



PROVINCIAL PLAN OF TRAINING

FOR THE

CONSTRUCTION ELECTRICIAN

OCCUPATION

Document Status	Date Distributed	Mandatory Implementation Date	Comments
Original Version	July 2004	September 2005	
Addendum # 1	November 2004	September 2005	Refer to Addendum Page

July 2004

Addendum #1

1. NOA (National Occupational Analysis) Tasks updated.
2. Course (Heat Pumps) Number correction ELE-1135 to **IEL-1135**.

Preface

This Apprenticeship Training Standard is based on the 2003 edition of the National Occupational Analysis for the Industrial Electrician trade. It was developed through the cooperative efforts of the Atlantic Apprenticeship Council, which consists of both the Atlantic Directors of Apprenticeship and Apprenticeship Board Chairs. This document describes the curriculum content for the Industrial Electrician apprenticeship training program and outlines each of the technical training units necessary for completion of apprenticeship.

Acknowledgement

Advisory committees, industry representatives, instructors and apprenticeship staff provided valuable input to the development of this Apprenticeship Training Standard. Without their dedication to quality apprenticeship training, this document could not have been produced. A sincere thank you.

Apprenticeship Plan of Training Evaluation Form

Thank you for your interest in the development and revision of this Plan of Training. Upon review of this document, please record your feedback in relation to the following items:

- course division and organization
- relevancy of the content
- errors or omissions
- other suggestions for improvement and consideration

Overall comments are to be entered on this evaluation form and specific changes are to be entered directly on the document in the relevant area(s). When all feedback has been recorded, return this evaluation form along with the revised Plan of Training to the Apprenticeship Office noted at the bottom of the page.

(PLEASE PRINT)

Trade: Construction Electrician

Full Name: _____

Type of Position: (Trade Practitioner, Instructor, etc.): _____

Company: _____

Address: _____

Telephone: _____

Comments: (Use a separate sheet of paper if necessary)

Return Evaluation Form and Plan of Training to:

*Manager, Industrial Training
Division of Institutional and Industrial Education
Department of Education
P.O. Box 8700
St. John's, NF
A1B 4J6*

Table of Contents

Preface	i
Acknowledgment	ii
Evaluation Form	iii
Conditions Governing Apprenticeship Training	1
Requirements for Red Seal Certification	7
Roles and Responsibilities of Stakeholders in the Apprenticeship Process	8
Program Outcomes	10
Program Content	11
Program Structure	13
REQUIRED RELATED COURSES	
Workplace Correspondence	128
Customer Service	130
Quality Assurance/Quality Control	132
Introduction to Computers	134
Workplace Skills	139
Job Search Techniques	141
Entrepreneurial Awareness	142

CONDITIONS GOVERNING APPRENTICESHIP TRAINING

1.0 GENERAL

The following general conditions will apply to all apprenticeship training programs approved by the Provincial Apprenticeship and Certification Board in accordance with the Apprenticeship Training and Certification Act. Where an occupation requires additional conditions, these will be noted in the specific plan of training for that occupation. In no case should there be a conflict between these conditions and the additional requirements specified in certain plans of training.

2.0 ENTRANCE REQUIREMENTS

2.1 Entry into the occupation as an apprentice requires:

Indenturing into the occupation by an employer who agrees to provide the appropriate training and work experiences as outlined in this plan of training.

2.2 Notwithstanding the above, each candidate must have successfully completed a high school program or equivalent and in addition may be required to have completed certain academic subjects as specified in particular plans of training. Mature students, at the discretion of the Director of Institutional and Industrial Education, may be registered. A mature student is defined as one who has reached the age of 19 and who can demonstrate the ability and the interest to complete the requirements for certification.

2.3 At the discretion of the Director of Institutional and Industrial Education, credit towards the apprenticeship program may be awarded to an apprentice for previous work experience and/or training as validated through prior learning assessment.

2.4 A Registration for Apprenticeship form must be duly completed.

3.0 PROBATIONARY PERIOD

The probationary period for each memorandum of understanding will be six months. Within that period the memorandum may be terminated by either party upon giving the other party and the Provincial Apprenticeship and Certification Board one week notice in writing.

4.0 TERMINATION OF A MEMORANDUM OF UNDERSTANDING

After the probationary period referred to in Section 3.0 herein, the memorandum of understanding may be terminated by the Board by mutual consent of the parties thereto or cancelled by the Board for proper and sufficient cause in the opinion of the Board.

5.0 APPRENTICESHIP PROGRESSION SCHEDULE AND WAGE RATES

5.1 Progression Schedule

7200 Hour Programs	Requirements for Progression	Progress To
First Year Apprentice	Completion of entry level (Block 1) courses, plus relevant work experience totaling a minimum of 1800 hours *	Second Year
Second Year Apprentice	Completion of advanced level (Block 2) courses, plus relevant work experience totaling a minimum of 3600 hours	Third Year
Third Year Apprentice	Completion of advanced level (Block 3) courses, plus relevant work experience totaling a minimum of 5400 hours	Fourth Year
Fourth Year Apprentice	Completion of advanced level (Block 4) courses and (Block 5) <i>if applicable</i> , plus sign-off of workplace skills required for certification totaling a minimum of 7200 hours**	Write Certification Examination
5400 Hour Programs	Requirements for Progression	Progress To
First Year Apprentice	Completion of entry level (Block 1) courses, plus relevant work experience totaling a minimum of 1800 hours *	Second Year
Second Year Apprentice	Completion of advanced level (Block 2) courses, plus relevant work experience totaling a minimum of 3600 hours	Third Year
Third Year Apprentice	Completion of advanced level (Block 3) courses, plus sign-off of workplace skills required for certification totaling a minimum of 5400 hours	Write Certification Examination

Construction Electrician

4800 Hour Programs	Requirements for Progression	Progress To
First Year Apprentice	Completion of entry level courses (Block 1), plus relevant work experience totaling a minimum of 1600 hours *	Second Year
Second Year Apprentice	Completion of advanced level (Block 2) courses, plus relevant work experience totaling a minimum of 3200 hours	Third Year
Third Year Apprentice	Completion of advanced level (Block 3) courses, plus sign-off of workplace skills required for certification totaling a minimum of 4800 hours	Write Certification Examination

* All direct entry apprentices must meet the **Requirements for Progression** either through Prior Learning Assessment and Recognition or course completion before advancing to the next year.

** Apprentices in a 7200 hour program which incorporates more than four blocks of training are considered fourth year apprentices pending completion of 100% course credits and workplace skills requirements.

5.2 For the duration of each Apprenticeship Training Period, the apprentice, who is not covered by a collective agreement, shall be paid a progressively increased schedule of wages which shall not be less than:

Program Duration	Wage Rates		Comments
7200 Hours	1 st Year	55%	These wage rates are percentages of the prevailing journey person's wage rate in the place of employment of the apprentice. No apprentice shall be paid less than the wage rate established by the Labour Standards Act (1988), as now in force or as hereafter amended, or by other Order, as amended from time to time replacing the first mentioned Order.
	2 nd Year	65%	
	3 rd Year	75%	
	4 th Year	90%	
5400 Hours and 4800 Hours	1 st Year	55%	
	2 nd Year	70%	
	3 rd Year	85%	
4000 Hours			(Hairstylist Program) - The apprentice shall be paid no less than the minimum wage for hours worked and a commission agreed upon between the apprentice and the employer.

6.0 TOOLS

Apprentices shall be required to obtain hand tools as and when specified by the Board.

7.0 PERIODIC EXAMINATIONS AND EVALUATION

7.1 Every apprentice shall submit to such occupational tests and examinations as the Board shall direct. If after such occupational tests and examinations the apprentice is found to be making unsatisfactory progress, his/her rate of wage shall not be advanced as provided in Section 5 until his/her progress is satisfactory to the Director of Institutional and Industrial Education and his/her date of completion shall be deferred accordingly. Persistent failure to pass required tests shall be a cause for revocation of his/her Memorandum of Understanding.

7.2 Upon receipt of reports of accelerated progress of the apprentice, the Board may shorten the term of apprenticeship and advance the date of completion accordingly.

7.3 For each and every course, a formal assessment is required for which 70% is the pass mark. At the discretion of the instructor, the summative mark may be for completion of a theory examination or a combination of the theory examination and an assigned practical project.

8.0 GRANTING OF CERTIFICATES OF APPRENTICESHIP

Upon the successful completion of apprenticeship, the Board shall issue a Certificate of Apprenticeship

9.0 HOURS OF WORK

Any hours employed in the performance of duties related to the designated occupation will be credited towards the completion of the term of apprenticeship. Appropriate documentation of these hours must be provided.

10.0 COPIES OF THE REGISTRATION FOR APPRENTICESHIP

The Director of Institutional and Industrial Education shall provide copies of the Registration for Apprenticeship form to all signatories to the document.

11.0 RATIO OF APPRENTICES TO JOURNEYPERSONS

The ratio of Apprentices to Journeypersons normally shall not exceed one apprentice to every one journeyperson employed. Exceptions for specific occupations may occur with the approval of the Provincial Apprenticeship and Certification Board.

12.0 RELATIONSHIP OF THE PLAN OF TRAINING TO A COLLECTIVE BARGAINING AGREEMENT

Collective agreements take precedence over the conditions outlined in the plan of training.

13.0 AMENDMENTS TO A PLAN OF APPRENTICESHIP TRAINING

A plan of training may be amended at any time by the Provincial Apprenticeship and Certification Board.

14.0 EMPLOYMENT, RE-EMPLOYMENT AND TRAINING REQUIREMENTS

14.1 The plan of training requires Apprentices to attend regularly their place of employment.

14.2 The plan of training requires Apprentices to regularly attend training programs for that occupation as prescribed by The Provincial Apprenticeship and Certification Board.

14.3 Failure to comply with Sections 14.1 and/or 14.2 will result in cancellation of the Memorandum of Understanding. Apprentices may have their M.O.U.'s reinstated by the Provincial Apprenticeship and Certification Board but would be subject to a commitment to complete the entire program as outlined in the General Conditions of Apprenticeship. Permanent cancellation in the said occupation is the result of non-compliance.

14.4 Cancellation of the Memorandum of Understanding to challenge journeyperson examinations, if unsuccessful, would require an apprentice to serve a time penalty of two (2) years before reinstatement as an apprentice or registering as a Trade Qualifier.

14.5 Under the plan of training the employer is required; to keep each apprentice employed as long as work is available, and if the apprentice is laid off due to lack of work, to give opportunity to be re-employed before another is hired.

14.6 The employer will permit each apprentice to attend regularly training programs as prescribed by the Provincial Apprenticeship and Certification Board.

14.7 Apprentices who cannot acquire all the workplace skills at their place of employment will have to be evaluated in a simulated work environment at a training institution and have sign-off done by instructors to meet the requirements for certification.

15.0 APPEALS TO DECISIONS BASED ON CONDITIONS GOVERNING APPRENTICESHIP TRAINING

Persons wishing to appeal any decisions based on the above conditions must do so in writing to the Minister of Education within 30 days of the decision.

REQUIREMENTS FOR RED SEAL CERTIFICATION

1. Evidence that the required work experiences outlined in this plan of training have been obtained. This evidence must be in a format that clearly outlines the experiences and must be signed by an appropriate person or persons attesting that these experiences have been obtained to the level required.
2. Normally, a combination of training from an accredited training program and suitable work experience totalling 7200 hours

Or

A total of 9000 hours of suitable work experience.
3. Completion of a National Red Seal examination, to be set at a place and time determined by the Industrial Training Division.
4. Payment of the appropriate examination fee.

ROLES AND RESPONSIBILITIES OF STAKEHOLDERS IN THE APPRENTICESHIP PROCESS

The Apprenticeship process involves a number of stakeholders playing significant roles in the training of apprentices. This section captures, in a broad sense, these roles and the responsibilities that result from them.

The Apprentice

- ▶ to complete all required technical training courses as approved by the Provincial Apprenticeship and Certification Board.
- ▶ to find appropriate employment.
- ▶ to complete all required work experiences in combination with the required hours.
- ▶ to ensure that the work experiences are well documented.
- ▶ to approach apprenticeship training with an attitude and commitment that fosters the qualities necessary for a successful career as a qualified journeyman.
- ▶ to obtain the required hand tools as specified by the Board for each period of training of the apprenticeship program.

The Employer

- ▶ to provide high quality work experiences in an environment that is conducive to learning.
- ▶ to remunerate apprentices as set out in this Plan of Training or Collective Agreements.
- ▶ to provide feedback to Training Institutions, Industrial Training Division and Apprentices in an effort to establish a process of continuous quality improvement.
- ▶ where appropriate, to release apprentices for the purpose of returning to a training institution to complete the necessary technical courses.
- ▶ to ensure that work experiences of the apprentices are documented.

The Training Institution

- ▶ to provide a high quality learning environment.
- ▶ to provide the necessary student support services that will enhance an apprentice's ability to be successful.
- ▶ to participate with other stakeholders in the continual updating of programs.

The Industrial Training Division

- ▶ to establish and maintain program advisory committees under the direction of the Provincial Apprenticeship and Certification Board.
- ▶ to promote apprenticeship training as a viable career option to prospective apprentices and other appropriate persons involved, such as career guidance counsellors, teachers, parents, etc.
- ▶ to establish and maintain a protocol with training institutions, employers and other appropriate stakeholders to ensure the quality of apprenticeship training programs.
- ▶ to ensure that all apprentices are appropriately registered and records are maintained as required.
- ▶ to schedule all necessary technical training periods for apprentices to complete requirements for certification.
- ▶ to administer provincial/interprovincial examinations.

The Provincial Apprenticeship and Certification Board

- ▶ to set policies to ensure that the provisions of the Apprenticeship Training and Certification Act are implemented.
- ▶ to ensure that advisory and examination committees are established and maintained.
- ▶ to accredit institutions to deliver apprenticeship training programs.
- ▶ to designate occupations for apprenticeship training and/or certification.

