities at Latakia.
- Vocational (secondary) school in Damascus.
- Architects office in Damascus and Latakia.
- Air-conditioning contractor in Damascus.

Team members each visited shops and laboratories relating to their special interest and held numerous discussions with Syrian technicians. The trip to Latakia provided Dr. Foody with the opportunity

to observe the port handling facilities. The purpose of these visits and discussions was to ascertain the "state of the art" and Syrian needs in each of the designated technical areas as a basis for developing syllabi and eventually identifying equipment required to carry out the instructional program.

2.3. Architectural Considerations

Although the team had no contractual responsibilities for assisting the architects designing the intermediate institutes, it was apparent from the beginning orientation that they urgently needed and wanted the team's help. The team agreed to draft scale floor plans showing the locations of major equipment items, to review IBRD space allocations, and to consult with the architects as needed.

2.4. Master Plan

The overall work plan developed by Dr. Reynolds in consultation with the team, Mr. Mustafa Kazziha, and Mr. Munir Azzam of the Ministry of Education, S.A.R., involved frequent review and discussion between the team members and responsible officials (See PERT Schedule, Appendix A). Since Mr. Kazziha was the senior MOE official with an engineering background and completely familiar with the technical education programs of the S.A.R., he was the team's prime contact. Mr. Azzam was responsible for providing support facilities for the team's work. The work plan called for Mr. Kazziha to review each team member's output at critical intervals to insure Syrian input, understanding, and agreement. These reviews were carried out during the preparation of the syllabi, and at the completion of the development of the equipment list and the list of specifications.

Although the S.A.R. was expected to provide counterparts for the team at the outset to assist in the work, they were not available until about three weeks after the project was started. As a result their value to the team was primarily to review material.

Since it was anticipated that team members might not be able to complete all of their work in Syria due to a lack of certain catalogs or technical information, the project provided time in the U.S. for completion and review. Each team member was asked to prepare a summary of the additional material he would submit in the U.S., prior to departure from Syria. The decision was made to develop one audio-visual equipment list and specifications representing items to be allocated to Homs, Latakia, and Deir-ez-Zor.

3. DEVELOPMENT OF SYLLABI

3.1. Format

The format for syllabi was simple and direct and used a performance-based approach. However, the familiarity with and experience of the team in writing behavioral objectives varied considerably, so the products naturally reflect these variations. Since time was of the essence and the prime goal was to develop syllabi on which the selection of equipment could be based, relatively little time was spent in producing a highly refined product. (Note: The recommendations at the end of the report provides for the teacher training program to include a curriculum development component. Refinement of the syllabi would be accomplished at this time.) The format, which became the first section of each technician's final report, was as follows:

- Title page.
- Introduction - identifies assumptions and limitations.
- Syllabus.
 - a. Statement of purpose.
 - b. General objectives in behavioral terms.
 - c. Typical course titles - including time factors; changes made from IBRD plan.
 - d. Course outline - title; behavioral objectives.

- Recommendations.
 - a. Program.
 - b. Architectural - includes draft layout; suggestions to architects.

3.2. Construction

The basis for constructing each syllabus included the IBRD Syrian Arab Republic First Education Project, Working Papers, Volume I, dated April 1977; other documents on Syrian education from USAID and IBRD; visitations to existing intermediate technical institutes and some related commercial business; consultation with appropriate Syrian; academic preparation of entering students; and competencies needed by program graduates. This input was balanced against each technician's extensive knowledge and experience in his special field to produce an outline appropriate to Syrian needs.

Although in some cases related technical subjects were identified, the syllabi was concerned primarily with technical content requiring laboratory facilities.

4. DEVELOPMENT OF MASTER EQUIPMENT LIST AND SPECIFICATIONS

4.1. Format

A format was designed to meet IBRD requirements in consultation with the team and Mr. Kazziha which would:

- Identify equipment by general category and type of laboratory.
- Locate the equipment according to the institute site.
- Assign the equipment to a specific laboratory using the IBRD space number (See Appendix B, Laboratory Space Identification Numbers, and Appendix C, Code System).

The final report contains the following sections relating to equipment:

- Master Equipment List - By item number, technical area and category of items; i.e., Equipment, Small Tools, Instructional Materials, Furniture, Chemicals, Usable Supplies. This list gives a brief description of the items, the quantity needed, item cost, and total cost.
- Specifications - Detailed descriptions are presented of each item identified in the Master Equipment List along with the appropriate identification number and code noted earlier. Each item of equipment is tied to an IBRD space allocation number identifying each specific laboratory.
- Budget Summary - Identifies cost by category of item, total cost of all categories, IBRD estimate of cost, and the amount the projected total cost under or over IBRD estimates.
- Priority Items - Indicates items which might be cut out with least damage to carrying out the instructional program in the event a reduction in cost becomes necessary.

4.2. Criteria for Equipment Selection

The prime criteria for the selection of equipment was to identify items needed to carry out the education program as set forth in the syllabi. Careful consideration was given to the current status of technology in Syria, the input of Syrian engineer consultants and plans for industrial development. The team was also concerned that the equipment give maximum value for the investment and that each item was really needed to carry out the objectives of the instructional program.

4.3. Standards and General Specifications

- Shipping - All prices quoted include shipping charges, i.e., F.O.B. in the U.S.
- Electrical Service - Electrical items should be ready to plug in to the following services unless otherwise specified: 1 phase 220 Volt 50 Hz AC

Service to buildings will be:

3 phase 380 Volt 50 Hz AC (4 wire)

- Quality - All items shall be new standard production models of the latest design. Tools shall be of preferred quality and construction. All items shall conform to latest applicable international standards and specifications.
- Dimensions - Calibrations and ranges shall be in metric units unless otherwise specified.
- Language Requirements - The preferred language is Arabic but technical manuals may be in English.

5. DEVELOPMENT OF FLOOR PLANS

As noted earlier, each team member worked with the architects responsible for the construction of the intermediate institutes at Dier-ez-Zor, Homs, and Latakia. They reviewed the space allocation, location of the laboratory in relation to other facilities, safety, electrical needs, and storage and office considerations. Each of the team prepared a scale floor plan locating all major items of equipment for each laboratory, following numerous consultations with the architects.

Extensive discussions were also held with Mr. Lindsay and Mr. Go of IBRD regarding architectural recommendations during their visit to Damascus. The result was that a number of changes were put forth which seemed to meet with general agreement of all concerned.

6. TRAINING AND DEVELOPMENT PROGRAM

6.1. Proposal

A discussion of the need, as identified by S.A.R., for a comprehensive training program to prepare instructors for the new institute curriculums was held between Acting Director Chandler and Technical Specialist Roberts of USAID/Syria, IBRD team Lindsay and Go, and Dr. Reynolds, team leader. Dr. Reynolds proposed a four-phase approach to insure maximum return on their investment for the Syrians and to guarantee that the institutes are ready with equipment and trained staff in place by the September 1980 target date. The proposal to be funded by USAID included:

- English language training
- Teacher training in the U.S.
- Technical training in the U.S.
- Return of technical team to assist in setting up equipment.

It was recommended by USAID/Syria that English language training be started as soon as possible in order that sixteen candidates could achieve fluency by the target departure date of June 1978. The USAID funded training program would provide Syrian candidates with technical training at a two-year U.S. technical college in the subject they intend to teach at the institutes. They would receive the same preparation U.S. technicians do in laboratories similar in equipment to those being designed by the technical team. Dr. Reynolds also recommended, that to the extent possible, the Syrian candidates be sent to the institutions in the U.S. where the technical team members are currently teaching, to insure that their program is relevant to the facilities being planned and equipment being ordered. In addition, candidates would receive intensive teacher training during the summer at State University of New York College at Buffalo. The proposal met with the approval of all concerned.

6.2. Program Plan for Training

The plan provided for an individualized training program in five technical subjects for sixteen Syrian teacher candidates. In addition, it provided for the training of three laboratory technicians to service the electronics laboratories. The technical content for each of the technologies was designed by the appropriate team member:

- Air-Conditioning - E. J. Nicholson
- Building Construction & Surveying - Michael Danehy
- Chemical - Theodore Georgian
- Control Systems and Transducers - John Cowan

- Mechanical Power and Materials Handling - John Foody
- Laboratory Technician - John Cowan

The overall structure provided for:

- English language training in Syria to reach a "fluent" level. (6 to 10 months)
- An intensive teacher training program. (2 summer months)
- Technical training program - 4 semesters. (20 months)
- Curriculum development workshop (1 week).
- Development of course of study in technical area. [(2 summer months)

6.3. Installing Institute Programs

According to the IBRD, the institutes should be in operation by September 1980. In order to insure that the equipment is properly arranged and installed, it was proposed that the same team leader and technical team involved in this Project and in the training of the institute technical teachers return to Syria for two to three months during the summer of 1980. Each team member would work directly with the counterpart he had trained in the U.S. to install the equipment and program.

7. RECOMMENDATIONS TO USAID

- 7.1. Every effort should be made to encourage the Syrians to follow through on the total training program package. This will require frequent contact with the Director of Technical and Vocational Education, Mr. Sharifuddin; Senior Advisor, Department of Planning, Munir Azzam; and Inspector of Technical Education, Mustafa Kazziha, especially in regard to the early selection of candidates for technical training.
- 7.2. Preparations should be made in the fall of 1979 to provide for transportation, per diem and salary for the technical team and team leader to return to Syria for at least two months during the

summer of 1980. The purpose of their mission should be to work with their counterparts to:

- Check the equipment orders and receipts to ascertain any needed revisions in floor plan layout.
- Arrange and assist in installing equipment, supplies and instructional materials.
- Check out operation of equipment.
- Assist in the preparation of instructional materials.

7.3. There are three other leaders with whom we worked who expressed a sincere interest in a short applied study program in the U.S.

- Mr. Ayman Muwakki, the Chief Architect of the Ministry of Education responsible for planning the intermediate technical institutes, could benefit greatly from such an experience. He has expressed a desire to learn about technical facility planning in the U.S. His U.S. program should include: visits to several two-year technical colleges and vocational high schools; orientation and a short period of study with a school planning architect involved in developing technical training facilities; visits to two companies which provide technical school equipment and have planning departments, such as E.H. Sheldon in Muskegon, Michigan; visit to a four-year college with a vocational-technical teacher education program to discuss facilities planning; visit to the National Institute for Occupational Safety and Health at HEW.
- Mr. Mimir Azzam's responsibilities are in the Directorate of Planning, Ministry of Education, where he is currently in charge of the IBRD project. He is responsible for developing long-range educational plans. He indicated that he would like to study computer applications for planning. The S.A.R. has a computer facility and he would like to know how he can make use of this in generating five-year plans. His U.S. program should include: visits to state education planning offices in states similar in population to Syria; attendance at a short basic computer data applications course such as offered by preparatory schools; visits to appropriate offices in the USOE.
- Mr. Mustafa Kazziha, the Inspector of Technical Education at the Ministry, was our chief counterpart and the most knowledgeable person there in relation to technical education. He would like to study technical education in the U.S. Unfortunately he is currently on a visit to Japan to study the use of production jobs in technical schools. Under S.A.R. regulations he will not be eligible for foreign study again until two years have elapsed. In light of his responsibility for the technical institutes, USAID should approach the Minister of Education with the recommendation that a study tour for Kazziha would be invaluable, especially if he could come to the U.S. while the Syrian technical teachers are in training. Specifically it is recommended that he visit the following:

The intensive teacher training program to be offered for the Syrian technical institute teachers during the summer of 1978; several two-year technical colleges in New York State including Niagara Community College, Canton Agricultural and Technical Institute and Erie Community College; and a facilities planning program at a four-year college which has a vocational-technical education program such as the one at State University of New York at Buffalo.

8. RECOMMENDATIONS TO IBRD

- 8.1. Since the IBRD is financing the construction and equipment of the institutes, it undoubtedly is concerned that the end result will be properly equipped schools being operated by competent teachers and open for classes on the target date of September 1980. Although there may be other means to insure that this will happen, the agreed-upon plans of USAID are well thought out and provide maximum support with no further investment by either Syria or IBRD. Accordingly, the Bank should encourage the S.A.R. Ministry of Education to move as quickly as possible to work with USAID in finalizing these plans and the selection of appropriate candidates.
- 8.2. The Bank should maintain close contact with AID/Washington and USAID/Syria to articulate and expedite the training program.
- 8.3. Installation of the equipment and program during the summer of 1980 is the final phase of the project; therefore the Bank should encourage USAID/Syria to prepare appropriate documentation in the fall of 1979 to implement the last part of the program, as identified in item 7.2 above.

9. SUMMARY AND COMMENTS

It would seem appropriate at this point to record my personal reactions to the project and the efforts of all concerned.

Despite the fact that all the team members had other plans for summer activities, they gave them up on very short notice to take on a challenging assignment. Although none of the team knew each other prior to

the project, they worked well together and established lasting friendships. They approached their task with dedication and persistence. All worked long hours, often in extreme heat with little in the way of refreshments and they did so with a sense of humor. Their consistent efforts, hard work and willingness to adjust to somewhat trying conditions, made our assignment a rewarding experience.

The one serious problem that came up early in the project was the lack of competent secretarial help. Although the Syrian MOE was to provide support services, they simply did not have a secretary who could handle the task of typing technical material for six people. Mrs. Reynolds' arrival on July 18 solved that problem as she promptly took over the typing responsibilities. Every team member spoke of the dedication and happy patience she exhibited in handling highly technical material that required frequent interpretation and cross-checking. She managed to have accurately typed drafts of the work of each of the team in their hands to review prior to their departure. Often she worked late at night so the material was ready for review the next day. So, on behalf of the team - thanks and well done!

The team also appreciated the reliable assistance provided by Mr. Yassin Akkad of the Syrian MOE, who took charge of cutting the stencils and seeing that reproductions were made and collated on time. He is to be commended for the quality of his efforts and his willingness to work on his day off.

The Syrians in the MOE were most helpful. Mr. Azzam (Munir), who provided support during the entire project, and Mr. Kazziha (Mustafa), who was our reliable technical expert, facilitated the work of the team. Their friendly, helpful, and receptive attitude resulted in a spirit of cooperation and friendship throughout our stay in Syria. The engineers assisting individual team members also demonstrated a spirit of cooperation. All contributed to the success of the project.

We all appreciated the support and concern for our needs of the AED

Washington staff who, without exception, were most helpful in every way. Their patience and persistence in attending to the many details involved and in understanding our human differences was sincerely appreciated. A special note of thanks goes to Cheryl Greenwood and Steve Moseley for their well-organized efforts and spirit of helpfulness. We would do it all again!

APPENDIX A

SUGGESTED PERT SCHEDULE

<u>Time Required</u>	<u>Activity</u>	<u>Date to be Started</u>	<u>Completion Target Date</u>
3	Orientation-AID, Ministry of Education	7/4	7/6
3	Plan Format of Syllabi and Equipment	7/5	7/7
4	Site Visits	7	11
8	Prepare Syllabi	5	14
3	Prepare Equipment List Draft	14	17
1	Review with Ministry of Education	17	18
3	Prepare Final Equipment List (Type and Review)	18	20
16	Prepare Specification Draft	18	8/4
3	Review Specifications with Ministry of Education	8/6	8/8
3	Prepare Final Specifications (Type and Review)	8	10
3	Prepare of Recommendations Draft	8	10
1	Review Recommendations with M.E.	11	12
1	Preparation of Final Recommendations (Type)	13	14
1	Compilation of Final Reports (Indexing etc.)	14	15
3	Identification of Additional Material to be secured in the U.S.	15	17

Departure Date 8/23 (Latest)

Note: This was prepared to provide a time guide to team members.

APPENDIX B

LABORATORY SPACE IDENTIFICATION NUMBERS

(From World Bank)

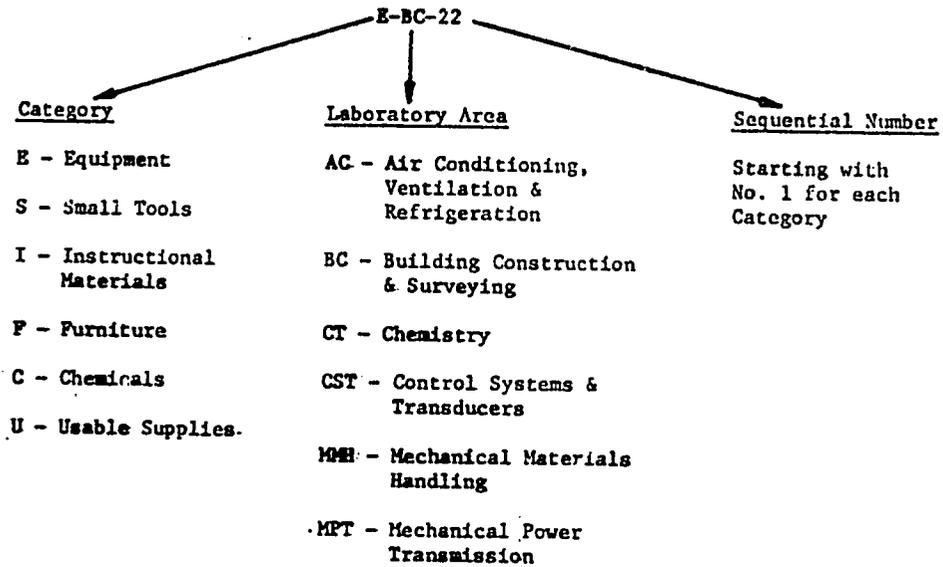
A. <u>Air Conditioning</u> (Homs)				
			<u>Space Number</u>	
1.	Heating, Fuels & Hot Water Systems		32	
2.	Air Conditioning & Refrigeration		33	
B. <u>Building Construction Labs</u> (Latakia and Deir-Ez-Zor and Homs)				
			<u>Space Number</u>	
		<u>Latakia</u>	<u>Deir-Ez-Zor</u>	<u>Homs</u>
1.	Applied Mechanics	28	28	28
2.	Construction	33	33	
3.	Engineering Materials and Soils	34	32	
4.	Surveying and Photo Grammetry	35	35	
C. <u>Chemical Tech. Laboratories</u> (Homs)				
				<u>Space Number</u>
1.	Industrial Inorganic and Quantitative Chemistry			34
2.	Industrial Organic Chemistry			34A
3.	Chemicals Processing Unit Operations (Pilot Plants)			35
4.	Mineral Processing Unit Operations			36
D. <u>Control Systems and Transducers</u> (Homs)				
				<u>Space Number</u>
1.	Control Systems			31
2.	Transducers (Instruments)			37
3.	Common Room		} Support for	C
4.	Printed Circuit Room			P
			31, 37, 22, 27	
E. <u>Materials Handling and Mechanical Power</u> (Latakia)				
				<u>Space Number</u>
1.	Machine Elements and Industrial Drawing			29
2.	Diesel Power Technology			30
3.	Power Transmission and Control Systems			31
4.	Material Handling Equipment			32

APPENDIX C

CODE SYSTEM

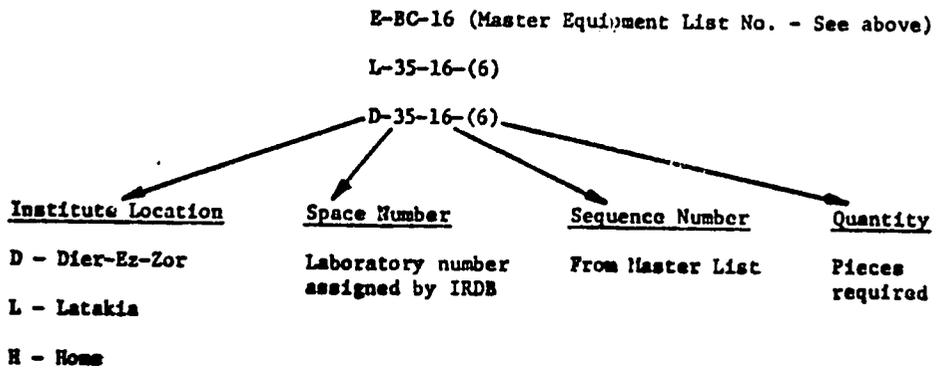
MASTER EQUIPMENT LIST - REFERENCE NUMBER

Sample:



SPECIFICATION CODE NUMBERS (FOR ALLOCATION PURPOSES)

Sample:



AC-1

AIR CONDITIONING VENTILATION AND REFRIGERATION

A PROPOSED SYLLABUS AND EQUIPMENT LIST

For The

SYRIAN ARAB REPUBLIC GOVERNMENT

Developed by

ELWOOD J. NICHOLSON JR., PROFESSOR

ENGINEERING TECHNOLOGY DIVISION

STATE UNIVERSITY OF NEW YORK

AGRICULTURAL AND TECHNICAL COLLEGE

CANTON, NEW YORK

Contracted

By

ACADEMY FOR EDUCATIONAL DEVELOPMENT

DAMASCUS, SYRIA

JULY - AUGUST, 1977

LABORATORY SPACE IDENTIFICATION NUMBERS

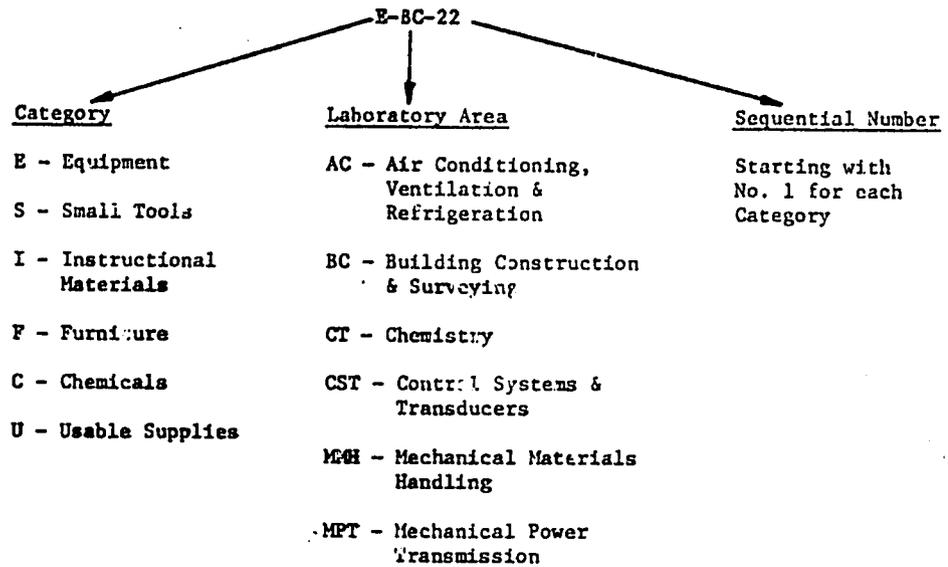
(From World Bank)

A. <u>Air Conditioning</u> (Homs)			
			<u>Space Number</u>
1.	Heating, Fuels & Hot Water Systems		32
2.	Air Conditioning & Refrigeration		33
B. <u>Building Construction Labs</u> (Latakia and Deir-Ez-Zor and Homs)			
			<u>Space Number</u>
		<u>Latakia</u>	<u>Deir-Ez-Zor</u>
			<u>Homs</u>
1.	Applied Mechanics	28	28
2.	Construction	33	33
3.	Engineering Materials and Soils	34	32
4.	Surveying and Photo Grammetry	35	35
C. <u>Chemical Tech. Laboratories</u> (Homs)			
			<u>Space Number</u>
1.	Industrial Inorganic and Quantitative Chemistry		34
2.	Industrial Organic Chemistry		34A
3.	Chemicals Processing Unit Operations (Pilot Plants)		35
4.	Mineral Processing Unit Operations		36
D. <u>Control Systems and Transducers</u> (Homs)			
			<u>Space Number</u>
1.	Control Systems		31
2.	Transducers (Instruments)		37
3.	Common Room	} Support for	C
4.	Printed Circuit Room		P
		31, 37, 22, 27	
E. <u>Materials Handling and Mechanical Power</u> (Latakia)			
			<u>Space Number</u>
1.	Machine Elements and Industrial Drawing		29
2.	Diesel Power Technology		30
3.	Power Transmission and Control Systems		31
4.	Material Handling Equipment		32

CODE SYSTEM

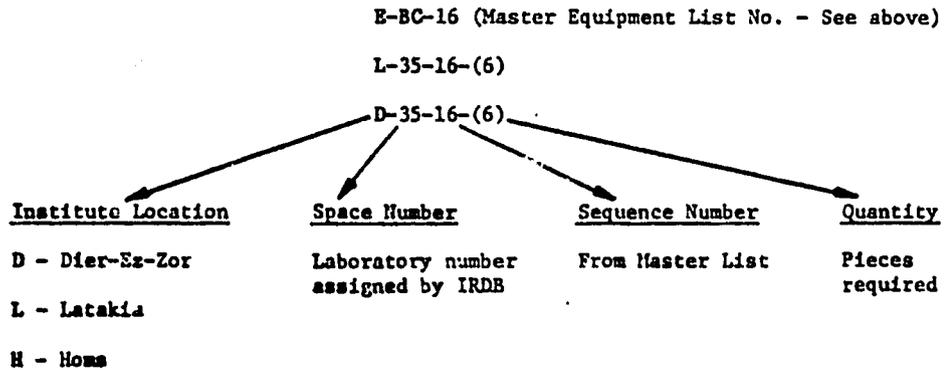
MASTER EQUIPMENT LIST - REFERENCE NUMBER

Sample:



SPECIFICATION CODE NUMBERS (FOR ALLOCATION PURPOSES)

Sample:



1. INTRODUCTION

- 1.1 The syllabus and equipment list that follows was based on discussions with Mr. Mustafa Kazziha, Inspector of Technical Education; my air conditioning and refrigeration technology counterpart; Mr. Abd El Salam Mostafa; observations of air conditioning and refrigeration installations; the World Bank "Reconnaissance-in-Depth Mission Report on the Education and Training System in Syria, Issues and Priorities"; technical appendix to the above report; other World Bank documents and discussions with World Bank personnel in Washington, D.C. and Damascus.
- 1.2 The problems of implementating a technical education program in a technology as yet playing only a minor role in the economic development of the country were considered. At the present time air conditioning and refrigeration is not in wide spread use but should in the future play a critical role in the economic development of Syria. Considering the climatic conditions in Syria, full utilization of the productive capacity of the Syrian people, the exchange of people with business and technical expertise with other countries of the world, and developing a world tourist trade will depend upon significant expansion of the air conditioning and refrigeration industry.
- 1.3 The two areas of immediate importance to the S.A.R. in the field of air conditioning and refrigeration are industrial air conditioning and commercial refrigeration. In the area of industrial air conditioning such processes as textile manufacturing are of primary importance. In the area of commercial refrigeration the processing, storage and transportation of food is of primary importance. With the efforts now being made in the S.A.R. to increase agricultural production through agrarian reform, irrigation and increase fertilizer production and use, the effective use of the increased food production will increasingly depend upon commercial refrigeration.
- 1.4 At the present time there is no viable air conditioning and refrigeration training program at the vocational or intermediate level in Syria. Equipment bids have just been received by the Ministry of Education for an air conditioning and refrigeration training

program at the vocational school level. The vocational school program should play a key role in developing expertise for an expanding refrigeration and air conditioning industry in Syria. The vocational program will supply tradesmen to the industry and provide candidates for entrance to the intermediate technical institute refrigeration and air conditioning program. The different but complementing objectives of the vocational program and the technical institute air conditioning and refrigeration programs were considered in writing the syllabus and equipment list for the intermediate technical institute.

- 1.5 The equipment recommended for the Intermediate Technical Institute at Homs for air conditioning and refrigeration technology consists primarily of packaged training units that may be put in operation with a minimum of installation, will be provided with laboratory manuals for instructional purposes and will require a minimum of maintenance.
- 1.6 The lack of personnel with an in-depth background in air conditioning and refrigeration technology presents a problem, but the extensive use of packaged training units and training of instructors through fellowships in the U.S.A. should make possible the development of a viable air conditioning and refrigeration technology program in Syria in a minimum time period.
- 1.7 The recommendations in this report in regard to syllabus and workshop equipment were made in consideration of the predictable future growth of the air conditioning and refrigeration industry and its present underdeveloped status. The equipment is adaptable to teaching the most basic fundamentals and also the more advanced applications of the technology of air conditioning and refrigeration.
- 1.8 Consultations were held with the following individuals, either in group meeting or individual conferences:
 - Mr. Mustafa Kazziha, Technical Education Directorate, Ministry of Education, S.A.R.
 - Mr. Munir Azzam, Director, Directorate of Planning, Ministry of Education, S.A.R.

- Mr. Sharifuodin Mohammed, Director of Technical Education, Ministry of Education, S.A.R.
- Mr. Ayman Muwakki, Engineer, School Building Institute, Damascus, S.A.R.
- Mr. Farouk Khatly, Director, Intermediate Technical Institute, Damascus, S.A.R.
- Mr. Riad Alizam, Architect for Dier-Ez-Zor School, Damascus, S.A.R.
- Mr. Hisham Shamout, Director, Technical Secondary School, Damascus, S.A.R.
- Mr. C. Lindsay, World Bank
- Mr. Harry Go, World Bank
- Mr. Michael Davis, Commercial Attache, U.S. Embassy, Damascus, S.A.R.
- Mr. Adib El Ahamian, Air Conditioning Engineer, Industrial and Chemical Engineering Union, Damascus, S.A.R.
- Mr. Atif Apu-El-Nassir, Director of Barada Refrigeration Factory, Damascus, S.A.R.
- Mr. Abd El Salam Mostafa, Director Technical School and Industrial Institute, Dier-Ez-Zor, S.A.R.

2. PURPOSE

The primary objective of the air conditioning ventilation and refrigeration curriculum is to provide technicians with skills needed to fill the intermediate position between the engineer who designs the system and the skilled tradesman who installs the system or equipment.

The technician will be familiar with and understand much of both the work of the engineer and the tradesman.

Some graduates will supplement their technical training with additional courses in pedagogy, and will become instructors in technical secondary schools and in some fields in the intermediate institutes themselves.

3. PROGRAM OBJECTIVES

The graduate of an air conditioning ventilation and refrigeration program should be able to perform the following functions:

- 3.1 Service and/or supervise the servicing of equipment.
- 3.2 Calculate cooling, heating, ventilation and refrigeration loads.
- 3.3 Select equipment for air conditioning and refrigeration systems.
- 3.4 Write specifications for air conditioning and refrigeration systems.
- 3.5 Supervise the installation of air conditioning and refrigeration systems.

4. TYPICAL COURSE TITLES FOR AN AIR CONDITIONING VENTILATION AND REFRIGERATION PROGRAM AS FOLLOWS:

AIR CONDITIONING VENTILATION AND REFRIGERATION	Number of Periods per Week	
	Theory	Practical
First Year		
Social Studies and Language	2	1
Industrial Safety	1	-
Principles of Air Conditioning Drawing	-	2
Applied Mathematics	2	1
Applied Physics (Heat, Sound)	1	2
Heat Generation and Fuels	2	3
Refrigeration I	3	5
Ventilation and Air Conditioning I	3	3
Electrical Technology	<u>2</u>	<u>3</u>
Total	16	20
Second Year		
Social Studies and Language	2	1
Industrial Organization	2	-
Applied Mathematics	2	1
Applied Mechanics - Fluid Flow	2	2
Heating and Hot Water Services	2	3
Ventilation and Air Conditioning II	3	3
Refrigeration II	3	3
Electrical Control	2	2
Design Drawing and Fabrication Project	<u>-</u>	<u>3</u>
Total	18	18
<u>LABORATORIES</u>		
Air Conditioning & Refrigerating		
Heating Fuels and Hot Water Systems		
Access to: 1 - Sheet Metal & Plumbing Shop		
2 - Electrical Machinery Laboratory		
3 - Electrical Controls Laboratory		

5. OUTLINE FOR COURSES

The following is a partial list of the course titles and the competencies the student will achieve in the air conditioning and refrigeration curriculum courses.

5.1 Principles of Air Conditioning Drawing

- Be able to read architectural plans and mechanical plans of air conditioning and refrigeration systems.
- Be able to list materials required for a job from working drawings.
- Make piping, duct work and detail drawings using correct symbols.

5.2 Heat Generation and Fuels

- Know characteristics and operating principles and be able to service oil burners, gas burners, furnaces and boilers.
- Know the functions and be able to service the control systems for oil and gas burners.
- Be able to select oil and gas furnaces and boilers to meet specified load requirements.

5.3 Refrigeration I

- Know the theory of the vapor-compression refrigeration system and its component parts.
- Perform service operations such as evacuating and charging the system.
- Calculate refrigeration loads.

5.4 Ventilation and Air Conditioning I

- Determine economical and comfortable indoor design conditions.
- Know the physical properties of air and the use of the psychrometric chart.
- Be able to calculate air conditioning loads.

5.5 Heating and Hot Water Services

- Calculate heating loads.
- Layout warm air systems including duct sizing, supply outlet and return selection.
- Layout hot water and steam heating systems, size piping and select radiation units.

5.6 Ventilation and Air Conditioning II

- Design duct systems and select equipment for all-air conditioning systems.
- Design and select equipment for hot and chilled water air conditioning systems.
- Layout basic air conditioning central systems.

5.7 Refrigeration II

- Select evaporators, compressors, condensers, cooling towers.
- Size refrigeration piping and select accessories.
- Describe the absorption refrigeration cycle.
- Describe and be able to service an automotive refrigeration system.

5.8 Design Drawing and Fabrication Project

- Design refrigeration systems and summer-winter air conditioning systems.
- Layout systems, select equipment and write specifications.
- Make working drawing of systems.

6. PROGRAM RECOMMENDATIONS

- 6.1 In consultation with Mr. Mustafa Kazziha, Inspector of Technical Education and Mr. Abd El Salam Mostafa, Air Conditioning and Refrigeration Technology counterpart, it was decided to recommend Industrial Planning (2 hrs. of theory) be replaced in the first year by Principles of Air Conditioning Drawing (2 hrs. of practical). Students entering the Air Conditioning and Refrigeration Program will have had mechanical drawing but will lack piping and duct work drawing which is necessary for design drawing and the fabrication project, as scheduled for the 2nd year. The addition of Principles of Air Conditioning Drawing in the first year should correct their deficiency.
- 6.2 It is recognized that the lack of experienced air conditioning and refrigeration instructors familiar with the philosophy of technician education and lacking an in-depth background in the field of air-conditioning will seriously jeopardize the establishment of an effective program. Thus it is recommended that an educational program be established in the United States for the instructors who will be teaching the air conditioning and refrigeration program at the Intermediate Technical Institute at Homs, and that fellowships be established to support the program.

7. ARCHITECTURAL RECOMMENDATIONS - Spaces 32 & 33

- 7.1 See attached sketches

- 7.2 Space 33 has been reduced in size from 10 m x 20.5 m to 10 m x 18 m. Space 32 has been increased from 10 m x 9 m to 10 m x 11.5 m.
- 7.3 Space 32 and 33 should be equipped with, 2 each, service sinks with water faucets and drains.
- 7.4 Each space should be equipped with an overhead door for moving large equipment into the laboratory. Largest piece of equipment specified for spaces 32 & 33 is 8 ft. long x 4 ft. wide x 7 ft. high.

AIR CONDITIONING AND REFRIGERATION - EQUIPMENT

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
E-AC-1	H-32-1-(1)	<u>Oil Burner Trainer</u> - For teaching the operation and servicing of oil burners; fully operative unit with standard gun-type oil burner; easy access to combustion chamber, nozzle and ignition points; easily cleanable observation window to observe flame and effect of adjustments; both cadmium cell (photoelectric) and mechanical types of flame safety equipment interchangeable on unit; stack draft control; 2 extra burner nozzles with different ratings and discharge angles; fuel tank; oil pressure gage on pump; mounted on cabinet. Unit should be equal in capability to Brodhead-Garrett model 9901.
E-AC-2	H-32-2-(1)	<u>Oil Burner Trainer Test Equipment Package</u> - For use with E-AC-1; to contain the following: 1 heating system analyzer; 1 draft gauge; 1 CO ₂ and O ₂ Flue gas analyzer set; 1 smoke test set. Package to be equal to Brodhead-Garrett, model # 9950.
E-AC-3	H-32-3-(1)	<u>Gas Burner Trainer</u> - For: demonstrating all test and adjustments required on modern gas fired equipment; standard forced air furnace heat exchanger and gas manifold; draft diverter on top of heat exchanger; thermopile gas safety and control equipment supplied; gas pressure regulator; complete unit mounted on cabinet to operate. Equal to Brodhead Garrett model 9902.
E-AC-4	H-32-4-(1)	<u>Gas Burner Trainer Test Equipment Package</u> - For use with E-AC-3 to contain the following: 1 heating system analyzer; 1 draft gauge; 1 CO ₂ and O ₂ Flue gas analyzer set; 1 smoke test set. Package to be equal to Brodhead-Garrett Model # 9951.
E-AC-5	H-32-5-(1)	<u>Electric Heat Control Training Board</u> - For teaching wiring and trouble shooting for an electric furnace; system can be wired by student; three-element furnace; sequencer; Klixon limit switch; fusible link safety device; thermostat; transformer and fan delay control; electric lights simulate heater elements and indicate when fan is running; wiring visible but completely protected. Equal to Brodhead Garrett model # 9230.

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AIR CONDITIONING AND REFRIGERATION - EQUIPMENT

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
E-AC-6	H-32-6-(1)	<u>Forced Air Control Training Board, Oil Fired</u> - For teaching control principles and wiring for oil fired forced air furnace with summer air conditioning; board to contain complete set of operating controls including: stack relay, and cadmium cell types of flame safety, devices, heating-cooling thermostat, fan and limit switch and fan relay; action of all units to be indicated by signal lamps; unit to be designed for use on bench or table. Equal to Brodhead-Garrett model # 9210.
E-AC-7	H-32-7-(1)	<u>Forced Air Control Training Board, Gas Fired</u> - For demonstrating the wiring system and controls for a gas fired forced air furnace with summer air conditioner; components mounted on board; wires brought from component terminals to strip on board for easy wiring; Control equipment for both thermocouple with thermopile systems supplied; simulated operation of burner valves, circulating fan, and air conditioning compressor shown by signal lamps on board. Equal to Broadhead Garrett model # 9205.
E-AC-8	H-32-8-(1)	<u>Forced Air Heating Training Unit</u> - For teaching the principles and practices of forced warm air heating systems including air balancing, temperature control, humidity control, air distribution, relative humidity and dew-point measurement; unit to consist of residential size (approximately 80,000 B.T.U./hr capacity) furnace with variable speed fan, oil fired; oil tank, high capacity humidifier, diffusers for perimeter heating, ceiling diffusers, wall registers, complete control system including damper operated zone control; all components to be full size, completely operable, standard make equipment; unit to be a complete package ready for operation. Equal to Brodhead-Garrett model # 9805.
E-AC-9	H-32-9-(1)	<u>Hydronic (Circulated Hot Water) Heating Training Unit</u> - For teaching the principles and practices of hot water heating systems including heat transfer devices such as baseboard radiation and convection unit heaters, multizone controls, hot water systems balancing, temperature control and combustion principles; unit to consist of residential size (approximately 100,000 B.T.U./hr capacity) gas fired boiler, recirculating pump, cast iron radiator, cast iron baseboard radiation,

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AIR CONDITIONING AND REFRIGERATION - EQUIPMENT

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
E-AC-9 (Cont'd)	H-32-9-(1)	tinned tube radiation, forced convection unit heater, complete control system with zone valves for multizone controls; all components to be full size, completely operable, standard make equipment; unit to be completely packaged ready for operation. Equal to Brodhead-Garrett model # 9808.
E-AC-10	H-32-10-(1)	<u>Electric Heat Training Unit</u> - To teach the fundamentals of electric heat devices including central heating systems, baseboard heaters, wall mounted resistance heaters and in-the-ceiling heat cables; electric furnace with approximate capacity of 34,000 B.T.U./hr; zone controls; simulated wall with diffusers; duct system; temperature control system with sequencers, damper control, heat cables; all components to be full size, completely operable, standard make equipment; unit to be completely packaged ready for operation. Equal to Brodhead Garrett catalog model # 9811.
E-AC-11	H-32-11-(1)	<u>Fluid Circuit System Trainer</u> - To teach the principles of incompressible fluids (water) in piping systems; pump; motor; calibrated tank; several pipes of equal length but different diameters; associated valves, fittings, orifice meter, venturi meter differential pressure manometers, quick couples to pressure points. Equal to "Technovate" Inc. Fluid Circuit System, model # 9009.
E-AC-12	H-32-12-(1)	Vari-Speed, Multi-Fan Air Distribution Learning System - Unit shall be self-contained, mobile, vari-speed, multi-fan, air distribution system; for operational studies of residential, commercial and industrial air distribution as an independent service or as a part of a total controlled-environment system and shall meet the following specification:

AIR CONDITIONING AND REFRIGERATION - EQUIPMENT

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION															
E-AC-12 (Cont'd)	H-32-12-(1)	<p align="center"><u>Instrumentation</u></p> <table border="0"> <tr> <td>Tachometer (rpm)</td> <td></td> <td>0-3000</td> </tr> <tr> <td>Ammeter (Ampr)</td> <td></td> <td>0-25</td> </tr> <tr> <td>Magnehelic pressure gages</td> <td>Two</td> <td>0-2.0</td> </tr> <tr> <td>(inches of water)</td> <td>One</td> <td>0-1.0</td> </tr> <tr> <td>Pilot probe</td> <td></td> <td>12 inch.</td> </tr> </table> <p>Motor-type; constant-speed capacitor-start rating $\frac{1}{4}$ H.P.; basic experiments package and high-velocity experiments package to be included. Unit to be Technovate Inc. Air Distribution Variable Speed, Multi-Fan Air Distribution System model 9007 with all available accessories.</p>	Tachometer (rpm)		0-3000	Ammeter (Ampr)		0-25	Magnehelic pressure gages	Two	0-2.0	(inches of water)	One	0-1.0	Pilot probe		12 inch.
Tachometer (rpm)		0-3000															
Ammeter (Ampr)		0-25															
Magnehelic pressure gages	Two	0-2.0															
(inches of water)	One	0-1.0															
Pilot probe		12 inch.															
E-AC-13	H-32-13-(6)	<p><u>Oil Burner</u> - For teaching oil burner service and repair, disassembly and assembly; modern pressure atomizing gun type; residential capacity; standard make; complete oil burner.</p>															
E-AC-14	H-33-14-(1)	<p><u>Forced Air Heating Training Unit with Summer Air Conditioning Training Unit</u> - For teaching the principles and practices of forced air winter-summer air conditioning; residential size (approximately 100,000 B.T.U./hr capacity) gas fired furnace with variable speed fan; high capacity humidifier, diffusers for perimeter heating, ceiling diffusers, wall registers, ducts, refrigeration condensing unit, direct expansion refrigeration coil in plenum or duct; complete summer-winter air conditioning temperature control system; all components to be full size, completely operable, standard make equipment; unit to be completely packaged ready for operation. Equal to Brodhead Garrett model # 9804.</p>															
E-AC-15	H-33-15-(1)	<p><u>Hydronic (Circulated Hot Water and Chilled Water) Heating System Trainer With Summer Chilled Water Cooling System</u> - For teaching the principles and practices of winter-summer hydronic air conditioning; residential size (approximately 80,000 B.T.U./hr capacity) oil fired boiler; recirculating pump; cast iron radiator; cast iron base board radiation; finned tube radiation; forced convection unit heater; forced convection unit for hot water heating</p>															

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AIR CONDITIONING AND REFRIGERATION - EQUIPMENT

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
E-AC-15 (Cont'd)	H-33-15-(1)	and chilled water cooling (chilled water room conditioner); water chiller, complete control system with zone valves for multizone control; summer-winter switch over control; all components to be full size, completely operable, standard make equipment; unit to be completely packaged ready for operation. Equal to Brodhead Garrett model # 9807 and 9809 combined.
E-AC-16	H-33-16-(1)	<u>Programmable Compressor Trouble Shooting Center</u> - For teaching compressor trouble shooting; compressor is a standard operating fully hermetic compressor instructor implements defect by switches on back of panel; student turns selector switch to his diagnosis made with use of panel mounted instrumentation; pushing button will light up signal lamp next to diagnosis if correct; typical malfunctions include moisture in compressor, windings shorted; grounded, open, shorted, bad capacitor, bad starting relay, etc.; instrument mounted on board includes voltmeter, ohmmeter, ammeter, capacitor analyzer, potential and current relay tester and megometer; panel complete with panel mounted instruments ready for mounting on bench or tables. Equal to Brodhead Garrett model # 9225.
E-AC-17	H-33-17-(1)	<u>Single Phase Compressor Control Board</u> - To demonstrate all the common types of control in refrigeration and air conditioning systems; compressor and other components are full-size completely operable standard make equipment; compressor is full hermetic type; various components may be put into system with patch cords into plug-in jacks; voltage and currents required to operate current and potential relays are read on the compressor as it runs; shut off valves in suction and discharge lines allow pressure to be varied to operate low pressure control and high pressure cut out; capacitors supplied for capacitor start systems, PSC (permanent split capacitors) and running capacitors; control board to be designed for mounting on bench or table completely assembled and ready to operate. Equal to Brodhead Garrett model # 9215.

AIR CONDITIONING AND REFRIGERATION - EQUIPMENT

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
E-AC-18	H-33-18-(3)	<p><u>Fundamentals of Refrigeration Demonstrator</u> - To teach the student the basic refrigeration cycle and its components; system to be capillary tube system with air cooled condenser, full flooded type evaporator and hermetic compressor; high and low side pressure gages permanently mounted; sight glasses located at both inlet and outlet of evaporator and condenser; temperature wells located throughout system for temperature monitoring with an electronic thermometer. Equal to Brodhead Garrett model # 9240.</p>
E-AC-19	H-33-19-(1)	<p><u>Commercial Refrigeration Training Unit with Multiple Evaporators</u> - To teach the principles and practices of multiple evaporator commercial refrigeration systems; single phase semi-hermetic (bolted) type reciprocating compressor, two forced convection evaporators with variable speed blowers, forced convection condenser with variable speed blower, evaporators may be used in series or parallel, each evaporator provided with capillary tube and thermostatic expansion valve; wells for electronic thermometers at all points where temperature differential exists; flow meters in liquid lines to evaporators; mal-functions simulated by hand valves; controls included; pressure gages permanently mounted where significant pressure changes occur; mounted on cabinet with backboard. Unit equal to Brodhead Garrett model # 9501.</p>
E-AC-20	H-33-20-(1)	<p><u>Basic Refrigeration Theory Trainer Single Evaporator System</u> - To teach the theory and practice of single evaporator systems; single phase hermetically sealed reciprocating compressor, evaporator with variable speed blower, condenser with variable speed blower, low pressure high pressure and thermostat controls, evaporator and condenser with glass tube inlet and outlet wells for electronic thermometer located ahead and after each component having a temperature differential; pressure gages where pressure differentials occur; flow meter in liquid line, refrigerant metering to evaporator by capillary tube or thermal expansion valve; may be operated as a heat pump (Reverse Cycle); completely self contained mounted on cabinet with backboard. Equal to Brodhead Garrett model # 9001.</p>

AIR CONDITIONING AND REFRIGERATION - EQUIPMENT

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
E-AC-21	H-33-21-(1)	<u>Light Commercial Air Conditioner</u> - A built-up training unit to simulate small office air conditioning system; student can assembly units making a complete system; 1 H.P. semi-hermetic compressor with water cooled condenser; 1 ton air handler with centrifugal blower thermal expansion valve, dryer, sight glass and temperature control; mounted on structural supporting frame. Unit equal to Brodhead Garrett model # 9111.
E-AC-22	H-33-22-(4)	<u>Installation Kit</u> - For Item E-AC-21 - consisting of tubing, wiring, electrical connections and copper fittings; equal to Brodhead Garrett model # 9111K.
E-AC-23	H-33-23-(1)	<u>Auxillary Apparatus Unit</u> - For Item E-AC-21 - Consisting of: 1 Oil Separator 1 Accumulator 1 Evaporator pressure regulator 1 Crank case pressure regulator 1 Heat exchanger 1 Flow meter Equal to Brodhead Garrett catalog # 9113.
E-AC-24	H-33-24-(1)	<u>Cooling Tower</u> - For Item E-AC-21 - Cooling tower to supply cooling water to Item E-AC-21; complete with installation supplies; centrifugal pump and water temperature control. Equal to Brodhead Garrett model # 9112.
E-AC-25	H-33-25-(1)	Domestic Refrigeration Trainer Build-Up Unit, Double Evaporator - Simulates modern 2 door refrigerator type application; 1/4 M.P. hermetic compressor; air cooled condenser; domestic freezer evaporator; finned high humidity evaporator; capillary tube; dehydrator; temperature control; hand valve to regulate temperature difference in evaporator; unit to be mounted on cabinet with backboard for mounting of components. Equal to Brodhead Garrett model # 9102.

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AIR CONDITIONING AND REFRIGERATION - EQUIPMENT

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
E-AC-26	H-33-26-(4)	<u>Installation Kit</u> - For Item E-AC-25 - Consisting of: tubing, wiring, electrical connections and copper fittings. Equal to Brodhead Garrett # 9102K.
E-AC-27	H-33-27-(1)	<u>Heat Pump Training Unit</u> - To teach the theory and application of the heat pump; standard commercial heat pump installed on base cabinet with simulated wall. The front deck simulates the outdoor portion of the heating system; easy access to compressor, evaporator, reversing valve and external equalized expansion valve; interior of building simulated on back side of wall with condenser expansion valve and complete electrical control system; control system can be wired by student; unit mounted free standing with storage area and casters. Unit uses R-22 refrigerant. Equal to Brodhead Garrett model #9050.
E-AC-28	H-33-28-(2)	<u>Automotive Air Conditioning Trainer</u> - Factory installed type air conditioner unit complete with heater coil; an electric heating unit to heat water for heater coil and pump to circulate water through conditioner; approximately 3 H.P. meter with variable speed drive, tachometer, refrigerant meter; special control equipment used by various car manufacturers; uses R-12 refrigerant; unit mounted, self contained on storage cabinets. Equal to Brodhead Garrett model # 9303.
E-AC-29	H-33-29-(2)	<p><u>Automotive Air Conditioning and Service Equipment Package</u> - Complete package of automobile air conditioning service and test equipment for use with Item E-AC-28; package to consist of the following items (minimum):</p> <ul style="list-style-type: none"> 1 Electronic thermomenter (Thermal Deluxe Temperature check or equivalent) with a minimum of 4 low temperature probes. 1 Testing manifold and gauge set with hoses. 1 Special auto air conditioning tool set with special tools for all types of automotive air conditioners. 1 Halide leak detector.

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AIR CONDITIONING AND REFRIGERATION - EQUIPMENT

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
E-AC-29 (Cont'd)	H-33-29-(2)	<p>1 Thermal model 7153 or equivalent. Evacuating and charging station (Brodhead Garrett model # 7153).</p> <p>1 Ratchet type valve wrench.</p> <p>1 Kit of special automotive air conditioning test fittings.</p> <p>1 9201 Refrigeration Demonstrator.</p> <p>Above items equal to items in Brodhead Garrett 9350.</p>
E-AC-30	H-33-30-(6)	<p><u>Open Type Refrigeration Compressor</u> - Compressor complete with service valves; for student disassembly and reassembly training; approximately 1 H.P., standard make.</p>
E-AC-31	H-33-31-(6)	<p><u>Semi-Hermetic Compressor</u> - For student disassembly and reassembly; bolted type; approximately 1 H.P. capacity; with service valves; standard make.</p>
E-AC-32	H-33-32-(6)	<p><u>Thermostatic Expansion Valve</u> - For student disassembly and assembly; externally equalized; approximately 1 ton capacity; adjustable super heat, loose assembled; standard make.</p>
E-AC-33	H-33-33-(6)	<p><u>Thermostatic Expansion Valve</u> - For student disassembly and assembly; internally equalized; approximately 1 ton capacity; adjustable super heat; standard make.</p>
E-AC-34	H-32-34-(3)	<p><u>Heating Test Equipment Package</u> - For use with E-AC-8, E-AC-9, E-AC-10; test package to contain following minimum equipment:</p> <p>1 Heating system analyzer - volt ohmeter and millivoltmeter with power source for testing thermocouple and thermopile safety equipment; also thermocouple thermometer to read flue temperature with scale approximately 0-10-00°F.</p>

AIR CONDITIONING AND REFRIGERATION - EQUIPMENT

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
E-AC-34 (Cont'd)	H-32-34-(3)	<ul style="list-style-type: none"> 1 Thermister type electronic thermometer approximately range - 50° to +400°F, min 4 low temperature probes and 1 high temperature probe, dew point indicator approximate range -30° to +100°F. 1 Sling Psychrometer. 1 Vane type velocity meter to measure air flow from registers. 1 Direct reading velocity meter to balance air flow. 1 Draft gauge to measure furnace draft and duct pressure. 1 Manometer to measure gas and air pressure. 1 CO₂ analyzer to check CO₂ content of flue gases 0-20% range and oxygen analyzer to check content of flue gas or any gas mixture, 0-20% range. 1 Portable test stand for above items. <p>Equipment equal to that listed in Brodhead Garrett catalog model # 9850.</p>
E-AC-35	H-33-35-(2)	<p><u>Heating Test Equipment Package</u> - For use with item # E-AC-14, E-AC-15; to contain the following minimum equipment;</p> <ul style="list-style-type: none"> 1 Heating system analyzer - volt ohmeter and millivoltmeter with power source for testing thermocouple and thermopile safety equipment; also thermocouple thermometer to read flue temperature with approximate range of 0-1500°F. 1 Hermetic compressor analyzer to check air conditioning compressor. 1 Sling psychrometer. 1 Vane type air velocity meter to check air flow from registers. 1 Direct reading velocity meter to balance air flows. 1 Component analyzer to check electrical components. 1 Draft gauge to measure furnace draft and duct pressure. 1 Manometer to measure gas and air pressures. 1 CO₂ analyzer to check CO₂ content flue gases 0-20% range and oxygen analyzer to check oxygen content of flue gas or any gas mixture, 0-20% range.

AIR CONDITIONING AND REFRIGERATION - EQUIPMENT

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
E-AC-35 (Cont'd)	H-33-35-(2)	<ul style="list-style-type: none"> 1 Direct reading humidity meter to measure relative humidity in room or air flow. 1 Amprobe clamp-on type ammeter. 1 CO indicator to measure CO in flue gas or any enclosed space where CO would be dangerous. 1 Portable test stand for above equipment package. <p>Equipment equal to that listed in Brodhead Garrett catalog number model 9850.</p>
E-AC-36	H-33-36-(2)	<p><u>Refrigeration and Air Conditioning Test Equipment Package</u> - For use with Item # E-AC-19 and E-AC-20; to consist of the following items equal to or equivalent to Test Equipment Package model 9600E Brodhead Garrett catalog.</p> <p>Test Equipment Package is made up of the following items:</p> <ul style="list-style-type: none"> 1 Thermal Super Hermeti-Check Compressor Analyzer to analyze compressor problems and to start compressors without the original electrical components. 1 Thermal Super Compon-E-Check Component Analyzer with voltmeter, ohmmeter, capacitor and relay tester in a compact unit. 1 Thermal Deluxe Temp-Check Electronic Thermometer to check temperatures of -50 to +400°F at up to six locations with 4 low temperature probes and 2 high temperature probes. 1 Thermal Catalog Number 1801, 1.25CFM two-stage vacuum pump to evacuate systems below 100 microns. 1 Thermal Super Vak-Check Vacuum Gauge with thermistor sensor to read vacuums to microns. Battery operated. 1 Thermal 2½ lb Charging Cylinder in metal case to charge correct amount of refrigerant into systems. 1 Tong type clamp-on Ammeter with ranges of 0-5, 15, 40, 100 amps to measure current draw in any AC circuit.

AC-21

AIR CONDITIONING AND REFRIGERATION - EQUIPMENT

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
E-AC-36 (Cont'd)		<ul style="list-style-type: none"> 1 Thermal Charge-Oil Pump to fit directly to a one gallon oil can and charge oil into a compressor under pressure. 1 Electronic Leak Detector - Battery operated - to detect refrigerant leaks and indicate. 1 Catalog Number 9201 Refrigerant Demonstration Unit to teach fundamental pressure temperature relationships of refrigerants.
E-AC-37	H-33-37-(5)	<p><u>Refrigeration Test Equipment Package</u> - For use with Items number E-AC-18, E-AC-21, E-AC-25. Package to consist of the following minimum items equal to items listed in Brodhead Garrett catalog 48th edition page 587, model 9600.</p> <ul style="list-style-type: none"> 1 Thermal Super Hermeti-Check Hermetic Compressor Analyzer to analyze compressor problems and to start compressors without the original electrical components. 1 Thermal Super Compon-E-Check Component Analyzer with voltmeter, ohmmeter, capacitor and relay tester in a compact unit. 1 Thermal Deluxe Temp-Check Electronic Thermometer to check temperatures of -50 to +400°F at up to six locations with 4 low temperature probes and 2 high temperature probes. 1 Thermal Super Vak-Check Vacuum Gauge with thermistor sensor to read vacuums to 10 microns. Battery operated. 1 Tong type clamp-on Ammeter with ranges of 0-5, 15, 40, 100 amps to measure current draw in any AC circuit.
E-AC-38	H-33-38-(2)	<p><u>Mobile Charging and Testing Station</u> - To service air conditioning and refrigeration equipment; unit to consist of vacuum pump, charging and testing manifold complete with pressure gauge and compound gauge, 60 inches charging lines and 5 lb charging cylinder; Brodhead Garrett # 7153 or equivalent.</p>

AIR CONDITIONING AND REFRIGERATION - EQUIPMENT

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
E-AC-39	H-32-39-(4) H-33-39-(4)	<p><u>Air Velocity Meter</u> - For measuring static and total duct pressure, combination inclined/vertical manometer, range inches of water minimum 0-5 inches, corresponding velocity scale minimum 400 to 9,000 feet per minute; minor scale divisions for inclined section .01 inches from 0.0 inches to 1.0 inches W.C., vertical section scale division .10 from 1.0 inches to 1.5 inches W.C., leveling screws and calibration adjustment with ground glass bubble level. Accessories to include: stainless steel calibrated pitot tube (minimum length 18 inches) graduated on both sides to show insertion depth for accurate duct traverse, suitable for temperatures up to approximately 1500°F; two coils of rubber tubing (minimum length 9 feet) with metal terminal tubes; magnetic clips for attaching instrument to steel duct or surface; spare bottle of gage oil; carrying case lined and fitted to protect meter and accessories. Instructions to be included.</p>
E-AC-40	H-32-40-(4) H-33-40-(2)	<p><u>Mechanical Draft Inducer</u> - For use where flue is not available; for units E-AC-1, E-AC-3, E-AC-8, E-AC-9, E-AC-14, E-AC-15. Brodhead Garrett catalog # Q 8.</p>

MASTER EQUIPMENT LISTAIR CONDITIONING & REFRIGERATIONGeneral Specifications

1. All packaged educational training units should include student laboratory manuals which contain an introduction to principles, pre-laboratory questions, laboratory procedure and past laboratory exercises for major experiments that can be performed on a specific training unit. Each training unit should include 4 copies of the student laboratory manual applicable to that specific unit.
2. Where available 4 copies of the instructors manual should be included with each training unit package.
3. All instruments are to be accompanied by at least 2 instruction booklets covering usage and servicing of the instrument.
4. All training units electrically powered are to be single phase, 220V, AC 50 cycle current unless otherwise noted.
5. The source of most of the training units is the Brodhead-Garrett Co. as they are the only known supplier of these highly specialized units. Catalog numbers are from Brodhead-Garrett, 48th Edition, 1976-77 Catalog.
6. All packaged training units are to be complete, ready to operate with fittings, electric cord, etc. for connection to required building services.
7. All printed instructional material is to be of the latest edition available on the date the order is shipped by the supplier.
8. Gages and instruments may be furnished in metric if available.

MASTER EQUIPMENT LIST
AIR CONDITIONING & REFRIGERATION
EQUIPMENT

REFERENCE NUMBER	DESCRIPTION	QUANTITY	UNIT	TOTAL
E-AC-1	Oil Burner Trainer	1	1,495	1,495
E-AC-2	Oil Burner Trainer Test Equipment Package	1	395	395
E-AC-3	Gas Burner Trainer	1	970	970
E-AC-4	Gas Burner Trainer Test Equipment Package	1	440	440
E-AC-5	Electric Heat Control Board	1	345	345
E-AC-6	Forced Air Control Board, Oil Fired	1	450	450
E-AC-7	Forced Air Control Board, Gas Fired	1	420	420
E-AC-8	Forced Air Heating Training Unit, Oil Fired	1	3,000	3,000
E-AC-9	Hydronic (Circulated Hot Water) - Heating Training Unit with L.P. Gas Fired Boiler	1	2,580	2,580
E-AC-10	Electric Heat Training Unit	1	2,275	2,275
E-AC-11	Fluid Circuit System Trainer	1	2,900	2,900
E-AC-12	Vari-Speed, Multi-Fan Air Distribution Learning System	1	4,660	4,660
E-AC-13	Oil Burner	6	100	600
E-AC-14	Forced Air Heating Training Unit (L.P. Gas Fired) with summer air conditioning	1	3,270	3,270
E-AC-15	Hydronic Heating System Trainer with Water Chiller and Room Conditioner for summer-winter air conditioning	1	3,970	3,970
E-AC-16	Programmable Compressor Trouble Shooting Center with Instrumentation	1	600	600
E-AC-17	Single Phase Compressor Control Board	1	400	400
E-AC-18	Fundamentals of Refrigeration Demonstrator	3	385	1,155
E-AC-19	Commercial Refrigeration Training Unit, Air Cooled Condenser, Multiple Evaporator (2 system)	1	2,700	2,700
E-AC-20	Basic Refrigeration Theory Trainer, Single Evaporator System	1	1,800	1,800
E-AC-21	Light Commercial Air Conditioning Build-up Unit	1	1,250	1,250
E-AC-22	Installation Kit for Item E-AC-21	4	50	200
E-AC-23	Auxillary Apparatus Unit for Item E-AC-21	1	300	300

MASTER EQUIPMENT LIST
AIR CONDITIONING & REFRIGERATION
EQUIPMENT

REFERENCE NUMBER	DESCRIPTION	QUANTITY	UNIT	TOTAL
E-AC-24	Cooling Tower for Item E-AC-21	1	800	800
E-AC-25	Domestic Refrigeration Trainer Build-up Unit Double Evaporator	1	650	650
E-AC-26	Installation Kit for item E-AC-25	4	38	152
E-AC-27	Heat Pump Training Unit	1	2,000	2,000
E-AC-28	Automotive Air Conditioning Trainer	2	2,500	5,000
E-AC-29	Automotive Air Conditioning Service Equipment Package (complete)	2	800	1,600
E-AC-30	Open Type Refrigeration Compressor	6	150	900
E-AC-31	Semi-Hermetic Compressor (Bolted)	6	200	1,200
E-AC-32	Thermostatic Expansion Valve, Externally Equalized	6	34	204
E-AC-33	Thermostatic Expansion Valve, Internally Equalized	6	34	204
E-AC-34	Heating Test Equipment Package for use with items # E-AC-8, E-AC-9, E-AC-10	3	870	2,610
E-AC-35	Heating Test Equipment Package for use with items # E-AC-14, E-AC-15	2	1,650	3,300
E-AC-36	Refrigeration Test Package for use with items # E-AC-19, and E-AC-20	2	1,300	2,800
E-AC-37	Refrigeration Test Package for use with items # E-AC-18, E-AC-21, E-AC-25	5	500	2,500
E-AC-38	Mobile Charging and Testing station	2	310	620
E-AC-39	Air Velocity Meter-Inclined Manometer	8	100	800
E-AC-40	Mechanical Draft Inducer	6	260	1,560

AIR CONDITIONING AND REFRIGERATION - FURNITURE

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
F-AC-1	H-32-1-(8) H-33-1-(8)	<u>Sliding Door Cabinet</u> - Heavy duty; sliding doors with nylon rollers; master keyed cylinder lock; center shelf; 2-1/4 inch thick heavy duty work surface of laminated full length maple strips; natural lacquer finish; 30" deep x 33" high x 6' long.
F-AC-2	H-32-2-(3) H-33-2-(5)	<u>Portable Test Stand</u> - Approximately 48" x 24" x 30" high; with casters; heavy duty laminated maple top; sliding doors with lock; 1 adjustable shelf; equal to portable test stand Brodhead Garrett model #9650 without instruments; for use with items E-AC-5, 6, 7, 16, 17 and 18.
F-AC-3	H-32-3-(3) H-33-3-(3)	<u>Tool Cart</u> Steel; approximately 24" long x 15" wide and 34-1/2" high; two 4" high drawers on nylon glides; 2-1/2" rubber casters.
F-AC-4	H-32-4-(3) H-33-4-(3)	<u>Steel Storage Cabinet</u> - Approximate dimensions 36" wide x 18" deep x 87" high; double swing doors; built in cylinder lock; painted; 6 shelves.
F-AC-5	H-32-5-(2) H-33-5-(2)	<u>Hardware Cabinet</u> - Approximate size 36" wide x 12" deep x 87" high; contains 1 bin 36" wide x 12" deep x 11" high; 3 bins approximate 12" wide x 12" deep x 12" high; 12 bins approximate 6" wide x 12" deep x 12" high; one 18 drawer unit each drawer 5-1/4" wide x 11" deep x 2-5/8" high with 2 adjustable dividers per drawer; 16 box drawers each 8-1/4" wide x 11-3/4" deep x 4-5/8" high; with one adjustable divider per drawer; double doors; master keyed lock.

MASTER EQUIPMENT LIST
AIR CONDITIONING & REFRIGERATION
FURNITURE

REFERENCE NUMBER	DESCRIPTION	QUANTITY	UNIT	TOTAL
F-AC-1	Sliding Door Cabinet with heavy duty maple top for workbench use	16	240	3,840
F-AC-2	Portable Test stand for use with items # E-AC-5, 6, 7, 16, 17, 18	8	220	1,760
F-AC-3	Tool Cart	6	80	480
F-AC-4	Steel Storage Cabinet	6	140	840
F-AC-5	Hardware Cabinet	4	360	1,440

AIR CONDITIONING AND REFRIGERATION - SMALL TOOLS

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION																																																		
S-AC-1	H-32-1-(1) H-33-1-(1)	<p><u>Refrigeration and Air Conditioning Tool Storage Cabinet</u> - Complete with tools for 20 students; equal to Brodhead Garrett model number TS 21CT. Cabinet includes hangers and hooks to mount the following list of tools in upper cabinet:</p> <table> <tbody> <tr> <td>5 Reversible Ratchet Wrench</td> <td>2 Set Screw Wrenches</td> </tr> <tr> <td>5 Ratchet Adapter Plug</td> <td>2 Pipe Wrench 10"</td> </tr> <tr> <td>25 Flare Nut Wrenches</td> <td>2 Pipe Wrench 18"</td> </tr> <tr> <td>5 Adjustable Wrenches 14"</td> <td>2 Service Valve Kit</td> </tr> <tr> <td>5 Adjustable Wrenches 16"</td> <td>2 Quick Start and Test Lead Kit</td> </tr> <tr> <td>5 Adjustable Wrenches 18"</td> <td>4 Service Gauges</td> </tr> <tr> <td>5 Standard Screwdriver 3"</td> <td>2 Test Plug Kit</td> </tr> <tr> <td>5 Standard Screwdriver 4"</td> <td>2 Inner-Outer Reamer</td> </tr> <tr> <td>5 Standard Screwdriver 8"</td> <td>2 Swaging Tool Set</td> </tr> <tr> <td>5 Screwdriver 10"</td> <td>2 Fuse Puller</td> </tr> <tr> <td>5 Combination Wrench Sets CW1232R</td> <td>2 Charge-Oil Pump</td> </tr> <tr> <td>5 Box Wrench Sets</td> <td>2 Cap-tube Gauge</td> </tr> <tr> <td>7 Tube Cutter</td> <td>2 Crimper Cutter</td> </tr> <tr> <td>5 Flaring Tool</td> <td>2 Protecto Shield</td> </tr> <tr> <td>5 Pinch-off Tool</td> <td>2 Double Flaring Tool</td> </tr> <tr> <td>5 Glass Pocket Thermometer in Steel Case - 30° to 120°F</td> <td>2 Needle Nose Pliers</td> </tr> <tr> <td>5 Dial Pocket Thermometer - -40° to 120°F</td> <td>2 Diagonal Cutting Pliers</td> </tr> <tr> <td>4 #CM 4-15 Manifold</td> <td>2 Rule 10'</td> </tr> <tr> <td>2 Socket Wrench Set</td> <td>1 Flaring and Swaging Tool</td> </tr> <tr> <td>2 Bending Springs</td> <td>1 1/4 Tube Bender</td> </tr> <tr> <td>2 Ball Pein Hammer</td> <td>1 3/8 Tube Bender</td> </tr> <tr> <td>2 Soft Fame Hammer</td> <td>1 1/2 Tube Bender</td> </tr> <tr> <td>2 Hacksaw</td> <td>1 5/8 Tube Bender</td> </tr> <tr> <td></td> <td>1 Gear Puller</td> </tr> <tr> <td></td> <td>1 Tin Snips - Left-10"</td> </tr> </tbody> </table>	5 Reversible Ratchet Wrench	2 Set Screw Wrenches	5 Ratchet Adapter Plug	2 Pipe Wrench 10"	25 Flare Nut Wrenches	2 Pipe Wrench 18"	5 Adjustable Wrenches 14"	2 Service Valve Kit	5 Adjustable Wrenches 16"	2 Quick Start and Test Lead Kit	5 Adjustable Wrenches 18"	4 Service Gauges	5 Standard Screwdriver 3"	2 Test Plug Kit	5 Standard Screwdriver 4"	2 Inner-Outer Reamer	5 Standard Screwdriver 8"	2 Swaging Tool Set	5 Screwdriver 10"	2 Fuse Puller	5 Combination Wrench Sets CW1232R	2 Charge-Oil Pump	5 Box Wrench Sets	2 Cap-tube Gauge	7 Tube Cutter	2 Crimper Cutter	5 Flaring Tool	2 Protecto Shield	5 Pinch-off Tool	2 Double Flaring Tool	5 Glass Pocket Thermometer in Steel Case - 30° to 120°F	2 Needle Nose Pliers	5 Dial Pocket Thermometer - -40° to 120°F	2 Diagonal Cutting Pliers	4 #CM 4-15 Manifold	2 Rule 10'	2 Socket Wrench Set	1 Flaring and Swaging Tool	2 Bending Springs	1 1/4 Tube Bender	2 Ball Pein Hammer	1 3/8 Tube Bender	2 Soft Fame Hammer	1 1/2 Tube Bender	2 Hacksaw	1 5/8 Tube Bender		1 Gear Puller		1 Tin Snips - Left-10"
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AIR CONDITIONING AND REFRIGERATION - SMALL TOOLS

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION																
S-AC-1 (Cont'd)		<table border="0"> <tr> <td>2 Rib Joint Plier 10"</td> <td>1 Tin Snips - Right-10"</td> </tr> <tr> <td>2 Slip Joint Plier</td> <td>1 Tin Snips - Combination-10"</td> </tr> <tr> <td>2 Nut Driver Set</td> <td>1 Feeler Gauge</td> </tr> <tr> <td>2 Phillips Screw Drivers 3"</td> <td>1 Cap-Check Kit</td> </tr> <tr> <td>2 Phillips Screw Drivers 4"</td> <td>2 Refrigeration Demonstrators</td> </tr> <tr> <td>2 Phillips Screw Drivers 6"</td> <td></td> </tr> <tr> <td>2 Phillips Screw Drivers 8"</td> <td></td> </tr> <tr> <td>2 Offset Screwdrivers</td> <td></td> </tr> </table>	2 Rib Joint Plier 10"	1 Tin Snips - Right-10"	2 Slip Joint Plier	1 Tin Snips - Combination-10"	2 Nut Driver Set	1 Feeler Gauge	2 Phillips Screw Drivers 3"	1 Cap-Check Kit	2 Phillips Screw Drivers 4"	2 Refrigeration Demonstrators	2 Phillips Screw Drivers 6"		2 Phillips Screw Drivers 8"		2 Offset Screwdrivers	
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S-AC-2	H-32-2-(1) H-33-2-(1)	<u>Safety Goggle Storage Cabinet</u> - Metal, wall mounted 30" wide x 36" high x 12" deep; double doors with snap catch; complete with 24 pairs safety goggles; clear poly carbonite lens; single piece headband; flexible frame; fully ventilated.																
S-AC-3	H-32-3-(2) H-33-3-(2)	<u>Soldering, Heating, Brazing Kit</u> - Complete with torch handle with shuf-off valve and pressure regulator; 3 torch stems, fine, light, medium; leak dectector stem; suction hose 3 ft.; fitted hose assembly, 12-1/2 ft, 3/16 in diameter; enameled steel carrying case; for use with "B" tank.																
S-AC-4	H-32-4-(6) H-33-4-(6)	<u>Swivel Base Machinists' Vise</u> - Jaw width 4-1/2", Jaw opening 7"; swivel base; replaceable "T" section jaw faces; self-lubricating bronze thrust bearing; ground and polished anvil; unbreakable malleable iron casting. Similar to Brodhead Garrett # 604-1/2 M2.																

MASTER EQUIPMENT LIST
AIR CONDITIONING & REFRIGERATION
SMALL TOOLS

REFERENCE NUMBER	DESCRIPTION	QUANTITY	UNIT	TOTAL
S-AC-1	Refrigeration and Air Conditioning - Tool Storage Cabinet complete with tools for 20 students	2	2,300	4,600
S-AC-2	Metal Safety Glass Cabinet complete with 24 pairs goggles	2	200	400
S-AC-3	Complete Soldering Kit	4	80	320
S-AC-4	Swivel Base Machinists' Vise	12	160	1,920

AIR CONDITIONING AND REFRIGERATION - INSTRUCTIONAL MATERIALS

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
I-AC-1	H-32-1-(1)	<u>8mm Film Loop, Refrigeration: Motors Controls and Testing</u> - Set of 6 film loops; consisting of the following: Single Phase Motor Compressors; How Single Phase Motors Operate; Capacitor Start Run (C.S.R.) and Permanent Split Capacitor (C.S.P.); Meters and How to Use Them; Locating Terminals on Unmarked Dome; Testing Relays, Capacitors and Fuses. Brodhead Garrett catalog # VE 4073.
I-AC-2	H-32-2-(1)	<u>8mm Film Loop, Refrigeration: Multiple Temperature Evaporators</u> - Set of 5 film loops; consisting of the following: Installation on Valves; Surge Tank and Oil Separator; Thermostat and Solenoid Valve; Short-Cycling of Compressor; Sizing Liquid Reservoirs. Brodhead Garrett catalog # VE 4097.
I-AC-3	H-32-3-(1)	<u>8mm Film Loop, Instrumentation: Flow control Devices</u> - Set of 6 film loops; consisting of the following: Flow Properties and Measurement; Measuring Elements Part I; Measuring Elements Part II; Flow Control Systems Part I; Flow Control Systems Part II; Air Flow; Brodhead Garrett catalog # VE 4095.
I-AC-4	H-32-4-(1)	<u>8mm Film Loop, Instrumentation: Pressure Control Devices</u> - Set of 6 film loops; consisting of the following: Bourbon Tube, Forms; Diaphragm, Bellows, Capsule; Regulators; Pressure Controlling Devices; Controlled Devices; Brodhead Garrett catalog # VE 5008.
I-AC-5	H-33-5-(1)	<u>8mm Film Loop, Instrumentation: Temperature Control Devices</u> - Set of 6 film loops; consisting of the following: Sensing Elements; Thermostats; Year' Round Air Conditioning Systems - Summer Mode; Year' Round Air Conditioning Systems - Winter Mode; Alarm and Limiting Thermostats; The Central Control Room. Brodhead Garrett catalog # VE 5009.
I-AC-6	H-32-6-(2) H-33-6-(2)	<u>Chalkboards</u> - Approximately 8 ft long (24 m) x 4 ft high (1.2 m); warp free panel; non-skip chalk surface, chalk easily removable with dry eraser; green non-glare color; frame of aluminum with wide lipped chalk rail; for wall mounting.

AIR CONDITIONING AND REFRIGERATION - INSTRUCTIONAL MATERIALS

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
I-AC-7	H-32-7-(2)	<u>Chalkboard</u> - Portable; hardwood construction, rigidly braced; non glare chalkboard on one side with chalktray; corkboard opposite side; 3½ ft x 5 ft approximate size.
I-AC-8	H-32-8-2 H-33-8-2	<u>Text Book</u> - "Modern Refrigeration and Air Conditioning" by Althouse, Tournquist and Bracciano, Publisher - The Goodheart-Wilcox Company Inc. 123 W. Taft Dr., South Holland, Ill. 60473, U.S.A.
I-AC-9	H-32-9-2 H-33-9-2	<u>Text Book</u> - "Contemporary Industrial Teaching" by Ronald J. Baird, Publisher Willcox Company Inc. 123 W. Taft Dr. South Holland, Ill. 60473, U.S.A.
I-AC-10	H-32-10-2 H-33-10-2	<u>Text Book</u> - "Principles of Refrigeration," by Roy J. Dossat, Publisher - John Wiley and Sons, Inc., U.S.A
I-AC-11	H-32-11-2 H-33-11-2	<u>Text Book</u> - "Air Conditioning and Refrigeration" by William H. Severns and Julian R. Fellows, Publisher John Wiley & Sons Inc. 605 Third Avenue, New York N.Y. 10016, U.S.A
I-AC-12	H-32-12-2 H-33-12-2	<u>Manual</u> - "Trane Air Conditioning Manual," Publisher The TRANE Company, Educational Division, La Crosse, Wisconsin, U.S.A.
I-AC-13	H-32-13-2 H-33-13-2	<u>Text Book</u> - "Domestic and Commercial Oil Burners," by Charles H. Burkhardt, Publisher Gregg/McGraw-Hill, Princeton Road, Hightstown, N.J. 08520, U.S.A.
I-AC-14	H-32-14-2 H-33-14-2	<u>Text Book</u> - "Modern Air Conditioning Practice," by Norman C. Harris and David F. Conde, Publisher Gregg/McGraw-Hill, Princeton Road, Hightstown, N.J. 08520, U.S.A.
I-AC-15	H-32-15-2 H-33-15-2	<u>Text Book</u> - "Concepts in Thermal Comfort," by M. David Egan, Publisher Prentice-Hall, Englewood Cliffs, New Jersey 07632, U.S.A.

AIR CONDITIONING AND REFRIGERATION - INSTRUCTIONAL MATERIALS

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
I-AC-16	H-32-16-2 H-33-16-2	Text Book - "Modern Refrigeration Practice," by Guy R. King, Publisher Gregg/McGraw Hill, Princeton Road, Hightstown, N.J. 08520 U.S.A.
I-AC-17	H-32-17-2 H-33-17-2	Text Book - "Control Systems for Heating, Ventilating and Air Conditioning," by Roger W. Hains, Publisher D. Van Nostrand Co. 300 Pike Street, Cincinnati, Ohio 45202 U.S.A.
I-AC-18	H-32-18-2 H-33-18-2	Handbook and Product Directory "Systems" Volume, American Society of Heating, Refrigeration and Air Conditioning Engineers," Publisher ASHRAE Publications Sales Department, 345 E. 47th Street, New York, N.Y. 10017 U.S.A.
I-AC-19	H-32-19-2 H-33-19-2	Handbook and Product Directory "Equipment" Volume, American Society of Heating, Refrigeration and Air Conditioning Engineers, Publisher, ASHRAE Publications, Sales Department, 345 E. 47th Street, New York, N.Y. 10017, U.S.A.
I-AC-20	H-32-20-2 H-33-20-2	Handbook and Product Directory "Applications" Volume American Society of Heating, Refrigeration and Air Conditioning Engineers," Publisher ASHRAE Publications, Sales Dept., 345 E. 47th Street, New York, N.Y. 10017 U.S.A.
I-AC-21	H-32-21-2 H-33-21-2	Handbook and Product Directory "Fundamentals," (Handbook of American Society of Heating, Refrigeration and Air Conditioning Engineers, Publisher ASHRAE Publications, Sales Dept., 345 E. 47th Street, New York, N.Y. 10017 U.S.A.
I-AC-22	H-32-22-2 H-33-22-2	"The Carrier Manual of Air Conditioning System Design," Catalog No. 590-017, Carrier Air Conditioning Company, Carrier Parkway, Syracuse, New York, 13201, U.S.A.

MASTER EQUIPMENT LIST
AIR CONDITIONING & REFRIGERATION
INSTRUCTIONAL MATERIALS

REFERENCE NUMBER	DESCRIPTION	QUANTITY	UNIT	TOTAL
	Film Loop, 8 ma as listed below:			
I-AC-1	Refrigeration: Motors, Controls and Brodhead-Garrett # VE 4073 set of 6 film loops	1	170	170
I-AC-2	Refrigeration: Multiple Temperature Evaporators, Brodhead-Garrett #VE 4097 set of 5 film loops	1	140	140
I-AC-3	Instrumentation: Flow Control Devices Brodhead-Garrett # VE 4093 set of 6 film loops	1	170	170
I-AC-4	Instrumentation: Pressure Control Devices, Brodhead-Garrett # VE 5008 set of 6 film loops	1	170	170
I-AC-5	Instrumentation: Temperature Control Devices, Brodhead-Garrett # VE 5009 set of 6 film loops	1	170	170
I-AC-6	Chalkboards Fixed	4	80	320
I-AC-7	Chalkboards - Portable	4	114	456
I-AC-8	<u>Text Book</u> - Modern Refrigeration and Air Conditioning	4	17	68
I-AC-9	<u>Text Book</u> - Contemporary Industrial Teaching	4	7	28
I-AC-10	<u>Text Book</u> - Principles of Refrigeration	4	20	80
I-AC-11	<u>Text Book</u> - Air Conditioning and Refrigeration	4	21	84
I-AC-12	<u>Manual</u> - Trane Air Conditioning Manual	4	15	60
I-AC-13	<u>Text Book</u> - Domestic and Commercial Oil Burners	4	15	60
I-AC-14	<u>Text Book</u> - Modern Air Conditioning Practice	4	16	64
I-AC-15	<u>Text Book</u> - Concepts in Thermal Comfort	4	14	56
I-AC-16	<u>Text Book</u> - Modern Refrigeration Practice	4	16	64
I-AC-17	<u>Text Book</u> - Control Systems for Heating Ventilating and Air Conditioning	4	22	88
I-AC-18	ASHRAE Systems Manual	4	43	172
I-AC-19	ASHRAE Equipment Manual	4	43	172
I-AC-20	ASHRAE Application Manual	4	44	176
I-AC-21	ASHRAE Fundamentals Manual	4	34	136
I-AC-22	Carrier Manual of Air Conditioning System Design	4	40	160
	Total			1,468

BUDGET SUMMARY

Equipment Cost	63,075
Furniture	8,360
Small Tools	7,240
Instructional Materials	<u>3,064</u>
TOTALS	<u>81,739</u>
World Bank Estimate	115,900
Total Cost Estimate	<u>81,739</u>
<u>Under</u> World Bank Estimate	<u>34,161</u>

PRIORITY ITEMS

Inasmuch as the total equipment and furniture estimated cost is approximately \$34,000 under total budgeted cost for spaces 32 & 33 at Homs it is strongly suggested that no further deletions of equipment be made from the two laboratories. However, if reductions become necessary the following items could be removed from the equipment list with the least damage to the program.