Program Outcomes

Upon completion of the Construction Electrician Apprenticeship Program, apprentices will have the knowledge and skills required to perform the following tasks:

- Task 1 Interprets occupational documentation.
- Task 2 Organizes work.
- Task 3 Communicates in the workplace.
- Task 4 Uses and maintains tools and equipment.
- Task 5 Installs service entrance.
- Task 6 Installs sub-panels, feeders and transformers.
- Task 7 Installs bonding, grounding and cathodic protection systems.
- Task 8 Installs power generation systems.
- Task 9 Installs high voltage systems.
- Task 10 Installs raceway systems and cables.
- Task 11 Installs power and lighting systems.
- Task 12 Installs heating and cooling systems.
- Task 13 Installs emergency lighting systems.
- Task 14 Installs motor controls.
- Task 15 Installs motors.
- Task 16 Installs signaling systems.
- Task 17 Installs voice and data systems.
- Task 18 Upgrades electrical systems.
- Task 19 Maintains electrical systems.
- Task 20 Performs preventative maintenance.

PROGRAM CONTENT

NF Course No.	Atlantic Course No.	Course Name	Hours	Pre-requisites	Page No.
TS1520	-	WHMIS	6	-	17
TS1530	-	Standard First Aid	16	-	20
ER-1100	ELE-1105	Rigging	30	ER-1410	21
ER-1110	ELE-0110	Hand Tools	15	ER-1410	23
ER-1120	ELE-1115	Power Tools	30	ER-1110	24
ER-1130	ELE-1120	Fasteners	15	ER-1120	25
ER-1140	ELE-0125	DC Theory	30	ER-1410	26
ER-1150	ELE-1130	Series and Parallel Circuits	45	ER-1140	29
ER-1160	ELE-0135	Codes	30	-	31
ER-1170	ELE-1140	Voltage Drop and Power Loss	30	ER-1150; 1160	33
ER-1180	ELE-1145	Single Phase Theory	60	ER-1170	35
ER-1190	ELE-1150	Three-phase Theory	30	ER-1180	38
ER-1200	ELE-0160	Blueprint (Generic)	30	ER-1160	40
ER-1210	ELE-1165	Blueprint 2	30	ER-1200	42
ER-1220	ELE-1170	Conduit, Tubing and Fittings	30	ER-1130; 1210	44
ER-1230	ELE-1180	Conductors and Cables	45	ER-1220	47
ER-1240	ELE-1185	Fundamental Wiring	45	ER-1230	50
ER-1250	ELE-1195	Protective Devices	30	ER-1230	54
ER-1260	ELE-1200	Transformers	30	ER-1190; 1250	56
ER-1270	ELE-1205	Single Phase Service Entrance	30	ER-1260	58
ER-1280	ELE-1210	Three-Phase Service Entrance	30	ER-1270	59
ER-1290	ELE-1215	Distribution Equipment	30	ER-1280	61
ER-1300	ELE-1220	DC Motors and Controls	30	Completion of All Entry Level Programs	66
ER-1340	ELE-1300	Fire Alarms	30	ER-1290	67
ER-1360	ELE-1425	Electric Heating Systems and Controls	30	ER-1290	69
ER-1410	ELE-0100	Safety Practices	30	-	71

Construction Electrician

NF Course No.	Atlantic Course No.	Course Name	Hours	Pre-requisites	Page No.
ER-2000	ELE-1175	Raceways, Wireways and Busways	30	ER-1220	73
ER-2010	ELE-1190	Lighting and Controls	30	Completion of All Entry Level Programs	75
ER-2020	ELE-1225	Single Phase AC Motors	30	ER-1270	77
ER-2030	ELE-1235	Three Phase Motors	30	Completion of All Entry Level Programs	79
ER-2040	ELE-1240	Control Devices	30	ER-2030	82
ER-2050	ELE-1230	Motor Starters and Controllers	60	ER-2040	85
ER-2060	ELE-1245	Central Heating Units	15	Completion of All Entry Level Programs	88
ER-2072	ELE-1265	Power Supply and Rectifiers	60	Completion of All Entry Level Programs	90
ER-2116	ELE-1285	Troubleshooting Techniques	6	ER-1410	94
ER-2122	ELE-1290	Application of Troubleshooting Techniques	6	ER-2030	95
ER-2132	ELE-1315	Intercom Systems	15	ER-1290	96
ER-2140	ELE-1310	Security Systems	15	ER-1290	98
ER-2160	ELE-1350	Solid State Drives	30	ER-2072	100
ER-2170	ELE-1355	PLC Fundamentals	15	ER-2050	102
ER-2180	ELE-1360	Programming PLCs	30	ER-2170	104
ER-2240	ELE-1365	DC Generators	30	ER-1300	106
ER-2250	ELE-1370	AC Generators	30	ER-2030	108
ER-2260	ELE-1375	Emergency Stand-by Units	30	Completion of All Entry Level Programs	110
ER-2270	ELE-1380	Emergency Lighting Systems	15	Completion of All Entry Level Programs	112
ER-2300	ELE-1395	Distribution System Conditioning	30	ER-2160	114
ER-2310	ELE-1400	Furnace Controls	15	ER-2050	117
ER-2332	IEL-1135	Heat Pumps	10	ER-2362	119

Construction Electrician

NF Course No.	Atlantic Course No.	Course Name	Hours	Pre-requisites	Page No.
ER-2350	ELE-1405	Electric Surface Heating Units	15	Completion of All Entry Level Programs	120
ER-2362	ELE-1145	Refrigeration and Air Conditioning Controls	10	ER-2050	121
ER-2390	ELE-1410	Fibre Optics	15	Completion of All Entry Level Programs	122
ER-2420	ELE-1160	HVAC Electrical Systems	10	ER-2332	124
ER-2440	ELE-1420	High Voltage Wiring	45	Completion of All Entry Level Programs	125
CM2150	-	Workplace Correspondence	45	-	128
MR1210	-	Customer Service	30	-	130
SP2330	-	QA/QC	30	-	132
MC1050	-	Intro to Computers	30	-	134
SD1700	-	Workplace Skills	30	-	139
SD1710	-	Job search Techniques	15	-	141
SD1720	-	Entrepreneurial Awareness	15	-	142
OT1230	-	Workplace Exposure	60	-	-
Total Hours			1699		

PROGRAM STRUCTURE

Entry Level Courses					
NF Course No.	Atlantic Course No.	Course Name	Hours	Pre-requisite	Page No.
TS1520	-	WHMIS	6	-	17
TS1530	-	Standard First Aid	16	-	20
ER-1100	ELE-1105	Rigging	30	ER-1410	21
ER-1110	ELE-0110	Hand Tools	15	ER-1410	23
ER-1120	ELE-1115	Power Tools	30	ER-1110	24
ER-1130	ELE-1120	Fasteners	15	ER-1120	25
ER-1140	ELE-0125	DC Theory	30	ER-1410	26

Construction Electrician

NF Course No.	Atlantic Course No.	Course Name	Hours	Pre-requisite	Page No.
ER-1150	ELE-1130	Series and Parallel Circuits	45	ER-1140	29
ER-1160	ELE-0135	Codes	30	-	31
ER-1170	ELE-1140	Voltage Drop and Power Loss	30	ER-1150/1160	33
ER-1180	ELE-1145	Single Phase Theory	60	ER-1170	35
ER-1190	ELE-1150	Three-Phase Theory	30	ER-1180	38
ER-1200	ELE-0160	Blueprint (Generic)	30	ER-1160	40
ER-1210	ELE-1165	Blueprint 2	30	ER-1200	42
ER-1220	ELE-1170	Conduit, Tubing and Fittings	30	ER-1130/1210	44
ER-1230	ELE-1180	Conductors and Cables	45	ER-1220	47
ER-1240	ELE-1185	Fundamental Wiring	45	ER-1230	50
ER-1250	ELE-1195	Protective Devices	30	ER-1230	54
ER-1260	ELE-1200	Transformers	30	ER-1190/1250	56
ER-1270	ELE-1205	Single Phase Service Entrance	30	ER-1260	58
ER-1280	ELE-1210	Three-Phase Service Entrance	30	ER-1270	59
ER-1290	ELE-1215	Distribution Equipment	30	ER-1280	61
ER-1340	ELE-1300	Fire Alarms	30	ER-1290	67
ER-1360	ER-1425	Electric Heating Systems and Controls	30	ER-1290	69
ER-1410	ELE-0100	Safety Practices	30	-	71
ER-2000	ELE-1175	Raceways, Wireways and Busways	30	ER-1220	73
ER-2020	ELE-1225	Single Phase AC Motors	30	ER-1270	77
ER-2116	ELE-1285	Troubleshooting Techniques	6	ER-1410	94
ER-2132	ELE-1315	Intercom Systems	15	ER-1290	96
ER-2140	ELE-1310	Security Systems	15	ER-1290	98
CM2150	-	Workplace Correspondence	45	-	128
MR1210	-	Customer Service	30	-	130
SP2330	-	QA/QC	30	-	132
MC1050	-	Intro to Computers	30	-	134
SD1700	-	Workplace Skills	30	-	139

Construction Electrician

NF Course No.	Atlantic Course No.	Course Name	Hours	Pre-requisite	Page No.
SD1710	-	Jobsearch Techniques	15	-	141
SD1720	-	Entrepreneurial Awareness	15	-	142
OT1230	-	Workplace Exposure	60	-	-
Total Hours			1108		

REQUIRED WORK EXPERIENCE

Block #2					
NF Course No.	Atlantic Course No.	Course Name	Hours	Pre-requisite	Page No.
ER-2010	ELE-1190	Lighting and Controls	30	Completion of All Entry Level Programs	75
ER-2030	ELE-1235	Three Phase Motors	30	Completion of All Entry Level Programs	79
ER-2040	ELE-1240	Control Devices	30	ER-2030	82
ER-2050	ELE-1230	Motors Starters and Controllers	60	ER-2040	85
ER-2072	ELE-1265	Power Supply and Rectifiers	60	Completion of All Entry Level Programs	90
Total Hours			210		

REQUIRED WORK EXPERIENCE

Block #3					
NF Course No.	Atlantic Course No.	Course Name	Hours	Pre-requisite	Page No.
ER-1300	ELE-1220	DC Motors and Controls	30	Completion of All Entry Level Programs	66
ER-2160	ELE-1350	Solid State Drives	30	ER-2072	100
ER-2240	ELE-1365	DC Generators	30	ER-1300	106
ER-2250	ELE-1370	AC Generators	30	ER-2030	108
ER-2260	ELE-1375	Emergency Stand-by Units	30	Completion of All Entry Level Programs	110

Construction Electrician

NF Course No.	Atlantic Course No.	Course Name	Hours	Pre-requisite	Page No.
ER-2270	ELE-1380	Emergency Lighting Systems	15	Completion of All Entry Level Programs	112
ER-2300	ELE-1395	Distribution System Conditioning	30	ER-2160	114
ER-2350	ELE-1405	Electric Surface Heating Units	15	Completion of All Entry Level Programs	120
Total Hours			210		

REQUIRED WORK EXPERIENCE

Block #4					
NF Course No.	Atlantic Course No.	Course Name	Hours	Pre-requisite	Page No.
ER-2060	ELE-1245	Central Heating Units	15	Completion of All Entry Level Programs	88
ER-2122	ELE-1290	Application of Troubleshooting Techniques	6	ER-2330	95
ER-2170	ELE-1355	PLC Fundamentals	15	ER-2050	102
ER-2180	ELE-1360	Programming PLCs	30	ER-2170	104
ER-2310	ELE-1400	Furnace Controls	15	ER-2050	117
ER-2332	IEL-1135	Heat Pumps	10	ER-2362	119
ER-2362	ELE-1145	Refrigeration and Air Conditioning Controls	10	ER-2050	121
ER-2390	ELE-1410	Fibre Optics	15	Completion of All Entry Level Programs	122
ER-2420	ELE-1160	HVAC Electrical Systems	10	ER-2332	124
ER-2440	ELE-1420	High Voltage Wiring	45	Completion of All Entry Level Programs	125
Total Hours			171		

TS-1520 WORKPLACE HAZARDOUS MATERIALS INFORMATION SYSTEM (WHMIS)

Description:

This course is designed to give participants the knowledge and skills necessary to define WHMIS, examine hazard identification and ingredient disclosure, explain labeling and other forms of warning, and introduce material safety data sheets (MSDS).

Course Outcomes:

Upon successful completion of this course, the apprentice will be able to:

1. Interpret and apply the Workplace Hazardous Materials Information System (WHMIS) Regulation under the Occupational Health & Safety Act.

Required Knowledge and Skills:

1. Define WHMIS safety
 - Rational and key elements
 - History and development of WHMIS
 - WHMIS legislation
 - WHMIS implementation program
 - Definitions of legal and technical terms
2. Examine hazard identification and ingredient disclosure
 - Prohibited, restricted and controlled products
 - Classification and the application of WHMIS information requirements
 - Responsibilities for classification
 - the supplier
 - the employer
 - the worker - Classification: rules and criteria
 - information on classification
 - classes, divisions and subdivision in WHMIS
 - general rules for classification
 - class A - compressed gases
 - class B - flammable and combustible materials
 - class C - oxidizing material
 - class D - poisonous and infectious material
 - class E - corrosive material
 - class F - dangerously reactive material
 - Products excluded from the application of WHMIS legislation
 - consumer products
 - explosives
 - cosmetics, drugs, foods and devices

- pest control products
 - radioactive prescribed substances
 - wood or products made of wood
 - manufactured articles
 - tobacco or products of tobacco
 - hazardous wastes
 - products handled or transported pursuant to the Transportation of Dangerous Goods (TDG) Act
 - Comparison of classification systems - WHMIS and TDG
 - General comparison of classification categories
 - Detailed comparison of classified criteria
3. Explain labeling and other forms of warning
- Definition of a WHMIS label
 - supplier label
 - workplace label
 - other means of identification
 - Responsibility for labels
 - supplier responsibility
 - employer responsibility
 - worker responsibility
 - Introduce label content, design and location
 - supplier labels
 - workplace labels
 - other means of identification
4. Introduce material safety data sheets (MSDS)
- Definition of a material safety data sheet
 - Purpose of the data sheet
 - Responsibility for the production and availability of data sheets
 - supplier responsibility
 - employer responsibility
 - workers responsibility

Practical

Practical skills enhance the apprentices' ability to meet the objectives of this course. The learning objectives outlined below are **mandatory** in Newfoundland, but are provided as suggestions for Nova Scotia, Prince Edward Island and New Brunswick.

1. Locate WHMIS label and interpret the information displayed.
2. Locate a MSDS sheet for a product used in the workplace and determine what personal protective equipment and other precautions are required when handling this product.