<u>Code</u>	<u>Item Name</u>	<u>Reduction</u>	<u>Value \$</u>
E-AC-18	Fundamentals of Refrig. Demonstrator	- 1	385
E-AC-28	Automotive Air Cond. Trainer	- 1	2,500
E-AC-29	Automotive Air. Cond. Service Equipment Package	- 1	800

BC-1

BUILDING CONSTRUCTION TECHNOLOGY AND SURVEYING

A PROPOSED SYLLABUS AND EQUIPMENT LISTS

For The

SYRIAN ARAB REPUBLIC GOVERNMENT

Developed By

MICHAEL J. DANBY, DEAN

ENGINEERING TECHNOLOGY DIVISION

STATE UNIVERSITY OF NEW YORK

AGRICULTURAL AND TECHNICAL COLLEGE

CANTON, NEW YORK

Contracted

By

ACADEMY FOR EDUCATIONAL DEVELOPMENT

DAMASCUS, SYRIA

JULY - AUGUST, 1977

LABORATORY SPACE IDENTIFICATION NUMBERS

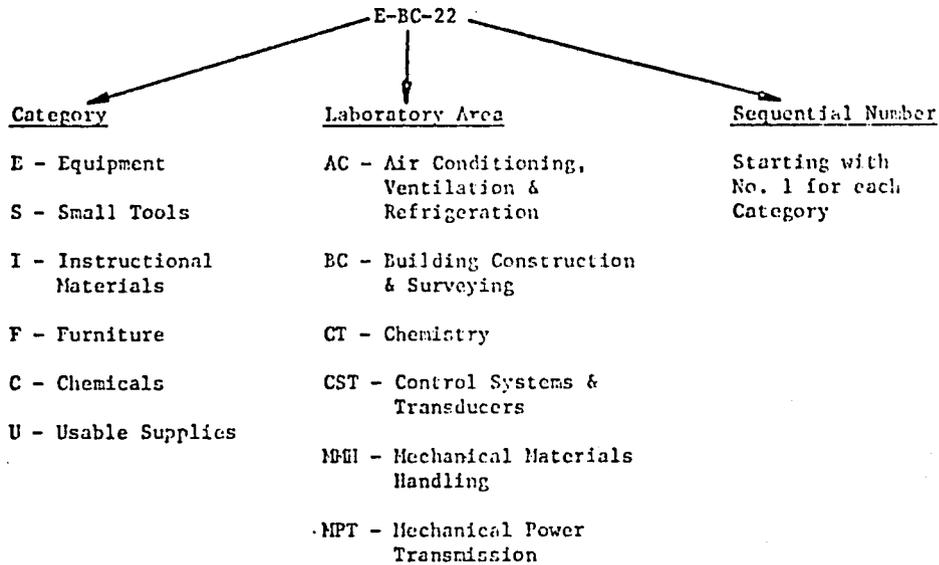
(From World Bank)

A. <u>Air Conditioning</u> (Homs)			
			<u>Space Number</u>
1.	Heating, Fuels & Hot Water Systems		32
2.	Air Conditioning & Refrigeration		33
B. <u>Building Construction Labs</u> (Latakia and Deir-Ez-Zor and Homs)			
			<u>Space Number</u>
		<u>Latakia</u>	<u>Deir-Ez-Zor</u>
			<u>Homs</u>
1.	Applied Mechanics	28	28
2.	Construction	33	33
3.	Engineering Materials and Soils	34	32
4.	Surveying and Photo Grammetry	35	35
C. <u>Chemical Tech. Laboratories</u> (Homs)			
			<u>Space Number</u>
1.	Industrial Inorganic and Quantitative Chemistry		34
2.	Industrial Organic Chemistry		34A
3.	Chemicals Processing Unit Operations (Pilot Plants)		35
4.	Mineral Processing Unit Operations		36
D. <u>Control Systems and Transducers</u> (Homs)			
			<u>Space Number</u>
1.	Control Systems		31
2.	Transducers (Instruments)		37
3.	Common Room	} Support for	C
4.	Printed Circuit Room		P
		31, 37, 22, 27	
E. <u>Materials Handling and Mechanical Power</u> (Latakia)			
			<u>Space Number</u>
1.	Machine Elements and Industrial Drawing		29
2.	Diesel Power Technology		30
3.	Power Transmission and Control Systems		31
4.	Material Handling Equipment		32

CODE SYSTEM

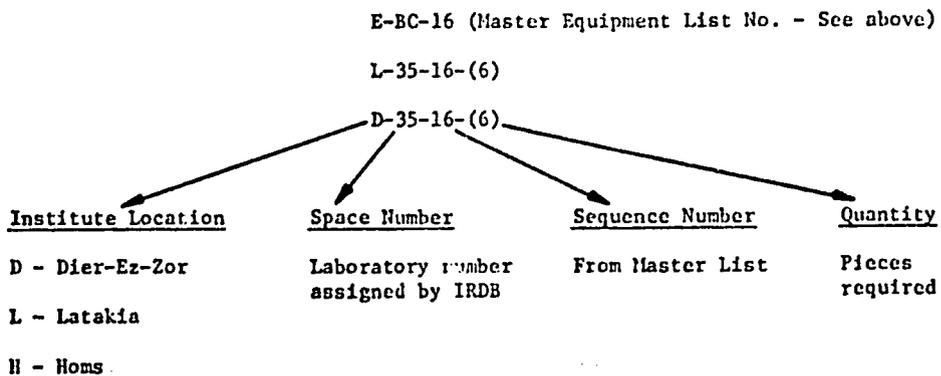
MASTER EQUIPMENT LIST - REFERENCE NUMBER

Sample:



SPECIFICATION CODE NUMBERS (FOR ALLOCATION PURPOSES)

Sample:



I. INTRODUCTION

- 1.1 The syllabi and equipment lists which follow are based on the following assumptions and/or guidelines:
- 1.2 The World Bank schedule of accommodations, S.A.R. First Education Project, working papers, Volume I, dated April, 1977, forms the basic plan on which the syllabi and equipment list is based.
- 1.3 The final recommended equipment list and syllabi reflect the plan as indicated above, the input of various Syrian authorities and individuals as listed below, and the professional opinion of the author of this document.
- 1.4 Consultations were held with the following individuals, either in group meetings or individual conferences:
 - Mr. Mustafa Kazziha Technical Education Directorate, Ministry Education, S.A.R.
 - Mr. Munir Azzam, Director, Directorate of Planning, Ministry of Education, S.A.R.
 - Mr. Sharifuodin Mohammed, Director of Technical Education, Ministry of Education, S.A.R.
 - Mr. Ayman Muwakki, Engineer, School Building Institute, Damascus, S.A.R.
 - Mr. Riad Alimam, Architect for Dier-Ez-Zor School, Damascus, S.A.R.
 - Mr. Farouk Kuatly, Director, Intermediate Technical Institute, Damascus.
 - Mr. Hisham Shamout, Director, Technical Secondary School, Damascus.
 - Mr. C. Lindsay, World Bank
 - Mr. Harry Go, World Bank
 - Mr. Michael Davis, Commercial Attache, U.S. Embassy, Damascus, S.A.R.
 - Mr. Yusuf Rashid Samman, Teacher, Secondary Vocational School, Homs, S.A.R.
 - Dr. Hanna Professor, College of Engineering, University of Damascus, S.A.R.
 - Dr. Andrawas, College of Engineering, University of Damascus, S.A.R.
- 1.5 Equipment lists will be identical for the schools at Latakia and Dier-Ez-Zor.

- 1.6 Choice of equipment is intended to prepare the students for equipment now available in the field and for future years when more advanced technology becomes more commonly used. Some test equipment in soils and concrete is ahead of the current state of usage in Syria, but is required to develop personnel who will be able to take a more sophisticated view toward analysis of building and construction problems.
- 1.7 Students will be coming to this program with an adequate mathematics background including algebra, geometry, and trigonometry. Any additional mathematics required will be furnished by the instructor or teacher within each course.

BUILDING CONSTRUCTION TECHNOLOGY

2. PURPOSE

The purpose of this curriculum is to educate students in the Building Construction field to fill the need for technical manpower in the broad range of job categories which fall between the unskilled laborer or craftsman and the engineer. Typically, graduates will work under the direct supervision of an engineer. The graduate will apply established engineering principles to real problems. As they gain experience, they will have greater decision making responsibilities. Graduates will supplement their technical training with additional courses in pedagogy, and will become instructors in technical secondary schools and in vocational training centers.

3. PROGRAM OBJECTIVES

At the end of the 2 year training program, the student should be able to do or to know the following:

- 3.1 The basic rules of safety in a construction project.
- 3.2 Masonry work, including laying straight and level brick and block walls, doorways, windows, and corners.
- 3.3 Concrete work, including finishing concrete and building forms for concrete.
- 3.4 Wood shop, including building small projects which require measuring, sawing (hand & power) and assembling.
- 3.5 Design and building of scaffolding.

- 3.6 Nomenclature, function and use of hand and power tools required on a construction project.
- 3.7 Nomenclature and function of major equipment items usually found on a construction project.
- 3.8 Prepare detail drafting in both steel and reinforced concrete structural design.
- 3.9 Select finishing materials and other required building components using available catalog and manufacturers information, usually under supervision.
- 3.10 Estimate costs of construction projects.
- 3.11 All drafting work required for typical construction projects, under engineering supervision.
- 3.12 Nomenclature and function of various kinds of surveying equipment. Determine elevations, distances, & angles, prepare site layout.
- 3.13 Run engineering laboratory tests, and write reports on various engineering materials, including soils, concrete, and metals.
- 3.14 Work through the physical operations required in completing a small building (including roofing) constructed on materials typical of the area.
- 3.15 Supervise laborers or craftsmen at a construction site, to see that work is done efficiently and correctly.
- 3.16 The fundamental steps required to complete a construction project, including:
 - Architectural & structural planning, design and detailing.
 - Project detailing.
 - Bidding principles.
 - Contracting, building, supervising.
 - Project startup after completion of construction phase.
- 3.17 The major problems likely to be encountered in coordinating the building of a basic structure with the required mechanical systems, including the heating, cooling, plumbing, and electrical systems.

4. TYPICAL COURSE TITLES AND TIME ALLOCATION

4.1 Initial program suggested by Syrian authorities:

BUILDING CONSTRUCTION TECHNOLOGY AND SURVEYING		Number hrs week
First Year	Theory	Practical
Social Studies and Languages	2	1
Industrial Safety and Industrial Planning	3	0
Applied Mechanics - Structures	2	2
Materials of Construction - Testing	2	3
Surveying - Work Measurement	2	3
Steel and Concrete Structures Technology	3	3
Structures Details - Drawing	2	4
Construction Equipment	<u>2</u>	<u>2</u>
Total	18	18 = 36
Second Year		
Social Studies and Languages	2	1
Administration and Construction Regulations	2	0
Steel Structures - Analysis	4	3
Construction Technology	4	3
Structures - Details	1	3
Electrical - Mechanical Equipment	2	2
Construction Site Supervision - Work Study	1	3
Cost Estimating - Project	<u>2</u>	<u>3</u>
Total	18	18 = 36
Laboratories: Construction Laboratory Materials Testing Laboratory Masonry and Plumbing Shops Access to: Applied Mechanics and Structures Lab Welding and Metal Shops Electrical Technology Lab Materials Handling Lab		

4.2 Suggested changes in construction technology:

- Change applied mechanics from 2 to 3 practical hours as much material must be covered.
- Change name of Materials of Construction - Testing to Building Materials and Soil Mechanics, to more accurately reflect content.

- Change practical hours in Structures details - drawing from 4 to 5, as drawing labs require large blocks of time.
- Eliminate work measurement from title of Surveying - work measurement, as this topic will be covered in one of the planning courses.
- Eliminate practical time from Construction equipment, as equipment will be used in other courses, and practical use of large industrial machines is not feasible.
- Combine Steel structures - analysis and Structures - details into a new course called Steel and Concrete Structures Analysis and Design with time allotted 4 theory and 7 practical.
- Change Construction site supervision - work study from 3 hours practical to 2 hours practical and from 1 hour theory to 2 hours theory.

4.3 The final course structure recommendation, on which the rest of this report is based, is shown below:

<u>First Year</u>	Theory	Practical
Social Studies and Languages	2	1
Industrial Safety and Industrial Planning	3	0
Applied Mechanics - Structures	2	3
Building Materials and Soil Mechanics	2	3
Surveying	2	3
Steel and Concrete Structures Technology	3	3
Structures Details - Drawing	2	5
Construction Equipment	2	0
<u>Second Year</u>		
Social Studies and Languages	2	1
Administration & Construction Regulation	2	0
Steel & Concrete Structures Analysis & Design	4	7
Construction Technology	4	3
Electrical - Mechanical Equipment	2	2
Construction Site Supervision - Work Study	2	2
Cost Estimating - Project	2	3

5. OUTLINES FOR COURSES

Note: These outlines are intended as a guideline for equipment purchase planning, and as a guide for the initial instruction of these courses. It is anticipated that changes will be made by the individuals teaching the courses. Note that these are lists of topics to be covered, not statements of performance objectives. Note also that some courses which are similar in both years are included under one heading.

5.1 Social Studies and Languages (both years).

- Content will be directed by Syrian authorities.
- Industrial Safety & Industrial Planning, Administration & Construction Regulations.
- Need for industrial safety.
- Rules and procedures for safety.
- Advantages of following good safety procedures.
- Safety equipment and its use.
- Management techniques for safety.
- Case studies in safety.
- Rational approach to industrial planning.
- Planning methods (such as critical path method).
- Employee incentives.
- Engineering cost studies.
- Time and money relationships.
- Costs of accidents and delays.
- Analysis of various construction activities.
- Record keeping.
- Company organization.
- Factors affecting selection of equipment.
- Laws and regulations pertinent to the construction industry.
- Administrative methods for efficient project completion.
- Term project.

5.2 Applied Mechanics - Structures

- Fundamentals of statics.

- Forces in bars and trusses.
- Stress - strain relationships.
- Shear, bending moment, and deflection problems.
- Analysis and design of bolted, riveted, & welded connections.
- Analysis and design of columns.
- Analysis of fundamental engineering properties of wood and metals through laboratory experiments.
- Tension, compression, bending, shear & column tests and reports.

5.3 Building Materials and Soil Mechanics

- Investigate all basic building materials used in Syria relative to the factors of properties, frequency of use, cost, future supply, advantages and disadvantages: include stone, concrete blocks, tile, wood, steel, as well as various sub-assemblies available, such as prehung doors and windows, pre-stressed concrete, finishing materials, and panels.
- Geology of Syria, as appropriate to the building construction industry.
- Engineering properties of soils, and soil selection procedures for various applications.
- Soil analysis, including the following:
 - (1) Soil classifications.
 - (2) Dry preparation of soil samples.
 - (3) Particle size analysis.
 - (4) Liquid limit, plastic limit, and plasticity index.
 - (5) Moisture density relationships.
 - (6) Specific gravity.
 - (7) Measure soil density in place.
 - (8) Soil Sampling.

5.4 Surveying

- Correct note taking procedures.
- Use of levels, transits, and theodolites.
- Adjustment and maintenance of above equipment.
- Distance measurement log pacing, tapes, and stadia.
- Measuring elevations.
- Measuring angles
- Building layouts.
- Simple maps of open or closed traverses.
- Simple pipeline layout.

5.5 Steel and Concrete Structures Technology and Construction

Technology

- Use of all basic carpentry hand and power tools.
- Use of all masonry hand and power tools.
- Use of all concrete hand and power tools.
- Small projects of wood construction.
- Straight and level concrete block wall construction.
- Concrete block corners, door openings, window openings.
- Safe operation of all construction tools.
- Principles of making quality concrete.
- Concrete mix design.
- Strength measurement of various concrete mixes.
- Standard tests on concrete.
- Strength measurement of reinforced concrete.
- Form and finishing work with concrete.
- Develop knowledge of how to supervise installation of the following:
 - (1) Tile
 - (2) Wall covering
 - (3) Paneling
 - (4) Prehung windows and doors
 - (5) Ceilings
 - (6) Finish plaster and cement work

5.6 Structures Details - Drawing

- Proper use of drawing equipment.
- Drawing with correct line weights, and lettering.
- Standard architectural symbols.
- Site work plans.
- Architectural floor plans.
- Elevation drawings.
- Pictorial drawings.
- Foundation requirement drawing.
- Floor and window schedules.
- Complete materials list for small construction project.

5.7 Construction Equipment

- Major items of construction equipment.
- Uses, costs, efficiency, and relative importance of major equipment items.
- Nomenclature of major parts of each equipment item.
- Calculation of the required number of various equipment items needed to perform a major project, data to be furnished by instructor.
- Job site visits to observe function of major equipment items:
 - (1) Trucks
 - (2) Bull dozers
 - (3) Cranes
 - (4) Front loaders
 - (5) Scrapers
 - (6) Power shovels
 - (7) Compaction equipment
 - (8) Hoists

5.8 Steel and Concrete Structures Analysis and Design

- Properties of structural steel.
- Stress analysis in steel beams and columns.
 - (1) Moments in beams
 - (2) Stresses in beams
 - (3) Stresses and failure loads in long and short columns
 - (4) Stresses and failure loads in beam columns
- Beam and column design.
- Connections in steel structures, including welds, rivets, & bolts.
- Detail drawing project, complete in sufficient detail to permit development of a complete set of working drawings for a small steel structure.
- Properties of commercially acceptable concrete mixes.
- Reinforced concrete beam, columns, and beam columns.
- Reinforced concrete structural components:
 - (1) Beams
 - (2) Columns
 - (3) Slabs
 - (4) Footings

- Detailed drawing project for a complete reinforced concrete structure, complete in sufficient detail for actual construction of such a building.
- Properties and uses of various types of reinforcing components, including bar and wire mesh.

5.9 Electrical - Mechanical Equipment

- Function of basic electrical systems in buildings.
- Function of basic HVAC systems in buildings.
- Function of basic sanitary systems in buildings.
- Function of basic water supply systems in buildings.
- Heat loss and gain calculations for simple structures.
- Effects of the above systems on the design of the basic building. Emphasis on design considerations which must be made to allow for installation and maintenance of those systems.
- Function of safety equipment in buildings.

5.10 Construction Site Supervision - Work Study

- Actual construction project work.
 - (1) Carpentry
 - (2) Masonry
 - (3) Layout
 - (4) Finishing
- Problems encountered by each student.
- Development, through class discussion, of an understanding of the overall supervisory requirements on a construction project.

5.11 Cost estimating - Project

- Estimation of total labor cost for a building project.
- Estimation of total equipment cost for a building project.
- Estimation of total excavation cost for a building project.
- Estimation of total earthwork cost for a building project.
- Estimation of total concrete cost for a building project.
- Estimation of total masonry cost for a building project.
- Overhead and contingency costs.
- Factors causing errors and changes in estimates.
- Preparation of total cost estimate for a small building project.

SURVEYING TECHNOLOGY1. PURPOSE

The general purpose of this curriculum is to educate the student in the field of Surveying so as to fill the need for qualified individuals to assist engineers and surveyors in doing surveys, processing results of surveys, and converting survey data to useful form. The curriculum will be sufficiently broad to permit graduates to work in other construction related areas. Some graduates will become teachers in vocational training centers and technical secondary schools. Specific jobs for graduates will include survey crew members, engineering aide, architectural aide, and engineering office work in photogrammetric analysis and map making.

2. PROGRAM OBJECTIVES

The graduates of the Surveying Technology program will be able to do or to know the following:

- 2.1 The basic rules of safety on a construction or surveying project site.
- 2.2 The fundamental steps required to adequately plan and complete a construction job, with emphasis on road construction including legal surveys.
- 2.3 The legal requirements involved in surveying and recording results of surveys.
- 2.4 Nomenclature, proper care, and use of all surveying equipment, including levels, transits, automatic levels, theodolites, electronic distance measuring equipment, plane tables, and photogrammetric equipment.
- 2.5 Perform the following types of surveying functions:
 - Proper note keeping
 - Distance measurement
 - Elevations
 - Traverses

- Area determination
 - Topographic surveys
 - Mapping
 - Boundary surveys
 - Construction surveys
 - Circular and parabolic curves
- 2.6 Interpret air photos by photogrammetric methods.
- 2.7 Supervise simple survey projects.
- 2.8 Draw maps using photogrammetric methods.
- 2.9 Develop detailed maps using basic survey data.
- 2.10 Use basic hand and power tools found in most construction applications.
- 2.11 Be familiar with nomenclature and function of major equipment items used in building and road construction.
- 2.12 Be familiar with concrete and masonry tools and procedures, sufficient to supervise simple projects and insure conformance to proper standards.
- 2.13 Perform and analyze results of physical tests on engineering materials, including steel and concrete.

3. TYPICAL COURSE TITLES AND TIME ALLOCATIONS

3.1 Initial program suggested by Syrian authorities:

BUILDING CONSTRUCTION TECHNOLOGY AND SURVEYING		Number Hrs Week	
First Year	Theory	Practical	
Social Studies and Languages	2	1	
Industrial Safety and Planning	3	0	
Applied Mechanics - Structures	2	2	
Building Materials - Soil Mechanics	2	3	
Surveying (land, road and construction) and Drawing	2	5	
Building and Road Construction	3	3	
Accounting, Costing and Price Analysis	2	2	
Construction Equipment and Electrical/Mechanical Installation	<u>2</u>	<u>2</u>	
Total	18	18 = 36	

BUILDING CONSTRUCTION TECHNOLOGY AND SURVEYING		Number Hrs Week
Second Year	Theory	Practical
Social Studies and Language	2	1
Town and Urban Planning and Legislation	2	0
Surveying (land, road and construction)	3	5
Photogrammetry	3	3
Cartography	2	3
Building Construction	2	2
Quantity and Cost Estimates	2	0
Reports, Specifications, Tender Documents	<u>2</u>	<u>4</u>
	18	18 = 36

3.2 Suggested changes in Surveying Technology:

- Change Applied Mechanics practical from 2 to 3 hours to allow more time to cover necessary material.
- Reduce practical time in Construction Equipment and Electrical/Mechanical Installation by 1 hour. Most work in this course will be descriptive, not project oriented, and will not require large amounts of practical time.
- Increase practical time in Building Construction from 2 hours to 3 hours, to permit student to complete projects.
- Reduce practical time in Reports, Specifications, Tender Documents by 1 hour, as long periods will be required to complete work in this course.

3.3 The final course structure recommendation, on which the rest of this report is based, is as follows:

BUILDING CONSTRUCTION TECHNOLOGY AND SURVEYING		Number Hrs Week
First Year	Theory	Practical
Social Studies and Languages	2	1
Industrial Safety and Planning	3	0
Applied Mechanics - Structures	2	3
Building Materials - Soil Mechanics	2	3
Surveying (land, road, construction) and Drawing	2	5
Building and Road Construction	3	3

BUILDING CONSTRUCTION TECHNOLOGY AND SURVEYING		Number Hrs Week
First Year (continued)	Theory	Practical
Accounting, Costing, and Price Analysis	2	2
Construction Equipment and Electrical and Mechanical Installations	2	1
Second Year		
Social Studies and Languages	2	1
Town and Urban Planning and Legislation	2	0
Surveying (land, road, construction)	3	5
Photogrammetry	3	3
Cartography	2	3
Building Construction	2	2
Quantity and Cost Estimates	2	0
Reports, Specifications, and Tender Documents	2	4

4. COURSE OUTLINES

Note: These outlines are intended as a guideline for equipment purchase planning, and as a guide for the initial instruction of these courses. It is anticipated that changes will be made by the individuals teaching the courses. Note also that some courses which are similar in both years are included under one course heading, and that some courses which occur in the Building Construction curriculum are described there, and not repeated here.

4.1 Social Studies and Languages (both years)

- Content will be directed by Syrian authorities.

4.2 Industrial Safety and Planning and Town and Urban Planning and Legislation

- Need for industrial safety.
- Rules and procedures for safety.
- Economic and psychological advantages of following good safety procedures.
- Safety equipment and its use.

- Managing for safety.
- Case studies in safety.
- Rational approach to industrial planning.
- Planning methods (such as Critical Path Method).
- Employee incentives.
- Engineering cost studies.
- Time and money relationships.
- Costs of accidents and delays.
- Analysis of various construction activities.
- Record keeping.
- Company organization.
- Factors affecting selection of equipment.
- Laws and regulations pertinent to the construction industry and to town and urban planning.
- Administrative methods for efficient project completion.
- Term project.

4.3 Applied Mechanics - Structures

- Same course as for Construction Technology. See Construction Technology syllabus for detailed information.

4.4 Building Materials and Soil Mechanics

- Same course as for Construction Technology. See Construction Technology syllabus for detailed information.

4.5 Surveying (land, road, construction) and Drawing, and second year course in Surveying (land, road, construction).

- Correct note taking procedures.
- Nomenclature, care and use of the following types of survey equipment:
 - (1) Engineers Level
 - (2) Transit
 - (3) Automatic Level
 - (4) Theodolite
 - (5) Plane Table and Alidade
 - (6) Electronic Distance Measuring Equipment
- Adjustment and maintenance of surveying equipment.
- Distance measurement by pacing, taping, and stadia.

- Elevation measurement.
- Angle measurement.
- Building layout.
- Simple maps.
- Open and closed traverses.
- Pipeline layout.
- Area surveys.
- Boundary surveys.
- Circular and parabolic curve surveys.

4.6 Building and Road Construction and Building Construction

- The basic structure of these courses is the same as the Construction Technology course titles, Steel and Concrete Structures Technology and Construction Technology. Refer to those course titles in the Construction Technology syllabus for detailed information.

4.7 Accounting, Costing, and Price Analysis

- No detailed outline furnished, as this course does not use any of the assigned laboratory facilities. However, suggested course coverage would include:
 - (1) Book keeping procedures.
 - (2) Basic accounting principles.
 - (3) Methods of determining costs.
 - (4) Evaluating course comparisons.
 - (5) Establishing prices for both goods and services.
 - (6) Engineering economics.

4.8 Construction Equipment and Electrical and Mechanical Installations

- Fundamental functions, basic nomenclature and relationship to the basic building structure of the following mechanical systems:
 - (1) Water supply system.
 - (2) Sanitation systems.
 - (3) Heating and cooling systems.
 - (4) Electrical systems.
- Nomenclature and function of major equipment items used in building and road construction, including trucks, cranes, bulldozers, paving equipment, compressors, loaders, compaction equipment, and hoists.
- Comparison of job requirements with equipment capabilities.
- Selection of equipment for a given task, based on job requirements and economic considerations.

4.9 Photogrammetry

- General discussion of:
 - (1) Types of air photographs.
 - (2) Photographic equipment.
 - (3) Geometry of aerial photography.
 - (4) Flight planning for aerial photography.
 - (5) Establishing control for aerial photography.
 - (6) Stereoscopy and parallax.
 - (7) Function, nomenclature and use of complex stereoscopic instruments.
- Detailed analysis and project work in:
 - (1) Identification of objects on photographs.
 - (2) Determination of elevations of points on photographs.
 - (3) Measurement of distances on photographs.
 - (4) Plotting maps from photographs.
 - (5) Drawing rough topographic maps from photographs.
 - (6) Obtaining photographs for areas already photographed.
 - (7) Requesting assistance in obtaining air photographs of required areas.
 - (8) Skilled use of mirror stereoscope, stereometer, and stereoscope table.

4.10 Cartography

- Schematic symbols for map making.
- Various types of maps and their uses.
- How to contact various mapping agencies for existing map data.
- Performance of topographic surveys to develop extensive data for accurate plotting of maps.
- Map drafting functions:
 - (1) Plotting the traverse.
 - (2) Plotting the details.
 - (3) Drawing the topography and special data.
 - (4) Finishing the map.

- Map development for specific purposes:
 - (1) Topography
 - (2) Property boundaries
 - (3) Precise location of traverse points
 - (4) Routes for highways and railroads
 - (5) Soil erosion and irrigation projects
 - (6) Mineral lands
 - (7) Building sites

4.11 Quantity and Cost Estimates

- Cut and fill requirements for roads, railroads and other projects.
- Cost estimation for surveying projects.
- Cost estimation for road projects, in preparation for the bidding process.
- Requirements for estimating costs of building projects.

4.12 Reports, Specifications, and Tender Documents

- Required documentation for road and building projects.
 - (1) To fulfill government regulations.
 - (2) To meet legal requirement.
 - (3) To enable contractors to bid and complete projects.
- Write specifications.
 - (1) For equipment.
 - (2) For projects going out to bid.
- Take basic requirements for a small building project and generate all required documentation, specifications, and tender documents (except detailed working drawings, which will be furnished.).

5. PROGRAM RECOMMENDATIONS

- 5.1 Ability of students in mathematics should be carefully monitored. If students seem deficient, a course sequence in mathematics through intermediate algebra and trigonometry should be instituted, and some technical areas reduced by a corresponding amount.
- 5.2 Students are to come to this program only from the secondary general education track. Consideration should be given to permit students from the secondary vocational training track to enroll. Some curriculum modifications would probably be necessary to allow these students to increase their math background, but most of the technical content could be maintained.
- 5.3 Consideration should be given to combining the 2 programs (construction and surveying). There are many common courses in the two curriculums, and it may be possible to establish a basic curriculum with elective courses which would permit students to emphasize surveying or building construction. Experience with the surveying curriculum may show that too much time is placed on photogrammetry and cartography, for instance. If so, these courses should be modified and the students should be permitted to take additional construction oriented course work which will increase the versatility of their skills.

6. ARCHITECTURAL RECOMMENDATIONS

6.1 Electrical

- Electrical outlets required on walls in all 4 laboratory spaces, should be spaced every 1 meter around laboratory. Specific power required for high load items is shown on laboratory floor plan. All outlets to be located 90 cm above floor level.
- 220V, 50 cycle, single phase.

6.2 Water

- Sinks are required in soils lab and construction lab. Fixtures should allow for hose connections. Water connections required for humidifier in wet room.

6.3 Ventilation

- An exhaust hood and fan is required for the capping area in the soils lab. See floor plan.

- 6.4 Overhead doors are required in the construction lab, soils lab, and applied mechanics lab. Wide doors, 1 m minimum, 1½ m preferred, are required throughout.
- 6.5 Construction lab ceiling should have minimum height of 6.5 m.
- 6.6 Wet room required adjacent to soils lab for curing concrete. Humidifier requires water and electrical connections.
- 6.7 Compressed air in all laboratories is desirable.
- 6.8 Applied mechanics laboratory should have reinforced floor slab.
- 6.9 Laboratory size, location, and layout
- A suggested layout of all four laboratories follows. The major requirement which must be met is that the engineering materials and soils laboratory and construction laboratory must be interconnected by large doors as shown. Some projects will require use of 2 of these spaces at the same time.
 - Location of the surveying laboratory is not important, as long as an exterior door is available.
 - Space requirement summary
 - (1) Surveying laboratory - reduce from 140 m² to about 100 m² (7 m x 14 m)
 - (2) Engineering materials and soils laboratory to be 140 m², as planned (10 m x 14 m)
 - (3) Applied mechanics laboratory to be 140 m² as planned (10 m x 14 m)
 - (4) Construction laboratory to be 230 m² as planned (10 x 23 m), but will have additional adjacent storage of approximately 40 m² (4 m x 10 m)

BUILDING CONSTRUCTION - EQUIPMENT

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
E-BC-1	L-35-1-(6) D-35-1-(6)	<u>Construction Level W/Tripod</u> - Simple construction level; 18X minimum magnification; erect image; glass reticle with one vertical and one horizontal cross line; may also have short 1:100 stadia cross lines, but not required; complete with carrying case, adjustment tools, instructions; with tripod, wide frame, fixed leg, compatible with level.
E-BC-2	L-35-2-(6) D-35-2-(6)	<u>Transit W/Tripod</u> - Transit, 20X minimum magnification; double numbered horizontal circle reading 0-360° and 360°-0°, reading to 20 seconds of arc; vertical circle reading to 1 minute of arc; reticle with 1:100 stadia cross lines; erect image; with optical plummet, complete with carrying case, rain hood, instructions, and adjusting tools; with compatible tripod, wide frame, adjustable.
E-BC-3	L-35-3-(6) D-35-3-(6)	<u>Theodolite W/Tripod</u> - Repeating type, with glass horizontal and vertical circles; with erect telescope image; digital micrometer reading direct in grads to 0.0001 g. of arc; automatic vertical circle index, with self contained optical plummet, sunshade, plastic hood, optical telescope sight, carrying handle, carrying case, adjustment tools and parts; with tripod, extension leg; theodolite magnification 30X minimum, 20 second sensitivity per 2 mm movement.
E-BC-4	L-35-4-(6) D-35-4-(6)	<u>Automatic Level W/Tripod</u> - Precision universal automatic level; with 400 grad horizontal circle; 30X minimum magnification; erect image; circular level sensitivity of 10' per 2 mm or better; circle direct reading to 1 grad; with stadia cross lines; automatic leveling; with sunshade, plastic hood, and carrying case; with adjustment pins and tools; with adjustable tripod.

BUILDING CONSTRUCTION - EQUIPMENT

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
E-BC-5	L-35-5-(2) D-35-5-(2)	<p><u>Electronic Distance Measuring Instrument</u> - Instrument system must be capable of measuring distances up to 2000 meters under average atmospheric conditions; the bidder is responsible to see that device furnished is compatible with theodolite described in item E-BC-4 and that instrument is furnished complete with necessary fittings and ready for use; the bidders proposal shall indicate the specific instrument (theodolite) for which the bid is developed; accuracy of $\pm (5 \text{ mm} + 5 \text{ ppm})$; minimum measuring cycle of 15 seconds; readout in meters and 400 g circle; must compute horizontal distances, differences in height, coordinate differences, and slope distance; includes large capacity battery and recharger; it should be stressed that the bidder is responsible to supply a complete package with all required adapters for compatibility with theodolites purchased.</p>
E-BC-6	L-35-6-(6) D-35-6-(6)	<p><u>Polar Planimeter</u> - To measure areas, in cm^2, up to approximately 33 cm dia circle, or 25 x 50 cm rectangle with pole set outside of circle accuracy to within $\pm .4\%$; magnifying lens of at least 1.5x; with integrating wheel; in case.</p>
E-BC-7	L-35-7-(20) D-35-7-(20)	<p><u>Mirror Stereoscope</u> - Stereoscope, with 3x binocular and 1.5x swing-in magnifier; with stereometer paralax-measuring bar; minimum field of view of 18 cm x 24 cm; paralax-measuring bar minimum gradation 0.05 mm and range of 50 mm.</p>
E-BC-8	L-35-8-(10) D-35-8-(10)	<p><u>Stereoscope Attachment</u> - Attachment track for mounting of mirror stereoscope, to permit simultaneous displacement of stereoscope and stereometer paralox measuring bar both vertically and laterally; must be compatible with stereoscope, item E-BC-8.</p>

BUILDING CONSTRUCTION - EQUIPMENT

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
E-BC-9	L-35-9-(18) D-35-9-(18)	<u>Surveyors Tapes with Tape Reel, Clamp, and Tape Tension Handle</u> - Steel, with low thermal expansion coefficient; 30 meter; chrome clad or otherwise corrosion resistant; last meter graduated in mm, if available, in cm if not available in mm; other graduations at each meter; with crank operated tape reel; with tape clamp handle; with tape tension handle, 15 kg; with tape ring.
E-BC-10	L-35-10-(1) D-35-10-(1)	<u>Tape Repair Kit</u> - Kit for splicing steel tapes of various kinds; includes punch, riveting block, piercing punch, cutting snips, riveting hammer, steel tape repair pieces including Nubian (black), rivet set, tweezers, rivets; in case.
E-BC-11	L-35-11-(6) D-35-11-(6)	<u>Level Rod</u> - Folding; 3 m; upright figures; graduation interval 1 cm; graduation width 80 mm minimum.
E-BC-12	L-35-12-(6) D-35-12-(6)	<u>Circular Spirit Level</u> - Circular spirit level mounted in 90° angle frame; for use in determining that rod is being held in perpendicular position; minimum length of right angle blade 8 cm; minimum level vial diameter of 20 mm.
E-BC-13	L-35-13-(24) D-35-13-(24)	<u>Range Poles</u> - Metal range poles; 2.5 meter length in two sections; alternating red and white color sections at each 500 mm; approximate diameter 31 mm.
E-BC-14	L-35-14-(7) D-35-14-(7)	<u>Chain Pin Set (Surveyors Arrows)</u> - Approximately 4.5 mm diameter, approximately 35 cm length; alternate red and white markings; hardened steel; set of 11; with chain pin carrying ring.
E-BC-15	L-35-15-(6) D-35-15-(6)	<u>Standard Alidade</u> - For plane table work; 25 cm telescope minimum; minimum of 17X magnification, resolution 5 seconds; vertical arc 5 cm minimum, graduated to 30 minutes, to read angles of elevation and depression to 30°; with 1:100 stadia reticle; compass: blade at least 7.6 cm (3") by 38 cm (15"); including instrument case, sunshade, objective cap, adjusting tools, and instructions.

BUILDING CONSTRUCTION - EQUIPMENT

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
E-BC-16	L-35-16-(6) D-35-16-(6)	<u>Plane Table Tripod</u> - For use with item E-BC-15; Johnson type; to permit each leveling of plane table and table rotation in azimuth; wing nuts for clamping board; fixed leg.
E-BC-18	L-35-18-(1) D-35-18-(1)	<u>Laser Level</u> - Laser alignment system for use in pipe laying, general construction, and engineering alignment; to perform the basic function of furnishing a true reference line for such functions as laying pipeline and accurately locate manhole connections; includes basic laser level, with removable spotting scope; slide post tripod; power cord; shockproof case; 12V battery; operating instruction; basic instrument has micrometer grade control; universal mounting clamp; grade accuracy to 1/100 of 1%; 26X spotting scope; such as Micro Grade Model #42 ASL (42-00-002).
E-BC-19	L-35-19-(200) D-35-19-(200)	<u>Field Book, Engineers</u> - Approximately 80 pages; one side 6 columns; one side 4 x 8 grid; approximate size 11 cm x 18 cm (4 1/2" x 7 1/4"); heavy paper binding.
E-BC-20	L-28-20-(2) D-28-20-(2) H-28-20-(2)	<u>Universal Test Machine</u> - For general purpose high accuracy tension and compression testing of metals and some non-metals; 27,000 kg minimum load capacity; 220V, 50 cycle, 3 phase; load indicator dial must have minimum diameter of 50 cm; load indicator accurate to within 0.5% of gauge reading; may be either hydraulic or mechanically applied loading mechanism; minimum 120 cm between cross heads for compression testing; minimum 50 cm clearance between screws or columns; minimum of 3 load ranges, approximately 0-450 kg, 0-5500 kg, 0-27000 kg, 4 load ranges preferred; complete with set of vee grips, set of wedge grips, shims, standard specimen holder for threaded tensile specimens, platen for compression testing, shear fixture suitable for shear test on round stock of approximately 1 cm (any size near 1 cm will be adequate); complete with tools for test setup and complete instruction manual.

BUILDING CONSTRUCTION - EQUIPMENT

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
E-BC-21	L-28-21-(2) D-28-21-(2)	<u>Stress-Strain Recorder, with Instrumentation</u> - Recorder, compatible with universal test machine of 27000 kg minimum capacity (item E-BC-20); complete with necessary fittings and ready for use; to graphically record load in kg and corresponding unit strain; 3 magnification scales; includes chart paper, calibrated for each load range of U.T.M., one box of each.
E-BC-22	L-28-22-(2) D-28-22-(2)	<u>Compression Tester</u> - For general purpose compression testing; 120,000 kg minimum capacity; hydraulically applied load with electric pump attachment; load indicator dial diameter 30 cm minimum; 2 load ranges, 0-120000 kg and approximately 0-10000 kg; load frame must allow clearance for test specimens up to 16 cm (6") wide and 31 cm (12") tall; may be either bench mounted or floor mounted; gauge accuracy must be within 1% of applied load; supplied with instruction manual; upper platen must swivel to allow for lack of parallelism in specimen ends.
E-BC-23	L-28-23-(2) D-28-23-(2) H-28-23-(2)	<u>Mechanical Extensometer</u> - For use in measuring elongation of tensile test specimens; for 5 cm and 20 cm gauge length; to be attached by 4 hardened thumb screws; for test specimens up to 15 mm diameter; complete with dial indicator with approximately 6 cm face diameter, minimum 5 mm range, 0.002 mm divisions.
E-BC-24	L-28-24-(2) D-28-24-(2)	<u>Electronic Extensometer</u> - For use with item E-BC-21, Stress-Strain Recorder; must be compatible, complete with necessary fittings and wire connections and ready for use; electronically record strains for tensile test specimens approximately 5 cm gauge length and 13 mm diameter.
E-BC-25	L-28-25-(1) D-28-25-(1)	<u>Tension and Compression Tester</u> - General use for tension and compression testing of non metals, especially concrete and masonry products; 30,000 kg minimum capacity; floor mounted; minimum clearance between columns and platens 310 mm wide by 430 mm high; hydraulically applied load; electric pump; 2 load scales, 0-30000 kg and 0-6000 kg; top

BC-28

BUILDING CONSTRUCTION - EQUIPMENT

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
E-BC-25 (Cont'd)		and bottom platens at least 155 mm diameter; equipped with grips and shims required to perform tension test on cement briquettes, tension test on wire up to 6.4 mm; and shear test fixture equipped with blades for 9.6 mm specimea, all grips for maximum 4536 kg capacity.
E-BC-26	L-28-26-(1) D-28-26-(1)	Beam Tester - Hand operated; for flexure testing of concrete beams, 6900 kg capacity; with fixtures to permit either third point or center point loading; must permit testing of beams which are 16 cm by 16 cm by 76 cm long; load indication may be by direct reading gauge or by proving ring indicator readings and calibration curves; tester frame to be of steel, welded or bolted.
E-BC-27	L-28-27-(2) D-28-27-(2) H-28-27-(2)	Digital Strain Indicator - Portable; 220 V, 50 cycle, one phase; measure unit strains up to 60,000 microinches/inch with resolution of 1 microinch/inch (or corresponding ranges in metric); to handle a range of gauge factors and gauge resistances including gauge factor of 2.0 and gauge resistance of 120 Ohms; digital readout; for 1/4, 1/2 and full bridge configuration.
E-BC-28	L-28-28-(2) D-28-28-(2) H-28-28-(2)	Portable Balancing and Switching Unit - Must interconnect with item E-BC-27, Portable Digital Strain Indicator; complete with fittings and ready for use; to connect up to 10 independent strain gauges; must handle strain gauges with some characteristics as required for the strain indicator.

BUILDING CONSTRUCTION - EQUIPMENT

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
E-BC-29	L-28-29-(15) and D-28-29-(5) D-28-29-(15) and D-28-29-(5) H-28-29-(15)	<p><u>Strain Gauges, with Mounting Kit</u> - Foil type resistance strain gauges; square grid; approximately 9 mm wire length; preferred material constantan with polyimide carrier, but other combinations with required characteristics are permissible; 120 Ohms gauges; with loads attached; in packages; for operation at approximately 15° - 40C; also includes strain gauge mounting kit containing all required tools and materials, including wire for connection to switching and balancing unit; kit materials must be compatible with strain gauges furnished; to be applied to steel and aluminum round and flat stock</p> <p>Number required: Strain gauges - 45 packages of 5 each Mounting kits - 15 kits</p>
E-BC-30	L-28-30-(140) D-28-30-(140) *	<p><u>Tensile Test Specimens</u> - Standard Tensile test specimens, threaded (3/4"-10NC), 4.5" long, 0.505" diameter, 2.5" gauge length, or corresponding metric sizes (metric preferred if available), of following materials:</p> <ol style="list-style-type: none"> 1. Steel, 0.2% carbon, hot rolled 2. Steel, 0.2% carbon, cold rolled 3. Steel, 0.4% carbon, hot rolled 4. Steel, 0.8% carbon, hot rolled <p style="padding-left: 40px;">Note: all carbon % are approximated.</p> <ol style="list-style-type: none"> 5. Cast iron, grey 6. Aluminum, 2017-T4 7. Aluminum, 6061-T6 <p>*Twenty (20) of each of the 7 types.</p> <p style="text-align: right;">Recommended Supplier: Engineering Education Equipment Company R.R.4, Box 430 Kankakee, Illinois, 60901 U.S.A.</p>

BUILDING CONSTRUCTION - EQUIPMENT

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
E-BC-31	L-28-31-(2) D-28-31-(2)	<u>Elasticity of Flexure Apparatus</u> - To measure deflection of a beam loaded at its midpoint; includes 2 knife edge clamps; stirrup; scale pan, standard micrometer screw with heavy base, 3 different wood test beams 102 cm long; and instructions.
E-BC-32	L-28-32-(2) D-28-32-(2)	<u>Meter Stick Balance Set</u> - To study principles of statics, showing balancing of moments; includes meter stick with grooved edge, 3 lever knife edge clamps, an 18 cm high metal support, and set of 9 hooked weights, ranging from 1 gram to 1 kg, in a wood block.
E-BC-33	L-28-33-(2) D-28-33-(2)	<u>Compound Lever Apparatus</u> - Demonstrates principle of the compound lever; consists of 2 horizontal levers, 28 cm, on a wood base, 2 hooked weights and instructions included.
E-BC-34	L-28-34-(2) D-28-34-(2)	<u>Force Table Apparatus With Weights</u> - Table for demonstrating the composition and resolution of forces; 35 cm diameter table, 16 mm thick; top of table calibrated in degrees from 0° to 360°; table top is clamped to a rod and tripod base with leveling screws; 4 weight hangers, center ring and pin, cord and set of slotted weights are included; with instructions.
E-BC-35	L-28-35-(2) D-28-35-(2)	<u>Crane Boom Assembly</u> - To demonstrate force relationships in derrick and crane structures; consists of following components: cylindrical tube holding scale and compression spring; chain; scale; rod; clamp; main rod to serve as mast; table clamp and hook collar; weight hanger, slotted weights totaling 9 kg; complete and ready to measure forces in both tension and compression member of crane boom.
E-BC-36	L-28-36-(2) D-28-36-(2)	<u>Truss Assembly With Supports</u> - To measure forces in truss members; consists of 7 truss units, with calibrated scale to indicate force in member; connecting strips and rods; approximately 20 cm long and 1500 gram capacity; with 2 swivel clamps, 2 adapter sleeves, 2 support rods, table clamps, and rod clamps.

BUILDING CONSTRUCTION - EQUIPMENT

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
E-BC-37	L-28-37-(1) D-28-37-(1)	<p>Pulley Demonstration Set - To show use of pulleys to develop mechanical advantage; consists of pulley platform base, two vertical rods and one horizontal rod connected by clamps; eight hanging collars; the following pulley systems:</p> <ul style="list-style-type: none"> 7 single pulley 2 triple-tandem pulleys 2 quadruple pulleys 1 wheel and axle <p>Also 7 weight hangers, 1 spool of cord, 23 m long, and 15 slotted weights, from 10 to 500 grams.</p>
E-BC-38	L-34-38-(2) D-32-38-(2)	<p><u>Precision Balance</u> - Balance, of approximately 160 gram capacity; 220V, 50 cycle, 1 phase, AC; top loading; one pan; .001 gram readability; with dust cover; direct reading.</p>
E-BC-39	L-34-39-(5) D-32-39-(5)	<p><u>Platform Beam Scale</u> - 100 kg capacity; bench mounted; 2 beams, one reading approximately 0-10 kg x 0.5 kg, the other reading 0-500 gram by 5 gram; platform minimum size 35 cm x 40 cm; platform clear of obstruction from weighing devices to permit objects larger than the platform to be weighed; with weights and weight hanger.</p>
E-BC-40	L-34-40-(4) D-32-40-(4)	<p><u>Balance, Triple Beam</u> - Approximately 2600 g capacity; sensitivity 0.1 g; single pan; top loading; one beam 10 g by 0.1 g; one beam 100 g by 10 g; one beam 500 g by 100 g; with weights; stainless steel weighing plate; with dust cover; approximately 15 cm diameter weighing plate.</p>

BUILDING CONSTRUCTION - EQUIPMENT

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION																																						
E-BC-41	L-34-41-(3) D-32-41-(3) *	<p><u>Sieve Set</u> - Sieve set, 20.3 cm diameter (8" diameter); standard full height sieves; conforming to ASTM and US National Bureau of Standards Requirements and approved by the International Standards Organization; sieve frames of seamless spun brass, with rigid rolled edges with extended bottoms to fit frames and pans to permit stacking; in the following sizes; with pan; with brass cover with ring.</p> <table border="0"> <thead> <tr> <th align="center">USS - ASTM Sieve Size or Number</th> <th align="center">Sieve Opening Millimeters</th> </tr> </thead> <tbody> <tr><td align="center">1½"</td><td align="center">37.5</td></tr> <tr><td align="center">1"</td><td align="center">25</td></tr> <tr><td align="center">¾"</td><td align="center">19</td></tr> <tr><td align="center">½"</td><td align="center">12.5</td></tr> <tr><td align="center">3/8"</td><td align="center">9.5</td></tr> <tr><td align="center">#4</td><td align="center">4.75</td></tr> <tr><td align="center">#8</td><td align="center">2.36</td></tr> <tr><td align="center">#10</td><td align="center">2.00</td></tr> <tr><td align="center">#16</td><td align="center">1.18</td></tr> <tr><td align="center">#20</td><td align="center">0.85</td></tr> <tr><td align="center">#30</td><td align="center">0.60</td></tr> <tr><td align="center">#40</td><td align="center">0.425</td></tr> <tr><td align="center">#50</td><td align="center">0.300</td></tr> <tr><td align="center">#60</td><td align="center">0.25</td></tr> <tr><td align="center">#100</td><td align="center">0.15</td></tr> <tr><td align="center">#200</td><td align="center">0.075</td></tr> <tr><td align="center">Brass Pan, 2" deep</td><td></td></tr> <tr><td align="center">Brass cover, with ring</td><td align="center">Brass Pan, 5 cm deep</td></tr> </tbody> </table> <p>*Number required: 6 sets of 16 sieves, with pan and cover.</p>	USS - ASTM Sieve Size or Number	Sieve Opening Millimeters	1½"	37.5	1"	25	¾"	19	½"	12.5	3/8"	9.5	#4	4.75	#8	2.36	#10	2.00	#16	1.18	#20	0.85	#30	0.60	#40	0.425	#50	0.300	#60	0.25	#100	0.15	#200	0.075	Brass Pan, 2" deep		Brass cover, with ring	Brass Pan, 5 cm deep
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BC-33

BUILDING CONSTRUCTION - EQUIPMENT

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
E-BC-42	L-34-42-(3) D-32-42-(3)	<u>Sieve Shaker</u> - Motorized dynamic sieve shaker, for 8" (20.3 cm) diameter sieves; must subject sieve set to rhythmic, circular, and impact motions; must accommodate a minimum of 8 sieves, pan, and cover.
E-BC-43	L-34-43-(5) D-32-43-(5)	<u>Hydrometer Analysis Set</u> - Complete set of all equipment and materials required to perform grain size analysis of soils passing the #200 (0.75 mm) sieve; includes 1 hydrometer jar bath; 1 mechanical analysis stirrer with dispersion cup and paddle; 1 pound (.5 kg) package of sodium hexametaphosphate; 1 hydrometer 0 to 60 grams; 1 hydrometer 0.995 to 1.038 specific gravity; 1 case of 6 hydrometer jars (1000 ml).
E-BC-44	L-34-44-(5) D-32-44-(5)	<u>Desiccator Jar</u> - Glass jar, with cover; approximately 200 mm diameter, 135 mm depth; with matching desiccator plate. steel, cadmium plated.
E-BC-45	L-34-45-(3) D-32-45-(3)	<u>Laboratory Oven</u> - Forced draft; 0-260°C temperature range; fully insulated; inside dimensions approximately 40 cm wide by 38 cm deep by 46 cm high; uniformity of $\pm 1^\circ\text{C}$; stainless steel interior; 2 shelves; with thermometer.
E-BC-46	L-34-46-(10) D-32-46-(10)	<u>Liquid Limit Set</u> - Include all equipment and materials required to do liquid limit device with grooving tool; 1 mixing dish, porcelain, approximately 9 cm diameter; 1 flexible spatula; 1 100 cc graduated cylinder; and 2 dozen moisture content cans (approximately 5 cm diameter x 2 cm deep); such as Soiltest CL209 ASTM liquid limit set.
E-BC-47	L-34-47-(10) D-32-47-(10)	<u>Plastic Limit Set</u> - To perform plastic limit test on soil samples; includes 1 plastic limit plate; 1 mixing dish; 1 flexible spatula; 1 25 ml glass graduate; 1 dozen 2 oz (65cc) moisture cans.

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BUILDING CONSTRUCTION - EQUIPMENT

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
E-BC-48	L-34-48-(10) D-32-48-(10)	<u>Shrinkage Limit Set</u> - To perform shrinkage limit test on soils; set to include 1 evaporating dish approximately 10 cm (4") in diameter; 1 menel shrinkage dish; 1 crystallizing dish; 1 prong plate; and 1 plastic bottle of mercury, 0.45 kg (1 pound).
E-BC-49	L-34-49-(10) D-32-49-(10)	<u>Field Density Set</u> - Apparatus required to perform field density tests on soils by the sand cone method, consisting of the following items: 1 sand cone apparatus and jug; 1 replacement jug; 1 field density plate; 1 spoon; 12 one gallon (3.8 liter) field cans; 1 steel chisel 2.5 cm (1"); 1 rubber mallet; 1 45 kg (100 pound) bag of Ottawa sand; 1 sand scoop; 1 field scale 16 kg capacity.
E-BC-50	L-34-50-(10) D-32-50-(10)	<u>Field Compaction Kit</u> - Complete set of equipment required to perform field compaction tests relating compaction to water content, including the following items: 1 standard compaction mold 847 cc (1/30 FT ³); 1 modified compaction hammer; 1 standard compaction hammer; 1 straight edge (steel); 1 mixing trowel; 6 mixing pans, (41 cm x 10 cm x 10 cm) (16" x 4" x 4"); 3 dozen moisture cans (85 g) (3 oz); 1 wash bottle, 1000 ml.
E-BC-51	L-34-51-(5) D-32-51-(5)	<u>Proctor Penetrometer Basic Set</u> - To determine penetration resistance of soil; calibrated spring dynamometer with pressure scale on stem; 130 pound ₂ (60 kg) capacity; supplied with needles having end area of 1/20, 1/10, 1/4, 1/2, and 1 in ² ; or corresponding metric units complete and ready to operate; in carrying case.
E-BC-52	L-34-52-(2) D-32-52-(2)	<u>Unconfined Compression Apparatus</u> - For unconfined compression testing of cohesive soils; load capacity of 230 kg (small variations of \pm 5% acceptable); hand operated; load indicator sensitive to 60 g; with calibration curves; or direct reading; in kg; platens of 76 mm diameter minimum, stainless steel; specimen height up to 20 cm; with strain dial, in metric units, and required clamps to attach to tester and measure strain.

BUILDING CONSTRUCTION - EQUIPMENT

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
E-BC-53	L-34-53-(2) D-32-53-(2)	<u>Sample Ejector</u> - Bench mounted; 2720 kg push force minimum; hand operated hydraulic force system; vertical ram; 20 cm (8") ram travel minimum; with extension plates, and piston discs for 101.6 mm (4") and 152.4 mm (6") molds, and for 50.8 mm (2") sample tubes.
E-BC-54	L-34-54-(5) D-32-54-(5)	<u>Combination Permeameter</u> - To measure rate of flow of water through soil samples; plastic chamber for soil specimens of 6.35 cm (2.5") diameter; chamber in 2 sections; sample lengths up to 14 cm (5.5") with extension; with porous stones, plastic funnel reservoir, inflow tube, graduated pipette 100 cc; with plastic tubing; with meter stick and clamps.
E-BC-55	L-34-55-(1) D-32-55-(1)	<u>Direct Shear Apparatus</u> - 700 kg load capacity; hand operated; normal load applied through weight hanger system, 160 kg minimum capacity, with two 1 kg and two 4 kg weights; dial indicators for strain measurement and consolidation, 25 mm by .01 mm increments; shear box for 63.5 mm (2.5 in) diameter specimen; complete with shear box housing, specimen shear rings, centering pins, specimen cutters, specimen gripper assembly, proving ring assembly with dial indicator and calibration chart, vertical strain dial, shear strain dial, and weights, all calibrations in metric.
E-BC-56	L-34-56-(4) D-32-56-(4)	<u>Soil Sampling Kit</u> - Set of 12 samplers in steel case; capable of drilling to depth of at least 6 m (20 ft); of high quality tool steel construction in various sampling tubes and augers.
E-BC-57	L-34-57-(2) D-32-57-(2)	<u>Consolidometer and Consolidation Apparatus</u> - To be used to measure soil settlement characteristics versus time; load applied thru mechanical lever system; weights supplied to allow various pressures, to a maximum pressure of 20 kg/cm ² on soil surface; 6.35 cm (2½") diameter test specimen; bench mounted; with 6.35 cm (2½") diameter, fixed type consolidometer, 2.54 cm (1") high specimen; with dial indicator 10 mm by .0025 mm increments.

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BUILDING CONSTRUCTION - EQUIPMENT

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
E-BC-58	L-34-58-(1) D-34-58-(1)	<u>Vacuum Pump</u> - For deairing test soil samples, complete with electric motor, base v belt, and operating instructions; free air displacement of 10 liters/min; 20.9 in Hg vacuum capability required.
E-BC-59	L-34-59-(3) D-32-59-(3)	<u>Laboratory Warming Pot</u> - For melting capping compound; 4 liter minimim capacity; must heat to 175°C minimum; fast heating action required.
E-C-60	L-34-60-(1) D-32-60-(1)	<u>Air Compressor</u> - For miscellaneous laboratory applications; single stage compressor; with controls, tank, safety and drain valves, pressure gauge pressure control valve, 4 m of hose, and air chuck; deliver .077 m ³ (2.7ft ³) at 10.5 kg/cm ² (150 psi).
E-BC-61	L-34-61-(2) D-32-61-(2)	<u>Marshall Stability Test Apparatus</u> - Test set for measuring resistance to flow of bituminous mixtures; includes following items: <ul style="list-style-type: none"> 1 water bath with step down transform to 220V 1 stability compaction hammer 2 stability compaction molds 1 compaction mold holder 1 extractor for stability mold 1 stability mold 1 asphalt flow indicator 1 compaction pedestal
E-BC-62	L-34-62-(1) D-32-62-(1)	<u>Laboratory Humidifier</u> - For use in concrete wet storage room; evaporate 2 liters/hour minimum; 220V, 1 phase, 50 cycle, a c required; to be connected directly to water line.

BC-37

BUILDING CONSTRUCTION - EQUIPMENT

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
E-BC-63	L-34-63-(1) D-32-63-(1)	<u>Concrete Vibrator</u> - Electrically driven; tip length 350 mm minimum; top diameter 34 mm minimum; shaft length 150 cm minimum; vibrating speed 9000 rpm minimum.
E-BC-64	L-34-64-(1) D-32-64-(1)	<u>Concrete Mixer</u> - Capacity 0.115 m ³ (4 ft ³), can vary from 0.1 m ³ to 0.15 m ³ 3½ ft ³ to 4½ ft ³ ; with tow pole and rubber tires; all steel constructions; electrically operated; with handwheel discharge and brake; if no electrically driven machine is available, gasoline engine operated machine may be substituted.
E-BC-65	L-34-65-(1) D-32-65-(1)	<u>Mortar Mixer</u> - Capacity 0.115 m ³ (4 ft ³), can vary from 0.1 m ³ to 0.15 m ³ (3.5 ft ³ to 4.5 ft ³); all steel construction; rubber tired with tow ring; electrically operated; with rubber mixing paddles; with grid with bag splitter.
E-BC-66	L-34-66-(5) D-32-66-(5)	<u>Air Content Meter Set</u> - To be used to measure the amount of air entrained in freshly mixed concrete; gauge to read % of air entrained directly; ½ ft ³ (7.3 liter) capacity; for readings up to 22% entrained air; set includes carrying case, tamping rod, straight edge, syringe with operating instructions.
E-BC-67	L-34-67-(5) D-32-67-(5)	<u>Vicat Apparatus</u> - For determining normal consistency and time of setting of cement; consisting of frame, 300 g weight plunger, with 1 cm diameter at one end, 1 mm needle at other; with indicator graduated in mm; also includes hard rubber mold.
E-BC-68	L-34-68-(5) D-32-68-(5)	<u>Gillmore Apparatus</u> - To measure the time of set of cement; consists of 2 needles, one of 1/12" diameter point and weighing 1/4 pound, the other of 1/24" diameter point and weighing one pound; base; support shaft; and horizontal arms.

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BUILDING CONSTRUCTION - EQUIPMENT

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
E-BC-69	L-34-69-(1) D-32-69-(1)	<u>Concrete Test Hammer</u> - For measuring the quality and strength of concrete in-place; operates on impact rebound principle; rebound number is read on rebound scale, then converted to concrete compressive stress by referencing to calibrated curves which are supplied with instrument; results accurate to approximately 15% of true compressive strength; with carrying case and operating instructions.
E-BC-70	L-34-70-(1) D-32-70-(1)	<u>Sample Splitter</u> - For halving soils, cement etc., into 2 equal parts; includes stainless steel hopper with 16 chutes, each 2.54 cm (1"); approximate size of hopper opening 24 cm x 48 cm (9" x 19"); with three pans, flat scoop, and cleaning brush.
E-BC-71	L-34-71-(5) D-32-71-(5)	<u>Organic Impurities Test Set</u> - To determine the presence of injurious organic impurities in sand to be used for concrete or mortar; consists of 6 graduated test bottles; 1 color standards chart; 1 pint of sodium hydroxide solution.
E-BC-72	L-34-72-(5) D-32-72-(5)	<u>Kelly Ball Penetration Set</u> - Used to determine the relative amount of water in freshly poured concrete; consists of cylinder with ball shaped bottom, weighing 13.6 kg (30 pounds), with handle and stirrup frame.
E-BC-73	L-34-73-(5) D-32-73-(5)	<u>Slump Test Set</u> - Used to indirectly measure water content of concrete by its amount of slump; set consists of galvanized steel slump cone of 10 cm (4") diameter top, 20 cm (8") diameter bottom, and 30 cm (12") height; steel tamping rod, galvanized steel pan, approximately 60 cm x 60 cm x 8 cm high, wire bristel brush, and steel trowel with wooden handle.

BUILDING CONSTRUCTION - EQUIPMENT

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
E-BC-74	L-34-74-(3) D-32-74-(3)	<u>Cylinder Capping Set</u> - Horizontal cylinder capper for concrete test cylinders 15.3 cm x 30.6 cm (6" diameter x 12" long); capping ladle; 4 bags of concrete capping compound in 23 kg (50 pound) bags; with cylinder carrier.
E-BC-75	L-34-75-(2) D-32-75-(2)	<u>Safety Cage</u> - Safety guard for concrete cylinder; for cylinders 15 cm x 30 cm; 2 peice, metal mesh, quick closure clamps; approximately 19 cm diameter x 38 cm (7-5/8" x 15").
E-BC-76	L-34-76-(2) D-32-76-(2)	<u>Bearing Plate with Alignment Device</u> - Fixture for compression testing of beam pieces from 15 cm x 15 cm (6" x 6") beam; platens hardened and ground; all steel construction.
E-BC-77	L-34-77-(5) D-32-77-(5)	<u>Conifal Mold with Tamper</u> - For testing specific gravity and assorption of fine aggregate; brass mold, 40 mm top diameter; 90 mm base diameter, and 75 mm height; 12 oz (340 gram) steel tarping rod, 2.54 cm diameter on working end.
E-BC-78	L-34-78-(5) D-32-78-(5)	<u>Yield Bucket</u> - Plated steel; with bail type handles; (14 liter) ($\frac{1}{4}$ ft ³) capacity.
E-BC-79	L-34-79-(5) D-32-79-(5)	<u>Yield Bucket</u> - Plated steel; with bail type handle; 28 liter (1 ft ³) capacity.
E-BC-80	L-34-80-(5) D-32-80-(5)	<u>Density Basket</u> - For making density tests on aggregates; galvanized wire mesh construction, with bail type handle; approximately 20 cm (8") diameter and 20 cm (8") high.
E-BC-81	L-34-81-(5) D-32-81-(5)	<u>Drying Pan</u> - Galvanized steel drying pan; approximately 60 cm x 60 cm x 8 cm.

BC-40

BUILDING CONSTRUCTION - EQUIPMENT

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
E-BC-82	L-34-82-(15) D-32-82-(15)	<u>Cylinder Molds</u> - For making standard concrete test cylinders for compressive strength tests; dimensions 15.3 cm diameter by 30.6 cm length (6" diameter x 12" length); heavy duty, steel, wall thickness 6 mm (1/4"); 2 piece cylinder with quick acting clamps; includes mold base.
E-BC-83	L-34-83-(10) D-32-83-(10)	<u>Beam Mold</u> - Molds to make concrete beams for flexure tests; dimensions 15.3 cm x 15.3 cm x 76 cm (6" x 6" x 30"); all steel construction; must be easily assembled and disassembled after concrete has set.
E-BC-84	L-34-84-(2) D-32-84-(2)	<u>Briquette Mold</u> - Cement briquette mold for molding samples for tension test of cement and mortar specimens, with quick connecting clamps; makes 3 briquettes.
E-BC-85	L-34-85-(2) D-32-85-(2)	<u>Concrete Micrometer</u> - Micrometer for accurately measuring diameter of concrete test cylinders; specially designed from approximately 14 cm to 16 cm (5.5" to 6.5"); read to 0.1 mm or .001 inch.
E-BC-86	L-34-86-(2) D-32-86-(2)	<u>Cement Cube Mold</u> - Molds for making cement and mortar cubes for testing compressive strength; mold makes 3 cubes at once; cubes are 50.8 mm (2 inch); mold in 2 halves; must be easily disconnected; with base plate.
E-BC-87	L-34-87-(1) D-32-87-(1)	<u>Hand Specimen Trimmer</u> - Trimmer for shaping consolidation specimens; must have rotating base to hold sample; must have trimming knife, hardened steel, clamped to base by an adjustable support; with guide to prevent overcutting; for 63.5 mm (2.5 inch) diameter specimens.
E-BC-88	L-34-88-(2) D-32-88-(2)	<u>Hand Specimen Trimmer</u> - For trimming cohesive soil samples for compression testing; for 71 mm (2.8") diameter specimens; vertical height between platens 150 mm (6") minimum; platens must rotate freely; with wire saw included.

BUILDING CONSTRUCTION - EQUIPMENT

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
E-BC-89	L-34-89-(10) D-32-89-(10)	<u>Miter Box Mold</u> - Circular miter boxes for making soil compression test samples; for specimen diameter of 71 mm (2.8 inches); for specimen length of 142 mm (5.6 inches); steel, plated.
* E-BC-90	L-34-90-(5) D-32-90-(5)	<u>Split Miter Box</u> - 2 piece miter box; for preparation of compression test samples; 71mm (2.8") diameter; 142 mm (5.6") length.
E-BC-93	L-33-93-(1) D-33-93-(1)	<u>Planer</u> - For planing of wood to exact parallel thickness; minimum capacity of 32.5 cm (6 inches) thickness of material, and maximum cut per pass of 3 mm (1/8"); variable rate of feed; 3 horsepower 3 phase motor with switch and overload protection; complete and ready to run, with set of three high speed steel knives; with instruction booklet; with 3 extra sets of knives.
E-BC-94	L-33-94-(1) D-33-94-(1)	<u>Shaper</u> - For shaping doors, window casing, decorative moldings; heavy duty; table size with 1 extension approximately 68 cm (27" x 36"); 1 HP motor, 3 phase, with 24V push button station, starter, and overload protection; includes 1 table extension, miter gauge, spring hold downs, fence guard assembly, and one sash and cabinet cutter set and one standard cutter set.
E-BC-95	L-33-95-(1) D-33-95-(1)	<u>Jointer</u> - For square board edges prior to gluing or assembly; rabbeting capacity 13 mm (1/2") to 15 cm (6"); cutting capacity 15 cm (6") width; 13 mm (1/2") depth; 3/4 HP, 3 phase motor with push button station, magnetic starter and overload protection; knife guard; 3 extra sets of knife blades; table surface minimum 17 cm (7") wide and 106 cm (42") long, with instructions; complete and ready to run.

* NOTE: Nos. 91 & 92 Deleted.

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BUILDING CONSTRUCTION - EQUIPMENT

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
E-BC-96	L-33-96-(2) D-33-96-(2)	<u>Radial Arm Saw</u> - 30 cm (12") saw diameter; cross cut capacity 38 cm (15") on 1" stock; maximum depth of cut 10 cm (4"); bevel position stops at 0°, 45°, 90°; wood table top approximately 65 cm (25") by 76 cm (30"); 2 HP, 3 phase motor, with on-off key lock switch, magnetic starter and overload protection; with steel legs; dado capability; cutter head; shaping guard; 5 cross cut blades, 100 teeth; 4 rip saw blades, 36 teeth; with instruction book; complete and ready to run. Bidder to insure that blades are of correct arbor size for machine furnished.
E-BC-97	L-33-97-(1) D-33-97-(1)	<u>Drill Press</u> - 15" Floor model; tilting table, approximately 280 mm x 356 mm (11" x 14"); 6 speeds minimum; push button station, magnetic starter, and overload protection; 13 mm (1/2") key chuck; with instructions; 1 set of drills from 17/32 to 1" by 1/32 increments, with 1/2" shank, in carrying case.
E-BC-98	L-33-98-(1) D-33-98-(1)	<u>Bandsaw</u> - For wood cutting only; floor model; blade to frame approximately 50 cm (20"); table size 60 cm(24") square; table tilt 15° minimum, each direction; blade width 2 cm (3/4") maximum; blade length 380 cm (150 inches); 1 HP motor; with pushbutton switch; with instructions; with three 3/4" band saw blades and three 3/8" band saw blades; with rip fence and miter gauge; adjustment wrenches; complete and ready to run.
E-BC-99	L-33-99-(1) D-33-99-(1)	<u>Table Saw</u> - Tilting arbor, 30 cm (12") diameter saw blade; table size of approximately 96 cm x 122 cm (38" x 48") with 2 extensions; in place; table height 86 cm (34"); rip fence; miter gauge; dado capability; blade guard; maximum width of cutoff of 48 cm (19") for 1" stock; maximum depth of cut 10.5 cm (4-1/8"); 220 V, 3 phase, 5 HP motor, 50 cycle, with on-off key lock switch and over load protection; floor mounted; with instructions; stop rods; 2 table inserts; moulding cutterhead; furnished with 5 rip saw blades, 36 tooth, and 5 cut off blades, 100 teeth; blade guard.

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BUILDING CONSTRUCTION - EQUIPMENT

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
E-BC-100	L-33-100-(1) D-33-100-(1)	<u>Belt and Disc Sander</u> - Floor mounted; table size approximately 17 cm (7") x 20 cm (8"), with slot; belt to column capacity approximately 17 cm (7"); belt width approximately 15 cm (6"); disc diameter approximately 30 cm (12"); furnished with instructions; 1-1/2 HP motor, 220 V, 50 cycle, 3 phases; starter switch and overload protection; miter gauge; furnished with 10 garnet belts, 15 cm (6") x 122 cm (48") of 80 grit and 10 garnet belts of 40 grit; furnished with 20 garnet discs of 50 grit, medium; and with 2 containers of disc adhesive.
E-BC-101	L-33-101-(1) D-33-101-(1)	<u>Scroll Saw</u> - Capacity, arm to saw, 50 cm (24") approximately; thickness of cut 4.5 cm (1-3/4"); table size approximately 35 cm x 35 cm (14" x 14"); table tilt 45° front, 45° one side, 15° other side; floor mounted; variable speed; with sabre saw blade guides; switch and overload protection; with instructions; 10 scroll saw blades, 10 teeth per inch; 10 scroll saw blades, 7 teeth per inch.
E-BC-102	L-33-102-(1) D-33-102-(1)	<u>Masonry Saw with Blades</u> - For cutting hard, medium hard, and soft materials, such as glazed brick, common brick, tiles, concrete block; 35 cm (14 inch) head; must make 13 cm (5") minimum cut; with coolant system; mounted on steel frame; adjustable for 45° and 90° cuts; minimum of 5 HP motor, 220 V, 50 cycle, 3 phase; with safety shield; complete with following blades, 14 inch diameter, in cartons of 10; for hard materials - 1 carton; for medium hard materials - 2 cartons; for soft materials - 2 cartons.
E-BC-103	L-35-103-(10) D-35-103-(10)	<u>Electronic Calculator</u> - For performance of basic calculations in the surveying laboratory; electronic; digital display; rechargeable batteries; with 220 V, 50 cycle, AC adapter; must have the following functions: addition, subtraction, multiplication, division, clear, decimal, sign change, find powers, roots, factorials, logarithms, trigonometric functions; store, recall, scientific notation, angles in degrees or radians; 10 significant digits; approximate size 76 mm x 152 mm;

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BUILDING CONSTRUCTION - EQUIPMENT

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
E-BC-103 (Cont'd)		complete with batteries. AC adaptor/charger, carrying case; instructions; with locking device for permanent clamping in one area, if available.
E-BC-105	L-34-105-(1) D-32-105-(1) L-33-105-(1) D-33-105-(1)	<u>Laboratory Sink</u> - Stainless steel; 2 compartment; approximate size of each compartment to be 76 cm x 60 cm x 30 m deep (30" x 24" x 12"); with large trap, approximately 36 cm (14") deep; with hose attachment on sink nozzle; with all required fittings to water lines and drain.

BC-45

MASTER EQUIPMENT LIST

BUILDING CONSTRUCTION & SURVEYING

The following general specifications shall apply to all items:

1. All equipment shall be new and unused models embodying the most up-to-date principles, design, and styling.
2. All dimensions, ranges and calibrations shall be in metric units except where otherwise specified.
3. All electrical connections will be arranged for 220 volts, 50 cycle, 1 phase, AC, unless otherwise indicated. Most exceptions will be where 3 phase power is required.

MASTER EQUIPMENT LIST
BUILDING CONSTRUCTION & SURVEYING

EQUIPMENT

REFERENCE NUMBER	DESCRIPTION	QUANTITY	UNIT	TOTAL
E-BC-1	Construction Level with Tripod	12	600	7,200.00
E-BC-2	Transit with Tripod	12	1,000	12,000.00
E-BC-3	Theodolite with Tripod	12	4,200	50,400.00
E-BC-4	Automatic Level with Tripod	12	1,500	18,000.00
E-BC-5	Electronic Distance Measuring Instrument	4	9,000	36,000.00
E-BC-6	Polar Planimeter	12	150	1,800.00
E-BC-7	Mirror Stereoscopes with Stereometer	40	500	20,000.00
E-BC-8	Stereoscope attachment	20	400	8,000.00
E-BC-9	Surveyors Tapes, Steel, 30 m	36	50	18,000.00
	Tape Reels, Clamps	36	5	180.00
	Tape Tension Handle (Spring Scale)	36	5	180.00
E-BC-10	Tape Repair Kit	2	50	100.00
E-BC-11	Level Rods	12	175	2,100.00
E-BC-12	Circular Spirit Level	12	10	120.00
E-BC-13	Range Poles	48	10	480.00
E-BC-14	Chain Pin Set, 11 Pins	10	14	140.00
E-BC-15	Standard Alidade	12	1,000	12,000.00
E-BC-16	Plane Table Tripod	12	200	2,400.00
E-BC-17	Plane Table Drawing Board, 24" x 31"	12	50	600.00
E-BC-18	Laser Level	2	10,000	20,000.00
E-BC-19	Field Book, Engineers	400	2	800.00
E-BC-20	Universal Test Machine (28,000 kg) (60,000 lb)	6	20,000	120,000.00
E-BC-21	Stress Strain Recorder, with Instrumentation	4	2,500	10,000.00
E-BC-22	Compression Tester (120,000 kg) (250,000 lb)	4	3,200	12,800.00
E-BC-23	Mechanical Extensometer	6	500	3,000.00
E-BC-24	Electronic Extensometer	4	1,000	4,000.00
E-BC-25	Tension & Compression Tester (30,000 kg)	2	4,600	9,200.00
E-BC-26	Beam Tester	2	1,100	2,200.00
E-BC-27	Digital Strain Indicator	6	1,400	8,400.00
E-BC-28	Switching and Balancing Unit	6	500	3,000.00
E-BC-29	Strain Gauges, Sets of 5 With Mounting Kit	30 10	20 40	600.00 400.00

MASTER EQUIPMENT LIST
BUILDING CONSTRUCTION & SURVEYING

EQUIPMENT

REFERENCE NUMBER	DESCRIPTION	QUANTITY	UNIT	TOTAL
E-BC-30	Tensile Test Specimens	280	2	560.00
E-BC-31	Elasticity of Flexure Apparatus	4	140	560.00
E-BC-32	Meter Stick Balance Set	4	104	416.00
E-BC-33	Compound Lever Apparatus	4	70	280.00
E-BC-34	Force Table Apparatus with Weights	4	180	720.00
E-BC-35	Crane Boom Assembly	4	330	1,320.00
E-BC-36	Truss Assembly with Supports	4	125	500.00
E-BC-37	Pulley Demonstration Set	2	150	300.00
E-BC-38	Precision Balance, 160 g	4	1,600	6,400.00
E-BC-39	Platform Beam Scale, 100 kg	10	290	2,900.00
E-BC-40	Balance, Triple Beam, 2600 g	8	65	520.00
E-BC-41	Sieve Set, 8 " (20.3 cm), 16 Sieves	6	360	2,160.00
E-BC-42	Sieve Shaker, Motorized	6	500	3,000.00
E-BC-43	Hydrometer Analysis Set	10	840	8,400.00
E-BC-44	Desiccator Jars	10	33	330.00
E-BC-45	Laboratory Oven, 260°C	6	735	4,410.00
E-BC-46	Liquid Limit Set	20	93	1,860.00
E-BC-47	Plastic Limit Set	20	10	200.00
E-BC-48	Shrinkage Limit Set	20	13	260.00
E-BC-49	Field Density Set, Sand Cone	20	200	4,000.00
E-BC-50	Field Compaction Set	20	275	5,500.00
E-BC-51	Proctor Penetrometer Basic Set	10	120	1,200.00
E-BC-52	Unconfined Compression Apparatus	4	715	2,860.00
E-BC-53	Sample Ejector	4	190	760.00
E-BC-54	Combination Permeameter	10	162	1,620.00
E-BC-55	Direct Shear Apparatus	2	3,500	7,000.00
E-BC-56	Soil Sampling Kit	8	700	5,600.00
E-BC-57	Consolidometer, & Consolidation Apparatus	4	1,100	4,400.00
E-BC-58	Vacuum Pump	2	200	400.00
E-BC-59	Laboratory Warming Pot	6	160	960.00
E-BC-60	Air Compressor	2	700	1,400.00

MASTER EQUIPMENT LIST
BUILDING CONSTRUCTION & SURVEYING

EQUIPMENT

REFERENCE NUMBER	DESCRIPTION	QUANTITY	UNIT	TOTAL
E-BC-61	Marshall Stability Test Apparatus	4	762	3,048.00
E-BC-62	Laboratory Humidifier	2	415	830.00
E-BC-63	Concrete Vibrator	2	305	610.00
E-BC-64	Concrete Mixer (0.115 ³) (4 ft ³)	2	1,000	2,000.00
E-BC-65	Mortar Mixer (0.115 ³) (4 ft ³)	2	620	1,240.00
E-BC-66	Air Content Meter, Set	10	395	3,950.00
E-BC-67	Vicat Apparatus	10	69	690.00
E-BC-68	Gillmore Apparatus	10	80	800.00
E-BC-69	Concrete Test Hammer	2	155	310.00
E-BC-70	Sample Splitter	2	115	230.00
E-BC-71	Organic Impurities Test Set	10	47	470.00
E-BC-72	Kelly Ball Penetration Set	10	44	440.00
E-BC-73	Slump Test Set	10	42	420.00
E-BC-74	Cylinder Capping Set (Horizontal)	6	100	600.00
E-BC-75	Safety Cage for Concrete Specimens	4	38	152.00
E-BC-76	Bearing Plate with Alignment Device	4	50	200.00
E-BC-77	Conical Mold with Tamper	10	15	150.00
E-BC-78	Yield Bucket with Handle (14 liter) ($\frac{1}{2}$ ft ³)	10	50	500.00
E-BC-79	Yield Bucket with Handle (28 liter) (1 ft ³)	10	65	650.00
E-BC-80	Density Basket	10	42	420.00
E-BC-81	Drying Pans (60 cm x 60 cm x 8 cm)	10	20	200.00
E-BC-82	Cylinder Modls (15.3 cm x 30.6 cm x 30.6 cm) (6" x 12")	30	46	1,380.00
E-BC-83	Beam Mold (15.3 cm x 15.3 cm x 76 cm) 6" x 6" x 30"	20	75	1,500.00
E-BC-84	Briquet Mold	4	116	464.00
E-BC-85	Concrete Micrometer (14 cm to 16 cm) (5.5" to 6.5")	4	88	352.00
E-BC-86	Cement Cube Molds	4	150	600.00
E-BC-87	Hand Specimen Trimmer, Consolidation	2	200	400.00
E-BC-88	Hand Specimen Trimmer, Compression	4	235	940.00
E-BC-89	Miter Box, Mold, Circular (71 mm) (2.8 inches)	20	20	400.00

BC-50

MASTER EQUIPMENT LIST
BUILDING CONSTRUCTION & SURVEYING

EQUIPMENT

REFERENCE NUMBER	DESCRIPTION	QUANTITY	UNIT	TOTAL
E-BC-90	Split Miter Box (71 mm) (2.8 inches)	10	35	350.00
E-BC-91	Delete	-	-	-
E-BC-92	Delete	-	-	-
E-BC-93	Planer (13 inches (32.5 cm)	2	1,800	3,600.00
E-BC-94	Shaper, Wood	2	1,300	2,600.00
E-BC-95	Jointer (6 inches (15 cm)	2	700	1,400.00
E-BC-96	Radial Arm Saw (12 inches) (30 cm)	4	1,200	4,800.00
F-BC-97	Drill Press (15 inches) (38 cm)	2	800	1,600.00
E-BC-98	Bandsaw, Wood (20 inches) 50 cm)	2	1,700	3,400.00
E-BC-99	Table Saw, Tilting Arbor (12 inches) (30 cm)	2	2,100	4,200.00
E-BC-100	Belt & Disk Sander, Floor Mounted	2	920	1,840.00
E-BC-101	Scroll Saw, (24 inches) (50 cm)	2	650	1,300.00
E-BC-102	Masonry Saw, with Blades	2	1,120	2,240.00
E-BC-103	Electronic Calculator	20	100	2,000.00
E-BC-104	Delete	-	-	-
E-BC-105	Laboratory Sink	4	400	1,600.00

BUILDING CONSTRUCTION - FURNITURE

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
F-BC-1	L-35-1-(6) D-35-1-(6) L-34-1-(5) D-32-1-(5)	<u>Student Work Tables</u> - 183 cm long by 107 cm wide by 76 cm high (72" x 42" x 30") approximate dimensions; stain and scratch resistant top, such as "colorlith"; minimum top thickness of 3 cm (1-1/4").
F-BC-2	L-28-2-(12) D-28-2-(12) L-35-2-(20) D-35-2-(20) L-34-2-(20) D-32-2-(20)	<u>Chair, Swivel</u> - Adjustable seat, 15 cm (6") minimum vertical adjustments; round swivel seat, wood, concave form, approximately 35 cm (14") diameter; adjustable wood back; frame of welded tubular steel; foot ring; vertical adjustment range 45 cm (18") to 60 cm (24").
F-BC-3	L-33-3-(8) D-33-3-(8) L-35-3-(4) D-35-3-(4) L-19-3-(2) D-19-3-(2) H-19-3-(2)	<u>Open Shelving</u> - Free standing; shelf width approximately 46 cm (18") wide; units are approximately 92 cm (36") long, and 215 cm (85") high; 6 shelf; all steel construction; weight capacity of 52 kg (115 pounds) per shelf.
F-BC-4	L-33-4-(6) D-33-4-(6) L-28-4-(5) D-28-4-(5) L-35-4-(4) D-35-4-(4) L-34-4-(4) D-32-4-(4) H-28-4-(2)	<u>Cabinet, Storage</u> - Free standing; double door; all steel construction; 4 shelves; approximately 92 cm (36") wide, 46 cm (18") deep, and 183 cm (72") high.

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BUILDING CONSTRUCTION - FURNITURE

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
F-BC-5	L-28-5-(20) D-28-5-(20) H-28-5-(20)	<u>Chair, Tablet Arm - Seat</u> , saddle formed, steel, approximately 40 cm x 40 cm (16" x 16"); tubular steel frame; laminated tablet arm approximately 30 cm x 55 cm (12" x 22").
F-BC-6	L-28-6-(5) D-28-6-(5)	<u>Student Work Table</u> - Approximately 150 cm long by 60 cm wide by 76 cm high (50" long by 24" wide by 30" high); stain and scratch resistant top such as "colorlith"; minimum top thickness of 3 cm (1-1/4").
F-BC-7	L-28-7-(4) D-28-7-(4) H-28-7-(5)	<u>Bench Cabinet, Sliding Door</u> - Approximately 182 cm long, 76 cm wide, and 83 cm high, (72" x 30" x 35"); with maple laminated top, approximately 5.7 cm (2-1/4") thick; one shelf, steel; galvanized steel construction.
F-BC-8	L-34-8-(10) D-32-8-(10)	<u>Wall Assembly Units</u> - Counter space, resting on cabinet bases, to furnish storage and work space; units approximately 183 cm long by 61 cm deep (72" x 24"); 5.7 cm (2-1/4") maple tops; each unit to have 2 cabinet bases, steel construction, 2 swing out doors, keyed, one shelf, adjustable, base unit approximate dimensions of 91 cm wide by 53 cm deep by 79 cm high (36" x 21" x 31").
F-BC-9	L-34-9-(10) D-32-9-(10)	<u>Storage Cabinet, Wall Mounted</u> - Approximate dimensions 120 cm long, 30 cm deep, and 76 cm high (47" x 12" x 30"); sliding doors; prefer wood construction with glass windows in sliding doors; steel cabinets of equal capacity will be sufficient.
F-BC-10	L-33-10-(10) D-33-10-(10)	<u>Work Table with 2 Woodworking Vises</u> - 2 station, wood working bench; 5.7 cm (2-1/4") thick laminated maple top; work surface of approximately 71 cm wide by 163 cm long (28" x 64"); with 2 door base cabinet with 1 shelf and swing out doors; base unit approximately 91 cm x 53 cm x 79 cm (36" x 21" x 31"); steel constructed base cabinet; vises for wood orking.

MASTER EQUIPMENT LIST
BUILDING CONSTRUCTION & SURVEYING

FURNITURE

REFERENCE NUMBER	DESCRIPTION	QUANTITY	UNIT	TOTAL
F-BC-1	Student Work Tables (183 cm x 107 cm x 76 cm)	22	345	7,590.00
F-BC-2	Chair, Swivel	104	36	3,744.00
F-BC-3	Shelving, Open (92 cm x 46 cm x 215 cm)	30	40	1,200.00
F-BC-4	Cabinet, Storage, Double Door	40	115	4,600.00
F-BC-5	Chair, Tablet Arm	60	25	1,500.00
F-BC-6	Student Work Table (150 cm x 60 cm x 76 cm)	10	225	2,250.00
F-BC-7	Bench, Cabinet, Sliding Door (182 cm x 76 cm x 83 cm)	13	232	3,016.00
F-BC-8	Wall Assembly Units (133cm x 61 cm)	20	195	3,900.00
F-BC-9	Storage Cabinets, Wall Mounted (120 cm x 30 cm x 76 cm)	20	200	4,000.00
F-BC-10	Work Table, with 2 Vises (163 cm x 71 cm)	20	250	5,000.00
DRAFTING ROOMS (DR)				
F-DR-1	Drafting Table (120 cm x 90 cm)	360	216	77,760.00
F-DR-2	Drafting Stool	360	45	16,200.00
F-DR-3	Instructors Drafting Table & Machine	3	600	1,800.00
F-DR-4	White Printer with Accessories	3	1,500	4,500.00
F-DR-5	Parallel Straight Edge	360	40	14,400.00

BUILDING CONSTRUCTION - FURNITURE (DRAFTING ROOMS)

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
DR-1	L-19-1-(120) D-19-1-(120) H-19-1-(120)	<u>Drafting Table</u> - Table size approximately 122 cm wide by 92 cm deep; with hard plastic work surface such as "Fiberesin" or "Formica"; adjustable top with locking mechanism on adjustment device; overall height to front of working surface approximately 95 cm; solid hardwood frame construction; with pencil edge; with one shallow drawer and one tool drawer.
DR-2	L-19-2-(121) D-19-2-(121) H-19-2-(121)	<u>Drafting Stool</u> - Tubular steel base construction; with foot ring, approximately 56 m leg spread; adjustable height, from approximately 45 cm to 60 cm; round seat, concave shape, hardwood preferred, steel will be considered.
DR-3	L-19-3-(1) H-19-3-(1) D-19-3-(1)	<u>Instructors Drafting Table with Drafting Machine</u> - Drafting Table, 152 cm wide, 95 cm deep, approximately 94 cm high; adjustable top, with heavy duty adjustable knobs; hard plastic surface top, solid maple construction, joints mortised and tenoned, reinforced with bolts and steel dowels; front pencil ledge; with print drawer; includes drafting machine; shipped with drafting machine mounted and ready to operate; machine rides on nylon bearings; scales rotate full 360°; one each 30 cm and 45 cm scale to be furnished with machine.
DR-4	L-19-4-(1) D-19-4-(1) H-19-4-(1)	<u>White Printer</u> - Printer to make copies of student drawings; copy width up to 106 cm (42") wide; to copy material from translucent sheets; dry ammonia vapor development; 220 V, 50 cycle, 1 phase; furnished with console stand, furnished with 5 extra lamps; furnished with all fittings for ammonia containers and with ammonia solution in suitable size containers approximately 50 gallons total; furnished with 6 packages of reproduction paper, 60 cm x 90 cm (24" x 36") sensitized opaque paper, medium speed, in packages of 250 sheets; this unit must be complete and ready to run.

BUILDING CONSTRUCTION - FURNITURE (DRAFTING ROOMS)

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
DR-5	L-19-5-(120) D-19-5-(120) H-19-5-(120)	<u>Straight Edge</u> - Parallel Straightedge for use with 122 cm drafting table described in DR-1; this item must be compatible with item DR-1; furnished complete with necessary hardware and instruction for mounting on the drafting table.

BUILDING CONSTRUCTION - SMALL TOOLS

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
S-BC-1	L-35-1-(6) D-35-1-(6) L-33-1-(10) D-33-1-(10)	<u>Folding Rule</u> - Metric-English; 2 meters; one side graduated in metric showing meters, decimeters, centimeters and millimeters; other side in feet, inches, and 1/16 inches.
S-BC-2	L-35-2-(6) D-35-2-(6)	<u>Sledge</u> - 2 kg (4 pound); short wood handle; forged tool steel.
S-BC-3	L-35-3-(12) D-35-3-(12)	<u>Plumb Bob</u> - 340 g (12 oz); with sheath, polished brass with hardened steel point.
S-BC-4	L-35-4-(6) D-35-4-(6)	<u>Magnifying Glass</u> - Folding pocket sized magnifier, 2 lens, 4X and 8X magnification; lens diameter 2.5 cm minimum.
S-BC-5	L-28-5-(1) D-28-5-(1)	<u>Box and Open End Wrench Set</u> - 11 piece set of wrenches; English units; alloy forged; sizes 3/8", 7/16", 1/2", 9/16", 11/16", 3/4", 13/16", 7/8", 15/16", 1" in plastic roll case.
S-BC-6	L-28-6-(1) D-28-6-(1)	<u>Box and Open End Wrench Set</u> - 15 piece set of wrenches; metric units; alloy forged; sizes 7 mm through 22 mm, each mm; in plastic roll case.
S-BC-7	L-28-7-(2) D-28-7-(2)	<u>Vise Grips</u> - Jaw locks onto work; adjustable clamp; 18 mm (7"); forged tool steel.
S-BC-8	L-28-8-(2) D-28-8-(2)	<u>Adjustable Wrench</u> - Utility wrench; forged steel; 25 cm (10 inch) length; capacity 28 mm (1-1/8").
S-BC-9	L-28-9-(3) D-28-9-(3)	<u>Screw Driver Slotted Head</u> - Plastic handle; standard blade; one each of 3 inch blade, 6 inch blade, and 8 inch blade; high quality tool steel.

BUILDING CONSTRUCTION - SMALL TOOLS

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
* S-BC-10	L-28-10-(2) D-28-10-(2)	<u>Screw Driver Phillips Head</u> - Plastic handle; Phillips head; one each of 3 inch blade, and 8 inch blade, high quality tool steel.
S-BC-12	L-28-12-(2) D-28-12-(2)	<u>Utility Vise</u> - Swivel base; machinists vise; ductile alloy frame; swivel lock; jaw width 8 cm (3-1/2"); maximum opening 13 cm (5-1/4").
S-BC-13	L-28-13-(2) D-28-13-(2)	<u>Dial Indicator Test Set</u> - Must include base, support column, horizontal arm, and clamp, with dial indicator calibrated each 0.002 mm, approximate range 9 mm; nearest available range will be considered.
S-BC-14	L-28-14-(2) D-28-14-(2) H-28-14-(2)	<u>Dial Indicator Test Set</u> - Must include base, support column, horizontal arm, and clamp, with dial indicator calibrated each 0.02 mm, approximately 25 mm range.
S-BC-15	L-28-15-(2) D-28-15-(2)	<u>Meter Sticks</u> - Wood; calibrated in decimeters, centimeters, and millimeters.
S-BC-16	L-28-16-(2) D-28-16-(2)	<u>Gauge Punch</u> - 2 points punch, set to accurately punch 0.08 cm (2") gauge length on tensile test specimen; high quality tool steel.
S-BC-17	L-28-17-(2) D-28-17-(2)	<u>Prick Punch</u> - Forged steel; heat treated; 12 mm (1/2") stock; 12 cm (5") long approximately.
S-BC-18	L-28-18-(2) D-28-18-(2)	<u>Hammer</u> - All high quality tool steel; ball pein; leather or plastic grip; approximately 340 gram (12 oz).
* <u>NOTE:</u> No. S-BC-11 Deleted.		

BUILDING CONSTRUCTION - SMALL TOOLS

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
S-BC-19	L-28-19-(2) D-28-19-(2)	<u>Dividers</u> - Spring dividers; thumb screw adjustment; forged steel; 25 cm (10") approximate size.
S-BC-20	L-28-20-(2) D-28-20-(2)	<u>Hex Key Set</u> - Set of 7 hex keys; sizes 1.5 mm, 2, 2.5, 3, 4, 5, 6 mm, in metal handle; also set of hex keys, English units, size 3/32", 7/64", 1/8", 9/64", 5/32", 3/16", 7/32", 1/4", in metal handle.
S-BC-21	L-28-21-(2) D-28-21-(2)	<u>Steel Rule</u> - Steel; satin finished; metric units, 300 mm, graduated in centimeters, millimeters, and half millimeters.
S-BC-22	L-28-22-(2) D-28-22-(2)	<u>Micrometer</u> - 0-25 mm; graduated to 0.01 mm; satin chrome finish; with ratchet and locknut.
S-BC-23	L-28-23-(2) D-28-23-(2)	<u>Micrometer, Cone Point</u> - 0-25 mm; graduated to 0.01 mm; satin chrome finish; with ratchet and locknut; must have one point for measuring curved outside surfaces.
S-BC-24	L-34-24-(12) D-32-24-(12)	<u>Washbottle, Plastic</u> - 250 ml capacity; molded one piece construction of bottle and jet tube; screw cap.
S-BC-25	L-34-25-(10) D-32-25-(10)	<u>Beaker, 250 ml</u> - with pourout; heavy duty glass; heat resistant.
S-BC-26	L-34-26-(10) D-32-26-(10)	<u>Cylinder, Graduated, 250 ml</u> - with pourout; heavy duty; heat resistant glass; subdivisions each 2 ml.
S-BC-27	L-34-27-(10) D-32-27-(10)	<u>Volumetric Flask, 500 ml</u> - Heat resistant glass; with stopper; 500 ml at 20°C.

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BUILDING CONSTRUCTION - SMALL TOOLS

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
S-BC-28	L-34-28-(12) D-32-28-(12)	<u>Moisture Boxes</u> - Tin Boxes; approximately 5 cm diameter by 4 cm deep; with cover; in dozens.
S-BC-29	L-34-29-(5) D-32-29-(5)	<u>Wheel Barrow, Wood Frame</u> - Rubber tire; capacity level full of approximately 0.1 m ³ (3.5 ft ³); heavy duty construction.
S-BC-30	L-34-30-(5) D-32-30-(5)	<u>Stop Watch</u> - Fifth second, "Timeout" type; long hand one turn each 60 seconds; small hand registers up to 30 minutes; zero reset.
S-BC-31	L-34-31-(5) D-32-31-(5)	<u>Mixing Bowl, Stainless</u> - Approximately 22 cm (9") diameter, 10 cm (4") deep, stainless steel.
S-BC-32	L-34-32-(5) D-32-32-(5)	<u>Mallet, Rubber</u> - 5 cm (2") diameter; approximately 25 cm (10") wooden handle.
S-BC-33	L-34-33-(10) D-32-33-(10)	<u>Shovel</u> - Round point; short handle; forged high carbon steel.
S-BC-34	L-34-34-(10) D-32-34-(10)	<u>Hoe, Mortar</u> - 2 holes in blade, approximately 25 cm (10") width; approximately 170 cm (5½ ft) handle.
S-BC-35	L-34-35-(10) D-32-35-(10)	<u>Mortar and Pestle Set</u> - Heavy porcelain construction; mortar approximately 12 cm (5") in diameter; 6 cm (2½") high; pestle rubber tipped; wooden handle; approximately 20 cm (8") long.

BUILDING CONSTRUCTION - SMALL TOOLS

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
S-BC-36	L-34-36-(5) D-32-36-(5)	<u>Heat Gun</u> - For approximate heat range from 300 ⁰ F (135 ⁰ C) to 500 ⁰ F (245 ⁰ C); hot, cold and off switch positions; adjustable air intake; hand held.
S-BC-37	L-34-37-(5) D-32-37-(5)	<u>Funnel, Plastic</u> - 10 cm diameter (4") approximately; short stem; heavy weight; stem length approximately 75 mm.
S-BC-38	L-34-38-(5) D-32-38-(5)	<u>Thermometer</u> - Dial type, accurate to 0.5% of full scale reading; 45 mm diameter dial (approximately) 200 mm long stem; record from 0 ⁰ C to 110 ⁰ C approximate range.
S-BC-39	L-34-39-(5) D-32-39-(5)	<u>Scoop</u> - One piece; aluminum; bowl size approximately 12 cm x 20 cm x 8 cm (5" x 8" x 3").
S-BC-40	L-33-40-(5) D-33-40-(5)	<u>Circular Saw</u> - Portable electric circular saw for general purpose wood cutting; heavy duty rating; must be of industrial quality; saw blade size 17 cm (6-3/4") minimum and may be 18.5 cm (7 1/2") maximum; with instruction manual; in case; furnished with extra saw blades, 6 or 7 teeth/inch acceptable.
S-BC-41	L-33-41-(3) D-33-41-(3)	<u>Vacuum Cleaner Wet/Dry</u> - For general shop cleaning; 75 liter (20 gallon) capacity; must handle wet or dry materials; 6 cm (2.5") diameter hose; on wheels or casters.
S-BC-42	L-33-42-(5) D-33-42-(5)	<u>Hand Drill, Electric, W/Drills</u> - For general drilling in wood and metal; 9.5 cm (2/8") nominal drill capacity; heavy duty construction of industrial quality; double gear train; reversing; with 2 drill sets, metric, in metal index case, 19 piece set from 1.00 mm to 10 mm in increments of 0.5 mm.

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BUILDING CONSTRUCTION - SMALL TOOLS

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION																																																																																																
S-BC-43	L-33-43-(2) D-33-43-(2)	<p><u>Tool Storage Cabinet, with Tools, Woodworking</u> - Complete woodworking hand tool storage for 20 students; in wooden cabinet; upper swing out doors with tools attached; lower storage area with tray storage. Containing the following tools:</p> <table border="0"> <tr> <td>3</td> <td>Rubber mallets 18 oz.</td> <td>5</td> <td>½" hand chisels</td> </tr> <tr> <td>8</td> <td>16 oz nail hammers</td> <td>5</td> <td>¾" hand chisels.</td> </tr> <tr> <td>8</td> <td>13 oz nail hammers</td> <td>3</td> <td>1" hand chisel</td> </tr> <tr> <td>4</td> <td>Hand drills ¾" capacity</td> <td>5</td> <td>Marking gauges</td> </tr> <tr> <td>4</td> <td>Ratchet braces 10"</td> <td>6</td> <td>Handled cabinet rasps 10"</td> </tr> <tr> <td>2 sets</td> <td>Augers bits sizes 4-16 complete</td> <td>6</td> <td>Handled cabinet wood files 10"</td> </tr> <tr> <td>2</td> <td>Expansion bits</td> <td>7</td> <td>Scratch awls</td> </tr> <tr> <td>2</td> <td>¾" brace counter sinks</td> <td>1</td> <td>Nail Set, 12 assorted sizes</td> </tr> <tr> <td>1</td> <td>Bit gauge</td> <td>4</td> <td>Screwdrivers 4" blade</td> </tr> <tr> <td>2</td> <td>Hand chisels ½"</td> <td>4</td> <td>Screwdrivers 6" blade</td> </tr> <tr> <td>3</td> <td>¾" hand chisels</td> <td>2</td> <td>Screwdrivers 8" blade</td> </tr> <tr> <td>3</td> <td>Screwdrivers bits assorted</td> <td>1</td> <td>T bevel 6"</td> </tr> <tr> <td>2</td> <td>Rip saws 26" - 5½" point</td> <td>1</td> <td>T bevel 8"</td> </tr> <tr> <td>4</td> <td>Cross cut saws 24" - 10" point</td> <td>12</td> <td>Steel rules 30 cm</td> </tr> <tr> <td>5</td> <td>Back saws 12"</td> <td>1</td> <td>24" level</td> </tr> <tr> <td>1</td> <td>Compass saw 12"</td> <td>6</td> <td>Coping saw frames</td> </tr> <tr> <td>1</td> <td>Keyhole saw 10"</td> <td>5</td> <td>9 planes</td> </tr> <tr> <td>10</td> <td>Try squares 15 cm</td> <td>5</td> <td>11½" planes</td> </tr> <tr> <td>2</td> <td>Try squares 20 cm</td> <td>6</td> <td>14" planes</td> </tr> <tr> <td>2</td> <td>Try squares 25 cm</td> <td>8</td> <td>Block planes</td> </tr> <tr> <td>1</td> <td>Framing square 60 cm x 40 cm</td> <td>1</td> <td>Cabinet scraper</td> </tr> <tr> <td>2</td> <td>Wood turning chisel sets</td> <td>1</td> <td>set Twist drills with stand</td> </tr> <tr> <td>1</td> <td>Basic carving set</td> <td></td> <td>1/16" - 1/2" x 32nds</td> </tr> <tr> <td>6</td> <td>Sloyd knives</td> <td>6</td> <td>Adjustable handscrews #3/0</td> </tr> </table>	3	Rubber mallets 18 oz.	5	½" hand chisels	8	16 oz nail hammers	5	¾" hand chisels.	8	13 oz nail hammers	3	1" hand chisel	4	Hand drills ¾" capacity	5	Marking gauges	4	Ratchet braces 10"	6	Handled cabinet rasps 10"	2 sets	Augers bits sizes 4-16 complete	6	Handled cabinet wood files 10"	2	Expansion bits	7	Scratch awls	2	¾" brace counter sinks	1	Nail Set, 12 assorted sizes	1	Bit gauge	4	Screwdrivers 4" blade	2	Hand chisels ½"	4	Screwdrivers 6" blade	3	¾" hand chisels	2	Screwdrivers 8" blade	3	Screwdrivers bits assorted	1	T bevel 6"	2	Rip saws 26" - 5½" point	1	T bevel 8"	4	Cross cut saws 24" - 10" point	12	Steel rules 30 cm	5	Back saws 12"	1	24" level	1	Compass saw 12"	6	Coping saw frames	1	Keyhole saw 10"	5	9 planes	10	Try squares 15 cm	5	11½" planes	2	Try squares 20 cm	6	14" planes	2	Try squares 25 cm	8	Block planes	1	Framing square 60 cm x 40 cm	1	Cabinet scraper	2	Wood turning chisel sets	1	set Twist drills with stand	1	Basic carving set		1/16" - 1/2" x 32nds	6	Sloyd knives	6	Adjustable handscrews #3/0
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BUILDING CONSTRUCTION - SMALL TOOLS

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION																								
S-BC-43 (Cont'd)		<table border="0"> <tr> <td>10</td> <td>Small cabinet scrapers</td> <td>6</td> <td>Adjustable handscrews #0</td> </tr> <tr> <td>1</td> <td>pair Carpenters pincers</td> <td>9</td> <td>Bar clamps 3 ft</td> </tr> <tr> <td>6</td> <td>File cards</td> <td>6</td> <td>C-clamps 6</td> </tr> <tr> <td>100</td> <td>Coping saw blades</td> <td>2</td> <td>pair Monogoggles</td> </tr> <tr> <td>1</td> <td>Combination India oilstone</td> <td>2</td> <td>Wing dividers 8"</td> </tr> <tr> <td>2</td> <td>India oilslips</td> <td>12</td> <td>Bench dusters</td> </tr> </table> <p>All dimensions may be in equivalent metric units; all calibrated instruments must be in metric units. All tools high quality tool steel.</p>	10	Small cabinet scrapers	6	Adjustable handscrews #0	1	pair Carpenters pincers	9	Bar clamps 3 ft	6	File cards	6	C-clamps 6	100	Coping saw blades	2	pair Monogoggles	1	Combination India oilstone	2	Wing dividers 8"	2	India oilslips	12	Bench dusters
10	Small cabinet scrapers	6	Adjustable handscrews #0																							
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1	Combination India oilstone	2	Wing dividers 8"																							
2	India oilslips	12	Bench dusters																							
S-BC-44	L-33-44-(2) D-33-44-(2)	<u>Mitre Box with Back Saw</u> - Adjustable from 45° to 90°; adjustable stops to control depth of cut; back saw size 66 cm (26") by 10 cm (4").																								
S-BC -45	L-33-45-(2) D-33-45-(2)	<u>Stepladder</u> - Wood stepladder 4 meters (12 feet); large platform; heavy duty construction; with stabilizer brace.																								
S-EC-46	L-33-46-(1) D-33-46-(1)	<u>Belt Sander, Portable</u> - Dustless mode; belt size 7.5 cm (3") by 61 cm (24"); helical gear belt drive; sander length 35 cm (14"); with 24 extra sanding belts.																								
S-BC-47	L-33-47-(10) D-33-47-(10)	<p><u>Cement Masons Apprentice Tool Kit</u> - The following tools are included in this kit:</p> <table border="0"> <tr><td>1</td><td>12" x 4" Trowel, Str. Handle</td></tr> <tr><td>1</td><td>14" x 4" Trowel, Str. Handle</td></tr> <tr><td>1</td><td>16" x 3½" Bevel End Magnesium Float</td></tr> <tr><td>1</td><td>18" x 3½" Bevel Edge Mahogany Float</td></tr> <tr><td>1</td><td>Rubber Cushion Knee Pads (pr)</td></tr> <tr><td>1</td><td>Universal sidewalk groover</td></tr> <tr><td>1</td><td>6" x 2½" x ½" edger, 3/8" lip</td></tr> <tr><td>1</td><td>6" x 3½" x 3/8" edger, ½" lip</td></tr> </table>	1	12" x 4" Trowel, Str. Handle	1	14" x 4" Trowel, Str. Handle	1	16" x 3½" Bevel End Magnesium Float	1	18" x 3½" Bevel Edge Mahogany Float	1	Rubber Cushion Knee Pads (pr)	1	Universal sidewalk groover	1	6" x 2½" x ½" edger, 3/8" lip	1	6" x 3½" x 3/8" edger, ½" lip								
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BUILDING CONSTRUCTION - SMALL TOOLS

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION												
S-BC-47 (Cont'd)		1 6" x 4" x 1/2" edger, 5/8" lip 1 Utility Brush 1 Rubber Float, 8" x 4" 1 5" x 2" margin trowel 1 20" tool bag Equivalent metric sizes of all tools acceptable.												
S-BC-48	L-33-48-(10) D-33-48-(10)	<u>Bricklayers Apprentice Tool Kit</u> - The following tools are included in this kit: <table border="0"> <tr> <td>1 2 Meter Spacing Rule</td> <td>1 3" Brick Set</td> </tr> <tr> <td>1 Tool Bag</td> <td>1 3/8" x 1/2" Jointer</td> </tr> <tr> <td>1 48" Level</td> <td>1 5/8" x 3/4" Jointer</td> </tr> <tr> <td>1 Narrow Heel London Trowel</td> <td>1 5 1/2" Pointing Trowel</td> </tr> <tr> <td>11" with Wood Handle</td> <td>1 Yellow Line 250</td> </tr> <tr> <td>1 Brick Hammer</td> <td>1 Corner Block</td> </tr> </table> Equivalent metric sizes of all tools acceptable.	1 2 Meter Spacing Rule	1 3" Brick Set	1 Tool Bag	1 3/8" x 1/2" Jointer	1 48" Level	1 5/8" x 3/4" Jointer	1 Narrow Heel London Trowel	1 5 1/2" Pointing Trowel	11" with Wood Handle	1 Yellow Line 250	1 Brick Hammer	1 Corner Block
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11" with Wood Handle	1 Yellow Line 250													
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S-BC-49	L-33-49-(10) D-33-49-(10)	<u>Plasterers Apprentice Tool Kit</u> - The following tools are included in this kit <table border="0"> <tr> <td>1 20" Tool Bag</td> <td>1 8" Pal Scarifier</td> </tr> <tr> <td>1 24" Level</td> <td>1 Underhill Lath Hatchet</td> </tr> <tr> <td>1 Plastering Trowel 11" x 4-3/4"</td> <td>1 Sponge Rubber Float - Dense Cell</td> </tr> <tr> <td>1 13 x 13 Magnesium Hawk</td> <td>1 S.S. Angle Float</td> </tr> <tr> <td>1 Utility Brush</td> <td>1 5" x 2" Margin Trowel</td> </tr> <tr> <td>1 S.S. Bound Brush</td> <td>1 2m folding rule</td> </tr> </table> Equivalent metric sizes of all tools are acceptable.	1 20" Tool Bag	1 8" Pal Scarifier	1 24" Level	1 Underhill Lath Hatchet	1 Plastering Trowel 11" x 4-3/4"	1 Sponge Rubber Float - Dense Cell	1 13 x 13 Magnesium Hawk	1 S.S. Angle Float	1 Utility Brush	1 5" x 2" Margin Trowel	1 S.S. Bound Brush	1 2m folding rule
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BUILDING CONSTRUCTION - SMALL TOOLS

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
S-BC-50	L-33-50-(5) D-33-50-(5)	<u>Mortar Box</u> - Steel, welded joints; rolled edges for reinforcements; approximately 250 liter (9ft ³) capacity; approximate dimensions 150 cm x 89 cm x 28 cm (58" x 35" x 11" deep).
S-BC-51	L-33-51-(5) D-33-51-(5)	<u>Wrecking Bar</u> - Forged steel; goose neck claw at one end, pinch bar at other; 80 cm (30").
S-BC-52	L-33-52-(5) D-33-52-(5)	<u>Concrete Step Tools, Matched Set of 2</u> - approximately 8" long, 4" wide, 4" lip, 1/2" radius. Equivalent metric sizes acceptable.
S-BC-53	L-33-53-(5) D-33-53-(5)	<u>Concrete Corner Tools</u> - Pair, inside and outside; approximate dimensions 6" long with 2½" sides, or metric equivalent; no cutback.
S-BC-54	L-33-54-(5) D-33-54-(5)	<u>Curb Tool</u> - Approximately 6" long, 5" wide at top, 2" radius' or metric equivalent.
S-BC-55	L-33-55-(5) D-33-55-(5)	<u>Gutter Tool</u> - Approximately 6" long, 1" radius, or metric equivalent.
S-BC-56	L-33-56-(2) D-33-56-(2)	<u>Caulking Trowel</u> - High lift, 18 cm (7") blade length, 6 mm (¼") width; wood handle.
S-BC-57	L-33-57-(2) D-33-57-(2)	<u>"V" Sled Rubber</u> - For making horizontal "V" joints in mortar; 36 cm (14") length; 16 mm (5/8") sides; wood handle.
S-BC-58	L-33-58-(2) D-33-58-(2)	<u>Half Round Sled Rubber</u> - 36 cm (14") long, 13 mm (½") half round; wood handle.

BUILDING CONSTRUCTION - SMALL TOOLS

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
S-BC-59	L-33-59-(5) D-33-59-(5)	<u>Mash Hammer</u> - One piece, forged steel; with nylon vinyl cushion grip; 1 kg (2 pound) hammer.
S-BC-60	L-33-60-(5) D-33-60-(5)	<u>Mud Masher</u> - Solid steel handle, rubber hand grip, minimum length 95 cm.
S-BC-61	L-33-61-(6) D-33-61-(6)	<u>Clamps, Double Bar</u> - For gluing table tops, etc.; side bars 12 mm ($\frac{1}{2}$ "); distance between bars 82 mm ($3\frac{1}{2}$ "); length 120 cm (4 ft).
S-BC-62	L-33-62-(10) D-33-62-(10)	<u>Adjustable Hand Screw</u> - Wood frame, "Jorgenson" type adjustable hand screws, 25 cm x 15 cm (10" x 6").
* C-BC-64	L-33-64-(2) D-33-64-(2) L-28-64-(2) D-28-64-(2)	<u>Cart Utility</u> - 2 tray; 200 kg capacity; trays 7.5 cm deep; steel construction; 90 cm x 60 cm (36" x 24"), and 80 cm (32") high; on casters, 9 cm diameter minimum.
S-BC-65	L-33-65-(1) D-33-65-(1)	<u>Storage Bin, Rotary</u> - For nail storage; all steel construction; 5 compartments per tier; 7 tiers; overall height approximately 165 cm (65") overall diameter approximately 86 cm (34").
S-BC-66	L-33-66-(4) D-33-66-(4)	<u>Broom, Push</u> - Medium sweep capacity, 60 cm (24") width; handle approximately 3 cm x 150 cm long (1-1/8" x 60" long).
S-BC-67	L-33-67-(4)	<u>Dust Pan</u> - Industrial type open dust pan, steel, approximately 18 cm x 32 cm steel.

* NOTE: No. S-BC-63 Deleted.

BUILDING CONSTRUCTION - SMALL TOOLS

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
S-BC-68	L-34-68-(1) D-34-68-(1) L-33-68-(1) D-33-68-(1)	<u>Hose, Water</u> - 2.5 cm (1 inch) approximate inside diameter; 15 cm (50 ft) length; with couplings, one male end and one female end; designed for 10 Kg/cm ² (150 pounds/square inch) minimum pressure

BC-66

MASTER EQUIPMENT LIST
BUILDING CONSTRUCTION & SURVEYING

SMALL TOOLS

REFERENCE NUMBER	DESCRIPTION	QUANTITY	UNIT	TOTAL
S-BC-1	Folding Rule, 2 m	32	3	96.00
S-BC-2	Sledge (4 lb) (2 kg), Short Handle	12	10	120.00
S-BC-3	Plumb Bob, (12 oz) (340 g) with Sheath	24	15	360.00
S-BC-4	Magnifying Glass, 2 lenses, 25 mm diameter	12	10	120.00
S-BC-5	Box and Open End Wrench Set, English	2	30	60.00
S-BC-6	Box and Open End Wrench Set, Metric	2	30	60.00
S-BC-7	Vise Grips (7 inches) (18 cm)	4	5	20.00
S-BC-8	Adjustable Wrench (10 inch) (25 cm)	4	12	48.00
S-BC-9	Screwdriver, Slotted Head	6	4	24.00
S-BC-10	Screwdriver, Phillips Head	4	4	16.00
S-BC-11	Delete	-	-	-
S-BC-12	Utility Vise, Swivel Base (3½ inches) (8 cm)	4	50	200.00
S-BC-13	Dial Indicator Test Set (8 mm range by .002mm Div)	4	100	400.00
S-BC-14	Dial Indicator Test Set (25 mm range by .02 mm Div)	6	100	600.00
S-BC-15	Meter Sticks	4	3	12.00
S-BC-16	Gauge Punch, (2 inches) (5.08 cm)	4	10	40.00
S-BC-17	Prick Punch, (5 inches) (12 cm)	4	2	8.00
S-BC-18	Hammer, 340 gr (12 oz)	4	10	40.00
S-BC-19	Dividers (10 inches) (25 cm)	4	9	36.00
S-BC-20	Hex Key Set (Metric & English)	4	3	12.00
S-BC-21	Steel Rule (300 mm)	4	5	20.00
S-BC-22	Micrometer (25 mm)	4	30	120.00
S-BC-23	Micrometer, Cone Point (25 mm)	4	40	160.00
S-BC-24	Wash Bottle, Plastic	24	1	24.00
S-BC-25	Beaker, 250 ml	20	1	20.00
S-BC-26	Graduated Cylinder, 250 ml	20	7	140.00
S-BC-27	Volumetric Flask, 500 ml	20	9	180.00
S-BC-28	Moisture Boxes (approximately 5 cm diameter x 4 cm), dozen	24	2	48.00
S-BC-29	Wheel Barrow, Wood Frame (0.1 m ³) (3.5 ft ³)	10	77	770.00

BC-68

MASTER EQUIPMENT LIST
BUILDING CONSTRUCTION & SURVEYING

SMALL TOOLS

REFERENCE NUMBER	DESCRIPTION	QUANTITY	UNIT	TOTAL
S-BC-30	Stop Watch	10	42	420.00
S-BC-31	Mixing Bowl, Stainless (20 mm) (9 inch)	10	7	70.00
S-BC-32	Mallet, Rubber (2 inches) 5 cm	10	4	40.00
S-BC-33	Shovel, Round Point, Short Handle	20	13	260.00
S-BC-34	Hoe, Mortar	20	13	260.00
S-BC-35	Mortar & Pestle	20	6	120.00
S-BC-36	Heat Gun	10	66	660.00
S-BC-37	Funnel, Plastic (4 inches) (10 mm)	10	2.50	25.00
S-BC-38	Thermometer, Metal, Dial Type (0-110°C)	10	12	120.00
S-BC-39	Scoop	10	12	120.00
S-BC-40	Circular Saw, Portable Electric (6 3/4 inch diameter) (17 cm diameter)	10	90	900.00
S-BC-41	Vacuum Cleaner, Wet/Dry	6	150	900.00
S-BC-42	Hand Drill, Electric (3/8 inch) (1 cm)	10	54	540.00
S-BC-43	Tool Storage Cabinet, with Tools, Wood Working	4	2,334	9,336.00
S-BC-44	Mitre Box with Back Saw	4	94	376.00
S-BC-45	Stepladder (4 m) (12 ft)	4	155	620.00
S-BC-46	Belt Sander, Portable, Belt 7.5 cm (3 inches) x 61 cm (24 inches)	2	160	320.00
S-BC-47	Cement Masons Apprentice Tool Kit	20	72	1,440.00
S-BC-48	Bricklayers Apprentice Tool Kit	20	70	1,400.00
S-BC-49	Plasterers Apprentice Tool Kit	20	107	2,140.00
S-BC-50	Mortar Boxes (9 ft ³) (250 liter)	10	55	550.00
S-BC-51	Wrecking Bar (30 inches) (80 cm)	10	8	80.00
S-BC-52	Concrete Step Tools, Matched Set of 2	10	12	120.00
S-BC-53	Concrete Corner Tool, Pair, Inside & Outside	10	7	70.00
S-BC-54	Curb Tool (2 inch radius) (5 cm)	10	8	80.00
S-BC-55	Gutter Tool (2 inch radius) (5 cm)	10	8	80.00
S-BC-56	Caulking Trowel (7 " x 1/4") (18 cm x 6 mm)	4	3	12.00
S-BC-57	V Sled Runner (14 inches) (36 cm)	4	3	12.00
S-BC-58	Half Round Sled Runner (14" x 1/2") 36 cm x 13 mm)	4	4	16.00
S-BC-59	Nash Hammer (2 lb) (1 kg)	10	10	100.00

MASTER EQUIPMENT LIST
BUILDING CONSTRUCTION & SURVEYING

SMALL TOOLS

REFERENCE NUMBER	DESCRIPTION	QUANTITY	UNIT	TOTAL
S-BC-60	Mud Masher	10	8	80.00
S-BC-61	Clamp, Double Bar, (4 inches) (120 cm)	11	21	231.00
S-BC-62	"Jorgenson" Adjustable Hand Screw (10" x 6") (25 cm x 15 cm)	20	11	220.00
S-BC-63	Delete	-	-	-
S-BC-64	Cart, Utility, 2 Shelf (36" x 24") (90 cm x 60 cm)	8	56	448.00
S-BC-65	Storage Bin, Rotary	2	300	600.00
S-BC-66	Broom, Push, 24 inch (60 cm)	9	10	90.00
S-BC-67	Dustpan, Industrial, Steel	8	2	16.00
S-BC-68	Hose, Water, 2.5 cm Diameter	4	15	60.00

BUILDING CONSTRUCTION - INSTRUCTIONAL MATERIALS

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION												
I-BC-1	L-28-1-(2) D-28-1-(2) H-28-1-(2) L-35-1-(2) D-35-1-(2) L-34-1-(2) D-32-1-(2) L-33-1-(2) D-33-1-(2)	<p><u>Chalkboard</u> - Approximately 1.2 m x 2.4 m; warp free panel; non-skip chalk surface, chalk easily removable with dry eraser; green non-glare color; frame of aluminum with wide lipped chalk rail.</p>												
I-BC-2	L-35-2-(1) D-35-2-(1)	<p><u>Mechanical Drawing Film Loop Set</u> - Set of 24 Super 8 mm film loops to cover the following topics: sketching straight lines; sketching circles and arcs; T-square and triangles, Part I; T-square and triangles, Part II; lettering; drawing irregular curves; compasses; drawing with templates; inking techniques; drafting machines; understanding orthographic multiview projects; spacing views; developing an orthographic multiview drawing; auxiliary projection; full sections and half sections; revolved sections and removed sections; offset and broken out sections; surface development (parallel lines, radial line, triangulation); isometric drawing; oblique drawing, one point perspective drawing; two point perspective drawing; such as Brodhead-Garrett stock # 490804, Mechanical drawing, # VE3012.</p>												
I-BC-3	L-35-3-(1) D-35-3-(1)	<p><u>Saw Film Loop Set</u> - Set of 9 Super 8 mm film loops to show how to use various types of saws; topics covered include: types; rip saw; cross cut saw; compass, keyhole, and coping saw; backsaw and mitre box; classification; sharpening; safety; picture framer. Such as Brodhead-Garrett</p> <table border="0"> <thead> <tr> <th>Stock #</th> <th>Model</th> <th>Stock #</th> <th>Model</th> </tr> </thead> <tbody> <tr> <td>490077</td> <td>SHT-2A</td> <td>490128</td> <td>SHT-2F</td> </tr> <tr> <td>490088</td> <td>SHT-2B</td> <td>490139</td> <td>SHT-2G</td> </tr> </tbody> </table>	Stock #	Model	Stock #	Model	490077	SHT-2A	490128	SHT-2F	490088	SHT-2B	490139	SHT-2G
Stock #	Model	Stock #	Model											
490077	SHT-2A	490128	SHT-2F											
490088	SHT-2B	490139	SHT-2G											

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BUILDING CONSTRUCTION - INSTRUCTIONAL MATERIALS

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION			
I-BC-3 (Cont'd)		Stock #	Model	Stock#	Model
		490099	SHT-2C	490140	SHT-2H
		490106	SHT-2D	490150	SHT-2I
		490117	SHT-2E		
I-BC-4	L-35-4-(1) D-35-4-(1)	<u>Plane Film Loop Set</u> - Set of 9 Super 8 mm film loops to show how to use planes; includes the following: their purpose; common types; block planes; rabbet and other planes; their parts; making adjustments; using a plane; sharpening the plane iron; special types. Such as Brodhead-Garrett			
		Stock #	Model	Stock #	Model
		490183	SHT-3A	490234	SHT-3F
		490194	SHT-3B	490245	SHT-3G
		490201	SHT-3C	490256	SHT-3H
		490212	SHT-3D	490267	SHT-3I
		490223	SHT-3E		
I-BC-5	L-35-5-(1) D-35-5-(1)	<u>Radial Arm Saw Film Loops with Cassettes</u> - Set of 5 Super 8 mm film loops with cassettes, to show use of radial arm saw, including: nomenclature; basic operations; dado and cutter applications; special operations. Such as Brodhead Garrett			
		Stock #	Model	Stock #	Model
		473485	FAR-011	473514	FAR-041
		473496	FAR-021	473525	FAR-051
		473503	FAR-031		

BUILDING CONSTRUCTION - INSTRUCTIONAL MATERIALS

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION																
I-BC-6	L-35-6-(1) L-35-6-(1)	<p><u>Scroll Saw Film Loops with Cassettes</u> - Set of 4 Super 8 mm film loops with cassettes, to show use of the scroll saw, including: cutting techniques; selecting and changing blades; specialized work; using scroll saw accessories. Such as Brodhead-Garrett</p> <table border="0"> <tr> <td>Stock #</td> <td>Model</td> </tr> <tr> <td>473536</td> <td>fas-011</td> </tr> <tr> <td>473547</td> <td>FAS-021</td> </tr> <tr> <td>473558</td> <td>FAS-031</td> </tr> <tr> <td>473569</td> <td>FAS-041</td> </tr> </table>	Stock #	Model	473536	fas-011	473547	FAS-021	473558	FAS-031	473569	FAS-041						
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473547	FAS-021																	
473558	FAS-031																	
473569	FAS-041																	
I-BC-7	L-35-7-(1) D-35-7-(1)	<p><u>Planer Film Loops with Cassettes</u> - Set of 5 Super 8 mm Film loops with cassettes, to show the use of a planer, including: the 13" x 6" planer; various sizes; how it works; precautions; special applications; Such as Brodhead-Garrett</p> <table border="0"> <tr> <td>Stock #</td> <td>Model</td> <td>Stock #</td> <td>Model</td> </tr> <tr> <td>446620</td> <td>FAP-011</td> <td>446652</td> <td>FAP-041</td> </tr> <tr> <td>446630</td> <td>FAP-021</td> <td>446653</td> <td>FAP-051</td> </tr> <tr> <td>446641</td> <td>FAP-031</td> <td></td> <td></td> </tr> </table>	Stock #	Model	Stock #	Model	446620	FAP-011	446652	FAP-041	446630	FAP-021	446653	FAP-051	446641	FAP-031		
Stock #	Model	Stock #	Model															
446620	FAP-011	446652	FAP-041															
446630	FAP-021	446653	FAP-051															
446641	FAP-031																	
I-BC-8	L-35-8-(1) D-35-8-(1)	<p><u>Jointer Film Loop Set</u> - Set of 4 Super 8 mm film loops with cassettes, to show use of the jointer, including: sizes and nomenclature, controls and basic operations, beveling, chamfering, and rabbetting operations, and special operations. Such as Brodhead-Garrett</p> <table border="0"> <tr> <td>Stock #</td> <td>Model</td> </tr> <tr> <td>446016</td> <td>FAJ-011</td> </tr> <tr> <td>446027</td> <td>FAJ-021</td> </tr> <tr> <td>446038</td> <td>FAJ-031</td> </tr> <tr> <td>446049</td> <td>FAJ-041</td> </tr> </table>	Stock #	Model	446016	FAJ-011	446027	FAJ-021	446038	FAJ-031	446049	FAJ-041						
Stock #	Model																	
446016	FAJ-011																	
446027	FAJ-021																	
446038	FAJ-031																	
446049	FAJ-041																	

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BUILDING CONSTRUCTION - INSTRUCTIONAL MATERIALS

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION																
I-BC-9	L-35-9-(1) D-35-9-(1)	<p><u>Circular Saw Film Loops</u> - Set of 6 Super 8 mm film loops with cassettes, to show use of circular saws, including: sizes and nomenclature; controls and basic operations; special sawing operations; sawing and dadoing with saw blade; using the dado set; using the molding cutterhead. Such as Brodhead-Garrett</p> <table border="0"> <tr> <td>Stock #</td> <td>Model</td> <td>Stock #</td> <td>Model</td> </tr> <tr> <td>445872</td> <td>FAC-011</td> <td>445901</td> <td>FAC-041</td> </tr> <tr> <td>445883</td> <td>FAC-021</td> <td>445912</td> <td>FAC-051</td> </tr> <tr> <td>445894</td> <td>FAC-031</td> <td>445923</td> <td>FAC-061</td> </tr> </table>	Stock #	Model	Stock #	Model	445872	FAC-011	445901	FAC-041	445883	FAC-021	445912	FAC-051	445894	FAC-031	445923	FAC-061
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445883	FAC-021	445912	FAC-051															
445894	FAC-031	445923	FAC-061															
I-BC-10	L-35-10-(1) D-35-10-(1)	<p><u>Drafting Transparency Set</u> - Set of overhead transparencies consisting of 36 multicolored transparencies with 20 overlays; 15 transparencies depict basic drafting skills; 8 transparencies show size and shape descriptions, and 13 transparencies show pictorial drawing; with instructors guide. Such as Brodhead Garrett Stock # 123518, the ABC's of Drafting series.</p>																
I-BC-11	L-35-11-(1) D-35-11-(1)	<p><u>Brick and Stone Masonry Transparencies</u> - Set of overhead transparencies consisting of 26 transparencies with 4 overlays; covering topics of tools, joints, mortar, brick, block, corners, doors, and stonework. Such as Brodhead Garrett stock # 347708.</p>																
I-BC-12	L-35-12-(1) D-35-12-(1)	<p><u>Power Tools Transparencies</u> - Set of 24 multicolored transparencies showing cut away views and labelled parts of portable and stationary power tools, including drills, saws, sanders, planer, shaper, and others. Such as Brodhead-Garrett stock # 343880.</p>																
L-BC-13	L-35-13-(1) D-35-13-(1)	<p><u>Architectural Drafting Transparency Set</u> - Set of 27 overhead transparencies depicting important aspects of architectural drafting, including: the floor plan; the basement; elevations; door and window details; framing; sectioning; Such as Brodhead-Garrett stock # 343181.</p>																

MASTER EQUIPMENT LIST
BUILDING CONSTRUCTION & SURVEYING

INSTRUCTIONAL MATERIALS

REFERENCE NUMBER	DESCRIPTION	QUANTITY	UNIT	TOTAL
I-BC-1	Chalkboard, 1.2 m x 2.4 m	18	80	1,440.00
I-BC-2	Mechanical Drawing Film Loop Set (24)	2 sets	672	1,344.00
I-BC-3	Saw Film Loops (9)	2 sets	216	432.00
I-BC-4	Plane Film Loops (9)	2 sets	216	432.00
I-BC-5	Radial Arm Saw Film Loops (5) with Cassettes	2 sets	135	270.00
I-BC-6	Scroll Saw Film Loops (4) with Cassettes	2 sets	108	216.00
I-BC-7	Planner Film Loops (5) with Cassettes	2 sets	135	270.00
I-BC-8	Jointer Film Loops (4) with Cassettes	2 sets	108	216.00
I-BC-9	Circular Saw Film Loops (6)	2 sets	162	324.00
I-BC-10	Drafting Transparencies	2 sets	150	300.00
I-BC-11	Brick & Stone Masonry Transparencies	2 sets	74.50	149.00
I-BC-12	Power Tools Transparencies	2 sets	52.50	105.00
I-BC-13	Architectural Drafting Transparencies	2 sets	172.50	345.00

BUDGET SUMMARY

NOTE: Numbers represent total dollars for both curriculums at both schools, and some costs of the applied mechanics laboratory at Homs. Some costs are estimates. No shipping costs are included.

Equipment	462,632
Furniture	143,178
Small Tools	34,730
Instructional Materials	<u>5,843</u>
TOTAL	651,383
*World Bank Estimate	655,390
Amount <u>Under</u>	4,007

* Includes \$51,590 from the Applied Mechanics Laboratory in Homs. The rest of the allocation for that laboratory is listed with the Chemistry Technology report.

BC-76

PRIORITY ITEMS

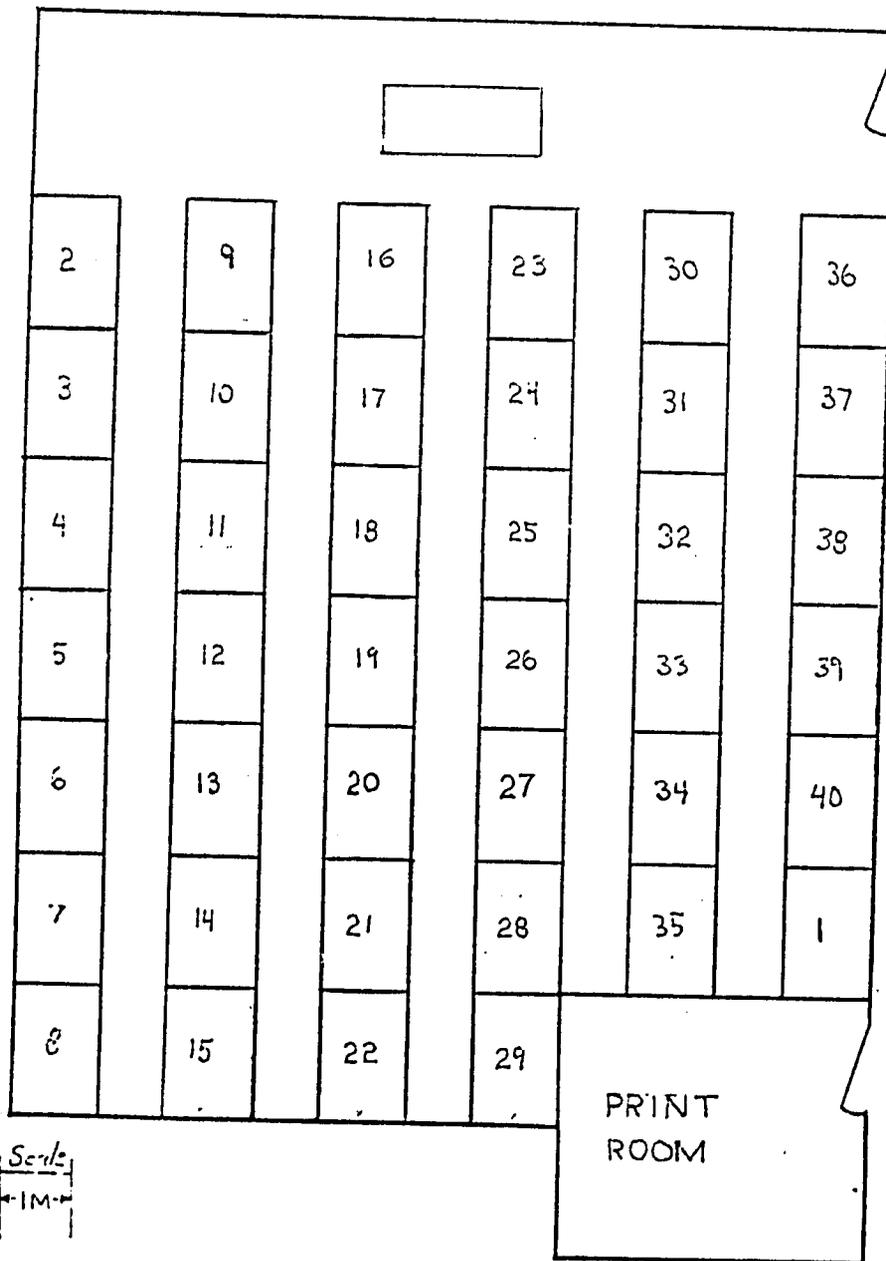
All of the listed equipment items are needed to carry out the program as envisioned in the syllabus. If it becomes necessary to reduce the recommended equipment due to insufficient funds, the following list should be used as a guide. These items are needed to carryout the program, but will cause the least damage to the curriculum.

<u>Code</u>	<u>Item Name</u>	<u>Reduction</u>	<u>Value \$ Saved</u>
E-BC-18	Laser Level	-1 x 2 locations = 2	20,000
E-BC-94	Shaper, Wood	-1 x 2 locations = 2	2,600
E-BC-57	Consolidometer	-1 x 2 locations = 2	2,200

DRAFTING ROOM PREFERRED LAYOUT

180 M² , 12 M x 15 M . THIS ALTERNATIVE SIZE IS SUGGESTED IN ORDER TO AVOID OVERCROWDING IN THE SMALLER 140 M² ROOMS. THE LARGER BOARDS WITH STRAIGHTEDGES WILL RESULT IN IMPROVED INSTRUCTION.

THIS ROOM SIZE SHOULD BE CONSIDERED EVEN IF SMALL TABLES ARE PURCHASED.



EACH NUMBERED SPACE IS FOR ONE DRAFTING TABLE, STOOL AND STUDENT WORK SPACE

CT-1

CHEMICAL ENGINEERING TECHNICIAN
CURRICULUM

A PROPOSED SYLLABUS AND EQUIPMENT LIST
FOR THE
SYRIAN ARAB REPUBLIC GOVERNMENT

Developed By
THEODORE GEORGIAN
ASSOCIATE PROFESSOR OF ORGANIC CHEMISTRY
DIRECTOR OF LABORATORY SCIENCE TECHNOLOGY CURRICULUM
NIAGARA COUNTY COMMUNITY COLLEGE
SANBORN, NEW YORK

Contracted
By
ACADEMY FOR EDUCATIONAL DEVELOPMENT

DAMASCUS, SYRIA

JULY - AUGUST 1977

LABORATORY SPACE IDENTIFICATION NUMBERS

(From World Bank)

A. Air Conditioning (Homs)

	<u>Space Number</u>
1. Heating, Fuels & Hot Water Systems	32
2. Air Conditioning & Refrigeration	33

B. Building Construction Labs (Latakia and Deir-Ez-Zor and Homs)

	<u>Latakia</u>	<u>Deir-Ez-Zor</u>	<u>Space Number</u> <u>Homs</u>
1. Applied Mechanics	28	28	28
2. Construction	33	33	
3. Engineering Materials and Soils	34	32	
4. Surveying and Photo Grammetry	35	35	

C. Chemical Tech. Laboratories (Homs)

	<u>Space Number</u>
1. Industrial Inorganic and Quantitative Chemistry	34
2. Industrial Organic Chemistry	34A
3. Chemicals Processing Unit Operations (Pilot Plants)	35
4. Mineral Processing Unit Operations	36

D. Control Systems and Transducers (Homs)

	<u>Space Number</u>
1. Control Systems	31
2. Transducers (Instruments)	37
3. Common Room	C
4. Printed Circuit Room } Support for	P
	31, 37, 22, 27

E. Materials Handling and Mechanical Power (Latakia)

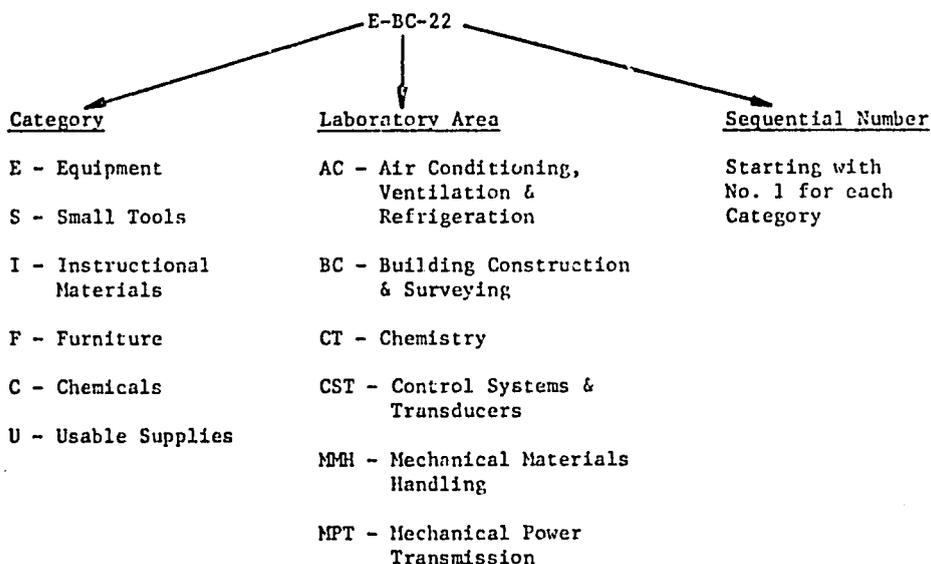
	<u>Space Number</u>
1. Machine Elements and Industrial Drawing	29
2. Diesel Power Technology	30
3. Power Transmission and Control Systems	31
4. Material Handling Equipment	32

CT-3

CODE SYSTEM

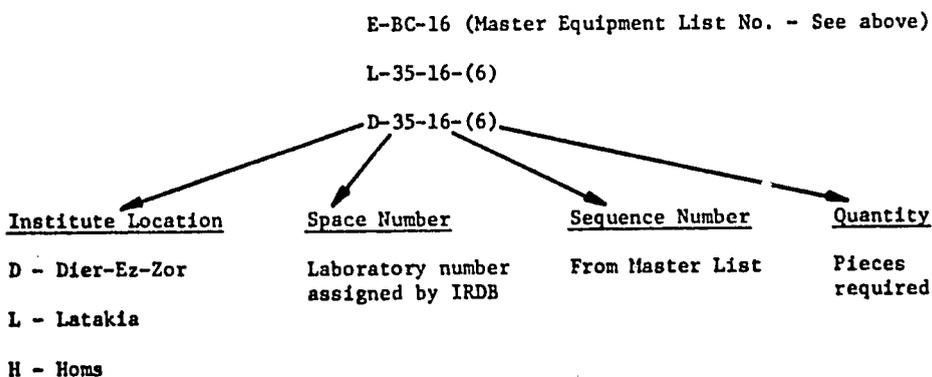
MASTER EQUIPMENT LIST - REFERENCE NUMBER

Sample:



SPECIFICATION CODE NUMBERS (FOR ALLOCATION PURPOSES)

Sample:



1. INTRODUCTION

- 1.1. The syllabi and equipment lists which follow are based upon the following limitations and assumptions.
- 1.2. The World Bank schedule of accommodations, Syrian Arab Republic First Education Project, Working Papers, Volume I, dated April 1977, forms the basic plan on which the syllabi and equipment list is based.
- 1.3. The final recommended equipment list and syllabi reflect the World Bank plan as indicated above, and the input of various authorities and individuals both in the Syrian Arab Republic, the United States, and England, along with the professional opinion of the author.
- 1.4. Conversations were held with the following individuals, either singly or in group meetings:

- Syrian Arab Republic

Mr. Mustafa Kazina, Technical Education Directorate, Ministry of Education, S.A.R.

Mr. Munir Azzam, Director, Directorate of Planning, Ministry of Education, S.A.R.

Mr. Sharifuodin Mohammed, Director of Technical Education, Ministry of Education, S.A.R.

Mr. Ali Barakat, Engineer, Vocational Training School, Homs, S.A.R., served as the Syrian Chemical Engineering counterpart assigned to the Chemical Technology expert from the United States.

Dr. Waley, Professor of Chemical Engineering, Petroleum Institute, Homs, S.A.R.

Dr. Daghastani, Dean, Petroleum Institute, Homs, S.A.R.

Dr. Wadih Moukabair, Sales Representative; Hilton and Plint, Damascus, S.A.R.

Mr. Jean Mourad, Recherches et Realizations Industrielles, Sales Representative, Armfield Technical Education Co. Ltd., England.

Mr. Michael Davis, Commercial Attache, U.S. Embassy, Damascus, S.A.R.

Mr. Patrick Theros, Duty Officer, U.S. Embassy, Damascus, S.A.R.

Dr. Chadir Zayafoun, Professor of Chemistry, Damascus University, Damascus, S.A.R.

Mr. Antoine Affaki, Sales Representative, Tecquipment Limited, Nottingham, England.

Mr. Ayman Muwakki, Engineer, School Building Institute, Damascus, S.A.R.

Mr. C.J. Mroz, Resident Manager, Forboro Company, Middle East Sales and Service, Amman, Jordan.

• England

Mr. Michael D. Hellowell, Projects Director, ABMTM Education and Science, Cambridge, England.

Dr. Chris Treleven, Armfield Technical Education Co., Ltd., Ringwood, Hampshire, England, by telex and letter.

Mr. Peter Allen, Valley Control Systems, England, by telex.

• United States of America

Dr. John Miserllis, former Professor of Chemical Engineering at Lowell Technical Institute, Lowell, Massachusetts, presently President of Silresim Chemical Corporation, Lowell, Massachusetts.

Dr. Kaiser, Professor of Chemical Engineering, University of Buffalo, Buffalo, New York.

Dr. Webber, Professor of Chemical Engineering, University of Buffalo, Buffalo, New York.

Mr. Wade Ponder, formerly Director of Chemical Engineering Technician Program at Greenville Technical Educational Center, Greenville, South Carolina. Presently at the Environmental Protection Agency, Research Triangle, South Carolina.

Dr. Green, Dean of Technical Education, Thames Valley State Technical College, Connecticut.

Dr. William J. Bailey, former President of the American Chemical Society, Research Professor, University of Maryland.

Mr. Mike Passer, Director of the Division of Educational Activities, American Chemical Society, Washington, D.C.

Mr. Andrew Spencer, Technical Sales Representative, Tecquipment Incorporated, Acton, Massachusetts.

Dr. Peter Zanetti, President of Technovate Learning Systems, Pompano Beach, Florida.

Mr. Les Nelson, Technical Sales Representative, Howard W. Sands and Company Inc., Indianapolis, Indiana.

Mr. Harry Go, International Bank for Reconstruction and Development, Washington, D.C.

Mr. C. Noel Lindsay, International Bank for Reconstruction and Development, Washington, D.C.

Dr. Ken Cashin, Professor of Chemical Engineering, University of Massachusetts, Amherst, Massachusetts.

Dr. Wagner, Professor of Chemical Engineering, Worcester Polytechnic Institute, Worcester, Massachusetts.

Mr. Craig W. Angell, Vice President-Sales, Artisan Industries Inc., Waltham, Massachusetts.

Mr. James Donnelly, President, Artisan Industries, Inc., Waltham, Massachusetts.

1.5. The two people that have most influenced the direction and level of sophistication of the program are Dr. John Miserlis of the United States and Mr. Ali Barakat of the Syrian Arab Republic. Both men have reviewed the preliminary draft of this report in detail and their recommendations and changes have been incorporated into the final report.

1.6. The following assumptions arose from the above conversations and meetings:

- The students entering the two-year chemical technician program will be from the college-bound graduating class.
- The students in the technical institutes work in groups of two, three, and four students per group in almost all laboratory settings. There are usually twenty students per laboratory.
- The students seldom have textbooks of laboratory experiments to go by and must depend upon the notes and directions provided by the instructor.
- The design of laboratories frequently does not take into account the equipment that is to be housed in the laboratory, therefore self contained teaching units are preferred.
- The supply of steam and the maintenance of a steam system would be both difficult and costly. Consequently, equipment utilizing steam is avoided wherever possible.
- There are very highly qualified technical personnel in Syria but their numbers are small. There is a significant lack of supporting technical personnel at all levels. This problem leads to a situation in which the academic goals are high but the actuation of these goals is far from probable.
- The laboratory organization and the initiation of a new laboratory program seems to take an inordinate amount of time in Syria. Totally self-contained experimental packages are favored over many single items that must be put together to attempt to shorten the time necessary for the full implementation of a laboratory program.

2. PURPOSE

The curriculum is designed to provide technicians to assist chemical engineers and to provide instructors for the technical secondary schools. The courses taught should reflect these goals by providing a broad and strongly scientific approach to the subject material rather than a limited in-depth approach to one specialized area of chemical engineering. Some of the courses in the chemical technicians' program may reflect the first three years of a four-year chemical engineering curriculum, but differ in the level of sophistication in that the two-year curriculum concentrates on those courses emphasizing basic chemical engineering skills and not on those courses needed to train technical or design chemical engineering.

The graduates of this curriculum are not experts in any area of chemical engineering but are able to achieve a high degree of proficiency in any specialized area of chemical engineering in a very short period of time.

3. PROGRAM OBJECTIVES

The graduates of the Chemical Technician Curriculum should be able to know or to perform the following functions:

- 3.1. The basic chemical engineering calculations involving energy balances, material balances, and momentum balances.
- 3.2. Principles of controllers and the sensing devices used to control various industrial continuous processes.
- 3.3. Serve as a chemical operator, engineering assistant, plant maintenance personnel, developmental pilot plant technicians, plant instruments calibrator or inspector, quality control technicians.
- 3.4. Chemical analysis involving pH meter, visible and infrared spectrometer gas chromatographs.

- 3.5. The principles involved in various physical processes such as fluid flow, heat transfer, evaporation, distillation, absorption, extraction, drying, filtration, humidification and dehumidification, and the relationship of these principles to the industrial equipment carrying out these physical processes.
- 3.6. The presentation of oral and written reports based upon collected experimental results.
- 3.7. The physical significance of the mathematical equations used in chemical engineering and the physical significance of the result of a calculation.
- 3.8. Basic rules of safety and the safety equipment used in industrial chemical and mineral processing plants.
- 3.9. The nomenclature and function of basic industrial equipment and chemicals.
- 3.10 The ability to read a simple chemical engineering schematic diagram.
- 3.11. The description of the complete chemical process involved in the processing of basic industrial chemicals and minerals.

4. TYPICAL COURSE TITLES AND TIME ALLOCATIONS

4.1. Initial program suggested by Syrian authorities:

<u>CHEMICAL TECHNOLOGY</u>		Number of Periods per Week	
First Year	Theory	Practical	
Social Studies and Language	2	1	
Industrial Safety and Industrial Planning	3	-	
Applied Mathematics	3	1	
Applied Physics (Heat and Materials)	2	2	
Industrial Chemistry	3	3	
Process Equipment and Fabrication	2	5	
Technical Drawing	1	3	
Electrical Technology	<u>2</u>	<u>3</u>	
Total	18	18	= 36
Second Year	Theory	Actual	
Social Studies and Language	2	1	
Industrial Safety and Industrial Planning	3	-	
Applied Mathematics	2	1	
Applied Mathematics (Fluid Flow)	2	2	
Industrial Chemistry	3	3	
Chemicals Manufacture Unit Operations	3	3	
Minerals Processing Unit Operations	2	3	
Electrical Controls	1	2	
Design, Fabrication and Testing Project	<u>-</u>	<u>3</u>	
Total	18	18	= 36
<u>LABORATORIES</u>			
Industrial Chemical Laboratory			
Unit Operations Laboratory			
Pilot Plan Area: Chemical Processing, Minerals Processing			
Access to: 1 - Sheet Metal and Plumbing Shops			
2 - Electrical Machinery Laboratory			
3 - Electrical Controls Laboratory			
4 - Applied Mechanics Laboratory			
5 - Applied Physics Laboratory			

4.2. Suggested Changes in the Chemical Technician Curriculum:

- The title of the curriculum may change from chemical technician to chemical engineering technician. A chemical technician closely parallels the work of a chemist while a chemical engineering technician parallels the work of a chemical engineer.
- The titles of the following courses in the chemical technician program may change to best reflect the content of the courses.

<u>First Year</u>	
<u>Original Title</u>	<u>New Title</u>
Industrial Chemistry	Industrial Inorganic and Quantitative Chemistry
<u>Second Year</u>	
<u>Original Title</u>	<u>New Title</u>
Industrial Chemistry	Industrial Organic Chemistry
Electrical Controls	Control Systems

- The electrical controls laboratory is increased from a two-hour laboratory to a three-hour laboratory. The time interval of two hours allotted for the experiments is not sufficient to complete the experimental work. The lecture portion of electrical controls is increased from one period to two periods per week to meet the requirements set by the educational work sheet for the two-year institute at Homs.
- The deletion of the applied mathematics course in the second year may not affect the student's knowledge of mathematics since these are students that were formerly in the university-bound curriculum and consequently have a strong mathematical background.

4.3. The final recommended curriculum, on which the rest of this report is based, is shown below.

<u>CHEMICAL ENGINEERING TECHNOLOGY</u>		Number of Periods per Week	
First Year	Theory	Practical	
Social Studies and Language	2	1	
Industrial Safety and Industrial Planning	3	-	
Applied Mathematics	3	1	
Applied Physics (Heat and Materials)	2	2	
Industrial Inorganic and Quantitative Chemistry	3	3	
Process Equipment and Fabrication	2	5	
Technical Drawing	1	3	
Electrical Technology	<u>2</u>	<u>3</u>	
Total	18	18	
Second Year	Theory	Practical	
Social Studies and Language	2	1	
Industrial Safety and Industrial Organization	3	-	
Applied Mechanics (Fluid Flow)	3	2	
Industrial Organic Chemistry	3	3	
Chemicals Processing Unit Operations	3	3	
Minerals Processing Unit Operations	2	3	
Control Systems	2	3	
Design, Fabrication and Testing Project	<u>-</u>	<u>3</u>	
Total	18	18	

5. OUTLINES FOR COURSES

These course outlines are included as a guideline for the purchase of equipment and as an initial guideline to the future instructor as to possible course content.

The student may be able to know or to perform the following functions:

5.1. Course Title: Industrial Inorganic and Quantitative Chemistry

- The calculations involved in the laws of conservation of matter, conservation of energy, law of combining weights in chemical reactions, law of definite and multiple proportions, gas laws, solution chemistry, thermodynamics, and electrochemistry.

- A knowledge of common industrial inorganic processes and the industrial terms used for various inorganic chemicals and processes.
- The ability to use a handbook of physics and chemistry to obtain the physical and chemical properties of a compound.
- The ability to recognize the broad chemical category that a compound fits into such as an acid, base, or salt.
- A knowledge of the basic reactions involved in inorganic chemistry.
- The use of basic laboratory equipment such as volumetric glassware and analytical balances.
- The basic volumetric type analysis.
- The use of pH meters, visible spectrometer in industrial analyses.

5.2. Course Title: Industrial Organic Chemistry

- The use of ground glassware commonly found in organic chemistry laboratories.
- The determination of the physical properties needed to characterize an organic compound such as melting point and boiling point.
- The physical methods used to purify organic compounds such as distillation, steam distillation, crystallization, extraction, and chromatography.
- A knowledge of the major classes of organic compounds and in general their means of preparation.
- A knowledge of the common organic industrial processes and the common terms used for various organic chemicals and processes.
- A knowledge of the major types of organic reactions.
- The ability to use a handbook of physics and chemistry to obtain the physical and chemical properties of a compound.
- The ability to recognize the broad chemical category that a compound fits into, such as an acid, or neutral, compound.
- A knowledge of the relative degree of reactivity of compounds to certain reagents.
- Characterization of organic compounds by means of infrared spectroscopy and gas chromatography.

5.3. Course Title: Chemical Processing Unit Operations

- The operation of a distillation column in both a batch and continuous manner.
- Determination of mass balances and thermal energy balances involved in pilot plant operations.

- The operation of a chemical reactor in both a batch and continuous mode.
- The safe use of steam generation equipment and the safety practices used in the operation of plant equipment.
- A knowledge of the characteristics of packed tower hydrodynamics and absorption processes.
- A knowledge of the characteristics of centrifugal and axial flow pumps.
- The ability to list pump specifications for a given task.
- A knowledge of sedimentation, filtration, fluid particle behavior, permeability and fluidization.

5.4. Course Title: Mineral Processing Unit Operations

- The separation of dry solids into various sizes and the determination of the particle size distribution in the solid.
- The characteristics of the flow of solids in bulk form.
- The calibration and use of thermocouples, thermopiles, and optical pyrometers.
- The determination of the densities, viscosities and diffusivities of gases and liquids.
- The principles and methods involved in industrial drying operations.
- The calibration of pressure gauges.
- The reduction in size of solid particles to a predetermined particle size.
- A knowledge of heat transfer in a conduction process.

5.5. Course Title: Control Systems

- Calibration of the elements comprising a three-term controller.
- The control of plant operations.
- A knowledge of closed loop control equipment and the sensing elements involved in liquid level, temperature, and pH control.

6. PROGRAM RECOMMENDATIONS

- 6.1. Continue the practice of having the majority if not all of the incoming students in the Chemical Engineering Technicians' curriculum from the college-bound curriculum.
- 6.2. Instructors should teach both laboratory and lecture courses. For the technicians, the laboratory courses are as important if not more important than the lecture courses.
- 6.3. A supplementary budget comprising five percent of the original budget is allotted to the program after one to two years of operation to be used for additional equipment, furniture or alterations to existing facilities.
- 6.4. The training of key instructors in the Chemical Engineering Technology curriculum in the United States for two years in a similar two-year program.
- 6.5. The development of a half-year (one semester) laboratory course in analytical chemistry emphasizing both volumetric and gravimetric determinations. The inclusion of a one-year laboratory course in Instrumental Chemical Analysis, utilizing such instruments as: visible, infrared, ultra-violet, and atomic absorption spectrometers; pH meters; gas and liquid chromatographs.

Projected Cost:

<u>Analytical Chemistry Laboratory:</u>	
<u>Description</u>	<u>Cost</u>
2 Fume hoods	\$ 10,000
Furniture	18,000
5 Analytical balances	6,000
1 Muffle furnace	800
1 Drying oven	500
Glassware and hardware	3,500
Distilled water apparatus and tank	1,800
Chemicals	<u>1,000</u>
Total	<u>\$ 41,600</u>

Instrumental Chemical Analysis:

<u>Description</u>	
1 Thermal conductivity gas chromatograph and accessories	\$ 5,500
3 Visible spectrometers and accessories	2,100
1 Infra-red spectrometer and accessories	5,000
1 Atomic absorption spectrometer and accessories	15,000
1 Ultra-violet spectrometer and accessories	15,000
5 pH meters and accessories	2,250
1 Analytical balance	1,300
Glassware and hardware	3,000
Furniture	10,000
Fume hood	5,000
Chemicals	1,000
Total	<u>\$ 64,150</u>

The basic equipment necessary for these courses such as: distilled water apparatus; muffle furnace; gas chromatograph; infra-red spectrometer; visible spectrometer; pH meters; analytical balances; support accessories; is requested under the current budget.

7. ARCHITECTURAL RECOMMENDATIONS

7.1. Electrical

- Electrical outlets required on all walls in all four laboratory areas. Specific power requirements for high load items is shown on the preliminary laboratory floor plans. All items to be located one meter above floor level.
- The following areas require 220v., 50 cycle, single phase A.C.:
 - a. Industrial Inorganic Chemistry, Area 34 - all electric outlets spaced one meter around the laboratory; all electrical outlets spaced one half meter above laboratory benches against a wall; two electrical outlets on the outside front of every fume hood.
 - b. Industrial Organic Chemistry, Area 34A - all electrical outlets spaced one meter around the laboratory; a group of two electrical outlets spaced every one meter above a laboratory bench against a wall; two electrical outlets on the outside front of every fume hood.
 - c. Main Storage Room, Area 34B - a group of two electrical outlets spaced every one meter on the wall above the laboratory bench. Three equal spaced overhead lights.
 - d. Instrument Room, Area 34C - a group of two electrical outlets spaced every one meter on all four walls; three overhead lights.

- e. Unit Operations - Minerals, Area 35 - electrical outlets spaced one meter apart on all four walls and down the center length of the laboratory.
- f. Unit Operations - Chemicals, Area 36 - electrical outlets spaced one meter apart on all four walls and two meters down the center length of the laboratory.
- g. Storage Room, Area 36A - two overhead electric lights.
- h. Instrument Room, Area 36B - two overhead electric lights; electric outlets spaced one meter apart on all four walls.

7.2. Water

- All sink drain pipes in laboratory benches and fume hoods should be lead lined, leading into chemical resistant drain pipes.
- All laboratory benches and fume hoods need a source of water.
- Unit operations - chemicals, area 36 should have water outlets 75 cm above the floor and be located every two meters along each of the four walls and every four meters down the center length of the laboratory.

7.3. Air Exhaust Systems

- Fume Hoods:
 - a. Exhaust fan and ductwork needed for each fume hood in the following laboratories: Inorganic Industrial Chemistry, Area 34; Organic Industrial Chemistry, area 34A; Unit Operations Chemicals, area 36.
- Laboratory Exhaust Systems - powerful (2 speed fans) air exhaust systems in each of the follow laboratories to remove corrosive and combustible vapors:
 - a. Inorganic Industrial Chemistry, area 34.
 - b. Organic Industrial Chemistry, area 34A.
 - c. Main Storage Room, area 34B.
 - d. Instrument Room, area 34C.
 - e. Instrument Room, area 36B.
 - f. Storage Room, area 36A.
 - g. Unit Operations - Chemicals, area 36.
 - h. Unit Operations - Minerals, area 35.

7.4. Laboratory Size

	Dimensions Length Width	Ceiling Height	Door Size
Industrial Inorganic Chemistry, Area 34	10 x 10 m	Normal	Normal
Industrial Organic Chemistry, Area 34A	10 x 10 m	Normal	Normal
Main Storage Room, Area 34B	5 x 5.2 m	Normal	Normal
Instrument Room, Area 34C	5 x 4.8 m	Normal	Normal
Unit Operations - Minerals, Area 35	11 x 7 m	Normal	One door: 1.5 m wide 2.5 m high
Unit Operations - Chemicals, Area 36	14 x 7 m	6 m high	One door: 1.5 m wide 2.5 m high
Storage Room - Area 36A	3 x 3 m	Normal	Normal
Instrument Room - Area 36B	3 x 4 m	Normal	Normal

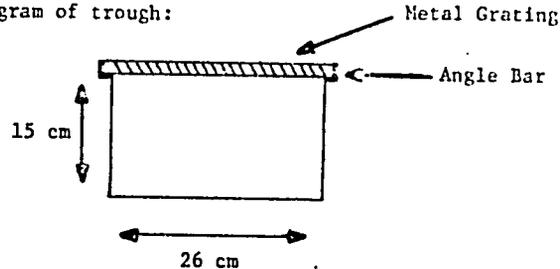
7.5. Location

- Industrial Inorganic Chemistry, Area 34 and Industrial Organic Chemistry, Area 34A, should be adjacent to one another and share a common storage room Area 34B and instrument room Area 34C.
 - a. These laboratories and rooms should be located at the end of a building because of the odors and corrosive fumes.
- Unit Operations - Minerals, Area 35, and Unit Operations - Chemicals, Area 36 should be adjacent to one another and share a common storage room (Area 36A) and a common instrument room (Area 36B).
 - a. The laboratories and rooms should be located at the end of the building because of the noise, odors, and corrosive fumes.
- An ideal arrangement of the series of laboratories and rooms mentioned above would be to arrange the series of Industrial Chemistry laboratories and rooms across the corridor from the series of Unit Operations laboratories and rooms.

7.6. Drainage*

- Unit Operations - Chemicals, Area 36:
 - a. A special drainage trough used in Unit Operation laboratories lies around the laboratory, .4 meter from the base of all 4 walls of the laboratory and another trough runs down the center of the laboratory. All three lengthwise troughs connect with the two end troughs.
 - b. The trough is fitted with a recessed metal grating so that the grating is flush with the floor. The gratings dimensions are approximately 90 cm long, 30 cm wide, and 1.9 cm thick.
 - c. Two metal gratings in the center of the trough in the middle of the laboratory may be replaced by two 90 cm length, 1.9 cm thickness pieces of plywood to allow equipment to be moved from one side of the laboratory to the other.

d. Diagram of trough:



Grating spaces are approximately 2.54 cm per side.

- e. The inside of the trough is fitted with a 10 cm in diameter plastic pipe with 3 cm in diameter holes cut into the top of the pipe every two meters. All plastic piping interconnects and exits into a sewage system. The plastic piping is to get rid of noxious vapors that can not be exited into an open trough.

7.7. Safety

- Safety Showers and Eyewash - The eyewash and safety shower is located in the same area. The locations of the safety showers and eyewashers are shown on the preliminary laboratory floor plans. These have been ordered by the Chemical technology expert.
- Fire Extinguishers:
 - a. Carbon dioxide type with a five pound charge.
 - b. These have been ordered by the Chemical Technology expert.

* A similar trough drainage system may be seen in the Unit Operations Laboratory of the Petroleum Institute in Homs, Syria.

- c. There are two fire extinguishers in the following locations: Area 36, Area 34, and Area 34A.
- d. There is one fire extinguisher in the following locations: Area 35 and 34B.

7.8. Space Requirement Summary

Area	World Bank Space Allocation	Space Used	Length - Width
Area 36	180 m ²	98 m ²	14 x 7 m
Area 36A	-	9 m ²	3 x 3 m
Area 36B	-	12 m ²	3 x 4 m
Area 35	80 m ²	77 m ²	11 x 7 m
Area 34	120 m ²	100 m ²	10 x 10 m
Area 34A	-	100 m ²	10 x 10 m
Area 34B	-	26 m ²	5.2 x 5 m
Area 34C	-	24 m ²	4.8 x 5 m
Total*	<u>380 m²</u>	<u>446 m²</u>	
	Over 66 m ²		

* Mr. Lindsey and Mr. Go of the World Bank gave approval for the increase in space allotments.

CHEMICAL TECHNOLOGY - EQUIPMENT
INDUSTRIAL INORGANIC AND QUANTITATIVE CHEMISTRY (AREA 34)

REFERENCE NUMBER	SPECIFICATI CODE	DESCRIPTION
E-CT-1	H-34-1-(36) H-34A-1-(36) H-36-1-(6) H-35-1-(6)	"SCOOPULA" - Stainless steel spatula; length 16.5 cm.
E-CT-2	H-34-2-(3) H-35-2-(2)	<u>HANDLE</u> - Wooden; compatible with Item E-CT-1.
E-CT-3	H-34-3-(30) H-34A-3-(30) H-36-3-(4) H-35-3-(4)	<u>Spatula and Spoon</u> - Stainless steel; for use in analytical weightings; flat blade at one end, spoon at other; overall 23 cm; blade 50 x 8 mm; spoon 32 x 14 mm.
E-CT-4	H-34-4-(34) H-34A-4-(36) H-36-4-(2)	<u>Asbestos Board Squares</u> - Dimensions 1.57 x 15 x 15 mm.
E-CT-5	H-34-5-(34) H-34A-5-(24) H-36-5-(2)	<u>Wire Gauzes</u> - Chromel; size 12.5 x 12.5 cm.
E-CT-6	H-36-6-(24)	<u>Triangles</u> - Pipe stem; metal with porcelain pipe stem covering; sides 50 mm.
E-CT-7	H-34-7-(36)	<u>Crucible</u> - Porcelain; high form; glazed inside and out except bottom surface; capacity 30 ml.

CHEMICAL TECHNOLOGY - EQUIPMENT

INDUSTRIAL INORGANIC AND QUANTITATIVE CHEMISTRY (AREA 34)

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
E-CT-8	H-34-8-(36)	<u>Crucible Covers</u> - Porcelain; glazed inside and out; with ring handle; compatible with crucible Item E-CT-7.
E-CT-9	H-31-9-(1) H-34-9-(3) H-34A-9-(2) H-36-9-(1) H-35-9-(1)	<u>Triple Beam Metric Balance</u> - Top loads; magnetic damping; capacity over 2000 g; sensitivity 0.1g.
E-CT-10	H-36-10-(2) H-34-10-(2) H-34A-10-(2) H-35-10-(2)	<u>Cylinders</u> - Polycarbonate; double scale; 500 ml capacity; 5 ml subdivisions.
E-CT-11	H-34-11-(20) H-34A-11-(14) H-36-11-(4)	<u>Tripod Bases</u> - Made of cast iron; with three point symmetrical stability; threaded opening for a threaded rod; tripod base; leg 12.5 cm; threads 1/2 - 13.
E-CT-12	H-34-12-(20) H-34A-12-(14) H-36-12-(4)	<u>Threaded Rod Without Shoulder</u> - Rod is threaded at one end; compatible with Item E-CT-11; rod diameter and length is 1.3 x 61 cm; rod diameters and length 1.3 x 61 cm; threads 1/2 - 13.
E-CT-13	H-34-13-(15) H-36-13-(4)	<u>Buret Clamp</u> - Made from Castaloy-R metal; with plastic buret grips; clamp made of heavy duty cast alloy steel and not pressed steel.

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CHEMICAL TECHNOLOGY - EQUIPMENT

INDUSTRIAL INORGANIC AND QUANTITATIVE CHEMISTRY (AREA 34)

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
E-CT-14	H-36-14-(25) H-34-14-(25) H-34A-14-(25) H-35-14-(12)	<u>Safety Goggles</u> - Replaceable lens of clear plastic; vinyl frame; baffle-vents for indirect ventilation; can be worn over prescription eyeglasses; rubber headband for flexible fitting.
E-CT-15	H-34-15-(48 vials) H-34A-15-(24 vials)	<u>Litmus Paper</u> - Blue; 12 vials of 100 strips each.
E-CT-16	H-34-16-(48 vials) H-34A-16-(24 vials)	<u>Litmus Paper</u> - Red; 12 vials of 100 strips each.
E-CT-17	H-34-17-(25)	<u>Dishes</u> - Evaporating; glazed inside and out; overall diameter 80 mm; height 30 mm.
E-CT-18	H-34-18-(36) H-34A-18-(36)	<u>Hoffman Open Type Tubing Clamp</u> - Screw compressor; metal; for tubing up to 1/2 inch (1.2 cm).
E-CT-19	H-34-19-(36) H-34A-19-(36)	<u>Pinchcock</u> - DAY's type spring pinchcock; for tubing up to 10 mm overall diameter.
E-CT-20	H-34-20-(48) H-34A-20-(48) H-36-20-(12) H-35-20-(12)	<u>Sponge</u> - Not affected by dilute acids, alkalies, or abrasives; rectangular shaped; approximate size 82 x 130 x 19 mm.