SUGGESTED RESOURCES:

1. WHMIS Regulation
2. Sample MSDS sheets

TS-1530

FIRST AID

Description:

This course is designed to give the apprentice the ability to recognize situations requiring emergency action and to make appropriate decisions concerning first aid.

Complete a **St. John Ambulance** Standard First Aid Certificate course.

ER-1100

RIGGING

Outcomes:

Upon the successful completion of this unit the apprentice will be able to use lifting and rigging procedures and equipment.

Objectives and Content:

1. Define the terms related to mechanical advantage.
2. Identify and describe wire rope.
 - i) Fatigue and abrasion resistance
 - ii) Safety factor
3. Identify and describe fibre rope.
 - i) Types and characteristics
 - ii) Safety factor
 - iii) Safe working loads
 - iv) Care
 - coiling and uncoiling
 - storage
 - v) Inspection
 - vi) Knots, bends and hitches
4. Identify and describe chains used in rigging.
5. Identify and describe rigging hardware items and the procedures for installing them.
 - i) Drums
 - ii) Sheaves
 - iii) Hooks
 - iv) Rings, links and swivels
 - v) Shackles
 - vi) Eye bolts
 - vii) Turnbuckles
 - viii) Spreader and equalizer beams
 - ix) Blocks
6. Describe the procedures used to select slings.
 - i) Sling configurations
 - ii) Sling angles
 - iii) Safe working loads

7. Identify and describe jacks and their uses.
 - i) Screw jacks
 - ii) Ratchet jacks
 - iii) Hydraulic jacks
 - with integral pump
 - with separate pump (ram)

- 8 Describe the procedures used to select and use ladders and scaffolds.
 - i) Ladder safety
 - ii) Tubular steel sectional scaffolding
 - iii) Characteristics of steel scaffolding
 - ease of erection
 - common hoists

9. Describe procedures used to move a load.
 - i) load weights
 - ii) center of gravity
 - iii) crane signals
 - iv) OSHA requirements

Practical Projects:

Practical skills enhance the apprentices' ability to meet the objectives of the unit.
Practical Projects include:

1. Tie knots, bends, and hitches used for lifting and moving equipment.
2. Inspect, select and use the appropriate sling to perform a given task.
3. Inspect, select and use various chain blocks and rope falls.
4. Select and use ladders and scaffolds.
5. Secure, lift and move loads vertically and horizontally.

ER-1110

HAND TOOLS

Outcomes:

Upon successful completion of this unit, the apprentice will be able to select, use and care for basic hand tools.

Objectives and Content:

1. Identify types of hand tools and describe their applications and procedures for care and use.
 - i) Screwdrivers
 - ii) Hammers
 - iii) Pliers
 - iv) Wrenches
 - v) Saws and blades
 - vi) Files
 - vii) Taps and dies
 - viii) Layout tools
 - ix) Punches and chisels
 - x) Knives
 - xi) Fuse pullers
 - xii) Knockout punches
 - xiii) Hand benders
 - xiv) Measuring instruments

Practical Projects:

Practical skills enhance the apprentices' ability to meet the objectives of the unit. Practical Projects include:

1. Identify, use and maintain screwdrivers.
2. Identify, use and maintain hammers.
3. Identify, use and maintain pliers.
4. Identify, use and maintain wrenches.
5. Select, use and maintain files.
6. Select and use hacksaw to cut various types of metal.
7. Select, use and clean taps and dies.
8. Select and use measuring and layout tools.
9. Select and use punches and chisels.
10. Select and use handsaws.
11. Select and use hand-operated knock-out punches.

ER-1120

POWER TOOLS

Outcomes:

Upon successful completion of this unit, the apprentice will be able to select, use and service power tools.

Objectives and Content:

1. Identify types of power tools and describe their applications and procedures for service and use.
 - i) Drills
 - drill bits
 - ii) Drill presses
 - iii) hammers
 - iv) Saws
 - v) Grinders
 - vi) Hydraulic tools
 - vii) Pneumatic tools
2. Describe the operation of power tools.
 - i) Components
 - ii) Grounding

Practical Projects:

Practical skills enhance the apprentices' ability to meet the objectives of the unit.

Practical Projects include:

1. Select and use a portable drill and bits for a specific task.
2. Use rotary hammer.
3. Operate a drill press.
4. Determine safe working speeds of wheels on portable and pedestal grinders.
5. Select wheels and discs for portable and pedestal grinders.
6. Operate portable and pedestal grinders.
7. Sharpen bits.
8. Operate circular, saber and reciprocating saws.

ER-1130

FASTENERS

Outcomes:

Upon the successful completion of this unit, the apprentice will be able to select and install fasteners.

Objectives and Content:

1. Identify types of nails and describe their applications and procedures for use.
2. Identify types of screws and bolts and describe their applications and procedures for use.
 - i) Wood screws
 - ii) Sheet metal screws
 - iii) Machine screws and bolts
 - iv) Nuts and washers
3. Identify types of anchors and shields and describe their applications and procedures for use.
 - i) Masonry anchors
 - ii) Cavity fasteners
 - iii) Screw anchors
 - fiber
 - metal
 - lead
 - plastic
 - E-Z anchor
 - iv) Miscellaneous fasteners
 - concrete screws
 - hollow rivets
 - spring-steel fasteners
 - chemical fasteners
 - v) Joining dissimilar metals (electrolysis)
4. Explain the operation of explosive actuated tools.

Practical Projects:

Practical skills enhance the apprentices' ability to meet the objectives of the unit. Practical Projects include:

1. Install fasteners
2. Use powder actuated tools to fasten materials to concrete and steel.
3. Dismantle, inspect, clean and reassemble powder actuated tools.

ER-1140

DC THEORY

Outcomes:

Upon the successful completion of this unit the apprentice will be able to demonstrate knowledge of direct current circuit theory and the selection and use of measuring instruments.

Objectives and Content:

1. Describe the atomic structure of matter.
 - i) Electron theory
 - matter
 - atoms
 - electric charge
 - protons, electrons, neutron
 - ii) Static electricity and electrostatics
 - positive and negative charge
 - electrostatic field
 - transferring static electricity
 - conduction
 - induction
 - discharging static charges
 - iii) Electrons in motion
 - causes of current
 - conductors, insulators
 - electron current flow
 - conventional current flow
2. Identify electrical units and symbols
 - i) absolute electrical units
 - current
 - voltage
 - resistance
 - ii) prefixes for absolute units
3. Identify different forms of energy and describe the effects of dynamic electricity.
 - i) Different forms of energy to produce electricity
 - chemical action
 - piezoelectric effect
 - magnetism
 - heat
 - light and solar energy
 - friction

- ii) Effects of dynamic electricity
 - heating effects
 - chemical effects
 - magnetic effects
 - psychological and physiological effects

- 4. Describe the procedures used to analyze the components necessary for the assembly of an electric circuit.
 - i) the electron path (conductors)
 - ii) the load
 - iii) the source
 - iv) the control
 - v) closed circuit
 - vi) open circuit
 - vii) short circuit

- 5. Identify and describe the three basic electrical properties.
 - i) voltage
 - ii) current
 - iii) resistance

- 6. Describe the relationship among the three basic electrical properties.
 - i) Ohm's Law

- 7. Describe the relationship between work done and electricity.
 - i) work
 - ii) power
 - iii) electrical work
 - iv) joules and coulombs
 - v) electrical power (watt)
 - vi) combination of the Power formulas and Ohm's Law
 - vii) watts and horsepower
 - viii) electrical energy
 - xi) energy and BTU
 - x) kilowatt hours
 - meter reading and cost

- 8. Identify measuring instruments and describe their applications and procedures for use.
 - i) ammeter
 - ii) voltmeter
 - iii) ohmmeter
 - iv) multimeter
 - v) circuit tester
 - vi) continuity tester

Practical Projects:

Practical skills enhance the apprentices' ability to meet the objectives of the unit.

Practical Projects include:

1. Compute values of electrical energy and power.
2. Use electrical measuring instruments.

ER-1150

SERIES AND PARALLEL CIRCUITS

Outcomes:

Upon the successful completion of this unit the apprentice will be able to determine absolute values of devices connected in series, parallel or any combination of these two.

Objectives and Content:

1. Describe the characteristics of a series circuit.
 - i) Resistance
 - ii) Current
 - iii) Voltage
 - iv) Power
 - v) Open resistor
 - vi) Shorted resistor
 - vii) Troubleshooting
2. Calculate series circuit values
3. Describe the characteristics of a parallel circuit.
 - i) Resistance
 - ii) Current
 - iii) Voltage
 - iv) Power
 - v) Open resistor
 - vi) Shorted resistor
 - vii) Troubleshooting
4. Calculate parallel circuit values.
5. Explain Kirchhoff's Laws
 - i) current law
 - ii) voltage law
6. Describe the characteristics of a combination circuit.
7. Calculate combination circuit values.

Practical Projects:

Practical skills enhance the apprentices' ability to meet the objectives of the unit.

Practical Projects include:

1. Analyze and measure amperage and voltage in series DC circuits.
2. Analyze and measure amperage and voltage in parallel DC circuits.
3. Analyze and measure amperage and voltage in combination DC circuits.
4. Analyze and measure resistance and/or continuity in basic DC circuits.
5. Analyze and measure power consumption in basic DC circuits.

ER-1160

CODES

Outcomes:

Upon the successful completion of this unit the apprentice will be able to use the Canadian Electrical Code and the National Building Code to find various rules and regulations required to work safely.

Objectives and Content:

Canadian Electrical Code

1. Explain the structure of the Canadian Electrical Code.
 - i) General Information
 - importance of interpretation of the CEC
 - introduction to the CEC
 - ii) Profile
 - contents of the CEC
 - general rules (sections)
 - supplementary and amendatory sections
 - tables
 - diagrams
 - appendices
 - contents and index
 - definitions (Section 0)
 - division, subdivision, etc.
 - numbering system and symbol use

2. Describe the procedures used to locate information contained in the CEC.
 - i) Initiation to general aspects
 - ii) Application
 - main key word
 - using key words in the index
 - using main contents

3. Describe the procedures used to locate, select and gather information from the CEC handbook.
 - i) Purpose of the handbook
 - ii) Rational for rules
 - iii) Intent for rules
 - iv) Using diagrams and figures

National Building Code

4. Describe the structure of the National Building Code (NBC).
 - i) Background and purpose of the code
 - ii) Preface
 - iii) Table of contents
 - iv) Numbering system
 - v) Index
 - vi) Appendix
 - vii) Tables

5. Describe the procedures used to locate, select and gather information from the NBC.
 - i) Scope and definitions
 - ii) General requirements
 - iii) Use and occupancy

Practical Projects:

Practical skills enhance the apprentices' ability to meet the objectives of the unit.
Practical Projects include:

1. Locate and select information from the CEC, Part 1.
2. Locate and select information from the CEC Handbook.
3. Locate and select information from the National Building Code, NBC.

ER-1170 VOLTAGE DROP AND POWER LOSS

Outcomes:

Upon the successful completion of this unit the apprentice will be able to calculate voltage drop and power loss.

Objectives and Content:

1. Describe the characteristics of:
 - i) Conductors
 - wire type
 - cable
 - flexible cord
 - size
 - mils, circular mils, square mils
 - area
 - AWG size
 - ii) Insulators/insulation
 - terminology
2. Describe the effects of resistance of wires in circuits.
 - i) Conductor resistance
 - resistivity(ohms/mil-foot)
 - cross-sectional area(circular mil, millimeter squared)
 - length
 - temperature coefficient of resistance
 - ii) Line voltage drop
 - factor affecting voltage drop
 - calculations
 - CEC requirements
 - voltage drop percentage
 - effects of voltage drop
 - iii) Power loss
 - calculations
 - effects of power loss
3. Describe the operation of a three-wire system.
 - i) Purpose of a three-wire system
 - ii) Neutral wire
 - iii) Solving a three-wire system

Practical Projects:

Practical skills enhance the apprentices' ability to meet the objectives of the unit.

Practical Projects include:

1. Apply Kirchoff's current and voltage laws.
2. Calculate the absolute values in three-wire circuits.
3. Use CEC tables to calculate voltage drop.

ER-1180

SINGLE PHASE THEORY

Outcomes:

Upon the successful completion of this unit the apprentice will demonstrate knowledge of the basic concepts of alternating current (AC) and perform calculations.

Objectives and Content:

1. Describe the principles of magnetism and the action of magnets.
 - i) Magnetic and nonmagnetic substances categories
 - magnetic and nonmagnetic substances
 - Ferromagnetic, diamagnetic, and paramagnetic
 - poles of a magnet and the earth
 - magnetic laws
 - ii) The theory of magnetism
 - magnetized and unmagnetized
 - magnetic field
 - magnetic lines
 - iii) Magnetism properties
 - flux density (Weber's theory)
 - forces between magnetic poles
 - induced magnetism
 - permeability
 - reluctance
 - shielding
 - permanent and temporary magnet
 - retentivity
 - residual magnetism
 - demagnetizing

2. Describe the principles of electromagnetism.
 - i) The theory of electromagnetism
 - characteristics of an electromagnetic field
 - magnetic field around a current-carrying conductor
 - ii) Direction of current flow and magnetic flux
 - direction of current and flux
 - dot-cross method
 - left-hand conductor rule
 - electromagnetic coil
 - left-hand coil rule
 - iii) The Electromagnet
 - characteristic of electromagnets (core, turns, strength)
 - magnetic saturation
 - core losses (hysteresis, eddy current, I^2R)

- uses of electromagnets
- 3. Describe the principles and characteristics of electromagnetic induction.
 - i) Principles of electromagnetic induction
 - Faraday's Law
 - factors affecting amount of induced voltage
 - ii) Self and mutual induction
 - self induction
 - henries
 - CEMF
 - mutual induction
- 4. Describe the generation of alternating current.
 - i) direction of induced voltage
 - ii) left-hand generator rule
 - iii) alternation/revolution
 - iv) cycle
 - v) sine wave/plotting
 - vi) electrical and mechanical degrees
- 5. Define different values and terms of alternating current.
 - i) Alternating current values
 - instantaneous values
 - maximum (peak) values
 - peak to peak values
 - effective (RMS) values
 - average values
 - ii) Terminology of alternating current circuits
 - frequency / hertz
 - period
 - phase (in phase, lagging, leading)
- 6. Describe the characteristics of RL, RC, and RLC circuits.
 - i) Resistance in an AC circuit
 - ii) Inductance in an AC circuit
 - iii) Capacitance in an AC circuit
 - iv) Impedance in an AC circuit
 - series RCL
 - trigonometric functions
 - impedance vector
 - v) AC power and power factor correction in an AC circuit
 - power factor introduction
 - pure resistive circuit
 - pure inductive circuit
 - pure capacitive circuit

- resistive-reactive circuit
 - apparent power and reactive power
 - power factor correction
7. Solve RL, RC, and RLC AC series circuits.
- i) AC series circuit calculations
 - circuits with resistance and inductive reactance
 - circuits with resistance capacitive reactance
 - circuits with resistance, inductive reactance and capacitive reactance
 - power factor calculation
8. Solve RL, RC and RLC AC parallel circuits.
- i) AC parallel circuit calculations
 - circuits with resistance and inductive reactance
 - circuits with resistance capacitive reactance
 - circuits with resistance, inductive reactance and capacitive reactance
 - power factor calculation

Practical Projects:

Practical skills enhance the apprentices' ability to meet the objectives of the unit
Practical Projects include:

1. Determine the properties of an AC circuit.
2. Determine absolute values in an AC series circuit containing RLC components.
3. Determine absolute values in a AC parallel circuits containing RLC components.
4. Calculate power and power factor in AC circuits.

ER-1190

THREE-PHASE THEORY

Outcomes:

Upon the successful completion of this unit the apprentice will be able to perform three-phase voltage, current and power calculations.

Objectives and Content:

1. Describe the generation of three-phase voltages.
 - i) Characteristics of three-phase
 - ii) Voltage generation of three-phase voltages
 - iii) Phase sequence

2. Describe the voltage and current values in three-phase wye connections.
 - i) Voltage relationships in a wye connection
 - ii) Current relationships in a wye connection
 - iii) Ground connections
 - iv) 3-wire wye connections
 - v) 4-wire wye connections
 - vi) phase loss calculations

3. Describe the voltage and current values in three-phase delta connections.
 - i) Cautions regarding improper delta connections
 - ii) Voltage relationships in a delta connection
 - iii) Current relationships in a delta connection
 - iv) Open delta connections
 - v) 3-wire delta connections
 - vi) 4-wire delta connections
 - vii) Comparing wye and delta systems

4. Describe the procedures used to calculate three-phase power, volt-amperes, reactive power and power factor.
 - i) Three-phase apparent power
 - ii) Three-phase power
 - iii) Power factor
 - iv) Measurements for three-phase power

5. Describe the procedures used to measure three-phase power using wattmeters.
 - i) Two watt meter method
 - ii) Three watt meter method
 - iii) Polyphase watt meter

Practical Projects:

Practical skills enhance the apprentices' ability to meet the objectives of the unit.

Practical Projects include:

1. Calculate three-phase power, volt-amperes, reactive power, and power factor.
2. Measure three-phase power using watt-meters.

ER-1200

BLUEPRINT (GENERIC)

Outcomes:

Upon the successful completion of this unit the apprentice will be able to interpret basic blueprints and specifications.

Objectives and Content:

1. Identify different projections and drawings and describe their purpose
 - i) General information
 - how blueprints are made
 - ii) Orthographic projections
 - multi view
 - iii) Pictorial drawings
 - perspective drawings
 - oblique drawings
 - isometric drawings

2. Describe the procedures used to determine measurements from scaled drawings.
 - i) Alphabet of lines
 - ii) Sketching
 - iii) Scaling a dimension
 - scales
 - ratios
 - imperial/metric scales
 - using a scale

3. Describe the procedures used to read plans.
 - i) Symbols
 - ii) Site plans
 - survey plans
 - subdivision plans
 - landscape plans
 - plot plans
 - iii) Floor plans
 - iv) Foundation plans

4. Identify and describe different types of views and details.
 - i) Elevations
 - ii) Sections and details

5. Identify and describe the information shown in schedules and specifications.
 - i) Schedules

- doors
 - windows
 - finishing material
 - ii) Specifications
6. Identify drawings and describe their purpose.
- i) Electrical
 - i) Heating, ventilation and air conditioning (HVAC)
 - ii) Plumbing
 - iv) Shop drawings
 - v) As-built drawings
7. Describe procedures used to obtain material lists.

Practical Projects:

Practical skills enhance the apprentices' ability to meet the objectives of the unit.
Practical Projects include:

1. Gather and interpret information from site plans.
2. Gather and interpret information from elevation/floor plans.
3. Gather and interpret information from floor plans in order to complete an efficient and effective installation.
4. Determine measurements from scaled drawings.
5. Gather and interpret information as per course content.

ER-1210

BLUEPRINT 2

Outcomes:

Upon the successful completion of this unit the apprentice will be able to interpret electrical blueprints, specifications and drawings and compile information from relevant documents.

Objectives and Content:

1. Describe the procedures used to gather and interpret information from site plans.
 - i) Protected areas
 - ii) Original contours/grades
 - iii) Underground pipe lines
 - iv) Bench marks/datum points
 - v) Grounding grid
 - vi) Area lighting
 - vii) Trench details
 - viii) Service/utility location
 - ix) Symbols

2. Describe the procedures used to gather and interpret information from elevations, floor plans and reflected ceiling plans.
 - i) General building design
 - ii) Interior finishes
 - iii) Control joints
 - iv) Exterior finishes
 - v) Location of door/windows, air intake/exhaust
 - vi) Number of floors c/w elevations

3. Describe the procedures used to interpret reference/key diagrams used on blueprints.
 - i) Structural reference grids
 - ii) Key diagrams
 - iii) Reference bubbles
 - iv) Section reference bubbles

4. Describe the procedures used to gather and interpret information from distribution system layout drawings.
 - i) Switchboards/substations
 - ii) Metering centres
 - iii) Component tables

5. Describe the procedures used to gather and interpret information from single-line drawings.
 - i) Feeder size/risers
 - ii) Transformers
 - voltage ratings
 - capacity
 - connections
 - iii) Panel board designations
 - iv) Distribution boards
 - v) Connected apparatus
 - vi) Equipment layout elevations
 - vii) Fire alarm systems
 - viii) Communication systems
 - ix) Energy management systems

6. Describe the procedures used to gather and interpret information from equipment schedules.

7. Describe the procedures used to gather and interpret information from motor control center diagrams.
 - i) Starter/controller locations
 - ii) Wiring diagrams (generic)
 - iii) Overload/overcurrent
 - iv) Conductor sizes
 - v) Interconnections/interlocking

Practical Projects:

Practical skills enhance the apprentices' ability to meet the objectives of the unit.
Practical Projects include:

1. Gather and interpret information from site plans.
2. Gather and interpret information from elevation/floor plans.
3. Gather and interpret information from floor plans in order to complete and efficient and effective installation.
4. Determine measurements from scaled drawings.
5. Gather and interpret information from distribution system layout drawings.
6. Gather and interpret information from single-line drawings.
7. Gather and interpret information from equipment schedules.
8. Extract information from project documents.
9. Interpret reference/key diagrams used on blueprints.

ER-1220 CONDUIT, TUBING AND FITTINGS

Outcomes:

Upon the successful completion of this unit the apprentice will be able to install various types of conduit and associated fittings as per CEC requirements.

Objectives and Content:

1. Describe the various types of conduits and tubing, their characteristics and applications.
 - i) Metallic rigid and EMT
 - ii) Non-metallic rigid
 - iii) Flexible

2. Describe the various fittings, couplings, and device boxes used with conduits and tubing.
 - i) Fittings
 - ii) Couplings
 - iii) Connectors
 - iv) Boxes
 - FS boxes
 - utility boxes
 - v) Supporting methods

3. Describe the terms associated with the bending of conduit and tubing.
 - i) Back-to-Back
 - ii) 90° bend
 - iii) Come back
 - iv) Concentric bends
 - v) “dog leg” or “kick”
 - vi) Gain
 - vii) Leg length
 - viii) Offsets
 - ix) Rise on stub-up
 - x) Spring back
 - xi) Segment bend
 - xii) Round saddle
 - xiii) Square saddle
 - xiv) Developed length

4. Describe the procedures used to prepare, bend and install rigid metal conduit as per CEC requirements.
 - i) Preparation
 - ii) Cutting conduit by hand

- iii) Cutting conduit using power devices
 - iv) Bending
 - v) Reaming rigid conduit
 - vi) Threading rigid conduit by hand
 - vii) Machine threading
 - viii) Portable power units
 - ix) Hazardous locations
5. Describe the procedures used to properly prepare, bend and install EMT as per CEC requirements.
- i) Preparation
 - cutting EMT
 - safety precautions
 - reaming EMT
 - ii) Bending
 - hand benders
 - mechanical benders
 - hydraulic benders
 - the little “kicker”
 - iii) Installation
 - couplings and connectors
 - raintight and watertight types
 - general purpose types
 - fittings
 - boxes
6. Describe the procedures used to prepare, bend and install PVC conduits as per CEC requirements.
- i) Preparation
 - ii) Cutting
 - iii) Joining
 - iv) Bending
 - preparing for bending
 - hand held heaters
 - floor model heaters
 - liquid PVC heaters
 - precautions when bending
 - prefabricated bends
 - expansion and contraction
7. Describe ENT, its applications and limitations.
- i) General information
 - ii) Couplings and connectors
 - iii) CEC requirements

8. Describe EB1, DB2/ES2, their applications, limitations and installation.
 - i) Restrictions
 - ii) Methods of installation
 - iii) CEC requirements

9. Describe flexible conduit, its applications, limitations and installation.
 - i) Cutting
 - ii) Connectors
 - iii) CEC requirements

10. Identify the size requirements of pull boxes and junction boxes according to CEC requirements.
 - ii) straight pulls
 - iii) angle pulls
 - iii) U-pulls

Practical Projects:

Practical skills enhance the apprentices' ability to meet the objectives of the unit. Practical Projects include:

1. Apply proper cutting, coupling and termination methods used with conduit.
2. Install rigid metal conduit.
3. Prepare and bend EMT.
4. Install EMT.
5. Prepare and install PVC conduit.
6. Determine the size requirements of pull boxes and junction boxes.

ER-1230

CONDUCTORS AND CABLES

Outcomes:

Upon the successful completion of this unit the apprentice will be able to install and terminate conductors and cables.

Objectives and Content:

1. Identify common wires and cables.
 - i) CSA designations
 - ii) Voltage ratings
 - iii) Number and size range of conductors
 - iv) Number of strands
 - v) Conditions of use
 - vi) Allowable ampacity
 - vii) Temperature ratings

2. Describe the procedures used to identify, select and install flexible cords and equipment wire as per CEC requirements.
 - i) Applications
 - ii) CSA designations
 - iii) Voltage ratings
 - iv) Number and size range of conductors
 - v) Construction
 - vi) Conditions of use
 - vii) Allowable ampacity
 - viii) Temperature ratings
 - ix) Installation
 - x) Terminations

3. Describe the procedures used to identify, select, and install TECK90 cable as per CEC requirements.
 - i) Applications
 - ii) CSA designations
 - iii) Voltage ratings
 - iv) Number and size range of conductors
 - v) Construction (outer covering and conductor insulation)
 - vi) Conditions of use
 - vii) Allowable ampacity
 - viii) Temperature ratings
 - ix) Installation
 - x) Terminations
 - xi) Sheath currents
 - xii) Hazardous location fittings and terminations

4. Describe the procedures used to identify, select and install MI cables as per CEC requirements.
 - i) Applications
 - ii) CSA designations (MI or LWMI)
 - iii) Voltage ratings
 - iv) Number and size range of conductors
 - v) Construction (copper, aluminum, or stainless steel)
 - vi) Conditions of use
 - vii) Allowable ampacity
 - viii) Temperature ratings
 - ix) Installation
 - x) Terminations and splices
 - xi) Sheath currents
 - xii) High voltage surges
 - xiii) Fault location

5. Describe the procedures used to prepare conductors for installation in raceways.
 - i) CEC requirements
 - ii) Conductor lubricants
 - iii) Identification and colour coding of conductors
 - iv) Equipment preparation

6. Describe the mechanical procedures used to install conductors in raceways.
 - i) Installing fish tapes
 - ii) Use of jet line and air pressure
 - iii) Vacuum fishing
 - iv) Fish lines and ropes
 - v) Adding conductors to existing conduit
 - vi) Installation of conductors in flexible conduit

7. Describe the procedures used to set reels on jacks and stands.

8. Describe the procedures used to install conductors in raceways with power equipment.
 - i) Mechanical pullers
 - ii) Power drives for cable pulling
 - iii) Pulleys, rollers, and extended sheaves
 - iv) Attachment of conductors to pull cords

9. Locate and interpret CEC requirements related to the installation of conductors in raceways.
 - i) Allowable ampacity
 - ii) Temperature ratings
 - iii) Protection of conductors at the ends of raceways
 - iv) Radii of bends in raceways
 - v) Number of conductors in conduit and tubing

Practical Projects:

Practical skills enhance the apprentices' ability to meet the objectives of the unit.

Practical Projects include:

1. Identify wires and cables (other than flexible cords and fixture wires).
2. Prepare conductors for installation in raceways.
3. Set reels on jacks and stands.
4. Install conductors in raceways.
5. Use power drives for conductor installation.
6. Install conductors in cable tray.
7. Identify, select and install MI cables.
8. Identify, select and install armored cables.
9. Identify, select and install TECK90 cables.
10. Identify, select and install aluminum sheathed cables.
11. Apply CEC requirements in respect to the installation of flexible cords and equipment wire.
12. Determine size of devices and junctions.

ER-1240

FUNDAMENTAL WIRING

Outcomes:

Upon the successful completion of this unit the apprentice will be able to install fundamental wiring systems according to code requirements.