CHEMICAL TECHNOLOGY - EQUIPMENT

INDUSTRIAL INORGANIC AND QUANTITATIVE CHEMISTRY (AREA 34)

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
E-CT-21	H-34-21-(200 pieces) H-34A-21-(200 pieces) H-36-21-(50 pieces) H-35-21-(50 pieces)	<u>Cloth Toweling</u> - Part linen; may be washed and reused; linen and cotton; approximate dimensions of each piece 43 x 30 cm.
E-CT-22	H-34-22-(3)	<u>Quill Brushes</u> - Camel's hair; bristles 10 x 16 mm; length 80 mm.
E-CT-23	H-34-23-(2 pkg.) H-34A-23-(2 pkg.)	<u>Pipe Cleaners</u> - For cleaning small hole pipettes; core diameter about 1 mm; each package.
E-CT-24	H-34-24-(10) H-36-24-(2)	<u>Buret Brushes</u> - For cleaning 50 and 100 ml burets; bristles, and wire handle.
E-CT-25	H-34-25-(36) H-34A-25-(24)	<u>Test Tube Brushes</u> - White nylon; for cleaning tubes 13 to 16 mm in diameter.
E-CT-26	H-34-26-(42) H-34A-26-(48) H-36-26-(6) H-35-26-(6)	<u>Test Tube Brushes</u> - White nylon; for cleaning tubes 19 to 25 mm in diameter.
E-CT-27	H-34-27-(5)	<u>Bottle Brush</u> - Black nylon bristles; overall length 50 cm; 6 in a package.
E-CT-28	H-34-28-(5) H-36-28-(1)	<u>Volumetric Flask Brush</u> - For cleaning 250 ml volumetric flasks; 6 brushes in a package.

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CHEMICAL TECHNOLOGY - EQUIPMENT
INDUSTRIAL INORGANIC AND QUANTITATIVE CHEMISTRY (AREA 34)

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
E-CT-29	H-34-29-(5) H-36-29-(1)	<u>Volumetric Flask Brush</u> - For cleaning 500 ml volumetric flasks; 6 brushes in a package.
E-CT-30	H-34-30-(5) H-36-30-(1)	<u>Volumetric Flask Brush</u> - For cleaning 1000 ml volumetric flasks; 6 brushes in a package.
E-CT-31	H-34-31-(15) H-34A-31-(15) H-36-31-(1)	<u>Burners</u> - H-base with needle valve; valve control gas; turning stack controls air; hexagon at tip; operates on bottled gas; stack diameter 13 mm; compatible with wing top Item E-CT-32.
E-CT-32	H-34-32-(20) H-34A-32-(20)	<u>Burner Wing Tops</u> - Produces wide flat flame; must be compatible for stack diameter 13 mm of H base burner item E-CT-31.
E-CT-33	H-34-33-(12) H-34A-33-(12) H-36-33-(2)	<u>Gas Lighter</u> - Flat file; for lighting gas burners. Compatible with E-CT-34.
E-CT-34	H-34-34-(6 packages) H-34A-34-(3 packages) H-36-34-(1 package)	<u>Spark Metal Renewals</u> - Screw on type; compatible with item E-CT-33; 12 per package.
E-CT-35	H-34-35-(15) H-34A-35-(24)	<u>Clamp, Extension</u> - Medium size; vinylized round jaws; maximum grip up to 2 1/4 inches; made of non-rusting metal; overall length 8 7/8 inches.
E-CT-36	H-34-36-(15) H-34A-36-(15)	<u>Clamp Extension</u> - Medium size; asbestos coated jaws; maximum grip up to 2 1/4 inches; made of non-rusting metal; overall length 8 7/8 inches.
E-CT-37	H-34-37-(15) H-34A-37-(15)	<u>Clamp Extension</u> - Three fingered; medium size; vinylized jaws; maximum opening of 2 1/4 inches; overall length 8 3/4 inches.

CHEMICAL TECHNOLOGY - EQUIPMENT

INDUSTRIAL INORGANIC AND QUANTITATIVE CHEMISTRY (AREA 34)

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
E-CT-38	H-34-38-(50) H-34A-38-(50) H-36-38-(2)	<u>Clamp Holder</u> - Hold rods and clamps up to 3/4 inch diameter; non-ferrous die cast alloy; aluminum thumb screws.
E-CT-39	H-34-39-(25) H-34A-39-(25) H-36-39-(1)	<u>Test Tube Support Wood</u> - 2 deck; lower deck fits 6 tubes with 25 mm diameter; upper deck fits 7 tubes with 19 mm diameter; dove tailed joints; oil finished; size 24 x 20 x 7.50 cm.
E-CT-40	H-34A-40-(1) H-36-40-(1) H-35-40-(1) H-34-40-(1)	<u>Respirator</u> - Chemical; protection against light concentrations of fumes of organic vapors, chlorine, acid fumes; with a pair of replacable cartridges; adjustable head band; compatible with Item E-CT-156.
E-CT-41	H-34-41-(3)	<u>Magnetic Stirrer</u> - For variable low speed stirring applications; diameter at least 4 1/2 inches (11.4 cm); 250V/50Hz; supplied with 25 mm (1 inch) Teflon stirring bar.
E-CT-42	H-34-42-(3)	<u>Stirring Bars</u> - Magnetic; Teflon coated; length 15 mm (1 inch).
E-CT-43	H-34-43-(12) H-34A-43-(12) H-36-43-(3)	<u>Gloves</u> - .046 cm (.018") latex gloves; acid, base, and organic resistant; twelve pairs per box; medium size (size 9).
E-CT-44	H-34-44-(12) H-34A-44-(12) H-36-44-(3)	<u>Gloves</u> - .046 cm (.018") thick latex gloves; acid, base and organic resistant; twelve pairs per box; large size (Size 10).
E-CT-45	H-34-45-(5 pkg. of 12) H-34A-45-(2 pkg. of 12)	<u>Rubber Bulb</u> - Gum rubber diameters from 6 to 8 mm (1/4 to 5/16 in); capacity 2 ml; in package of 12.

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CHEMICAL TECHNOLOGY - EQUIPMENT
INDUSTRIAL INORGANIC AND QUANTITATIVE CHEMISTRY (AREA 34)

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
E-CT-46	H-34-46-(100 ft.) H-34A-46-(100 ft.)	<u>Rubber Tubing</u> - Seamless gum rubber tubing; internal diameter 6.4 mm (1/4"); wall thickness 1.6 mm (1/16"); 50 ft. (15 m) length per box.
E-CT-47	H-34-47-(1) H-34A-47-(3) H-36-47-(1)	<u>Labels</u> - Rectangular; pressure sensitive; size 38 x 26 mm (1 1/2 x 1"); white surface; 500 labels per box.
E-CT-48	H-34-48-(1) H-34A-48-(3)	<u>Labels</u> - Rectangular; pressure sensitive; size 76 x 38 mm; white surface; 250 labels per package.
E-CT-49	H-34-49-(5) H-34-49-(8)	<u>Cork Borer Sets</u> - For boring holes in corks or rubber stoppers; 6 nickel-plated brass borers; size range 5-13 mm.
E-CT-50	H-34-50-(5) H-34-50-(4)	<u>Cork Borer Sets</u> - For boring holes in corks or rubber stoppers; 6 steel borers; size range 5-13 mm.
E-CT-51	H-34-51-(2) H-34A-51(1)	<u>Cork Borer Sharpener</u> - For sharpening borers from 5 to 25 mm in diameter; brass cone with steel knife.
E-CT-52	H-34-52-(10) H-34A-52-(5) H-36-52-(5) H-35-52-(5)	<u>Economy Slide Rule</u> - White plastic slide rule; scales of one color on body and another color on sliding scale; includes A, B, C, C 1, and D on front side.
E-CT-53	H-34-53-(2) H-34-53-(1)	<u>Beaker Tongs</u> - Spring grip; for handling heated beakers; jaws are asbestos covered; jaws open under spring tension and close when grips are pressed together; overall length 33 cm.

CHEMICAL TECHNOLOGY - EQUIPMENT

INDUSTRIAL INORGANIC AND QUANTITATIVE CHEMISTRY (AREA 34)

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
E-CT-54	H-34-54-(25)	<u>Crucible Tongs</u> - For holding hot crucibles at tip; made of stainless steel; longneck type; length 25 cm.
E-CT-55	H-34-55-(24) H-34A-55-(24)	<u>Forceps</u> - Flat thin blades with square ends; nickle plated; length about 4 1/2 inches.
E-CT-56	H-34-56-(1)	<u>Bottle Forceps</u> - For removing articles from bottle and jars; nickle plated; length 250 mm.
E-CT-57	H-34-57-(1) H-34A-57-(1) H-36-57-(1) H-35-57-(1)	<u>Scientific Calculator</u> - Electronic; digital display; electronic slide rule; small battery operated; 8 digit mantissa; 2 digit exponent; rechargeable battery pack; recharger/A.C. adapter that works on 220/240 50 Hz; soft carrying case; illustrated owners handbook.
E-CT-58	H-34-58-(8) H-34A-58-(12) H-36-58-(1) H-35-58-(1)	<u>Filter Pump</u> - Water aspirator; conventional laboratory pump for general laboratory use; made of brass; compatible with conventional standard metric piping; length 136 mm.
E-CT-59	H-34-59-(12) H-34A-59-(12) H-36-59-(1)	<u>Iron Extension Support Rings</u> - Fastened to support rods by means of clamp holders; medium size; internal diameter about 8.5 cm; overall diameter about 10 cm.
E-CT-60	H-34-60-(36) H-34A-60-(24) H-36-60-(12)	<u>Wash Bottle</u> - Squeeze type bottle having polyethylene spout set at 45° angle; 250 ml size.
E-CT-61	H-34-61-(30) H-34A-61-(24) H-36-61-(2)	<u>Stoddard's Test Tube Clamp</u> - Holds test tubes up to 25 mm diameter; heavy gauge brass spring wire.

CHEMICAL TECHNOLOGY - EQUIPMENT

INDUSTRIAL INORGANIC AND QUANTITATIVE CHEMISTRY (AREA 34)

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
E-CT-62	H-34-62-(3) H-34A-62-(1) H-36-62-(1)	<u>Bottles</u> - Aspirator; rectangular; with spigot; polyethylene; built in carry loop on top; 2 gallon (8.5 liter) capacity; supplied with polypropylene cap.
E-CT-63	H-34-63-(1) H-36-63-(3)	<u>Bottles</u> - 5 gallon (21 liters) capacity; aspirator; rectangular; with spigot; polyethylene; built in molded in handgrips; supplied with polypropylene cap.
E-CT-64	H-34-64-(10) H-36-64-(1)	<u>Tripod</u> - Iron; plain; for supporting evaporating dishes and crucibles; ring size overall diameter 12.7 cm; overall height 9 inches.
E-CT-65	H-34-65-(1)	<u>Filter Aid</u> - Finely divided diatomaceous silica; accelerates filtration; such as "celite".
E-CT-66	H-34-66-(500 g) H-34A-66-(500 g)	<u>Smooth Boiling Granules</u> - Granules which insure smooth boiling; not attacked by acid alkalies or organic reagents; 500 g.
E-CT-67	H-34-67-(2) H-36-67-(1)	<u>Support, Pipet, Hardwood</u> - Stores 12 pipets of 25 cm minimum length.
E-CT-68	H-34-68-(2 packages)	<u>Wood Splints</u> - For testing ability of gases to support combustion; thin strips of soft dry wood; 500 to a bundle; a package contains 3 bundles.
E-CT-69	H-34A-69-(2) H-36-69-(1)	<u>Hot Plate Magnetic Stirrer</u> - Combination magnetic stirrer and hot plate; chemical resistant glass ceramic top; one dial for heating; another dial for stirring; with Teflon coated stirring bar; compatible with Item E-CT-161 (same manufacturer) to minimize repair costs; 220V/50Hz.
E-CT-70	H-34-70-(1)	<u>Standard Water Stills</u> - For preparation of mineral-free pure distillate; constant bleeder device; constant level device; equipped with chain valve; immersion type heaters; complete with junction box for direct connection to electrical service; 220/240V / 50 Hz; Barnstead type; produces 1 gallon (4.2 liters) an hour; complete with solid state low cut-off control unit.

CHEMICAL TECHNOLOGY - EQUIPMENT
INDUSTRIAL INORGANIC AND QUANTITATIVE CHEMISTRY (AREA 34)

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
E-CT-71	H-34-71-(12) H-36-71-(2) H-35-71-(4)	<u>Stop Watch</u> - Will start, stop and reset to zero by consecutive depressions crown; smallest interval 1/5 sec; max. range 30 min.; chrome plated.
E-CT-72	H-34-72-(3) H-36B-72-(1)	<u>Analytical Balance</u> - Single pan; electrical; constant sensitivity at all loads; capacity of 160 g; readability of .1 mg; digital readout; a coarse filling guide facility; air release beam; precision ± 0.05 mg; removable top and sides; complete with cleaning cloth, brush, screwdriver, extra lamp, plastic cover; teaching aids, and instructions; 220/240 50Hz; pre-weighing capability.
E-CT-73	H-34-73-(1)	<u>Two-Pan Analytical Balance</u> - Drum chain attachment; agate bearings; paired knife edges; beam graduated and notched 1 x 0.1 g for use with externally manipulated beam weight; dial counter with scale for interpolation to .1 mg; balance capacity 200 g, full load sensitivity .1 mg; sliding glass doors; dust cover; drawer space; with magnetic damping.
E-CT-75	H-34-75-(1) H-34A-75-(1) H-36-75-(1) H-35-75-(1)	<u>First Aid Cabinet</u> - Metal cabinet; cover acts as work tray; approximate assortment includes: gauze bandages, pads, muslin bandage, surgical gauze, cotton, adhesive tape, triangular bandage medicinals, applicators, splints, scissors, tweezers, first aid manual, etc.
E-CT-76	H-34-76-(1)	<u>Lab Coat</u> - Cotton twill; full length; 3 pockets; collar suitcoat type; removable buttons; white; size 34.
E-CT-77	H-34-77-(1) H-34A-77-(1) H-36-77-(1) H-35-77-(1)	<u>Lab Coat</u> - Cotton Twill; full length; 3 pockets; collar suitcoat type; removable buttons; white; size 36.

CHEMICAL TECHNOLOGY - EQUIPMENT
INDUSTRIAL INORGANIC AND QUANTITATIVE CHEMISTRY (AREA 34)

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
E-CT-78	H-34-78-(1) H-34A-78-(1) H-36-78-(1) H-35-78-(1)	<u>Lab Coat</u> - Cotton twill; full length; 3 pockets; collar suitcoat type; removable buttons; white; size 38.
E-CT-79	H-34-79-(1)	<u>Lab Coat</u> - Cotton twill; full length; 3 pockets; collar suitcoat type; removable buttons; white; size 40.
E-CT-80	H-34-80-(2) H-36-80-(1)	<u>Rubber Aprons</u> - Rubberized muslin; medium apron.
E-CT-81	H-34-81-(1) H-35-81-(1)	<u>Laboratory Oven</u> - 220/240 V, 50 Hz; with thermostat; 100 watts; for sample drying; baking; sterilizing etc.; steel construction with asbestos insulation; 2 adjustable shelves; thermostatically controlled; damper regulated induced air circulation; temperature range 270°C; sensitivity of $\pm 1/2^\circ\text{C}$; chamber 33 x 33 x 33 cm; with mercury thermometer.
E-CT-82	H-34-82-(1)	<u>Muffle Furnace</u> - Automatic trigger control; temperatures from 66° to 1093°C; heating elements and firebrick impervious to most compounds; millivolt pyrometer in F° and C°; 2 thermocouples; removable load trays; 50 Hz; terminal box for connection to electric service; 2000 watts/220V; Inside diameter 21 x 17 x 15 inches.
E-CT-83	H-34-83-(1)	<u>Asbestos Gloves</u> - with gauntlet; for handling hot wares; loose fitting fingers; flannel lined.
E-CT-84	H-34-84-(1)	<u>Tongs</u> - Crucible; spring; steel; nickel plated; used for furnace work; Julian type; length 55.9 cm (22 inches).
E-CT-85	H-34-85-(12)	<u>Trough</u> - Pneumatic, polypropylene, gas delivery tube to inlet nipple on the bottom and passes up through hole in rim at one end of trough to prevent siphoning; inlet and overflow tubes; Size (33 x 19.1 x 9.5 cm) 13 x 7 1/2 x 3 3/4 inches.

CHEMICAL TECHNOLOGY - EQUIPMENT

INDUSTRIAL INORGANIC AND QUANTITATIVE CHEMISTRY (AREA 34)

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
E-CT-86	H-34-86-(1)	<u>Mercurial Barometer</u> - English and metric scales; for measuring atmospheric pressure; ready for use; tube fitted with mercury; scales etched on stainless steel plate; sliding vernier is provided which reads to 0.01 inch and 0.1 mm; brackets for wall mounting; attached Celsius-Fahrenheit thermometer, reading from -10° to 55°C and 15° to 125°F; length 102 cm (40 inches).
E-CT-87	H-34-87-(1)	<u>Barometer Mount</u> - Metal; with holes for attaching brackets of Item E-CT-89; for wall mounting; compatible with Item E-CT-86; size 10 x 90 cm (4 x 35 1/2 inches).
E-CT-88	H-34-88-(1)	<u>Analytical Weights</u> - Class S-1, stainless steel; large weights of stainless steel; smaller weights of aluminum; contained in velvet lined box; pair of nylon-tipped forceps; plastic cover for fractional weights; 18 weights, 10 mg to 100 g.
E-CT-89	H-34-89-(6) H-34A-89-(6) H-36-89-(6) H-35-89-(6)	<u>Nickel Cadmium Batteries</u> - rechargeable; compatible with scientific calculator Item E-CT-57.
E-CT-90	H-34-90-(2)	<u>Natural Rubber Acid Gloves</u> - Protects against acids, alkalis, and solvents; size 8; gauge .015.
E-CT-91	H-34-91-(2)	<u>Natural Rubber Acid Gloves</u> - Protects against acids, alkalis, and solvents; size 9; gauge .015.
E-CT-92	H-34-92-(2)	<u>Natural Rubber Acid Gloves</u> - Protects against acids, alkalis, and solvents; size 10; gauge .015.

CHEMICAL TECHNOLOGY - EQUIPMENT

INDUSTRIAL INORGANIC AND QUANTITATIVE CHEMISTRY (AREA 34)

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
E-CT-93	H-34C-93-(3) H-36B-93-(1)	<u>PH Meter</u> - Solid state; line operated; PH Range 0-14 PH; millivolt range \pm 700 MV; readability \pm 0.05 PH; accuracy \pm .1; instructions printed on front panel; instruction manual with experiments; glass and reference electrodes; calibrating buffer; support rod; electrode clamp; 220 volts 50Hz; overall dimensions 31.8 x 10.8 x 18 cm (12 1/2 x 4 1/4 x 7 1/8 in.).
E-CT-94	H-34C-94-(6)	<u>Reference Electrode</u> - Silver - silver chloride; ceramic junction; 10-80°C; lead with pin plug; compatible with item E-CT-93.
E-CT-95	H-34C-95-(6)	<u>Glass Electrode</u> - Plastic cup; silver-silver chloride internal element; PH range, 0-14.
E-CT-96	H-34C-96-(2)	<u>Spectrophotometer</u> - For colorimetric and spectrophotometric work; grating 600 grooves per mm; spectral range of 340 mm to 650 mm may be easily extended to 950 mm with change of phototube and addition of supplementary infrared transmitting filter; twelve 13 mm diameter test tubes; 13 mm test tube adapter; plastic dust cover built in voltage regulation; cooling fan; 220/240 50Hz; compatible with items E-CT-97, 98, 99, 100, 101, 102, 103, 104, 105.
E-CT-97	H-34C-97-(5)	<u>Educational Manual</u> - Introduction to spectrometry and procedure for performing nine experiments; compatible with Item E-CT-96.
E-CT-98	H-34C-98-(36)	<u>Test Tube Cells</u> - Overall diameter 13 mm (1/2 in.); length 10 cm (4 in.); optical path 11.6 mm; compatible with Item E-CT-96; 12 test tubes per package.
E-CT-99	H-34C-99-(1)	<u>Filter Kit</u> - Set of four stray light filters; didymium filter for calibration; compatible with Item E-CT-96.
E-CT-100	H-34C-100-(2)	<u>Support</u> - For six 13 mm test tube cells and six square cuvettes; compatible with E-CT-93, 104.

CHEMICAL TECHNOLOGY - EQUIPMENT
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REFERENCE NUMBER	SPECIFICATION CODE	D E S C R I P T I O N
E-CT-101	H-34C-101-(2)	<u>Infrared Sensitive Phototube</u> - Extends Item E-CT-96 range from 650 to 950 mm; compatible with Item E-CT-96.
E-CT-102	H-34C-102-(2)	<u>Infrared Filter</u> - Compatible with Item E-CT-101 and E-CT-96.
E-CT-103	H-34C-103-(3)	<u>Lamp</u> - Replacement; compatible with Item E-CT-96.
E-CT-104	H-34C-104-(6)	<u>Cuvette</u> - Square; size 1.3 x 10.2 cm ($\frac{1}{2}$ x 4 in.); optical path 11.7 mm; two cuvettes per package; compatible with E-CT-96, 100.
E-CT-105	H-34C-105-(2)	<u>Adapter</u> - For square cuvettes; compatible with Item E-CT-105 and E-CT-96.
E-CT-106	H-34A-106-(29)	<u>Rubber Stoppers</u> - Solid black gum; size 5; dimension 27 x 23 mm.
E-CT-107	H-34A-107-(2 lb or 1 kg)	<u>Cotton</u> - Nonabsorbant; bleached fiber; suitable for chemical use; provided in a roll.
E-CT-108	H-34-108-(36) H-35-108-(6)	<u>Buret Meniscus Reader</u> - Waterproof celluloid; removable device with black and white background; used for reading a buret meniscus.
E-CT-109	H-34-109-(22) H-36-109-(2)	<u>Buret Funnels</u> - Polyethylene; top 28 mm; stem 6 mm.
E-CT-110	H-34-110-(6)	<u>Boyle's Law Apparatus</u> - Air thermometer: two experiments may be performed; glass stopcock tube; tube with funnel top; plastic connection throughout; tubes may be moved along a white plastic metric scale; air thermometer bulb; complete with instructions.

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REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
E-CT-111	H-34-111-(15)	<u>Burners</u> - Alcohol; pyrex glass, polyhedral; wick included; 175 ml capacity; metal screw cap, wick holder and flame extinguishing cap.
E-CT-112	H-34-112-(36)	<u>Wicks</u> - Flatwicks; compatible with Item E-CT-110.
E-CT-113	H-34B-113-(12) H-36A-113-(2)	<u>Cleaning Compound</u> - Detergent; made especially for laboratory ware; such as alconox.
E-CT-114	H-34-114-(24)	<u>Combustion Boats</u> - Glazed; Porcelain; dimensions 60 x 10 x 3 mm.
E-CT-115	H-34-115-(2) H-34A-115-(1)	<u>Cork Knife</u> - Stainless steel; serrated blade; especially for cutting corks.
E-CT-116	H-34-116-(1) H-34A-116-(1)	<u>Cork Press</u> - Rotary form; takes corks up to number 22; compresses and softens corks; metal.
E-CT-117	H-34-117-(18)	<u>Deflagration Spoon</u> - Monel metal; 406 mm handle and 19 mm cup.
E-CT-118	H-34-118-(1) H-34A-118-(3)	<u>Mortar and Pestle</u> - Porcelain; capacity 225 ml; including pestle.
E-CT-119	H-34-119-(1)	<u>Stopper Remover</u> - A device for removing frozen stoppers from reagent bottles of all sizes; straight vertical pressure; for necks from 2.5 to 5 cm (1 to 2 in.) diameter; metal.
E-CT-120	H-34-120-(1 box) H-34A-120-(2 boxes)	<u>Labels</u> - Rectangular; pressure sensitive; 26 x 19 mm; white surface; 1000 labels per box.

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REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
E-CT-121	H-34-121-(10)	<u>Support, Funnel, Wood</u> - Four place funnel support; with iron clamp; length 41.2 cm (14 1/2 in).
E-CT-122	H-34-122-(2) H-36-122-(1)	<u>Block</u> - Reagent bottle wooden block holds five 30 ml bottles Item G-CT-10.
E-CT-123	H-34-123-(15)	<u>Bottles</u> - Wide mouth; round; screwcap; all polyethylene; capacity 63 ml (2 oz).
E-CT-124	H-34-124-(48) H-36-124-(6)	<u>Bottles</u> - Capacity 1050 ml (32 oz); round; flexible polypropylene; with screw cap.
E-CT-125	H-34-125-(6) H-36-125-(2)	<u>Bottles</u> - Polyethylene; 2.1 l. (1/2 gal) with polyethylene screw cap.
E-CT-126	H-34-126-(12)	<u>Flasks</u> - Vacuum; wide neck; plastic jacket and cover; 500 ml capacity; internal diameter of neck 70 mm (2 3/4 in); inside depth 159 mm (5 1/4 in).
E-CT-127	H-34-127-(18) H-34A-127-(18) H-36-127-(2) H-35-127-(1)	<u>Splash Eliminator</u> - Slips on to filter pump outlet; eliminates splashing of water; compatible with Item E-CT-58; constructed of rubber; attaches to outlet tubes of 19 mm (3/8 in) outside diameter.
E-CT-128	H-34-128-(15) H-34A-128-(15) H-36-128-(1)	<u>Filter Paper</u> - Semi-creped; general purpose; very rapid very retentive; diameter 11 cm (4 5/16 in); package of 100.
E-CT-129	H-34-129-(10) H-34A-129-(10) H-36-129-(1)	<u>Filter Paper</u> - Semi-creped; general purpose; very rapid and retentive; diameter 12.5 cm (5 in).

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REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
E-CT-130	H-34-130-(2)	<u>Filter Paper</u> - Semi-creped; general purpose; very rapid and retentive; diameter 20 cm (7 7/8 in.).
E-CT-131	H-34-131-(2)	<u>Cork</u> - Stopper; Grade xxx; cork size 2; top 13 mm; bottom 10 mm; length 17 mm.
E-CT-132	H-34-132-(2)	<u>Cork</u> - Stopper; Grade xxxx; cork size 4; top 16 mm; bottom 12 mm; length 21 mm.
E-CT-133	H-34-133-(1)	<u>Cork</u> - Stopper; Grade xxxx; cork size 10; top 25 mm; bottom 20 mm; length 32 mm.
E-CT-134	H-34-143-(2)	<u>Cork</u> - Stopper; Grade xxxx; cork size 6; top 19 mm; bottom 15 mm; length 23 mm.
E-CT-135	H-34-135-(2 lb.)	<u>Rubber Stoppers</u> - Black gum; size # 6; 22 stoppers to a lb; solid stopper; dimensions 32 x 26 mm.
E-CT-136	H-34-136-(1 lb.)	<u>Rubber Stoppers</u> - Black gum; size # 6; 1-hole; dimensions 32 x 26 mm; at least 22 stoppers per pound.
E-CT-137	H-34-137-(1 lb.)	<u>Rubber Stoppers</u> - Black gum; size # 6; 2-hole; dimensions 32 x 26 mm; at least 22 stoppers per pound.
E-CT-138	H-34-138-(1 lb.)	<u>Rubber Stoppers</u> - Solid black gum; size # 1; dimensions 19 x 14 mm; at least 58 stoppers per pound; solid.
E-CT-139	H-34-139-(2 lb.)	<u>Rubber Stoppers</u> - Solid black gum; size # 8; dimensions 41 x 33 mm; at least 13 stoppers per pound.

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REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
E-CT-140	H-34-140-(2 lb.)	<u>Rubber Stoppers</u> - Solid black gum; size # 7; dimensions 37 x 30 mm; at least 16 per pound.
E-CT-141	H-34-141-(1 lb.)	<u>Rubber Stoppers</u> - Solid black gum; size # 11; dimensions 56 x 48 mm; at least 6 per pound.
E-CT-142	H-34-142-(1 lb.)	<u>Rubber Stoppers</u> - Solid black gum; size # 13; dimensions 68 x 58 mm; at least 4 per pound.
E-CT-143	H-34-143-(1 lb.)	<u>Rubber Stoppers</u> - Solid black gum; size "00"; dimensions 15 x 10 mm; at least 116 per pound.
E-CT-144	H-34-144-(1 lb.)	<u>Rubber Stoppers</u> - Solid black gum; size # 4; dimensions 26 x 20 mm; at least 33 per pound.
E-CT-145	H-34-145-(1 lb.)	<u>Rubber Stoppers</u> - Black gum; size # 4; one hole; dimensions 26 x 20 mm; at least 33 per pound.
E-CT-146	H-34-146-(1 lb.)	<u>Rubber Stoppers</u> - Solid black Gum; size # 2; dimensions 20 x 16 mm; at least 54 per pound.
E-CT-147	H-34-147-(1 lb.)	<u>Rubber Stopper</u> - Solid Black Gum; size # 3; dimensions 24 x 18 mm; at least 44 per pound.
E-CT-148	H-34A-148-(50)	<u>Cork</u> - Stopper; Economical quality; grade xx; size 19; top 40 mm; bottom 32 mm; length 38 mm.
E-CT-149	H-34A-149-(14)	<u>Support Bases</u> - Cast iron; a base shape to give three-point stability; compatible with Item E-CT-150; base width x length 19.7 cm; threads 3/8-16; finished in baked enamel.
E-CT-150	H-34A-150-(14)	<u>Threaded Rod with Shoulder</u> - Metal rod; rod compatible with Item E-CT-149; length 81 cm; diameter 1.3; thread 3/8-16 (inch).
E-CT-151	H-34A-151-(100 ft)	<u>Rubber Tubing</u> - Red rubber tubing; for pressure and vacuum work; internal diameter 1/4 in. (6.4 mm); wall thickness 3/16 in. (4.8 mm); 50 ft (15 m) per package.
E-CT-152	H-34A-152-(150 ft)	<u>Plastic Tubing</u> - Transparent; flexible; polyvinyl chloride; inner diameter 6.4 mm (1/4 in.); wall thickness 1.6 mm (1/16 in.); comes in packages of 50 ft. (15 m) lengths.

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INDUSTRIAL INORGANIC AND QUANTITATIVE CHEMISTRY (AREA 34)

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
E-CT-153	H-34A-153-(12)	<u>Iron Extension Support Rings</u> - Fasten to support rods by means of clamp holders; small size; internal diameter about 6.4 cm (2 1/2 in.); 19 cm rod length; finished in blue-baked enamel.
E-CT-154	H-34A-154-(18)	<u>Cork Ring</u> - Compressed cork; for supporting round bottom flasks; internal diameter 60 mm; overall diameter is 110 mm.
E-CT-155	H-34A-155-(18)	<u>Cork Ring</u> - Compressed cork; for supporting round bottom flasks; internal diameter 90 mm; overall diameter 140 mm.
E-CT-156	H-34A-156-(2 pr.) H-36-156-(1 pr.)	<u>Cartridges</u> - replaceable pair of cartridges for a chemical respirator; compatible with Item E-CT-183.
E-CT-157	H-34A-157- (12 yd or 11 m)	<u>Rubber Matting</u> - Open mesh; rubber; for sinks to reduce breakage; thickness 3 mm (1/8 in.); width 61 cm (26 in.).
E-CT-158	H-34A-158-(12)	<u>Burner Shield</u> - Metal; contains the heat from a bunsen burner; conical shape; attaches to barrel of bunsen burner from 11 mm to 13 mm diameter; compatible with Item E-CT-31.
E-CT-159	H-34A-159-(30)	<u>Filter Paper</u> - For suction filtration; diameter 5.5 cm (2 3/16 in.); compatible with G-CT-37.
E-CT-160	H-34A-160-(10)	<u>Water Bath</u> - Made of stainless steel; four 12.5 cm (5 in.) diameter openings; 3-heat switch; for use as a steam bath; complete with 1100 watt immersion coil; size, length 35.5 cm; width 35.5 cm; depth 12.5 cm; 220 V/50 Hz.

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CHEMICAL TECHNOLOGY - EQUIPMENT

INDUSTRIAL INORGANIC AND QUANTITATIVE CHEMISTRY (AREA 34)

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
E-CT-161	H-34A-161-(11)	<u>Hot Plate</u> - Fast heating; top resistant to corrosion from spilled materials; glass ceramic top; temperature adjust knob and pilot light; up to 960 F; metal casing; compatible with E-CT-69 to minimize repair costs; 600 watts; dimensions 178 x 127 x 127 mm (7x5x5 in.).
E-CT-162	H-34A-162-(11)	<u>Water Bath</u> - Made of heavy copper; with handles and a steam escape tube; interior is tin coated; 7 concentric rings; diameter 20.3 cm (8 in.); depth at least 6.7 cm (2-5/8 in.).
E-CT-163	H-34A-163-(2)	<u>Pails</u> - Plastic; for carrying shaved ice; about 3 gallon (11 l) capacity; with metal handle and plastic grip.
E-CT-164	H-34A-164-(2)	<u>Magnetic Stirring Bar</u> - Teflon coated; center pivot ring; dimensions 7.9 x 1.3 cm (5/16 x 1/2 in.).
E-CT-165	H-34A-165-(2)	<u>Magnetic Stirring Bar</u> - Teflon coated; center pivot ring; dimensions 2.5 x .9 cm (1 x 3/8 in.).
E-CT-166	H-34A-166-(2) H-36-166-(3)	<u>Magnetic Stirring Bar</u> - Teflon coated; center pivot ring; dimensions 3.8 x .95 cm (1 1/2 x 3/8 in.).
E-CT-167	H-34A-167-(2)	<u>Magnetic Stirring Bar</u> - Teflon coated; egg shaped; dimensions 2.5 x 1.3 cm (1 x 1/2 in.).
E-CT-168	H-34A-168-(2) H-36-168-(1)	<u>Magnetic Stirring Bar Retriever</u> - Polyethylene; 30.5 (12 in.) long; magnet sealed at one end.
E-CT-169	H-34A-169-(2)	<u>Magnetic Stirring Bars</u> - Teflon coated; center pivot ring dimensions 7.6 x 1.3 cm (3 x 1/2 in.).
E-CT-170	H-34A-170-(24)	<u>Files</u> - Rattail type; without handles; dimensions 10.2 cm (4 in.) x 4.8 mm (3/16).

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INDUSTRIAL INORGANIC AND QUANTITATIVE CHEMISTRY (AREA 34)

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
E-CT-171	H-34A-171-(25)	<u>Extraction Thimble</u> - Paper of uniform thickness; dimensions 22 x 80 mm.
E-CT-172	H-34A-172-(200)	<u>Cork</u> - Stopper; grade xxxx; cork size 14 (32 x 25 x 32 mm).
E-CT-173	H-34A-173-(150 ft.)	<u>Aluminum Foil</u> - In rolls; thickness 0.25 mm (.001 in.); width 30.5 cm (1 ft.).
E-CT-174	H-34A-174-(100)	<u>Cork</u> - Stopper; high quality; grade xxxx; size number 5 (17 x 13 x 22 mm).
E-CT-175	H-34A-175-(100)	<u>Cork</u> - Stopper; high quality; grade xxxx; size number 7 (21 x 16 x 25 mm).
E-CT-176	H-34A-176-(100)	<u>Cork</u> - Stopper; high quality; grade xxxx; size number 9 (24 x 19 x 28 mm).
E-CT-177	H-34A-177-(100)	<u>Cork</u> - Stopper; high quality; grade xxxx; size 11 (27 x 21 x 32 mm).
E-CT-178	H-34A-178-(50)	<u>Cork</u> - Stopper; high quality; grade xxxx; size 15 (33 x 26 x 32 mm).
E-CT-179	H-34A-179-(50)	<u>Cork</u> - Stopper; high quality; grade xx; size 19 (40 x 32 x 38 mm).
E-CT-180	H-34A-180-(1)	<u>Fractional Distillation Trainer</u> - Self contained electrically heated training device with all accessories which are required to perform the following studies: hydraulics, pressure drops, efficiencies with respect to plate column separations; the effects of feed plate locations, boil-up rates, reflux ratios, and plate geometry with respect to plate column separations; evaluations of pressure drop, efficiency, and types of packings with respect to packed column separations; effects of boil-up rates, reflux ratios and packing geometries with respect to packed column separations; determination of mass balances, thermal energy balances, and physical and chemical characteristics of feeds, reflux, products in both plate and packed column separations; calibration of rotameters and thermocouples; operation of liquid level and temperature controls; operation and heat transfer efficiency of shell and tube condensers; mounted on a castored base; such as Technovate model 9076; height 80 inches; width 60 inches; depth 32 inches; portable unit; applied with column packings. Such as Technovate model 9079.

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CHEMICAL TECHNOLOGY - EQUIPMENT

INDUSTRIAL INORGANIC AND QUANTITATIVE CHEMISTRY (AREA 34)

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
T-181	H-36-181-(1)	<u>Refractometer</u> - Determines the refractive index for liquids and dispersion for solids; accuracy for liquids in the fourth decimal place and for solids in the tenth percent; suitable accessories for calibration; instruction manual and dispersion table; suitable case with lock and key.
T-182	H-36-182-(1)	<u>Westphal Balance</u> - Determine specific gravity to the fourth decimal place; metal base mounted with leveling adjustment thumb screws; complete with a carrying case.
T-183	H-36-183-(1)	<u>Circulating System</u> - Refrigerated; maintains a constant temperature environment for the refractometer; E-CT-181; complete with heating, cooling, circulating and regulating unit (range 0 to 60°C sensitive to -.02°C); steel container; 120V/50Hz; 1300 watts; dual 500 watt heating elements; 1/6 H.P. compressor; dimensions 13 x 14 x 28 inches; such as found in V.W.R. catalogue #58036-488.
T-184	H-34B-184-(1)	<u>Film Holder</u> - Magnetic; infrared sample holder for films; complete with backplate and rubberized magnetic ring; compatible with item E-CT-252.
T-185	H-36-185-(1)	<u>Liquid Phase Chemical Reactor Trainer</u> - Self contained training device mounted on a floor-standing device with all accessories which are required to perform the following studies: chemical kinetic studies; operation of the reactor in batch manner and a continuous mode; heat transfer studies; measure the effect of temperature on conversion; mixing studies; the effect of non ideal mixing conditions on reaction conversions; includes instructor/operator manual; 220V/50Hz; dimensions, width 2 m, depth 1 m, height 2 m; such as Armfield Model RG3675.
T-186	H-36-186-(1)	<u>Replacement thermometer</u> - For refractometer; compatible with Item E-CT-181.
T-187	H-36-187-(10)	<u>Replacement Bulbs</u> - For refractometer; compatible with Item E-CT-181.

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CHEMICAL TECHNOLOGY - EQUIPMENT

INDUSTRIAL INORGANIC AND QUANTITATIVE CHEMISTRY (AREA 34)

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
E-CT-188	H-36-188-(1)	<u>Gas/Liquid Absorption Column Trainer</u> - A self-contained training device with a floor standing framework with all accessories necessary to perform the following studies: characteristics of flow through packed towers, including loading and flooding points, and the relation of liquid hold-up to the gas flow rate; mass balance calculations; determination of mass transfer coefficients, and the effect on these various gas and liquid flow rates; the system may also be used to study other gas/liquid systems; includes instructor/operator manual; complete with ladder for access to column and 300 liter effluents; such as Armfield model RG3/25.
E-CT-189	H-36-189-(1)	<u>Gas Regulator</u> - Ammonia 2-stage regulator for attachment to both high and low pressure large cylinders; maximum inlet pressure 3000 psi; delivery pressure 75 psi; high pressure gauge range 4000 psi; low pressure gauge range 100 psi; compatible with large ammonia gas tank Item C-CT-175; complete with hose nipple outlet and tubing compatible for attachment to Item E-CT-188; stainless steel regulator with teflon seals.
E-CT-190	H-36-190-(1)	<u>Gas Regulator</u> - Carbon dioxide 2-stage regulator for attachment to both high and low pressure cylinders; maximum inlet pressure 3000 psi; delivery pressure 75 psi; high pressure gauge range 100 psi; compatible with large carbon dioxide gas tank Item C-CT-176; complete with hose nipple outlet and tubing compatible for attachment to Item E-CT-188.
E-CT-191	H-36-191-(25)	<u>Safety Cap</u> - Colored; hard plastic protective shell; adjustable head size from 6-1/2 to 8; sweat band; head protection for chemical plant operator.
E-CT-192	H-36-192-(2) H-34A-192-(1)	<u>Gas Cylinder Clamp</u> - Cast metal clamp with two thumbscrews; attaches to benchtop up to 5 cm (2 in.) in thickness; webbed straps and buckle; fits common sizes of commercial gas cylinders.

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INDUSTRIAL INORGANIC AND QUANTITATIVE CHEMISTRY (AREA 34)

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
E-CT-193	H-35-193-(1)	<u>Sling Psychrometer</u> - Determination of wet and dry bulb temperatures; compatible with forced convection drier trainer E-CT-195; -5 to 50°C range.
E-CT-194	H-35-195-(1)	<u>Anemometer</u> - Determination of air velocities of 200 ft. per minute and above; compatible with forced convection drier trainer E-CT-195.
E-CT-195	H-35-195-(1)	<u>Forced Convection Drier</u> - A self-contained floor mounted training device with all the accessories necessary to perform the following studies; rates of drying under different conditions of temperature and air velocity; mass and energy balances; determine heat transfer coefficients for a steam heated air heater battery; determine the heat loss by radiation and natural convection from the drier; complete with wet and dry bulb thermometers; anemometers; stop clock; overall dimensions, height 1.75 m, length 2.75 m, depth .8 / m, such as Armfield model RG-3600; connecting piping to E-CT-280.
E-CT-196	H-35-196-(1)	<u>Temperature Radiation Trainer</u> - A bench top self-contained teaching system mounted on a rigid portable framework complete with accessories and instrumentation necessary for the experimental capabilities leading to derivations of: <ol style="list-style-type: none"> 1. Kirchhoff's Law of Thermal radiation. 2. The Stephan-Boltzmann Law. 3. Prevost's Law of radiant intercommunication. 4. Planck's Law of radiation. 5. Wien's Displacement Law. 6. Lambert's Cosine Law. 7. Lambert's Law of absorption. 8. Newton's Law of cooling. Such as found in Technovate's Temperature Radiation training Unit 9053; complete with optical pyrometer and precision potentiometer; dimensions, height 1.30 m (51 in); width 1.83 m (72 in), depth 1.07 m (42 in); 220V/50Hz).

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CHEMICAL TECHNOLOGY - EQUIPMENT
INDUSTRIAL INORGANIC AND QUANTITATIVE CHEMISTRY (AREA 34)

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
E-CT-197	H-35-197-(1)	<u>Properties of Gases and Liquids Trainer</u> - A self-contained teaching system mounted on a rigid portable floor mounted frame with complete accessories and instrumentation necessary for the following experimental capabilities; density of liquids by Pycnometer method; viscosity of liquids and gases; diffusivities of gases and liquids; such as found in Armfield's Properties of Gases and Liquids training Unit # RG-3800; 220V/50Hz; supplied with suitable liquids and chemicals; dimensions, width 2 m, height 1 m, depth 0.6 m.
E-CT-198	H-35-198-(1)	<u>Solids Handling Trainer</u> - A self-contained teaching system mounted on a rigid floor mounted frame with complete accessories and instrumentation necessary for the following experimental capabilities: study of sieving techniques, including size distribution plots and effect of sieve load on screen blinding; angle of repose measurements; efflux rates from storage hoppers, as affected by hopper load; exit geometry, size distribution, and angle of repose; studies of mixing solids and appropriate sampling techniques including effect of sample size and position; demonstration of the application of statistical techniques; such as found in Armfield's Solid Handling training Unit # RG-3700; 220V/50Hz; overall dimensions, width 2 m, height 1.5 m, depth 1 m.
E-CT-199	H-36-199-(1)	<u>Permeability - Fluidization Trainer</u> - A bench top self-contained teaching system mounted on a rigid portable framework complete with accessories and instrumentation necessary for the following experimental capabilities: verification of Kozeny's equation; characteristics of liquid fluidized bed; measurement of permeability of selected solids; such as found in Armfield's Permeability-Fluidization Trainer # RG-2650; supplied with ballotini for packed bed; dimensions, height 1.5 m width 1.5 m, depth .5 m.

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CHEMICAL TECHNOLOGY - EQUIPMENT

INDUSTRIAL INORGANIC AND QUANTITATIVE CHEMISTRY (AREA 34)

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
E-CT-200	H-36-200-(1)	<p><u>Centrifugal and Axial Flow Pump Test Rig Trainer</u> - A self-contained floor mounted training device with all necessary instrumentation to permit the following pump testing: suction and delivery pressures; pump speeds; pump input torque; the flow; includes instructor/operator manual; 220V/50Hz; approximate dimensions 2 x 2 x 2 m; complete with the following accessories:</p> <ol style="list-style-type: none"> 1. <u>Propeller Meter</u>: A helix type propeller meter which measures flow and is compatible for use in the delivery line of the axial flow pump of the centrifugal and axial flow pump test rig trainer E-CT-200; similar to Armfield model HBE 2. 2. <u>Shunt Type Variable Aperture Meter</u>: Must be compatible in the delivery line of the centrifugal pump of the centrifugal and axial flow pump test rig trainer E-CT-200; similar to Armfield model HBE 3. 3. <u>6 ft. (1.8 m) Mercury Filled MANOMETER</u>: Mounted on a support stand and fitted with all the accessories needed to measure the differential heads developed by the axial and centrifugal pumps on the centrifugal and axial flow pump test rig trainer E-CT-200; similar to Armfield model HBE 4.
E-CT-201	H-36-201-(1)	<p><u>Basic Centrifugal Pump Test Rig Trainer</u> - A self-contained training device with all accessories which are required to perform the following studies: pump head flow characteristics at constant speed; comprehensive pump performance characteristic; determination of the relationship between speed, flow, head and power absorbed for a centrifugal pump; power input-flow characteristic; impeller radial pressure distribution; closed valve power-head characteristic; venturi tube calibration; floor mounted; includes instructor/operator manual; such as Armfield model HBB; 220V/50Hz; dimensions, height 1.65 m, depth .94 m, width 1.58 m; complete with the following accessories:</p> <ol style="list-style-type: none"> 1. <u>Tanks and Pipework</u>: The tanks and pipework compatible with basic centrifugal pump test rig trainer which are necessary for carrying out performance testing on the centrifugal pump. Such as Armfield model HBB 2.

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CHEMICAL TECHNOLOGY - EQUIPMENT
INDUSTRIAL INORGANIC AND QUANTITATIVE CHEMISTRY (AREA 34)

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
E-CT-201 (cont.)		<ol style="list-style-type: none"> 2. <u>Perapex Venturi and Differential Manometer</u>: To be compatible for installation in the pump delivery pipe of the tanks and pipework system Item E-CT-201, installed on the basic centrifugal pump set Item E-CT-201, such as Armfield model HBB 3. 3. <u>3 ft (0.9 m) Mercury Manometer</u>: All necessary fittings are compatible for installation on the basic centrifugal pump set Item E-CT-201, such as Armfield model HBB 4. 4. <u>Variable Speed Dynamometer Motor</u>: Stepless speed variation from rest to 2,900 r.p.m.; 200 volts single phase, 50Hz.
E-CT-202	H-36-202-(1)	<p><u>Evaporator Trainer</u> - A self-contained teaching system mounted on a rigid floor mounted frame with complete accessories and instrumentation necessary for the following experimental capabilities: to study the effects of temperature drop and liquid level on the capacity and overall heat transfer coefficient of a long tube evaporator; to determine the capacity and overall heat transfer coefficient for the evaporation of water in a single effect-forced circulation evaporator; to study the comparative performance of tubular and spray condensers; such as found in Armfield model RC 3575; height 4.0 m, width 2.5 m, depth 0.9 m; connecting piping and lagging to .1 ... Item E-CT-280; 400-440V/50Hz, 3 phase, 4 wire, 30 Kw.</p>
E-CT-203	H-36-203-(1)	<p><u>Thermal Conduction Trainer</u> - A self-contained teaching system floor mounted on a rigid portable framework complete with accessories and instrumentation necessary for the following experimental capabilities: Analysis of thermal conduction through constant cross-section conductors of various metals alone or in pressure contact with each other in a series or parallel configurations; analysis of thermal conduction in conductors of constant and variable cross-section; comparison of linear thermal conductivities based on the speed of heat transfer using Irgenhausz conductometer; analysis of heat losses in differently insulated "Thermos" type flasks; such as found in Technovate conductivity trainer 9051; 220V/50Hz, 20 amps, 2300 watts; dimensions height 61 in, width 72 in (1.83 m), depth 42 in (1.07 m).</p>

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REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION																																																												
E-CT-204	H-35-204-(1)	<p><u>Laboratory Sieves</u> - Used for particle size separation; complies with international standard sieve series; screen of woven brass wire cloth mounted to seamless brass frame; frame 8 in (20.3 cm) in diameter; depth to screen is 2 in (5.0 cm); rolled edges and extended bottom to fit frames and pans to permit parking; one of each below comprises a set.</p> <table style="margin-left: auto; margin-right: auto; border: none;"> <thead> <tr> <th style="text-align: center;"><u>Mesh Designation</u></th> <th style="text-align: center;"><u>mm Designation</u></th> <th style="text-align: center;"><u>Mesh Designation</u></th> <th style="text-align: center;"><u>mm Designation</u></th> </tr> </thead> <tbody> <tr><td style="text-align: center;">2 ½</td><td style="text-align: center;">8.0</td><td style="text-align: center;">24</td><td style="text-align: center;">710 mm</td></tr> <tr><td style="text-align: center;">3</td><td style="text-align: center;">6.7</td><td style="text-align: center;">28</td><td style="text-align: center;">600 mm</td></tr> <tr><td style="text-align: center;">3½</td><td style="text-align: center;">5.6</td><td style="text-align: center;">32</td><td style="text-align: center;">500 mm</td></tr> <tr><td style="text-align: center;">4</td><td style="text-align: center;">4.75</td><td style="text-align: center;">35</td><td style="text-align: center;">425 mm</td></tr> <tr><td style="text-align: center;">5</td><td style="text-align: center;">4.00</td><td style="text-align: center;">42</td><td style="text-align: center;">355 mm</td></tr> <tr><td style="text-align: center;">6</td><td style="text-align: center;">3.35</td><td style="text-align: center;">48</td><td style="text-align: center;">300 mm</td></tr> <tr><td style="text-align: center;">7</td><td style="text-align: center;">2.80</td><td style="text-align: center;">60</td><td style="text-align: center;">250 mm</td></tr> <tr><td style="text-align: center;">8</td><td style="text-align: center;">2.36</td><td style="text-align: center;">65</td><td style="text-align: center;">212 mm</td></tr> <tr><td style="text-align: center;">9</td><td style="text-align: center;">2.00</td><td style="text-align: center;">80</td><td style="text-align: center;">180 mm</td></tr> <tr><td style="text-align: center;">10</td><td style="text-align: center;">1.70</td><td style="text-align: center;">100</td><td style="text-align: center;">150 mm</td></tr> <tr><td style="text-align: center;">12</td><td style="text-align: center;">1.40</td><td style="text-align: center;">115</td><td style="text-align: center;">125 mm</td></tr> <tr><td style="text-align: center;">14</td><td style="text-align: center;">1.18</td><td style="text-align: center;">150</td><td style="text-align: center;">106 mm</td></tr> <tr><td style="text-align: center;">16</td><td style="text-align: center;">1.00</td><td style="text-align: center;">170</td><td style="text-align: center;">90 mm</td></tr> <tr><td style="text-align: center;">20</td><td style="text-align: center;">850 mm</td><td style="text-align: center;">200</td><td style="text-align: center;">75 mm</td></tr> </tbody> </table>	<u>Mesh Designation</u>	<u>mm Designation</u>	<u>Mesh Designation</u>	<u>mm Designation</u>	2 ½	8.0	24	710 mm	3	6.7	28	600 mm	3½	5.6	32	500 mm	4	4.75	35	425 mm	5	4.00	42	355 mm	6	3.35	48	300 mm	7	2.80	60	250 mm	8	2.36	65	212 mm	9	2.00	80	180 mm	10	1.70	100	150 mm	12	1.40	115	125 mm	14	1.18	150	106 mm	16	1.00	170	90 mm	20	850 mm	200	75 mm
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E-CT-205	H-35-205-(1)	<p><u>Sieve Shaker</u> - Reproduces the circular and tapping motion given testing sieves in hand sieving; accommodates six 8 in full height sieves with receiving pan; ½ horsepower motor; running parts operated in oil; compatible with Items E-CT-204 and E-CT-208.</p>																																																												

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REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
E-CT-206	H-35-206-(1)	<u>Sieve Cover</u> - With center recessed ring handle; 8 in diameter; brass; compatible with Item E-CT-204.
E-CT-207	H-35-207-(1)	<u>Sieve Pan</u> - Formed from single piece of brass; rolled rim; lacquered finish; compatible with Item E-CT-204.
E-CT-208	H-35-208-(1)	<u>Timer</u> - Used with sieve shaker to provide reproducible, controlled test conditions; stops shaker automatically; calibrated from 0 to 60 minutes in 1-minute intervals; compatible with E-CT-205.
E-CT-209	H-36E-209-(1)	<u>Balance</u> - Electric top loading; Mettler model P2000; precision ± 0.05 g; automatic over 1000 g; optical scale; 1000 g of built in weight; 500 g of tare; total capacity 2500 g; analog and digital readout; capacity 2000 g; readability 0.1 g; supplied with dust cover with clear window and spare light bulb; 220V/50Hz.
E-CT-210	H-35-210-(3)	<u>Lamp</u> - Replacement lamp for top loading balance; compatible with Item E-CT-209.
E-CT-211	H-35-211-(2)	<u>Fine Sieve Brush</u> - Fine hair brush for cleaning fine grades of sieves; compatible with E-CT-204; one inch wide; wood handle 9-3/4 in long.
E-CT-212	H-35-212-(2)	<u>Wire Sieve Brush</u> - Wire type brush for cleaning coarse series sieves; compatible with E-CT-204.
E-CT-213	H-34-213-(1)	<u>Distilled Water Storage Tank</u> - Barnstead type; 25 gal. capacity; copper tanks with hot wiped tin lining; complete with removable cover; gauge glass, drawoff faucet, and thread topings for inlet and overflow; compatible with distilled water Unit E-CT-70.

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REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
E-CT-214	H-34-214-(1)	<u>Vent Guard Filter</u> - Protects stored water from airborne contamination; install in air vent of tank to remove dust, gases, and acids; complete with chamber, water seal chamber, seal tape for tank cover, and connection to tank; compatible with Item E-CT-213.
E-CT-215	H-34-215-(6)	<u>Filter Element</u> - For use with the replacement of filter element in E-CT-214; compatible with Item E-CT-214; 6 elements per package.
E-CT-216	H-34B-216-(1)	<u>Distilled Water Storage Tank Stand</u> - Floor mounted metal stand; compatible with 25 gallon storage tank Item E-CT-213; with mounting ring and support for bottom of tank.
E-CT-217	H-35-217-(1)	<u>Corrosion Studies Trainer</u> - A self-contained teaching system complete accessories and instrumentation necessary for the following experimental capabilities: effect on corrosion rate of PH level; effect of dissolved oxygen concentration; galvanic action; electrolytic corrosion; cathodic protection; chemical inhibition; prevention of scaling; such as found in Armfield's corrosion training Unit RG-3775; 220V/50Hz; complete with necessary chemical reagents.
E-CT-218	H-36-218-(1)	<u>Fluid Particle Behavior Trainer</u> - A bench top self-contained teaching system mounted on a rigid portable framework complete with accessories and instrumentation necessary for the following experimental capabilities: measurement of drag coefficients of spheres over several decades of Reynolds number; dimensional analysis and dynamic similarity; introduction to effects of boundary layer separation; effect of particle shape on rate of fall and drag coefficient; such as found in Armfield's Fluid Particle Behavior Trainer RG-2125; complete with appropriate test liquids; 220V/50Hz; dimensions, height 2.0 m, width 1.0 m, depth .5 m.

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REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
E-CT-219	H-36-219-(1)	<u>Filter Ability Index Trainer</u> - A bench top self-contained teaching system mounted on a rigid portable framework complete with accessories and instrumentation necessary for the following experimental capabilities: measurement of filterability of a given suspension; performance of a standard water quality test procedure for filtration; basic principles of filter operation for student study; such as found in Armfield's Filterability Index trainer RG-2010; complete with collecting vessel suspension samples; dimensions, height 1.0 m, width .5 m, depth .5 m.
E-CT-220	H-36-220-(1)	<u>Sedimentation Trainer</u> - A bench top self-contained teaching system mounted on a rigid portable framework complete with accessories and instrumentation necessary for the following experimental capabilities: variation of sedimentation rate with concentration; variation of sedimentation rate with height of suspension; particle size estimation; identification of the various settling regimes; such as found in Armfield's Sedimentation Trainer RG-2625; dimensions, height 2.0 m, width 1.5 m, depth 0.5 m.
E-CT-221	H-36-221-(1)	<u>Sedimentation Tank Trainer</u> - A fully self-contained teaching system mounted on a rigid floor mounted frame with complete accessories and instrumentation necessary for the following experimental capabilities: flow visualization of regimes in a sedimentation tank; determination of hydraulic characteristics of the tank, including short-circuiting, average retention times; hold back and flow profiles, as a function of flow rate; efficiency of tank in terms of the percentage of solids removed; effect on efficiency of changing the tank geometry, by use of baffles and adjusting the overflow weir configuration; such as found in Armfield's Sedimentation Tank training Unit RG-2675; 220V/50Hz; dimensions, width 2 m, height 1.5 m, depth 1 m.
E-CT-222	H-36-222-(1)	<u>Multi-Purpose Trainer</u> - A self-contained teaching system floor mounted on a rigid portable framework with complete accessories and instrumentation necessary for the following experimental capabilities: measurement of power input to stirred vessels; effect of impeller dimensions on

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REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
E-CT-222 (cont.)		power input; effect of mixing on heat transfer to coils; the study of the temperature response curve on the heating of the contents of a tank; the effect of tube diameter on heat transfer in forced convection; the effect of fluid physical properties on heat transfer in forced convection; pressure drop for flow in pipes; analogy between fluid friction and heat transport; estimation of heat transfer coefficient for a condensing system; calibration of variable aperture and orifice type flow meters; the effect of irrigation, flooding and loading characteristics in packed towers; such as found in Armfield's Multi-Purpose training Unit RG-3500; 220V/50Hz, single phase 1.2 Kw; complete with pipework between system and laboratory services; overall dimensions, height 2.7 m, width 2.7 m, depth 0.85.
E-CT-223	H-28-223-(2)	<u>Hydraulics Bench</u> - Self contained; training device; circulating fluid water; with all accessories required to perform the following experiments: orifice flow, venturi, flow over notch, pipe friction jet impact, flow measurement, vortex, loss in bends, peiton wheel; with bench top work surface; floor mounted; includes textbook, and operating instructions such as: Techquipment Model # H1 MK 111.
E-CT-224	H-28-224-(1)	<u>Flow Measuring Apparatus</u> - Bench mounted; training device; demonstrates following principles: Application of Bernoulli equation for incompressible fluids; direct comparison of flow measurement using venturimeter, orifice plate, and rotameter; comparison of pressure drop across each device; complete with instructor manual and operating instructions and suggested list of experiments; for use with <u>hydraulics bench</u> ; must be compatible with all required fittings and ready for use such as Techquipment Model # H10.
E-CT-225	H-28-225-(1)	<u>Loss in Pipe Bend Apparatus</u> - Floor mounted training device; must be used with hydraulics bench; furnished with all required interfacing and ready for use; to perform following functions: measurement of friction loss in pipe, elbows, valves, sudden contraction; with instruction manual and suggested experiment procedures such as: Techquipment Model # H16.

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REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION									
E-CT-226	H-28-226-(1)	<p><u>Pipe Friction Apparatus</u> - Bench mounted with training device; for use with hydraulics bench, must be compatible with all fittings and ready for use; function is to create both laminar and turbulent flow conditions, and measure changes in resistance from laminar to turbulent flow; also to enable establishment of the critical Reynolds number, complete with installation and servicing manual, and instruction manual on how to use the apparatus; such as: Techquipment Model # H7.</p>									
E-CT-227	H-28-227-(1)	<p><u>Orifice Flow Apparatus</u> - Bench mounted training device; for use with hydraulics bench; must be compatible with all required fittings and ready for use; used to determine coefficient of contraction, coefficient of velocity, and coefficient of discharge; includes instruction manual and installation and service instructions; such as: Techquipment Model # H4.</p>									
E-CT-228	H-28-228-(1)	<p><u>Pressure Gauge Claibrator</u> - to 500 psi; calibrator reading shall be accurate to 1/10 of 1 percent of indicated reading; works on dead weight principle; oil actuated; tester piston must be rotateable to prevent friction errors; forged brass pressure chamber; cast iron bases with black wrinkle finish; storage containers for weights, tools and adapters to be provided. Price to include tester, weights, 1/4 inch male, 1/8, 1/4, and 1/2 inch female adapters, 2 wrenches, screwdriver, handset, gauge pointer lifter, oil supply and operating instructions; Technovate model.</p> <table border="0"> <tr> <td></td> <td align="center"><u>psi</u></td> <td></td> </tr> <tr> <td align="center"><u>Range</u></td> <td align="center"><u>Min. Test</u></td> <td align="center"><u>Weight Increment</u></td> </tr> <tr> <td align="center">500</td> <td align="center">5</td> <td align="center">1</td> </tr> </table>		<u>psi</u>		<u>Range</u>	<u>Min. Test</u>	<u>Weight Increment</u>	500	5	1
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REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
E-CT-229	H-28-229-(1)	<p><u>Flow Visual Inflation Apparatus</u> - Training device, mounted on its own base; water as working medium; visually shows flow patterns in various conditions including flow through an orifice, sudden expansion and contraction; flow around aerofoils; flow around heat exchanger pipes, flow around car bodies, requires electrical and water supply connections; clear plate so that flow may be seen; complete with operators manual and suggested experimental procedures. Such as Techquipment Model # H14.</p>
E-CT-230	H-28-230-(1)	<p><u>Venturi Meter</u> - Bench mounted training device; for use with hydraulics bench, must be compatible with all fittings and ready for use; function is to show and measure the static head variation of water flowing through a horizontal venturi tube; will also measure coefficient of discharge; complete with installation and servicing manual and suggested experimental procedure; such as Techquipment Model # H5.</p>
E-CT-231	H-28-231-(1)	<p><u>Properties of Fluids and Hydrostatics Bench Trainer</u> - A fully self-contained teaching system mounted on a portable steel framed bench, with complete accessories and instrumentation necessary for the following experimental capabilities:</p> <ol style="list-style-type: none"> 1. Determination of density and specific gravity 2. Verification of the principle of flotation and Archimedes Law. 3. The function on use of a hydrometer. 4. Demonstration of Pascal's Law. 5. Study of capillarity. 6. Measurement of viscosity. 7. Measurement of hydrostatic pressure on a plane surface. 8. Determining the position of the centre of pressure. 9. Barometer with the significance of gauge and absolute pressure.

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REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
E-CT-231 (cont.)		<ol style="list-style-type: none"> 10. The operation of a Bourdon Pressure Gauge. 11. Dead weight calibration of gauges. 12. Measurement of fluid levels by Vernies Point Gauge. 13. Stability and periodicity of a floating body. 14. Determination of metocentric height. 15. The study of potential, pressure, and elastic energy. 16. The principle and application of Manometry. 17. The effect of flow upon static head.
E-CT-232	H-28-232-(1)	<p>Such as found in Armfield's Properties of Fluids and Hydrostatics Bench Training Unit Model 9092.</p> <p><u>Flowmeter Calibration Rig Trainer</u> - A fully self-contained system mounted on a rigid floor mounted frame with a complete set of accessories and instrumentation necessary for determining the following: optimum range and specific characteristics of various flow meters; the correct selection of a meter for a particular flow problem; such as found in Armfield's Flowmeter Calibration Rig Training Unit, Model C8-00.</p>
E-CT-233	H-28-233-(1)	<p><u>Fluid Friction Apparatus Trainer</u> - A self-contained teaching system mounted on a rigid floor mounted frame with complete accessories and instrumentation necessary for testing the following: three bore pipes of various diameters; a 90° bend; a 90° elbow; two 45° elbows; a gate valve; a basket strainer; a venturi meter made of perspex; an orifice meter made of perspex complete with three interchangeable orifice plates; a change of area assembly made of perspex with pivot static tube; such as found in Armfield's Fluid Friction Apparatus Trainer Model C6-00.</p>
E-CT-234	H-35-234-(1)	<p><u>Laboratory Crusher</u> - High capacity laboratory jaw crusher; standard model; capacity 1000 to 2000 pounds per hour based on limestone; 4 by 6 jaw openings; discharge opening adjustable from ¼ to 1½ inch; handwheel adjust jaw openings; complete with 3 horsepower motor; 380/50Hz 3 phase A.C. connections made available to motor for power consumption measurements; such as found in Soiltest Catalogue Number C-2-8.</p>

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REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
E-CT-235	H-35-235-(1)	<u>Laboratory Jar Rolling Mill</u> - Two rolls 24 inches in length; single tier inset; adjustable roll spacing; containers between 2 inches and 24 inches in outside diameter, may be rolled on these mills; bearings never require lubrication; rugged supports are mounted on a rolled steel base plate; safety guard covering belt; with enclosed explosion proof motor; compatible with E-CT-236; such as found in Paul O. Abbe Jar Mills catalogue.
E-CT-236	H-35-236-(4)	<u>Grinding Jars</u> - Procelain jars fortified with burundum; lids have locking bar and hand wheel; 1/2 gal (2 l.) capacity; inner surface unglazed; neoprene gaskets; compatible with E-CT-235.
E-CT-237	H-35-237-(20 lbs)	<u>Grinding Media</u> - Cylindrical; burundum; for wet and dry application in jar milling; diameter 13/16 in, length 13/16 in (2 x 2 cm); hardness 9.0; average number per package 180.
E-CT-238	H-35-238-(20 lbs)	<u>Grinding Media</u> - Flint pebbles; for jar mill use; hard; uniform; average number per package 450; free from holes; minimum contamination.
E-CT-239	H-35-239-(1)	<u>AC Ammeter</u> - Range 0-25 amperes; to measure power requirements in E-CT-234.
E-CT-240	H-35-240-(1)	<u>AC Voltmeter</u> - Range 0-300 volts; to measure power requirements in E-CT-234.
E-CT-241	H-36B-241-(1)	<u>Hand Tachometer</u> - Photoelectric, vibrational frequencies up to 30,000 per minute; complete with probe, retractile cord, solid state circuitry, mercury dry cell battery, reflector tape.
E-CT-242	H-36-242-(1)	<u>Dry Ice Generator Kit</u> - Produces dry ice in three different forms from a tank of carbon dioxide; complete with generator, 3 fittings, and nylon washer for making tight seal at cylinder or other connections.

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REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
E-CT-243	H-36-243-(1)	<u>High Pressure Hose Assembly</u> - with fittings that are compatible to large carbon dioxide tanks found in Syria; 6 ft (2 m) long black reinforced plastic tubing; such as Central Scientific Catalogue Number 16911-000.
E-CT-244	H-34C-244-(1)	<u>Gas Chromatograph</u> - Operation on 220V/50Hz; equipped with single column, 8 wire thermal conductivity detector with four WX filaments; injector port with independent temperature control to 400°C; isothermal of nonlinear programming capabilities up to 400°C; solid state 0-24 v bridge power supply with filament current meter; 10 step attenuators, fine red course adjust controls; separate needle valves for reference and differential flow control; oven controller variable to 400°C; large one space; pyrometer and 6-position selector switch; accessories including one stainless steel column (5 ft or 6 ft) with standard absorbant; package of septa; bubble flow meter; set of space fuses; copper tubing with fitting appropriate to hook up to gas gauge Item E-CT-245; comparable to Varian Model 920; complete with 6 ft packed column with absorbant appropriate for water analysis.
E-CT-245	H-34C-245-(1)	<u>Pressure Regulator</u> - Two stage regular for helium gas; 0 to 4000 psig input gauge and a 0 to 100 rated output gauge; compatible with fittings on large European helium gas tanks.
E-CT-246	H-34C-246-(1)	<u>Recorder</u> - Compatible with gas chromatograph E-CT-244; 10 inch strip chart recorder; potentiometric type or equivalent having a 1-mv full scale, 1-second response with floating point; variable chart speeds; 220V/50Hz; fiber tip pen (cartridge, fountain, or ball point pen may be used); with electronic integrator.
E-CT-247	H-34C-247-(5)	<u>Chart Paper</u> - Metric; compatible with E-CT-246 10 inch strip chart recorder; comes in a roll.
E-CT-248	H-34C-248-(1)	<u>Pen for Recorder</u> - Compatible with E-CT-246.
E-CT-249	H-34C-249-(5)	<u>Syringes</u> - Two inch fixed needle; capacity of syringe 0-10 ml.

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REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
E-CT-250	H-34C-250-(1)	<u>Soap Solution</u> - Used in bubble flow meter or for detecting leaks in pressurized systems; 8 oz. (250 ml) bottle.
E-CT-251	H-34C-251-(50)	<u>Septa</u> - Standard injector septa; made of thermally stable silicone rubber; compatible to injector port in gas chromatograph Item E-CT-244.
E-CT-252	H-34C-252-(1)	<u>Infra-red Spectrometer</u> - Spectral range 4000 to 600 cm^{-1} ; double beam optical null monochrometer; filter grating; variable scanning speeds; for operating on 220V/50Hz; with dust cover; compatible with E-CT-254, E-CT-255, E-CT-271, 272, 273, 274.
E-CT-253	H-34C-253-(1)	<u>Press</u> - Carver type; self contained; hand operated; provides up to 24,000 psi; platens are 6 in. ² ; bench mounted; complete with short handle and pressure gauge; such as found in Scientific Products Catalogue Number P7250.
E-CT-254	H-34C-254-(3)	<u>Disposable Pen</u> - Felt tip; red color; compatible with infra-red spectrometer Item E-CT-252.
E-CT-255	H-34C-255-(3)	<u>Chart Paper</u> - Compatible with infrared spectrometer Item E-CT-252; paper indicates frequency, wave number and percent transmission; 100 ft. roll.
E-CT-256	H-34B-256-(8 pkg)	<u>Demountable Window (NaCl)</u> - For infrared cell; sodium chloride window; diameter 25 mm; compatible with E-CT-257; 2 windows per package.
E-CT-257	H-34B-257-(5)	<u>Demountable Infra-red Cell</u> - For qualitative analysis of non-volatile liquids and nujol mulls; stainless steel; complete with three battery nuts; packet of two spacers dimensions 0.025 mm, 0.5 mm and 0.1 mm; without windows; compatible with E-CT-252.
E-CT-258	H-34B-258-(2)	<u>Potassium Bromide Pellet Maker Die</u> - Evacuatable KBr die; 13 mm; unidie; pellet is produced directly in the barrel which is then placed in the beam of the spectrometer for analysis; readily evacuatable and may be used with standard hydraulic press; 3 piece construction with cell holder.

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INDUSTRIAL INORGANIC AND QUANTITATIVE CHEMISTRY (AREA 34)

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION																		
E-CT-259	H-34C-259-(2)	<u>Mortar and Pestle Sets</u> - Agate; diameter of mortar is 40 mm; pestle included; no imperfections.																		
E-CT-260	H-34A-260-(4 oz)	<u>High-Vacuum Stopcock Grease</u> - Silicone lubricant; for high vacuum work; low vapor pressure; comes in 2 oz. jars.																		
E-CT-261	H-34A-261-(1)	<u>Vacuum Pump</u> - Single stage; with belt guard; ultimate pressure of 0.015 torr; free air displacement of 35 litres/minute (1.2 ft. ³ /min); 1/3 horsepower motor; 220/50Hz; supplied filled with oil; similar to Sargent-Welch Catalogue number 1399B-01.																		
E-CT-262	H-34A-262-(10 ft)	<u>Rubber Tubing</u> - Vacuum or pressure tubing; red gum rubber; low vapor pressure; internal diameter 7/16 in (1.11 cm) wall thickness 5/16 in (.79 cm).																		
E-CT-263	H-34B-263-(1 set)	<u>Rubber Tubing Clamps</u> - Metal; holds rubber tubing; worm type self locking screw; a set comprises 10 each of the following:																		
		<table style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th style="text-align: center;">Number of Items</th> <th style="text-align: center;">Fits Tubing O.D.,</th> <th style="text-align: center;">Size mm (in.)</th> </tr> </thead> <tbody> <tr> <td style="text-align: center;">10</td> <td style="text-align: center;">11 to 20</td> <td style="text-align: center;">(1/16 to 25/32)</td> </tr> <tr> <td style="text-align: center;">10</td> <td style="text-align: center;">17 to 32</td> <td style="text-align: center;">(11/16 to 1 1/4)</td> </tr> <tr> <td style="text-align: center;">10</td> <td style="text-align: center;">21 to 44</td> <td style="text-align: center;">(13/16 to 1 3/4)</td> </tr> <tr> <td style="text-align: center;">10</td> <td style="text-align: center;">38 to 57</td> <td style="text-align: center;">(1 1/2 to 2 1/4)</td> </tr> <tr> <td style="text-align: center;">10</td> <td style="text-align: center;">64 to 83</td> <td style="text-align: center;">(2 1/2 to 3 1/4)</td> </tr> </tbody> </table>	Number of Items	Fits Tubing O.D.,	Size mm (in.)	10	11 to 20	(1/16 to 25/32)	10	17 to 32	(11/16 to 1 1/4)	10	21 to 44	(13/16 to 1 3/4)	10	38 to 57	(1 1/2 to 2 1/4)	10	64 to 83	(2 1/2 to 3 1/4)
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10	64 to 83	(2 1/2 to 3 1/4)																		
E-CT-264	H-34A-264-(1)	<u>Vacuum Pump Cart</u> - has non-skid rubber mat; two of four wheels have locks; dimensions of top area of cart at least 45.7 x 61 cm (18 x 24 in); must hold at least 100 kg; compatible with high vacuum pump Item E-CT-261.																		

CHEMICAL TECHNOLOGY - EQUIPMENT

INDUSTRIAL INORGANIC AND QUANTITATIVE CHEMISTRY (AREA 34)

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
E-CT-265	H-34A-265-(4 qt)	<u>Vacuum Pump Oil</u> - Oil of very low vapor pressure; compatible with high vacuum pump Item E-CT-261.
E-CT-266	H-34A-266-(1)	<u>Heating Mantle</u> - Electric; glas-col type; heating element embedded in layers of glass fiber; bottom half only; fits 100 ml capacity round bottom flask; 220V/50Hz.
E-CT-267	H-34A-267-(1)	<u>Heating Mantle</u> - Electric; glas-col type; heating element embedded in layers of glass fiber; bottom half only; fits 200 ml capacity round bottom flasks; 220V/50Hz.
E-CT-268	H-34A-268-(1)	<u>Heating Mantle</u> - Electric; glas-col type; heating element embedded in layers of glass fiber; bottom half only; fits 300 ml capacity round bottom flasks; 220V/50Hz.
E-CT-269	H-34A-269-(1)	<u>Heating Mantle</u> - Electric; glas-col type; heating element embedded in layers of glass fiber; bottom half only; fits 500 ml capacity round bottom flask; 220V/50Hz.
E-CT-270	H-34A-270-(2)	<u>Autotransformer</u> - Variable; enclosed back-type transformer; input 220V/50Hz; output 0-220V/50Hz; compatible with heating mantles Items E-CT-266, 267, 269, 269.
E-CT-271	H-34B-271-(1)	<u>Beam Attenuator</u> - Used in the reference beam of infrared spectrometer to balance for energy losses in the sample beam; attenuator has a useful range from 100% transmission to 0%; compatible with E-CT-252.
E-CT-272	H-34B-272-(2)	<u>Sealed Infrared Cells</u> - 0.025 mm thick NaCl windows; for obtaining infrared spectra of liquids; consists of two crystals amalgamated together with a silver or lead spacer and with the top crystal drilled; interchangeable cells with holder, nuts, two teflon "o" rings; compatible with E-CT-252.

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CHEMICAL TECHNOLOGY - EQUIPMENT

INDUSTRIAL INORGANIC AND QUANTITATIVE CHEMISTRY (AREA 34)

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
E-CT-273	H-34B-273-(1)	<u>Cell Holder</u> - For sealed infrared cells; compatible with E-CT-252.
E-CT-274	H-34B-274-(1)	<u>Mini Press, Delux, KBr Pellet Maker Kit</u> - Forms KBr pellets; two bolts are turned against each other in a steel cylinder; all length 2.2 cm; outside cell diameter 2.82 cm; complete with sample press, two polished & hardened bolts, sample press holder, bench top press, T-handle socket wrench, instructions; compatible with E-CT-252.
E-CT-275	H-36A-275-(5)	<u>Gas Control Valves</u> - Brass valve; lecture cylinder; hose connection; needle valve for fine control of gases; compatible with C-CT-167 through C-CT-171.
E-CT-276	H-36A-276-(1)	<u>Gas Control Valve</u> - Stainless steel; for lecture cylinder; hose connection; compatible with C-CT-166.
E-CT-277	H-36A-277-(2)	<u>Gas Cylinder Stand</u> - Wire stand to hold lecture cylinder erect; compatible with Items C-CT-166 through C-CT-171.
E-CT-278	H-35-278-(1) H-36-278-(1)	<u>Balance</u> - Solution; 20 kg capacity; tare capacity 2270 g; sensitivity 1 g; complete with one each 1, 5 and 10 kg and two kg weights.
E-CT-279	H-35-279-(1)	<u>Ice Flaker</u> - Continuous automatic production of hard ice flakes; bin control stops production when storage bin is filled; ice production 250 lb/24 hour; 175 lb ice storage capacity; 1/3 horsepower; 3/8 in. water inlet; (2) 1/2 in. water diameter.

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CHEMICAL TECHNOLOGY - EQUIPMENT

INDUSTRIAL INORGANIC AND QUANTITATIVE CHEMISTRY (AREA 34)

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
E-CT-280	H-36-280-(1)	<p><u>Electrode Steam Boiler System</u> - Complete with the following:</p> <ol style="list-style-type: none"> 1. <u>Electrode Steam Boiler</u>: To produce steam for and compatible with Items E-CT-195, E-CT-202, E-CT-222; 3 electrodes; 125 psig maximum steam pressure; 10 b.h.p. (100 kw); 345 lbs/hr of steam; 154 amps/380V 3 phase; 334,750 BTU per hour; water and steam outlets compatible with Syrian fittings; such as found in EBCOR model number 10-125-4 produced by Electric Boiler Corporation of America, 200 Gold Star Blvd., Box 40, Worcester, Massachusetts, 01601, USA. Dimensions, length 34 inches, height 61 inches, width 22 inches. 2. <u>Condensate Return System</u>: Compatible with the above electrode steam boiler; complete with condensate tank; model MP motor and pump; Model FW-249 water level controller; ball float; piping and necessary valves; such as found in EBCOR model number CRS 10-125 and model WF-249 control; floor space 28 x 28 inches. 3. <u>Automatic Boiler Blow-Down</u>: Conductivity sensing controls for automatically removing sludge, salts and solids in a liquid state from the boiler; 220V/50Hz; with selenoid. 4. <u>Ebcolyte</u>: A solid material added to the water to increase the flow current in the liquid. 5. <u>Lagging, Insulation, Flanges and Piping</u>: All hot pipes that supply steam from steam generator to trainer shall be insulated with 4 inch thick suitable insulation to handle temperatures between 212°F and 350°F; outside protective surface shall consist of 1/4 inch steel lagging; all flanges, piping and fittings shall be provided for connecting the steam generator to trainers E-CT-195 (steam: 12 kg per hour maximum at 2.5 bar), E-CT-202 (steam: 90 kg per hour maximum at 2.5 bar), E-CT-222 (steam: 30 kg per hour at 2.5).

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CHEMICAL TECHNOLOGY - EQUIPMENT
INDUSTRIAL INORGANIC AND QUANTITATIVE CHEMISTRY (AREA 34)

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
E-CT-281	H-34A-281-(200)	<u>Cork</u> - Stopper; Grade xxxx; cork size 6 (19 x 15 x 23 mm).
E-CT-282	H-34-282-(1)	<u>Barometer Case</u> - Locking; finished wood case, with glass front for mounted barometer Item E-CT-86; with lock and key and pressure conversion table; size 107 x 17 x 9 cm (42 x 6 3/4 x 3 1/2 inch).
E-CT-283	H-34B-283-(1)	<u>Scoop</u> - Polyethylene; large; cylindrical total length 35.6 cm (14 inch) scoop diameter 15.2 cm (6 inch).
E-CT-284	H-34C-284-(20 boxes)	<u>Cloths</u> - Disposable paper tissues; highly absorbent, soft lint free; in dispensing boxes; Kimwipes; tissue size 5 x 8 1/2 inch; tissues per box 270.
E-CT-285	H-34B-285-(5 tubes) H-36A-285-(1 tube)	<u>Stopcock Lubricant</u> - Lubriseal; for sealing and lubricating stopcock plugs; and desicators; acid and alkalic resistant; melting point about 40°C; in 25 g collapsible tubes.
E-CT-286	H-34B-286-(1)	<u>Safety Goggles Sanitizer</u> - Up to seventy pairs of safety goggles sanitized at one time; prevention of transmission of infectious disease; stainless steel cabinet 76 x 20 x 91 cm (30 x 8 x 36 inch) high and may be table or wall mounted; two 91 cm (36 inch) germicidal ultraviolet lamps and timer; 5 minute sanitizing action; unit does not start unless cabinet doors closed; 220V/50Hz, 60 watt; 3 wire cord and plug; such as found in Sargent-Welch catalogue number S-40419.
E-CT-287	H-34C-287 (3 pkg) H-36B-287-(2 pkg)	<u>Lens Paper</u> - Optical, soft, clean non-abrasive; book form; perforated for easy removal; book size 10 x 14 cm; in package of 50 sheets.

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CHEMICAL TECHNOLOGY - EQUIPMENT

INDUSTRIAL INORGANIC AND QUANTITATIVE CHEMISTRY (AREA 34)

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
E-CT-288	H-34B-288-(12)	<u>Iron Ring</u> - For fastening to support rods; rod length 19 cm; diameter 7 mm; finished in blue-baked enamel; 4 inch overall diameter; 3 3/8 inches internal diameter.
E-CT-289	H-36E-289-(1)	<u>Cradle</u> - For use with Mettler top loading balance Item E-CT-209; four prong cradle is mounted on a pan support similar to regular balance pan, which it replaces for use; similar to V.W.R. catalogue number 11324-015.
E-CT-290	H-36B-290-(1)	<u>Scoop</u> - Fits on top of cradle Item E-CT-289 and compatible with Mettler top loading balance Item E-CT-209; made of aluminum with high sides and low ends for easy pouring of bulky materials; dimensions of scoop may be easily formed into many configurations; similar to V.W.R. catalogue number 11324-059.

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MASTER EQUIPMENT LIST

CHEMICAL TECHNOLOGY

The following general specifications shall apply to all items.

1. All equipment shall be new and unused models embodying the most up-to-date principles, design, and styling.
2. All dimensions, ranges and calibrations shall be in metric units except where otherwise specified.
3. All electrical connections will be arranged for 220 volts, 50 cycle, 1 phase, AC, unless otherwise indicated. Most exceptions will be where 3 phase power is required.

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MASTER EQUIPMENT LIST
CHEMICAL TECHNOLOGY
EQUIPMENT

REFERENCE NUMBER	DESCRIPTION	QUANTITY	UNIT	TOTAL
E-CT-1	"Scoopula"	84	5.00/12	35.00
E-CT-2	Handle for "Scoopula"	5	1.00/1	5.00
E-CT-3	Spatula and Spoon	68	2.00/1	136.00
E-CT-4	Asbestos Board Squares	72	1.55/12	9.30
E-CT-5	Wire Gauzes	60	16.00/24	40.00
E-CT-6	Triangles	24	5.00/12	10.00
E-CT-7	Crucible	36	21.00/12	63.00
E-CT-8	Crucible Covers	36	6.00/12	18.00
E-CT-9	Triple Beam Metric Balance	8	47.00/1	376.00
E-CT-10	Cylinders	8	12.00/1	96.00
E-CT-11	Tripod Bases	38	5.00/1	190.00
E-CT-12	Threaded Rod	38	1.00/1	38.00
E-CT-13	Buret Clamp	19	16.00	304.00
E-CT-14	Safety Goggles	87	21.00/10	182.00
E-CT-15	Litmus Paper, Blue	72 vials	1.50/12 vials	9.00
E-CT-16	Litmus Paper, Red	72 vials	1.50/12 vials	9.00
E-CT-17	Dishes, Evaporating	25	1.15/1	28.75
E-CT-18	Hoffman Open Type Tubing Clamp	72	8.45/12	59.70
E-CT-19	Pinchcock, Day's	72	4.05/12	24.30
E-CT-20	Sponge	120	2.70/12	27.00
E-CT-21	Cloth Toweling	500 pieces	10.00/200 pieces	25.00
E-CT-22	Quill Brushes	3	4.00	12.00
E-CT-23	Pipe Cleaner	4 pkg.	1.90/pkg of 10	7.60
E-CT-24	Buret Brushes	12	5.60/12	5.60
E-CT-25	Test Tube Brushes	60	6.15/12	30.75
E-CT-26	Test Tube Brushes	102	9.20/12	78.20
E-CT-27	Bottle Brush	5	7.80/5	7.80
E-CT-28	Volumetric Flask Brush (250 ml)	6	5.55/6	5.55
E-CT-29	Volumetric Flask Brush (500 ml)	6	7.00/6	7.00

MASTER EQUIPMENT LIST
CHEMICAL TECHNOLOGY
EQUIPMENT

REFERENCE NUMBER	DESCRIPTION	QUANTITY	UNIT	TOTAL
E-CT-30	Volumetric Flask Brush (1000 ml)	6	8.25/6	8.25
E-CT-31	Burners	31	10.75/1	322.50
E-CT-32	Burner Wing Top	40	10.25/12	26.47
E-CT-33	Gas Lighter	26	6.70/12	14.51
E-CT-34	Spark-Metal Renewals	10 pks of 12	1.10/12	11.00
E-CT-35	Clamp Extension, Medium	39	2.20/1	85.00
E-CT-36	Clamp, Extension, Medium	30	2.30/1	69.00
E-CT-37	Clamp, Extension, 3 Fingere	30	2.50/1	75.00
E-CT-38	Clamp, Holder	102	1.10/1	112.10
E-CT-39	Test Tube Support Wood	51	4.65/1	237.15
E-CT-40	Respirator	4	8.00	32.00
E-CT-41	Magnetic Stirrer	3	32.50	97.00
E-CT-42	Stirring Bars 25 mm	3	2.10	6.00
E-CT-43	Gloves Size 9, Medium	27 pair	7.31/box 12	16.44
E-CT-44	Gloves Size 10, Large	27 pair	8.76/box 12	19.71
E-CT-45	Rubber Bulb	7 pkg	2.00/pkg 12	14.00
E-CT-46	Rubber Tubing $\frac{1}{4}$ in (.6 mm)	200ft(60m)	26.80/5ft	216.00
E-CT-47	Labels (38 x 26 mm)	5 pkg of 1000	1.75/1000	8.75
E-CT-48	Labels (76 x 38 mm)	4 pkg of 250	3.75/250	15.00
E-CT-49	Cork Borer Sets	13	7.50/1	97.50
E-CT-50	Cork Borer	9	16.50	148.50
E-CT-51	Cork Borer Sharpener	3	9.50	28.50
E-CT-52	Economy Slide Rule	25	2.25/1	56.25
E-CT-53	Beaker Tongs	3	28.80/1	87.00
E-CT-54	Crucible Tongs	25	2.15/1	53.75
E-CT-55	Forceps	48	.64/1	30.72
E-CT-56	Bottle Forceps	1	4.10/1	4.10
E-CT-57	Scientific Calculator	4	50.00	200.00
E-CT-58	Filter Pump	22	5.60	123.20
E-CT-59	Iron Extension Support	25	7.55/6	188.75

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MASTER EQUIPMENT LIST
CHEMICAL TECHNOLOGY
EQUIPMENT

REFERENCE NUMBER	DESCRIPTION	QUANTITY	UNIT	TOTAL
E-CT-60	Wash Bottle	72	39.80/36	79.60
E-CT-61	Stoddard's Test Tube Clamp	56	7.85/6	73.25
E-CT-62	Bottles (Polyethylene) 2 gal.	5	13.00/1	65.00
E-CT-63	Bottles (Polyethylene) 5 gal.	4	22.00	88.00
E-CT-64	Tripod	11	2.75/1	30.25
E-CT-65	Filter Aid	1 lb.	24.00/lb.	24.00
E-CT-66	Smooth Boiling Granules	1000 g.	7.00/500 g	14.00
E-CT-67	Support, Pipet, Hardwood	3	19.30/1	27.90
E-CT-68	Wood Splints	2 pkg of 500	4.15 pkg of 500	8.30
E-CT-69	Hot Plate Magnetic Stirrer	3	124.00	372.00
E-CT-70	Standard Water Still	1	605.00	605.00
E-CT-71	Plain Stopwatches	18	42.00	336.00
E-CT-72	Analytical Balance	4	1195.00	4780.00
E-CT-73	Lamp	6	2.55	15.30
E-CT-74	Two-Pan Analytical Balance	1	495.00	495.00
E-CT-75	First Aid Cabinet	4	27.00	108.00
E-CT-76	Lab Coat	1	19.00	19.00
E-CT-77	Lab Coat	4	19.50	78.00
E-CT-78	Lab Coat	4	19.50	78.00
E-CT-79	Lab Coat	1	19.50	19.50
E-CT-80	Rubber Aprons	3	2.35	7.05
E-CT-81	Laboratory Oven	1	167.00	167.00
E-CT-82	Muffle Furnace	2	285.00	570.00
E-CT-83	Asbestos Gloves	1	13.50	13.50
E-CT-84	Tongs, Crucible	1	15.00	15.00
E-CT-85	Trough	12	4.45	53.40
E-CT-86	Mercurial Barometer	1	110.00	110.00
E-CT-87	Barometer Mount	1	12.75	12.75
E-CT-88	Analytical Weights	1	150.00	150.00
E-CT-89	Battery--Nickel Cadmium	24	1.00/1	24.00
E-CT-90	Natural Rubber Acid Gloves	2	2.00	4.00

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MASTER EQUIPMENT LIST
CHEMICAL TECHNOLOGY
EQUIPMENT

REFERENCE NUMBER	DESCRIPTION	QUANTITY	UNIT	TOTAL
E-CT-91	Natural Rubber Acid Gloves	2	2.00	4.00
E-CT-92	Natural Rubber Acid Gloves	2	2.00	4.00
E-CT-93	PH Meter	4	300.00	1200.00
E-CT-94	Reference Electrode	6	28.00	168.00
E-CT-95	Glass Electrode	6	31.50	189.00
E-CT-96	Spectrophotometer - Regulated Model	2	600.00	1200.00
E-CT-97	Educational Manual	5	2.00	10.00
E-CT-98	Test Tube Cells	36	9.50/12	28.80
E-CT-99	Filter Kit	1	35.00	35.00
E-CT-100	Support for Cells	2	6.00	12.00
E-CT-101	Infrared Sensitive Phototube	2	10.00	20.00
E-CT-102	Infrared Filter	2	4.00	8.00
E-CT-103	Lamp Replacement	3	3.50	10.50
E-CT-104	Cuvette	6	18.00/2	54.00
E-CT-105	Adapter	2	12.00	24.00
E-CT-106	Rubber Stoppers #5	29 / 1 lb.	3.75/29	3.75
E-CT-107	Cotton	2 lb.	(1000 g) 3.50 lb.	7.00
E-CT-108	Buret Meniscus Reader	42	8.10/12	28.35
E-CT-109	Buret Funnels	24	4.49/12	8.98
E-CT-110	Boyle's Law Apparatus	6	75.00	450.00
E-CT-111	Burners	15	3.75	56.25
E-CT-112	Wicks	36	3.50/12	10.50
E-CT-113	Cleaning Compound	14/box	3.50/3 lb. box	49.00
E-CT-114	Combustion Boats	24	1.40/1	33.60
E-CT-115	Cork Knife	3	1.85/1	5.55
E-CT-116	Cork Press	2	17.50	35.00
E-CT-117	Deflagration Spoons	18	7.50/6	22.50
E-CT-118	Mortar and Pestle (224 ml)	4	4.00	16.00
E-CT-119	Stopper Remover	1	75.00	75.00
E-CT-120	Labels (26 x 19 mm)	3000	2.20/1000	6.60
E-CT-121	Support, Funnel Wood	10	4.50	45.00

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MASTER EQUIPMENT LIST
CHEMICAL TECHNOLOGY
EQUIPMENT

REFERENCE NUMBER	DESCRIPTION	QUANTITY	UNIT	TOTAL
E-CT-122	Reagent Bottle Block	3	3.50	10.50
E-CT-123	Bottles Polyethylene	15	3.90/12	4.87
E-CT-124	Bottles Polyethylene	54	29.95/24	67.50
E-CT-125	Bottles Polyethylene	8	15.28/6	20.40
E-CT-126	Flasks	12	4.50	54.00
E-CT-127	Splash Eliminator	39	21.50/12	69.81
E-CT-128	Filter Paper 11 cm	31/box of 100	.80/box	24.80
E-CT-129	Filter Paper 12.5 cm	21/box of 100	1.03/box	21.63
E-CT-130	Filter Paper 20 cm	2/box of 100	1.90/box	3.80
E-CT-131	Cork Size 2	2/pkg of 100	2.40/pkg of 100	4.80
E-CT-132	Cork Size 4	2/pkg of 100	2.75/pkg of 100	5.50
E-CT-133	Cork Size 10	1/pkg of 100	7.50/pkg of 100	7.50
E-CT-134	Cork Size 6	2/pkg of 100	3.50/pkg of 100	7.00
E-CT-135	Rubber Stoppers #6	2 lb.	3.75/1 lb.	7.50
E-CT-136	Rubber Stoppers #6 1 hole	1 lb.	3.75 (22)	3.75
E-CT-137	Rubber Stoppers #6 2 hole	1 lb.	3.75 (22)	3.75
E-CT-138	Rubber Stoppers #1	1 lb.	4.65 (58)	4.65
E-CT-139	Rubber Stoppers #8	2 lb.	2(13) 3.75 1 lb.	7.50
E-CT-140	Rubber Stoppers #7	2 lb.	2(16) 3.75 1 lb.	7.50
E-CT-141	Rubber Stoppers #11	1 lb.	(6) 3.75	3.75
E-CT-142	Rubber Stoppers #13	1 lb.	(4) 3.75	3.75
E-CT-143	Rubber Stoppers #00	1 lb.	(116) 3.75	3.75
E-CT-144	Rubber Stoppers #4	1 lb.	(33) 4.65	4.65
E-CT-145	Rubber Stoppers #4 1 hole	1 lb.	(33) 4.65	4.65
E-CT-146	Rubber Stoppers #2	1 lb.	(44) 3.75	3.75
E-CT-147	Rubber Stopper #3	1 lb.	(44) 3.75	3.75
E-CT-148	Cork Stopper #19 xx	50	5.55/50	6.00
E-CT-149	Support Bases	14	4.00	56.00

CT-70

MASTER EQUIPMENT LIST
CHEMICAL TECHNOLOGY
EQUIPMENT

REFERENCE NUMBER	DESCRIPTION	QUANTITY	UNIT	TOTAL
E-CT-150	Threaded Rod with Shoulder	14	2.70	37.80
E-CT-151	Rubber Tubing - Pressure	100 ft.	30.42/50 ft	61.00
E-CT-152	Plastic Tubing	150 ft	17.25/50 ft	52.00
E-CT-153	Iron Extension Support Rings	12	6.50/6	13.00
E-CT-154	Cork Ring (110 x 60 mm)	18	1.75	31.00
E-CT-155	Cork Ring (140 x 90 mm)	18	1.95	34.00
E-CT-156	Cartridges	3 pair	3.00 pair	9.00
E-CT-157	Rubber Matting	12 yd (1 m)	6.50/yd.	78.00
E-CT-158	Burner Shield	12	2.50	30.00
E-CT-159	Filter Paper 5.5 cm	30	.50/100	15.00
E-CT-160	Water Bath	10	205.00	2050.00
E-CT-161	Hot Plate	11	48.00	528.00
E-CT-162	Water Baths	11	20.00	220.00
E-CT-163	Pails	2	3.00	6.00
E-CT-164	Magnetic Stirring Bar	2	1.50	3.00
E-CT-165	Magnetic Stirring Bar	2	1.85	4.00
E-CT-166	Magnetic Stirring Bar	5	2.25	11.25
E-CT-167	Magnetic Stirring Bar	2	3.15	6.30
E-CT-168	Magnetic Stirring Bar Retriever	3	3.00	9.00
E-CT-169	Magnetic Stirring Bar	2	5.00	10.00
E-CT-170	Files	24	1.55	37.00
E-CT-171	Extraction Thimble	pkg of 25	5.00/pkg	5.00
E-CT-172	Cork Size #14 xxxxx	200	5.60/50	22.00
E-CT-173	Aluminum Foil	150 ft.	.85/roll	6.00
E-CT-174	Cork Size #5 xxxxx	100	2.90/100	3.00
E-CT-175	Cork Size #7 xxxxx	100	4.30/100	4.00
E-CT-176	Cork Size #9 xxxxx	100	5.70/100	6.00
E-CT-177	Cork Size #11 xxxxx	100	7.85/100	8.00
E-CT-178	Cork Size #15 xxxxx	50	6.50/50	7.00
E-CT-179	Cork Size #19 xx	50	6.50/50	6.00

CT-71

MASTER EQUIPMENT LIST
CHEMICAL TECHNOLOGY
EQUIPMENT

REFERENCE NUMBER	DESCRIPTION	QUANTITY	UNIT	TOTAL
E-CT-180	Fractional Distillation Trainer	1	18,400.00	18,400.00
E-CT-181	Re-ractometer	1	1,700.00	1,700.00
E-CT-182	Westphal Balance	1	135.00	135.00
E-CT-183	Circulating System	1	695.00	695.00
E-CT-184	Film Holder	1	14.00	14.00
E-CT-185	Liquid Phase Chemical Reactor Trainer	1	5,900.00	5,900.00
E-CT-186	Replacement Thermometer	1	12.00	12.00
E-CT-187	Replacement Lamp Bulbs	10	5.00	50.00
E-CT-188	Gas/Liquid Absorption Column Trainer	1	13,500.00	13,500.00
E-CT-189	Gas Regulator	1	125.00	125.00
E-CT-190	Gas Regulator	1	125.00	125.00
E-CT-191	Safety Cap	25	4.00	100.00
E-CT-192	Gas Cylinder Clamp	3	10.00	30.00
E-CT-193	Sling Psychrometer	1	35.00	35.00
E-CT-194	Anemometer	1	230.00	230.00
E-CT-195	Forced Convection Drier - Trainer	1	4,800.00	4,800.00
E-CT-196	Temperature Radiation - Trainer	1	7,400.00	7,400.00
E-CT-197	Properties of Gases and Liquids - Trainer	1	6,300.00	6,300.00
E-CT-198	Solids Handling Trainer	1	4,900.00	4,900.00
E-CT-199	Permeability - Fluidization Trainer	1	1,400.00	1,400.00
E-CT-200	Centrifugal Axial Flow Pump Trainer	1	10,200.00	10,200.00
E-CT-201	Centrifugal Pump Trainer	1	6,700.00	6,700.00
E-CT-202	Evaporator Trainer	1	18,000.00	18,000.00
E-CT-203	Thermal Conduction Trainer	1	8,600.00	8,600.00
E-CT-204	Laboratory Sieves	1	680.00	680.00
E-CT-205	Sieve Shaker	1	840.00	840.00
E-CT-206	Sieve Cover	1	6.00	6.00
E-CT-207	Sieve Pan	1	10.00	10.00
E-CT-208	Timer	1	44.00	44.00
E-CT-209	Balance	1	1,025.00	1,025.00
E-CT-210	Lamp	3	2.35	7.00

CT-72

MASTER EQUIPMENT LIST
CHEMICAL TECHNOLOGY
EQUIPMENT

REFERENCE NUMBER	DESCRIPTION	QUANTITY	UNIT	TOTAL
E-CT-211	Fine Sieve Brush-Drying Oven; Ohaus Balance	2	3.90	7.80
E-CT-212	Wire Sieve Brush	2	1.80	3.60
E-CT-213	Distilled Water Storage Tanks	1	700.00	700.00
E-CT-214	Vent Guard Filter	1	100.00	100.00
E-CT-215	Filter Element - package of 6	6	10.00/6	10.00
E-CT-216	Distilled Water Storage Tank Stand	1	80.00	80.00
E-CT-217	Corrosion Studies Trainer	1	2,637.00	2,637.00
E-CT-218	Fluid Particle Behavior Trainer	1	1,430.00	1,430.00
E-CT-219	Filter Ability Index Trainer	1	500.00	500.00
E-CT-220	Sedimentation Trainer	1	1,318.00	1,318.00
E-CT-221	Sedimentation Tank Trainer	1	3,918.00	3,918.00
E-CT-222	Multi-Purpose Trainer	1	16,767.00	16,767.00
E-CT-223	Hydraulics Bench	2	1,300.00	2,600.00
E-CT-224	Flow Measurement Apparatus	1	1,300.00	1,300.00
E-CT-225	Loss in Pipe Bend Apparatus	1	2,000.00	2,000.00
E-CT-226	Pipe Friction Apparatus	1	500.00	500.00
E-CT-227	Orifice Flow Apparatus	1	460.00	460.00
E-CT-228	Pressure Gauge Calibrator	1	1,500.00	1,500.00
E-CT-229	Flow Visualization Apparatus	1	1,720.00	1,720.00
E-CT-230	Venturi Meter	1	430.00	430.00
E-CT-231	Properties of Fluids and Hydrostatics Bench Trainer	1	9,230.00	9,230.00
E-CT-232	Flowmeter Calibration Rig Trainer	1	2,500.00	2,500.00
E-CT-233	Fluid Friction Apparatus Trainer	1	2,500.00	2,500.00
E-CT-234	Laboratory Crusher	1	2,350.00	2,350.00
E-CT-235	Laboratory Jar Rolling Mill 2" x 24"	1	800.00	800.00
E-CT-236	Grinding Jars, Burundum 1/2 gal.	4	50.00	200.00
E-CT-237	Grinding Media, Cylindrical, Burundum - 10 lb unit	20 lb.	16.00	32.00
E-CT-238	Grinding Media, Flint Pebbles - 10 lb. unit	20 lb.	5.00	10.00
E-CT-239	A.C. Ammeter	1	40.00	40.00
E-CT-240	A.C. Voltmeter	1	40.00	40.00

CT-73

MASTER EQUIPMENT LIST
CHEMICAL TECHNOLOGY
EQUIPMENT

REFERENCE NUMBER	D E S C R I P T I O N	QUANTITY	UNIT	TOTAL
E-CT-241	Hand Tachometer	1	175.00	175.00
E-CT-242	Dry Ice Generator Kit	1	160.00	160.00
E-CT-243	High Pressure Hose	1	40.00	40.00
E-CT-244	Gas Chromatograph	1	1,800.00	1,800.00
E-CT-245	Pressure Regulator	1	100.00	100.00
E-CT-246	Recorder	1	950.00	950.00
E-CT-247	Chart Paper	5	5.00	25.00
E-CT-248	Pen for Recorder	1	10.00	10.00
E-CT-249	Syringes	5	12.00	60.00
E-CT-250	Soap Solution	1	2.00	2.00
E-CT-251	Septa	50	3.00	3.00
E-CT-252	Infra-red Spectrometer	1	4,300.00	4,300.00
E-CT-253	Hydraulic Press	1	650.00	650.00
E-CT-254	Disposable Pen	3	3.00	9.00
E-CT-255	Chart Paper	3	10.00	30.00
E-CT-256	Demountable NaCl Windows	8 pkg	14.00	112.00
E-CT-257	Demountable Infra-red Cell	5	18.00	90.00
E-CT-258	Potassium Bromide Pellet Maker Die	2	100.00	200.00
E-CT-259	Agate Mortar and Pestle	2	25.00	50.00
E-CT-260	High Vacuum Stop Cock Grease	4 oz.	2.00	4.00
E-CT-261	Vacuum Pump	1	320.00	320.00
E-CT-262	Rubber Tubing, Vacuum	10 ft.	22.00	22.00
E-CT-263	Rubber Tubing Clamps	1 set	25.00/set	25.00
E-CT-264	Vacuum Pump Cart	1	80.00	80.00
E-CT-265	Vacuum Pump Oil	4 qt.	2.50 qt.	10.00
E-CT-266	Heating Mantle (100 ml)	1	16.00	16.00
E-CT-267	Heating Mantle (200 ml)	1	16.00	16.00
E-CT-268	Heating Mantle (300 ml)	1	17.00	17.00
E-CT-269	Heating Mantle (500 ml)	1	19.00	19.00
E-CT-270	Auto Transformer	2	40.00	80.00
E-CT-271	Beam Attenuator	1	40.00	40.00

CT-74

MASTER EQUIPMENT LIST
CHEMICAL TECHNOLOGY
EQUIPMENT

REFERENCE NUMBER	DESCRIPTION	QUANTITY	UNIT	TOTAL
E-CT-272	Sealed Infra-red Cells	2	35.00	70.00
E-CT-273	Cell Holder	1	25.00	25.00
E-CT-274	Mini-Press, Delux, KBr Pellet Maker Kit	1	45.00	45.00
E-CT-275	Gas Control Valves - Brass	5	8.00	40.00
E-CT-276	Gas Control Valve - Stainless Steel	1	16.00	16.00
E-CT-277	Gas Cylinder Stand	2	5.00	10.00
E-CT-278	Balance, Solution, 20 kg Capacity	2	250.00	500.00
E-CT-279	Ice Flaker	1	1,029.00	1,029.00
E-CT-280	Electrode Steam Boiler System	1	4,330.00	4,330.00
E-CT-281	Cork Size #6 xxxx	200	3.50/100	7.00
E-CT-282	Barometer Case	1	60.00	60.00
E-CT-283	Scoop	1	12.00	12.00
E-CT-284	Cloth, Tissues	20 box	1.00/box	20.00
E-CT-285	Stopcock Lubricant	6 tube	1.00/tube	6.00
E-CT-286	Safety Goggles Sanitizer	1	286.00	286.00
E-CT-287	Lens Paper	6 pkg	.50 pkg	3.00
E-CT-288	Iron Ring	12	1.25/1	15.00
E-CT-289	Cradle	1	27.00/1	27.00
E-CT-290	Scoop	1	11.00/1	11.00

CHEMICAL TECHNOLOGY - FURNITURE

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
F-CT-1	H-34A-1-(4) H-34B-1-(1) H-34C-1-(1) H-35-1-(2) H-36-1-(2) H-36A-1-(1) H-36B-1-(1)	<u>Waste Jars</u> - Stoneware; without covers; capacity 18.9 liters (5 gal).
F-CT-2	H-34-2-(10) H-34B-2-(6) H-34C-2-(6) H-36-2-(20) H-36B-2-(4) H-35-2-(20)	<u>Stool</u> - Adjustable 18 to 27 inches; has automatic break which grips and hold fast; are metal construction; such as found in Scientific Products catalogue # L 5110; portable; 13 in diameter seat.
F-CT-3	H-34-3-(3) H-34A-3-(1) H-36-3-(1) H-35-3-(1)	<u>Cart</u> - Metal, chemical; two compressed asbestos shelves; non-corrosive and stain resistant; dimensions 19 x 35 x 36 inches; such as Labconco Model 80200.
F-CT-4	H-34-4-(4) H-34A-4-(4) H-36-4-(1) H-35-4-(1)	<u>Step Stool</u> - Metal; portable; non-skidding; swivel casters retract when stool is stepped on; intermediate step and rubber threads; height 35.6 cm (14 in).
F-CT-5	H-34-5-(1) H-34A-5-(1) H-36-5-(1) H-35-5-(1)	<u>Step Ladders</u> - Portable; non-skidding; spring locked retractable casters; tubular steel with tubular steps; four steps; height 96.5 cm (38 in); such as found in Sargent-Welch catalogue # S-75-980 D.

CI-75

CHEMICAL TECHNOLOGY - FURNITURE

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
F-CT-6	H-34-6-(2) H-34A-6-(1) H-36-6-(1) H-35-6-(1) H-34B-6-(1)	<u>Drying Rack</u> - Wall mounted; for draining and drying test tubes, flasks, etc.; wooden or chemically resistant backboard; large and small chemically resistant pegs; such as found in Hamilton laboratory equipment and furniture catalogue # 52L806 or 52L807; approximately 50 x 50 cm.
F-CT-7	H-36-7-(1) H-35-7-(1) H-34-7-(1) H-36A-7-(1) H-34A-7-(1) H-34B-7-(1)	<u>Instructors' Chair</u> - Arm swivel tilts on chrome base with rubber wheel caster; seat size 19 x 17½ x 16/21 inches; frost tan.
F-CT-8	H-34B-8-(1) H-36A-8-(1)	<u>Cylinder Trucks</u> - Metal; three wheel truck for carrying large gas cylinders; third wheel is rubber tired swivel caster on a retractable leg; with safety chain.
F-CT-9	H-34-9-(1) H-34A-9-(1) H-34B-9-(1)	<u>Compact Modular Cabinets</u> - Fifteen transparent plastic drawers; metal cabinet; drawer size 3 1/8 x 3 1/32 x 11 inches (7.9 x 7.7 x 28 cm); nests on top of other cabinets items. Such as found in Brodhead-Garrett stock # 462749.
F-CT-10	H-34-10-(1) H-34A-10-(1) H-34B-10-(1)	<u>Compact Modular Cabinets</u> - Nine plastic transparent drawers; dividable; metal cabinet; drawer size 5 1/4 x 3 1/32 x 11 inches (13.3 x 7.7 x 28 cm); nests on top of other cabinets items. Such as found in Brodhead-Garrett stock # 462760.
F-CT-11	H-34-11-(1) H-34A-11-(1) H-34B-11-(1)	<u>Compact Modular Cabinets</u> - Three heavy duty styrene drawers; dividable; metal cabinet; drawer size 16 3/4 x 3 1/32 x 11 inches (42 x 7.4 x 28 cm); such as found in Garrett stock # 128606; nests on top of other cabinets.

CT-76

CHEMICAL TECHNOLOGY - FURNITURE

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
F-CT-12	H-36-12-(1) H-36B-12-(1) H-34B-12-(1) H-34C-12-(2)	<u>Science Wall Cabinets</u> - Glass sliding doors; wood cabinets; dimensions 47 x 16 x 30 inches (119.4 x 40.6 x 76.2 cm); such as found in Brodhead-Garrett stock # 159568.
F-CT-13	H-34-13-(2) H-34A-13-(2) H-36-13-(1)	<p><u>Science Fume Hood</u> - Compatible with fume hood base cabinets F-CT-14.</p> <p>Exterior: Steel with baked on chemical resistant finish.</p> <p>Interior: Stainless steel with 5 inch diameter cupsink. External controls for water, gas, electricity on one side of the hood, with lighting in the hood.</p> <p>Baffles: Type 304, 18 gauge self reinforced and removable.</p> <p>Sash: Sliding sash on fume hood with 1/4 inch safety glass.</p> <p>Overall size is: 47 inch wide (119.4 cm) x 33 1/3 inch deep (84.7 cm) x 49 inches high (124.5 cm); such as found in Brodhead - Garrett stock # 158397, model # LA-4748.</p>
F-CT-14	H-34-14-(4) H-34A-14-(4) H-36-14-(2)	<u>Fume Hood Base Cabinet</u> - Wood base unit; 2 doors, one shelf; 47 inches wide; compatible with Science Fume Hood F-CT-13.

CT-77

CHEMICAL TECHNOLOGY - FURNITURE

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION																																			
F-CT-15	H-36-15-(1) H-35-15-(1) H-34B-15-(1) H-34A-15-(1)	<p><u>Science Laboratory Bench</u> - Two cold water pantry cock; one double gas cock; electrical receptical in front of bench with two outlets; complete with the following items:</p> <table border="0"> <thead> <tr> <th></th> <th><u>Length</u></th> <th><u>Width</u></th> <th><u>Height</u></th> <th><u>Depth</u></th> </tr> </thead> <tbody> <tr> <td>Overall Bench dimensions</td> <td>8 ft (2.4 cm)</td> <td>30 in (76 cm)</td> <td>36 in (91 cm)</td> <td></td> </tr> <tr> <td>1 wooden cupboard</td> <td></td> <td>33 in (85 cm)</td> <td>27 3/4in(70.5cm)</td> <td>24 3/4in(62.8cm)</td> </tr> <tr> <td>2 drawers (wooden)</td> <td></td> <td>14 in(37.8cm)</td> <td>5 5/8in(14.3cm)</td> <td>21in(53.3cm)</td> </tr> <tr> <td>3 drawers (wooden)</td> <td></td> <td>33 1/8in(84cm)</td> <td>5 5/8in(14.3cm)</td> <td>21in(53.3cm)</td> </tr> <tr> <td>1 duracon sink</td> <td>18in(45.7cm)</td> <td>14 in(35.6cm)</td> <td></td> <td>10 1/2in(2.67cm)</td> </tr> <tr> <td>Knee space</td> <td></td> <td>23in(58.4cm)</td> <td>31 3/8in(79.7cm)</td> <td>25 1/8in(63.8cm)</td> </tr> </tbody> </table> <p>Such as found in Brodhead - Garrett catalogue stock # 465027.</p>		<u>Length</u>	<u>Width</u>	<u>Height</u>	<u>Depth</u>	Overall Bench dimensions	8 ft (2.4 cm)	30 in (76 cm)	36 in (91 cm)		1 wooden cupboard		33 in (85 cm)	27 3/4in(70.5cm)	24 3/4in(62.8cm)	2 drawers (wooden)		14 in(37.8cm)	5 5/8in(14.3cm)	21in(53.3cm)	3 drawers (wooden)		33 1/8in(84cm)	5 5/8in(14.3cm)	21in(53.3cm)	1 duracon sink	18in(45.7cm)	14 in(35.6cm)		10 1/2in(2.67cm)	Knee space		23in(58.4cm)	31 3/8in(79.7cm)	25 1/8in(63.8cm)
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Knee space		23in(58.4cm)	31 3/8in(79.7cm)	25 1/8in(63.8cm)																																	
F-CT-16	H-34-16-(3) -34A-16-(3)	<p><u>Student Laboratory Bench</u> -</p> <p>Overall Bench Dimensions: Length 158 in (4.27 m) Width 54 in (1.37 m) Height 36 in (91.5 cm)</p> <p>Bottle Shelf: Height 18 in (45.7 cm) Dimensions: Width 12 in (30.5 cm) Length full length of bench top</p> <p>Contains: 6 cold water hose cocks 6 gas cocks. 6 duplex elect electric outlets</p>																																			

CT-78

CHEMICAL TECHNOLOGY - FURNITURE

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
F-CT-16 (cont'd)		<p>Trough: Runs the full length of the bench under the bottle shelf and drains into sink; trough lead lined.</p> <p>Sink: Dimensions: 24 x 20 x 10 in (61 x 50.8 x 25.4 cm) deep. Contains: Outlet and stopper; made out of soapstone.</p> <p>Bench Top: Made out of chemically resistant material such as Shelstone.</p> <p>Cabinets: 8 cabinets; wood; contains 4 drawers. Dimensions: 18 1/8 x 21 x 35 inches high.</p> <p>Cabinets: 6 cabinets; with door and 1 adjustable shelf. Dimensions: 18 1/8 x 21 x 35 inches high. All drawers have number plates and locks and keys.</p> <p>Such as found in E.H. Sheldon catalogue number 18122 with 6 additional wood base cabinet units catalogue number 36060 inserted into knee space; sink may be enclosed to hold a small butane gas tank.</p>
F-CT-17	H-34B-17-(9) H-36A-17-(1)	<p><u>Adjustable Steel Shelving Set - First Section</u> - Closed back and ends; industrial type adjustable steel shelving; standard 18 gauge; post 13 gauge stock; six adjustable shelves; compatible with F-CT-18; First Section is unit type; shelving dimension 36 x 12 x 87 in (91 x 30 x 221 cm).</p>
F-CT-18	H36A-18-(1) H-34B-18-(3)	<p><u>Adjustable Steel Shelving - First Section</u> - Closed back and ends; industrial type shelving; standard 18 gauge; post 13 gauge stock; six adjustable shelves; First Section is unit type; shelving dimension 36 x 18 x 87 inches; (91 x 46 x 221 cm).</p>

CT-79

CHEMICAL TECHNOLOGY - FURNITURE

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
F-CT-19	H-36A-19-(1) H-34B-19-(2)	<u>Steel Storage Shelving With Doors</u> - Closed back and ends; industrial type shelving; six adjustable shelves; dimension of shelving unit 36 x 24 x 87 inches (91 x 61 x 221 cm); with two metal doors provided with lock and key; doors come assembled on frame; compatible with Item F-CT-17.
F-CT-20	H-34B-20-(1)	<u>Floor Cabinet</u> - Wooden; open front; 84 inches high, 47 inches long and 18 inches deep; five adjustable wooden shelves such as found in V.W.R. catalogue number VL 1791; for acid storage.
F-CT-21	H-36A-21-(1) H-34B-21-(1)	<u>Laboratory Desk</u> - Metal; approximately 54 inches long, 24 inches deep, 36 inches high; frost gray; layer letter drawer; 4 box drawers; center drawer.
F-CT-22	H-34-22-(1) H-34A-22-(1) H-36-22-(3) H-35-22-(2)	<u>Student Table</u> - Wooden; Chemically resistant black 1½ inches (3.2 cm) top; dimensions 60 x 24 x 30 inches high (152.4 x 61 x 76.2 cm); with two drawers; such as found in Brodhead-Garrett stock number 196693.
F-CT-23	H-36-23-(1) H-35-23-(1) H-34-23-(2) H-34A-23-(2) H-34B-23-(1)	<u>Fire Extinguisher</u> - Carbon dioxide; capacity is 5 lbs (2.3 kg).
F-CT-24	H-36-24-(1) H-35-24-(1) H-34-24-(2) H-34A-24-(2)	<u>Safety Shower Eye/Wash Combination</u> - Shower head with a steel pull rod; eye wash foundation attached to shower stand; with eye wash catch basin; push handle; such as found in McMaster-Carr catalogue number 5227Y12.

CT-80

CHEMICAL TECHNOLOGY - FURNITURE

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
F-CT-25	H-36-25-(2) H-36-25-(2) H-35-25-(2) H-34C-25-(5) H-34-25-(2) H-34A-25-(1)	<p><u>Cabinet Type Work Benches</u> - Wooden top; length 8 ft (2.44 m); width 2 ft (.61 m); height 32 in (.81 m); 2½ in thick; base consists of three base cabinets; each cabinet containing three drawers cabinet size 29 ¾ inches high, 22 inches deep, 24 inches wide, drawer size 5 ⅜ inches x 13 ⅞ inches x 18 ⅝ inches; such as found in Brodhead - Garrett stock number 464331 and catalogue number AB 800.</p>
F-CT-26	H-36-26-(2) H-36A-26-(1) H-36B-26-(1)	<p><u>Cabinet Type Work Benches</u> - Wooden top; length 6 ft (1.83 m); width 2 ft (.61 m); height 32 in (.81 m); 2½ inch thick; base consists of two base cabinets; each cabinet containing three drawers; cabinet size 29 ¾ inches high; 22 inches deep, 24 inches wide, drawer size 5 ⅜ inches x 13 ⅞ inches x 18 ⅝ inches; such as found in Brodhead - Garrett stock number 464320 and catalogue number AB 601.</p>

CT-81

CT-87

MASTER EQUIPMENT LIST
 CHEMICAL TECHNOLOGY
FURNITURE

REFERENCE NUMBER	DESCRIPTION	QUANTITY	UNIT	TOTAL
F-CT-1	Waste Jars Stone Ware	12	20.00	240.00
F-CT-2	Stool	66	22.00	1,452.00
F-CT-3	Cart	6	111.00	666.00
F-CT-4	Step Stool	10	31.00	310.00
F-CT-5	Step Ladder	4	75.00	300.00
F-CT-6	Drying Rack	6	20.00	120.00
F-CT-7	Instructors' Chair	6	85.00	510.00
F-CT-8	Cylinder Trucks	2	37.00	74.00
F-CT-9	Compact Modular Cabinets - 15 Drawers	3	41.00	123.00
F-CT-10	Compact Modular Cabinets - 9 Drawers	3	41.00	123.00
F-CT-11	Compact Modular Cabinets - 3 Drawers	3	41.00	123.00
F-CT-12	Science Wall Cabinets - Glass Sliding Doors	5	234.00	1,190.00
F-CT-13	Science Fume Hoods	5	3,000.00	15,000.00
F-CT-14	Fume Hood Base Units	10	142.00	1,420.00
F-CT-15	Science Laboratory Bench	4	1,100.00	4,400.00
E-CT-16	Student Laboratory Bench	6	4,300.00	25,800.00
E-CT-17	Adjustable Steel Shelving 12" - First Section	10	64.00	640.00
E-CT-18	Adjustable Steel Shelving 18" - First Section	4	78.00	312.00
E-CT-19	Steel Storage Shelving 24" - With #2 Doors	3	157.00	491.00
E-CT-20	Floor Cabinet Wooden	1	240.00	240.00
F-CT-21	Laboratory Desk	2	150.00	300.00
F-CT-22	Student Table	7	200.00	1,400.00
F-CT-23	Fire Extinguishers - Carbon Dioxide	7	60.00	420.00
F-CT-24	Safety Shower/Eye Wash Combinations	6	322.00	1,932.00
F-CT-25	Cabinet Type Work Benches - 8 ft.	14	423.00	5,922.00
F-CT-26	Cabinet Type Work Benches - 6 ft.	4	293.00	1,172.00

CHEMICAL TECHNOLOGY - GLASSWARE

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
G-CT-1	H-34-1-(36) H-34A-1-(30) H-36-1-(6)	<u>Beakers</u> - 50 ml; low form; pourout; heavy duty; graduated; compatible with Items G-CT-2 through G-CT-7.
G-CT-2	H-34-2-(36) H-34A-2-(30) H-36-2-(6)	<u>Beakers</u> - 100 ml; low form; pourout; heavy duty; graduated; compatible with Items G-CT-1 through G-CT-7.
G-CT-3	H-34-3-(36) H-34A-3-(30) H-36-3-(6)	<u>Beakers</u> - 150 ml; low form; pourout; heavy duty; graduated; compatible with Items G-CT-1 through G-CT-7.
G-CT-4	H-34-4-(48) H-34A-4-(40) H-36-4-(6)	<u>Beakers</u> - 250 ml; low form; pourout; heavy duty; graduated; compatible with Items G-CT-1 through G-CT-7.
G-CT-5	H-34-5-(36) H-34-5-(30) H-36-5-(6)	<u>Beakers</u> - 400 ml; low form; pourout; heavy duty; graduated; compatible with Items G-CT-1 through G-CT-7.
G-CT-6	H-34-6-(36) H-34A-6-(30) H-36-6-(6)	<u>Beakers</u> - 600 ml; low form; poutout; heavy duty; graduated; compatible with Items G-CT-1 through G-CT-7.
G-CT-7	H-34-7-(30) H-34A-7-(6) H-34B-7-(6) H-35-7-(6) H-36-7-(12)	<u>Beakers</u> - 1000 ml; low form; pourout; heavy duty; graduated; compatible with Items G-CT-1 through G-CT-6.

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CHEMICAL TECHNOLOGY - GLASSWARE

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
G-CT-8	H-34-8-(2)	<u>Beakers</u> - 2000 ml; low form; pourout; heavy duty; graduated compatible with G-CT-1 through G-CT-7.
G-CT-9	H-34-9-(92)	<u>Bottles</u> - Gas collection; wide mouth; round; reagent quality glass; 250 ml capacity.
G-CT-10	H-34-10-(10) H-36-10-(5)	<u>Bottles</u> - Dropping, glass pipet stopper; with rubber bulb; capacity 30 ml; compatible with Item E-CT-122.
G-CT-11	H-34-12-(12)	<u>Bottles</u> - Narrow mouth; flint glass; screw cap; capacity 480 ml (16 oz).
G-CT-12	H-34-12-(12)	<u>Bottles</u> - Narrow mouth; flint glass; screw cap; capacity 960 ml (32 oz).
G-CT-13	H-34-13-(6)	<u>Bottle</u> - "Acid Bottle"; narrow mouth; round; for molded screw cap; 5 pint; with handle; Compatible with Item G-CT-14.
G-CT-14	H-34-14-(12)	<u>Bottle Caps</u> - Molded plastic caps; compatible with Item G-CT-13.
G-CT-15	H-36-15-(6) H-34-15-(24) H-36-15-(8)	<u>Burets</u> - 50 ml capacity; type 1 class A buret; fitted with Teflon plug; .1 ml division; compatible with Item G-CT-16; tolerance ± 0.05 ml.
G-CT-16	H-34-16-(6) H-36-16-(2)	<u>Burets</u> - 50 ml capacity; type 1 class A buret; <u>not</u> fitted with Teflon plug; compatible with Item G-CT-15; .1 ml divisions; tolerance ± 0.05 ml.
G-CT-17	H-34-17-(18)	<u>Flasks</u> - Boiling, flat bottom; long ring neck; capacity 500 ml.
G-CT-18	H-34-18-(60) H-34A-18-(40) H-36-18-(30) H-35-18-(10)	<u>Thermometers</u> - Mercury; 76 mm immersion; yellow back; temperature range - 20° to 110°C; Graduation in 1°C.

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CHEMICAL TECHNOLOGY - GLASSWARE

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
G-CT-19	H-34-19-(12)	<u>Thermometers</u> - Fractional scale .1° graduation; temperature range -1 to 101°C; total immersion.
G-CT-20	H-34-20-(60) H-36-20-(24)	<u>Erlenmeyer Flask</u> - 250 ml capacity; wide mouth; for titration; heavy duty rim; with capacity scale.
G-CT-21	H-34-21-(4) H-34A-21-(1) H-36-21-(1)	<u>Desiccator</u> - Knob top; glass; internal diameter 200 mm; chamber depth 125 mm; compatible with Item G-CT-22.
G-CT-22	H-34-22-(4) H-34A-22-(1) H-36-22-(1)	<u>Desiccator Plate</u> - Porcelain; with numerous perforations; diameter 200 mm; compatible with Item G-CT-21.
G-CT-23	H-34-23-(12) H-36-23-(4)	<u>Flasks</u> - Volumetric; class B tolerances; glass stopper; capacity 500 ml; tolerance ± 0.40 ml.
G-CT-24	H-34-24-(12) H-36-24-(4)	<u>Flasks</u> - Volumetric; 1000 ml; class B tolerances; glass stopper; capacity 1000 ml; tolerance ± 0.60 ml.
G-CT-25	H-34-25-(4)	<u>Flasks</u> - Volumetric; class B tolerance; glass stopper; capacity 25 ml; tolerance ± 0.06 ml.
G-CT-26	H-34-26-(4)	<u>Flasks</u> - Volumetric; class B tolerance; glass stopper; capacity 100 ml; tolerance ± 0.16 ml.
G-CT-27	H-34-27-(4) H-36-27-(4)	<u>Flasks</u> - Volumetric; class B tolerances; glass stopper capacity 250 ml; tolerance ± 0.24 ml.

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CHEMICAL TECHNOLOGY - GLASSWARE

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
G-CT-28	H-34-28-(60) H-34A-28-(60) H-36-28-(4)	<u>Funnels</u> - Analytical; 60°; fluted; short stem; diameter 75 mm.
G-CT-29	H-34-29-(2) H-36-29-(1)	<u>Funnels</u> - Ribbed glass; heavy glass; capacity 480 ml; short stem allows escape of air.
G-CT-30	H-34-30-(2) H-36-30-(1)	<u>Funnels</u> - Ribbed; heavy glass; allows escape of air; capacity 960 ml.
G-CT-31	H-34-31-(4) H-36-31-(2)	<u>Erlenmeyer Flasks</u> - Wide mouth; heavy duty rim; graduation; 1000 ml capacity.
G-CT-32	H-34-32-(4) H-36-32-(2)	<u>Erlenmeyer Flasks</u> - Wide mouth; heavy duty rim; graduation; 2000 ml capacity.
G-CT-33	H-34-33-(144) H-34A-33-(144)	<u>Test Tubes</u> - Chemical; with lip; dimension 13 x 100 mm.
G-CT-34	H-34-33-(216) H-34A-33-(216) H-36-33-(24)	<u>Test Tubes</u> - Chemical; with lip; dimensions 16 x 150 mm.
G-CT-35	H-34-35-(30) H-34A-35-(30)	<u>Test Tubes</u> - Chemical; with lip; dimensions 25 x 200 mm.

CHEMICAL TECHNOLOGY - GLASSWARE

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
G-CT-36	H-34-36-(12) H-34A-36-(24)	<u>Flasks</u> - Filtering; with side arm; 500 ml; graduated.
G-CT-37	H-34-37-(12) H-34A-37-(24)	<u>Funnel</u> - Buchner; porcelain; diameter of plate 56 mm; size 1.
G-CT-38	H-34-38-(24)	<u>Funnel Tubes</u> - Thistle top; square body to prevent rolling; stem diameter 5.5 mm; stem length 355 mm; diameter of bulb 5.5 mm.
G-CT-39	H-34-39-(96) H-34A-39-(96) H-36-39-(12)	<u>Pipet</u> - Medicine dropper; straight; capacity 1 to 2 ml; with rubber bulb.
G-CT-40	H-34-40-(36) H-34A-40-(36) H-36-40-(4)	<u>Cylinders</u> - Single graduated; reinforced glass and glass base; red glass band; calibrated to contain; capacity 10 ml; 0.1 ml subdivisions.
G-CT-41	H-34-41-(36) H-34A-41-(36) H-36-41-(4)	<u>Cylinders</u> - Single graduated; reinforced glass and glass base; red glass band; calibrated to contain; capacity 25 ml; 0.2 ml subdivisions.
G-CT-42	H-34-42-(36) H-34A-42-(36) H-36-42-(4)	<u>Cylinders</u> - Single graduated; reinforced glass and glass base; red glass band; calibrated to contain; capacity 100 ml; 1 ml subdivisions.
G-CT-43	H-34-43-(60) H-34A-43-(60) H-36-43-(12)	<u>Flasks</u> - Erlenmeyer; narrow mouth; graduated range from 20 to 50; capacity 50 ml.

CHEMICAL TECHNOLOGY - GLASSWARE

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
G-CT-44	H-34-44-(30 lbs or 13.6 kg) H-34A-44-(60 lbs or 27.2 kg)	<u>Glass Tubing</u> - Standard wall; flint glass; 4 ft (1.2 meter) length; overall diameter 7 mm; wall thickness 1.10 mm.
G-CT-45	H-34-45-(4 lb or 2000 g)	<u>Glass Tubing</u> - Standard wall; flint glass; assortment of sizes from 5 to 8 mm.
G-CT-46	H-34-46-(20 ft)	<u>Glass Tubing</u> - Standard wall; pyrex glass; shelf pack has five 4 ft (1.2 m) pieces; overall diameter 22 mm.
G-CT-47	H-34-47-(36)	<u>Square Glass Plates</u> - Five covering gas collecting bottles Item G-CT-9; size 3 x 3 inches (7.6 x 7.6 cm).
G-CT-48	H-34-48-(36) H-34A-48-(24)	<u>Watch Glasses</u> - Pyrex glass; diameter 100 mm (4 in); 3 ribs on underside for venting of vapors.
G-CT-49	H-34-49-(24) H-36-49-(4)	<u>Weighing Bottles</u> - Cylindrical body with ground glass stopper; 12 ml capacity; internal diameter 25 mm; body height 40 mm stopper number 24/12.
G-CT-50	H-34-50-(3) H-36-50-(3)	<u>Weighing Bottle</u> - Cylindrical body with ground glass stopper; 70 ml capacity; internal diameter 40 mm; body height 80 mm; stopper number 40/12.
G-CT-51	H-34A-51-(60) H-35-51-(8) H-36-51-(12)	<u>Thermometers</u> - Mercury; 76 mm immersion; yellow back; temperature range -10 to 260°C; graduation in 1°C.
G-CT-52	H-34A-52-(60)	<u>Erlenmeyer Flasks</u> - 250 ml capacity; narrow mouth; for recrystallizations; with capacity scales.

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CHEMICAL TECHNOLOGY - GLASSWARE

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
G-CT-53	H-34A-53-(108)	<u>Erlenmeyer Flasks</u> - 25 ml capacity; narrow mouth; with capacity scales.
G-CT-54	H-34A-54-(48)	<u>Flasks</u> - Boiling; round bottom; short neck; 250 ml capacity.
G-CT-55	H-34-55-(30)	<u>Flasks</u> - Boiling; round bottom; short neck; 500 ml capacity.
G-CT-56	H-34A-56-(48)	<u>Flasks</u> - Distilling; with sidearm below the top of the neck; capacity 50 ml.
G-CT-57	H-34A-57-(48)	<u>Flasks</u> - Distilling; with sidearm below the top of the neck; capacity 125 ml.
G-CT-58	H-34A-58-(30)	<u>Flasks</u> - Distilling; with sidearm below the top of the neck; capacity 250 ml.
G-CT-59	H-34A-59-(30)	<u>Flasks</u> - Distilling; 3 necked; angle; 500 ml capacity; round bottom.
G-CT-60	H-34A-60-(30)	<u>Flasks</u> - Capacity 1000 ml; long neck; tooled mouth; for steam distillation; mouth wide enough to take #8 stopper.
G-CT-61	H-34-61-(36)	<u>Condenser</u> - West type; all glass; compatible with #3 rubber stopper; jacket length 300 mm.
G-CT-62	H-34A-62-(30)	<u>Distilling Tubes</u> - Fractionating; Hempel type; overall length 300 mm; delivery tube; top fits number 3 rubber stopper; for 75 mm immersion thermometers.
G-CT-63	H-34A-63-(30)	<u>Drying Tubes</u> - Straight form; single bulb; 100 mm length.
G-CT-64	H-34A-64-(24)	<u>Powder Funnels</u> - For use in transferring powders to containers; 75 mm diameter; 30 mm stem length; 17 mm diameter of stem.

CHEMICAL TECHNOLOGY - GLASSWARE

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
G-CT-65	H-34A-65-(24)	<u>Hirsh Funnel</u> - Porcelain; fixed perforated plate; conical sides; size number 00000; outside diameter 42 mm; plate diameter 11.5 mm.
G-CT-66	H-34A-66-(24)	<u>Separatory Funnel</u> - Squib type; with Teflon stopcock; 125 ml capacity; glass stopper; compatible to Item G-CT-67.
G-CT-67	H-34A-67-(18)	<u>Separatory Funnel</u> - Squib type; without Teflon stopcock; 125 ml capacity; glass stopper; compatible to Item G-CT-66.
G-CT-68	H-34A-68-(24)	<u>Separatory Funnels</u> - Squib type; with Teflon stopcock; 250 ml capacity; glass stopper; compatible to Item G-CT-69.
G-CT-69	H-32A-69-(6)	<u>Separatory Funnel</u> - Squib type; <u>without</u> Teflon stopcock; 250 ml capacity; glass stopper; compatible to Item G-CT-68.
G-CT-70	H-34-70-(12)	<u>Separatory Funnel</u> - Squib type; glass stopper; glass stopcock 500 ml capacity.
G-CT-71	H-34A-71-(36)	<u>Melting Point Tube</u> - Thiele Dennis type; designed to increase the circulation of the oil; dimensions 165 x 25 mm (1 x 6½ in).
G-CT-72	H-34A-72-(40)	<u>Melting Point Tubes</u> - Capillary tubes; open at one end; closed at the other; length 90 mm; vial contains 100 tubes.
G-CT-73	H-34A-73-(30)	<u>Tubing Connectors</u> - T-shaped; with formed ends for tubing; outer diameter 7.9 mm (5/16 in); glass, outer diameter 7.9 mm (5/16 in).
G-CT-74	H-34A-74-(2 1b)	<u>Glass Wool</u> - Fiber of pyrex glass; soft and pliable.

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CHEMICAL TECHNOLOGY - GLASSWARE

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
G-CT-75	H-34A-75-(6)	<u>Extraction Apparatus</u> - Consists of: Allihn condenser bottom joint 34/45, small size, dimensions 30 x 190 mm; Soxhlet extraction tube with top joint 34/45 and bottom joint 24/40, capacity 50 ml; compatible with Items G-CT-76 to G-CT-77.
G-CT-76	H-34A-76-(6)	<u>Flask</u> - with 24/40 joint; 125 ml capacity; compatible with Items G-CT-74 to G-CT-78.
G-CT-77	H-34A-77-(6)	<u>Extraction Thimble</u> - Glass; fretted disc with extra coarse porosity; 25 x 85 mm; compatible with Items G-CT-74 to G-CT-78.
G-CT-78	H-34A-78-(42)	<u>Adapters</u> - Used at the end of a condenser; bent shape included angle of 105 degrees; fits cork stopper number 7; length 150 mm.
G-CT-79	H-34A-79-(2)	<p><u>Organic Chemistry Kit</u> - With 24/40 joints. Includes:</p> <ol style="list-style-type: none"> 1. 300 mm West condenser. 2. 300 mm distilling column. 3. 1 each 50, 100, 200, 300, and 500 ml single neck round bottom flasks. 4. 125 ml separatory and addition funnel with Teflon plug. 5. Glass stopper. 6. Straight adapter tube with thermometer opening. 7. Claisen connecting tube. 8. 3-way connecting tube. 9. Vacuum connecting tube. 10. Neoprene thermometer adapter. 11. All items enclosed in a polyethylene case.
G-CT-80	H-34A-80-(72)	<u>Viials</u> - Flint glass; capacity 22 ml; complete with molded screw cap; 70 x 28 mm.

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CHEMICAL TECHNOLOGY - GLASSWARE

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
G-CT-81	H-34A-81-(72)	<u>Vials</u> - Flint glass; capacity 35 ml; complete with molded screw cap; 95 x 28 mm.
G-CT-82	H-34A-82-(2)	<u>Claisen Head</u> - Has all 24/40 joints except side neck on the connecting tube has outer 10/30 joint at top for thermometer.
G-CT-83	H-34A-83-(2)	<u>Mercury Manometer</u> - With "T" arm side connection; red scale calibrated from 0 to 160 mm; for measuring reduced pressures; with instructions; approximate height 234 mm; glass.
G-CT-84	H-34A-84-(1)	<u>McLeod Gauge</u> - For measuring low pressures; range of 5 m to 5 mm Hg; high vacuum seals throughout; attached to stand of plastic or wood.
G-CT-85	H-34A-85-(2)	<u>Cold Trap</u> - For vacuum systems; used to freeze out any vapors and prevent them from entering the pump; dimensions outer tube length 200 mm (7-7/8 in); inner tube length 175 mm (6 7/8 in); ground joint between the inner and outer tube.
G-CT-86	H-34A-86-(2)	<u>Thermometer</u> - 10/30 joint; 3 in (7.5 cm) immersion; centigrade; yellow back; graduated in 1°C divisions range -10 to 250°C; compatible with E-CT-82.
G-CT-87	H-36-87-(4)	<u>Specific Gravity Bottles</u> - 25 ml capacity; for use in determining specific density of a liquid where temperature must be known; thermometer scale from 14° to 37°C in intervals of 0.2°C.
G-CT-88	H-34B-88-(3)	<u>Stopcock</u> - High vacuum; vacuum cup; oblique bore; overall diameter of tubes 10 mm (3/8 in); bore of plug 4 mm (5/32 in); side tubes attached for oblique connection through plug; small end of stopcock barrel is closed.

CT-92

MASTER GLASSWARE LIST

CHEMICAL TECHNOLOGY

The following specifications shall apply to all items:

1. All glassware shall be Pyrex type glassware and not flint glassware unless otherwise specified.
2. All glassware edges shall be fire polished.
3. All glassware shall be bubble-free and unstrained.
4. All glassware shall have graduations unless otherwise specified.
5. All ground glassware shall have 24/40 joints unless otherwise specified.
6. All major types of glassware with different sizes shall be from one glassware manufacturer. For example, all sizes of beakers or volumetric flasks or graduated cylinders, etc., shall be Kimax, Pyrex, Corning, etc. brand, and not a mixture.

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MASTER EQUIPMENT LIST
 CHEMICAL TECHNOLOGY
GLASSWARE

REFERENCE NUMBER	DESCRIPTION	QUANTITY	UNIT	TOTAL
G-CT-1	Beakers (50 ml)	72	28.80/48	43.20
G-CT-2	Beakers (100 ml)	72	31.20/48	46.80
G-CT-3	Beakers (150 ml)	72	28.80/48	43.20
G-CT-4	Beakers (250 ml)	94	28.80/48	56.40
G-CT-5	Beakers (400 ml)	72	34.56/48	51.84
G-CT-6	Beakers (600 ml)	72	32.40/36	64.80
G-CT-7	Beakers (1000 ml)	60	41.76/24	104.40
G-CT-8	Beakers (2000 ml)	2	27.12/8	6.78
G-CT-9	Bottles	92	21.60/24	82.80
G-CT-10	Bottles	15	42.84/12	53.55
G-CT-11	Bottles	12	6.00/12	6.00
G-CT-12	Bottles	12	8.75/12	8.75
G-CT-13	Bottles	6	1.75/1	10.50
G-CT-14	Screw Caps	12	2.00/12	2.00
G-CT-15	Burets	38	50.30/2	955.70
G-CT-16	Burets	8	40.00/2	160.00
G-CT-17	Flasks	18	19.00/6	57.00
G-CT-18	Thermometers	140	3.60	504.00
G-CT-19	Thermometers	12	15.00	180.00
G-CT-20	Erlenmeyer Flasks	84	42.25/48	73.92
G-CT-21	Desicator	6	40.00/1	240.00
G-CT-22	Desicator Plate	6	12.00	72.00
G-CT-23	Flasks (500 ml)	16	58.00/8	116.00
G-CT-24	Flasks (1000 ml)	16	52.35/6	139.60
G-CT-25	Flasks (25 ml)	4	8.90/2	17.80
G-CT-26	Flasks (100 ml)	4	10.25/2	20.50
G-CT-27	Flasks (250 ml)	8	12.50/2	50.00
G-CT-28	Funnels	124	61.00/48	157.48
G-CT-29	Funnel - Ribbed	3	2.75	8.25
G-CT-30	Funnel - Ribbed	3	3.50	10.50
G-CT-31	Erlenmeyer Flask (1000 ml)	6	2.50	15.00
G-CT-32	Erlenmeyer Flask (2000 ml)	6	3.45	20.70

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MASTER EQUIPMENT LIST
CHEMICAL TECHNOLOGY
GLASSWARE

REFERENCE NUMBER	DESCRIPTION	QUANTITY	UNIT	TOTAL
G-CT-33	Test Tubes (13 x 100 mm)	288	6.98/72	27.91
G-CT-34	Test Tubes (16 x 150 ml)	456	9.07/72	118.42
G-CT-35	Test Tubes (25 x 200 mm)	60	7.20/24	20.00
G-CT-36	Flasks, Filtering	36	61.02/18	122.04
G-CT-37	Funnel, Buchner	36	32.10/8	144.36
G-CT-38	Funnel Tubes	24	17.40/12	34.80
G-CT-39	Pipet, Medicine Dropper	204	.95/12	15.64
G-CT-40	Cylinders, Graduated (10 ml)	76	77.04/24	243.96
G-CT-41	Cylinders, Graduated (25 ml)	76	77.76/18	328.32
G-CT-42	Cylinders, Graduated (100 ml)	76	65.88/12	417.24
G-CT-43	Flasks, Erlenmeyer (50 ml)	132	36.00/48	99.00
G-CT-44	Glass Tubing (76 mm)	90 lbs or 40.8 kgs	31.50/30 lbs.	94.50
G-CT-45	Glass Tubing Assortment	4 lbs (2000 g)	6.00/500 g	24.00
G-CT-46	Glass Tubing, Pyrex	20 ft	8.30/5 ft	33.20
G-CT-47	Square Glass Plates (3 x 3 in)	36	1.00/12	3.00
G-CT-48	Watch Glasses	60	4.68/12	23.40
G-CT-49	Weighing Bottles (cap 12 ml)	28	42.24/24	4.28
G-CT-50	Weighing Bottles (cap 70 ml)	6	3.00	18.00
G-CT-51	Thermometers (-10 to 260)	80	4.40	352.00
G-CT-52	Erlenmeyer Flasks (250 ml)	60	35.50/48	46.00
G-CT-53	Erlenmeyer Flasks (25 ml)	108	36.00/48	72.00
G-CT-54	Flasks, Boiling (250 ml)	48	77.04/36	195.00
G-CT-55	Flasks, Boiling (500 ml)	30	85.20/30	85.20
G-CT-56	Flasks, Distilling (50 ml)	48	42.96/24	86.00
G-CT-57	Flasks, Distilling (125 ml)	48	55.20/24	110.00
G-CT-58	Flasks, Distilling (250 ml)	30	63.36/24	81.00
G-CT-59	Flasks, 3-Neck Angle	30	105.12/12	270.00
G-CT-60	Flasks (100 ml)	30	72.00/30	72.00
G-CT-61	Condenser West	36	43.20/6	259.00
G-CT-62	Distilling Tubes (300 mm)	30	63.90/18	110.00

CT-96

MASTER EQUIPMENT LIST
 CHEMICAL TECHNOLOGY
GLASSWARE

REFERENCE NUMBER	DESCRIPTION	QUANTITY	UNIT	TOTAL
E-CT-63	Drying Tubes (100 mm)	30	14.16/12	35.00
G-CT-64	Powder Funnels (75 mm)	24	33.00/24	33.00
G-CT-65	Hirsch Funnel Size 00000	24	37.29/18	47.00
G-CT-66	Separatory Funnels (125 ml)	24	61.12/4	367.00
G-CT-67	Separatory Funnels (125 ml)	18	38.00	171.00
G-CT-68	Separatory Funnels (250 ml)	24	72.52/4	435.00
G-CT-69	Separatory Funnels (250 ml)	6	50.00/4	75.00
G-CT-70	Separatory Funnels (500 ml)	12	15.00	180.00
G-CT-71	Melting Point Tube	36	82.68/12	248.00
G-CT-72	Melting Point Tubes	40	31.60/20	63.00
G-CT-73	Tubing Connectors	30	.60	18.00
G-CT-74	Glass Wool	2 lb	14.25/1 lb	28.50
G-CT-75	Extraction Apparatus	6	58.82/2	176.46
G-CT-76	Flask	6	21.00/6	21.00
G-CT-77	Extraction Thimble	6	5.00	30.00
G-CT-78	Adapters	42	61.20/36	72.00
G-CT-79	Organic Chemistry Kit	2	100.00	200.00
G-CT-80	Vials - Capacity 22 ml	72	7.00/24	31.00
G-CT-81	Vials - Capacity 35 ml	72	8.00/24	24.00
G-CT-82	Claisen Head	2	20.00	40.00
G-CT-83	Mercury Manometer	2	20.00	40.00
G-CT-84	McLeod Gauge	1	100.00	100.00
G-CT-85	Cold Trap	2	21.00	42.00
G-CT-86	Thermometer	2	14.00	28.00
G-CT-87	Specific Gravity Bottles	4	37.00/2	74.00
G-CT-88	Stopcock	3	20.00/1	60.00

CHEMICAL TECHNOLOGY - SMALL TOOLS

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
S-CT-1	H-34-1-(2)	<u>Tool Set</u> - Two x celite screw drivers with tapered stems 5 x 75 mm; one each Crescent long nose pliers, diagonal cutters; forged steel tin snips.
S-CT-2	H-34-2-(1)	<u>Hammer</u> - Claw; unbreakable tool steel; handle forged with head and tempered in one piece; head 500 g.
S-CT-3	H-34-3-(1)	<u>Pliers</u> - Utility; has fine position joint; opening 2.7 cm; overall length 18 cm.
S-CT-4	H-34-4-(2)	<u>Pliers</u> - Combination; adjustable; high grade forged steel, pipe cutter; wire cutter; length 15 cm.
S-CT-5	H-34-5-(2)	<u>Screwdrivers</u> - Tempered steel; with handle; blade length 9.0 cm; blade width 5 mm; overall length 18.4 cm.
S-CT-6	H-34-6-(2)	<u>Screwdrivers</u> - Tempered steel; with handle; blade length 12.5 cm; blade width 8 mm; overall length 26.8 cm.
S-CT-7	H-34-7-(2)	<u>Shears</u> - Cutlery steel; stationary type cutting blades; paper 7.5 cm blade lengths.
S-CT-8	H-34-8-(2)	<u>Shears</u> - Cutlery steel; stationary type cutting blades; overall length 11.4 cm; sharp point.
S-CT-9	H-34C-9-(4)	<u>Wrench</u> - Adjustable end; thumbscrew adjust; maximum jaw opening 29 mm (1 1/8 in); tooled steel.
S-CT-10	H-34-10-(2)	<u>Wrench</u> - Adjustable end; thumbscrew adjust; maximum jaw opening 13 mm (1/2 in); length 10 cm (4 in).
S-CT-11	H-34-11-(1) H-36A-11-(1)	<u>Wrench</u> - Adjustable end; thumbscrew adjust; maximum jaw opening 25 mm (1 in) length 20 cm (8 in).

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CHEMICAL TECHNOLOGY - SMALL TOOLS

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
S-CT-12	H-34-12-(48) H-34A-12-(36)	<u>Files Rectangular</u> - For use in cutting glass rods.
S-CT-13	H-34A-13-(10)	<u>Files</u> - Rattail; tapered; length of cut section 10.2 cm (4 in).
S-CT-14	H-34B-14-(1) H-36A-14-(1)	<u>Wrench</u> - Adjustable end; thumbscrew adjust; maximum jaw opening 29 mm (1 1/8 in, length 25 cm (10 in).
S-CT-15	H-36A-14-(2)	<u>Pipe Wrench</u> - Length 25 cm (10 in); will take pipe from 3.2 to 32 mm (1/8 to 1 1/4 in) in diameter.
S-CT-16	H-34B-16-(2) H-36A-16-(2)	<u>Brush</u> - Counter; for dusting laboratory benches; 5 rows of standard bristles mounted on wooden handle; total length 35 cm; length of bristle face 23 cm; width of brush face 6.3 cm; height of bristles 6 cm.
S-CT-17	H-34B-17-(1) H-36A-17-(1)	<u>Dust Pan</u> - Metal, pan with handle; approximate dimensions of 30 x 20 cm.
S-CT-18	H-36A-18-(1) H-34B-18-(1)	<u>Mop Wringers</u> - Squeeze type; galvanized steel; wrings mop dry with no splash; fitted with metal handle with rubber grip; compatible with Items S-CT-18, 20 and 21.
S-CT-19	H-36A-19-(1) H-34B-19-(1)	<u>Mop Bucket</u> - Galvanized steel; oval shape; 26 quart size; rides on four 2 inch or 3 inch casters; compatible with Items S-CT-18, 20 and 21.
S-CT-20	H-36A-20-(1) H-34B-20-(1)	<u>Wooden Handle</u> - For 16 oz mop head; 54 inches long; 1 inch in diameter; compatible with Items S-CT-18, 19 and 21.
S-CT-21	H-36A-21-(1) H-34B-21-(1)	<u>Mop Head</u> - Weight 16 oz; nylon or cotton; compatible with Items S-CT-18, 19 and 20.

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MASTER EQUIPMENT LIST
 CHEMICAL TECHNOLOGY
SMALL TOOLS

REFERENCE NUMBER	DESCRIPTION	QUANTITY	UNIT	TOTAL
S-CT-1	Tool Set	2	24.50/1	49.00
S-CT-2	Hammer, Claw	1	18.00/1	18.00
S-CT-3	Pliers, Utility	1	7.35/1	7.35
S-CT-4	Pliers	2	2.05/1	4.00
S-CT-5	Screwdrivers	2	3.00/1	6.00
S-CT-6	Screwdrivers	2	3.25/1	6.00
S-CT-7	Shears	2	2.50	5.00
S-CT-8	Shears	2	5.30/1	11.00
S-CT-9	Wrench	4	9.00/1	36.00
S-CT-10	Wrench	2	6.25/1	13.00
S-CT-11	Wrench	2	7.25	14.00
S-CT-12	Files	84	21.85/12	152.95
S-CT-13	Files	10	1.50	15.00
S-CT-14	Wrench	2	9.00	18.00
S-CT-15	Pipe Wrench	2	10.00	20.00
S-CT-16	Brush	4	3.00/1	12.00
S-CT-17	Dust Pan	2	3.00/1	6.00
S-CT-18	Mop Wringers	2	20.00/1	40.00
S-CT-19	Mop Bucket	2	30.00/1	60.00
S-CT-20	Wooden Handle	2	7.00/1	14.00
S-CT-21	Mop Head	2	5.00/1	10.00

CHEMICAL TECHNOLOGY - CHEMICALS

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
C-CT-1	H-34B-1-(100g)	<u>Acetaldehyde</u> - Reagent Grade; and as found in Scientific Products catalogue number AX 25.
C-CT-2	H-34B-2-(250g)	<u>Acetanilide</u> - Reagent Grade; such as found in Scientific Products catalogue number AX 65.
C-CT-3	H-34B-3-(6 pt)	<u>Acetic Acid</u> - Glacial; reagent grade; such as found in Scientific Products catalogue number AX 73; one pint containers.
C-CT-4	H-34B-4-(32 pt)	<u>Acetone</u> - Reagent Grade; such as found in Scientific Products catalogue number AX 120; in one pint containers.
C-CT-5	H-34B-5-(15 gal)	<u>Acetone</u> - Reagent Grade; 5 gal metal containers; such as found in Scientific Products catalogue number AX 120.
C-CT-6	H-34B-6(16 oz)	<u>Aluminum Chloride</u> - Anhydrous; reagent grade; powder; 4 oz bottles; such as found in Scientific Products catalogue number AX 684.
C-CT-7	H-34B-7-(500 g)	<u>Adipic Acid</u> - Reagent Grade; such as found in Scientific Products catalogue number AX 380.
C-CT-8	H-34B-8-(6 pt)	<u>Ethyl Alcohol</u> - Anhydrous; 200 proof such as found in Scientific Products catalogue number AX 441; in one pint containers.
C-CT-9	H-34B-9-(6 pt)	<u>Ethyl Alcohol</u> - Reagent Grade; 190 proof ethanol; such as found in Scientific Products catalogue number AX 442; in one pint containers.
C-CT-10	H-34B-10-(3 lb)	<u>Alumina - Activated</u> , chromatographic grade; 80-200 mesh; such as found in Scientific Products catalogue number AX 612; in one pound bottles.
C-CT-11	H-34B-11-(1 lb)	<u>Ammonium Acetate</u> - Reagent Grade; such as found in Scientific Products catalogue number AX 1220.

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CHEMICAL TECHNOLOGY - CHEMICALS

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
C-CT-12	H-34B-12-(1 lb)	<u>Ammonium Chloride</u> - Reagent Grade; such as found in Scientific Products catalogue number AX 1270.
C-CT-13	H-34B-13-(6 pt)	<u>Ammonium Hydroxide</u> - Reagent Grade; pint glass bottles; such as found in Scientific Products catalogue number AX 1303; in one pint containers.
C-CT-14	H-34B-14-(1 pt)	<u>Aniline</u> - Reagent Grade; such as found in Scientific Products catalogue number AX 1460.
C-CT-15	H-34B-15-(100g)	<u>Anthracene</u> - Reagent Grade; such as found in Scientific Products catalogue number AX 1590.
C-CT-16	H-34B-16-(25 g)	<u>Anthranilic Acid</u> - Reagent Grade; such as found in Scientific Products catalogue number AX 160.
C-CT-17	H-34B-17-(1 lb)	<u>Barium Chloride</u> - Dihydrate; Reagent Grade; such as found in Scientific Products catalogue number BX 60.
C-CT-18	H-34B-18-(100 g)	<u>Benzamide</u> - Reagent Grade; such as found in Scientific Products catalogue number BX 195.
C-CT-19	H-34B-19-(7 pt) H-36A-19-(1 pt)	<u>Benzene</u> - Reagent Grade; A.C.S. specifications; thiophene free; such as found in Scientific Products catalogue number BX 220; in one pint containers.
C-CT-20	H-34B-20-(1 lb)	<u>Benzoic Acid</u> - Reagent Grade; such as found in Scientific Products catalogue number BX 360.
C-CT-21	H-34B-21(100 g)	<u>Benzoin</u> - Reagent Grade; such as found in Scientific Products catalogue number BX 385.
C-CT-22	H-34B-22-(250 g)	<u>Benzophenone</u> - Reagent Grade; such as found in Scientific Products catalogue number BX 410.
C-CT-23	H-34B-23-(3 lb)	<u>Bromine</u> - Reagent Grade; such as found in Scientific Products catalogue number BX 965; in one lb bottles.

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CHEMICAL TECHNOLOGY - CHEMICALS

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
C-CT-24	H-34B-24-(1500 g)	<u>Bromobenzene</u> - Reagent Grade; such as found in Scientific Products catalogue number BX 1020; in three 500 g containers.
C-CT-25	H-34B-25-(250 g)	<u>Bromobutane</u> - Reagent Grade; such as found in Scientific Products catalogue number BX 1045.
C-CT-26	H-34B-26-(250 g)	<u>2-Bromopropane</u> - Reagent Grade; such as found in Scientific Products catalogue number BX 1450.
C-CT-27	H-34B-27-(100 ml)	<u>Bromothymol Blue</u> - Reagent Grade; such as found in Scientific Products catalogue number BX 1562.
C-CT-28	H-34B-28-(1 lb)	<u>Brown Sugar</u> - Commercial grade.
C-CT-29	H-34B-29-(1 pt)	<u>Buffer</u> - pH 4; for standardization of pH meters; such as found in Scientific Products catalogue number BX 1631.
C-CT-30	H-34B-30-(1 pt)	<u>Buffer</u> - pH 7; for standardization of pH meters; such as found in Scientific Products catalogue number BX 1635-5.
C-CT-31	H-34B-31-(1 pt)	<u>Buffer</u> - pH 10; for standardization of pH meters; such as found in Scientific Products catalogue number BX 1636.
C-CT-32	H-34B-32-(2 pt)	<u>Butyl Alcohol</u> - Reagent Grade; such as found in Scientific Products catalogue number BX 1780.
C-CT-33	H-34B-33-(1 pt)	<u>ISO-Butyl Alcohol</u> - Reagent Grade; such as found in Scientific Products catalogue number BX 1791.
C-CT-34	H-34B-34-(1 kg)	<u>SEC-Butyl Alcohol</u> - Reagent Grade; such as found in Scientific Products catalogue number BX 1795.
C-CT-35	H-34B-35-(1 kg)	<u>Test-Butyl Alcohol</u> - Reagent Grade; such as found in Scientific Products catalogue number BX 1805.

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CHEMICAL TECHNOLOGY - CHEMICALS

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
C-CT-36	H-34B-36-(1 kg)	<u>2 Butanone</u> - Reagent Grade; such as found in Scientific Products catalogue number BX 1795.
C-CT-37	H-34B-37-(4 oz)	<u>Calcium</u> - Granular; 6 mesh; such as found in Scientific Products catalogue number CX 84.
C-CT-38	H-34B-38-(4 oz)	<u>Calcium Acetate</u> - Reagent Grade; powder; such as found in Scientific Products catalogue number SX 90.
C-CT-39	H-34B-39-(1 lb)	<u>Calcium Carbide</u> - Small lumps; such as found in Scientific Products catalogue number CX 105.
C-CT-40	H-34B-40-(1 lb)	<u>Calcium Carbonate</u> - Reagent Grade; powder; such as found in Scientific Products catalogue number CX 110.
C-CT-41	H-34B-41-(1 lb)	<u>Calcium Chloride</u> - Dihydrate; Reagent Grade; granular; such as found in Scientific Products catalogue number CX 130.
C-CT-42	H-34B-42-(3 lb)	<u>Calcium Chloride</u> - Anhydrous; Reagent Grade; 4 mesh; such as found in Scientific Products catalogue number CX 140; in one pound glass containers.
C-CT-43	H-34B-43-(1 lb)	<u>Calcium Sulfate</u> - Dihydrate; Reagent Grade; powder; such as found in Scientific Products catalogue number CX 295.
C-CT-44	H-34B-44-(4 oz)	<u>Camphor</u> - Such as found in Scientific Products catalogue number CX 330.
C-CT-45	H-34B-45-(4 pt)	<u>Carbon Tetrachloride</u> - Reagent Grade; such as found in Scientific Products catalogue number CX 420; in one pint containers.
C-CT-46	H-34B-46-(1 lb)	<u>Charcoal</u> - Activated; "Norit A"; powder; such as found in Scientific Products catalogue number CX 655.

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CHEMICAL TECHNOLOGY - CHEMICALS

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
C-CT-47	H-34B-47-(1 kg)	<u>Chlorobenzene</u> - Reagent Grade; such as found in Scientific Products catalogue number CX 855.
C-CT-48	H-34B-48-(100 g)	<u>O-Chlorobenzoic Acid</u> - Such as found in Scientific Products catalogue number CX 870.
C-CT-49	H-34B-49-(2 pt) H-36A-49-(1 pt)	<u>Chloroform</u> - Reagent Grade; such as found in Scientific Products catalogue number CX 1055.
C-CT-50	H-34B-50-(500 g)	<u>1 Chlorobutane</u> - Such as found in Scientific Products catalogue number CS 915.
C-CT-51	H-34B-51-(100 g)	<u>Trans-Cinnamic Acid</u> - Such as found in Scientific Products catalogue number CX 1690.
C-CT-52	H-34B-52-(1 lb)	<u>Citric Acid</u> - Monohydrate; Reagent; granular; such as found in Scientific Products catalogue number CX 1725.
C-CT-53	H-34B-53-(1 lb)	<u>Copper Metal</u> - Turnings; heavy; such as found in Scientific Products catalogue number CX 1939.
C-CT-54	H-34B-54-(10 g)	<u>Crystal Violet</u> - Such as found in Scientific Products catalogue number CX 2100; indicator.
C-CT-55	H-34B-55-(1 lb)	<u>Cupric Oxide</u> - Reagent; powder; such as found in Scientific Products catalogue number CX 2170.
C-CT-56	H-34B-56-(1 lb)	<u>Cupric Sulfate</u> - Reagent; fine crystals; pentahydrate; such as found in Scientific Products catalogue number CX 2185.
C-CT-57	H-34B-57-(500 g)	<u>Cyclohexane</u> - Reagent Grade; such as found in Scientific Products catalogue number CX 2290.
C-CT-58	H-34B-58-(500 g)	<u>Cyclohexanol</u> - Such as found in Scientific Products catalogue number CX 2325.
C-CT-59	H-34B-59-(500 g)	<u>Cyclohexanone</u> - Such as found in Scientific Products catalogue number CX 2335-1.

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CHEMICAL TECHNOLOGY - CHEMICALS

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
C-CT-60	H-34B-60-(1 kg)	<u>p-Dichlorobenzene</u> - Such as found in Scientific Products catalogue number DX 695.
C-CT-61	H-34B-61-(25 g)	<u>2,4 - Dinitrophenylhydrazine</u> - Such as found in Scientific Products catalogue number DX 2075.
C-CT-62	H-34B-62-(6 lb)	<u>Diethyl Esther</u> - Reagent; absolute; such as found in Scientific Products catalogue number EX 190; in one pound cans.
C-CT-63	H-34B-63-(10 g)	<u>Eriochrome Black T</u> - Such as found in Scientific Products catalogue number EX 95; Indicator for EDTA titrations.
C-CT-64	H-36-A-64-(1 pt)	<u>Ethyl Acetate</u> - Anhydrous; reagent grade; such as found in Scientific Products catalogue number EX 240.
C-CT-65	H-34B-65-(250 g)	<u>Bromoethane</u> - Such as found in Scientific Products catalogue number BX 1225; free from ether;
C-CT-66	H-34B-66-(500 g)	<u>(Ethylenedinitrilo) Tetraacetic Acid</u> - Such as found in Scientific Products catalogue number EX 535; 99% pure.
C-CT-67	H-34B-67-(4 oz)	<u>Ethyl Iodide</u> - Such as found in Scientific Products catalogue number EX 685. Reagent grade.
C-CT-68	H-34B-68-(2 l)	<u>Hydrochloric Acid</u> - 2 normal solution; such as found in Scientific Products catalogue number HX 604-58; in one liter containers.
C-CT-69	H-34B-69-(36 pt) H-31-69-(6 pt)	<u>Hydrochloric Acid</u> - Concentrated; such as found in Scientific Products catalogue number HX 603; Reagent grade; in one pint glass bottles.

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CHEMICAL TECHNOLOGY - CHEMICALS

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
C-CT-70	H-34B-70-(4 oz)	<u>Iodine</u> - Reagent Grade; resublimed; such as found in Scientific Products catalogue number IX 120.
C-CT-71	H-34B-71-(1 pt)	<u>Hydrogen Peroxide</u> - 3% solution; such as found in Scientific Products catalogue number HX 645.
C-CT-72	H-34B-72-(1 lb)	<u>Iron Filings</u> - Such as found in Scientific Products catalogue number IX 240; degreased.
C-CT-73	H-34B-73-(1 lb)	<u>Ferrous Ammonium Sulfate</u> - Such as found in Scientific Products catalogue number FX 245; Reagent grade; fine crystals; hexahydrate.
C-CT-74	H-34B-74-(500 g)	<u>Ligroin</u> - Temperature range 65-90°C; such as found in Scientific Products catalogue number LX 255.
C-CT-75	H-34B-75-(2 oz)	<u>Magnesium Ribbon</u> - Such as found in Scientific Products catalogue number MX 10.
C-CT-76	H-34B-76-(1 lb)	<u>Magnesium Shavings</u> - For Grignard Reactions; such as found in Scientific Products catalogue number MX 20.
C-CT-77	H-34B-77-(1 lb)	<u>Magnesium Chloride</u> - Hexahydrate; reagent grade; such as found in Scientific Products catalogue number MX 45.
C-CT-78	H-34B-78-(1 lb)	<u>Magnesium Sulfate</u> - Heptahydrate; reagent grade; such as found in Scientific Products catalogue number MX 70.
C-CT-79	H-34B-79-(1 lb)	<u>Magnesium Sulfate</u> - Anhydrous; reagent grade; powder; such as found in Scientific Products catalogue number MX 75.
C-CT-80	H-34B-80-(2 lb)	<u>Manganese Dioxide</u> - Reagent Grade; crystalline powder; such as found in Scientific Products catalogue number MX 190; in one pound containers.

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CHEMICAL TECHNOLOGY - CHEMICALS

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
C-CT-81	H-34B-81-(1 oz)	<u>Mercuric Chloride</u> - Such as found in Scientific Products catalogue number MX 345.
C-CT-82	H-34B-82-(1 oz)	<u>Mercuric Nitrate</u> - Reagent Grade; such as found in Scientific Products catalogue number MX 360.
C-CT-83	H-34B-83-(20 lb) H-36A-83-(30 lb)	<u>Mercury</u> - Redistilled; such as found in Scientific Products catalogue number MX 400; in 5 lb containers.
C-CT-84	H-34B-84-(3 pt)	<u>Methanol</u> - Reagent Grade; such as found in Scientific Products catalogue number MX 485.
C-CT-85	H-34B-85-(10 lb)	<u>Cottonseed Oil</u> - For melting point bath; such as found in Scientific Products catalogue number CX 1960.
C-CT-86	H-34B-86-(1 pt)	<u>Methyl Orange</u> - Solution 0.1%; such as found in Scientific Products catalogue number MX 1256.
C-CT-87	H-34B-87-(250 g)	<u>Naphthalene</u> - Such as found in Scientific Products catalogue number NX 5; Recrystallized from alcohol; M,P, 80-81.
C-CT-88	H-34B-88-(4 oz)	<u>Nickel Lumps</u> - Such as found in Scientific Products catalogue number NX 305; 99% pure.
C-CT-89	H-34B-89-(4 pt)	<u>Nitric Acid</u> - 90%; concentrated; such as found in Scientific Products catalogue number NX 409; reagent grade; in one pint containers.
C-CT-90	H-34B-90-(1 kg)	<u>Nitrobenzene</u> - Such as found in Scientific Products catalogue number NX 520; M,P, 5-6°C.
C-CT-91	H-34B-91-(4 oz)	<u>Oxalic Acid</u> - Primary standard.
C-CT-92	H-34B-92-(2 pt) H-36A-92-(1 pt)	<u>Petroleum Ether</u> - Reagent Grade; such as found in Scientific Products catalogue number PX 425.