Objectives and Content:

1. Identify the procedures to follow when doing an electrical installation.
 - i) Blueprints and drawings
 - symbols
 - ii) Rough-in
 - iii) Finish-up and connection
 - finish-up procedures
 - panel “tie-in”

2. Describe the procedures used to strip and splice wires.
 - i) Stripping wires
 - knife stripping
 - wire strippers
 - ii) Common wire splices
 - pigtail splice
 - fixture splice

3. Identify mechanical connectors and compression tools and describe their applications.
 - i) twist-on connectors
 - ii) pressure type terminals (crimp)

4. Identify lampholders and describe their connections.
 - i) Types of lampholders
 - screw base sizes
 - ii) Connection of lampholders

5. Identify types of switches and describe their applications and connections.
 - i) Types of switches
 - toggle, decorative, key, etc.
 - single pole
 - three-way
 - four-way
 - pilot light
 - door
 - dimming control
 - ii) Construction and rating of switches

- iii) Switches applications
 - single pole connection
 - three-way connection
 - four-way connection

- 6. Identify types of receptacles and describe their applications and connections.
 - i) Types of receptacles
 - CSA configurations
 - ii) Construction of receptacles
 - duplex receptacle
 - iii) Receptacle grounding
 - iv) Split receptacle
 - split-switched duplex receptacle
 - split-receptacle for two 15A outlets
 - v) Ground fault interrupter receptacle

- 7. Identify types of outlet boxes and describe their applications and procedures for installation.
 - i) Types of outlet boxes
 - junction and outlet boxes
 - ganged boxes
 - types of covers
 - ii) Mounting methods of outlet boxes.
 - iii) Maximum number of conductors in boxes.
 - CEC requirements

- 8. Identify types of nonmetallic sheathed cables, and describe their standards, and their procedures for installation.
 - i) Types
 - NMD90
 - NMWU
 - ii) Applications
 - iii) Stripping
 - iv) Termination to outlet boxes
 - v) CEC requirements

- 9. Identify armored cables and describe their standards, tolerances and procedures for installation.
 - i) AC90
 - ii) Stripping
 - iii) Termination to outlet boxes
 - iv) CEC requirements

- 10. Describe the procedures used to protect cables.
 - i) Mechanical damage
 - CEC requirements

- ii) Overcurrent
 - GFCI
 - Arc Fault
11. Describe the procedures used to install switches.
- i) Single-pole switch
 - source feed to the switch
 - source feed to the light
 - ii) Pilot light switch
 - source feed to the switch
 - source feed to the light
 - iii) Three-way and four-way switches
 - source feed to the three-way switch
 - source feed to the light
 - light between the two switches
 - all other types of circuit configurations
12. Describe the procedures used to install receptacles as per CEC requirements.
- i) split-switched duplex receptacle
 - ii) split-receptacle for two 15A outlets
 - iii) mixed circuit with split-switched duplex receptacle and lights
13. Identify and describe installation standards and types of lighting equipment control devices.
- i) General lighting circuits
 - CEC requirements
 - ii) Lighting controls
 - iii) Installation and wiring of lighting equipment
14. Identify and describe residential ventilation systems and their installation.
- i) Kitchen exhaust fans.
 - ii) Bathroom fans.
15. Describe the procedures used to install water pumps and electric water heaters.
- i) Water pumps
 - jet or piston pump
 - submersible pump
 - ii) Electric water heaters
 - storage tank water heater
 - tankless water heater
16. Locate and interpret the CEC requirements related to interior lighting equipment.
- i) General characteristics of interior lighting equipment.
 - ii) Location of interior lighting equipment
 - iii) Installation of interior lighting equipment
 - iv) Wiring of interior lighting equipment

- v) Lamp holder characteristics
- 17. Locate and interpret the CEC requirements related to the protection and control of circuits.
 - i) Fuses
 - ii) Circuit breakers
 - iii) Switches
 - iv) Miscellaneous apparatus
- 18. Locate and interpret CEC requirements related to receptacles.
 - i) Receptacles in residential occupancies
 - ii) Branch circuits in residential occupancies
 - iii) Electric heating and cooking appliances
- 19. Locate and interpret CEC requirements related to boxes, cabinets, outlets and terminal fittings.
 - i) General
 - ii) Wiring space in enclosures
- 20. Locate and interpret CEC requirements related to pools, tubs and spas.

Practical Projects:

Practical skills enhance the apprentices' ability to meet the objectives of the unit.
Practical Projects include:

- 1. Determine location of service equipment.
- 2. Determine the branch circuit requirements for a dwelling unit according to the CEC.
- 3. Determine lighting and switching requirements for a dwelling unit according to the CEC.
- 4. Space, locate and install convenience outlets according to CEC.
- 5. Locate and determine the circuit requirements and install specific-use outlets according to the CEC.
- 6. Install a door bell/door chime system.
- 7. Conduct acceptable roughing-in and finish-up.

ER-1250

PROTECTIVE DEVICES

Outcomes:

Upon the successful completion of this unit the apprentice will be able to select and install appropriate protective devices as per CEC requirements.

Objectives and Content:

1. Describe the function of protective devices.
 - i) Overcurrent
 - ii) Overload
 - iii) Short circuit
2. Describe the effects of short-circuit current.
 - i) Fault currents
 - ii) Percent impedance
 - iii) Types of damage
3. Describe overcurrent devices, their characteristics and applications
 - i) Voltage
 - ii) Current
 - iii) Interrupting capacity
 - iv) Time-current characteristics
4. Identify types of fuses and describe their characteristics and applications.
 - i) Screw-base plug fuses.
 - ii) Standard cartridge fuses
 - iii) Renewable link fuses
 - iv) High rupture capacity fuses
 - v) Classifications
 - vi) Time delay fuses
5. Identify types of low-voltage circuit breakers and describe their characteristics and applications.
 - i) Thermal trip action
 - ii) Magnetic trip action
 - iii) Moulded case
 - iv) High interrupting capacity type
 - v) Ground fault interrupters
 - vi) Arc fault circuit interrupters
6. Locate and interpret CEC requirements concerning protective devices.

7. Describe the coordination of protective devices.
 - i) Manufacturer's chart
 - ii) Engineer's responsibilities
 - iii) Electrician's responsibilities

Practical Projects:

Practical skills enhance the apprentices' ability to meet the objectives of the unit.
Practical Projects include:

1. Select fuses/breakers according to specific requirements.
2. Determine interrupting capacity requirements of fuses/breakers.

ER-1260

TRANSFORMERS

Outcomes:

Upon the successful completion of this unit the apprentice will be able to install transformers.

Objectives and Content:

1. Describe the operating principles of a transformer.
 - i) Mutual induction
 - ii) Turns ratio
 - iii) Classes of transformers
2. Identify and describe components of transformers.
 - i) High-voltage windings
 - ii) Low-voltage windings
 - iii) Core designs
3. Describe transformer polarity and terminal markings.
 - i) Additive and subtractive polarity
 - ii) Polarity tests
4. Describe various connections for multi-coil transformers.
 - i) Double-wound transformers
 - ii) Series/Parallel connections
5. Describe the procedures used to perform transformer calculations.
 - i) Turns/voltage/current ratios
 - ii) Voltage, current and kVA calculations
6. Describe the use of schematic diagrams to illustrate how single-phase transformers are connected for parallel operation.
 - i) Connections for paralleling dual-winding transformers
 - ii) Back-feed hazard
7. Describe the operation of various primary and secondary connections for three-phase operation.
 - i) Wye to wye transformer bank
 - ii) Wye to delta transformer bank
 - iii) Delta to wye transformer bank
 - iv) Delta to delta transformer bank
 - v) Three-phase four-wire delta transformer bank
 - vi) Open delta transformer break

8. Identify and describe different applications for special transformers.
 - i) Instrumental
 - ii) Auto transformer
 - iii) Ignition
 - iv) Isolation
 - v) Buck and Boost

9. Identify types of specialty transformer connections and describe their applications.
 - i) multi-tap
 - ii) zig zag
 - iii) Scott /Tee

Practical Projects:

Practical skills enhance the apprentices' ability to meet the objectives of the unit.
Practical Projects include:

1. Perform polarity tests.
2. Measure transformer voltage/current ratios.
3. Calculate turns ratio, current, KVA and voltage.
4. Measure and calculate three-phase voltage and current.
5. Connect three-phase transformers.

ER-1270 SINGLE-PHASE SERVICE ENTRANCE

Outcomes:

Upon the successful completion of this unit the apprentice will be able to install an overhead or underground single-phase service entrance.

Objectives and Content:

1. Describe the procedures used to prepare an electrical installation.
 - i) Plan approval
 - ii) Wiring permits
2. Identify and describe different components of service equipment.
 - i) Service entrance mast
 - ii) Meter connection box
 - iii) Main switch and panelboard
3. Describe the different types of service entrances for single dwelling.
4. Describe the different types of service entrances for apartment buildings.
 - i) Multiple metering
 - ii) Splitter troughs
5. Describe the different methods of grounding and bonding.
 - i) Grounding electrodes types
 - ii) Grounding conductors
 - iii) Bonding conductors
6. Calculate demand factors.

Practical Projects:

Practical skills enhance the apprentices' ability to meet the objectives of the unit.

Practical Projects include:

1. Install a single-phase, three wire distribution system.
2. Install single-phase service entrance equipment.
3. Install grounding and bonding electrodes and conductors.
4. Determine service layout and equipment/materials required.

ER-1280

THREE-PHASE SERVICE ENTRANCE

Outcomes:

Upon the successful completion of this unit the apprentice will be able to calculate service demand and install a three-phase service entrance.

Objectives and Content:

1. Describe the installation procedures for a three-phase system.
 - i) Service entrance types
 - ii) Wye systems
 - iii) Delta systems
2. Describe the installation procedures for three-phase service entrance equipment.
 - i) Distribution panels
 - ii) Splitters and splitter troughs
 - iii) Metering
 - iv) Service disconnecting means
3. Describe requirements for conductor installation and termination.
 - i) Conductors in parallel
 - ii) Colour coding of conductors
 - iii) Conductor terminations
4. Describe instrument transformers, their applications and procedures for installation.
 - i) Operation and bonding of instrument transformers
5. Perform demand factor calculations for three-phase services as per CEC.
6. Perform calculations to determine the minimum capacity of feeder conductors.
 - i) Determination of areas
 - ii) Demand factors
7. Describe underground service entrances and their procedures for installation. .
 - i) Duct requirements
 - ii) Conductor requirements
 - iii) Pad mounted transformers

Practical Projects:

Practical skills enhance the apprentices' ability to meet the objectives of the unit.

Practical Projects include:

1. Install three-phase service entrance complete with CT's and PT's.

ER-1290

DISTRIBUTION EQUIPMENT

Outcomes:

Upon the successful completion of this unit the apprentice will be able to install various types of distribution equipment as per CEC requirements.

Objectives and Content:

1. Describe enclosures, their applications and construction as per CEC requirements.
 - i) Enclosure types
 - ii) EEMAC/CSA designations

2. Identify disconnect switches and describe their sizes, ratings and requirements for installation.
 - i) Voltage and current ratings
 - ii) Intended applications
 - isolation use
 - service use
 - iii) Motor-circuit switches
 - high interrupting capacity switches
 - horsepower ratings
 - dual-horsepower ratings
 - iv) Contact assembly
 - quick-make, quick-break
 - non-teasing mechanism
 - bolted-pressure contact
 - v) Optional attachments
 - vi) Ground fault protection
 - vii) Phase-failure relay
 - viii) Shunt tripping
 - ix) Auxiliary contacts
 - x) Anti-single-phasing blown fuse indicator
 - xi) Neutral grounding device

3. Identify panel boards and describe their classifications, ratings and requirements for installation.
 - i) Loadcenters
 - construction
 - applications
 - ratings
 - pole positions
 - stab ratings
 - service entrance applications

- breaker mounting options
 - typical IC ratings of breakers
 - add-on features
 - ii) Lighting and distribution panel boards
 - construction
 - applications
 - main lugs/breakers
 - branch circuit breaker ratings
 - stab ratings
 - pole positions
 - on-site assembly
 - add-on features
 - iii) Breaker and fusible power panel boards
 - service (voltage and frequency)
 - interrupting capacity
 - ampere rating of main device
 - environment (enclosure types)
 - enclosure layout/dimensions
 - integrated tvss systems
 - diagnostic options
 - determining breaker/fusible disconnect spaces
 - selecting breaker mounting kits
4. Describe the features, installation procedures and applications of low-voltage switchboards.
- i) Applications
 - ii) Current and voltage ratings
 - iii) Incoming arrangements
 - bottom entry
 - top entry/top hat
 - side wireways
 - bussed
 - not bussed
 - mandatory bussed
 - busway entry
 - bus sub
 - iv) Construction
 - cell dimensions
 - bus bracing standards
 - bus options
 - inside/outside corner units
 - receiving, storage and assembly of shipping units
 - v) Main disconnect section
 - vi) Utility compartments
 - vii) Distribution arrangements
 - twin mounted breakers

- single mounted breakers
 - breaker/fusible switch units
 - subpanels
 - viii) Metering centres
 - ix) Customer metering, relay functions
 - digital meter/analog meter
 - volts
 - amps
 - pf
 - kW
 - kWh
 - kVA
 - Hz
 - communications/transducers
 - pulse initiator outputs
 - relaying and protective functions
 - undervoltage
 - single-phase
 - phase sequence
 - x) Check list before energizing
 - ground system for continuity
 - retorque all bolted connections
 - tighten bus mountings
 - align breakers, switches and other mechanisms for proper operation
 - xi) Megger test
 - switches/breakers open
 - phase-to-phase
 - phase-to-ground
 - switches/breakers closed
 - phase-to-phase
 - phase-to-ground
 - xii) Check wiring and operation of relays meters and instrumentation
 - xiii) Test electrically operated switches and breakers
 - xiv) Test ground fault operation
5. Describe the applications and features of metal-enclosed low voltage power switchgear.
- i) ANSI definition
 - ii) Current and voltage ratings
 - iii) Switchgear construction
 - indoor
 - outdoor
 - iv) Free standing units (cells)
 - front enclosure
 - breaker cells

- auxiliary cell
 - fixed-metering
 - bus compartment
 - horizontal main bus
 - vertical bus
 - cable and termination compartment
 - cable load terminations
 - bus load terminations
 - neutral bus
 - ground bus
 - ground detection transformers
 - v) Transformer unit
 - liquid-filled
 - air-cooled
 - single-ended
 - double-ended
6. Describe the applications and features of medium-voltage metal-clad switchgear.
7. Describe the procedures used to receive, handle, store and install switchgear.
- i) Receiving switchgear
 - checking damage
 - checking material received
 - filing claim
 - transportation company
 - manufacturer
 - ii) Handling switchgear
 - lifting by crane
 - lifting hooks
 - using spreader bars
 - skidded on rollers
 - longitudinal skidding
 - front-to-back skidding
 - removing rollers
 - iii) Temporary storage
 - environmental conditions
 - surface considerations
 - outdoor storage
 - temporary storage building
 - heating requirements
 - iv) Installation
 - location
 - foundation
 - floor steel
 - conduits
 - shipping skids

- shipping braces
- v) Final assembly
 - setting reference lines for front panels
 - centre to centre spacing of units
 - setting units plumb
 - securing shipping groups together
 - secure entire assembly to floor channels or base pad
- vi) Connections
 - bus connections
 - ground bus connections
 - main power connections
 - bolt torque
 - control connections
 - moving parts
 - removal of blocking and bracing
 - key operated interlocks

Practical Projects:

Practical skills enhance the apprentices' ability to meet the objectives of the unit.
Practical Projects include:

1. Conduct megger test.
2. Conduct hipot test.

ER-1300

DC MOTORS AND CONTROLS

Outcomes:

Upon the successful completion of this unit the apprentice will be able to install and maintain DC motors and controls as per CEC requirements.

Objectives and Content:

1. Describe the construction of direct current (DC) motors.
 - i) Motor nameplate data
2. Identify various types of DC motors and describe their characteristics and applications.
3. Describe the operation of automatic motor controls.
 - i) Motor braking
 - dynamic
 - ii) Voltage drop acceleration controller
 - iii) CEMF acceleration controller
4. Describe the procedures used to install and connect DC motors and their controls.
5. Describe the procedures used to maintain DC motors.

Practical Projects:

Practical skills enhance the apprentices' ability to meet the objectives of the unit. Practical Projects include:

1. Connect and operate DC motors.
2. Dismantle, identify, test and reassemble DC motors.
3. Troubleshoot DC motors.

ER-1340

FIRE ALARMS

Outcomes:

Upon the successful completion of this unit the apprentice will be able to install and troubleshoot fire alarm systems.

Objectives and Content:

1. Describe the common initiating devices of a fire alarm.
 - i) Manual Pull Stations
 - general information
 - pull station location requirements
 - ii) Smoke detectors
 - ionization detection
 - photo electronic smoke detection
 - combination smoke detectors
 - location requirements
 - wiring smoke detectors
 - sensitivity testing
 - maintenance and cleaning
 - iii) Duct type smoke detectors
 - sensitivity testing
 - detector installation
 - wiring duct detectors
 - iv) Thermal detectors
 - terminology
 - non-restorable thermal detectors
 - self-restoring thermal detectors
 - combination thermal detectors
 - location requirements
 - wiring thermal detectors
2. Describe types of common signaling devices of a fire alarm and describe their applications.
 - i) Audible signals
 - typical dB levels
 - audible signal mounting requirements
 - electric bells
 - electric chimes
 - electric horns
 - speakers
 - ii) Visual signals
 - requirements

3. Describe procedures used to install signaling devices for a fire alarm.
4. Identify types of fire alarm systems and describe their components and operation.
 - i) Single stage/single zone
 - ii) Multi-zone fire alarm systems
 - iii) Two-stage systems
 - iv) Addressable systems
 - v) Fire department connections
 - vi) Communications system wiring
 - vii) Emergency visual/audio control systems
 - viii) Fire alarm/extinguishing systems
 - ix) Electromagnetic door release devices
 - x) Fire alarm accessories
5. Describe the procedures used to install fire alarm systems as per code requirements.
 - i) Manufacturer's wire types/size requirements
 - ii) End-of-line resistors selection chart
 - iii) Component connections
 - iv) Control panel connections
 - v) Typical test procedures
6. Describe the procedures used to troubleshoot problems with alarm systems.
 - i) System check
 - ii) Systems verification and certification
7. Identify rules and standards governing fire alarm installations.
 - i) Regulations and codes
 - National Fire Code
 - National Building Code
 - National Research Standards
 - Underwriter's Laboratories
 - Canadian Electrical Code
 - Provincial Fire Marshall
 - Provincial Regulations and Acts
 - Fire Alarm Standards

Practical Projects:

Practical skills enhance the apprentices' ability to meet the objectives of the unit.

Practical Projects include:

1. Install, test and troubleshoot a fire alarm system.

ER-1360 ELECTRIC HEATING SYSTEMS AND CONTROLS

Outcomes:

Upon the successful completion of this unit the apprentice will be able to select and install electric heaters and controls and install wiring for electric heating systems.

Objectives and Content:

1. Identify various types of electric heating systems and describe their components and procedures for installation.
 - i) Baseboard heaters
 - uses
 - ratings
 - heating method
 - control
 - installation
 - ii) Thermostats and relays
 - use of thermostats and relays
 - thermostats operation (bimetal, hydraulic filled, solid state)
 - thermostat installations
 - line voltage thermostats
 - low voltage thermostats
 - anticipators
 - built-in thermostats
 - single-pole and double pole thermostats
 - magnetic relays
 - thermal relays
 - solid state relays
 - iii) Radiant heating
 - cable sets
 - temperature control
 - spacing / CEC requirements
 - inspection and test procedure
 - heating panels
 - installation
 - temperature control
 - heating lamps (feature and types)
 - iv) Forced convection heaters
 - fan forced heaters
 - over temperature protection (liner - snap disc)
 - installation of convector type unit
 - installation of wall / floor / ceiling fan forced heaters
 - temperature control

2. Perform heat loss calculations for a given space.

Practical Projects:

Practical skills enhance the apprentices' ability to meet the objectives of the unit.

Practical Projects include:

1. Perform heat loss calculations.
2. Install forced air heaters.
3. Select and install the type of low-voltage thermostat and relay appropriate to a specified job.
4. Install a baseboard heater with built-in thermostat.
5. Install a baseboard heater with a wall mounted line-voltage thermostat.

ER-1410

SAFETY PRACTICES

Outcomes:

Upon successful completion of this unit of instruction, the apprentice will be able to understand the requirements and rights of Regulation 91-191 under the Occupational Health and Safety Act as applicable to the construction trades.

Objectives and Content:

1. Describe basic employer and employee duties to comply with the applicable Act and regulations.
 - i) employers responsibilities
 - ii) supervisors responsibilities
 - iii) employees rights and responsibilities
 - iv) Health and Safety Committee responsibilities
2. Describe practices used to control workplace hazards.
 - i) identification of hazards
 - ii) hazard assessment
 - iii) housekeeping
 - iv) fire extinguishers
3. Identify personal protective equipment (PPE) and describe procedures for use and care.
4. Describe safety practices when working in and around trenches.
5. Describe safe practices when working with tools and equipment.
6. Describe mobile equipment safety practices.
7. Identify types of access equipment and describe their construction and safe working practices.
 - i) ladders
 - ii) scaffolds
 - iii) man lifts
8. Describe potential hazards while working around welding areas.
 - i) harmful gases
 - ii) flashing
 - iii) burns
 - iv) grounding
9. Describe confined space safety practices.

10. Describe lifting techniques and work posture.
11. Describe safety measures related to electricity.
12. Describe safety measures for lockout and tagging of equipment.

Practical Projects:

Practical skills enhance the apprentices' ability to meet the objectives of the unit.
Practical Projects include:

1. Classroom exercises as determined by the instructor.

ER-2000 RACEWAYS, WIREWAYS AND BUSWAYS

Outcomes:

Upon the successful completion of this unit the apprentice will be able to install raceways, wireways and busways as per CEC requirements.

Objectives and Content:

1. Describe the procedures used to install one-piece surface raceways.
 - i) Fittings
 - ii) Boxes
 - iii) Installation
 - iv) Tools
 - v) Connecting to conduit and armored cable
 - vi) Connecting to concealed wiring

2. Describe the procedures used to install two-piece surface raceways.
 - i) Single channel and multi channel
 - ii) Applications
 - iii) Fittings
 - iv) Boxes
 - v) Supporting methods

3. Describe the procedures used to install cellular floor raceways.
 - i) Applications
 - ii) Installation
 - iii) Fittings and adapters
 - iv) Outlets and boxes
 - v) Extending from underfloor ducts

4. Describe the procedures used to install multi-outlet assemblies.
 - i) Plugmold
 - pre-wired
 - installation
 - devices and fittings
 - ii) Electro-strip
 - construction
 - outlets and adapters
 - iii) Pole type multi-outlet assemblies
 - channel arrangements
 - installation

5. Describe the procedures used to install lighting fixture raceways.
 - i) Construction

- ii) Mounting methods
6. Describe the procedures used to install undercarpet strips.
 - i) flat conductor cables (FCC)
 - ii) Power systems
 - iii) Installation method
 - iv) Undercarpet telecommunication systems
 7. Describe wireways, their applications and procedures for installation.
 - i) restrictions
 8. Describe busways, their applications and procedures for installation.
 - i) restrictions
 - ii) Supports
 9. Identify types of cable trays and describe their applications and procedures for installation.
 - i) Ladder cable trays
 - ii) Ventilated cable trays
 - iii) Non-ventilated cable trays
 - iv) Cable tray accessories (fittings, adapters, etc.)
 - v) Supporting cable trays
 - vi) Bonding cable trays
 - vii) Cable tray barriers
 10. Describe the procedures used to install and secure cables and conductors in cable trays.
 11. Describe the procedures used to install underfloor metallic raceways.
 - i) After-set inserts
 12. Describe the procedures used to install underground raceways.

Practical Projects:

Practical skills enhance the apprentices' ability to meet the objectives of the unit
Practical Projects include:

1. Install one-piece surface raceways.
2. Install two-piece surface raceways.
3. Install wall and pole type multi-outlet assemblies.
4. Install lighting fixture raceways.
5. Install cable tray.
6. Install wireways.

ER-2010

LIGHTING AND CONTROLS

Outcomes:

Upon the successful completion of this unit the apprentice will be able to install, maintain and troubleshoot various types of lighting systems as per CEC requirements.

Objectives and Content:

1. Define terms associated with lighting.
2. Identify various types of incandescent lamps and describe their physical and electrical characteristics and applications.
3. Describe the procedures used to install incandescent lighting as per CEC requirements.
4. Identify various types of fluorescent lamps and describe their physical and electrical characteristics and applications.
5. Identify components of fluorescent lighting systems.
6. Describe the procedures used to install fluorescent lighting systems as per CEC requirements.
7. Describe the procedures used to maintain and troubleshoot fluorescent lighting systems.
 - i) Lamp testers
 - ii) Ballast testers
8. Describe the procedure used to handle, store and dispose of ballasts and capacitors.
9. Identify types of high intensity discharge (H.I.D.) fixtures and describe their characteristics and applications.
10. Describe the procedures used to install high intensity discharge (H.I.D.) fixtures as per CEC requirements.
11. Describe the procedures used to maintain and troubleshoot high intensity discharge (H.I.D.) fixtures.
12. Describe the procedures used to install line voltage system controls as per CEC requirements.
 - i) Lighting control function

- ii) Line voltage switches
 - iii) Dimming circuits
 - iv) Photocells
 - v) Timers and time clocks
 - vi) Passive infrared lighting control
 - vii) Lighting contractor
 - viii) Programmable Lighting Controls
13. Describe the procedures used to install low voltage system control as per CEC requirements.
- i) 3 wires
 - ii) 2 wires
 - iii) Wireless

Practical Projects:

Practical skills enhance the apprentices' ability to meet the objectives of the unit.
Practical Projects include:

1. Install incandescent lighting according to CEC requirements in a specified location.
2. Install fluorescent lighting systems according to CEC requirements in a specified location.
3. Troubleshoot problems with fluorescent lighting systems.

ER-2020

SINGLE-PHASE AC MOTORS

Outcomes:

Upon the successful completion of this unit, the apprentice will be able to install and maintain single-phase AC motors as per CEC requirements.

Objectives and Content:

1. Identify various types of single-phase AC motors and describe their components, characteristics and principles of operation.
 - i) Induction motors
 - ii) Split-phase motors
 - iii) Capacitor start motor
 - iv) Permanent-split capacitor motor
 - v) Two-capacitor motor
 - vi) Capacitor-Autotransformer motor
2. Describe the operation of single-phase series motors (universal).
 - i) Construction
 - ii) Speed regulation
3. Identify and describe the elements to consider when selecting a motor.
 - i) Motor classification
 - general purpose
 - definite-purpose
 - engineered special motors
 - standard voltage and frequency
 - ii) Starting characteristics and motor enclosures
 - starting current
 - running current (FLC)
 - locked-rotor current
 - motor enclosures types
 - effect of duty cycle
 - iii) Motor temperature
 - temperature considerations
 - temperature rise
 - iv) Motor characteristics (physical)
 - frame size
 - motor mounts
 - bearing and thrust
 - power supply and connections (120 V and 240 V)
4. Identify and describe devices for protection of motors.
 - i) Overcurrent protection

- non-time delay fuse
 - time delay fuse
 - circuit breaker
 - ii) Overload protection
 - eutectic and bimetallic
 - time-delay fuse
 - built-in overheating protection
 - low voltage protection and release
 - selection table of heater elements
5. Describe the procedures used to calculate the rating of protection devices and conductor size as per CEC requirements.
- i) Conductor size supplying a motor
 - ii) Motor branch circuit overcurrent protection device rating
 - iii) Feeder conductor size supplying a group of motors
 - i) Feeder overcurrent protection device rating for a group of motors
 - ii) Bonding

Practical Projects:

Practical skills enhance the apprentices' ability to meet the objectives of the unit.

Practical Projects include:

1. Dismantle, identify, test and reassemble single phase motors.
2. Troubleshoot single phase motors.

In order to successfully complete this unit of instruction, apprentices will be expected to complete the following LabVolt laboratory experiments:

1. Single-phase induction motors.

ER-2030

THREE-PHASE MOTORS

Outcomes:

Upon the successful completion of this unit the apprentice will be able to install, test and maintain three-phase motors as per CEC requirements.