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CHEMICAL TECHNOLOGY - CHEMICALS

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
C-CT-93	H-34B-93(100 g)	<u>Phenacetin</u> - Such as found in Scientific Products catalogue number PX 440; M.P. 134-136.
C-CT-94	H-34B-94-(1 pt) H-36A-94-(1 pt)	<u>Phenolphthalein</u> - Indicator solution; 1% in 70% alcohol; such as found in Scientific Products catalogue number PX 527-7.
C-CT-95	H-34B-95-(4 oz)	<u>Phenylhydrazine Hydrochloride</u> - Reagent Grade; such as found in Scientific Products catalogue number PX 780.
C-CT-96	H-34B-96-(1 pt)	<u>Phosphoric Acid</u> - Concentrated; 85%; reagent grade; such as found in Scientific Products catalogue number PX 995.
C-CT-97	H-34B-97-(4 oz)	<u>Phosphorus</u> - Red; anosphous; such as found in Scientific Products catalogue number PX 1020.
C-CT-98	H-34B-98-(1 lb)	<u>Potassium Carbonate</u> - Anhydrous; reagent grade; such as found in Scientific Products catalogue number PX 1390.
C-CT-99	H-34B-99-(2 lb)	<u>Potassium Chlorate</u> - Reagent Grade; such as found in Scientific Products catalogue number PX 1396; in one pound glass bottles.
C-CT-100	H-34B-100-(4 oz)	<u>Potassium Chloride</u> - Reagent Grade; such as found in Scientific Products catalogue number PX 1405.
C-CT-101	H-34B-101-(4 oz)	<u>Potassium Chromate</u> - Reagent Grade; such as found in Scientific Products catalogue number PX 1420.
C-CT-102	H-34B-102-(1 lb)	<u>Potassium Dichromate</u> - Reagent Grade; such as found in Scientific Products catalogue number PX 1445.

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CHEMICAL TECHNOLOGY - CHEMICALS

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
C-CT-103	H-34B-103-(2 lb)	<u>Potassium Hydrogen Phthalate</u> - Primary standard Reagent; in one pound containers.
C-CT-104	H-34B-104-(4 oz)	<u>Potassium Iodate</u> - Such as found in Scientific Products catalogue number PX 1500; Reagent; crystalline powder
C-CT-105	H-34B-105-(1 lb)	<u>Potassium Iodide</u> - Reagent Grade; granular; such as found in Scientific Products catalogue number PX 1507.
C-CT-106	H-34B-106-(1 lb)	<u>Potassium Permanganate</u> - Reagent Grade; such as found in Scientific Products catalogue number PX 1550.
C-CT-107	H-34B-107-(1 lb)	<u>Potassium Thiocyanate</u> - Reagent Grade; such as found in Scientific Products catalogue number PX 1630.
C-CT-108	H-34B-108-(100 g)	<u>Propionaldehyde</u> - Such as found in Scientific Products catalogue number PX 1740; B.P. 47-49°C.
C-CT-109	H-34B-109-(1 kg)	<u>Propyl Alcohol</u> - Such as found in Scientific Products catalogue number PX 1815; B.P. 96-98°C.
C-CT-110	H-34B-110-(1 pt)	<u>ISO - Propyl Alcohol</u> - Reagent Grade; such as found in Scientific Products catalogue number PX 835.
C-CT-111	H-34B-111-(100 g)	<u>Resorcinol</u> - Recrystallized; such as found in Scientific Products catalogue number RX 28.
C-CT-112	H-34B-112-(8 oz)	<u>Silver Nitrate</u> - Reagent Grade; such as found in Scientific Products catalogue number SX 205.

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CHEMICAL TECHNOLOGY - CHEMICALS

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
C-CT-113	H-34B-113-(1 lb)	<u>Sodium</u> - Reagent; cylindrical; such as found in Scientific Products catalogue number SX 235.
C-CT-114	H-34B-114-(1 lb)	<u>Sodium Acetate</u> - Reagent Grade; such as found in Scientific Products catalogue number SX 255.
C-CT-115	H-34B-115-(1 lb)	<u>Sodium Benzoate</u> - Powder; such as found in Scientific Products catalogue number SX 315.
C-CT-116	H-34B-116-(1 lb)	<u>Sodium Borate Decahydrate</u> - Reagent Grade; such as found in Scientific Products catalogue number SX 360.
C-CT-117	H-34B-117-(1 lb)	<u>Sodium Bromide</u> - Granular; Reagent Grade; such as found in Scientific Products catalogue number SX 391.
C-CT-118	H-34B-118-(75 g)	<u>Potassium Bromide</u> - Powder for infrared spectroscopy; such as found in Scientific Products catalogue number PX 1378.
C-CT-119	H-34B-119-(1 lb)	<u>Sodium Carbonate</u> - Anhydrous reagent; "primary standard"; such as found in Scientific Products catalogue number SX 394.
C-CT-120	H-36A-120-(25 lb)	<u>Sodium Hydroxide</u> - Reagent Grade; pellets such as found in Scientific Products catalogue number SX 590.
C-CT-121	H-34B-121-(1 lb) H-36A-121-(1 lb)	<u>Sodium Chloride</u> - Reagent Grade; such as found in Scientific Products catalogue number SX 420; in one pound bottles.
C-CT-122	H-36A-122-(25 lb)	<u>Sodium Chloride</u> - Reagent Grade; such as found in Scientific Products catalogue number SX 420.
C-CT-123	H-34B-123-(1 lb)	<u>Sodium Dichromate</u> - Reagent Grade; such as found in Scientific Products catalogue number SX 505.
C-CT-124	H-34B-124-(1 lb)	<u>Sodium Bicarbonate</u> - Powder; Reagent Grade; such as found in Scientific Products catalogue number SX 320

CT-110

CHEMICAL TECHNOLOGY - CHEMICALS

CT-111

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
C-CT-125	H-34B-125-(1 lb)	<u>Sodium Bisulfate</u> - Reagent Grade; such as found in Scientific Products catalogue number SX 340.
C-CT-126	H-34B-126-(12 lb) H-36A-126-(6 lb) H-31-126-(6 lb)	<u>Sodium Hydroxide</u> - Reagent Grade; pellets; such as found in Scientific Products catalogue number SX 590; in one pound plastic containers.
C-CT-127	H-34B-127-(4 oz)	<u>Sodium Iodide</u> - Reagent Grade; granular; such as found in Scientific Products catalogue number SX 625.
C-CT-128	H-34B-128-(1 lb)	<u>Sodium Oxalate</u> - Powder; primary standard; such as found in Scientific Products catalogue number SX 686.
C-CT-129	H-34B-129-(1 lb)	<u>Sodium Sulfate</u> - Reagent Grade; anhydrous; such as found in Scientific Products catalogue number SX 760.
C-CT-130	H-34B-130-(1 lb)	<u>Sodium Sulfit</u> - Anhydrous; Reagent Grade; such as found in Scientific Products catalogue number SX 785.
C-CT-131	H-34B-131-(4 oz)	<u>Salicylic Acid</u> - Reagent Grade; such as found in Scientific Products catalogue number SX 60.
C-CT-132	H-34B-132-(100 g)	<u>Semicarbazide Hydrochloride</u> - Such as found in Scientific Products catalogue number SX 120.
C-CT-133	H-34B-133-(4 oz)	<u>Stannous Chloride</u> - Anhydrous; Reagent Grade; such as found in Scientific Products catalogue number SX 890.
C-CT-134	H-34B-134-(8 oz)	<u>Starch</u> - Iodometric solution; inhibited; such as found in Scientific Products catalogue number SX 937.

CHEMICAL TECHNOLOGY - CHEMICALS

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
C-CT-135	H-34B-135-(4 oz)	<u>Sodium Nitrite</u> - Reagent Grade; such as found in Scientific Products catalogue number SX 665.
C-CT-136	H-34B-136-(500 g)	<u>Succinic Acid</u> - Such as found in Scientific Products catalogue number SX 1040; M.P. 137-139°C.
C-CT-137	H-34B-137-(1 lb)	<u>Sulfur</u> - Sublimed powder; such as found in Scientific Products catalogue number SX 1225.
C-CT-138	H-34B-138-(18 pts)	<u>Sulfuric Acid</u> - Concentrated; reagent grade; such as found in Scientific Products catalogue number SX 1244; in one pint bottles.
C-CT-139	H-34B-139-(1 lb)	<u>Tin, Mossy</u> - Such as found in Scientific Products catalogue number TX 665.
C-CT-140	H-34B-140-(2 pt)	<u>Toluene</u> - Reagent Grade; such as found in Scientific Products catalogue number TX 735.
C-CT-141	H-34B-141-(4 oz)	<u>Urea</u> - Reagent Grade; such as found in Scientific Products catalogue number UX 65.
C-CT-142	H-34B-142-(1 pt)	<u>Xylene</u> - Reagent Grade; such as found in Scientific Products catalogue number XX 55.
C-CT-143	H-34B-143-(1 lb)	<u>Zinc, Mossy</u> - Reagent grade; such as found in Scientific Products catalogue number ZX 20.
C-CT-144	H-34B-144-(500 ml)	<u>Glycerol</u> - Spectroquality; such as found in Scientific Products catalogue number GX 175.
C-CT-145	H-34B-145-(16 oz)	<u>Methyl Red</u> - Indicator solution; such as found in Scientific Products catalogue number MX 1410-3.

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CHEMICAL TECHNOLOGY - CHEMICALS

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
C-CT-146	H-34B-146-(4 lb)	<u>Potassium Hydroxide</u> - Pellets; reagent grade; low carbonate; such as found in Scientific Products catalogue number PX 1478; in one pound plastic containers.
C-CT-147	H-34B-147-(2 lb)	<u>Potassium Hydrogen Phthalate</u> - Primary standard; such as found in Scientific Products catalogue number PX 1476; in one pound containers.
C-CT-148	H-34B-148-(1 pt)	<u>Parrafin Oil</u> - Light; such as found in Scientific Products catalogue number PX 44-7; Saybolt viscosity at 100°F is 90.
C-CT-149	H-34B-149-(1 lb)	<u>Ammonium Thiocyanate</u> - Reagent Grade; such as found in Scientific Products catalogue number AX 1415.
C-CT-150	H-34B-150-(1 lb)	<u>Ferric Ammonium Sulfate</u> - Reagent Grade; such as found in Scientific Products catalogue number FX 205.
C-CT-151	H-34B-151-(4 oz)	<u>Sodium Fluoride</u> - Powder; reagent grade; such as found in Scientific Products catalogue number SX 550.
C-CT-152	H-34B-152-(4 oz)	<u>Hydroxylamine Hydrochloride</u> - Reagent Grade; such as found in Scientific Products catalogue number HX 770.
C-CT-153	H-36A-153-(3 lb)	<u>Olive Oil</u> - Purified; such as found in Scientific Products catalogue number OX 180; in one pound containers.
C-CT-154	H-34B-154-(16 oz)	<u>Phenol Red</u> - Indicator solution; 0.02%; such as found in Scientific Products catalogue number PX 536-5.
C-CT-155	H-34B-155-(1 g)	<u>O-Phenanthroline</u> - Reagent Grade; needless; such as found in Scientific Products catalogue number PX 460.

CT-113

CHEMICAL TECHNOLOGY - CHEMICALS

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
C-CI-156	H-34B-156-(1 pt)	<u>Hydrogen Peroxide</u> - 30%; such as found in Scientific Products catalogue number HX 640.
C-CT-157	H-34B-157-(4 oz)	<u>Potassium Persulfate</u> - Reagent Grade; such as found in Scientific Products catalogue number PX 1562.
C-CT-158	H-34B-158-(1 oz)	<u>Potassium Meta-Periodate</u> - Reagent Grade; powder; such as found in Scientific Products catalogue number PX 1545.
C-CT-159	H-34B-159-(250 g)	<u>Cyclohexene</u> - Such as found in Scientific Products catalogue number CX 2355.
C-CT-160	H-34B-160-(250 ml)	<u>O-Xylene</u> - Chromatoquality; such as found in Scientific Products catalogue number XX 17.
C-CT-161	H-34B-161-(250 ml)	<u>M-Xylene</u> - Chromatoquality; such as found in Scientific Products catalogue number XX 42.
C-CT-162	H-34B-162-(250 ml)	<u>P-Xylene</u> - Chromatoquality; such as found in Scientific Products catalogue number XX 42.
C-CT-163	H-34B-163-(500 ml)	<u>Pentane</u> - Chromatoquality; such as found in Scientific Products catalogue number PX 168.
C-CT-164	H-34B-164-(250 ml)	<u>Hexane</u> - Chromatoquality; such as found in Scientific Products catalogue number HX 293.
C-CT-165	H-36A-165-(4 lb)	<u>Sand</u> - Sea sand; such as found in Scientific Products catalogue number SX 76; in one pound containers.
C-CT-166	H-36A-166-(1)	<u>Lecture Cylinder of Ammonia Gas</u> - High purity gas; cylinder equipped with a wrench type valve; such as found in Sargent Welch catalogue number S-37225.

CT-114

CHEMICAL TECHNOLOGY - CHEMICALS

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
C-CT-167	H-36A-167-(1)	<u>Lecture Cylinder of Carbon Dioxide</u> - High purity gas; cylinder equipped with hand-wheel valve; such as found in Sargent Welch catalogue S-37255.
C-CT-168	H-36A-168-(1)	<u>Lecture Cylinder of Dichloro-Dofluoromethane</u> - High purity gas; cylinder equipped with hand-wheel valve; such as found in Sargent Welch catalogue number 37270.
C-CT-169	H-36A-169-(1)	<u>Lecture Cylinder of Methane</u> - High purity gas; cylinder equipped with hand-wheel valve; 2 cu. ft.; such as found in Sargent Welch catalogue number S-37345.
C-CT-170	H-36A-170-(1)	<u>Lecture Cylinder of Nitrogen</u> - High purity gas; cylinder equipped with hand-wheel; 2 cu. ft.; such as found in Sargent Welch catalogue number S-37365.
C-CT-171	H-36A-171-(1)	<u>Lecture Cylinder of Oxygen</u> - High purity gas; cylinder equipped with hand-wheel; 2 cu. ft.; such as found in Sargent Welch catalogue number S-37385.
C-CT-172	H-36A-172-(5 gal)	<u>Ethyl Alcohol</u> - Anhydrous; not denatured.
C-CT-173	H-36A-173-(2 1) H-34B-173-(3 1)	<u>Sodium Hydroxide 1 Normal Solution</u> - Standard solution; such as found in Scientific Products catalogue number HX 607-10; in one liter containers.
C-CT-174	H-36A-174-(2 1) H-34B-174-(3 1)	<u>Hydrochloric Acid 1 Normal Solution</u> - Standard solution; such as found in Scientific Products catalogue number HX 604-48; in one liter containers.
C-CT-175	H-36-175-(1)	<u>Large Cylinder of Ammonia</u> - Anhydrous; compatible with 2 stage regulator item E-CT-189; 150 lbs.

CT-115

CHEMICAL TECHNOLOGY - CHEMICALS

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
C-CT-176	H-36-176-(1)	<u>Large Cylinder of Carbon Dioxide</u> - Anhydrous; compatible with 2 stage regulator item E-CT-190; 50 lbs.
C-CT-177	H-34B-177-(1)	<u>Large Cylinder of Helium</u> - Compatible with 2 stage regulator item E-CT-245; 242 cubic feet.
C-CT-178	H-34B-178-(5 lb)	<u>Drierite</u> - Regular; for drying of solids liquids and gases; anhydrous calcium sulfate; 8 mesh; such as found in V.W.R. catalogue number 22890-229.
C-CT-179	H-34B-179-(5 lb)	<u>Drierite, Indicating</u> - as it absorbs water the color changes from blue to rose-red; blue color can be regenerated; 8 mesh such as found in V.W.R. catalogue number 22891-040.
C-CT-180	H-34B-180-(500 g)	<u>Calcium Carbonate</u> - Primary standard; used for standardizing E.D.T.A.
C-CT-181	H-34B-181-(500 g)	<u>Sodium Carbonate</u> - Primary standard; used for standardizing acid.
C-CT-182	H-34B-182-(500 g)	<u>Ferrous Ammonium Sulfate</u> - Primary standard; used for standardizing chromate or permanganate.
C-CT-183	H-34B-183-(1 set)	<u>Set of Quantitative Unknowns</u> <ol style="list-style-type: none"> 1. <u>Potassium Hydrogen Phthalate</u> - Five different 100 g samples of unknowns whose analyses are known. 2. <u>Ferrous Ammonium Sulfate Unknowns</u> - Five different 100 g samples of unknowns whose analyses are known. 3. <u>Soda Ash (Sodium Carbonate) Unknowns</u> - Five different 100 g samples of unknowns whose analyses are known. 4. <u>Calcium Carbonate Unknowns</u> - Five different 100 g samples of unknowns whose analyses are known. Such as found at Thorn Smith Chemists Inc. 84 Park Street, Troy, Michigan, 48084, U.S.A.

CT-116

CT-117

MASTER CHEMICAL LIST

CHEMICAL TECHNOLOGY

The following specifications shall apply to all items:

1. All chemicals shall come in new, sealed, unused, and unopened containers.
2. All chemicals shall be reagent grade unless otherwise specified.
3. All solids in containers shall not come in amounts exceeding 500 g unless otherwise specified.
4. All liquids in containers shall not come in amounts exceeding 1 liter or 500 g unless otherwise specified.

MASTER EQUIPMENT LIST
 CHEMICAL TECHNOLOGY
CHEMICALS

REFERENCE NUMBER	DESCRIPTION	QUANTITY	UNIT	TOTAL
C-CT-1	Acetaldehyde	100 g	7.00/100 g	7.00
C-CT-2	Acetanilide	250 g	4.00/250 g	4.00
C-CT-3	Acetic Acid, Glacial	6 pt	11.00/6 pt	11.00
C-CT-4	Acetone	32 pt	4.00/8 pt	44.00
C-CT-5	Acetone	15 gal	25.00/5 gal	75.00
C-CT-6	Aluminum Chloride	16 oz	4.00/4 oz	16.00
C-CT-7	Adipic Acid	500 g	4.00/500 g	4.00
C-CT-8	Ethyl Alcohol - 200 Proof	6 pt	3.00/pt	18.00
C-CT-9	Ethyl Alcohol - 190 Proof	6 pt	3.00/pt	18.00
C-CT-10	Alumina, Activated	3 lb	5.00/lb	15.00
C-CT-11	Ammonium Acetate	1 lb	6.00/lb	6.00
C-CT-12	Ammonium Chloride	1 lb	4.00/lb	4.00
C-CT-13	Ammonium Hydroxide	6 pt	8.00/6 pt	8.00
C-CT-14	Aniline	1 pt	4.00/pt	4.00
C-CT-15	Anthracene	100 g	6.00/100 g	6.00
C-CT-16	Anthranilic Acid	25 g	4.00/25 g	4.00
C-CT-17	Barium Chloride	1 lb	3.00/lb	3.00
C-CT-18	Benzamide	100 g	17.00/100 g	17.00
C-CT-19	Benzene	8 pt	12.00/8 pt	12.00
C-CT-20	Benzoic Acid	1 lb	11.00/lb	11.00
C-CT-21	Benzoin	100 g	4.00/100 g	4.00
C-CT-22	Phenophenone	250 g	6.00/250 g	6.00
C-CT-23	Bromine	3 lb	13.00/lb	39.00
C-CT-24	Bromobenzene	1500 g	6.00/500 g	18.00
C-CT-25	Bromobutane	250 g	6.00/250 g	6.00
C-CT-26	2-Bromopropane	250 g	7.00/250 g	7.00
C-CT-27	Bromothymol Blue	100 ml	1.00/100 ml	1.00
C-CT-28	Brown Sugar	1 lb	1.00/lb	1.00
C-CT-29	Buffer pH 4	1 pt	3.00/pt	3.00
C-CT-30	Buffer pH 7	1 pt	3.00/pt	3.00
C-CT-31	Buffer pH 10	1 pt	3.00/pt	3.00
C-CT-32	Butyl Alcohol	2 pt	3.00/pt	6.00

MASTER EQUIPMENT LIST
 CHEMICAL TECHNOLOGY
CHEMICALS

REFERENCE NUMBER	DESCRIPTION	QUANTITY	UNIT	TOTAL
C-CT-33	Iso-Butyl Alcohol	1 pt	3.00/pt	3.00
C-CT-34	Sec-Butyl Alcohol	1 kg	4.00/kg	4.00
C-CT-35	Test-Butyl Alcohol	1 kg	5.00/kg	5.00
C-CT-36	2-Butanone	1 kg	4.00/kg	4.00
C-CT-37	Calcium	4 oz	10.00/4 oz	10.00
C-CT-38	Calcium Acetate	4 oz	10.00/4 oz	10.00
C-CT-39	Calcium Carbide	1 lb	4.00/lb	4.00
C-CT-40	Calcium Carbonate	1 lb	9.00/lb	9.00
C-CT-41	Calcium Chloride	1 lb	4.00/lb	4.00
C-CT-42	Calcium Chloride - Anhydrous	3 lb	5.00/lb	15.00
C-CT-43	Calcium Sulfate	1 lb	11.00/lb	11.00
C-CT-44	Camphor	4 oz	5.00/4 oz	5.00
C-CT-45	Carbon Tetrachloride	4 pt	4.00/pt	16.00
C-CT-46	Charcoal	1 lb	7.00/lb	7.00
C-CT-47	Chlorobenzene	1 kg	4.00/kg	4.00
C-CT-48	O-Chlorobenzoic Acid	100 kg	9.00/100 g	9.00
C-CT-49	Chloroform	3 pt	5.00/pt	15.00
C-CT-50	1-Chlorobutane	500 g	5.00/500 g	5.00
C-CT-51	Trans-Cinnamic Acid	100 g	6.00/100 g	6.00
C-CT-52	Citric Acid	1 lb	5.00/lb	5.00
C-CT-52	Copper Metal	1 lb	11.00/lb	11.00
C-CT-54	Crystal Violet	10 g	2.00/10 g	2.00
C-CT-55	Cupric Oxide	1 lb	13.00/4 oz	52.00
C-CT-56	Cupric Sulfate	1 lb	6.00/lb	6.00
C-CT-57	Cyclohexane	500 g	4.00/500 g	4.00
C-CT-58	Cyclohexanol	500 g	4.00/500 g	4.00
C-CT-59	Cyclohexanone	500 g	7.00/500 g	7.00
C-CT-60	p-Dichlorobenzene	1 kg	4.00/kg	4.00
C-CT-61	2,4 - Dinitrophenylhydrazine	25 g	5.00/25 g	5.00
C-CT-62	Diethyl Ether	6 lb	4.00/6 lb	24.00
C-CT-63	Eriochrome Black T	10 g	2.00/10 g	2.00

CT-120

MASTER EQUIPMENT LIST
CHEMICAL TECHNOLOGY
CHEMICALS

REFERENCE NUMBER	DESCRIPTION	QUANTITY	UNIT	TOTAL
C-CT-64	Ethyl Acetate	1 pt	4.00/pt	4.00
C-CT-65	Bromoethane	250 g	12.00/250 g	12.00
C-CT-66	(Ethylenedinitrilo) Tetra Acetate Acid	500 g	5.00/500 g	5.00
C-CT-67	Ethyl Iodide	4 oz	22.00/4 oz	22.00
C-CT-68	Hydrochloric Acid	2 liter	4.00/1	8.00
C-CT-69	Hydrochloric Acid	42 pt	24.00/12	84.00
C-CT-70	Iodine	4 oz	7.00/4 oz	7.00
C-CT-71	Hydrogen Peroxide	1 pt	3.00/pt	3.00
C-CT-72	Iron Filings	1 lb	5.00/lb	5.00
C-CT-73	Ferrous Ammonium Sulfate	1 lb	4.00/lb	4.00
C-CT-74	Ligroin 65-90 ^o	500 g	5.00/500 g	5.00
C-CT-75	Magnesium Ribbon	2 oz	6.00/1 oz	12.00
C-CT-76	Magnesium Shavings	1 lb	14.00/lb	14.00
C-CT-77	Magnesium Chloride	1 lb	6.00/lb	6.00
C-CT-78	Magnesium Sulfate Heptahydrate	1 lb	4.00/lb	4.00
C-CT-79	Magnesium Sulfate Anhydrous	1 lb	7.00/lb	7.00
C-CT-80	Manganese Dioxide	2 lb	11.00/lb	22.00
C-CT-81	Mercuric Chloride	1 oz	18.00/1 oz	18.00
C-CT-82	Mercuric Nitrate	1 oz	10.00/1 oz	10.00
C-CT-83	Mercury	50 lb	120.00/5 lb	1,200.00
C-CT-84	Methanol	3 pt	2.00/pt	6.00
C-CT-85	Cotton Seed Oil	10 lb	14.00/5 lb	28.00
C-CT-86	Methyl Orange	1 pt	2.00/pt	2.00
C-CT-87	Naphthalene	250 g	5.00/250 g	5.00
C-CT-88	Nickel Lumps	4 oz	9.00/4 oz	9.00
C-CT-89	Nitric Acid	4 pt	3.00/pt	12.00
C-CT-90	Nitrobenzene	1 kg	4.00/kg	4.00
C-CT-91	Oxalic Acid	4 oz	3.00/4 oz	3.00
C-CT-92	Petroleum Ether	3 pt	2.00/pt	6.00
C-CT-93	Phenacetin	100 g	5.00/100 g	5.00
C-CT-94	Phenolphthalein	2 pt	3.00/pt	6.00

MASTER EQUIPMENT LIST
 CHEMICAL TECHNOLOGY
CHEMICALS

REFERENCE NUMBER	DESCRIPTION	QUANTITY	UNIT	TOTAL
C-CT-95	Phenylhydrazine Hydrochloride	4 oz	14.00/4 oz	14.00
C-CT-96	Phosphoric Acid Concentrated	1 pt	7.00/pt	7.00
C-CT-97	Phosphorus Red	4 oz	7.00/4 oz	7.00
E-CT-98	Potassium Carbonate	1 lb	4.00/lb	4.00
C-CT-99	Potassium Chlorate	2 lb	5.00/lb	10.00
C-CT-100	Potassium Chloride	4 oz	2.00/4 oz	2.00
C-CT-101	Potassium Chromate	4 oz	3.00/4 oz	3.00
C-CT-102	Potassium Dichromate	1 lb	5.00/lb	5.00
C-CT-103	Potassium Hydrogen Phthalate	2 lb	10.00/lb	20.00
C-CT-104	Potassium Iodate	4 oz	7.00/4 oz	7.00
C-CT-105	Potassium Iodide	1 lb	13.00/lb	13.00
C-CT-106	Potassium Permanganate	1 lb	6.00/lb	6.00
C-CT-107	Potassium Thiocyanate	1 lb	13.00/lb	13.00
E-CT-108	Propionaldehyde	100 g	4.00/100 g	4.00
C-CT-109	Propyl Alcohol	1 kg	5.00/kg	5.00
C-CT-110	Iso-Propyl Alcohol	1 pt	3.00/pt	3.00
C-CT-111	Resorcinol	100 g	5.00/100 g	5.00
C-CT-112	Silver Nitrate	8 oz	28.00/4 oz	56.00
C-CT-113	Sodium	1 lb	10.00/lb	10.00
C-CT-114	Sodium Acetate	1 lb	4.00/lb	4.00
C-CT-115	Sodium Benzoate	1 lb	6.00/lb	6.00
C-CT-116	Sodium Borate Decahydrate	1 lb	4.00/lb	4.00
C-CT-117	Sodium Bromide	1 lb	6.00/lb	6.00
C-CT-118	Potassium Bromide	75 g	7.00/25 g	21.00
C-CT-119	Sodium Carbonate - Primary Standard	1 lb	6.00/lb	6.00
C-CT-120	Sodium Hydroxide	25 lb	23.00/lb	23.00
C-CT-121	Sodium Chloride	2 lb	3.00/lb	6.00
C-CT-122	Sodium Chloride	25 lb	18.00/25 lb	18.00
C-CT-123	Sodium Dichromate	1 lb	5.00/lb	5.00
C-CT-124	Sodium Bicarbonate	1 lb	3.00/lb	3.00
C-CT-125	Sodium Bisulfate	1 lb	6.00/lb	6.00

MASTER EQUIPMENT LIST
 CHEMICAL TECHNOLOGY
CHEMICALS

REFERENCE NUMBER	DESCRIPTION	QUANTITY	UNIT	TOTAL
C-CT-126	Sodium Hydroxide	24 lb	2.00/lb	48.00
C-CT-127	Sodium Iodide	4 oz	6.00/4 oz	6.00
C-CT-128	Sodium Oxalate - Primary Standard	1 lb	13.00/lb	13.00
C-CT-129	Sodium Sulfate	1 lb	3.00/lb	3.00
C-CT-130	Sodium Sulfite - Anhydrous	1 lb	3.00/lb	3.00
C-CT-131	Salicylic Acid	4 oz	4.00/4 oz	4.00
C-CT-132	Semicarbazide Hydrochloride	100 g	5.00/100 g	5.00
C-CT-133	Stannous Chloride - Anhydrous	4 oz	10.00/4 oz	10.00
C-CT-134	Starch, Iodometric Solution	8 oz	1.00/4 oz	2.00
C-CT-135	Sodium Nitrate	4 oz	3.00/4 oz	3.00
C-CT-136	Succinic Acid	500 g	5.00/500 g	5.00
C-CT-137	Sulfur - Sublimed	1 lb	6.00/lb	6.00
C-CT-138	Sulfuric Acid - Concentrated	18 pt	3.00/pt	54.00
C-CT-139	Tin, Mossy	1 lb	17.00/lb	17.00
C-CT-140	Tolvene	2 pt	4.00/pt	4.00
C-CT-141	Urea	4 oz	3.00/4 oz	3.00
C-CT-142	Xylene	1 pt	2.00/pt	2.00
C-CT-143	Zink, Mossy	1 lb	9.00/lb	9.00
C-CT-144	Glycerol, Spectroquality	500 ml	4.00/500 ml	4.00
C-CT-145	Methyl Red Solution	16 oz	5.00/16 oz	5.00
C-CT-146	Potassium Hydroxide	4 lb	5.00/lb	20.00
C-CT-147	Potassium Hydrogen Phthalate	2 lb	10.00/lb	20.00
C-CT-148	Paraffin Oil Light	1 pt	3.00/pt	3.00
C-CT-149	Ammonium Thiocyanate	1 lb	9.00/lb	9.00
C-CT-150	Ferric Ammonium Sulfate	1 lb	6.00/lb	6.00
C-CT-151	Sodium Fluoride	4 oz	4.00/4 oz	4.00
C-CT-152	Hydroxylamine Hydrochloride	4 oz	9.00/4 oz	9.00
C-CT-153	Olive Oil	3 lb	9.00/lb	27.00
C-CT-154	Phenol Red - Indicator Solution	16 oz	4.00/16 oz	4.00
C-CT-155	O-Phenanthroline	1 g	5.00/g	5.00
C-CT-156	Hydrogen Peroxide	1 pt	8.00/pt	8.00

CT-123

MASTER EQUIPMENT LIST
CHEMICAL TECHNOLOGY
CHEMICALS

REFERENCE NUMBER	DESCRIPTION	QUANTITY	UNIT	TOTAL
C-CT-157	Potassium Persulfate	4 oz	5.00/4 oz	5.00
C-CT-158	Potassium Meta-Periodate	1 oz	11.00/oz	11.00
C-CT-159	Cyclohexene	250 g	5.00/250 g	5.00
C-CT-160	O-Xylene	250 ml	4.00/250 ml	4.00
C-CT-161	M-Xylene	250 ml	7.00/250 ml	7.00
C-CT-162	P-Xylene	250 ml	5.00/250 ml	5.00
C-CT-163	Pentane	500 ml	7.00/500 ml	7.00
C-CT-164	Hexane	250 ml	8.00/250 ml	8.00
C-CT-165	Sand	4 lb	3.00/lb	12.00
C-CT-166	Lecture Cylinder of Ammonia Gas	1	26.00/ cyl- inder	26.00
C-CT-167	Lecture Cylinder of Carbon Dioxide	1	24.00/ cyl- inder	24.00
C-CT-168	Lecture Cylinder of Dichloro- Difluoromethane	1	26.00/ cyl- inder	26.00
C-CT-169	Lecture Cylinder of Methane	1	23.00/ cyl- inder	23.00
C-CT-170	Lecture Cylinder of Nitrogen	1	25.00/ cyl- inder	25.00
C-CT-171	Lecture Cylinder of Oxygen	1	23.00/ cyl- inder	23.00
C-CT-172	Ethyl Alcohol, Anhydrous	5 gal	18.00/5 gal	18.00
C-CT-173	Sodium Hydroxide - 1 Normal Solution	5 liter	2.00/1	10.00
C-CT-174	Hydrochloric Acid - 1 Normal Solution	5 liter	2.00/1	10.00
C-CT-175	Large Cylinder of Ammonia	1	100.00/1	100.00
C-CT-176	Large Cylinder of Carbon Dioxide	1	100.00/1	100.00
C-CT-177	Large Cylinder of helium	1	100.00/1	100.00
C-CT-178	Drierite	5 lb	5.00/5 lb	5.00
C-CT-179	Drierite, Indicating	5 lb	12.00/5 lb	12.00
C-CT-180	Calcium Carbonate	500 g	11.00/500 g	11.00
C-CT-181	Sodium Carbonate	500 g	11.00/500 g	11.00
C-CT-182	Ferrous Ammonium Sulfate	500 g	11.00/500 g	11.00
C-CT-183	Set of Quantitative Unknowns	1 set	45.00/set	45.00

CHEMICAL TECHNOLOGY - INSTRUCTIONAL MATERIALS

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
I-CT-1	H-34-1-(1) H-34A-1-(1) H-35-1-(1) H-36-1-(1)	<u>Chalkboard</u> - Approximately 1.2 m x 2.4 m; warp free panel; non-skip chalk surface; chalk easily removable with dry eraser; green non glare color; frame of aluminum with wide lipped chalk rail.
I-CT-2	H-34-2-(1)	<u>Chart of Atomic Sizes</u> - Atomic and ionic radio of elements are tabulated; dimensions 107 x 47 cm (42 x 58 in); such as found in Sargent-Welch catalogue number S-18795-20.
I-CT-3	H-34-3-(1) H-34A-3-(1) H-35-3-(1) H-36-3-(1)	<u>Atomic Chart</u> - Periodic table of the elements; lists over twenty properties and characteristics of each element; dimensions 127 x 96.5 cm (50 x 35 in); for wall hanging; such as found in Sargent-Welch catalogue number S-18805-50.
I-CT-4	H-34-4-(1)	<u>Chart of Electron Energy Levels</u> - Atomic orbital chart; used to teach electronic structure of atoms; dimensions 73.5 x 107 cm (29 x 42 in); for wall hanging; such as found in Sargent-Welch catalogue number S-18790.
I-CT-5	H-34-5-(1)	<u>Electromotive Series Chart</u> - Common elements, and ions are arranged according to their oxidizing ability; dimensions 73.5 x 106.5 cm (29 x 42 in); for wall hanging; such as found in Sargent-Welch catalogue number S-18792.
I-CT-6	H-34-6-(1)	<u>Solubility Chart</u> - List common salts and their solubility product constants; dimensions 41 x 184 cm (16 x 72 in); for wall hanging; such as found in Sargent-Welch catalogue number S-18791-20.

CHEMICAL TECHNOLOGY - INSTRUCTIONAL MATERIALS

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
I-CT-7	H-34-7-(1)	<u>Acid/Base Chart</u> - Lists common acids and bases and their ionization constants; dimensions 41 x 183 cm (16 x 72 in); for wall hanging; such as found in Sargent-Welch catalogue number S-18791-25.
I-CT-8	H-34-8-(1)	<u>Redox Chart</u> - List common oxidation reduction reactions and their respective potentials; dimensions 41 x 183 cm (16 x 72 in); for wall mounting; such as found in Sargent-Welch catalogue number S-18791-30.
I-CT-9	H-34-9-(1)	<u>Instability Chart</u> - List common complex ions and their instability constants; dimensions 41 x 183 cm (16 x 72 in); for wall mounting; such as found in Sargent-Welch catalogue number S-18791-35.
I-CT-10	H-34A-10-(20)	<u>Organic Molecular Models</u> - Organic; plastic, sufficient pieces to synthesize hundreds of organic compounds; illustrates single, double and triple bonds; such as found in Benjamin/Mauzen HGS Organic Molecular Structural Models; ordering address: W.A. Benjamin Inc., 2725 Sand Hill Road, Menlo Park California 94025, U.S.A.; in a clear plastic case, approximately 4 x 4 x 1/2 inches.
I-CT-11	H-34-11-(1)	<u>Chart of Metals</u> - Describes the physical and chemical properties of metals relative to hydrogen; for wall hanging; such as found in Sargent-Welch catalogue number S-18791-50.
I-CT-12	H-34-12-(2) H-34A-12-(2) H-35-12-(2) H-36-12-(2)	<u>Handbook of Chemistry and Physics</u> - Reference handbook containing about 3000 pages of mathematical, physical, and chemical tables and constants; any unused edition within the last 5 years; such as found in Sargent-Welch catalogue number S-8206.
I-CT-13	H-34-13-(1 set)	<u>Chemical Formulary</u> - A set of Volume I and II; useful formulas and laboratory recipes; any unused edition within the last 8 years; such as found in Sargent-Welch catalogue numbers S-8205 and S-8205-S.

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CHEMICAL TECHNOLOGY - INSTRUCTIONAL MATERIALS

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
I-CT-14	H-36-14-(4)	<u>Elementary Chemical Engineering</u> - Textbook used for chemical engineer technicians; author Max S. Peters; copyright 1954 by McGraw-Hill Book Company, Incorporated, New York, New York, U.S.A.
I-CT-15	H-36-15-(2)	<u>Unit Operations of Chemical Engineering</u> - A standard text used in most universities in a unit operations laboratory; authors Warren L. McCabe and Julian C. Smith; publisher McGraw Hill Company, New York, New York, U.S.A.; 3rd Edition.
I-CT-16	H-35-16-(1) H-36-16-(1)	<u>Chemical Engineers Handbook</u> - Standard reference handbook for chemical engineers world wide; authors are Robert H. Perry and Cecil H. Chilton; publisher is McGraw-Hill Company, New York, New York, U.S.A.; 5th Edition.
I-CT-17	H-34-17-(1) H-34A-17-(1) H-35-17-(1) H-36-17-(1)	<u>Chemical Technician's Ready Reference Handbook</u> - Common everyday information needed by a working chemical technician. Authors: Gershon J. Shugar; Ronald A. Shugar; Lawrence Bauman; publisher is McGraw-Hill Book Company, New York, New York, U.S.A.
I-CT-18	H-34-18-(1)	<u>Hoffman Apparatus</u> - For electrolysis of water; complete with glass unit; support; one clamp, two platinum electrodes with rubber stoppers, and binding post plate; with instructions; such as found in Sargent-Welch catalogue number S-29125.
I-CT-19	H-34-19-(1)	<u>Conductivity Tester</u> - Indicates qualitatively the electrical conductivity of solutions by the relative brightness of the lamp when two electrodes are immersed in various solutions; complete with socket having an attached clamp; a cord and plug for operation on 220 volts AC, 50 Hz; such as found in Sargent-Welch catalogue number S-29761-S0.

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MASTER EQUIPMENT LIST
 CHEMICAL TECHNOLOGY
INSTRUCTIONAL MATERIALS

REFERENCE NUMBER	DESCRIPTION	QUANTITY	UNIT	TOTAL
I-CT-1	Chalkboard (1.2 m x 2.4 m)	4	80.00	320.00
I-CT-2	Chart of Atomic Sizes	1	12.00	12.00
I-CT-3	Atomic Chart	4	11.00	44.00
I-CT-4	Chart of Electron Energy Levels	1	9.00	9.00
I-CT-5	Electromotive Series Chart	1	3.00	3.00
I-CT-6	Solubility Chart	1	7.00	7.00
I-CT-7	Acid/Base Chart	1	7.00	7.00
I-CT-8	Redox Chart	1	7.00	7.00
I-CT-9	Instability Chart	1	7.00	7.00
I-CT-10	Organic Molecular Models	20	7.00	140.00
I-CT-11	Chart of Metals	1	5.00	5.00
I-CT-12	Handbook of Chemistry and Physics	8	39.00	312.00
I-CT-13	Chemical Formulary Vol. 1 and 11	1 set	25.00	25.00
I-CT-14	Elementary Chemical Engineering	4	18.00	72.00
I-CT-15	Unit Operations of Chemical Engineering	2	26.00	52.00
I-CT-16	Chemical Engineer's Handbook	2	43.00	86.00
I-CT-17	Chemical Technicians' Ready Reference Handbook	4	25.00	100.00
I-CT-18	Hoffman Apparatus	1	65.00	65.00
I-CT-19	Conductivity Tester	1	18.00	18.00

CHEMICAL TECHNOLOGYBUDGET SUMMARY

Equipment	\$203,820.24
Glassware	9,491.70
Chemicals	3,461.00
Furniture	64,680.00
Tools	517.30
Instructional Materials	<u>1,291.00</u>
TOTAL	\$283,261.94
World Bank Estimate*	\$232,210.00
Amount <u>Over</u>	54,051.94

*Includes \$42,410 from the Applied Mechanics Laboratory in Homs. The remaining budget of \$51,900 is listed with the Building Construction and Surveying expert.

*Does not include \$19,000 (Items E-CST-35, E-CST-41) which is the Chemical Technology experts share of the Control Systems Laboratory in Homs. The total allocation of \$81,900 is listed with the Control Systems and Transducers expert.

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CHEMICAL TECHNOLOGY

PRIORITY ITEMS

All of the listed equipment items are needed to carry out the program as
invisioned in the syllabus.

CST-1

CONTROL SYSTEMS AND TRANSDUCERS

A PROPOSED SYLLABUS AND EQUIPMENT LIST

For The

SYRIAN ARAB REPUBLIC GOVERNMENT

Developed By

JOHN D. COWAN, JR., PROFESSOR

DEPARTMENT OF ELECTRICAL ENGINEERING

THE OHIO STATE UNIVERSITY

COLUMBUS, OHIO

Contracted For

The

UNITED STATES AGENCY FOR INTERNATIONAL DEVELOPMENT

By

THE ACADEMY FOR EDUCATIONAL DEVELOPMENT

DAMASCUS, SYRIA

JULY-AUGUST 1977

LABORATORY SPACE IDENTIFICATION NUMBERS

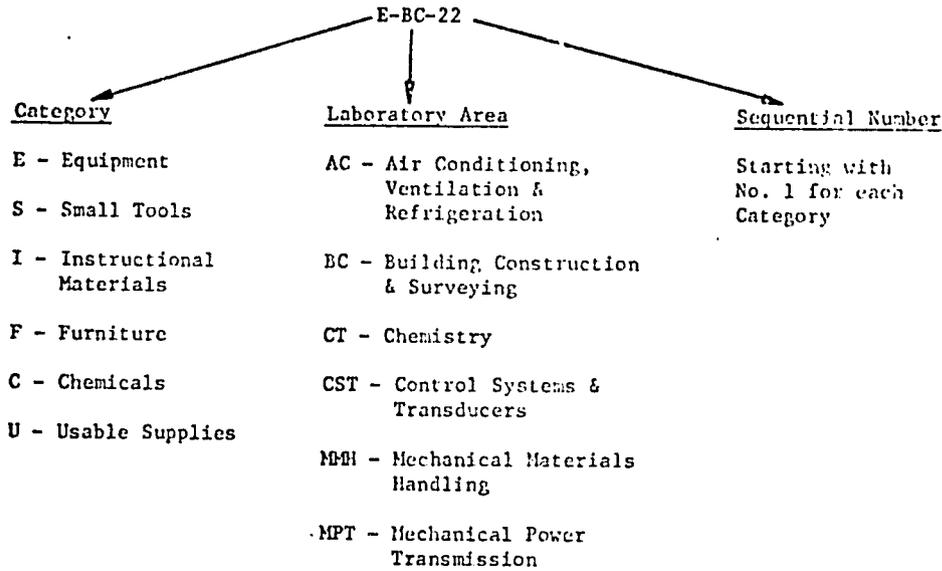
(From World Bank)

A. <u>Air Conditioning</u> (Homs)			
			<u>Space Number</u>
1.	Heating, Fuels & Hot Water Systems		32
2.	Air Conditioning & Refrigeration		33
B. <u>Building Construction Labs</u> (Latakia and Deir-Ez-Zor and Homs)			
			<u>Space Number</u>
			<u>Homs</u>
1.	Applied Mechanics	<u>Latakia</u> 28	<u>Deir-Ez-Zor</u> 28
2.	Construction	33	33
3.	Engineering Materials and Soils	34	32
4.	Surveying and Photo Grammetry	35	35
C. <u>Chemical Tech. Laboratories</u> (Homs)			
			<u>Space Number</u>
1.	Industrial Inorganic and Quantitative Chemistry		34
2.	Industrial Organic Chemistry		34A
3.	Chemicals Processing Unit Operations (Pilot Plants)		35
4.	Mineral Processing Unit Operations		36
D. <u>Control Systems and Transducers</u> (Homs)			
			<u>Space Number</u>
1.	Control Systems		31
2.	Transducers (Instruments)		37
3.	Common Room	} Support for	C
4.	Printed Circuit Room		P
		31, 37, 22, 27	
E. <u>Materials Handling and Mechanical Power</u> (Latakia)			
			<u>Space Number</u>
1.	Machine Elements and Industrial Drawing		29
2.	Diesel Power Technology		30
3.	Power Transmission and Control Systems		31
4.	Material Handling Equipment		32

CODE SYSTEM

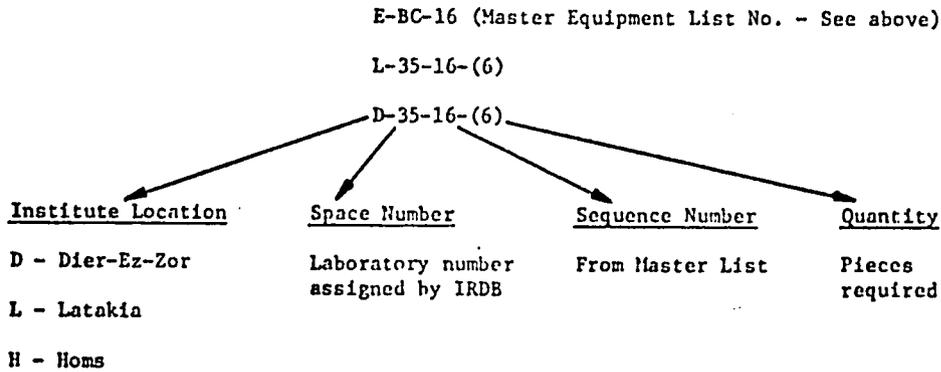
MASTER EQUIPMENT LIST - REFERENCE NUMBER

Sample:



SPECIFICATION CODE NUMBERS (FOR ALLOCATION PURPOSES)

Sample:



1. INTRODUCTION

- 1.1 The syllabi and equipment lists which follow are based on the following assumptions and/or guidelines:
- 1.2 The World Bank Schedule of Accommodations, S.A.R. First Education Project, working papers, Volume I, dated April, 1977, forms the basic plan on which the syllabi and equipment list is based.
- 1.3 The final recommended equipment list and syllabi reflect the plan as indicated above, the input of various Syrian authorities and individuals as listed below, and the professional opinion of the author of this document.
- 1.4 Consultations were held with the following individuals, either in group meetings or individual conferences:
 - Mr. Sharifuopin Mohammed, Director of Technical Education, Ministry of Education, S.A.R.
 - Mr. Munir Azzam, Senior Advisor, and Director, World Bank Project. Directorate of Planning, Ministry of Education, S.A.R.
 - Mr. Mustafa Kazziha, Inspector, Technical Education Directorate, Ministry of Education, S.A.R.
 - Mr. Aymam Muwakki, Engineer, School Building Institute, Damascus, S.A.R.
 - Mr. Farouk Kwatly, Director, Intermediate Technical Institute, Damascus, S.A.R.
 - Mr. Hisham Shammut, Director, Technical Secondary School, Damascus, S.A.R.
 - Mr. C.N. Lindsay, World Bank
 - Mr. Harry Go, World Bank
 - Mr. Michael Davis, Commercial Attache, U.S. Embassy, Damascus, S.A.R.
 - Dr. Y.M. Waly (at Homs 5 year Institute for Petroleum & Chemistry)
 - Dr. Nebah Mora, Professor, Electrical Intermediate Technical Institute, Damascus, S.A.R.
 - Mr. Mohammed Wajeeh Tayfour, Teacher, Intermediate Mech. Institute, Homs.
- 1.5 This program is required only at Homs.

1.6 The title of this program is listed as "Instruments" on the IBRD schedule of accommodations. That syllabi shows a strong emphasis on subjects in control systems and servomechanisms, so it would seem more accurate to change the course title to Control Systems and Transducers. The word instrument is far too general - when associated with control systems, instruments are more aptly called transducers.

Transducers are all those devices which sense, or measure, physical parameters such as temperature, velocity, pressure and light intensity, converting such measurements to a form useful to the control elements of the system. Such signals are best used as D.C. electric signals for use in electronic integrated circuit processing, but many systems still exist where the process controller uses information in pneumatic form. Transducers also include those devices which use signals in electric, pneumatic and other forms to control another action. A pneumatic actuated flow valve, or a thermal bimetallic strip turning a switch on or off are examples. These are sometimes called actuators.

Still other applications make it desirable to show some information to the operator - in these applications the instrument would be called a gauge, meter or just indicator, and would in general be in addition to the signal used by the system.

1.7 The control systems part of this course is taken, in part, by Mechanical, Air Conditioning, and Chemical Technology in addition to the CST students.

The Control System-Transducer student will have a different interest than the other students, however. He will be interested mainly in the dynamics that are associated with all feedback systems, and in the generality with which they can be studied. He will be concerned with questions of stability, accuracy during changing conditions and final accuracy for a given command. He will also be interested in how simple integrated circuitry can be used to provide stability to unstable systems, as well as to improve the

dynamic performance, whether the system be mechanical, hydraulic, thermal or a chemical processor.

- 1.8 These students should have high aptitude for mathematics, physics and electronics as well as skill and interest in working with their hands.

2. PURPOSE

- 1.1 To provide instruction and hands-on experience with a variety of control systems used throughout industry. In many cases he will know more about the maintenance and trouble shooting of such systems than the average engineer, except for one who has specialized in practical general feedback systems.
- 1.2 He will know enough to advise the control engineer when a system is not performing up to its' desired levels, and may even suggest to the engineer what the specific areas of deficiency are.
- 1.3 He will understand how to make dynamic tests on various systems, and will know how to provide test reports in the form suitable for study by an engineer.
- 1.4 He will also understand the primary signal processing elements of feedback systems, and how simple integrated circuitry may be used to accomplish these effects.
- 1.5 Some students will, with additional study in pedagogy and with special aptitudes for teaching, become teachers and instructors in technical secondary schools an vocational training centers.

3. PROGRAM OBJECTIVES

- 3.1 To understand, test and be able to repair the variety of transducers and actuators associated with control systems. This would include electronics such as power supplies.
- 3.2 To read and draw control system schematics. This will include electronic (especially integrated circuit) circuit diagrams, pneumatic and fluid diagrams and system block diagrams.
- 3.3 To skillfully use oscilloscopes, function generators, counters, volt ohmmeters, bridge and capacitance meters and 2 channel recorders.

- 3.4 To construct a variety of electronic circuits for special purposes, particularly using the integrated circuit prototype trainers.
- 3.5 To understand how to make transient and sinusoidal steady state tests on a variety of open and closed loop systems.
- 3.6 To be able to construct and interpret special plots of dynamic system performance, particularly Bode plots.
- 3.7 To understand that during testing, all of the variables of the system must not range into saturation, as the data accumulated will be unuseable.
- 3.8 To be able to use I.C.'s other than operational amplifiers such as analog switches, A/D & D/A converters, simple logic, timers, voltage regulator and line drivers.
- 3.9 To be able to work with hydraulic and pneumatic fittings and pipes.
- 3.10 To have a modest ability to build metal chassis and components as may sometimes be needed.

4. TYPICAL COURSE TITLES AND TIME ALLOCATIONS

CONTROL SYSTEMS AND TRANSDUCERS	Number Hours per Week	
	Theory	Practical
First (13th) Year		
Social Studies and Language	2	1
Industrial Safety and Planning	3	0
Mathematics for Dynamic Systems, I	3	1
Applied Physics	1	3
Elementary Transducers (Instruments)	2	3
Electric circuits and Schematics	3	3
Electric & Hydraulic Machines, Transformers	2	3
Electronics and Schematics	<u>2</u>	<u>4</u>
Total	18	18 = 36
Second (14th) Year		
Social Studies and Language	2	1
Industrial Safety and Planning	2	0
Mathematics for Dynamic Systems, II	2	1

Second (14th) Year (continued)	Theory	Practical
Applied Mechanics	2	2
Advanced Transducers (Instruments)	2	3
Integrated Circuits for Control Systems	2	2
Power Units and Power Amplifiers	2	3
Feedback Control Systems	4	4
Control Unit Design Project	<u>0</u>	<u>2</u>
Total	18	18 = 36

Special Note: These courses and the time assigned to them have been changed somewhat from the IBRD Syllabus. They do not yet represent a correct assignment of topics and time distribution. It is expected that a refinement of this syllabus will be accomplished by the students trained in the U.S. in collaboration with the author of this report.

5. COURSE OUTLINES (By Title and Objectives)

First (13th) Year

- 5.1 Social Studies and Language: It would be extremely valuable if students could learn to read American linear and digital data manuals.
- 5.2 Industrial Safety and Industrial Planning: Demonstrate knowledge of safe wiring practice, proper earthing of equipment, proper protection of wiring with circuit breakers or fuses, need for fused disconnect switches for heavy loads.
- 5.3 Mathematics for Dynamic Systems, I
- Use exponentials and sinusoids as solutions of differential equations.
 - To use exponentials to represent sinusoids.
 - To define phrase.
 - To use complex numbers in finding solution of differential equations with sinusoidal inputs.
 - Use of integrals as a graphical summation and mathematical integration of exponentials and sinusoids.
 - Use integrals to compute averages.

5.4 Applied Physics

- Define force, work, energy.
- Describe energy forms in mechanical, electrical and fluid systems.
- Describe terminal relations of electric, mechanical and fluid systems. (Voltage vs current, force vs velocity, pressure vs flow).
- Use of conservation principles (momentum and energy).

5.5 Elementary Transducers and Actuators

- To be able to describe the ways of measuring:

Temperature	Force
Pressure	Strain
Flow of Gases and Liquids	pH
Displacement	Liquid Level
Velocity	

5.6 Electric Circuits and Schematics

- To use unique polarity symbolism required to correctly identify circuit voltage and current:
 - To use KVL and KCL.
 - To use independent and dependent current & voltage sources.
 - To use coupled circuits.
- Compute: Energy in electric circuits.
 - Power in electric circuits.
- Use: Reduction of circuits by series parallel Combination, current and voltage division
Thevinin theorem
Generalized impedances with operational notation
- To find: The differential equation for a particular current or voltage in a circuit.
The complete solution to the differential equation for D.C., sinusoidal, and initial energy excitation.
- To use 3 phase sources.

5.7 Electric and Hydraulic Machines, Transformers

- Write differential equations of shunt and series D.C. motors, including mechanical load.
- Describe single phase and 3 phase motor characteristic curves.
- Define: how hydraulic devices convert fluid pressure to mechanical force and motion.
- To use: the differential equations of hydraulic systems.
- To identify: the various kinds and uses of transformers used in control systems.

- Describe: the use and operation of solenoids and relays;
Force between two currents;
Force between a current and a magnetic field;
Voltages generated by a conductor moving in a magnetic field.
- Compute forces using principle of virtual work.

5.8 Electronics; Schematics for Electronics Fluidics

- Use: Exponential and ideal diodes; to determine biasing for, and thermal limits of, transistors.
Silicon controlled rectifiers.
Thermistors.
- Use: Integrated circuits such as:
Operational amplifiers.
Voltage regulators.
Multipliers
Comparators
Monostables
Nand/Nor Logic and Inverters.
- Make and use: Electronic diagrams for linear and logic circuits using standard symbols.
Schematics for fluid (gas) systems using standard symbols for valves and actuators.

5.9 Mathematics for Dynamic Systems, II

- Obtain the exponential and sinusoidal solution to the linear differential equations of dynamic systems.
- Use complex numbers to obtain such solutions, to write these equations in transfer function form for use in block diagram schematics.
- Use Bode plots (Semilog plots of magnitude and phase of system response vs sinusoidal frequency inputs).
- Identify systems and applications of applied mechanics in relation to gearing, linkages, couplings, clutches, mounting and alignment of motors, rams and fastenings for couplings.

5.10 Advanced Transducers and Actuators

- To use:
 - Transducers, pneumatic output
 - Transducers, D.C. output
 - Transducers, A.C. output
 - Demodulators of A.C. signals to \pm D.C.
 - Comparators, pneumatic
 - Comparators, hydraulic
 - Comparators, electric, A.C. (synchros)
 - Comparators, oper. Ampl.
 - Series controllers (lead and lag)
 - Parallel controllers (proportional + rate + integral)
 - Linearize some signals with operational amplifiers
 - Actuators, electric
 - Actuators, pneumatic
 - Actuators, hydraulic
- To calibrate transducers.
- To remove Bias from the signal in (some) transducers.
- To build: Excitation for (some) transducers.

5.11 Integrated Circuits in Control Systems

- To Construct; using operational amplifiers;

- Summing and amplification
- Inverting
- Voltage follower
- Integrator
- Instrumentation amplifier
- Current source
- Lead circuits
- Lag circuits
- Power supplies using voltage regulators
- Timers
- Diode shaping circuits

- To Use:

- Linedrivers
- Comparators
- Analog switches
- Monostables
- Logarithmic multipliers and dividers
- A/D and D/A converters
- Sample and hold amplifiers

5.12 Power Units and Amplifiers

- To use:

- D.C. Servo motors
- D.C. series motors
- Hydraulic pumps, motors and rams
- Pneumatic motors

- To build and use:

- Stepping motors (use only)
- D.C. linear power amplifiers
- A.C. SCR units for heaters and D.C. motors

5.13 Feed Back Systems

- To use and derive transfer functions.
- To simulate transfer functions with operation amplifiers.
- To use block diagrams.
- To take frequency response, open and closed loop.
- To compute and take transient response, closed loop.
- To compare: Relations between open loop frequency response and closed loop performance to the speed of response and transient error.

Servo type number and its relation to steady state error.
- To make and use: Bode plots and inverse Nyquist plots for stability analysis.
- To use compensators or controllers to improve transient circuits.
- To compare series and parallel controllers.

- Control Unit Design Project
 - a. Assemble all parts of a D.C. servo system configured both for position and velocity operation.
 - b. Design lead and lag networks to improve the transient and steady state response.

6. PROGRAM RECOMMENDATIONS

- 6.1 This will be the only program in Syria about control systems as a discipline. The understanding of feedback systems is completely concerned with dynamics, so the secondary training for this study should provide the highest math, electronics and physics. Students should especially like working with their hands as well as with the theory.
- 6.2 Extensive use should be made of the oscilloscope in the laboratories so that the "pictures" of the system responses become "married" to the mathematics with which they are described. These "pictures" can easily be generated by the I.C. Proto board circuits using 2 or 3 op amps. Use of these "simulated systems" can also be a great economy in that most of the study of lead, lag and proportional control can be done with them, using the actual system only occasionally to validate the simulated performance.
- 6.3 The relation between the laboratory work and the theory is so interrelated that only teachers who know both the theory and the equipment can provide successful training. This is felt to be of major importance in U.S. training. One hour of laboratory work is counted as 2/3 hour of lecture - even more teaching credit is given where time is spent in improving the laboratory program, especially to include newer and more useful devices, particularly integrated circuits.
- 6.4 It is extremely important to have a full time man and an assistant to be responsible for the condition of the laboratory apparatus, particularly the test equipment, such as oscilloscopes. These men should routinely (twice a year) calibrate (check for accuracy) and check all oscilloscopes and coltmeters, as well as to repair these items as needed. It is helpful to advise instructors to

attach tags on any malfunctioned equipment with as much description of the fault as possible as an aid to the equipment man. This man should also see to the sufficiency of test leads and their repair, as well as the stocking of useable supplies such as integrated circuits, resistors, capacitors, and so on.

Such men could be sent to the U.S. and work in a school repair shop (such as our Electrical Engineering maintenance shop at the Ohio State University.) for 3 to 6 months, supplemented by short programs as offered, for example, by the Tektronix Co.

7. ARCHITECTURAL RECOMMENDATIONS

7.1 Where possible, laboratories which can use common test equipment should be clustered in groups of four sharing a common room for the storage of common equipment and supplies. These affinities are evident for electronics, electrical, control systems and transducers which will require similar oscilloscopes, meters, bridges, counters, function generators, I.C. proto boards and supplies such as resistors, capacitors, integrated circuits, transistors, diodes and small transformers.

It would be appropriate for this same common room to provide a work bench, tools and storage locker for the equipment maintenance man.

Several four drawer filing cabinets should be included for the storage of test equipment manuals, as well as maintenance manuals for the various experimental apparatus.

7.2 Student lockers about 25 x 50 cm should be provided for each student to store books and other personal material.

7.3 A lock and key plan with a grand master, and suitable submasters should be considered. In this way, trusted fulltime employees could have access to all facilities, limited or part time employees might have access to the outside door of the school with a submaster which included areas of special interest to their needs.

- 7.4 A common room for students with provisions for making coffee and tea, and spaces for study and some blackboard space will encourage students to study together while talking, to relax and to talk over problems that are not yet clear from theory or laboratory courses. This kind of space can help develop a learning from each other which is not possible in the library or the classroom.
- 7.5 15A 220V plugs should be located along the side walls of each laboratory room every 2.2 at a height above the floor of 1.5 m. These should have the center prong wired as a safety or earth ground.
- 360V/4 wire 3 ph service at a capacity of 50A should be available at the laboratory circuit breaker center since some units will require 3 phase power. Each outlet should have it's own circuit breaker at the lab power cabinet.
- 7.6 Services for water and a drain should be provided on each side wall of each laboratory since some equipment will require cooling water. The drain need only be a 3 cm copper pipe sticking out of the wall and appropriately connected through a trap to the building drainage system.
- 7.7 All laboratory and common room doors should be at least 1.05 m wide x 2.5 m high to assure easy entry of benches and equipment.
- 7.8 Laboratory work space for 20 students assumes 7 work spaces (3 students per group. A space .9 m x 2.5 m is allowed for the lab bench (or experimental unit, if it does not fit on a bench). About 1.2 m is allowed for student workspace between benches. Room is allowed for a teachers desk, aisle space and some local storage.

TO: (1) Mr. C. Noel Lindsey, IBRD
(2) Mr. Mustafa Kazziha, Tech. Educ. Directorate,
Ministry of Educ., S.A.R.

CONCERNING: Master Equipment List - Control Systems and Transducers

FOR: Homs IBRD spaces 31 and 37 (plus some of 22 and 27, see following note)

The CST program is only at Homs. However, because of the concept (developed in Damascus) of using a common instrument and repair room for groups of four related laboratories in order to reduce the inventory of expensive items, such as oscilloscopes, function generators and common room furniture, the equipment list will include sufficient equipment for common (C) use for Homs spaces 22 and 27.

Also, in consultation with Mr. Mustafa Kazziha, it was agreed that a small capability for making printed circuitry should be provided. The space for this, as well as for the common room, will be a part of the IBRD space allotted for spaces 31, 37 and 22 and 27.

The Master Equipment List will therefore include a space code for common room (C) and for printed circuitry (P).

Also many electronic common items absolutely essential to the immediate successful operation of these labs will be semi-expendable and will be coded as a "U" item.

Budgetary costs for spaces C and P will be shared with spaces 22 and 27.

CONTROL SYSTEMS AND TRANSDUCERS - EQUIPMENT

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
E-CST-1	H-C-1-(23)	<u>Oscilloscope, Dual Trace</u> - BNC inputs, D.C. to 10 Mhz., A + B mode, chop and alternate mode, $Z_{in} = 1 \text{ Meg.}$, ruled screen 8 x 10 cm, burn resist phosphor, matched x-y amplifiers, 1 mv/cm to 10 V/cm, supplied with three 1:1 4 foot probes, 220V/50Hz. Hewlett Packard 1222-Ascope, 10007B probes. Repair kit containing 6 fuses and proprietary components most likely to be needed in 5 years use. Repair & operating manual including parts list and schematic.
E-CST-2	H-C-2-(1)	<u>Camera, Oscilloscope</u> - To fit scopes of Item E-CST-1, fitted for use of Polaroid Type 107 film packs. Same repair kit and manual as Item E-CST-1
E-CST-3	H-C-3-(2)	<u>Oscilloscope, Dual Trace, Storage</u> - Variable persistence, D.C. to 10 Mhz., dual trace A + B mode, alternate or chop capability, supplied with 3-4 foot 1:1 probes, BNC input, 220V/50Hz. Same manual and repair kit as in E-CST-1.
E-CST-4	H-C-4-(1)	<u>Camera, Oscilloscope</u> - To fit Item E-CST-3, fitted for Polaroid # 107 film.
E-CST-5	H-C-5-(2)	<u>Recorders, Two Channel</u> - Two channels, rectilinear writing, pressurized ink, differential input, 10 megohm balanced, 2Z 40Hz response at full scale, 100 Hz @ 3d b. down, 1 mv. per chart division, to 500 V. Full scale, 40 mm 50 division channel span; dual chart speeds of 1, 5, 25, 125 mm/sec. and 1, 5, 25, 125 mm min. Supply with repair kit and manual as described in E-CST-1. Gould Brush 220, fitted for 220V, 50Hz and with starter kit of 12 rolls chart paper, gram gauge, 2 pen adjust wrenches, dust cover including 1 oz. ink cartridge.

CONTROL SYSTEMS AND TRANSDUCERS - EQUIPMENT

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
E-CST-6	H-C-6-(30)	<u>Digital Vomi Meters</u> - 4-1/2 Digit, 10 megohm input impedance, true RMS reading for A.C. Volts and current through 20 K hz., .05% of reading ± 1 lsd on ohms and D.C. volts, auto-polarity, BNC input. Volts, AC & DC - ± 199.9 mv. to ± 1000.0 V. Current, AC & DC - ± 199.9 ma Ohms 1.9999 kilohms to 19.999 megohms. Battery operated with built-in charger.
E-CST-7	H-C-7-(1)	<u>Digital Vom Meter, Reference</u> - 5-1/2 Digit, self test, ohms, D.C. Volts, true RMS AC volts. D.C. accuracy 0.003%, 10^7 ohms or more D.C. input impedance, A.C. accuracy 0.5% to 50 khz, 6% to 300 khz, 10^6 oms// 150 pf input impedance ohms range 19.999 ohms to 19.999 megohms. D.C. volts ± 0.1 to ± 1000 V. A.C. volts IV to 1000 V. Kelvin input for ohms, with input dual banana to BNC adaptor. For use at 220 V. 50 hz. same manual and repair kit as Item E-CST-1.
E-CST-8	H-C-8-(15)	<u>Capacitor Meter</u> - 3-1/2 Digit, battery powered, 10 ranges, autorange, 0.1 pf resolution to maximum of 0.199 farads. Supply with four spare AA batteries.
E-CST-9	H-C-9-(1)	<u>RLC Bridge</u> - Internal 120 hz. oscillator, capability of using external oscillator. Capacity range 1 pf to 1 farad, series and parallel inductance .01 MH to 20 H., resistance 0.1 ohms to 2 megohms, portable, 220 V/50 hz.
E-CST-10	H-C-10-(22)	<u>Function Generator</u> - 0.001 hz. to 2 Mhz., 20 V peak to peak 50 ohms output. Attenuator to -60 db in 3 ranges from 0 db. Short circuit proof output. Sine, ramp, square wave and pulse output, voltage control capability, 220 V, 50 hz. Repair kit and manual as in Item E-CST-1.

CONTROL SYSTEMS AND TRANSDUCERS - EQUIPMENT

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
E-CST-11	H-C-11-(8)	<u>Electronic Counter</u> - Autorange, 5 hz to 80 Mhz, 6 digit, input attenuator, 220 V, 50 hz input, 25 mv input sensitivity. At least 1 megohms input impedance protected against over voltage inputs.
E-CST-12	H-C-12-(2)	<u>Stroboscope</u> - For stop motion viewing (in day light) of moving parts and shafts, 200 to 6000 RPM \pm 2% accuracy, 220 V, 50 hz.
E-CST-13	H-P-13-(1)	<u>Drill Press, Ultra Precise</u> - Table top; supersensitive; chuck capacity 0-1/8"; rack and pinion action lowers head; 6 spindle speeds 7500 to 30,000 RPM; spindle parallelism with column dead true; maximum error of table squareness with spindle .001" to 5"; quickly adjustable for height and locks in precise squareness; 2 speed 1/17 H.P. motor; table size 4 x 4"; 5-3/4" table to chuck; 7" chuck to base; 1-1/4" spindle travel.
E-CST-14	H-C-14-(1)	<u>Pressure Gauge Calibrator</u> - Dead weight tester, non-corrosive, water medium with gauge calibrated -30 psi. Wts.: 2-1 kg, 4-500 gr., 4-200 gr.
E-CST-15	H-C-15-(2)	<u>Hand Tachometer</u> - Electric reading, approximately 2 V/1000 RPM fitted for hand placing in end of shaft.
E-CST-16	H-C-16-(2)	<u>Stopwatch</u> - Electronic, digital readout of hours, minutes and 0.1 seconds 220 V, 50 hz. May be battery operated.
E-CST-17	H-C-17-(8)	<u>Transformers, Stepdown</u> - 220 V/10 V, 50 hz, 250 watt minimum. Preferably mounted on board with banana plug input and output jacks and fused.
E-CST-18	H-C-18-(8)	<u>Transformers, Variable</u> - 220 V, 50 hz input, 3.5 A fused output.
E-CST-19	H-C-19-(20)	<u>Transformers, for \pm 15 V Power Supplies</u> - 220 V, 50 hz input, 34 V.C.T. at 125 ma output.

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CONTROL SYSTEMS AND TRANSDUCERS - EQUIPMENT

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
E-CST-20	H-C-20-(10)	<u>Transformer, For 5V Power Supply</u> - 220 V, 50 Hz, to 10 V at 5A.
E-CST-21	H-C-21-(8)	<u>Decade Resistor Box</u> - 0-99,999 ohms, 4 to 5 decades, 1% resistors specify on box current and/or voltage limits.
E-CST-22	H-C-22-(8)	<u>Decade Capacitor Box</u> - 100 pf to 0.1 mfd, 1% caps, 3 decades, preferably shielded box with poly, mylar or film caps.
E-CST-23	H-C-23-(8)	<u>Capacity Substitution Box</u> - 16 to 20 switch positions varying between about 0.001 mfd to 0.25 mfd. Non-polarized caps.
E-CST-24	H-C-24-(200)	<u>Hookup Leads, BNC to Grabber, with Repair Tips-</u> 100 36" Pomona # 3787-C-48 100 48" Pomona # 3787-C-48 200 Model 3925 Black repair tips 200 Model 3925 Red repair tips
E-CST-25	H-C-25-(200)	<u>Hookup Leads, Banana Plug, Stacking -</u> 100 3ft Pomona # B-36 100 4ft Pomona # B-48
E-CST-26	E-C-26-(10)	<u>Adaptors, Dual Banana to BNC</u> - To convert equipment with 3/4" dual banana outputs to BNC male. Supply with 0.166" holes for stacking.
E-CST-27	H-C-27-(8)	<u>Digital Panel Meter</u> - 3-1/2" digit, auto polarity; differential instrumentation type amplifier input, dual slope conversion, provision for external decimal point selection

CONTROL SYSTEMS AND TRANSDUCERS - EQUIPMENT

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
E-CST-27 (Cont'd)		and hold command. 1.999V input, 220V, 50 hz. Supplied with connector, and applications manual for constructing voltmeter, thermocouple, current and force measurements. Manual should also include schematics, theory of operation. repair guide and parts list.
E-CST-28	H-C-28-(25)	<u>Integrated Circuit Proto Trainer</u> - + 15 V at .5A, and 5 Vat, 1 A. power supplies; short proof; with 3 continental specialty WT-595 quick test sockets and 2 interconnect buses # QT-59B for DIP integrated circuits. Steel chassis for shielding. Such as James Electronic Proto Board 203 A. 1020 Howard Avenue, San Carlos, California 94070, U.S.A.
E-CST-29	H-C-29-(25)	<u>I.C. Socket and Bus Strips</u> - DIP solderless breadboards.
E-CST-30	H-C-30-(5)	<u>Power Supplies, Triple Output</u> - + 15 V, 200 ma. at 60° c., 500 ma. at 40° c. 1.5 mv. ripple and 5 V, 1.4 A at 60° c, 3 A at 40° c.
E-CST-31	H-C-31-(100)	<u>I.C. Sockets</u> - Solder tail, standard profile, tin or gold for DIP integrated circuits. 50 each 8 pin; 50 each 14 pin.
E-CST-32	H-C-32-(20)	<u>Adaptors, 3 Prong Europe to 3 Prong American</u> - To adapt European grounded outlets for use of equipment with 3 prong (grounded) American plugs.
E-CST-33	H-C-33-(200)	<u>Alligator Clip to Banana Plug Adaptor</u> - To adapt male banana plug leads to use with alligator clip.
E-CST-34	H-31-34-(5) H-37-34-(7)	<u>Strip Convenience Outlets</u> - To fasten to the back of laboratory work tables. Minimum of 6 European center earthed outlets furnished with 1.5 m cord, 10 A 3 wire, with European earthed plug. Holes for screw mounting to back of table.

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CONTROL SYSTEMS AND TRANSDUCERS - EQUIPMENT

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
E-CST-35	H-31-35-(1)	<p><u>Process Control System, Pneumatic, Liquid Level</u> - The "plant" should be real, rather than simulated. 3 term control capability, pneumatic controllers and actuators to be standard commercial items. All parts to be visible for maximum training value. All signals should be displayed with visible gauges - it would be desirable if system variables were also available as D.C. voltages, maximum ± 10 volts. It would also be desirable to have electric input capabilities as supplied by standard I.C. oper. amplifier ± 10 V at less than 10 m.a. Unit should be supplied with complete (2 copies) each of maintenance manual, Instructors guide, and student work book. Unit is to operate from 220 V, 50 hz and should include its own air supply. Suitable units are sold by: Industrial Photofact Division, Model FL-1, Howard W. Sams and Co., Inc. - Indianapolis, Indiana 46206, U.S.A. or MAC-4 unit, modified to include air supply and operate from 220 V 50 hz, supplied by Mickok Learning Systems, 2 Wheeling Ave. Woburn, Massachusetts 01801.</p>
E-CST-36	H-31-36-(1)	<p><u>Process Control System, Electric, Heat Load</u> - Control section should be operational amplifiers plugged into a DIP solderless Proto board, with a suitable ± 15 V power supply. The power unit should be an SCR unit designed to operate from ± 10 V, 10 ma maximum signals. The heat unit could be a water cooled block, suitably instrumented to give flow and temperature in the form of \pm D.C. signals not greater than ± 10 V. Temperature interlocks to preclude operation with lack of water and/or excessive temperature. Process power not to exceed 500 watts. System ready to operate requiring only tap water, a drain and a source of 220 V, 50 hz power. Two (2) training and two (2) maintenance manuals, including schematics and parts list, to be included. Such as Tecquipment No. CE3 and CE3a. Hooton Street Carlton Road, Nottingham NG32NJ, England.</p>

CONTROL SYSTEMS AND TRANSDUCERS - EQUIPMENT

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
E-CST-37	H-31-37-(1)	<u>Control System, Electro Mechanical, D.C.</u> - For experiments in control dynamics, D.C. motor and mechanical assembly capable of variable stiffness, damping and inertia loads. Control section capable of introduction of phase lead and lag networks. All necessary transducers and power supplies included. Two technical manuals to include experiments, use and repair of apparatus, and parts list; 220 V, 50 hz. Such as: Tecquipment CE4 is suitable.
E-CST-38	H-31-38-(1)	<u>Control System, Motor, D.C.</u> - Unit to be operable open or closed loop as either a position or velocity servo. Suitable position and velocity ± 10 V. D.C. signals for controlling the system using I.C. op amps whose circuits may be easily modified for variable gain and adding phase lead and lag components. Supply with 2 course manuals. Two (2) books titled "Speed Control" to be included. Such as: Electrocraft Corp. "Automatic Control Systems Lab". 1600 Second Street, South, Hopkins, Minn. 55343 U.S.A.
E-CST-39	H-31-39-(1)	<u>Control System, Electro Hydraulic</u> - Complete system trainer, including rotary and linear hydraulic motors. Includes servo valve, two pressure transducers one flow and one force transducer. All signals shown on gauges as well as electric for use in control and observation with recorders and oscilloscopes. Power supplies for controller electronics and transducers. Amplifier for servo valve drive and electric source for syncho transmitter. Unit to be furnished with hydraulic power supply, including a supply of oil, 2 training manuals, all necessary patch cords, electrical and hydraulic - a complete unit needing only 220 V, 50 hz supply; software should include experiments dealing with lead and lag control in the error channel. Such as: Feedback, Incorporated Control Systems E HS-160; Hydraulic Power Supply H PS-161; or Series 404, Hickok Learning Systems.
E-CST-40	H-31-40-(1)	<u>Numerical Controller</u> - A 4 bit digital system with manual input and shaft encoder, self powered, suitable for direct use with Item E-CST-39 230 V, 50 hz. Feedback, Inc. Model NC 40X or Series 404 Microprocessor and interface unit Hickok Learning Systems.

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CONTROL SYSTEMS AND TRANSDUCERS - EQUIPMENT

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
E-CST-41	H-31-41-(1)	<p><u>Process Control System, pH Process</u> - Unit to control a real, visible "plant" where the pH, of a fluid is to be the controlled variable. The controller should be capable of 3-term control and may be pneumatic - it would be desirable if the pneumatic actuators and transducers were also electrically rigged, so that an I.C. op amp controller could be interchanged with the pneumatic controller. Unit should be completely self contained including pneumatic air supply, needing only fluid and 220 V, 50 hz to become completely operable. A suitable unit is: Technovate Model RG-4575.</p>
E-CST-42	H-37-42-(1)	<p><u>Pneumatic Controller Trainer</u> - A trainer to demonstrate how 3-term control is achieved pneumatically and for the study of pneumatic transducers. It would be desirable to have electric output on the transducers for use of recorder and oscilloscope. Unit to be complete with visual gauges and its own air supply, needing only 220 V, 50 hz. power. Two (2) instruction manuals with experiments to be included. Such as Tecquipment, Controller # CE2; Air compressor # CE1b.</p>
E-CST-43	H-37-43-(1) H-31-43-(1)	<p><u>SCR or Transistor Speed Controller, with D.C. Motor</u> - Suitable for use as a general purpose drive for various test tachometers and gear trains. A motor of 1/50 to 1/20 hp. with speed to 2000 RPM is suitable. Arranged on a plate as a complete unit with room for mounting unit to be tested. To operate from 220 V, 50 hz, Schematic diagram, explanation of operation and parts list to be furnished. Such as: AST/Servo Systems, Stock # A-180; 930 Broadway, New York, N.Y. 07104, U.S.A.</p>
E-CST-44	H-37-44-(10)	<p><u>D.C. Motors</u> - Suitable for student projects using power supplies with output of about 1A, \pm 50 V. Permanent magnet field, rated for continuous operation and speeds to 5000 RPM. Such as: AST/Servo Systems, 5 # DM-187; 5 # DM-257.</p>

CONTROL SYSTEMS AND TRANSDUCERS - EQUIPMENT

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
E-CST-45	H-37-45-(1)	<u>Synchro Trainer</u> - Assembled unit to show individual and interconnected use of four synchros - one torque transmitter, one torque receiver, one torque differential transmitter and one control transformer. Completely assembled, ready for use with 220 V, 50 hz. Supplied with description and operation manual and U.S.Navy Synchro publication. Such as: ASI/Servo Systems Stock #SS23-B.
E-CST-46	H-37-46-(1)	<u>Kit, Temperature Transducers</u> - This kit should have a source of heat to produce temperatures in the range 150-400°F (65-200°C). A representative sample of devices used to sense temperature and convert to a signal suitable for use in a control system, especially those that have electric outputs. Complete set of experiments required. Parts to be clearly identified and suitable storage provided. 10 M input meters, recorders, function generators, and oscilloscopes, will be available, so they should not be included in this package. A kit partially fitting these needs is: TK 290 and TK 294 - Feedback Instruments, Inc.
E-CST-47	H-37-47-(1)	<u>Kit, Flow Transducers</u> - This kit should be a closed liquid system made of noncorrosive material throughout. The most representative flow meters should be separately available for testing with easy means for changing meters. It could be desirable if these were visible through a transparent pipe. Units with electric, as well as pneumatic outputs should be included. The kit should be completely self-contained with power supplies, pumps air supply, etc. as needed except for the available test equipment noted in the previous item. Experiments required. A partially suitable unit is: MAC-975 P plus Air supply Hickok Learning Systems.
E-CST-48	H-37-48-(1)	<u>Kit, Displacement Transducers</u> - This kit should include devices for linear and angular displacement, and convert to an electric signal. Some should be A.C., and several kinds of demodulators should be included, especially the multiplying type. Straingage and LVDT types should be included, along with all necessary power supplies. Experiments required. Test equipment mentioned in E-CST-46 not to be supplied. TK 290-4, feedback and MAC-975 P, Hickok kits each have some of these items and experiments.

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CONTROL SYSTEMS AND TRANSDUCERS - EQUIPMENT

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
E-CST-49	H-37-49-(1)	<u>Kit, Electromechanical, Student Projects</u> - Motorized trainer with interchangeable gears, motors, transducers and necessary power supplies along with a slotted metal mounting table. Complete student assembly of different feedback systems along with suitable manuals. Kit KE-140, PIC Design Division, P.O. Box 335, Ridgefield, Conn. 06877.
E-CST-50	H-37-50-(1)	<u>Kit, Chemical Transducers</u> - This kit should deal with measurement of pH, thermal conductivity, density and light absorption, among others. Outputs should be electrical and all necessary special power supplies furnished, along with suitable experiments. Test equipment mentioned in E-CST-46 should not be furnished. Several of these are furnished with the MAC-975 P kit of Hickok Learning Systems.
E-CST-51	H-37-51-(1)	<u>Kit, Light Transducers</u> - This kit should include the common devices used to sense light and convert to a useful electric signals. These should include photodiodes, plate transistors and light dependent resistors. A convenient apparatus including light source and experiments is required. Both the TK 290-4 feedback and MAC-975 P Hickok kits include some of these.
E-CST-52	H-37-52-(1)	<u>Kit, Pressure Transducers</u> - This kit, including a pressure source (such as a hand pump), should be equipped with quick disconnect couplings and/or standard screw in parts for testing various commercial gages having electric outputs. All of the various commercial methods should be represented, including the integrated circuit types such as manufactured by National Semiconductor. All necessary electric supplies and demodulators, along with appropriate experiments to be furnished. Several of these devices are included in the Hickok MAC-975 P kit.