Objectives and Content:

1. Identify types of three-phase motors and describe their characteristics and applications.
 - i) Compare single-phase and three-phase motors
 - ii) Data on nameplates

2. Describe the operating principles of three-phase squirrel cage induction motors.
 - i) Construction
 - ii) Calculations
 - synchronous speed
 - rotor speed
 - slip and speed regulation
 - power output and efficiency
 - power factor
 - iii) Three-phase motor reversal
 - iv) Motor connections
 - multi-speed motors
 - multi-voltage motors
 - v) Fast reversing motors

3. Describe the operating principles of three-phase wound rotor induction motors.
 - i) Construction
 - ii) Speed control
 - iii) Terminal markings
 - iv) Characteristics
 - v) Applications

4. Describe the operating principles of synchronous motors.
 - i) Construction
 - ii) Principles of operation
 - starting
 - DC field excitation to obtain synchronous speed
 - starting torque and damper winding
 - iii) Power factor
 - under, normal and over excitation
 - operating under different loads
 - iv) Industrial application

- constant speed application
 - synchronous condenser
 - v) Field discharge resistor
5. Identify devices for protection of motors and describe their applications.
- i) Overcurrent protection
 - non-time delay fuse
 - time delay fuse
 - circuit breaker
 - ii) Overload protection
 - eutectic and bimetallic
 - time-delay fuse
 - built-in overheating protection
 - iii) Bonding
6. Describe the procedures used to calculate the rating of protection devices and conductor size as per CEC requirements.
- i) Conductor size supplying a motor
 - ii) Motor branch circuit overcurrent protection device rating
 - iii) Motor overload protection device rating
 - iv) Feeder conductor size supplying a group of motors
 - v) Feed overcurrent protection device rating for a group of motors
7. Describe the procedures used to maintain three-phase motors.
8. Describe the procedures used to test motors.
- i) Speed testing and indicating
 - speed testing
 - speed indicators
 - tachometers
 - stroboscope
 - magnetos and impulse converters
 - using speed measuring devices
 - ii) Torque testing instruments
 - development of torque
 - torque measurement
 - iii) Frequency testing instruments
 - frequency indicators
 - vibrating reed frequency meter
 - shading coil frequency meters
 - resonant circuit frequency meter
 - electronic type frequency meter
 - iv) Phase indicating instruments
 - phase rotation tester
 - phase sequence indicator
 - marking of phase conductors

Practical Projects:

Practical skills enhance the apprentices' ability to meet the objectives of the unit.

Practical Projects include:

1. Connect, operate and troubleshoot three-phase motors in accordance with CEC requirements.

In order to successfully complete this unit of instruction, apprentices will be expected to complete the following LabVolt laboratory experiments:

1. The three-phase squirrel-cage induction motor.
2. Eddy-current brakes and asynchronous generators.
3. Effect of voltage on the characteristics of induction motors.
4. The three-phase synchronous motor.
5. Synchronous motor pull-out torque.

ER-2040

CONTROL DEVICES

Outcomes:

Upon the successful completion of this unit the apprentice will be able to select, install and maintain control devices as per CEC requirements.

Objectives and Content:

1. Describe the construction and operation of pushbuttons.
 - i) Pushbutton operators
 - ii) Contact assemblies
 - iii) Palm operator pushbuttons
 - iv) Special purpose pushbuttons
2. Describe the construction and operation of selector switches.
 - i) Cam operators
 - ii) Joy stick operators
 - iii) Contact assemblies
3. Describe the construction and operation of centrifugal switches.
 - i) Purpose
 - ii) Circuit connections
4. Describe the construction and operation of limit switches.
 - i) Operating units
5. Describe the operation/limitations of proximity switches.
 - i) Inductive proximity sensors
 - operation and examples
 - installation techniques
 - ii) Ultrasonic proximity sensors
 - operation
 - detection and accuracy
 - iii) Capacitive proximity sensors
 - operation
 - iv) Wiring proximity sensors
 - v) Troubleshooting techniques
6. Describe the operation of photo sensors and switches.
 - i) Phototubes (photoemissive cells)
 - ii) Solar cells (photovoltaic cells)
 - iii) Photoresistive cells (photoconductive)
 - iv) Photodiodes/Phototransistors
 - v) Installation of photo switches

7. Describe the operation of time switches.
 - i) Time switches and timing logic
 - ii) Associated terms
 - iii) Timing charts
 - iv) Wiring diagrams/connections

8. Describe types of counters and totalizers and describe their characteristics, applications and operation.
 - i) Associated terms
 - ii) Electronic counters
 - iii) Applying input signals
 - iv) Electromechanical counter

9. Describe types of relays and describe their characteristics, application sand operation.
 - i) General purpose
 - ii) Definite purpose
 - iii) Machine tool relays
 - iv) Protective relays
 - v) Construction

10. Describe the operation of temperature-operated devices.
 - i) Types
 - R.T.D
 - Thermo couple
 - ii) Purpose
 - iii) Associated terms
 - iv) Selecting temperature controls
 - v) Input devices
 - vi) Connections

11. Describe the methods of controlling/determining liquid levels.
 - i) Type of liquid levels
 - float switches/controls
 - probe-type level detector
 - pressure switches
 - radiation absorption types of level control

12. Describe the methods of controlling/determining pressure levels.
 - i) Types of pressure switches
 - ii) Installation and wiring

13. Describe the methods used to determine the flow of air or liquids.
 - i) Types of flow switches
 - ii) Installation and wiring

Practical Projects:

Practical skills enhance the apprentices' ability to meet the objectives of the unit.

Practical Projects include:

1. Classroom exercise as determined by the instructor.

ER-2050 MOTOR STARTERS AND CONTROLLERS

Outcomes:

Upon the successful completion of this unit the apprentice will be able to install, maintain and troubleshoot motor starters and controllers.

Objectives and Content:

1. Describe the procedures used to interpret wiring and schematic diagrams.
2. Describe the characteristics, purpose and construction of common magnetic starters.
 - i) Magnetic starters
 - contactor relay (armature, contact)
 - auxiliary contact
 - magnetic operation
 - removing and replacing contacts and coil
 - ii) Low voltage protection and release
 - iii) Control devices (pushbutton, limit switch, etc.)
 - iv) Power contacts
 - v) Starter size
3. Describe the construction, operation and installation of overload devices.
 - i) Overload relay trip characteristics
 - ii) Types of overload units
 - melting alloy
 - bimetallic
 - magnetic
 - iii) Thermal overload relay selection (charts and CEC tables)
 - iv) Ambient temperature compensation
4. Identify common circuits and describe their applications.
 - i) Two-wire control
 - ii) Three-wire control
5. Identify various types of circuits and describe their applications.
 - i) Single station
 - ii) Multiple station
 - iii) Forward and reverse
 - iv) Jogging
 - v) Sequential control
6. Identify motor interlock circuits and describe their applications.
 - i) Mechanical

- ii) Electrical
 - iii) Push button
7. Identify quick stop circuits and describe their applications.
- i) Plugging
 - ii) Dynamic braking
 - iii) Electro-magnetic brakes
8. Identify time delay relays and describe their applications.
- i) On-delay
 - ii) Off-delay
9. Identify circuit sources and describe their applications.
- i) Separate voltage source
 - ii) Control circuit transformer
 - selection
10. Describe the operation, construction and installation of wound rotor motor controllers as per CEC requirements.
11. Describe the construction of motor control centers and procedures for assembly and installation.
12. Identify types of reduced voltage starters and describe their applications.
- i) Primary resistor starters
 - ii) Autotransformer starters
 - iii) Wye-delta starters
 - iv) Reactor starters
13. Identify types of multi-speed controllers and describe their applications.
- i) Magnetic relays
 - manual control
 - automatic control
 - ii) Drum controllers
14. Identify and describe basic frequency drives.
- i) Soft-start electronic starters
15. Identify and describe programmable controllers (PLC).
- i) Basic operation overview (input card, CPU and output card)
16. Describe the procedures used to troubleshoot control circuits, starters and controllers.

17. Describe the procedures used to install and maintain motor starters and controllers.
 - i) Care for enclosures
 - ii) Cleaning
 - iii) Eliminating vibration problems
 - iv) Providing adequate ventilation
 - v) Preventing condensation
 - vi) torquing connections

18. Program programmable relays.

Practical Projects:

Practical skills enhance the apprentices' ability to meet the objectives of the unit.
Practical Projects include:

1. Connect and operate common magnetic starters and controllers.
2. Install overload devices.
3. Maintain and troubleshoot control circuits, starters and controllers.
4. Connect and operate manual starters.
5. Install/connect input devices according to specific requirements.
6. Install/connect input devices in a sequential operation.

ER-2060

CENTRAL HEATING UNITS

Outcomes:

Upon the successful completion of this unit the apprentice will be able to install central heating systems and their wiring.

Objectives and Content:

1. Describe the procedures used to install wiring and controls for electric furnaces.
 - i) Electric furnace controls
 - ii) Control switches
 - iii) Switching and relays
 - iv) Multi stage control
 - v) Electric furnace limit protection

2. Describe the procedures used to install wiring and controls for duct heaters.
 - i) Applications
 - primary
 - preheat
 - reheat
 - supplemental or auxiliary
 - ii) Installation
 - iii) Velocity
 - iv) Heater Position
 - v) Air flow direction
 - vi) Control

3. Describe the procedures used to install wiring and control for electric boilers.
 - i) Controls
 - ii) Adjustable aquastat
 - iii) High limit aquastat
 - iv) Pressure/temperature relief valves, gauges
 - v) Zone control for hydronic systems

4. Describe the procedures used to install wiring and controls for dual energy heating units.
 - i) Hot water
 - ii) Forced air
 - iii) Load management panels

5. Describe heat pumps and the procedures used to install wiring and controls.
 - i) Types and sizes of heat pumps
 - ii) Basic operating principles of heat pumps
 - iii) Outdoor and indoor fans

- iv) Auxiliary outdoor and indoor heaters
 - v) High pressure and low pressure control
 - vi) Indoor staging thermostats
 - vii) Fusing and disconnecting/isolating switch requirements
6. Describe power and control wiring.
- i) Over current devices
 - ii) Control wiring
 - iii) Hot water furnaces
 - iv) Hot air furnaces
 - v) Duct heaters

Practical Projects:

Practical skills enhance the apprentices' ability to meet the objectives of the unit.
Practical Projects include:

1. Classroom exercise as determined by the instructor.

ER-2072 POWER SUPPLY AND RECTIFIERS

Outcomes:

Upon the successful completion of this unit the apprentice will be able to install and troubleshoot power supply and rectifiers.

Objectives and Content:

1. Describe the construction, characteristics and power ratings of resistors.
 - i) Carbon
 - ii) Wire wound
 - iii) identification and colour code
 - iv) Variable resistors
 - connection as a rheostat
 - connection as a potentiometer
 - v) Testing a resistor
 - ohmmeter test
 - symbol

2. Identify types of capacitors and describe their construction, characteristics and applications.
 - i) Types of capacitors
 - standard (mica, ceramic etc.)
 - electrolytic
 - ii) Construction of capacitors
 - plate/area
 - isolation (dielectric)
 - iii) Capacitor operation
 - farad
 - charging and discharging
 - time constant
 - iv) Testing a capacitor
 - ohmmeter test
 - capacitor tester
 - symbol
 - capacitor rating

3. Identify types of inductors and describe their construction, characteristics and applications.
 - i) Types of inductors
 - air-core
 - iron-core
 - ii) Inductance effect
 - lenz-law

- iii) - time constant
- iii) Value (henry) and symbol
- 4. Describe the basic characteristics of semiconductor materials.
 - i) Semiconductor theory
 - ii) Covalent bonding
 - iii) N-type semiconductor material
 - iv) P-type semiconductor material
- 5. Describe the characteristics of the PN junction diode.
 - i) The PN junction
 - ii) Reverse bias
 - iii) Forward bias
 - iv) Voltage/current graph
 - v) Diode specifications
 - vi) Diode polarity
 - viii) Ohmmeter tests
- 6. Describe the operation of single-phase rectifier circuits.
 - i) Rectifier wave form
 - half-wave rectifier
 - full-wave bridge rectifier
 - ii) Ripple frequency
- 7. Describe the operation of the Zener diode.
 - i) Voltage/current graph
 - ii) DC voltage regulator circuits
 - iii) AC clipping action
 - iv) Terminal and symbol
- 8. Describe the procedures used to calculate and measure power, current and voltage values in rectifier circuits.
 - i) Average values
 - ii) Effective (RMS) values
 - iii) Peak inverse voltage
 - iv) Power value
 - v) Simple power supply calculations
- 9. Identify types of filter circuits for single-phase rectifiers.
 - i) Capacitor filter
 - ii) Choke filter
 - iii) LC Filter arrangements
 - iv) PI filter
- 10. Describe the procedures used to install and connect power supplies.
 - i) Wire size

- ii) Polarity
 - iii) Conductors overcurrent protection
11. Describe the features of the silicon-controlled rectifier (SCR).
- i) Construction
 - terminal and symbol
 - layers
 - ii) Operation
 - triggering action (two-transistors equivalent circuit)
 - iii) Characteristics
 - current/voltage graph
 - typical rating
12. Describe the action of the SCR in a circuit.
- i) AC circuit
 - half-wave rectification
 - phase control
 - firing point
 - full-wave rectification
 - ii) DC circuit
 - commutation circuit
13. Describe the features of the TRIAC.
- i) Construction
 - terminal and symbol
 - SCR equivalent circuit
 - ii) Operation
 - triggering action
 - iii) Characteristics
 - current/voltage graph
 - typical rating
14. Describe the procedures used to test SCR's and TRIAC's
- i) Ohmmeter test
 - SCR testing
 - TRIAC testing
15. Describe the common triggering circuit for achieving phase control with the SCR.
- i) Resistance Only Triggering
 - ii) Resistance-capacitance Triggering (time-constant)
16. Describe three-phase rectifiers and their operation.
- i) Wye connected half-wave rectifier
 - ii) Compute the average DC output of a half-wave, three-phase rectifier
 - iii) Bridge connected full-wave rectifier
 - iv) Compute the average DC output of a full-wave, three-phase rectifier

- v) Applications
 - basic example of three-phase motor speed controller
 - basic example of DC motor speed controller
 - vi) Ripple frequency
17. Describe basic circuits application using thyristors.
- i) Small DC motor speed control circuit example
 - ii) Small AC motor speed control circuit example
 - iii) Small AC and DC motor speed control circuit example
 - iv) Regulated battery charging circuit example
 - v) Static motor starting switch
 - vi) Incandescent lamp dimmer
18. Describe other diode applications.
- i) Free-wheeling diodes
 - ii) Light-emitting diodes
 - single LED's
 - seven segment LED display
 - iii) Photodiodes

Practical Projects:

Practical skills enhance the apprentices' ability to meet the objectives of the unit.
Practical Projects include:

1. Use an oscilloscope to measure and test regulated power supply.
2. Connect, operate and troubleshoot half wave and full wave rectifiers.
3. Connect, operate and troubleshoot regulated power supply.
4. Calculate and measure power, current and voltage values in rectifier circuits.