CONTROL SYSTEMS AND TRANSDUCERS - EQUIPMENT

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
E-CST-53	H-37-53-(1)	<u>Kit, Actuators</u> - Representative actuators to control force, flow and pressure and controlled by both electric and pneumatic signals. Actuators need not control an actual load, but the outputs should be measurable so that input-output frequency response test be made. All necessary equipment including experiments to be included (except for the test equipment listed in E-CST-46). No known suppliers.
E-CST-54	H-C-54-(1)	<u>Electric 1/4" Hand Drill</u> - 1/4", heavy duty, approximately 2000 RPM, 220 V, 50 hz.
E-CST-55	H-C-55-(2)	<u>Drill Set with Case</u> - Indexed case with high speed drills # 1 to # 80.
E-CST-56	H-P-56-(8)	<u>Chemical Trays</u> - Polypropylene, or other suitable material for processing photographic film. About 12" x 16" x 3" deep.
E-CST-57	H-P-57-(1)	<u>Wash Tank</u> - Polypropylene, suitable for washing prints up to 10" x 14", flexible tube for attaching to sink faucet.
E-CST-58	H-P-58-(1)	<u>Shear, Precision</u> - Lever operated, suitable for cutting glass epoxy plastic and sheet metal up to 1/16" thick and 12" wide, hardened steel blade.
E-CST-59	H-P-59-(1)	<u>Air Conditioner</u> - Suitable for cooling a photographic dark room, about 12 square meters, 5000 BTU suitable, to be mounted in an outside wall. 230 V, 50 hz.
E-CST-60	H-P-60-(24)	<u>Carbide Drills</u> - Solid carbide, straight shank, for drilling printed circuit boards, size # 60 (.040" - 1 mm).
E-CST-61	H-P-61-(2)	<u>Measuring Cup</u> - Pyrex, graduated in oz and grams, about one pint or 1/2 liter capacity.

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CONTROL SYSTEMS AND TRANSDUCERS - EQUIPMENT

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
E-CST-62	H-P-62-(12)	<u>Brown Glass Bottles</u> - About ¼ litre capacity, suitable for storing photographic chemicals.
E-CST-63	H-P-63-(2)	<u>Funnel</u> - Polypropylene, about 1 cm stem, with 7.5 cm top.
E-CST-64	H-P-64-(2)	<u>Thermometer</u> - Precision glass mercury thermometer, 0-100°C range, calibrated in ° Celsius and ° Fahrenheit.
E-CST-65	H-P-65-(2)	<u>Exposure Wheel</u> - About 6" disk with graded translucent pie shaped sections, ranging from clear to opaque in 8-10 divisions.
E-CST-66	H-P-66-(3)	<u>Processing Tank</u> - General purpose, polypropylene, .156" walls, about 14" x 10" x 10" deep for processing photoresist printed circuit boards.
E-CST-67	H-37-67-(3)	<u>Power Amplifiers, D.C.</u> - Suitable for driving servo motors and electrically operated valves. About 2A, ± 50 V, 70 watt, short circuit and thermal protection. Circuit diagram, theory of operation and maintenance manual required. Standard parts, especially transistors. 220 V, 50 hz.
E-CST-68	H-C-68-(1)	<u>Transistor Curve Tracer</u> - For testing bipolar, FET and diode devices. Provide up to 300 V of either polarity (NPN or PNP testing), adjustable with capability of selecting collector and/or emitter resistors of wattage to handle up to 5A. collector currents. Selectable base drive currents in 10-12 steps, 5 n A/step to 200 m A/step. X and Y outputs suitably calibrated for use with a standard general purpose oscilloscope. This may be bid as a unit for use with an oscilloscope, or as a complete unit including an oscilloscope. The capability of either package should be equivalent in performance to Tektronix # 577/D2 with Test Fixture # 177.

CONTROL SYSTEMS AND TRANSDUCERS - EQUIPMENT

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
E-CST-69	H-37-69-(10)	<u>Geared D.C. Motors</u> - For use in student projects. About 25 V, 0.25 A, speed approximately 100-300RPM, continuous duty. Such as AST/Servo Systems # D M-257.
E-CST-70	H-37-70-(5)	<u>P.M. D.C. Tachometer Generator</u> - Continuous operation to 5000 RPM, for student projects. Voltage output scale may vary from 1V/1000 to 10V/1000. Such as: AST/Servo Systems Stock # TG-181.
E-CST-71	H-P-71-(1)	<u>Process Camera, Vertical</u> - Compact, not over 25" deep x 30" wide x 50" high. Built in lighting, capable of backlighting, auto focus, accurate calibrated system to produce enlargement to 200% and reduction to 50% - built in timer. Capacity to 16" x 20" copy on negatives up to 12" x 18". Vacuum system for negative hold down for operation on 220 V 50 Hz.
E-CST-72	H-P-72-(1)	<u>Spray Etcher, P.C. Board</u> - Double sided spray etcher for printed circuit boards. Temperature controlled, with racks to hold boards up to 10" x 14". Pumps to operate from 220 V 50 Hz. About 4 gallon capacity. Such as Kepro Model # BTE-202, Kepro Circuit Systems, Inc. 3630 Scarlet Oak Blvd., St. Louis, MO. 63122, U.S.A.
E-CST-73	H-P-73-(1)	<u>Light Box Ultraviolet</u> - For exposure of up to 10" x 14" printed circuit board photosensitive coatings.
E-CST-74	H-C-74-(1)	<u>Clip on Ammeter</u> - To measure 50 hz A.C. Currents 0-150 A range and 0-600 A range.

CST-28

MASTER EQUIPMENT LIST

CONTROL SYSTEMS AND TRANSDUCERS (CST)

For

HOMS INTERMEDIATE TECHNICAL INSTITUTE

CODES:	1. Teaching Spaces	
	1.1 Control systems lab, IBRD No.	31
	1.2 Transducers (Instruments) Lab., IBRD No.	37
	1.3 Common Room	C
	1.4 Printed Circuit Facility	P
	2. Equipment	
	1.1 Equipment	E
	1.2 Small Tools	S
	1.3 Instructional Material	I
	1.4 Furniture	F
	1.5 Semi useable material	U

MASTER EQUIPMENT LIST
CONTROL SYSTEMS AND TRANSDUCERS

EQUIPMENT

REFERENCE NUMBER	DESCRIPTION	QUANTITY	UNIT	TOTAL
E-CST-1	Oscilloscopes, Dual Trace	23	1,000	23,000.00
E-CST-2	Oscilloscope, Camera (to fit scopes of E-CST-1)	1	550	550.00
E-CST-3	Oscilloscopes, Dual Trace, Storage	2	1,300	2,600.00
E-CST-4	Oscilloscope, Camera (to fit scopes of E-CST-3)	1	660	660.00
E-CST-5	Recorders, Two Channel	2	2,500	5,000.00
E-CST-6	Digital VOMI Meters	30	345	10,350.00
E-CST-7	Digital VOM Meter, Reference	1	2,200	2,200.00
E-CST-8	Capacitor Meter	15	300	4,500.00
E-CST-9	RLC Bridge	1	1,000	1,000.00
E-CST-10	Function Generators	22	400	8,800.00
E-CST-11	Electronic Counters	8	300	2,400.00
E-CST-12	Stroboscope	2	325	650.00
E-CST-13	Drill Press, Precision	1	255	255.00
E-CST-14	Pressure Gauge Calibrator	1	280	280.00
E-CST-15	Hand Tachometer	2	175	350.00
E-CST-16	Stopwatch	2	100	200.00
E-CST-17	Transformers, stepdown	8	18	144.00
E-CST-18	Transformers, Variable	8	40	320.00
E-CST-19	Transformers, Power Supply, $\pm 15V$	20	6	120.00
E-CST-20	Transformers, Power Supply, 5V	10	15	150.00
E-CST-21	Decade Resistor Box	8	40	320.00
E-CST-22	Decade Capacitor Box	8	30	240.00
E-CST-23	Capacitor Substitution Box	8	20	160.00
E-CST-24	Hookup Leads, BNC to Grabber, with repair tips	200	7	1,400.00
E-CST-25	Hookup Leads, Banana Plug, Stacking	200	1.70	340.00
E-CST-26	Adaptors, Dual Banana to BNC Receptacle	10	3.50	35.00
E-CST-27	Digital Panel Meters	8	80	640.00
E-CST-28	Integrated Circuit Proto Trainer	25	125	3,125.00
E-CST-29	I.C. Socket and Bu. Strips	25	15	375.00
E-CST-30	Power Supplies, Triple Output	5	80	400.00

MASTER EQUIPMENT LIST
CONTROL SYSTEMS AND TRANSDUCERS

EQUIPMENT

REFERENCE NUMBER	DESCRIPTION	QUANTITY	UNIT	TOTAL
E-CST-31	I.C. Sockets, 8 and 14 Pin	100	0.40	40.00
E-CST-32	Adaptors, 3 Prong Europe to 3 American	20	1	20.00
E-CST-33	Alligator Clips to Banana Socket, Adaptor	200	0.10	20.00
E-CST-34	Strip Convenience Outlets	12	30	360.00
E-CST-35	Process Control System, Pneumatic, Liquid Level	1	10,000	10,000.00
E-CST-36	Process Control System, Electric, Heat Load	1	2,000	2,000.00
E-CST-37	Control System, Electromechanical, D.C.	1	6,000	6,000.00
E-CST-38	Control System, Motor, D.C.	1	2,200	2,200.00
E-CST-39	Control System, Electrohydraulic	1	13,000	13,000.00
E-CST-40	Numerical Controller	1	1,500	1,500.00
E-CST-41	Process Control System, pH Process	1	16,750	16,750.00
E-CST-42	Pneumatic Controller Trainer	1	3,700	3,700.00
E-CST-43	SCR Speed Controller, with Motor	2	300	600.00
E-CST-44	D.C. Motors	10	20	200.00
E-CST-45	Synchro Trainer	1	289	289.00
E-CST-46	Kit, Temperature Transducers	1	2,500	2,500.00
E-CST-47	Kit, Flow Transducers	1	2,500	2,500.00
E-CST-48	Kit, Displacement Transducers	1	2,500	2,500.00
E-CST-49	Kit, Electromechanical, Student Projects	1	850	850.00
F-CST-50	Kit, Chemical Transducers	1	1,500	1,500.00
E-CST-51	Kit, Light Transducers	1	1,500	1,500.00
E-CST-52	Kit, Pressure Transducers	1	3,500	3,500.00
E-CST-53	Kit, Actuators	1	3,500	3,500.00
E-CST-54	Electric $\frac{1}{4}$ inch hand drill	1	50	50.00
E-CST-55	Drill Set with Case	2	50	100.00
E-CST-56	Chemical Trays	8	3	24.00
E-CST-57	Wash Tank	1	10	10.00
E-CST-58	Shear, Precision	1	175	175.00
E-CST-59	Air Conditioner	1	200	200.00
E-CST-60	Carbide Drills	24	1.67	40.00

CST-32

MASTER EQUIPMENT LIST
CONTROL SYSTEMS AND TRANSDUCERS

EQUIPMENT

REFERENCE NUMBER	DESCRIPTION	QUANTITY	UNIT	TOTAL
E-CST-61	Measuring Cup	2	1	2.00
E-CST-62	Brown Glass Bottles	12	1	12.00
E-CST-63	Funnel	2	1	2.00
E-CST-64	Thermometer	2	5	10.00
E-CST-65	Exposure Wheel	2	1	2.00
E-CST-66	Processing Tank	3	50	150.00
E-CST-67	Power Amplifiers, D.C.	3	350	1,050.00
E-CST-68	Transistor Curve Tracer	1	2,500	2,500.00
E-CST-69	Geared D.C. Motors	10	20	200.00
E-CST-70	P.M. D.C. Tachometer Generator	5	20	100.00
E-CST-71	Process Camera, Vertical	1	1,100	1,100.00
E-CST-72	Spray Etcher, P.C. Board	1	465	465.00
E-CST-73	Light Box, Ultra-violet	1	250	250.00
E-CST-74	Clip on Ammeter	1	50	50.00

CONTROL SYSTEMS AND TRANSDUCERS - FURNITURE

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
F-CST-1-(1)	H-31-1-(1) H-37-1-(1) H-C-1-(1) H-P-1-(1)	<u>Storage Lockers, Steel</u> - Two door, about 0.4 M deep by 0.9 M wide by 1.8 M high, with four shelves, adjustable by the user, grey color.
F-CST-2	H-C-2-(8) H-31-2-(2) H-37-2-(2)	<u>Shelving, Steel</u> - 18 gauge, grey color, free standing units with adequate bracing, each unit approximately 2 M high x 0.5 M deep x 1 M wide, 1 back, 1 side, 6 shelves plus top and bottom per unit. Designed so that user may adjust shelf height.
F-CST-3	F-C-3-(4)	<u>Shelving with Drawers, Steel</u> - Same 18 gauge steel units as Item F-CST-2, except fitted with steel drawers. Drawers approximately 0.12 M wide x 0.12 m high x 0.4 M deep, 3 dividers furnished per drawer. Unit will have about 3 drawers per shelf and 12 drawers high. Left over space at top as extra shelf.
F-CST-4	H-31-4-(5)	<u>Lab Benches</u> - Wooden benches approximately 0.9 M deep x 2.2 M long x 1.05 M high, sturdy enough to support up to 200 kilos of test equipment. Top could be 2 cm plywood covered with scratch resistant layer of material such as formica. Fitted with 2 drawers about 0.4 M wide x 0.15 M deep x 0.7 M long, and a fold out writing table of about 0.4 M x 0.4 M. Full shelf about 25 cm above floor, strong enough to hold equipment.
F-CST-5	H-31-5-(5) H-37-5-(7)	<u>Lab Bench, Instrument Stands</u> - Portable wooden rack with two shelves to sit on top of lab benches, to elevate instruments for easy viewing and minimize use of bench top for holding measuring instruments. Top shelf about 0.5 M deep sloped about 10° with a 0.3 cm ledge at front to keep equipment from sliding off, height of back of top shelf above table about 0.55 M above table top. Back covered only enough for suitable strength. Bottom shelf about 0.25 M from bottom, and 0.3 M deep.

CST-33

CONTROL SYSTEMS AND TRANSDUCERS - FURNITURE

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
F-CST-6	H-31-6-(1) H-37-6-(1)	<u>Coat Racks</u> - Simple wall mounting unit with bar long enough to hold 20 coats, approximately 1 M long. Top of structure should be a shelf for holding books.
F-CST-7	H-31-7-(1) H-37-7-(1)	<u>Student Lockers</u> - Suitable for storage of personal property and books. Cubicles about 12" x 12" x 15" deep for 40 students. A suitable arrangement of 20 units, 5 tiers, high x 4 wide.
F-CST-8	H-31-8-(20) H-37-8-(20)	<u>Lab Stool</u> - About 0.75 M high, sturdy wood or metal, non-marring feet, with foot ring.
F-CST-9	H-31-9-(1) H-37-9-(1)	<u>Instructors Desk</u> - About 0.7 M x 1.2 M fitted with legal size file drawer and pencil drawer. About 0.7 M high.
F-CST-10	H-C-10-(2)	<u>Maintenance Work Bench</u> - Construction similar to lab benches, item F-CST-4, except 0.75 M high, 3 drawers, and no writing table.
F-CST-11	H-C-11-(3) H-P-11-(1)	<u>File Cabinets</u> - Steel, legal size, 4 drawer, sturdy construction, roller type drawers, adjustable keeper to keep files of any size upright.
F-CST-12	H-C-12-(30)	<u>Clipboards</u> - 10" x 18" approximately, pressed board or sturdy plastic, for use of student in writing laboratory experimental data.
F-CST-13	H-31-13-(1) H-37-13-(1)	<u>Tote Carts, Steel</u> - Used to transport oscillosopes and other instruments from lab to lab, and to lecture room for demonstrations. About 20" wide x 28" long x 32" high; two trays about 3" deep; 4" - 5" castors, 2 of which swivel.

CST-34

CONTROL SYSTEMS AND TRANSDUCERS - FURNITURE

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
F-CST-14	H-P-14-(1)	<u>Chemical Sink and Sink Top</u> - Top to be chemical resistant material on wood or plywood about 2.5 cm thick - dimensions about 0.9 M x 2.5M with hole fitted for sink. Sink of stainless steel about 0.45 M wide x 0.35 M, 0.2 M deep. Lead lined trap and sufficient plumbing to reach main drain. All threaded parts to be acid resistant. Swivel faucet for hot and cold water to be furnished.
F-CST-15	H-P-15-(1)	<u>Work Table</u> - Same as in Item F-CST-10, except 1.2 M long.
F-CST-16	H-31-16-(1) H-37-16-(1) H-C-16-(1) H-P-16-(1)	<u>Waste Baskets</u> - About 0.3 M square x 0.4 M high; sturdy, grey plastic.

CST-36

MASTER EQUIPMENT LIST
CONTROL SYSTEMS AND TRANSDUCERS

FURNITURE

REFERENCE NUMBER	DESCRIPTION	QUANTITY	UNIT	TOTAL
F-CST-1	Storage Lockers, Steel	4	75	300
F-CST-2	Shelving, Steel	12	60	720
F-CST-3	Shelving with Drawers, Steel	4	630	2,520
F-CST-4	Lab Benches	12	200	2,400
F-CST-5	Lab Bench - Instrument Stands	12	75	900
F-CST-6	Coat Racks	2	15	30
F-CST-7	Student Lockers	2	177	354
F-CST-8	Lab Stools	40	13	520
F-CST-9	Instructors Desk	2	200	400
F-CST-10	Maintenance Work Bench	4	300	1,200
F-CST-11	File Cabinet	4	50	200
F-CST-12	Clipboards	30	2	60
F-CST-13	Tote Carts, Steel	2	45	90
F-CST-14	Chemical Sink and Sink Top	1	400	400
F-CST-15	Work Table	1	200	200
F-CST-16	Waste Baskets	4	10	40

CONTROL SYSTEMS AND TRANSDUCERS - USABLE

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
U-CST-1	H-P-1-(10)	<u>Layout Paper, Sheets</u> - 1/10" grid (light blue lines) layout paper for printed circuits. Good quality paper but not necessarily mylar. A suitable type in sheets 22 in wide x 10 f long is offered.
U-CST-2	H-P-2-(20)	<u>Printed Circuit Kit</u> - Contains three (3) 3" x 6' 1 oz copper coated glass epoxy laminated blanks, unsensitized, resist ink pen, assorted pressure sensitive terminal circles and conductor strips, graph layout paper, ferric chloride etching solution with tray and lid and cleaning pad to prepare finished board for soldering.
U-CST-3	H-P-3-(24)	<u>Developer, Film</u> - Standard Kodalith two-stage developer, or equivalent, in quart sizes.
U-CST-4	H-P-4-(24)	<u>Fixer, Hypo</u> - Any standard hypo in sealed cans of size to make one gallon.
U-CST-5	H-P-5-(6)	<u>Stop Fix</u> - Standard glacial Acetic Acid, pint size.
U-CST-6		Delete
U-CST-7	H-P-7-(2)	<u>Indicator, Hypo</u> - 3/4 fluid oz plastic drop dispenser package for checking hypo condition.
U-CST-8	H-P-8-(24)	<u>Copy Film</u> - Eastman Kodak Kodalith in 10" x 12" sheets.
U-CST-9	H-P-9-(100)	<u>Logic Chips, C-Mos Plastic DIP</u> - 24 each - Hexinverters; 24 each Quad 2 input NAND gates (CD-4011A); 24 each - Dual JK w/Set/Reset (CD-4027A); 24 each - Dual D w/Set/Reset (CD-4013A).
U-CST-10	H-P-10-(4)	<u>Photo Sensitive Resist</u> - For making dip or flow photo sensitive coating on copper clad boards, quart size. Kodak photo resist type 3, or equivalent.

CST-37

CONTROL SYSTEMS AND TRANSDUCERS - USABLE

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
U-CST-11	H-P-11-(6)	<u>Copper Clad Chemical Cleaner</u> - Suitable for preparing copper coated boards for photo resist covering, quart size.
U-CST-12	H-P-12-(3)	<u>Photo Resist Thinner</u> - Suitable for thinning material of U-CST-10 in quart size.
U-CST-13	H-P-13-(6)	<u>Photo Resist Developer</u> - Quart size, suitable for developing coating of U-CST-10.
U-CST-14	H-P-14-(4)	<u>Copper Clad Circuit Board</u> - 1/16" glass epoxy, coated both sides with about 2 oz (0.0027") copper. Sheets about 12" x 36".
U-CST-15	H-P-15-(4)	<u>Cleaning Pad</u> - Very fine cleaning pads for abrasive copper clad cleaning. Scotchbrite in 12" x 24" rolls is suitable.
U-CST-16		Delete
U-CST-17	H-P-17-(20)	<u>Art Work, Donuts</u> - Black, pressure sensitive, about 1/4" O.D. with 1/16" hole, supplied on cards of 96.
U-CST-18	H-P-18-(6)	<u>Art Work, Tape, Roll</u> - Black opaque, 18 yards per roll, 0.093" approximate width, pressure sensitive.
U-CST-19	H-P-19-(6)	<u>Art Work, Pads</u> - Black opaque, dual in line, pressure sensitive, 1 X size, 14 pin, supplied in packages of 60.
U-CST-20	H-P-20-(8)	<u>Art Work, Pads</u> - Black opaque, pressure sensitive, 2 X size, 14 pin DIP, supplied in packages of 44.

CST-38

CONTROL SYSTEMS AND TRANSDUCERS - USABLE

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION																																																			
U-CST-21	H-P-21-(1000)	<u>Labels</u> - Suitable for sticking to chemical bottles for labeling purposes. About 3/4" x 1-1/4", suitable for writing with ink.																																																			
U-CST-22	H-C-22-(12)	<u>Tape, Plastic, Electric, Roll</u> - Black, approximate 3/4" wide x 0.007" thick, dielectric strength 10,000 volts, 20 ft/roll.																																																			
U-CST-23	H-C-23-(50)	<u>Hook-up Wire, Rolls</u> - Solid, tinned, # 22 AWG wire, vinyl covered in five solid colors (i.e., 10 of each color), with 10 dispensing racks for groups of 5.																																																			
U-CST-24	H-C-24-(12,750)	<p><u>Resistors</u> - 1/4 watt hot molded fixed composition, industrial grade style RC, 10% tolerance, standard color code.</p> <table border="0" style="width: 100%;"> <tr> <td style="width: 33%;">10 ohm)</td> <td style="width: 33%;">1500 ohm)</td> <td style="width: 33%;"></td> </tr> <tr> <td>33 ohm)</td> <td>2700 ohm)</td> <td></td> </tr> <tr> <td>47 ohm)</td> <td>3300 ohm)</td> <td></td> </tr> <tr> <td>100 ohm)</td> <td>4700 ohm)</td> <td>250 each</td> </tr> <tr> <td>220 ohm)</td> <td>5600 ohm)</td> <td></td> </tr> <tr> <td>470 ohm)</td> <td>6800 ohm)</td> <td></td> </tr> <tr> <td>1000 ohm)</td> <td></td> <td></td> </tr> <tr> <td>1.8 megohm)</td> <td>82 kilohms)</td> <td></td> </tr> <tr> <td>2.7 megohm)</td> <td>100 kilohms)</td> <td></td> </tr> <tr> <td>4.7 megohm)</td> <td>150 kilohms)</td> <td>500 each</td> </tr> <tr> <td>10 megohm)</td> <td>220 kilohms)</td> <td></td> </tr> <tr> <td></td> <td>270 kilohms)</td> <td></td> </tr> <tr> <td>10 kilohms)</td> <td>330 kilohms)</td> <td></td> </tr> <tr> <td>15 kilohms)</td> <td>470 kilohms)</td> <td></td> </tr> <tr> <td>22 kilohms)</td> <td>560 kilohms)</td> <td></td> </tr> <tr> <td>33 kilohms)</td> <td>680 kilohms)</td> <td>500 each</td> </tr> <tr> <td>47 kilohms)</td> <td>1,000 kilohms)</td> <td></td> </tr> </table>	10 ohm)	1500 ohm)		33 ohm)	2700 ohm)		47 ohm)	3300 ohm)		100 ohm)	4700 ohm)	250 each	220 ohm)	5600 ohm)		470 ohm)	6800 ohm)		1000 ohm)			1.8 megohm)	82 kilohms)		2.7 megohm)	100 kilohms)		4.7 megohm)	150 kilohms)	500 each	10 megohm)	220 kilohms)			270 kilohms)		10 kilohms)	330 kilohms)		15 kilohms)	470 kilohms)		22 kilohms)	560 kilohms)		33 kilohms)	680 kilohms)	500 each	47 kilohms)	1,000 kilohms)	
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CST-39

CONTROL SYSTEMS AND TRANSDUCERS - USABLE

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION																																													
U-CST-24 (Cont'd)	H-C-24-(12,750)	56 kilohms) 68 kilohms) 500 each																																													
U-CST-25	H-C-25-(5300)	<p>Capacitors, Non Polarized - Suitable for low voltage, non polarized use in integrated circuits. Mylar, polycarbonate, polyester or polystyrene. 25 V is suitable, but higher voltage rating acceptable where extra bulk is not excessive. Wherever possible, lead diameter should not exceed # 22 AWG. In some cases (particularly the pico farad sizes), dipped mica is acceptable - ceramic is not.</p> <table> <tr> <td>0.001 microfarad)</td> <td>25 picofarads)</td> <td></td> </tr> <tr> <td>0.0022 microfarad)</td> <td>50 picofarads)</td> <td></td> </tr> <tr> <td>0.0047 microfarad)</td> <td>100 picofarads)</td> <td></td> </tr> <tr> <td></td> <td>200 picofarads)</td> <td>100 each</td> </tr> <tr> <td></td> <td>500 picofarads)</td> <td></td> </tr> <tr> <td>0.01 microfarad)</td> <td></td> <td></td> </tr> <tr> <td>0.047 microfarad)</td> <td></td> <td></td> </tr> <tr> <td>0.1 microfarad)</td> <td></td> <td></td> </tr> <tr> <td>0.22 microfarad)</td> <td>500 each</td> <td></td> </tr> <tr> <td>0.33 microfarad)</td> <td></td> <td></td> </tr> <tr> <td>0.47 microfarad)</td> <td></td> <td></td> </tr> <tr> <td>0.68 microfarad)</td> <td></td> <td></td> </tr> <tr> <td>1.0 microfarad)</td> <td></td> <td></td> </tr> <tr> <td>3.0 microfarad)</td> <td></td> <td></td> </tr> <tr> <td>7.0 microfarad)</td> <td>25 each</td> <td></td> </tr> </table>	0.001 microfarad)	25 picofarads)		0.0022 microfarad)	50 picofarads)		0.0047 microfarad)	100 picofarads)			200 picofarads)	100 each		500 picofarads)		0.01 microfarad)			0.047 microfarad)			0.1 microfarad)			0.22 microfarad)	500 each		0.33 microfarad)			0.47 microfarad)			0.68 microfarad)			1.0 microfarad)			3.0 microfarad)			7.0 microfarad)	25 each	
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7.0 microfarad)	25 each																																														

CST-40

CONTROL SYSTEMS AND TRANSCRIBERS - USALLE

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION												
U-CST-26	H-C-26-(40C)	<p><u>Trimpots</u> - 1 turn, thumb wheel adjust, cermet, P.C. mount, 0.25 watt to 0.75 watt rating.</p> <p>1000 ohms) 5000 ohms) 10000 ohms) 100 each 50000 ohms)</p>												
U-CST-27	H-C-27-(500)	<p><u>Diodes, Silicon, Signal</u> - Signal diodes suitable for use in operational amplifier circuits. 1N914 is a recommended type.</p>												
U-CST-28	H-C-28-(20)	<p><u>Diode Bridges</u> - 4 terminal, 5A, 200 V_{rrm}.</p>												
U-CST-29	H-C-29-(90)	<p><u>Zener Diodes</u> -</p> <table border="0"> <tr> <td>5.1 V</td> <td>1 watt</td> <td>-</td> <td>20 each</td> </tr> <tr> <td>6.8 V</td> <td>1 watt</td> <td>-</td> <td>20 each</td> </tr> <tr> <td>15 V</td> <td>1 watt</td> <td>-</td> <td>50 each</td> </tr> </table>	5.1 V	1 watt	-	20 each	6.8 V	1 watt	-	20 each	15 V	1 watt	-	50 each
5.1 V	1 watt	-	20 each											
6.8 V	1 watt	-	20 each											
15 V	1 watt	-	50 each											
U-CST-30	H-C-30-(100)	<p><u>Transistors, Silicon, General Purpose, Plastic Package</u> - Silicon, plastic package such as TO-92; V (Br) CEO, 50 V, hFE 200-600.</p> <p>70 each, NPN. 30 each, PNP.</p>												
U-CST-31	H-C-31-(200)	<p><u>Integrated Circuit, Operational Amplifier</u> - Eight (8) pin plastic mini-dip, J-fet input, 4.5 mhz open loop B.W. typical. 3-10 mv. input offset, 30 pa bias current, 10¹² ohms input impedance, typical. Internally compensated to unity gain. 10 V/ms minimum slew rate for use as precision high speed integrators, high impedance buffers, sample and hold circuits and other. Has standard 741 type pin out. Only known source: National Semiconductor # LF 356; 2900 Semiconductor Drive, Santa Clara, California 95051, U.S.A.</p>												

CST-41

CONTROL SYSTEMS AND TRANSDUCERS -USABLE

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
U-CST-32	H-C-32-(50)	<u>I.C. Voltage Regulators, Adjustable</u> - Only two external resistors needed to adjust output over range from 1.2 to 37 V, 1.5A output, with current limit, thermal over load and safe area protection. 80 dB. Ripple rejection, TO-5 package similar to National Semiconductor # LM 317H.
U-CST-33	H-C-33-(40)	<u>I.C. Voltage Regulators, Dual Tracking</u> - Eight (8) pin plastic minidip, fixed ± 15 V 60 ma short circuit and thermal protection. Similar to Raytheon 4195, commercial grade.
U-CST-34	H-C-34-(50)	<u>I.C. Timers</u> - 555 type, plastic (8 pin) minidip, for accurate time delays. Also used as an oscillator. Commercial grade.
U-CST-35	H-C-35-(50)	<u>I.C. Analog Switches</u> - Quad SPST, TTL/DTL compatible, 14 pin DIP plastic, suitable for analog signals up to ± 10 V. 200 ohms on resistance to 10^{11} ohms off, typical. Commercial rating similar to National Semiconductor # AH 0015C.
U-CST-36	H-C-36-(25)	<u>I.C. Voltage Controlled Oscillator</u> - Plastic 8 pin minidip, commercial grade. Type 566.
U-CST-37	H-C-37-(25)	<u>I.C. Transistor Arrays</u> - General purpose, 14 pin plastic DIP, 1 common emitter pair, 3 individual transistors, high voltage, all silicon NPN. Similar to National Semiconductor # LM 3146.
U-CST-38	H-C-38-(12)	<u>I.C. 2 Wire Transmitter</u> - Ten (10) pin TO-8 metal case, for use in process control, instrumentation and data acquisition applications. Designed to convert voltage from a sensor to a current, using supply wires also as signal wires. Single supply operation 10 to 50 V. Similar to National Semiconductor # LM 0045C.

CST-42

CONTROL SYSTEMS AND TRANSDUCERS - USABLE

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
U-CST-39	H-C-39-(175)	<p><u>Fuses, Assortment</u> - 250 V, 1" long x 1/4" diameter.</p> <p>1/8 Amp - 25 each 1/4 Amp - 25 each 1/2 Amp - 50 each 1 Amp - 50 each 2 Amp - 25 each</p>
U-CST-40	H-C-40-(100)	<p><u>Transistors, Silicon, TO-5 Case</u> - General purpose, medium power, in TO-5 metal package. 60 V; h_{FE} 40-140; IA:</p> <p>70 each, 2N-2102, NPN 30 each, 2N-4036, PNP</p>
U-CST-41	H-C-41-(25)	<p><u>Transistors, Silicon, 1.5A, 3.5 V</u> - TO-3, with current and power limiting, as well as thermal overload, NPN silicon.</p>
U-CST-42	H-C-42-(50)	<p><u>Transistors, 15A, 140 V, Silicon</u> - TO-66, matched NPN & PNP</p> <p># 2N3773 NPN - 30 each # 2N6609 PNP - 20 each</p>
U-CST-43	H-C-43-(25)	<p><u>Silicon Controlled Rectifiers</u> - General purpose, for use on 220 V power (Vorom, 700 V). Maximum gate trigger current 15 ma, Irms current 10A.</p>

CST-43

CONTROL SYSTEMS AND TRANSDUCERS - USABLE

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
U-CST-44	H-C-44-(25)	<u>I.C. Frequency to Voltage Converter</u> - For converting such things as tachometer pulses to a D.C. signal and over/under speed sensing, 50 ma source or sink to operate relays or solenoids, 8 pin plastic minidip. Such as National Semiconductor # LM 2917.
U-CST-45	H-C-45-(25)	<u>I.C. Temperature Controller</u> - Eight (8) pin epoxy minidip, suitable for measuring temperatures from -25°C to +85°C. Such as National Semiconductor # LM 3911.
U-CST-46	H-C-46-(50)	<u>Capacitors, Tubular, Aluminum, Electrolytic</u> - 50 each, 1500 microfarad, 50 V.
U-CST-47	H-C-47-(25)	<u>Capacitors, Tubular, Aluminum, Electrolytic</u> - 25 each, 6500 microfarad, 75 V.
U-CST-48	H-C-48-(75)	<u>Capacitors, Aluminum Vertical Mount, Electrolytic, Assorted - Miniature.</u> 25 each, 5 microfarad 25 each, 15 microfarad all 15 V rating. 25 each, 25 microfarad
U-CST-49	H-C-49-(75)	<u>Capacitors, Solid Tantalum</u> - Radial leads, 35 V, for use with power supplies. 25 each, 0.33 microfarads 25 each, 1.00 microfarads 25 each, 4.7 microfarads
U-CST-50	H-C-50-(24)	<u>Film, Oscilloscope</u> - Polaroid, Type # 107 filmpacks.

CST-44

CONTROL SYSTEMS AND TRANSDUCERS - USABLE

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
U-CST-51	H-C-51-(3)	<u>Solder, Electrical, 5 lb Rolls</u> - Solder, resin core, about 1 mm diameter on 5 lb (or 2 kg) rolls, 60 tin, 40 lead.
U-CST-52	H-C-52-(25)	<u>Power Diodes</u> - 3A, 800 V _{PRV} . Axial leads.

CST-45

CST-46

MASTER EQUIPMENT LIST
CONTROL SYSTEMS AND TRANSDUCERS

USABLE

REFERENCE NUMBER	DESCRIPTION	QUANTITY	UNIT	TOTAL
U-CST-1	Layout Paper, Sheets	10	3.15	31.50
U-CST-2	Printed Circuit Kit	20	6.85	137.00
U-CST-3	Developer, Film	24	2.00	48.00
U-CST-4	Fixer, Hypo	24	2.00	48.00
U-CST-5	Stop Fix	6	2.00	12.00
U-CST-6	Delete this item	-	-	-
U-CST-7	Indicator, Hypo	2	2.00	4.00
U-CST-8	Copy Film	24	2.00	48.00
U-CST-9	Logic Chips, C-Mos Plastic DIP	100	100.00	100.00
U-CST-10	Photo Sensitive Resist	4 qt	25.80	103.20
U-CST-11	Copper Clad Chemical Cleaner	6 qt	3.85	23.10
U-CST-12	Photo Resist Thinner	3	5.65	16.95
U-CST-13	Photo Resist Developer	6 qt	5.80	34.80
U-CST-14	Copper Clad Circuit Board	4	33.00	396.00
U-CST-15	Cleaning Pad	4	6.50	26.00
U-CST-16	Delete this item	-	-	-
U-CST-17	Art Work, Donuts on Cards	20	.70	14.00
U-CST-18	Art Work, Tape, Roll	6	1.25	7.50
U-CST-19	Art Work, Pads, 60/package	6	3.75	22.50
U-CST-20	Art Work, Pads, 44/package	8	2.75	22.00
U-CST-21	Labels	Package of 1000	3.00	3.00
U-CST-22	Tape, Pastic, Electric, roll	12	1.00	12.00
U-CST-23	Hook Up Wire, Rolls	50	3.00	150.00
U-CST-24	Resistors	12,750	0.11	1,400.00
U-CST-25	Capacitors, Non Polarized	5,300	varies	1,375.00
U-CST-26	Trim pots	400	0.60	240.00
U-CST-27	Diodes, Signal, Silicon	500	0.15	75.00
U-CST-28	Diode Bridges	20	4.00	80.00
U-CST-29	Zener Diodes	90	1.00	90.00
U-CST-30	Transistors, Silicon, general purpose, plastic pkg.	100	0.60	60.00

CST-47

MASTER EQUIPMENT LIST
CONTROL SYSTEMS AND TRANSDUCERS

USABLE

REFERENCE NUMBER	DESCRIPTION	QUANTITY	UNIT	TOTAL
U-CST-31	Integrated Circuits, Operational Ampl.	200	0.75	150.00
U-CST-32	I.C. Voltage Regulators, Adjustable	50	1.50	75.00
U-CST-33	I.C. Voltage Regulators, dual tracking	40	2.50	100.00
U-CST-34	I.C. Timers	50	1.00	50.00
U-CST-35	I.C. Analog Switches	50	2.00	100.00
U-CST-36	I.C. Voltage Controlled Oscillator	25	4.00	100.00
U-CST-37	I.C. Transistor Arrays	25	2.00	50.00
U-CST-38	I.C. 2 Wire Transmitter	12	8.00	96.00
U-CST-39	Fuses, assortment	175	0.20	35.00
U-CST-40	Transistors, Silicon, T-05 metal	100	2.00	200.00
U-CST-41	Transistors, Silicon, 1.5A, 35 V	25	6.00	150.00
U-CST-42	Transistors, 15A., 140 V	50	3.50	175.00
U-CST-43	Silicon Controlled Rectifiers	25	4.00	100.00
U-CST-44	I.C. Frequency to Voltage Converter	25	4.00	100.00
U-CST-45	I.C. Temperature Controller	25	5.00	125.00
U-CST-46	Capacitors, Electrolytic, 1500 mf.	50	1.80	90.00
U-CST-47	Capacitors, Electrolytic, 6500 mf	25	4.00	100.00
U-CST-48	Capacitors, Electrolytic, assorted	75	0.50	37.50
U-CST-49	Capacitors, Tantalum, Solid	75	0.60	45.00
U-CST-50	Film Oscilloscope	24	4.00	96.00
U-CST-51	Solder, Electrical, 5 lb Rolls	3	35.00	105.00
U-CST-52	Power Diodes	25	0.70	17.50

CONTROL SYSTEMS AND TRANSDUCERS - SMALL TOOLS

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
S-CST-1	H-C-1-(12)	<p><u>Pliers, Needle Nose</u> - Drop forged high grade steel, with cutter -</p> <p>about 2½" long jaws (regular, about 5½" overall) - 6 each about 1½" long jaws (midget, 4" overall) - 6 each</p>
S-CST-2	H-C-2-(12)	<p><u>Diagonal Cutters</u> - Drop forged high grade steel -</p> <p>midget size, about 4" overall - 6 each regular size, about 5" overall - 6 each</p>
S-CST-3	H-C-3-(2)	<p><u>Solder Gun</u> - 200 W, 200 V, 50 hz, include 3 long life copper replacement tips per kit.</p>
S-CST-4	H-C-4-(8)	<p><u>Solder Irons</u> - 40 W, 220 V pencil type with coil spring stand. Iron clad tellurium copper, silver plated. Include 2 spare tips with each iron.</p>
S-CST-5	H-C-5-(6)	<p><u>Wire Stripper, Simple</u> - Tool steel multi purpose - crimp, cut and strip from # 16 AWG to # 26 AWG.</p>
S-CST-6	H-C-6-(1)	<p><u>Wire Stripper, Automatic</u> - Automatic, one squeeze operation for any wire from AWG # 16 to 26, without scraping wire or injuring insulation; similar to "custom strip master" as sold by most US Electronic Supply houses.</p>
S-CST-7	H-C-7-(6)	<p><u>Allen Wrenches</u> - Fifteen (15) piece sets in plastic pouch 0.028", 0.035", 0.050" up to 3/8"; to be made of alloy steel..</p>
S-CST-8	H-C-8-(2)	<p><u>Spin Tite Nut Drivers</u> - Deep sockets connected to plastic screw driver type handle. 7 tools furnished with stand, sizes 3/16", 1/16", 5/16", 11/32", 3/8", 7/16" and 1/2".</p>
S-CST-9	H-C-9-(1)	<p><u>Open End-Box Combination Wrench, Set</u> - Forged chrome alloy, 10° box off-set, 15° open end</p>

CST-48

CONTROL SYSTEMS AND TRANSDUCERS - SMALL TOOLS

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
S-CST-9 (Cont'd)	H-C-9-(1)	angle. 14 pieces, 3/8" through 1-1/16" by 1/16" and 1-1/8" and 1-1/4" - supplied in plastic roll package.
S-CST-10	H-C-10-(6)	<u>Adjustable Wrench</u> - Crescent, forged alloy steel 2 - 6" size 2 - 10" size 2 - 15" size
S-CST-11	H-C-11-(1)	<u>Pliers, Channellock</u> - Forged and heat treated steel, tongue and groove construction, seven slip joint adjustments to 2".
S-CST-12	H-C-12-(2)	<u>Solder Suckers</u> - Rubber bulb with teflon tip for removal of hot solder.
S-CST-13	H-C-13-(18)	<u>Screw Drivers, Flat Head, General Purpose</u> - Hammer forged, head treated steel, deep fluted handle. 7/32" x 0.032" tip, 3" blade - 6 each required 1/2" x 0.037" tip, 4" blade - 6 each required 5/16" x 0.041" tip, 6" blade - 6 each required
S-CST-14	H-C-14-(6)	<u>Screw Driver, Phillips Head</u> - Forged or chrome vanadium Phillips size 1, 3" blade - 2 each Phillips size 2, 4" blade - 2 each Phillips size 3, 6" blade - 2 each

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CONTROL SYSTEMS AND TRANSDUCERS - SMALL TOOLS

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
S-CST-15	H-C-15-(3)	<u>Screw Driver Set, Industrial Miniature</u> - Forged steel, jewelers set of six complete screw drivers: 0.025", 0.055", 0.070", 0.080" and 0.100".
S-CST-16	H-C-16-(1)	<u>Nibbling Shears</u> - Heat treated tool steel jaws, to cut up to 1/16" steel for cutting straight or curved patterns without distorting metal.
S-CST-17	H-C-17-(2)	<u>Tin Snips</u> - Forged steel body, hardened cutting edge 7" length, 1 each 10" length, 1 each
S-CST-18	H-C-18-(4)	<u>Chassis, or Knock Out, Punch</u> - Hardened alloy steel punch, hardened screw. To cut up to 16 gauge steel. Round 1/2" - 1 each Round 3/4" - 1 each Round 1" - 1 each Square 1/2" - 1 each

CST-50

CST-51

MASTER EQUIPMENT LIST
CONTROL SYSTEMS AND TRANSDUCERS

SMALL TOOLS

REFERENCE NUMBER	DESCRIPTION	QUANTITY	UNIT	TOTAL
S-CST-1	Pliers, Needle Nose	12	8.00	96.00
S-CST-2	Diagonal Cutter	12	8.00	96.00
S-CST-3	Solder Gun	2	15.00	30.00
S-CST-4	Solder Iron	8	15.00	120.00
S-CST-5	Wire Stripper, Simple	6	8.00	48.00
S-CST-6	Wire Stripper, Automatic	1	30.00	30.00
S-CST-7	Allen Wrenches	6	3.00	18.00
S-CST-8	Spin Tite nut drivers	2	20.00	40.00
S-CST-9	Open end-box Combination Wrench, Set	1	50.00	50.00
S-CST-10	Adjustable Wrench	6	8.33	50.00
S-CST-11	Pliers, Channellock	1	5.00	5.00
S-CST-12	Solder Sucker	2	2.50	5.00
S-CST-13	Screwdriver, Flat Head, General Purpose	18	2.25	40.50
S-CST-14	Screwdriver, Phillips	6	1.00	6.00
S-CST-15	Screwdriver Set, Industrial Miniature	3	8.00	24.00
S-CST-16	Nibbling Shears	1	20.00	20.00
S-CST-17	Tin Snips	2	6.00	12.00
S-CST-18	Chassis Punches	4	8.75	35.00

CONTROL SYSTEMS AND TRANSDUCERS - INSTRUCTIONAL MATERIALS

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
I-CST-1	H-C-1-(4)	<p><u>Movies, 16 mm -</u></p> <p>"Synchronous Machines: Electromechanical Dynamics" 33 min, black/white, sound - about \$200.00</p> <p>"Basic Electromechanical Instrument Mechanisms" 29 min, black/white, sound - about \$180.00</p> <p>"An Introduction to the General Purpose Oscilloscope" 23 min, color, sound - about \$230.00</p> <p>"Harmonic Phasors" 7 min, black/white, silent - about \$35.00</p>
I-CST-2	H-C-2-(2)	<p><u>Movies, 16 mm -</u></p> <p>"Vorticity" 44 min, black/white, sound, Parts I and II - about \$200.00</p> <p>"Flow Visualization" 31 min, black/white, sound - about \$150.00</p>

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CONTROL SYSTEMS AND TRANSDUCERS - INSTRUCTIONAL MATERIALS

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
I-CST-3	H-C-3-(9)	<p><u>Film Loops, 8 mm Cartridges -</u></p> <p>"Identifying Solids by Density" 4 min, color, super 8 # A80-3262 - about \$20.00</p> <p>"Identifying Liquids by Density" 4 min, color, super 8 # A80-3270/1 - about \$20.00</p> <p>"Thermal Expansion of Solids" 4 min, color, super 8, # A80-3296/1 - about \$20.00</p> <p>"Thermal Expansion of Liquids" 4 min, color, super 8, # A80-3304/1 - about \$20.00</p> <p>"Liquid Forces" 3 min, color, super 8, # A82-0001/1 - about \$20.00</p> <p>"Density of Liquids" 2 min, color, super 8, # A82-0043/1 - about \$20.00</p> <p>"Convection in Liquids" 3 min, color, super 8, # A82-0050/1 - about \$20.00</p> <p>"Energy Conversion" 4 min, color, super 8 # A80-3437/1 - about \$20.00</p> <p>"Conservation of Energy" 4 min, color, super 8, # A80-3445/1 - about \$20.00</p>

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CONTROL SYSTEMS AND TRANSDUCERS - INSTRUCTIONAL MATERIALS

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
I-CST-3 (Cont'd)	H-C-3-(9)	All of the preceding cassettes are available from: The Ealing Corporation, 2225 Massachusetts Avenue, Cambridge, Massachusetts 02140, U.S.A.
I-CST-4	H-C-4-(12)	<p><u>Books, Text -</u></p> <p>"Circuits, Devices and Systems" - 3rd Edition, 1976; by Ralph J. Smith - John Wiley and Sons</p> <p>"Feedback Control System Analysis and Synthesis" - 2nd Edition; by D'Azzo and Houpis - McGraw-Hill</p> <p>"Introduction to Control Systems Technology - by Bateson - Chas E. Merrill Co., 1300 Alum Creek Drive Columbus, Ohio</p> <p>"Basic Instrumentation Lecture Notes & Study Guide: Measurement Fundamentals" - Published by: Instrument Society of America, 400 Stanwix Street Pittsburg, PA 15222, U.S.A.</p> <p>"Measurement Systems, Application and Design" - 1975 by E.O. Doebelin - McGraw-Hill</p> <p>"Industrial Instrumentation Fundamentals" - 1962 by Fribance - McGraw-Hill</p> <p>"Measurements Manual" by Fribance - Hickok Learning Systems, Woburn, Massachusetts, USA</p>

CST-54

CONTROL SYSTEMS AND TRANSDUCERS - INSTRUCTIONAL MATERIALS

CSI-15

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
I-CST-4 (Cont'd)	H-C-4-(12)	<p>"Dynamic Analysis and Feedback Control" by Doebelin - McGraw-Hill</p> <p>"Basic Instrumentation - Industrial Measurements" by O'Higgins - McGraw-Hill</p> <p>"Modern Digital Electronics" by Edward Gray - Brodhead-Garrett Cleveland, Ohio, USA</p> <p>"D.C. Motors, Speed Controls, Servosystems" - 2nd Edition by Electrocraft Corporation, 1600 2nd Street South Hopkins, Minn. 55343, USA</p> <p>"Printed Circuits Handbook" -- 1967 Edited by Clyde F. Coombs, McGraw-Hill</p>
I-CST-5	H-C-5-(9)	<p><u>Books, Semiconductor, Data -</u></p> <p>"Semiconductor Data Library, Volume # 6, Series B" Motorola Semiconduct Products, Box 20912, Phoenix, Arizona, 85036 USA.</p> <p>"Linear Data Book") "Linear Applications, Volume # 1") "Linear Applications, Volume # 2") "Transducers, Temp. and Pressure") "C-Mos Integrated Circuits") "TTL Data Book")</p> <p>All from: National Semiconductor Corporation 2900 Semiconductor Drive Santa Clara, California USA</p>

CONTROL SYSTEMS AND TRANSDUCERS - INSTRUCTIONAL MATERIALS

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION	
I-CST-5 (Cont'd)	H-C-5-(9)	"RCA Power Devices") "RCA Integrated Circuits")	RCA Solid State Box 3200 Sommerville, N.J. 08875

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MASTER EQUIPMENT LIST
CONTROL SYSTEMS AND TRANSDUCERS

INSTRUCTIONAL MATERIALS

REFERENCE NUMBER	DESCRIPTION	QUANTITY	UNIT	TOTAL
I-CST-1	Movies, 16 mm	4	varies	645.00
I-CST-2	Movies, 16 mm	2	varies	350.00
I-CST-3	Film Loops, Cartridges, Super 8	9	20.00	180.00
I-CST-4	Books, Text	12	varies	200.00
I-CST-5	Books, Semiconductor Data	9	Shipping costs only	

BUDGET SUMMARY, CST, HOMS

After talks with Mr. Lindsey and Mr. Go, of World Bank and Mr. Kazziha of Education Minister, S.A.R., the concept of a "common room" to share test equipment and electronic supplies, and to provide space for the repair of test equipment was accepted. Also, it was agreed to provide a small capability for making printed circuits. These decisions were, of course, contingent on not exceeding IBRD accommodation schedules for space and for equipment. Accordingly, all items and space designated common (C), and printed circuits (P), will be shared equally between IBRD spaces 31, 27, 21 and 27.

It should be noted that special equipment, lab tables, etc., for use specifically in spaces 21 and 27 is not included in the CST equipment specifications.

SPACE BUDGET

IBRD Allotment, Spaces 31 and 37	255 m ²
Space used for 31 and 37 plus 1/2 of common room	<u>240 m²</u>
<u>UNDER BUDGET</u>	<u>15 m²</u>

BUDGET

ITEM	SPACE	TOTAL COST	50% COST	CHARGED TO CST	
				FURNITURE	EQUIPMENT
Furniture	31 - 37	\$ 4,994		\$ 4,994	
	(C) Common				
	(P) Printed Circuit	<u>5,500</u>	\$ 2,750	<u>2,750</u>	
Total Furniture		\$ 10,494		\$ 7,744	
Equipment	31 - 37	\$ 70,004			\$ 70,004.00
	(C) & (P)	<u>\$ 76,423</u>	\$ 38,211.50		<u>\$ 38,211.50</u>
Sub Total		\$146,427			\$108,215.50
Useables	(C) & (P)	\$ 6,449.55	\$ 3,224.77		\$ 3,224.77
Instructional	(C) & (P)	\$ 1,245	\$ 622.50		\$ 622.50
Small Tools	(C) & (P)	\$ 725.50	\$ 362.75		\$ 362.75

SUMMARY

	Charged to IBRD Spaces 31 & 37	Charged to IBRD Spaces 21 & 27
	<u>CST</u>	<u>COMMON</u>
Equipment	\$108,215.50	\$ 38,211.50
Furniture	\$ 7,744.00	\$ 2,750.00
Small Tools	\$ 362.75	\$ 362.75
Instructional Materials	\$ 622.50	\$ 622.50
Useables	\$ 3,224.80	\$ 3,224.80
TOTAL	<u>\$117,169.55</u>	<u>\$ 45,171.55</u>
World Bank Estimate	<u>\$138,000.00</u>	
AMOUNT <u>UNDER</u>	\$ 20,830.00	

Note: The "Common" designation identifies resources shared with other electronics labs. The CST financial share has been set at 50% of the total (as shown on balance sheet) and this is the amount listed under "common". Exact breakdown is shown on the balance sheet.

CST-60

PRIORITY ITEMS

The analysis generating this report was quite frugal. It is my conviction that this is the minimum material required to support the proposed program and I can not, therefore, recommend any priorities.

MPT-1

MECHANICAL POWER TECHNOLOGY (MPT)

A PROPOSED SYLLABUS AND EQUIPMENT LIST
FOR THE
SYRIAN ARAB REPUBLIC GOVERNMENT

Developed by
DR. JOHN J. FOODY, PE, CONSULTING ENGINEER
PROFESSOR EMERITUS - STATE UNIVERSITY OF
NEW YORK MARITIME COLLEGE, NEW YORK
NEW YORK, U.S.A.

Contracted
By
ACADEMY FOR EDUCATIONAL DEVELOPMENT

DAMASCUS, SYRIA

JULY - AUGUST 1977

1. INTRODUCTION

- 1.1 The syllabi attached hereto is based on the following guidelines and/or assumptions:
- 1.2 The World Bank Schedule of Accommodations, S.A.R. First Education Project, Working Papers, Volume I, dated April 1977 forms the fundamental basis for the Syllabi.
- 1.3 The final recommended syllabi reflects the above World Bank Schedule of Accommodations, the input of various Syrian authorities and individuals as listed below and the professional opinion of the author of this document.
- 1.4 Consultations were held with the following either in group meetings or individual conferences:
 - Mr. Mostafa Kazziha, Technical Education Directorate, Ministry of Education, S.A.R.
 - Mr. Munir Azzam, Director, Directorate of Planning, Ministry of Education, S.A.R.
 - Mr. Hisham Turk, Architect, Latakia, S.A.R.
 - Mr. Sharifuopin Mohammed, Director of Technical Education, Ministry of Education, S.A.R.
 - Mr. Majed Attmanie, Assistant to Director, Port of Latakia, S.A.R.
 - Mr. Abdul Kader Farhat, Chief, Mechanical Repairs, Port of Latakia, S.A.R.
 - Mr. Bader Fattahi, Chief, Ship Disposition, Loading and Off-loading, Port Latakia, S.A.R.
 - Mr. Youssef Baddour, Mechanical Engineer, Technical Institute, Latakia, S.A.F.
 - Mr. Sami Zeitoun, Architect, Latakia, S.A.R.
 - Mr. C. Noel Lindsay, World Bank
 - Mr. Harry Go, World Bank
- 1.5 The equipment list attached to the Mechanical Materials Handling Technology report will equip and furnish the laboratories, or practice teaching areas, that are common to that curriculum and this - the Mechanical Power Technology.

While the author made accepted recommendations on the theory and practice content of First and Second Year Electrical Fundamentals and Machinery courses, it is pointed out that the World Bank Schedule of Accommodations for Latakia did not assign the space,

area 26, to anyone in the group. Therefore, the Master Equipment and individual item specifications for the Electrical Machinery Laboratory, area 26, is not part of this report.

- 1.6 The function of this curriculum is to prepare the student upon graduation to immediately contribute to improving the economy and mechanical functioning of a seaport. The equipment is selected for that purpose. The equipment, if properly used, will assist the student in preceptive, preventive and corrective maintenance and proper operation of seaport equipment which in turn will realize longer use and reduce costs to the economy of the seaport and its users.
- 1.7 Students will be coming to the program with adequate mathematical preparation. Any additional mathematics should be given by the teacher or instructor within each course.
- 1.8 It is strongly suggested that the teacher and the instructor, in each area, work as a willing and comprehending team whose only purpose is to ensure that each student receives maximum return for his investment in time in his specialized education and training.
- 1.9 The comprehensive teaching of courses concerning the mechanical operations and problems of a seaport calls for first hand personal knowledge. The knowledge of how and why an efficient seaport and its waterfront works effectively can not be obtained from books or second hand. One must work on the waterfront. Therefore, it is strongly recommended that the teachers and instructors be required to work several summers, for adequate pay, in meaningful positions on the waterfront, so that experience may be brought into the classroom and laboratory.

2. PURPOSE

At the completion of the MPT curriculum the student shall:

- 2.1 Have a basic understanding of the logistics of a seaport both from the administrative and use aspects.

- 2.2 Have a comprehensive understanding of the various types of equipment necessary to the movement of cargo through a seaport and the distinct contribution of well maintained equipment to the prosperity of a seaport.
- 2.3 A basic understanding of maintenance problems both from a preventive and corrective standpoint associated with mechanical power systems for material handling and transport equipment.

The equipment used would generally be what is necessary to move cargo from the ship's side, the tugboat and barge to the warehouse, outside the seaport, or from a ship tied at the dock to its destination inside or outside of the seaport.

MECHANICAL POWER TECHNOLOGY	Number of Hrs Week	
	Theory	Practical
First (13th) Year		
Social Studies and Language	2	1
Industrial Planning, Security and Safety	3	0
Applied Mathematics	2	1
Applied Mechanics	2	2
Engineering Materials, Testing and Soil Mechanics	2	3
Machine Elements and Industrial Drawing	2	4
Diesel Engine Technology	3	5
Power Transmission and Controls	<u>2</u>	<u>2</u>
Total	18	18 = 36
Second (14th) Year		
Social Studies and Language	2	1
Industrial Organization, Plants, Security and Safety	3	0
Applied Mathematics	2	1
Electrical Fundamentals and Machinery	3	4
Diesel Engine Technology	3	5
Power Transmission and Controls	3	5
Fabricating Skills	<u>2</u>	<u>2</u>
Total	18	18 = 36

3. TYPICAL TECHNICAL COURSE TITLES

3.1 First (13th) Year

- Industrial Planning, Security and Safety
- Machine Elements and Industrial Drawing
- Diesel Engine Technology
- Power Transmissions and Controls

3.2 Second (14th) Year

- Industrial Organization, Plants, Security and Safety
- Electrical Fundamentals and Machinery
- Diesel Engine Technology
- Power Transmissions and Controls
- Fabricating Skills

4. OUTLINES FOR COURSES

4.1 First (13th) Year

Course Title: #1 Industrial Planning, Security and Safety

Objectives: Identify and analyze various industrial sectors:

- Planning
 - a. History of, and need for planning systems.
 - b. The Management by Objective system (MEO).
 - c. The Program Evaluation and Review Techniques system (PERT).
 - d. Introduction to more complex forms of b and c above.
- Security
 - a. History of, and need for security.
 - b. Types of industrial security including use and limitations of:
 - (1) Personnel surveillance.
 - (2) TV Monitoring of areas.
 - (3) Combinations of (1) and (2) above.
- Safety
 - a. Need for industrial safety.
 - b. Types of industrial safety including:
 - (1) For personnel - hardhats, goggles, gloves, aprons, safety shoes, etc.
 - (2) For materials and cargos from damage from fire, elements, mishandling and improper storage.

4.2 First (13th) Year

Course Title: #2 Machine Elements and Industrial Drawing

Objectives:

- To identify, analyze functions(s) and interrelate the various components of a machinery system:
 - a. Structural frames, parts and heads.
 - b. Pistons, piston rings and rods.
 - c. Cranks, bearings, crossheads and counterweights.
 - d. Flywheel, valvegear, pumps and nozzles.
 - e. Other components.
- To sketch and, or draw, selected components from above list and properly dimension and identify specifications of same so that a student:
 - a. Can properly order that item from a manufacturer.
 - b. Can prepare a sketch, or drawing, from which the item can be made in a local machine shop, foundary, etc.

4.3 First (13th) Year

Course Title: #3 Diesel Engine Technology

Objectives:

- The student will be able to:
 - a. Describe diesel engine operations and identify components.
 - b. Install and operate engine according to specifications.
 - c. Carry out preventative and corrective maintenance procedures according to schedule.
 - d. Disassemble, repair, assemble, align, test and operate according to specifications.
 - e. Correctly use general and special tools such as test instruments, welders of various types, air compressors, and cleaning tanks.

4.4 First (13th) Year

Course Title: #4 Power Transmissions and Controls

Objectives:

- To identify, and analyze power transmission systems and controls designed into material handling systems of waterfront equipment.
- To describe forms of preventive maintenance and to analyze same for selected equipment for both machinery and controls.

- To operate, maintain and repair the following using appropriate tools and equipment:
 - a. Hydraulic power transmission systems.
 - b. Pneumatic power transmission systems.
 - c. Controls for 4.31 and 4.32 above.

4.5 Second (14th) Year

Course Title: #1 Industrial Organization, Plants, Security and Safety

Objectives: Identify and analyze the advantages and disadvantages of various industrial sectors as identified in the course title above:

- Organization: Describe the function and operation of the various types of industrial organization, public and private, that are common to the Arab world and other economies.
- Plants: Describe the plans and functioning of various types of industrial plants found in the Syrian economy both public and private.
- Security: Continue to emphasize and expand on the content in this area as covered in the First Year Course #1 - Objective b. Bring in experts from industry both public and private to explain their forms of security and problems.
- Safety: Emphasize and expand on coverage in First Year Course 31 - Objective b.

4.6 Second (14th) Year

Course Title: #2 Electrical Fundamentals and Machinery

Objectives:

- To teach students electrical fundamentals so that they will understand maintenance procedures. The fundamentals to include: OHMS law, resistance, power loss, series and parallel circuits, voltage drop and Kirchhoff's voltage law, summation of currents and Kirchhoff's current law, capacitance, inductance, circuit analysis, etc.
- The course will stress preventive and corrective maintenance procedures. The preventive maintenance procedures will:
 - a. Identify and localize common electrical faults.
 - b. Recommend procedures for emergency repairs.
 - c. Stress best electrical operating procedures.
 - d. Outline inspection programs.
- The corrective maintenance procedures will:
 - a. Identify major repair problems, i.e., grounds, burn-outs, short circuits, etc.
 - b. Teach procedures for efficient repairs.

- The laboratory will have equipment and instrumentation for:
 - a. Battery testing, charging and maintenance.
 - b. Motor and generator repair.
 - c. Electric and magnetic demonstrations and testing of:
Solenoids, magnetic contractors, circuits, etc.
 - d. Trouble shooting and testing of circuits and machines.

4.7 Second (14th) Year

Course Title: #3 Diesel Engine Technology

Objectives:

- To give a more comprehensive understanding of engine principles, work, installation, operation, maintenance and repair than was given in the First Year Course.
- Students will study governors, vibration and methods of balancing, rating, testing procedures, special repairs and salvaging.
- The laboratory experiments and sessions will be devoted to engine testing to ensure most efficient operation and use.

4.8 Second (14th) Year

Course Title: #4 Power Transmissions and Controls

Objectives:

- To continue the First Year Course and more comprehensively understand power transmission systems and controls that are designed into material handling equipment.
- Study preventive maintenance schedules and procedures.
- In the laboratory the student will be required to demonstrate his ability to analyze faults, correct same, and conduct corrective maintenance to ensure maximum availability of waterfront material handling equipment.

4.9 Course Title: #5 Fabricating Skills

Objectives:

- To give the student a fundamental understanding of the various associated skills that are necessary to doing a proper maintenance repair.

Some examples of the types of skills are:

- a. Cutting pipe and tubing.
- b. Threading - pipe, bolt, etc. different threads.
- c. Pipe and tube fittings - how to install properly.
- d. Tube bending - special tools.
- e. Making gaskets - gasket materials.
- f. Making special shapes from flat steel stock.

- g. Special devices - such as a spreader sling to lift a head from engine.
- h. Cleaning agents for internal passages of a machine under repair - example: Muriatic acid - precautions.
- i. Storage and centrifuging of lub. and diesel oils.
- j. Making a replacement bearing sleeve liner.
- k. Welding - electric arc and gas (oxyacetylene).
- l. Suggest teachers, instructors and students plan visits to related Industries where the above skills may be observed.

EQUIPMENT SELECTION CRITERIA

The types of equipment selected, wherever possible, are small size facsimiles of actual equipment that is being used on the waterfront. However, considering the constraints of the Technical Institute equipment budget, some laboratory mock-ups are included that will prove the principles stated in the theory class and with the teacher-instructor team cooperation show the direct relationship between the equipment used in the seaport and that in the laboratory.

The equipment selection is based on a serious need for qualified persons who, in the near future, will assist in preventive and corrective maintenance and in time build a pool of competent supervisory and mechanically knowledgeable personnel who will contribute to the growth of the seaport at Latakia.

5. PROGRAM RECOMMENDATIONS

- 5.1 If at any time in the conduct of a course the teacher senses a deficiency in mathematics or physics he should make sure that deficiency is corrected before he proceeds with the technical content of the course.
- 5.2 It is strongly recommended that students with automotive and mechanical backgrounds be given first priority in admission into this curriculum.
- 5.3 Serious consideration should be given to consolidating the Mechanical Materials Handling and the Mechanical Power curricula. There are many common courses in the two curricula. It may be possible to have a common first year and then a second year where a student could elect to go into one or the other speciality.

6. ARCHITECTURAL RECOMMENDATIONS

6.1 General

- While the author was in Syria the architects were more interested in the physical proportions of the building than the laboratory utility and ventilation needs.

6.2 Electrical

- At least one 220V/50Hz, single phase, 15 ampere outlet should be provided every 3.5 meters around each laboratory. The outlet should be approximately 90 cm above floor level.
- Reading of equipment specifications will indicate where 380V, 50Hz, 3 phase, 30 or more ampere outlets will be needed.
- In the Battery Service Room in teaching area 32 ("O") there should be sufficient power to recharge, to full charge, eight 12V, 200 amp. hr. batteries in any one 8 hour period.
- The overhead lighting in teaching area 29 ("L") should be adequate for a modern drafting room.

6.3 Water

- Water should be piped into two locations in each of teaching areas 30, 31 and 32 ("M", "N", and "O").

6.4 Ventilation

- Adequate ventilation should be provided in teaching area 30 ("M"). An adequate exhaust system should also be provided.
- The Battery Service Room in teaching area 32 ("O") should be provided with an adequate exhaust system for battery charging gases.

MASTER EQUIPMENT LIST
MECHANICAL POWER TECHNOLOGY

The following general specifications shall apply to all items:

1. All equipment shall be new and unused items embodying the most up-to-date principles, design and styling.
2. All dimensions, calibrations, etc. are in English units except where otherwise specified. The vendor, if necessary, will convert the given dimensional, etc. information into such units consistent with his designs and propose and/or furnish the nearest stock item that will meet specifications.
3. All electrical connections will be for 220V/50Hz, single phase AC unless otherwise specified. Most exceptions will be 380V/50Hz, three phase.
4. Manuals normally supplied with any of the following items will be expected to be furnished although not specifically mentioned in a particular specification.
5. This equipment, small tools, etc. is being purchased to aid in the teaching and training process in a technical institute to be located at Latakia, S.A.R. It is therefore strongly recommended that the following equipment items from the indicated Master List be purchased from one vendor. The reasons being: (1) it is essential that the storage of spare parts, gaskets, "O" rings, glands, etc. for these items be kept to a minimum; (2) the compatibility of the items one to another will lend itself to cross reference and in some instances possible assembly one to another to show the the interrelationship of parts. There is enough confusion on the waterfront - 16 different manufacturers of fork-lift trucks and the associated problem of warehousing 16 different manufacturer's parts from the U.S., Western Europe, Eastern Europe, and the Far East without introducing that problem into the Institute.

Only one engine manufacturer, where applicable, and/or one fork-lift

manufacturer should supply:

- E-MMH-1 Piston, Diesel Engine
- E-MMH-2 Crank Shaft, Diesel Engine
- E-MMH-19 Diesel Engine with Hynamometer Pulley, complete
- E-MMH-23 Two Speed Power Shift Transmission
- E-MMH-24 Four Speed Manual Transmission
- E-MMH-25 Five Speed Manual Transmission
- E-MMH-26 Three Speed Power Transmission
- E-MMH-27 Full Floating Drive Axle
- E-MMH-28 Planetary Drive Axle
- E-MMH-29 Hydraulic Lift and Tilt System, Fork Lift, complete
- E-MMH-31 Clutch, Plate
- E-MMH-32 Clutch, Disc
- E-MMH-33 Fork Lift Truck

The following item is specified in the English system if the above are purchased where components use the metric system, then it should be metric

- S-MMH-40 Socket Set, 20 pieces

The following conveyor components should be purchased from one vendor:

- E-MMH-36, 37 and 28.

NOTE: The following items are not attached to this report because they are part of the Mechanical Materials Handling Technology report. One purchase of equipment, furniture, small tools and instructional materials will satisfy both curricula.

Items:

1. Master Equipment Lists and individual equipment specifications for Equipment, Furniture, Small Tools, and Instructional Materials.
2. Summary Budget.
3. Priorities Statement.

MMH-1

MECHANICAL MATERIALS HANDLING TECHNOLOGY (MMHT)

A PROPOSED SYLLABUS AND EQUIPMENT LISTS

For The

SYRIAN ARAB REPUBLIC GOVERNMENT

Developed By

DR. JOHN J. FOODY, PE, CONSULTING ENGINEER

PROFESSOR EMURTIUS - STATE UNIVERSITY OF

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DAMASCUS, SYRIA

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LABORATORY SPACE IDENTIFICATION NUMBERS

(From World Bank)

A. <u>Air Conditioning</u> (Homs)			
			<u>Space Number</u>
1.	Heating, Fuels & Hot Water Systems		32
2.	Air Conditioning & Refrigeration		33
B. <u>Building Construction Labs</u> (Latakia and Deir-Ez-Zor and Homs)			
			<u>Space Number</u>
		<u>Latakia</u>	<u>Deir-Ez-Zor</u>
			<u>Homs</u>
1.	Applied Mechanics	28	28
			28
2.	Construction	33	33
3.	Engineering Materials and Soils	34	32
4.	Surveying and Photo Grammetry	35	35
C. <u>Chemical Tech. Laboratories</u> (Homs)			
			<u>Space Number</u>
1.	Industrial Inorganic and Quantitative Chemistry		34
2.	Industrial Organic Chemistry		34A
3.	Chemicals Processing Unit Operations (Pilot Plants)		35
4.	Mineral Processing Unit Operations		36
D. <u>Control Systems and Transducers</u> (Homs)			
			<u>Space Number</u>
1.	Control Systems		31
2.	Transducers (Instruments)		37
3.	Common Room	} Support for	C
4.	Printed Circuit Room		P
		31, 37, 22, 27	
E. <u>Materials Handling and Mechanical Power</u> (Latakia)			
			<u>Space Number</u>
1.	Machine Elements and Industrial Drawing		29
2.	Diesel Power Technology		30
3.	Power Transmission and Control Systems		31
4.	Material Handling Equipment		32

LABORATORY SPACE IDENTIFICATION NUMBERS

(From World Bank)

A. <u>Air Conditioning</u> (Homs)			
			<u>Space Number</u>
1.	Heating, Fuels & Hot Water Systems		32
2.	Air Conditioning & Refrigeration		33
B. <u>Building Construction Labs</u> (Latakia and Deir-Ez-Zor and Homs)			
			<u>Space Number</u>
		<u>Latakia</u>	<u>Deir-Ez-Zor</u>
			<u>Homs</u>
1.	Applied Mechanics	28	28
2.	Construction	33	33
3.	Engineering Materials and Soils	34	32
4.	Surveying and Photo Grammetry	35	35
C. <u>Chemical Tech. Laboratories</u> (Homs)			
			<u>Space Number</u>
1.	Industrial Inorganic and Quantitative Chemistry		34
2.	Industrial Organic Chemistry		34A
3.	Chemicals Processing Unit Operations (Pilot Plants)		35
4.	Mineral Processing Unit Operations		36
D. <u>Control Systems and Transducers</u> (Homs)			
			<u>Space Number</u>
1.	Control Systems		31
2.	Transducers (Instruments)		37
3.	Common Room	} Support for	C
4.	Printed Circuit Room		P
		31, 37, 22, 27	
E. <u>Materials Handling and Mechanical Power</u> (Latakia)			
			<u>Space Number</u>
1.	Machine Elements and Industrial Drawing		29
2.	Diesel Power Technology		30
3.	Power Transmission and Control Systems		31
4.	Material Handling Equipment		32

I. INTRODUCTION

- 1.1 The syllabi and equipment lists attached hereto are based on the following guidelines and/or assumptions.
- 1.2 The World Bank Schedule of Accommodations S.A.R. First Education Project, Working Papers, Volume I, dated April 1977 forms the fundamental basis for the syllabi and equipment list.
- 1.3 The final recommended equipment list and syllabi reflect the above World Bank Schedule of Accommodation, the input of various Syrian authorities and individuals as listed below, and the professional opinion of the author of this document.
- 1.4 Consultations were held with the following either in group meetings or individual conferences:
 - Mr. Munir Azzam, Director, Directorate of Planning, Ministry of Education, S.A.R.
 - Mr. Hisham Turk, Architect, Latakia, S.A.R.
 - Mr. Sharifuopin Mohammed, Director of Technical Education, Ministry of Education, S.A.R.
 - Mr. Majed Attmanic, Assistant to Director, Port of Latakia, S.A.R.
 - Mr. Abdul Kader Farhat, Chief, Mechanical Repairs, Port of Latakia, S.A.R.
 - Mr. Bader Fattahi, Chief, Ship Disposition, Loading and Off-loading, Port Latakia, S.A.R.
 - Mr. Youssef Baddour, Mechanical Engineer, Technical Institute, Latakia, S.A.R.
 - Mr. Sami Zeitoun, Architect, Latakia, S.A.R.
 - Mr. C. Noel Lindsay, World Bank
 - Mr. Harry Go, World Bank
- 1.5 The attached equipment list is only for the institute at Latakia, S.A.R. The list will provide equipment for the following laboratories that are common to the Mechanical Material Handling Technology and the Mechanical Power Technology curricula:
 - Machine Elements and Industrial Drawing
 - Mechanical Power Transmission & Control Systems
 - Mechanical Materials Handling

While the author made accepted recommendations on the theory content of the Second Year course: Electrical Fundamentals and Machinery, it is pointed out that the World Bank Schedule of Accommodations

for Latakia did not assign the space, area 26, to anyone in the group. Therefore the Master Equipment List and the individual specifications for the Electrical Machinery Laboratory, Area 26 (I) is not part of this report.

- 1.6 The function of both curricula is to prepare the student upon graduation to immediately contribute to improving the economy and mechanical functioning of a seaport. The equipment is selected for that purpose. The equipment, if properly used, will assist the student in preceptive preventive and corrective maintenance and proper operation of seaport equipment which in turn will realize longer use and reduce costs to the economy of the seaport and its users.
- 1.7 Students will be coming to the program with adequate mathematical preparation. Any additional mathematics needed within a subject should be given by the teacher or instructor within each course.
- 1.8 It is strongly suggested that the teacher and the instructor, in each area, work as a willing and comprehending team whose only purpose is to ensure that each student receives maximum return for his investment in time in his specialized education and training.
- 1.9 The comprehensive teaching of courses concerning the mechanical operations and problems of a seaport calls for first hand personal knowledge. The knowledge of how and why an efficient seaport and its waterfront works effectively can not be obtained from books or second hand. One must work on the waterfront. Therefore, it is strongly recommended that the teachers and instructors be required to work several summers, for adequate pay, in meaningful positions on the waterfront, so that experience may be brought into the classroom and laboratory.

2. PURPOSE

The purpose of this curriculum is to graduate specialists who will be educated and trained to economically and expeditiously process all forms of modern commercial cargo into and out of a seaport, such as, Latakia, Syria. The proposed intermediate technical institute where

this curriculum will be taught is to be located in the northern sector of Latakia. The student's knowledge should in time, because of education, training and developing expertise, materially contribute and result in:

- 2.1 Reducing and minimizing lost of port turn-around time for off-loading and loading cargo vessels.
- 2.2 Reducing the seaport handling and storage costs per metric ton.
- 2.3 More efficient use of all types of warehousing facilities.
- 2.4 More effective use of and expansion of container seaport facilities in the future.
- 2.5 Reduction to more competitive levels shippers' costs per metric ton which in turn should induce a spectacular future increase in seaport tonnage from the present (1976-1977) 2.2 million metric tons.

3. PROGRAM OBJECTIVES

At the completion of the MMH curriculum the student shall:

- 3.1 Have a basic understanding of the logistics of a seaport from both the administrative and use aspects.
- 3.2 Have a comprehensive understanding of general problems associated with the movement of commercial cargo from:
 - Ship to lighter (barge).
 - Lighter to pier.
 - Ship to pier.
 - Pier to outside of pier and seaport area to outside destination.
 - Pier to open warehousing.
 - Pier to semi-enclosed warehousing.
 - Pier to enclosed warehousing.
 - Ship to enclosed warehousing.
- 3.3 Have a knowledge of the:
 - Purpose and use of warehousing systems and problems.
 - Development and uses of various types of container seaport operations, including roll-on roll-off vessel seaport operations.
 - Types of and use of industrial security concerning all of the above operations.
 - Efficient seaport rolling material handling equipment use.

MHI-7

MECHANICAL MATERIALS HANDLING TECHNOLOGY	Number Hrs Week		
	First (13th) Year	Theory	Practice
Social Studies and Language	2	1	
Industrial Planning, Security and Safety	3	0	
Applied Mathematics	2	1	
Applied Physics - Mechanics, Fluid and Gas Flow	2	2	
Machine Elements and Industrial Drawing	2	4	
Materials Handling Technology	3	5	
Power Transmissions and Controls	2	2	
Electrical Fundamentals and Machinery	<u>2</u>	<u>3</u>	
Total	18	18 = 36	

MECHANICAL MATERIALS HANDLING TECHNOLOGY	Number Hrs Week		
	Second (14th) Year	Theory	Practice
Social Studies and Language	2	1	
Industrial Organization, Security and Safety	3	0	
Applied Mathematics	2	1	
Applied Mechanics - Structures	2	2	
Machine Elements and Drafting	1	3	
Materials Handling Technology	3	5	
Controls Systems	3	3	
Electrical Fundamentals and Machinery	<u>2</u>	<u>3</u>	
Total	18	18 = 36	

4. TYPICAL TECHNICAL COURSE TITLES

First (13th) Year
<ol style="list-style-type: none"> 1. Industrial Planning, Security and Safety 2. Machine Elements and Industrial Drawing 3. Material Handling Technology 4. Electrical Fundamentals and Machinery 5. Power Transmissions and Controls
Second (14th) Year
<ol style="list-style-type: none"> 1. Industrial Organization, Security, Plants and Safety 2. Machine Elements and Drafting 3. Material Handling Technology 4. Control Systems 5. Electrical Fundamentals and Machinery

5. OUTLINE FOR COURSES (By Title and Objective)

5.1 First (13th Year)

Course Title: #1 Industrial Planning, Security and Safety

Objectives: Identify and analyze the advantages and disadvantages of various industrial sectors:

- Planning
 - a. History of, and need for planning systems.
 - b. The Management By Objectives system (MBO).
 - c. The Program Evaluation and Review Techniques system (PERT).
 - d. Introduction to more complex forms of b and c above.
- Security
 - a. History of, and need for security.
 - b. Types of industrial security including use and limitations of:
 - (1) Personnel surveillance.
 - (2) TV monitoring of areas.
 - (3) Combinations of (1) and (2) above.

- Safety
 - a. Need for industrial safety.
 - b. Types of industrial safety including:
 - (1) For personnel - hardhats, goggles, gloves, aprons, safety shoes, etc.
 - (2) For materials and cargos from damage from fire, elements, mishandling and improper storage.

5.2 First (13th) Year

Course Title: #2 Machine Elements and Industrial Drafting

Objective:

- To identify, analyze function(s) and interrelate the various components of a machinery system:
 - a. Structural frames, parts and heads.
 - b. Pistons, piston rings and rods.
 - c. Cranks, bearings, crossheads, counterweights.
 - d. Flywheel, valv gear, pumps, nozzles.
 - e. Other components.
- To sketch and, or draw, selected components from above list and properly dimension and identify specifications of same so that a student:
 - a. Can properly order that item from a manufacturer.
 - b. Can prepare a sketch, or drawing, from which the item can be made in a local machine shop, foundary, etc.

5.3 First (13th) Year

Course Title: #3 Mechanical Materials Handling Technology

Objectives:

- A comprehensive preparation of the student in the proper use, and analysis of use of selected pieces of equipment essential to a seaport's operation. The items studied would include:
 - a. Ships cargo tackle and lighters (barge).
 - b. Pier stationery and limited movement cranes.
 - c. Fork-lifts of various types up to 10 tons.
 - d. Mobile cranes.
 - e. Container fork-lift truck - sideloader.

- The laboratory will have selected equipment to train the student in their proper use and preventive maintenance. The equipment will include:
 - a. Cargo tackle rig with selected size lifts.
 - b. Fork-lift machines.
 - c. Small mobile crane.
 - d. Fork-lift test machines.
- Several preplanned visits should be arranged for students, teachers and instructors to the Latakia seaport waterfront to see demonstrations and use of the large mobile cranes and container sideloader fork-lift trucks.

5.4 First (13th) Year

Course Title: #4 Electrical Fundamentals and Machinery

Objectives:

- To prepare the student to understand and use elementary electrical fundamentals, circuits and machinery. Wherever possible the circuits and machinery will be similar to those incorporated in one or more manufacturers equipment used in the seaport's material handling.
- The student will perform several experiments that will demonstrate and ensure an understanding of electrical fundamentals studied in the theory class. He will also perform machinery operation and circuit analysis tests. The tests should demonstrate the student's ability to find machinery and circuits faults, correct same to ensure continuous and correct operation. The emphasis will be on preventive maintenance.

5.5 First (13th) Year

Course Title: #5 Power Transmissions and Controls

Objectives:

- To identify, and analyze power transmission systems and controls designed into material handling systems of waterfront equipment.
- To study forms of preventive maintenance and to analyze same for selected equipment for both machinery and controls.
- In the laboratory the student will have hands-on experience with:
 - a. Hydraulic power transmission systems.
 - b. Pneumatic power transmission systems.
 - c. Controls for a and b above.
 - d. General maintenance equipment and tools for a, b, and c above.

5.6 Second (14th) Year

Course Title: #1 Industrial Organization, Plants, Security and Safety

Objectives: Identify and analyze the advantages and disadvantages of various industrial sectors as listed.

- Organization: Describe the function and operation of the various types of industrial organizations, public and private, that are common to the Arab World and other economies.
- Plants: Describe the plans and functioning of various types of industrial plants found in the Syrian economy both public and private.
- Security: Continue to emphasize and expand on the content in this area as covered in First Year course #1 Objective b.
- Safety: Emphasis and expand on this area as covered in First Year course #1 Objective c.

5.7 Second (14th) Year

Course Title: #2 Machine Elements and Drafting

Objectives:

- To rapidly review the subject coverage of First Year #2 course, Machine Elements and Industrial Drafting.
- To study in depth a few of the more complex elements of a machine.
- To increase the competence of the student in graphical presentation so that a component may be fabricated from the drawing.

5.8 Second (14th) Year

Course Title: #3 Material Handling Technology

Objectives:

- Quickly review First Year coverage in #3 course, Material Handling Technology.
- A more comprehensive study of the uses and limitations of all types of equipment used in material handling in a seaport.
- Develop student's knowledge of proper methods of minor repairs, such as, repair of a pneumatic tire flat, adjustment of brakes, lubrication of machine, replacement of oil filter with new one, etc.
- In the laboratory:
 - a. Establish and train students in minor repair techniques.
 - b. Train students to handle more complex cargo loads.
 - c. Train the students in use of conveyor systems; straight, curved, compound, static roller conveyor systems, motor driven roller conveyor systems.

5.9 Second (14th) Year

Course Title: #4 Control Systems

Objectives:

- To have student gain a comprehensive understanding and hands-on familiarity with selected control systems that are generally incorporated in most waterfront equipment. Examples of selected systems that will be studied are: on a fork-lift truck; the lift and tilt control system, the breaking control system. An example of the components of the lift-tilt control system are:
 - a. Hydraulic liquid storage and supply tank.
 - b. Hydraulic liquid pump.
 - c. Relief valve and system interconnecting tubing.
 - d. Fore and aft fork tilt cylinders.
 - e. Vertical lift cylinders.
 - f. Hydraulic liquid filter.
 - g. Lift and fore and aft tilt control valves and levers.
 - h. System pressure indicators.
- The student will have studied: analyzed faults, corrected faults and learned preventive maintenance procedures.

5.10 Second (14th) Year

Course Title: #5 Electrical Fundamentals and Machinery

Objectives:

- To enlarge the scope of knowledge gained in the course taken in First Year and stress need for, and practices, in preventive electrical maintenance. Course will:
 - a. Identify and localize common electrical troubles.
 - b. Recommend procedures for emergency repairs.
 - c. Stress best operating procedures.
 - d. Outline inspection programs.
- All the above will help ensure safe, efficient, economical and dependable operation of seaport material handling equipment.
- The laboratory will have equipment and instrumentation for:
 - a. Battery testing, charging and maintenance.
 - b. Motor and generator repair.
 - c. Electric and magnetic demonstrations and testing of: solenoids, magnetic contractor, etc.
 - d. D.C. Commutation problems.
 - e. Circuit testing and trouble shooting.

EQUIPMENT SELECTION CRITERIA

The types of equipment selected, wherever possible, are small size facsmilies of actual equipment that is being used on the waterfront. However, considering the constraints of the Technical Institute equipment budget, some laboratory mock-ups are included that will prove the principles stated in the theory class and with the teacher-instructor team cooperation show the direct relationship between the equipment used in the seaport and that in the laboratory.

The equipment selection is based on a serious need for qualified persons who, in the near future, will assist in preventive and corrective maintenance and in time build a pool of competent supervisory and mechanically knowledgeable personnel who will contribute to the growth of the seaport at Latakia.

6. PROGRAM RECOMMENDATIONS

- 6.1 If at any time in the conduct of a course the teacher senses a deficiency in mathematics or physics he should make sure that deficiency is corrected before he proceeds with the technical content of the course.
- 6.2 It is strongly recommended that students with automotive and mechanical backgrounds be given first priority in admission into this curriculum.
- 6.3 Serious consideration should be given to consolidating the Mechanical Materials Handling and the Mechanical Power curricula. There are many common courses in the two curricula. It may be possible to have a common first year and then a second year where a student could elect to go into one or the other specialty.

7. ARCHITECTURAL RECOMMENDATIONS

7.1 General

- While the author was in Syria the architects were more interested in the physical proportions of the building than the laboratory utility and ventilation needs.

7.2 Electrical

- At least one 220V/50Hz, single phase, 15 ampere outlet should be provided every 3.5 meters around each laboratory. The outlet should be approximately 90 cm above floor level.

- Reading of equipment specifications will indicate where 380V/50Hz, 3 phase, 30 or more ampere outlets will be needed.
- In the Battery Service Room in teaching area 32 ("O") there should be sufficient power to recharge, to full charge, eight 12V, 200 amp. hr. batteries in any one 8 hour period.
- The overhead lighting in teaching area 29 ("L") should be adequate for a modern drafting room.

7.3 Water

- Water should be piped into two locations in each of teaching areas 30, 31 and 32 ("M", "N", and "O").

7.4 Ventilation

- Adequate ventilation should be provided in teaching area 30 ("M"). An adequate exhaust system should also be provided.
- The Battery Service Room in teaching area 32 ("O") should be provided with an adequate exhaust system for battery charging gases.

MECHANICAL MATERIALS HANDLING TECHNOLOGY

EQUIPMENT

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
E-MMH-1	L-29-1-(5)	<u>Piston, Diesel Engine</u> - Perkins Model D3.152 47 SAE BHP at 2,600 rpm engine piston to fit in 3.60 inches (91.44 mm) bore cylinder.
E-MMH-2	L-29-2-(5)	<u>Crankshaft, Diesel Engine</u> - Perkins Model D 3.152 47 SAE BHP at 2,600 rpm engine crankshaft with a stroke throw of 5.00 inches (127 mm).
E-MMH-3	L-30-3-(1)	<u>Diesel Pump and Injector Test System</u> - System shall be a universal pump calibrating stand for all popular makes of American, and European injection pumps; including an injector flow comparator attachment for calibrating unit injectors 10 hp electric motor drive unit minimum acceptable; complete with necessary mountings and connections for testing above fuel injection pumps. The nozzle/injector tester should be able to test for opening pressure, leakage, spray pattern and plugged spray holes; Ready to use in a 380V 50 HZ three phase Syrian electrical system. It should be like the Bacharach Diesel Pump and Injector Test System for "Agricultural, Construction and Motor Truck." Applications complete or equivalent; capacity 5 gallons approximately. Any electrical or mechanical connection to an outside source must be compatible with Syrian requirements.
E-MMH-4	L-30-4-(1)	<u>Diesel Oil Storage Tank Complete</u> - Complete D.O. storage tank, 14 gauge steel construction with heavy coat of rust-resistant preservative paint. Vertical, 60 inches long x 44 inches high x 27 inches wide, 275 gallon. Tested to 5 psi and be U.L. listed. Openings: Three, 2 inch threaded on top; one 1/2 inch threaded on bottom; four brackets threaded for 1 1/2 inch pipe legs. The legs to be furnished shall raise the tank 6 inches off a level floor when installed and have 1 1/2 inch floor flanges on the bottom of the legs with four bolt holes therein so tank may be secured to the floor.

MECHANICAL MATERIALS HANDLING TECHNOLOGY

EQUIPMENT

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION															
E-MMH-5	L-30-5-(1)	<p><u>Lubricant Storage Tank with Legs</u> - Heavy gauge steel with liquid level gauge, two one inch outlet plugged globe valved outlets at bottom, Buna-N and Vellimoid gaskets and seals, sealed filler cap with strainer and air filter. Tank with four #6 diameter mounting holes.</p> <table border="1"> <thead> <tr> <th><u>Tank Cap.</u> <u>Gal.</u></th> <th><u>Height,</u> <u>inches</u></th> <th><u>Width,</u> <u>inches</u></th> <th><u>Depth,</u> <u>inches</u></th> <th><u>Baffle</u></th> </tr> </thead> <tbody> <tr> <td align="center">10</td> <td align="center">12</td> <td align="center">20</td> <td align="center">12</td> <td align="center">Yes</td> </tr> </tbody> </table> <p>The legs, two, shall be arc welded, riveted construction 14 gauge steel channel type legs with flare at bottom. The base plates shall be welded and riveted to legs and punches for securing to floor, top cross member should be four inches wide and punched for attaching to tank bottom braces. A 2½ inch cross brace shall be provided at bottom and suitably punched for attaching shelf, finish gray baked on enamel, width: 23½ inches, height: 30 inches.</p>	<u>Tank Cap.</u> <u>Gal.</u>	<u>Height,</u> <u>inches</u>	<u>Width,</u> <u>inches</u>	<u>Depth,</u> <u>inches</u>	<u>Baffle</u>	10	12	20	12	Yes					
<u>Tank Cap.</u> <u>Gal.</u>	<u>Height,</u> <u>inches</u>	<u>Width,</u> <u>inches</u>	<u>Depth,</u> <u>inches</u>	<u>Baffle</u>													
10	12	20	12	Yes													
E-MMH-6	L-30-6-(3) L-31-6-(3)	<p><u>Gantry Crane, Adjustable, Complete</u> - Crane legs adjustable in height and span; wheels - one ton models 2 inches x 6 inches - four swivel-type roller bearing, beam 8 inch SAI 11"6" long.</p> <table border="1"> <thead> <tr> <th><u>Capacity</u> <u>Tons</u></th> <th colspan="2"><u>Under I Beam to Ground</u></th> <th colspan="2"><u>Adj. Span (width)</u></th> </tr> <tr> <th></th> <th><u>Max.</u></th> <th><u>Min.</u></th> <th><u>Max.</u></th> <th><u>Min.</u></th> </tr> </thead> <tbody> <tr> <td align="center">1</td> <td align="center">10 ft</td> <td align="center">5 ft. 8 in.</td> <td align="center">10 ft.</td> <td align="center">4 ft.</td> </tr> </tbody> </table> <p>Chain hoist trolley of rugged four-wheel trolley for use with overhead I beam track, wheels shall be carburized, hardened ball bearing steel wheels and adjustable, self aligning side plates for mounting at any point on beam; axles with standard fittings for pressure gun lubrication.</p>	<u>Capacity</u> <u>Tons</u>	<u>Under I Beam to Ground</u>		<u>Adj. Span (width)</u>			<u>Max.</u>	<u>Min.</u>	<u>Max.</u>	<u>Min.</u>	1	10 ft	5 ft. 8 in.	10 ft.	4 ft.
<u>Capacity</u> <u>Tons</u>	<u>Under I Beam to Ground</u>		<u>Adj. Span (width)</u>														
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MECHANICAL MATERIALS HANDLING TECHNOLOGY

EQUIPMENT

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION				
E-MMH-6 (Cont'd)		<table border="0"> <tr> <td align="center">Capacity, lbs</td> <td align="center">I-Beam Size Inches</td> </tr> <tr> <td align="center">2,000</td> <td align="center">5 - 12</td> </tr> </table>	Capacity, lbs	I-Beam Size Inches	2,000	5 - 12
Capacity, lbs	I-Beam Size Inches					
2,000	5 - 12					
		<p>The hoist, high speed, shall have frame, hand wheel and covers of aluminum alloy; load bearing parts of high grade steel; chain of alloy steel, flexible, welded-link; upper and lower hook heavy drop forged, heat treated steel; hooks furnished with safety hook latches.</p>				
E-MMH-7	L-30-7-(1) L-32-7-(1)	<p><u>Battery Filler and Hydrometer</u> - Filler of one-piece molded, flexible rubber body; wide mouth; protected hydrometer holder molded into top of filler; 16 inch flexible filler hose with built-in non-drip hose holder; capacity one gallon; including hydrometer.</p>				
E-MMH-8	L-30-8-(2) L-32-8(1)	<p><u>Battery Filler</u> - Filler with one-piece polyethylene body, smooth grip handle; nozzle should be removable for filling; nozzle shall have hydrostatic valve which stops flow of distilled water when proper level is reached in battery.</p>				
E-MMH-9	L-30-9-(2)	<p><u>Safety Can With Faucet</u> - Steel with self-closing dispensing faucet near bottom of can; Fire Marshal approved; capacity: 5 gallons.</p>				
E-MMH-10	L-30-10-(8) L-31-10-(3) L-32-10-(2)	<p><u>Oily Waste Can</u> - Steel, 22 gauge and 24 gauge pointed red; legs 4 inches high; handle on top 3 inches high; foot lever to open can 60 degrees and top closes by gravity; capacity, 21 gallons.</p>				
E-MMH-11	L-30-11-(4) L-31-11-(3) L-32-11-(2)	<p><u>Tanks, Rinse-Clean</u> - Heavy gauge steel with angle iron reinforcement; overall height; 33-3/4 inches; inside size, 42 inches x 26 inches x 15 inches with full width shelf and 1/4 inch drain with plug. If shipped knocked down a complete set of fittings, nuts, bolts, etc.; with full assembly directions.</p>				

MECHANICAL MATERIALS HANDLING TECHNOLOGY

EQUIPMENT

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
E-MEH-12	L-30-12-(7) L-31-12-(8)	<u>Baskets, Cleaning, Expanded Metal</u> - Basket with 1 inch steel top frame and 5/16 inch diameter runner; zinc plated mesh; metal edge finished; two lifting handles; capacity, 300 lbs approximate dimensions, 20 inches long x 12 inches wide x 6 inches high, gauge steel 16/18, percent open area in expanded metal - 60.
E-MEH-13	L-30-13-(1) L-32-13-(2)	<u>Battery Charger, Multiple</u> - Capacity for charging 36 cells; isolating transformer; coarse and fine control for current adjustments; full wave silicon rectifier size: 10-1/2 10-1/2 inches high x 12 inches wide x 9-1/2 inches deep, 50 Hz, amperes 12, Volts 220. Outside electrical connections to be compatible with Syrian requirements.
E-MEH-14	L-30-14-(1)	<u>Purifier - Centrifuge</u> - Capable of removing all foreign matter and water that would be inconsistent with good and carefree operation of Diesel oil pumps, nozzle/injector, etc. systems; with a complete set of dam rings, etc.. so that both Diesel oil and lubricating oil for the Diesel may be properly purified; complete with necessary tools for maintenance and repair, seals, "O" rings, gaskets, etc; operate at approximately 7,000 rpm and have a capacity of approximately 50 gallons per hour. Electrical and mechanical connections to outside sources must be compatible with Syrian requirements.
E-MEH-15	L-30-15-(2) L-31-15-(3)	<u>Engine Stand, Work-Saver</u> - Rugged, light weight tube and channel construction with 2 rear, 1 front large swivel type casters; engine adapter plate capable of pivoting 360 degrees.
E-MEH-16	L-30-16-(1)	<u>Pressure Gauge Calibrator to 500 psi</u> - Calibrator reading accurate to 1/10 of 1 percent of indicated reading; works on dead weight principle; oil actuated; tester piston rotatable to prevent friction errors; forged brass pressure chamber; cast iron bases; storage containers for weights, tools and adapters to be provided. Price to include tester, weights, 1/4 inch male, 1/8, 1/4 and 1/2 inch female adapters, 2 wrenches, screwdriver, handset, gauge pointer lifter, oil supply and operating instructions.

MEH-13

MECHANICAL MATERIALS HANDLING TECHNOLOGY

EQUIPMENT

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION		
E-MMH-16 (Cont'd)	L-30-16-(1)	<u>Range</u> 500	<u>psi</u> <u>Min. Test</u> 5	<u>Weight Increment</u> 1
E-MMH-17	L-30-17-(1)	<u>Pressure Gauge Calibrator to 4,000 psi</u> - The same as E-MMH-16 above except that pressure chamber shall be steel instead of brass.		
E-MMH-18	L-30-18-(2)	<u>Range</u> 4,000	<u>psi</u> <u>Min. Test</u> 25	<u>Weight increment</u> 10
E-MMH-19	L-3J-19-(5)	<u>Diesel-Dynamometer Test Stand, Complete</u> - The complete unit shall be a Tecquipment, Ltd., Diesel Engine Test Bed TD 4a with exhaust gas analysis (orsat) equipment or equivalent. (Tecquipment Ltd., is located at Hooton Street, Carlton Road, Nottingham NG33NJ, England). <u>Diesel Engine with Dynamometer Pulley, Complete</u> - Diesel that is in the Caterpillar fork-lift truck V 30 B, or equal, complete, ready to run with a suitable smooth surface pulley of sufficient size and heat bearing ability to absorb about 25% of the rated BHP of the Diesel furnished; pulley firmly mounted and keyed on the spline shaft that normally would be connected to the clutch-transmission (not to be furnished) system. A wood block prony brake, not to be furnished, will be mounted on the pulley. Complete with six (6) sets of gaskets, seals, "O" rings, etc.		

MECHANICAL MATERIALS HANDLING TECHNOLOGY

EQUIPMENT

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION												
E-MGH-20	L-30-20-(1)	<p><u>Grinder, Pedestal</u> - Heavy duty 12 inch with 1,725 rpm 380 V, 50 HZ three phase 2 HP motor with wire and plug for Syrian electrical connection; distance between wheels about 24 inches; with overload protector manual starter; adjustable tool rests; wheel guards and spark arrestors; include 30 inch cast iron pedestal, water pot, tool trays and shatterproof adjustable eye shields; two grinding wheels.</p> <table border="1"> <thead> <tr> <th><u>Diameter,</u> <u>Inches</u></th> <th><u>Face,</u> <u>Inches</u></th> <th><u>Bore,</u> <u>Inches</u></th> <th><u>Grit</u></th> </tr> </thead> <tbody> <tr> <td>12</td> <td>2</td> <td>1-1/4</td> <td>30</td> </tr> <tr> <td>12</td> <td>2</td> <td>1-1/4</td> <td>46</td> </tr> </tbody> </table>	<u>Diameter,</u> <u>Inches</u>	<u>Face,</u> <u>Inches</u>	<u>Bore,</u> <u>Inches</u>	<u>Grit</u>	12	2	1-1/4	30	12	2	1-1/4	46
<u>Diameter,</u> <u>Inches</u>	<u>Face,</u> <u>Inches</u>	<u>Bore,</u> <u>Inches</u>	<u>Grit</u>											
12	2	1-1/4	30											
12	2	1-1/4	46											
E-MGH-21	L-30-21-(1)	<p><u>Drill Press</u> - Capacity 15 inch; floor model five speed spindle (500-5500 rpm); motor 1/2 HP, one phase, capacitor start 220 V, 50 HZ; 16 spline spindle with four sealed ball bearings; quills bored from high tensile, malleable alloy steel; safety push button; 5 inch spindle stroke; standard table, depth stop, motor mount, hand feed wheel, plain base, 1/2 inch key chuck, pulleys, belt and motor. ready for operation with Syrian electrical plug.</p>												
E-MGH-22	L-30-22-(1)	<p><u>Lathe With Motor, Complete</u> - V-belt drive - 16 spindle speeds instant reversible power cross and longitudinal feeds; safety clutch on lead screw; pedestal to have integral chip pan with removable plug for drain; 3/4 HP, 380 V, 50 HZ, three phase, 50 deg. C rise; capacitor start motor; 5/8 inches shaft with 1-7/8 inch usable length; rubber base mount sleeve bearing. totally enclosed. Lathe specifications:</p>												

MECHANICAL MATERIALS HANDLING TECHNOLOGY

EQUIPMENT

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION	
E-MMH-22 (Cont'd)	L-30-22-(1)	<p align="center"><u>Capacity</u></p> <p>Swing over saddle wing 12 ins Swing over bed 12-1/4 ins Swing over cross slide 7-3/4 ins Thread range std 4 to 240</p> <p align="center"><u>Carriage</u></p> <p>Gross slide travel 6-12 ins. Cross feed screw 1/2 in diameter Compound travel 2 .7/4 ins Tool post slot 3/8 ins x 7/8 ins Takes 3/8 in bits, Acme</p> <p>Other equipment to be furnished:</p> <p>Motor pulley for 5/8 in diameter motor shaft, graduated compound rest; 60 hole indexing mechanism; tool post, ring and rocker; threading dial; two (2) 60 degree lathe centers; wrenches; reducing sleeve for headstock centers; 6 inch face plate and instruction book in English. All mechanical and electrical connections to outside sources must be compatible with Syrian requirements.</p>	<p align="center"><u>Headstock</u></p> <p>Hole thru spindle 25/32 ins Collet capacity 1/2 in Spindle nose 1/2 in - 8 thread Spindle internal taper No. 3 MT</p> <p align="center"><u>Tailstock</u></p> <p>Spindle 1/18 in diameter Spindle internal taper No. 2 MT Spindle travel 2-3/14 ins</p>
E-MMH-23	L-31-23-(1)	<p><u>Two Speed Power Shift Transmission</u> - Complete transmission and housing ready to install in a Caterpillar, or equal, fork-lift truck. Includes twelve (12) complete sets of gaskets, "O" rings, seals and other damageable parts where such damage could occur while disassembling the transmission and necessary to proper reassembly; six (6) manuals in English for preventive and normal corrective maintenance; smallest capacity stock transmission of this type.</p>	

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MECHANICAL MATERIALS HANDLING TECHNOLOGY

EQUIPMENT

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
E-MMH-24	L-31-24-(1)	<u>Four Speed Manual Transmission</u> - Specifications are generally the same as for E-MMH-23 except that it should apply solely to a Four Speed Manual Transmission. It shall be the smallest capacity stock transmission of this type.
E-MMH-25	L-31-25-(1)	<u>Five Speed Manual Transmission</u> - Specifications are generally the same as for E-MMH-23 except that it should apply solely to a Five Speed Manual Transmission. It shall be the smallest capacity stock transmission of this type.
E-MMH-26	L-31-26-(1)	<u>Three Speed Power Shift Transmission</u> - Specifications are generally the same as for E-MMH-23 except that it should apply solely to a Three Speed Power Shift Transmission. It shall be the smallest capacity stock transmission of this type.
E-MMH-27	L-31-27-(1)	<u>Full Floating Drive Axle</u> - Full-floating drive axle with housing ready to install in a Caterpillar, or equal, fork lift truck. The quote price shall include twelve (12) complete sets of gaskets, "O" rings, seals and other items that may be damaged where such damage could occur while disassembling this axle and necessary to proper reassembly; six (6) manuals in English for preventive and normal corrective maintenance shall be included. It shall be the smallest capacity stock axle of this type.
E-MMH-28	L-31-28-(1)	<u>Planetary Drive Axle</u> - Specifications are generally the same for E-MMH-27 except that it should apply solely to a planetary drive axle. It shall be the smallest capacity stock axle of this type.
E-MMH-29	L-31-29-(1)	<u>Hydraulic Lift and Tilt System, Fork Lift, Complete</u> - This system shall include a hydraulic tank, hoist motor and pump, tilt cylinders, filter, hydraulic control valve, hoist cylinder, etc. as may be found in a caterpillar, or equal, fork-lift truck. The quoted price should include necessary tubing and fittings so that system may be mounted on a demonstration panel and be operable; twelve (12) complete sets of gaskets, "O" rings, seals and other items that may be damaged where such damage could occur while disassembling any component of this system and

MMH-22

MECHANICAL MATERIALS HANDLING TECHNOLOGY

EQUIPMENT

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
E-MMH-29 (cont'd)	L-31-29-(1)	necessary to proper reassembly. Six (6) manuals in English for preventive and normal corrective maintenance shall be included. It shall be the smallest capacity stock axle of this type.
E-MMH-30	L-31-30-(1) L-32-30-(1)	<u>Compressor, Portable, Complete</u> - Electric drive mounted on 12 gallon air receiver with wheels and handle; deliver 2.3 CFM and 100 psi maximum; with quick coupler, air chuck, 25 ft. hose, tank drain with valve and belt guard. Motor: 3/4 HP, 220 V, 50 HZ, one phase, built-in thermal overload protection, automatic pressure switch, release valve, shutoff valve, and 8 ft U.L. approved cord with electric plug suitable for Syrian electric service.
E-MMH-31	L-31-31-(1)	<u>Clutch, Plate</u> - Clutch system complete with housing ready to install in a typical Caterpillar transmission system. The quote price shall include twelve (12) complete sets of gaskets, "O" rings, seals and other items that may be damaged where such damage could occur while disassembling this clutch and necessary to proper reassembly; six (6) manuals in English for preventive and normal corrective maintenance shall be included. It shall be the smallest capacity stock clutch of this type.
E-MMH-32	L-31-32-(1)	<u>Clutch, Disc</u> - Multiple disc clutch with "creoper" pedal shall be complete with housing ready to install in a typical total transmission system of a Caterpillar, or equal. The quote price shall include twelve (12) complete sets of gaskets, "O" rings, seals and other items that may be damaged where such damage could occur while disassembling this clutch and necessary to proper reassembly; six (6) manuals in English for preventive and normal corrective maintenance shall be included. It shall be the smallest capacity stock clutch of this type.

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MECHANICAL MATERIALS HANDLING TECHNOLOGY

EQUIPMENT

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
E-MEH-33	L-32-33-(5)	<p><u>Fork Lift Truck</u> - Diesel driven 3,000 lb at 24 inches (1500 kg at 500 m) with hydrostatic transmission; full floating axles shifts on tapered roller bearings; positive oil flow to oil gears and bearings; self-energizing; self-adjusting, internal expanding hydraulic brakes in drive wheels; demountable non-skid pneumatic tires; bolted-in and removable fuel tanks; lift mechanism hydraulic system to be positive displacement; high pressure gear type pump with direct crankshaft drive - no belts; similar to Caterpillar V 30 B or equivalent.</p>
E-MEH-34	L-32-34-(1)	<p><u>Air Jack, Heavy Duty, Wide-Lift</u> - Portable with lifting capacity of 12,000 lbs on air pressure of 150 psi; 2-1.4 inch low clearance; jack in raised position shall have a safety lock and automatically releases when lift is to be lowered; raised height 11 inches; overall length 28 inches; width 18-1/2 inches.</p>
E-MEH-35	L-32-35-(2)	<p><u>Mast, Boom and Tackle, Complete</u> - Complete workable mast (Kingpost), boom and tackle system similar to that furnished on a small vessel; Mast (Kingpost) shall be 14 feet high above ground and the boom 12 feet long; bottom of the mast shall be designed so that it can be anchored and free standing in a reinforced concrete floor without back stays. The boom shall be rigged to lift a load of one ton (2,000 lbs); boom rigging should be able to be handled manually by two persons who are simulating lifting a one ton cargo from or into the hold of a ship; the rigging should permit the load from the hold either port or starboard over the side of a simulated vessel to a deck. The boom should be able to swing freely through 180 degrees; be able to be nested into the mast (kingpost) for storage when not working the rigging. The rigging sheets (ropes) should be stowable on the side of the mast when not in use. Proper size cleats that shall be anchored in the cement at proper locations to insure against overtravel of the boom while loading or unloading shall also be furnished. Installation drawings for the kingpost, mast, reaving of blocks, cleat installation and location and other items shall be furnished.</p>

MMH-24

MECHANICAL MATERIALS HANDLING TECHNOLOGY

EQUIPMENT

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION												
E-MMH-36	L-32-36-(8)	<u>Conveyor, Gravity Roller, Straight</u> - 10 feet long and straight; consist of free-running 2 inch diameter; steel tubing welded around greaseless, hardened cone bearings; shafts 1/4 inch cold drawn screw stock mounted in 2-1/2 inches x 1 inch x 1/2 inch channel iron frames; frames to have hooks at one end and rods at other, easily connectable; 3 inch roller centers, width 20 inch overall, 18 inch roller.												
E-MMH-37	L-32-37-(4)	Conveyor, Gravity Roller, 90 Degree Curve - The 90 degree curve shall have the same general specifications as E-MMH-36 above and be connectable, to make a usable conveyor system, to E-MMH-36.												
E-MMH-38	L-32-38-(20)	<u>Conveyor Stands, 3 Leg, 30 inches High</u> - These stands shall be compatible with E-MMH-36 and E-MMH-37 so that the usable conveyor system when assembled with be 30 inches off the ground and sturdy.												
E-MMH-39	L-30-39-(1) L-31-39-(1)	<p>Oxygen Regulator, Two Stage - First stage factory set at 150 psi, second stage operator controlled.</p> <table border="1"> <thead> <tr> <th>Type Regulator Stage</th> <th>For</th> <th>Del. Press. Gauge, psi</th> <th>Cyl. Press. Gauge, psi</th> <th>Max. Del. Press. psi</th> <th>Max. Flow C/hr</th> </tr> </thead> <tbody> <tr> <td>Two</td> <td>Oxygen</td> <td>400</td> <td>4000</td> <td>200</td> <td>6600</td> </tr> </tbody> </table>	Type Regulator Stage	For	Del. Press. Gauge, psi	Cyl. Press. Gauge, psi	Max. Del. Press. psi	Max. Flow C/hr	Two	Oxygen	400	4000	200	6600
Type Regulator Stage	For	Del. Press. Gauge, psi	Cyl. Press. Gauge, psi	Max. Del. Press. psi	Max. Flow C/hr									
Two	Oxygen	400	4000	200	6600									

MMH-39

MECHANICAL MATERIALS HANDLING TECHNOLOGY

EQUIPMENT

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION												
E-MMH-40	L-30-40-(1) L-31-40-(1)	<p><u>Acetylene Regulator, Two Stage</u> - Same as E-MMH-39 except:</p> <table border="1"> <thead> <tr> <th>Type Regulator Stage</th> <th>For</th> <th>Del. Press. Gauge, psi</th> <th>Cyl. Press. Gauge, psi</th> <th>Max. Del. Press. psi</th> <th>Max. Flow Cfhr</th> </tr> </thead> <tbody> <tr> <td>Two</td> <td>Acetylene</td> <td>30</td> <td>400</td> <td>15</td> <td>900</td> </tr> </tbody> </table>	Type Regulator Stage	For	Del. Press. Gauge, psi	Cyl. Press. Gauge, psi	Max. Del. Press. psi	Max. Flow Cfhr	Two	Acetylene	30	400	15	900
Type Regulator Stage	For	Del. Press. Gauge, psi	Cyl. Press. Gauge, psi	Max. Del. Press. psi	Max. Flow Cfhr									
Two	Acetylene	30	400	15	900									
E-MMH-41	L-30-41-(1) L-31-41-(1)	<p><u>Wall Bracket, Double Cylinder Holder</u> - Steel with special chain take-up feature; should be able to hold one large oxygen tank and one medium size acetylene tank; holes should be drilled in the bracket for suitable attachment to wall.</p>												

1E11-26

MASTER EQUIPMENT LISTMECHANICAL MATERIALS HANDLING TECHNOLOGYGeneral Specifications (To be Applied to All Items)

1. All equipment shall be new and unused items embodying the most up to date principles, design and styling.
2. All dimensions, calibrations, etc. are in English units except where otherwise specified. The vendor, if necessary, will convert the given dimensional, etc. information into such units consistent with his design and propose and/or furnish the nearest stock item that will meet specifications.
3. All electrical connections will be for 220V/50Hz, single phase AC unless otherwise specified. Most exceptions will be 380V/50Hz, three phase.
4. Manuals normally supplied with any of the following items will be expected to be furnished although not specifically mentioned in a particular specification.
5. This equipment, small tools, etc., is being purchased to aid in the teaching and training process in a technical institute to be located at Latakia, S.A.R. It is therefore strongly recommended that the following equipment items from the indicated Master List be purchased from one vendor. The reasons being: (1) it is essential that the storage of spare parts, gaskets, "O" rings, glands, etc., for these items be kept to a minimum; (2) the compatibility of the items one to another will lend itself to cross reference and in some instances possible assembly one to another to show the interrelationship of parts. There is enough confusion on the waterfront - 16 different manufacturers of fork-lift trucks and the associated problem of warehousing 16 different manufacturer's parts from the U.S., Western Europe, Eastern Europe, and the Far East without introducing that problem into the Institute. Only one engine manufacturer, where applicable, and/or one fork-lift manufacturer should supply:

E-MMH-1 Piston, Diesel Engine

E-MMH-2 Crankshaft, Diesel Engine

E-MMH-19 Diesel Engine with Dynamometer Pully, complete

E-MMH-23 Two Speed Power Shift Transmission

MMH-28

- E-MMH-24 Four Speed Manual Transmission
- E-MMH-25 Five Speed Manual Transmission
- E-MMH-26 Three Speed Power Transmission
- E-MMH-27 Full Floating Drive Axle
- E-MMH-28 Planetary Drive Axle
- E-MMH-29 Hydraulic Lift and Tilt System, Fork Lift, complete
- E-MMH-31 Clutch, Plate
- E-MMH-32 Clutch, Disc
- E-MMH-33 Fork Lift Truck

The following item is specified in the English system if the above are purchased where components use the metric system, then it should be metric:

- S-MMH-40 Socket Set, 20 pieces

The following conveyor components should be purchased from one vendor:

- E-MMH-36, 37 and 38.

MASTER EQUIPMENT LIST
MECHANICAL MATERIALS HANDLING TECHNOLOGY
EQUIPMENT

REFERENCE NUMBER	DESCRIPTION	QUANTITY	UNIT	TOTAL
E-MMH-1	Piston, Diesel Engine	5	45	375.00
E-MMH-2	Crankshaft, Diesel Engine	5	150	1,625.00
E-MMH-3	Diesel Pump and Injector Test System	1	24,100	24,100.00
E-MMH-4	Diesel Oil Storage Tank, complete	1	250	250.00
E-MMH-5	Lubricant Storage Tank with Legs	1	336	336.00
E-MMH-6	Gantry Crane, adjustable, complete	6	1,335	8,010.00
E-MMH-7	Battery Filler and Hydrometer	2	19	38.00
E-MMH-8	Spillnot Battery Filler	3	18	57.00
E-MMH-9	Safety Can with Faucet	2	57	114.00
E-MMH-10	Oily Waste Can	13	61	793.00
E-MMH-11	Tanks, Rinse-Clean	9	180	1,620.00
E-MMH-12	Baskets, Cleaning, Expanded Metal	15	37	555.00
E-MMH-13	Battery Charger, multiple	3	281	843.00
E-MMH-14	Purifier-Centrifuge D.O. and L.O.	1	9,500	9,500.00
E-MMH-15	Engine Stand, work saver	5	216	1,080.00
E-MMH-16	Pressure Gauge Calibrator to 500 psi	1	590	590.00
E-MMH-17	Pressure Gauge Calibrator to 4000 psi	1	945	945.00
E-MMH-18	Diesel-Dynamometer Test Stand, complete	2	20,000	40,000.00
E-MMH-19	Diesel Engine with Dynamometer Pulley, complete	5	3,500	17,500.00
E-MMH-20	Grinder, pedestal	1	645	645.00
E-MMH-21	Drill Press	1	435	435.00
E-MMH-22	Lathe with Motor, complete	1	1,645	1,645.00
E-MMH-23	Two Speed Power Shift Transmission	1	5,400	5,400.00
E-MMH-24	Four Speed Manual Transmission	1	5,250	5,250.00
E-MMH-25	Five Speed Manual Transmission	1	5,850	5,850.00
E-MMH-26	Three Speed Power Shift Transmission	1	6,450	6,450.00
E-MMH-27	Full Floating Drive Axle	1	5,250	5,250.00
E-MMH-28	Planetary Drive Axle	1	5,400	5,400.00
E-MMH-29	Hydraulic Lift and Tilt System, Fork Lift, complete	1	5,400	5,400.00
E-MMH-30	Compressor, portable, complete	2	317	634.00
E-MMH-31	Clutch, Plate	1	1,450	1,450.00

MASTER EQUIPMENT LIST
MECHANICAL MATERIALS HANDLING TECHNOLOGY
EQUIPMENT

REFERENCE NUMBER	DESCRIPTION	QUANTITY	UNIT	TOTAL
E-MMH-32	Clutch, Disk	1	2,000	2,000.00
E-MMH-33	Fork Lift Truck	5	18,500	92,500.00
E-MMH-34	Air Jack, heavy duty, wide-lift	1	540	540.00
E-MMH-35	Mast, Boom and Tackle, complete	2	20,000	40,000.00
E-MMH-36	Conveyer, Gravity Roller, straight	8	127	1,016.00
E-MMH-37	Conveyer, Gravity Roller, 90° curve	4	152	608.00
E-MMH-38	Conveyer, Stands, 3 leg, 30 inches high	20	20	400.00
E-MMH-39	Oxygen Regulator, Two Stage	2	71	142.00
E-MMH-40	Acetylene Regulator, Two Stage	2	69	138.00
E-MMH-41	Wall Bracket, Double Cylinder Holder	2	30	60.00
E-MMH-42	Arc Welder, AC, General Service	2	210	420.00
E-MMH-43	Welding Tip Set	2	63	126.00

MECHANICAL MATERIALS HANDLING TECHNOLOGY

FURNITURE

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
F-MMH-1	L-29-1-(22) L-30-1-(9) L-31-1-(1) L-32-1-(2)	<u>Production Machine Table</u> - 16 gauge steel; Legs 1½ inch x 1½ inch x 1/8 inch steel angle riddledly braced with 1 inch x 1/8 inch thick flat steel strips; gray/acqueror enamel finish. May be furnished knocked down and if so, adequate stove bolts, nuts and full assembly instructions must be provided. Table top size 24 inches x 30 inches by 26 inches high.
F-MMH-2	L-29-2-(3) L-30-2-(3) L-31-2-(3) L-32-2-(4)	<u>Storage Cabinet, Six Shelves</u> - Heavy gauge construction with six (6) adjustable shelves; 36 inches wide x 24 inches deep by 78 inches high; modern style, smooth rounded corners in front; no bolt heads showing on front or sides. Double doors open a full 180 degrees; door panels reinforced; polished chrome handles and built in lock with key; base with glides over finish in durable enamel or lacquer. May be shipped knock-down, if so, full assembly instructions and necessary fitting for proper assembly must be provided.
F-MMH-3	L-29-3-(1) L-30-3-(1) L-31-3-(1) L-32-3-(1)	<u>Desk, Storage Room</u> - Steel construction with durable walnut grained laminated plastic top; double pedestal, with box-drawer and file-drawer in each center drawer; finish in gray enamel or lacquer; self-leveling floor glides; overall dimensions: top 60 inches x 30 inches and 29½ inches high. If the desk is furnished knocked-down, a complete set of necessary fittings, nuts, bolts, etc., shall be furnished together with complete, and detailed, assembly instructions.
F-MMH-4	L-29-4-(1) L-30-4-(1) L-31-4-(1) L-32-4-(1)	<u>Chair, Storage Room</u> - Padded seat, full frame backrest, covered with vinyl; 18 gauge 7/8 inch square steel tubing frame, seam welded; legs shall have metal guides and bumpers; seat, 16 inch x 16 inch; back rest, 14 inch x 10 inches high, seat height 17 inches; metal parts enameled or lacquered gray.
F-MMH-5	L-29-5-(2) L-30-5-(4)	<u>Waste Paper Disposal Receptacle - Safety Type</u> - Heavy gauge steel, finished on the outside with baked gray enamel, inside baked phenolic coating; head finished in aluminum. Capacity 30 gallons. The head shall be specially designed to drive combustion gases of a fire back on to the fire in the container to cut off the oxygen supply.

MECHANICAL MATERIALS HANDLING TECHNOLOGY

FURNITURE

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
F-MMH-6	L-29-6-(2) L-30-6-(2)	<u>Display Cabinet</u> - Heavy gauge steel; 26 inches wide, 12 inches deep, 60 inches high with glass doors on ball bearing rollers and full width by-passing plate tracks; three (3) shelves which may be adjusted on 3/4 inch centers; baked enamel finish, gray.
F-MMH-7	L-30-7-(1) L-31-7-(1) L-32-7-(1)	<u>Drawer Unit, Revolving Base</u> - Entire unit revolves on a heavy duty bearing mounted base; individual cabinets shall stack together, no bolting required; each drawer shall be capable of being subdivided into at least 12 separate compartments; cabinet frame of heavy gauge welded steel, drawers of high-impact polystyrene; finish baked enamel charcoal finish; at least 300 storage drawers; drawers of 4 sizes; unit rotates 360 degrees; overall size approximately 29 inches square by 60 inches high.
F-MMH-8	L-30-8-(3) L-31-8-(3) L-32-8-(3)	<u>Rack, Eight High</u> - Arc welded, heavy gauge steel construction with olive green enamel finish; boxes specified in F-MMH-9 below shall slide in and out of the rack easily without disturbing the box above or below; rack shall be eight boxes high.
F-MMH-9	L-30-9-(24) L-31-9-(24) L-32-9-(24)	<u>Box, Steel for F-MMH-8-Rack</u> - Heavy gauge steel with notching rim on four sides, corners reinforced with steel bars and spot welded; drop handles on both ends, unpainted and leak-proof to a depth of one inch; must freely fit into F-MMH-8 rack above.
F-MMH-10	L-30-10-(4) L-31-10-(4) L-32-10-(8)	<u>Casters, Rubber for F-MMH-1 Above</u> - Size 3 inches x 1½ inches; load capacity 175 pounds; self lubricating bearing; wheels; 8 will be swivel type with lock and 8 will be rigid.
F-MMH-11	L-30-11-(3) L-31-11-(7) L-32-11-(2)	<u>Bench, Work</u> - Island type: 2½ inch heavy laminated maple top, solid 2½ inch square maple legs, with bolt reinforcement at all stringers and the 24 inch lower shelf; 36 inches deep with plain edges, no angle iron or rear curb; clear lacquer finish 12 feet, height 37 inches and have four (4) pairs of legs. The table may be furnished knocked-down, if so, a complete set of fittings, bolts, nuts, etc. must be furnished together with clear, complete assembly instructions.

MECHANICAL MATERIALS HANDLING TECHNOLOGY

FURNITURE

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
F-NMH-12	L-31-12-(2)	<u>Shelving, Industrial, Steel, Enclosed</u> - Enclosed at base; 36 inches wide x 87 inches high; seven 18 gauge shelves, 18 inches deep; angle posts of 13 gauge 1 inch x 3/4 inch steel punched on 1 inch centers for shelving location; unit shall be cross braced to eliminate sway; finish shall be gray baked enamel. If furnished knocked-down, a complete set of fittings, nuts and bolts, etc. together with clear, complete assembly instructions must be furnished.

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MASTER EQUIPMENT LIST
MECHANICAL MATERIALS HANDLING TECHNOLOGY
FURNITURE

REFERENCE NUMBER	DESCRIPTION	QUANTITY	UNIT	TOTAL
F-MHI-1	Production Machine Table, Steel	34	60	2,040.00
F-MHI-2	Storage Cabinet, 6 shelves, steel, gray	13	300	3,900.00
F-MHI-3	Desk, storage room	4	191	764.00
F-MHI-4	Chair, storage room	4	26	104.00
F-MHI-5	Waste Paper Disposal Receptacle	6	39	234.00
F-MHI-6	Display Cabinet	4	179	716.00
F-MHI-7	Drawer Unit, Revolving Base	3	884	2,652.00
F-MHI-8	Rack, Eight High	9	300	2,700.00
F-MHI-9	Box, Steel, stacking for F-MHI-8	72	22	1,584.00
F-MHI-10	Casters, Rubber for F-MHI-1	16	5	80.00
F-MHI-11	Bench, Island Type, work	12	470	5,640.00
F-MHI-12	Shelving, Industrial, Steel, closed	2	112	224.00

MECHANICAL MATERIALS HANDLING TECHNOLOGY

SMALL TOOLS

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
S-MNH-1	L-29-1-(3)	<u>Micrometer 00.00 - 24.40mm</u> - Read both in English and metric simultaneously as spindle is rotated; meet U.S. Federal Specifications for accuracy; positive locking clamp and clear graduations on stain chrome finish; carrying case. Range: thimble 0-1 inch counter 00.00-25.40mm; graduation: thimble 0.0001 inch and counter 0.01mm.
S-MNH-2	L-29-2-(3)	<u>Micrometer 25.40mm - 50.80mm</u> - Specifications same as for S-MNH-1 above except for the range; thimble 1 inch - 2 inch, counter 25.40 - 50.80mm.
S-MNH-3	L-29-3-(3)	<u>Micrometer 50.80 - 76.20mm</u> - Specifications same as for S-MNH-1 above except for the range; thimble 2 inch - 3 inch, counter 50.80mm - 76.20mm.
S-MNH-4	L-29-4-(3)	<u>Micrometer 76.20mm - 101.60mm</u> - Specifications same as for S-MNH-1 above except for the range; thimble 3 inch - 4 inch, counter 76.2mm - 101.60mm.
S-MNH-5	L-29-5-(20)	<u>Caliper, Inside</u> - Legs flat, high grade steel; hardened fulcrum stud; bow spring; sizes: 8 each of 10 inches; 6 each of 8 inches and 6 inches; Starrett or equal.
S-MNH-6	L-29-6-(20)	<u>Caliper, Outside</u> - Legs flat, high grade steel; hardened fulcrum stud; bow spring; sizes: 8 each of 10 inches; 6 each of 8 inches and 6 inches; Starrett or equal.
S-MNH-7	L-29-7-(20)	<u>Dividers</u> - Legs flat, high grade steel; hardened fulcrum stud; bow spring; sizes: 8 each of 10 inches; 6 each of 8 inches and 6 inches; Starrett or equal.
S-MNH-8	L-29-8-(42)	<u>"I" Square, Aluminum, 40 cm</u> - The square shall be approximately 40 cm but no longer. High temperature alloy-see-resistant aluminum alloy; blade approximately 5 cm wide, 2 mm gauge, 40 cm long; edge marked with cm to one-tenth on top edge.

MECHANICAL MATERIALS HANDLING TECHNOLOGY

SMALL TOOLS

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
S-MMH-9	L-29-9-(20)	<u>Square, Steel, Machinist</u> - 9 inch blade of hardened steel; true right angles, both inside and outside; ground and lapped for straightness and parallelism.
S-MMH-10	L-29-10-(2)	<u>Surface Plate - Semi Steel</u> - 12 inches x 24 inches heavy deep rib construction, three point bearing; scraped surface with a grade B finish; equipped with handles and a wooden cover.
S-MMH-11	L-29-11-(5)	<u>Screw Pitch Gauge, Metric</u> - 20 blades, pitch 0.25 - 5mm, metric thread 60 degrees, measuring range M2 to M60mm.
S-MMH-12	L-29-12-(5)	<u>Screw Pitch Gauge, 22 Pitches</u> - Narrow permitting both outside and inside threads to be gauged, teeth shall be sharp and clear cut, equal to Starrett 22 pitches: 9, 10, 11, 11½, 12, 13, 14, 15, 16, 18, 20, 22, 24, 26, 27, 28, 30.
S-MMH-13	L-29-13-(5)	<u>Screw Pitch Gauge, 24 Pitches</u> - Same specifications as S-MMH-12 except Starrett 24 pitches: 4, 4½, 5, 5½, 6, 7, 8, 9, 10, 11, 11½, 12, 13, 14, 15, 16, 18, 20, 22, 24, 26, 27, 28, 30.
S-MMH-14	L-29-14-(5)	<u>Screw Pitch Gauge, 20 Pitches</u> - Same as specifications for S-MMH-12 except Starrett 20 pitches: 6, 7, 8, 9, 10, 11, 11½, 12, 13, 14, 15, 16, 18, 20, 22, 24, 26, 27, 28, 30, 32, 34, 36, 38, 40, 42, 48, 50, 56, 60, with positive stop.
S-MMH-15	L-29-15-(5)	<u>Screw Pitch Gauge, 20 Whitworth</u> - Same as specifications for S-MMH-12 except Starrett 30 Whitworth standard pitches: 3½, 4, 4½, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 16, 18, 19, 20, 22, 24, 25, 26, 28, 30, 32, 36, 40, 44, 48, 50, 60 in two cases.

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MECHANICAL MATERIALS HANDLING TECHNOLOGY

SMALL TOOLS

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION						
S-MMH-16	L-29-16-(2)	<p><u>Vertical Dial Comparator, Adjustable</u> - Cast iron base with accurately ground working face; adjustable dial holder bracket, vertical capacity 7 inches; dial indicator shall be over 2 inches in diameter, have lift lever, adjustable bezel, unbreakable crystal and be furnished with ball anvil. The capacity shall be:</p> <table border="0"> <thead> <tr> <th>Graduations</th> <th>Travel</th> <th>Reading</th> </tr> </thead> <tbody> <tr> <td>0-5-0</td> <td>0.025 inches</td> <td>0.0001 inches</td> </tr> </tbody> </table>	Graduations	Travel	Reading	0-5-0	0.025 inches	0.0001 inches
Graduations	Travel	Reading						
0-5-0	0.025 inches	0.0001 inches						
S-MMH-17	L-29-17-(20)	<p><u>Depth and Angle Gauge</u> - Combination; use as depth gauge, caliper and protractor complete with 6 inch hook rule graduated to 1/64 inch; similar to Starrett # 236HB.</p>						
S-MMH-18	L-30-18-(2) L-32-18-(1)	<p><u>Battery Lifter</u> - Tension handle slides on one of the clamp jaws' handle; jaws shall have two non-slip, Neoprene gripping surfaces; cadmium plated, chrome dipped steel; maximum jaw opening at least 1 3/4 inches.</p>						
S-MMH-19	L-30-19-(2) L-32-19-(1)	<p><u>Pliers, Battery Terminal Lift</u> - Length 9 inches, forged steel, with insulated handles; pliers capable of disengaging the battery clamp without twisting or prying.</p>						
S-MMH-20	L-30-20-(2) L-32-20-(1)	<p><u>Cleaner, Post and Terminal, Battery</u> - Sharp, stainless steel scraper; fit positive and negative terminals; cleanable with hot water.</p>						
S-MMH-21	L-30-21-(1)	<p><u>Drill Set</u> - 115 high speed steel drills in fractional, wire gauge and letter sizes in a 22 gauge baked enamel case; all drills full jobbers length and contain 29 fractional drills in sizes 1/16 through 1/2 inch by 64ths; 26 letter size drills, A through Z; 60 wire gauge number sizes 1 through 60. See Note E5, page MMH-27.</p>						

MMH-37

MECHANICAL MATERIALS HANDLING TECHNOLOGY

SMALL TOOLS

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
S-MH-22	L-30-22-(2)	<u>Tool, Welding Double Bit</u> - Forged alloy steel with vertical chisel on one end and long tapered point on the other end.
S-MH-23	L-30-23-(2)	<u>Tip Refacer, Precision Welding</u> - Nylon tapered sleeve with tool steel cutter; 90 degree cut to clean orifices and keep holes true.
S-MH-24	L-30-24-(2)	<u>Hammer, Welder's Chipping</u> - Combination wire brush and chipping hammer; wire brush shall be replaceable; chipping hammer to be made from high grade forged steel.
S-MH-25	L-30-25-(2)	<u>Lighter, Spark, Gas, Welding and Flints</u> - Sturdy spring wire with round file in cup; furnished with twelve (12) extra flints.
S-MH-26	L-30-26-(5) L-31-26-(7) L-32-26-(2)	<u>Hammer, Ball Pein</u> - Forged high carbon steel, heat treated; 16 oz weight, 14½ inch handle; polished face and pein.
S-MH-27	L-30-27-(5) L-31-27-(7) L-32-27-(2)	<u>Mallett, Rubber</u> - Resilient smooth finish solid rubber head, hickory handle about 13½ inches long; securely locked to the head; well balanced and approximately 37 oz.
S-MH-28	L-30-28-(5) L-31-28-(7) L-32-28-(2)	<u>Screwdriver, Regular, Set</u> - General purpose round shank, the blade forged from a solid piece of high carbon steel which is then tempered its full length; flats, edges and points are precision cross-ground and polished; plastic handle; meets U.S. Federal Standards

MECHANICAL MATERIALS HANDLING TECHNOLOGY

SMALL TOOLS

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION																								
S-MMH-28 (Con't.)		<p>or equivalent; set comprises the following screwdrivers:</p> <table border="1"> <thead> <tr> <th>Blade,</th> <th>Length,</th> <th>Overall Length,</th> <th>Quantity,</th> </tr> <tr> <th><u>Size, Inches</u></th> <th><u>Inches</u></th> <th><u>Inches</u></th> <th><u>Sets</u></th> </tr> </thead> <tbody> <tr> <td>9/32</td> <td>4</td> <td>8½</td> <td></td> </tr> <tr> <td>3/8</td> <td>6</td> <td>11</td> <td></td> </tr> <tr> <td>3/8</td> <td>8</td> <td>13</td> <td>14</td> </tr> <tr> <td>7/16</td> <td>10</td> <td>16</td> <td></td> </tr> </tbody> </table>	Blade,	Length,	Overall Length,	Quantity,	<u>Size, Inches</u>	<u>Inches</u>	<u>Inches</u>	<u>Sets</u>	9/32	4	8½		3/8	6	11		3/8	8	13	14	7/16	10	16	
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S-MMH-29	L-30-29-(5) L-31-29-(7) L-32-29-(2)	<p><u>Screwdriver, Philips</u> - Chrome vanadium steel polished blade with plastic handle:</p> <table border="1"> <thead> <tr> <th>Philip</th> <th>Blade Length,</th> <th>Quantity,</th> </tr> <tr> <th><u>Size</u></th> <th><u>Inches</u></th> <th><u>Sets</u></th> </tr> </thead> <tbody> <tr> <td>2</td> <td>1½</td> <td></td> </tr> <tr> <td>1</td> <td>3</td> <td></td> </tr> <tr> <td>2</td> <td>4</td> <td>14</td> </tr> <tr> <td>3</td> <td>6</td> <td></td> </tr> </tbody> </table>	Philip	Blade Length,	Quantity,	<u>Size</u>	<u>Inches</u>	<u>Sets</u>	2	1½		1	3		2	4	14	3	6							
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S-MMH-30	L-30-30-(5) L-31-30-(7) L-32-30-(2)	<p><u>Pliers, Common Slip Joint</u> - Forged Steel, bright plated finish, hardened and oil tempered; jaws shall have sharp milled teeth and have a wire cutter; handles 8 inches long and jaw capacity of 1½ inches.</p>																								

MECHANICAL MATERIALS HANDLING TECHNOLOGY

SMALL TOOLS

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
S-MMH-31	L-30-31-(5) L-31-31-(7) L-32-31-(2)	<u>Channellock or Parallel Jaw Pliers</u> - Forged from high grade steel and heat treated; scored jaw, 12 inches long with a 2½ inch capacity.
S-MMH-32	L-30-32-(5) L-31-32-(7) L-32-32-(2)	<u>Pliers, Side Cutting</u> - Machined from special analysis forged steel, hardened, heat treated, keep cutting edges, gun metal handles, to meet U.S. Federal Specification GGG-P-471C, Type IX, Class I, Style A. Size 8 inches, or equal.
S-MMH-33	L-30-33-(5) L-31-33-(7) L-32-33-(2)	<u>Snap Ring Tool, Internal/External</u> - Capable of removing internal rings with 2-7/16 inches to 4½ inches housing diameter and external rings with 1½ inch to 4½ inch shaft diameter. The tool should include: one pair of jaw plate screws; one pair of points 0.108 inches diameter, 45 degree angle; one pair of point 0.123 inches diameter, 45 degrees angle.
S-MMH-34	L-30-34-(5) L-31-34-(7) L-32-34-(2)	<u>Retrieving Tool, Magnetic</u> - Capable of holding nuts, bolts, washers etc; magnetic head shall be adjustable to pick up at any angle; handle brass; capable of telescoping for storage; size: open: 14 5/8 inches - closed: 7 inches.
S-MMH-35	L-30-35-(5) L-31-35-(7) L-32-35-(2)	<u>Hack Saw With Blades, Assorted Sets</u> - Light weight aluminum construction; tubular back for storage of blades; enclosed handle and front grip for two hand sawing; blade tension controlled from top; no projecting wing nuts; 12 inch blade. One dozen (12) course blades plus one dozen (12) medium blades plus one dozen (12) fine grade blades for above hack saw.
S-MMH-36	L-30-36-(5) L-31-36-(7) L-32-36-(2)	<u>Screw and Pipe Extractor Set</u> - Chromed polished steel; with wood base stand; sizes A12, A13, A14, A15, and A17 plus one each drill 5/64 inch, 7/64 inch, 5/32 inch, 1/4 inch, 17/64 inch and 9/16 inch. The pipe extractor set should include: A16, A18, A22 and A23.

MECHANICAL MATERIALS HANDLING TECHNOLOGY

SMALL TOOLS

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION																				
S-MMH-37	L-30-37-(5) L-31-37-(7) L-32-37-(2)	<p><u>Tap Wrench, Set</u> - Solid handle forged integral with wrench center; wrench should be adjustable by turning the movable handle.</p> <table border="1"> <thead> <tr> <th colspan="2">Tap Size Capacity Inches</th> <th colspan="2">Hand</th> <th>Length</th> </tr> <tr> <th>Hand</th> <th>Machine</th> <th>Pipe</th> <th>Reamers</th> <th>Inches</th> </tr> </thead> <tbody> <tr> <td>1/16 - 1/4</td> <td>0-14</td> <td>-</td> <td>1/8 - 21/64</td> <td>7</td> </tr> <tr> <td>1/2 - 1 1/8</td> <td>-</td> <td>1/8 - 3/4</td> <td>9/32 - 29/32</td> <td>19</td> </tr> </tbody> </table>	Tap Size Capacity Inches		Hand		Length	Hand	Machine	Pipe	Reamers	Inches	1/16 - 1/4	0-14	-	1/8 - 21/64	7	1/2 - 1 1/8	-	1/8 - 3/4	9/32 - 29/32	19
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1/2 - 1 1/8	-	1/8 - 3/4	9/32 - 29/32	19																		
S-MMH-38	L-30-38-(5) L-31-38-(7) L-32-28-(2)	<p><u>Pipe Wrench, Fuclid Pattern</u> - Chrome vanadium steel with thin head; flick-thumb to open jaws; 3 point grip ratchet action.</p> <table border="1"> <thead> <tr> <th>Length</th> <th>Capacity</th> <th>Fits Nuts or Bolt</th> <th>Jaw Thick</th> </tr> <tr> <th>Inches</th> <th>Pipe, Inches</th> <th>Size, Inches</th> <th>Inches</th> </tr> </thead> <tbody> <tr> <td>8</td> <td>1/2 - 3/4</td> <td>5/16 - 5/8</td> <td>5/16</td> </tr> </tbody> </table>	Length	Capacity	Fits Nuts or Bolt	Jaw Thick	Inches	Pipe, Inches	Size, Inches	Inches	8	1/2 - 3/4	5/16 - 5/8	5/16								
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S-MMH-39	L-30-39-(5) L-31-39-(7) L-32-39-(2)	<p><u>Wrench, Adjustable</u> - Forged crestoloy steel or equal, hex shaped jaws, induction hardened, sides of wrench head polished, rest chrome plated; non slip handles; length 12 inches, capacity 1 1/2 inches.</p>																				
S-MMH-40	L-30-40-(5) L-31-40-(7) L-32-40-(2)	<p><u>Socket Set, 20 piece</u> - Set in a steel case; 1/2 inch square drive; alloy steel, fits hex head cap screw 1/4 inch through 3/4 inch diameter. Contents: one reversible ratchet wrench 11 1/2 inch long, nineteen 12-point sockets: all in inches - 3/8, 7/16, 1/2, 9/16, 19/32, 5/8, 21/32, 11/16, 3/4, 25/32, 13/16, 7/8, 5/16, 31/32, 1, 1-1/16, 1-1/8, 1-3/16, 1-1/4, or metric equivalent to be consistent with note #5 page MMH-11 (herein) requirement.</p>																				

MMH 41

MECHANICAL MATERIALS HANDLING TECHNOLOGY

SMALL TOOLS

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION																														
S-MMH-41	L-30-41-(5) L-31-41-(7) L-32-41-(2)	<p><u>Torque Wrench, Dial Type, Metric/English</u> - Dual scales, English and metric; accurate for left and right hand torquing; meet U.S. Government Specification GGG-W-696C and the calibration certified by the U.S. Bureau of Standards or equivalent governmental agencies; with memory pointer.</p> <table border="0"> <tr> <td>Torque</td> <td>Grad.</td> <td>Torque</td> <td>Grad.</td> <td>Sq.</td> <td>Overall</td> </tr> <tr> <td>Range,</td> <td>English,</td> <td>Range,</td> <td>Metric,</td> <td>Dr.,</td> <td>Length,</td> </tr> <tr> <td>English,</td> <td>In. lb.</td> <td>Metric,</td> <td>cm. kg.</td> <td>In.</td> <td>Ins.</td> </tr> <tr> <td><u>In. lbs.</u></td> <td><u> </u></td> <td><u>cm. kg.</u></td> <td><u> </u></td> <td><u> </u></td> <td><u> </u></td> </tr> <tr> <td>0-600</td> <td>10</td> <td>0-700</td> <td>20</td> <td>1/2</td> <td>14-7/8</td> </tr> </table>	Torque	Grad.	Torque	Grad.	Sq.	Overall	Range,	English,	Range,	Metric,	Dr.,	Length,	English,	In. lb.	Metric,	cm. kg.	In.	Ins.	<u>In. lbs.</u>	<u> </u>	<u>cm. kg.</u>	<u> </u>	<u> </u>	<u> </u>	0-600	10	0-700	20	1/2	14-7/8
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0-600	10	0-700	20	1/2	14-7/8																											
S-MMH-42	L-30-42-(5) L-31-42-(7) L-32-42-(2)	<p><u>Pipe and Machinist Vise</u> - Pipe jaws milled of high alloy steel and the vice jaws hardened steel; lockable swivel base.</p> <table border="0"> <tr> <td>Jaw Width,</td> <td>Max. Opening,</td> <td>Pipe Cap.,</td> <td>Weight,</td> </tr> <tr> <td><u>Inch</u></td> <td><u>Inch</u></td> <td><u>Inch</u></td> <td><u>lbs.</u></td> </tr> <tr> <td>3-1/2</td> <td>5-1/2</td> <td>2-1/2</td> <td>48</td> </tr> </table>	Jaw Width,	Max. Opening,	Pipe Cap.,	Weight,	<u>Inch</u>	<u>Inch</u>	<u>Inch</u>	<u>lbs.</u>	3-1/2	5-1/2	2-1/2	48																		
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3-1/2	5-1/2	2-1/2	48																													
S-MMH-43	L-30-43-(1) L-31-43-(1) L-32-43-(1)	<p><u>Hone, Engine Cylinder</u> - Sealed micrometer head; range 2-11/16 inch - 4 1/2 inch; guard plate to prevent stones from hitting crankshaft; stones and felts shall be easily changeable; complete with one set coarse and medium grit stones, cleaning brush, dressing paddle, counterbalance spring all in a steel box.</p>																														

MMH-43

MECHANICAL MATERIALS HANDLING TECHNOLOGY

SMALL TOOLS

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION																					
S-MMH-44	L-30-44-(5) L-31-44-(7) L-32-44-(2)	<u>Box and Tote Tray, Tool, Combination</u> - Heavy gauge steel box equipped with continuous hinge draw bolt and hasp for padlocking and two side catches; tote tray, that will fit within the box, with full grip handle, compartment for tools and a section for sockets; size: 24 inches long x 8 1/2 inches wide x 9 1/2 inches high.																					
S-MMH-45	L-30-45-(1) L-31-45-(1) L-32-45-(1)	<u>Close-Coupled Drill, 1/2 inch</u> - 220V 50Hz single phase motor, grounded with suitable plug for use in Syria; high temperature magnet wire for overall protection; removable, adjustable D-handle, and removable auxiliary handle; able to cut through 1/2 inch steel; universal motor; full power reversing capability and tapered spindle chuck for positive drilling both directions. Electrical fitting furnished to be compatible with Syrian requirements.																					
S-MMH-46	L-30-46-(5) L-31-46-(7) L-32-46-(2)	<p><u>Pin Punches</u> - Highest grade quality alloy steel; polished tapers, bevels and heads.</p> <table border="0"> <thead> <tr> <th>Point</th> <th>Stock</th> <th>Overall Length</th> <th>Drive Pin</th> </tr> <tr> <th><u>Ins.</u></th> <th><u>Ins.</u></th> <th><u>Ins.</u></th> <th><u>Length, Ins.</u></th> </tr> </thead> <tbody> <tr> <td>3/16</td> <td>1/2</td> <td>9</td> <td>3-5/16</td> </tr> </tbody> </table> <p>Long taper punch same material:</p> <table border="0"> <thead> <tr> <th>Point.</th> <th>Stock,</th> <th>Length,</th> </tr> <tr> <th><u>Ins.</u></th> <th><u>Ins.</u></th> <th><u>Ins.</u></th> </tr> </thead> <tbody> <tr> <td>3/16</td> <td>3.8</td> <td>8</td> </tr> </tbody> </table>	Point	Stock	Overall Length	Drive Pin	<u>Ins.</u>	<u>Ins.</u>	<u>Ins.</u>	<u>Length, Ins.</u>	3/16	1/2	9	3-5/16	Point.	Stock,	Length,	<u>Ins.</u>	<u>Ins.</u>	<u>Ins.</u>	3/16	3.8	8
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10-1-61

MECHANICAL MATERIALS HANDLING TECHNOLOGY

SMALL TOOLS

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
S-MMH-47	L-30-47-(5) L-31-47-(7) L-32-47-(2)	<p><u>Prick Punch</u> - Forged, high grade hexagon steel, heat treated and Rockwell Tested for hardness.</p> <p>Stock, Length,</p> <p><u>Ins.</u> <u>Ins.</u></p> <p>1/2 5-1/2</p>
S-MMH-48	L-30-48-(1) L-31-48-(1) L-32-48-(1)	<p><u>Gasket Cutting Punch Set</u> - Set in a canvas roll, capable of cutting gaskets, shims, templates, etc., from soft metals, rubber, sheet packing, leather and other materials; includes 5 arch punches (1/2 inch, 3/8 inch, 1/2 inch, 5/8 inch and 3/4 inch); 6 inch scratch awl; pair of 7 inch form cutting snips for cutting straight, circular and irregular shapes. It shall be of highest grade forged steel.</p>
S-MMH-49		

100-101

MASTER EQUIPMENT LIST
MECHANICAL MATERIALS HANDLING TECHNOLOGY
SMALL TOOLS

REFERENCE NUMBER	DESCRIPTION	QUANTITY	UNIT	TOTAL
S-MEH-1	Micrometer 00.00-25.40 mm	3	44	132.00
S-MEH-2	Micrometer 25.40-50.80 mm	3	50	150.00
S-MEH-3	Micrometer 50.80-76.20 mm	3	59	177.00
S-MEH-4	Micrometer 76.20-101.60 mm	3	65	195.00
S-MEH-5	Caliper, inside: 8@ 10"; 6@ 8" & 6"	20	10	200.00
S-MEH-6	Caliper, outside: 8@ 10"; 6@ 8" & 6"	20	10	200.00
S-MEH-7	Dividers: 8@ 10"; 6@ 8" & 6"	20	10.50	210.00
S-MEH-8	"T" Square, aluminum, 40 cm	42	8	336.00
S-MEH-9	Steel Square, Machinist	20	19.50	390.00
S-MEH-10	Surface Plate, Semi-Steel	2	665	1,330.00
S-MEH-11	Screw Pitch Gauge, Metric	5	3	15.00
S-MEH-12	Screw Pitch Gauge, 22 pitches	5	7	35.00
S-MEH-13	Screw Pitch Gauge, 24 pitches	5	8	40.00
S-MEH-14	Screw Pitch Gauge, 30 pitches	5	9	45.00
S-MEH-15	Screw Pitch Gauge, 30 whitworth	5	10	50.00
S-MEH-16	Vertical Dial Comparator, Adi	2	150	300.00
S-MEH-17	Depth and Angle Gauge	20	24	480.00
S-MEH-18	Battery Lifter	3	10	30.00
S-MEH-19	Pliers, Battery Terminal Lift	3	9	27.00
S-MEH-20	Cleaner, Post and Terminal, Battery	3	6	18.00
S-MEH-21	Drill Set	1	145	145.00
S-MEH-22	Tool, Welding Double Bit	2	6	12.00
S-MEH-23	Tip Refacer, Precision Welding	2	22	44.00
S-MEH-24	Hammer, Welders Chipping	2	8	16.00
S-MEH-25	Lighter, Spark Gas, Welding & Flints	2	2	4.00
S-MEH-26	Hammer, Ball pein	14	5	70.00
S-MEH-27	Mallet, Rubber	14	6	84.00
S-MEH-28	Screwdriver, regular, sets	14	11	154.00
S-MEH-29	Screwdriver, Philips	14	3	42.00
S-MEH-30	Pliers, common slip joint	14	1.50	21.00
S-MEH-31	Channellock, or Parallel Jaw Pliers	14	5	70.00
S-MEH-32	Pliers, side cutting	14	8.50	119.00

MASTER EQUIPMENT LIST
MECHANICAL, MATERIALS HANDLING TECHNOLOGY
SMALL TOOLS

REFERENCE NUMBER	DESCRIPTION	QUANTITY	UNIT	TOTAL
S-MMH-33	Snap Ring Tool, Internal/External	14	14	196.00
S-MMH-34	Retrieving Tool, magnetic	14	3.50	49.00
S-MMH-35	Hack Saw with Blades, assorted sets	14	40	560.00
S-MMH-36	Screw and Pipe Extractor set	14	40	560.00
S-MMH-37	Top Wrench, set	14	34	476.00
S-MMH-38	Pipe Wrench, Euclid Pattern	14	7.50	105.00
S-MMH-39	Adjustable Wrench	14	9	126.00
S-MMH-40	Socket set, 20 piece	14	51	714.00
S-MMH-41	Torque Wrench, Dial Type Metric/English	14	56	784.00
S-MMH-42	Pipe and Machinist Vise	14	136	1,904.00
S-MMH-43	Hone, Engine Cylinder	3	105	315.00
S-MMH-44	Box and Tote Tray, Tool, combination	14	21	294.00
S-MMH-45	Close-Coupled Drill, 1/2	3	95	285.00
S-MMH-46	Pin Punches	14	3	42.00
S-MMH-47	Prick Punch	14	2	28.00
S-MMH-48	Gasket Cutting Punch Set	3	31	93.00

MECHANICAL MATERIALS HANDLING TECHNOLOGY

INSTRUCTIONAL MATERIALS

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
I-MMH-1	L-29-1-(20)	<u>Drawing Board, Adjustable</u> - Dark oak finished top, adjustable from horizontal to vertical positions by turning a positive locking single handwheel; heavy steel rigid angle mounts; neight adjustment of board for setting or standing with positive locking handwheel; top and frame selected wood; top will have aliminum end cleats along its width; size: 31 inches wide x 42 inches long x 3/4 inches thick.
I-MMH-2	L-29-2-(4) L-30-2-(8) L-31-2-(6) L-32-2-(2)	<u>Chalkboard 1.2 m x 2.4 m</u> - Approximately, warp free panel; non-skip chalk surface, chalk easily removable with dry eraser; green non-glare color; frame of aluminum with individual chalk rail.
I-MMH-3	L-29-3-(3) L-30-3-(1)	<u>Turbocharger, Sectional Model</u> - One-quarter sectioned model of a diesel turbocharger with moveable internal parts that can be placed on a lecture table in a classroom.
I-MMH-4	L-29-4-(3) L-30-4-(1)	<u>Lube Oil Pump</u> - Irregularly sectioned model of a diesel lubricating oil pump so that all pertinent parts are exposed and workable; model light enough to be set on lecturer's table.
I-MMH-5	L-29-5-(3) L-30-5-(1)	<u>Oil Cooler</u> - Quarter sectioned tube and sheet type diesel oil cooler with one head removed so that a full tubesheet may be seen and the paralleling of tubing between sheets; light enough to be set on a lecturer's table.
I-MMH-6	L-30-6-(100)	<u>Safety Cap</u> - Heavy duty polycarbonate construction - must meet ANSI rating Z 89.1, Z 89.2, or equal. It shall have eight (8) point suspension. It shall be yellow.
I-MMH-7	L-30-7-(80)	<u>Glasses</u> - Safety with f. 1/2 wire sideshield meeting ANSI rating Z 87.1, or equal; eye size 48 mm, clear lens, adjustable spatula, temple shall be stainless steel cable covered with virgin Neoprene.

MECHANICAL MATERIALS HANDLING TECHNOLOGY

INSTRUCTIONAL MATERIALS

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
I-MMH-8	L-30-8-(2) L-31-8-(2)	<u>Kerosene</u> - Delivered unused, clean in 55 gallon sealed drums.
I-MMH-9	L-29-9-(3) L-30-9-(1)	<u>Diesel Pump and Ejector</u> - Sectioned model, mounted on a suitable base with a lever that will raise and lower the observable pump piston; movement of the rack should demonstrate how the pump output is controlled.
I-MMH-10	L-31-10-(1)	<u>Planetary Gear Model Diesel</u> - The model will be a complete unit and all parts shall function to show principals of planetary gear; model suitably mounted on a pedestal.
I-MMH-11	L-31-11-(1)	<u>Hydraulic Brake Model</u> - Clearly shows the design and mode of operation including handbrake of a hydraulic brake system; suitably mounted on a demonstration board. When operated the oil flow will be demonstrated by the lighting up of the oil line. A brake light shall also operate.
I-MMH-12	L-31-12-(1)	<u>Hydraulic Disc Brake Model</u> - Clearly shows the design and mode of operation including handbrake of a hydraulic disc brake system; simulated oil flow will light oil lines and cylinder. When brake is applied a light shall operate. The entire system shall be suitably mounted on a demonstration board.
I-MMH-13	L-31-13-(1)	<u>Starter Battery, Model</u> - The model will have one cell in cross section that will clearly show the various components for demonstration purposes.
I-MMH-14	L-31-14-(3)	<u>Hydraulic (Basic) Test</u> - A combined hydraulic analysis and worklifter system which shall: (1) be push-button remotely controlled, battery operated, heavy-duty, commercial, adjustable forklift, straddle-type hand truck, without tilting capabilities, which has an integral 8-amp. battery charger (220V 50Hz, single phase) and which uses a 25 inch (approximately); single-acting, linear actuator with a mechanical multiplier to achieve a lift of approximately

11-31-48

MECHANICAL MATERIALS HANDLING TECHNOLOGY

INSTRUCTIONAL MATERIALS

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
I-MMH-14 (Con't.)		<p>50 inches at a speed of 15 ft per minute when loaded with 1500 pounds centered 12 inches forward of the fork back risers; (2) have an instrument panel with means for measuring, (a) pump and cylinder pressures, (b) pump revolutions, (c) system operating volts and amps., (d) battery charger input and output volts and amps., (e) individual lift elapsed times, (f) lift distances in inches and wt, (3) have quick couple hydraulic hose fittings; (4) be supplied with a special extension cord with suitable Syrian electrical fitting for use when charging battery. System shall be furnished with enough hydraulic oil for three (3) complete changes of suitable hydraulic oil. The integral power unit for the rotary gear type pump shall be no greater than 1/2 hp, 220V 50Hz single phase with a maximum current of about 200 amperes at full load.</p>
I-MMH-15	L-31-15-(1)	<p><u>Fluidics Test Bench-Top System</u> - Contained in a vertically-oriented welded metal cabinet suitably supported on broadbase, tip-resistant legs and attractively finished; front panel shall be anodized aluminum with component identifying nomenclature and rear panel face shall be readily removable for easy access to internals; unit shall (1) accept compressed air, regulate pressure between at least 15 and 60 psig, filter, gauge and distribute the air to a minimum of eight low-pressure ports, each having its own independent means for regulation and pressure gauging, and two high pressure ports; (2) provide auxiliary independent instrumentation, together with access ports, consisting of a flowmeter (with metering valve), two each 0-15 and 0-30 psig pressure valves, five 12-inch water/mercury manometers, and six color-coded air operated visual indicators; (3) include a basic experimental manual, a set of fluidics components sufficient to execute basic familiarization experiments, a set of tubing, fittings, adaptors and other necessities. Any mechanical or electrical connection to an outside source must be compatible with Syrian requirements.</p>

MECHANICAL MATERIALS HANDLING TECHNOLOGY

INSTRUCTIONAL MATERIALS

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
I-MMH-16	L-31-16-(1)	<p><u>Fluid Power (Pneumatics) Test Table</u> - System shall be a self-contained, bench-top-sized fluid power education system using compressed air as the fluid medium with all major components mounted "breadboard" fashion on a rigid, durable, mica-filled molded phenolic panel and arranged that their functions may be conveniently studied. A square tubular steel framework with industrial casters shall be used to mount the system. Two drawers will be included for storage. The power supply to the system shall be 220V 50Hz single phase about 1 ampere. All valves shall be AAA Products, Inc. or equivalent. Safety features (1) air supply shut-off valve includes automatic system discharge feature; (2) main power safety switch with circuit breaker; (3) master safety-control key switches for electric and air supply; (4) on-off indicator lights for electric and air supply; (5) step-down transformer so that <u>all</u> exposed electrical equipment operates at 24V A.C.; (6) spring loading of plungers; (7) pressure regulator to limit pressure of incoming air. Any mechanical or electrical connection to an outside source must be compatible with Syrian requirements.</p>
I-MMH-17	L-31-17-(1)	<p><u>Hydraulic Governor with Digital Tachometer</u> - The basic unit shall be a 220V 50Hz, single phase 750% variable speed AC motor directly coupled to a DC generator. The hydraulic governor shall be driven by suitable gearing and the complete assembly mounted on a bedplate suitable for bench mounting. The output arm of the hydraulic governor shall be connected by a rigid linkage to the motor speed control lever. It shall be normally an isochronous governor. Standard controls on front panel for speed adjustment, droop and load limit controls shall be furnished. The synchronizing knob shall be used to change prime mover speed. The stalling work capacity of the governor shall be no more than eleven joules. A separate well ventilated bench for electrical supply shall be included and it should have loading resistors and suitable switches. It shall have engraved labels indicating the functions of various controls. The panel shall permit a wide range of loading conditions to be simulated. the free standing form digit tachometer shall read in a clear form - not blink. The "gate time" 1 second, accuracy + 0.01% of reading. There shall be a minimum length of interconnecting cable of 2 meters. Any mechanical or electrical connection to an outside source must be compatible with Syrian requirements.</p>

MMH-10

MECHANICAL MATERIALS HANDLING TECHNOLOGY

INSTRUCTIONAL MATERIALS

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
I-MMH-18	L-30-18-(2)	<u>Gloves, Welders</u> - 13 inches in length; chrome tanned leather palm and cuff with Carpincho leather back; clute cut gauntlet pattern with reinforced back and waterproof lining.
I-MMH-19	L-30-19-(2)	<u>Welders Cape Sleeve and Bib</u> - Cape sleeves shall be medium size and cover arm, chest, shoulder and upper back; soft chrome tanned leather with adjustable cuffs and snap front enclosure; bib shall be capable of covering neck, chest and waist; of rugged chrome tanned leather with adjustable neck and wrist straps.
I-MMH-20	L-30-20-(2)	<u>Welders Helmet</u> - Protect the forehead, face, eyes and side of head; one piece molded, impregnated fiberglass with rolled edges and curve front; moisture resistant, adjustable headgear; lift front retainer with plastic cover plate, filter and inner clear glass viewing plate that permits work inspection without raising helmet; conform to ANSI Z 87.1 standards; extra long front.
I-MMH-21	L-30-21-(2)	<u>Acetylene Gas Tank</u> - Tank style shall be "B", capacity of 40 cubic feet; 25 inches high and 6 1/2 inches in diameter; pure, clean-burning acetylene with key operated valve at 250 psi.
I-MMH-22	L-30-22-(2)	<u>Welding Rod, Assorted Pound Packages Each</u> - 1/16 inch in diameter, and 36 inches long and of the following types: <ul style="list-style-type: none"> 50 lbs Macarco No. 6-cc or equivalent 50 lbs Macarco No. 1-WT or equivalent 50 lbs Macarco low flaming bare bronze 10 lbs Phos-copper 10 lbs bare stainless steel No. 308

MMH-41

MASTER EQUIPMENT LIST
MECHANICAL MATERIALS HANDLING TECHNOLOGY
INSTRUCTIONAL MATERIALS

REFERENCE NUMBER	DESCRIPTION	QUANTITY	UNIT	TOTAL
1-MMH-1	Drawing Board, adjustable	20	130	2,600
1-MMH-2	Chalkboard 1.2 m x 2.4 m	20	80	1,600
1-MMH-3	Turbocharger, Sectioned model	4	670	2,680
1-MMH-4	Lube Oil Pump, Sectioned model	4	240	960
1-MMH-5	Oil Cooler, Sectioned model	4	210	840
1-MMH-6	Safety Cap, Polycarbonate	100	11	1,100
1-MMH-7	Glasses, Safety	80	4.50	360
1-MMH-8	Kerosene, 55 gal. Drum	4	63	252
1-MMH-9	Diesel Pump and Injector, Sectioned model	4	352	1,408
1-MMH-10	Planetary Gear model	1	625	625
1-MMH-11	Hydraulic Brake model	1	305	305
1-MMH-12	Hydraulic Disc Brake model	1	305	305
1-MMH-13	Starter Battery, model	1	68	68
1-MMH-14	Hydraulics (basics), Test Table	3	3,150	9,450
1-MMH-15	Fluidics, Test Table	1	2,778	2,778
1-MMH-16	Fluid Power (Pneumatics), Test Table	1	9,075	9,075
1-MMH-17	Hydraulic Governor and Digital Tachometer	1	6,750	6,750
1-MMH-18	Gloves, Welders	2 pairs	13	26
1-MMH-19	Welders, Cape, Sleeves and Bib, Medium	2	23	46
1-MMH-20	Helmet, Welder, Fiberglass Shade #10	2	16	32
1-MMH-21	Acetylene Gas Tank ("B") 40 ct.	2	57	114
1-MMH-22	Welding Rod, assorted, pkgs, each	2	52	104

BUDGET SUMMARY

NOTE: Unit and Total cost figures are in U.S. dollars.

No shipping costs are included.

Equipment	290,090
Furniture (For areas 29, 30, 31, 32 only)	20,862
Small Tools	11,672
Instructional Materials	<u>41,478</u>
Total	* <u>\$ 364,102</u>
** World Bank Estimate	361,800
Budget over Estimate	2,302

* For both MMHT and MPT curricula.

** Includes equipment and furniture allowances for teaching areas 29 (L), 30 (M), 31 (N), and 32 (O), for both MMHT and MPT curricula.

MM-54

PRIORITY ITEMS

All items are top priority items without exception.

AV-1

AUDIO VISUAL EQUIPMENT

for

Intermediate Technical Institutes

at

Dier-Ez-Zor, Homs, Latakia

Damascus, Syria

July - August 1977

Prepared by Dr. William S. Reynolds

AUDIO VISUAL EQUIPMENT SPECIFICATIONS

(For All 3 Schools)

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
E-AV-1	H-0-1-(9) L-0-1-(8) D-0-1-(4)	<p><u>Overhead Projector</u> - 267 mm (10½ in) stage; single lamp; articulated head, adjustment range 0-30 degrees; mirror at ½ rate of front lense; stage is non-fresnel type with glare control, focus wheel for screen size 1 m x 1 m to 3 m x 3 m; switch with lamp intensifier to increase output by 15%; provisions for side to side and back to back roller attachments and work tables; 360 watt dichroic reflector projection lamp with lamp ejector; heavy duty grounded 5 m power cord, cord storage; safety interlock shuts off power when access door is opened; safety thermostat cuts power to lamp should unit overheat, resets automatically when unit cools to safe level (3 m Brand Model 213 Classroom presenter or equal) with following accessories:</p> <p style="padding-left: 40px;">Side tables (2), detachable Roller attachment assembly Lamps (4 in box) 360 watt</p>
E-AV-2	H-0-2-(1) L-0-2-(1) D-0-2-(1)	<p><u>Transparency Maker, Copier</u> - To make transparencies for overhead projector, stencil masters, spirit masters, and general copying; capacity to 355 m (3M Brand Model 45 or equal).</p>
E-AV-3	H-0-3-(4) L-0-3-(2) D-0-3-(2)	<p><u>Super 8 mm Film Loop Projector</u> - Accepts cartridge film loop; 20-32 mmf 1.4 zoom lens; still clutch; lamp saver control; 2 spare lamps.</p>
E-AV-4	H-0-4-(4) L-0-4-(2) D-0-4-(2)	<p><u>Desk Top Viewer for Super 8 mm Film Loops</u> - Portable, high impact plastic; without projector; for use with Super 8 mm Film Loop projector above.</p>
E-AV-5	H-0-5-(1) L-0-5-(1) D-0-5-(1)	<p><u>Slide Projector 35 mm</u> - Automatic, portable with case; remote control unit for focusing, forward and reverse; 150 watt Halogen lamp; F 2.5 - 85 mm lens; slide magazine capacity at least 36; including 2 spare lamps and 4 magazines.</p>

AV 2

AUDIO VISUAL EQUIPMENT SPECIFICATIONS

(For All 3 Schools)

REFERENCE NUMBER	SPECIFICATION CODE	DESCRIPTION
E-AV-6	H-0-6-(9) L-0-6-(8) D-0-6-(4)	<u>Projection Screen, Wall 1.27 m x 1.27 m (50" x 50")</u> - For use with overhead projector, mat white surface; regular duty metal hanging case, automatic fabric roller lock.
E-AV-7	H-0-7-(1) L-0-7-(1) D-0-7-(1)	<u>Projection Screen Portable, 1.27 m x 1.27 m (50" x 50")</u> - Silver lenticular; folding tripod mount, automatic leg lock; standard roll-up type with double (saddle) suspension; fabric roller lock.
E-AV-8	H-0-8-(9) L-0-8-(8) D-0-8-(4)	<u>Mobile Equipment Table - Steel</u> ; quiet glide ball bearing casters (2 with locks); 3 shelves 45 cm x 60 cm (18" x 24") with mat on top shelf; shelves welded to legs; equipped with two electrical outlets and 6 m cord.
E-AV-9	H-0-9-(1) L-0-9-(1) D-0-9-(1)	<u>Motion Picture Projector, 16 mm, Sound</u> - Automatic threading system and system restorer; F 1.4 51 mm lens; lamp is 250W Halogen; reverse, amplifier, bass, treble tone controls; built in 32 ohm speaker; spool and spare lamp included; heavy duty cord.

NOTE: Where mutiple items have been ordered they are to be equally assigned to the labs identified at the beginning of the report. Single items are for general use in each school as in Item E-AV-4.

E-AV

AUDIO VISUALS (FOR ALL PROGRAMS)

EQUIPMENT MASTER LIST

REFERENCE NUMBER	DESCRIPTION	QUANTITY	UNIT	TOTAL
E-AV-1	Overhead Projector 267 mm (10½ inch) stage	21	190	3,990.00
E-AV-2	Transparency Maker, Copier	3	590	1,770.00
E-AV-3	Super 8 mm Film Loop Projector	8	199	1,592.00
E-AV-4	Desk Top Viewer for Super 8 mm Film loops	8	40	320.00
E-AV-5	Slide Projector	3	125	375.00
E-AV-6	Projection Screen, Wall, 1.27 m x 1.27 m	21	30	630.00
E-AV-7	Projection Screen, Portable, 1.27 m x 1.27 m	3	50	150.00
E-AV-8	Mobile Equipment Table, 34 inches HT	21	77	1,617.00
E-AV-9	Notion Picture Projector, 16 mm, Sound	3	480	1,440.00
	TOTAL			11,884.00