ER-2116

TROUBLESHOOTING TECHNIQUES

Outcomes:

Upon the successful completion of this unit the apprentice will be able to apply diagnostic and troubleshooting techniques.

Objectives and Content:

1. Describe personal and equipment safety practices.
 - i) Energy isolation
 - lockout / tagout
 - OSHA requirements
 - ii) Personal protective equipment
 - iii) "insulated" mats
 - iv) Quality of workmanship

2. Describe conventional troubleshooting methods.
 - i) Interview operator (owner)
 - ii) Verify "facts"
 - iii) Get to know the operating sequences of the machine
 - iv) Use machine manuals, schematics, etc.
 - v) Operator or record check for change to machine or environmental changes
 - vi) Determine symptoms
 - "dead" machine
 - marginal
 - intermittent
 - vii) Isolate problem
 - dividing method
 - viii) Set up and following logical troubleshooting sequence
 - ix) Use manufacturer's troubleshooting guide
 - x) Think beyond the "fix"
 - xi) Substitution troubleshooting
 - xii) Comparison troubleshooting
 - xiii) Record work done

Practical Projects:

Practical skills enhance the apprentices' ability to meet the objectives of the unit. Practical Projects include:

1. Classroom exercise as determined by the instructor.

ER-2122 APPLICATION OF TROUBLESHOOTING TECHNIQUES

Outcomes:

Upon the successful completion of this unit the apprentice will be able to select and apply troubleshooting techniques and equipment.

Objectives and Content:

1. Identify meters, high voltage probe adapters and indicators used to troubleshoot faults and describe their applications and operation.
 - i) Voltmeter
 - ii) Ohmmeter
 - iii) Clamp-on ammeter
 - adapters
 - dividers
 - iv) Multimeters
 - digital
 - analog
 - v) Megohm meter
 - vi) Infrared or thermal scanners
 - vii) Hipot
 - viii) Motor direction rotation indicator
 - ix) Phase sequence indicator
 - x) Signal transmitting source locator
 - xi) Miscellaneous testers
 - logic probe
 - digital pulsar
 - neon indicators
 - continuity testers
 - xii) Tachometer
 - mechanical
 - strobe
 - portable photo tachometer
 - xiii) Temperature measuring instruments
2. Describe requirements for recalibration of meters.
3. Describe the procedures used to interpret the readings taken from meters, high voltage probe adapters and indicators.

Practical Projects:

Practical skills enhance the apprentices' ability to meet the objectives of the unit. Practical Projects include:

ER-2132

INTERCOM SYSTEMS

Outcomes:

Upon the successful completion of this unit the apprentice will be able to install and troubleshoot intercom systems as per CEC requirements.

Objectives and Content:

1. Identify the symbols of communication devices.
2. Identify types of residential intercoms and describe their components.
 - i) Basic master/sub units
 - ii) Door answering system
 - iii) Residential voice communication
 - iv) Radio intercom
 - v) Residential video intercoms
3. Describe a typical apartment building intercom system, its main components and operation.
 - i) Vestibule assemblies
 - ii) Back boxes
 - iii) Amplifiers
 - iv) Vestibule panel/directory
 - v) Suite stations
 - vi) Electric door strike
 - vii) Wiring connections
 - viii) Interfacing telephone and intercom/door release systems
4. Describe video intercom systems, their components and operation.
 - i) System interconnections
 - ii) System operational logic
5. Describe commercial sound/intercom systems, their components and operation.
 - i) Telephone-access paging
 - ii) Access modules
 - iii) Communication/sound systems
6. Describe nurse call systems, their components and operation.
 - i) Control consoles
 - ii) Patient stations
 - iii) Emergency stations
 - iv) Corridor lights
 - v) Annunciator modules
 - vi) Power supplies

7. Describe the procedures used to install various intercom systems.
8. Describe the procedures used to troubleshoot intercom systems.
 - i) Sound/communication systems
 - ii) Video intercom systems
9. Identify CEC requirements in respect to communications cables.

Practical Projects:

Practical skills enhance the apprentices' ability to meet the objectives of the unit.
Practical Projects include:

1. Classroom exercise as determined by the instructor.

ER-2140

SECURITY SYSTEMS

Outcomes:

Upon the successful completion of this unit the apprentice will be able to install and troubleshoot security systems.

Objectives and Content:

1. Describe the types and classifications of security systems.
 - i) Local alarm system
 - ii) Central and monitoring stations
 - iii) Typical alarm systems

2. Describe basic alarm systems, their components and operation.
 - i) Ultrasonic space protection devices
 - ii) Microwave space protection devices
 - iii) Infrared body heat detector
 - iv) Photoelectric beam devices
 - v) Perimeter protection devices
 - vi) Alarm signals
 - vii) Cable types

3. Describe basic control panel functions.
 - i) Local alarm control unit
 - ii) Control loops
 - 24 hour loop (instant)
 - permanent loop (instant)
 - moveable protection loop (delayed)
 - iii) Remote control inputs
 - iv) Tamper protection
 - v) Panel tamper switch operation
 - vi) Auxiliary contacts
 - vii) Auxiliary power output
 - viii) Signal circuit
 - ix) Standby power
 - x) Proprietary alarm control panel
 - xi) Remote station

4. Describe regulations for qualifications and licensing in the security alarm industry.
 - i) Requirements, regulations, and acts
 - provincial requirements
 - agency license application
 - Private Investigators and Security Services Act
 - employee license application

- ii) Underwriters Laboratories of Canada Standards
 - iii) Canadian Electrical Code requirements
5. Describe the procedures used to install and troubleshoot security systems.

Practical Projects:

Practical skills enhance the apprentices' ability to meet the objectives of the unit.
Practical Projects include:

1. Classroom exercise as determined by the instructor.

ER-2160

SOLID STATE DRIVES

Outcomes:

Upon the successful completion of this unit the apprentice will be able to install and troubleshoot solid state controls for motors.

Objectives and Content:

1. Describe the operation of solid state DC motor controllers.
 - i) Power converters
 - ii) Field voltage control
 - iii) Armature voltage control
 - iv) Protection
 - v) Speed control
 - vi) Reversing
2. Describe the procedures used to install, maintain and troubleshoot solid state DC motor controllers.
3. Describe the procedures used to install, maintain and troubleshoot variable frequency AC drives.
 - i) DC power section
 - ii) AC power section
 - iii) Control section
 - iv) Filtering
 - v) Size and ratings
4. Describe the operation of the frequency converter (inverter).
 - i) Variable Voltage Inverter (VVI)
 - ii) Pulse Width Modulated Inverter (PMW)
 - iii) Current Source Inverter (CSI)
5. Describe the operation of motors used with variable frequency AC drives.
 - i) Speed characteristics
 - ii) Torque characteristics
 - iii) Braking
 - iv) Reversing
 - v) Protection
6. Describe the procedures used to test and troubleshoot variable frequency AC drives.
 - i) Start-up and adjustments
 - ii) Voltage readings
 - iii) Oscilloscope readings

iv) Harmonics

7. Identify types of drives and describe their operation.

Practical Projects:

Practical skills enhance the apprentices' ability to meet the objectives of the unit.

Practical Projects include:

1. Connect, operate, test and troubleshoot solid state DC motor controllers.
2. Connect, operate, test and troubleshoot solid state frequency AC drives

ER-2170

PLC FUNDAMENTALS

Outcomes:

Upon the successful completion of this unit the apprentice will be able to install, maintain and troubleshoot PLC's as well as identify basic programming instructions.

Objectives and Content:

1. Describe the central processing unit of a PLC.
 - i) CPU diagnostics
 - ii) Memory types
 - iii) Memory organizations
 - iv) Program execution (scan)
 - v) Power supply
 - power to PLC
 - emergency stop requirement

2. Describe the I/O system of a PLC
 - i) I/O addressing
 - ii) Discrete inputs
 - iii) Discrete outputs
 - iv) Analog I/O
 - v) Remote I/O (racks and slots)

3. Describe the programming terminals and peripheral devices used with PLC's.
 - i) Dedicated programming terminals
 - ii) Mini-programming devices (hand held)
 - iii) Computer-based programming terminals
 - iv) Peripheral devices

4. Describe the basic programming methods of PLC's.
 - i) Ladder logic programs
 - ii) I/O instruction and addressing
 - examine if close (ON) input instruction
 - examine if open (OFF) input instruction
 - internal control bit (sealing contact)
 - iii) Inserting and closing rungs
 - iv) Inserting branches
 - v) File manipulating
 - saving
 - opening
 - copying
 - vi) Program testing
 - downloading to PLC

- uploading from PLC
 - online monitoring
5. Describe the procedures used to install, maintain and troubleshoot a programmable logic controller.
- i) Safety considerations
 - ii) System layout
 - iii) Proper grounding techniques
 - iv) Source of electrical interference
 - v) Input/Output connection
 - vi) Field checkout of PLC's
 - vii) PLC maintenance
 - viii) PLC troubleshooting
6. Describe the physical characteristics and applications of programmable relays.

Practical Projects:

Practical skills enhance the apprentices' ability to meet the objectives of the unit.
Practical Projects include:

ER-2180

PROGRAMMING PLC'S

Outcomes:

Upon the successful completion of this unit the apprentice will be able to program a PLC and work with PLC's connected to a network.

Objectives and Content:

1. Describe the procedures used to program a PLC using ladder logic or "instruction set" type languages.
 - i) Ladder logic programs
 - ii) I/O instruction and addressing
 - examine if close (ON) input instruction
 - examine if open (OFF) input instruction
 - output instruction
 - internal control bit (sealing contact)
 - iii) Inserting and closing rungs
 - iv) Inserting branches
 - v) File manipulating
 - saving
 - opening
 - copying
 - printing
 - vi) Program testing
 - downloading to PLC
 - uploading from PLC
 - online monitoring

2. Describe the procedures used to program timers in a PLC.
 - i) Types of PLC timers
 - ON delay
 - OFF delay
 - ii) Timer addressing
 - iii) Timer output bits
 - iv) Timer reset

3. Describe the procedures used to insert counters in a PLC system.
 - i) Types of PLC counters
 - up counter
 - down counter
 - ii) Counter addressing
 - iii) Counter output bits
 - iv) Counter reset

4. Identify DATA manipulation commands and insert them in a PLC.
 - i) DATA comparison command
 - ii) DATA transferring commands
 - move function
 - iii) DATA logic commands and gates
 - iv) Special functions
 - force ON/OFF
 - latch coil

5. Describe the procedures used to insert math functions in a PLC.
 - i) Addition
 - ii) Subtraction
 - iii) Multiplication
 - iv) Division

6. Identify the general principles for testing and troubleshooting PLC data highway systems.
 - i) Data highway types
 - protocol and terminology(LAN, TCP/IP etc.)
 - ii) LAN and ethernet
 - the Local Area Network (LAN)
 - LAN topology
 - bus or branch
 - star
 - ring
 - LAN token
 - ethernet
 - iii) Transmission media
 - factor for selection the type of medium
 - cable types (twisted-pair, coaxial, fiber-optic)

7. Describe the procedures used to install and maintain a PLC data highway system.
 - i) System layout
 - ii) Connect PLC's to a network interface devices
 - iii) Program a PLC controlling other PLC's on a network system

Practical Projects:

Practical skills enhance the apprentices' ability to meet the objectives of the unit
Practical Projects include:

1. Program a PLC using ladder logic or 'instruction set' type language.

ER-2240

DC GENERATORS

Outcomes:

Upon the successful completion of this unit the apprentice will be able to install, maintain and troubleshoot DC generators.

Objectives and Content:

1. Identify and describe the basic components of a typical DC generator.
2. Describe the generation of voltage.
 - i) Magnets and magnetic fields
 - ii) Magnetic terms and definitions
 - iii) Permanent and temporary magnets
 - iv) Left-hand coil rule
 - v) Current flow (electron and conventional)
 - vi) Losses in magnetic coils (eddy current and hysteresis)
 - vii) Induced voltages
 - viii) Generator effect
 - ix) Left-hand generator rule
 - x) Generating an EMF
 - xi) Motor effect in a generator
 - xii) Losses and efficiency of a generator
3. Describe the characteristics of series, shunt and compound DC generators.
 - i) Method of field excitation
 - ii) Shunt generators
 - iii) Series generators
 - iv) Compound generators
 - v) Generator rheostats
 - field rheostats
 - diverter rheostats
 - vi) Static excitation
4. Describe the procedures used to install and maintain DC generators as per CEC requirements.
 - i) Installation of generators and peripheral devices
 - ii) Pre-commissioning checks
5. Describe the procedures used to troubleshoot generator problems.
 - i) Failure to generate voltage
 - lack of residual magnetism (field flashing and motorizing)
 - loose connection
 - poor brushes contact

- wrong brushes position
- wrong field polarity
- field rheostat
- ii) Brush tension
- iii) Care of commutator
- iv) Generator reversal

Practical Projects:

Practical skills enhance the apprentices' ability to meet the objectives of the unit.

Practical Projects include:

1. Identify the basic components of a typical DC generator.
2. Connect and operate DC generators in accordance with CEC requirements.
3. Troubleshoot problems with DC generators.

ER-2250

AC GENERATORS

Outcomes:

Upon the successful completion of this unit the apprentice will be able to install, maintain and troubleshoot AC generators and identify alternative power systems.

Objectives and Content:

1. Identify types of AC generators.
 - i) salient
 - ii) cylindrical
2. Describe the construction and characteristics of AC generators.
 - i) Construction
 - frame, rotor, field pole
 - exciter
 - rectifier assembly
 - ii) Characteristics
 - armature reaction
 - reactance
 - factors affecting the output voltage
 - effects of load power factor
 - voltage regulation
 - automatic regulators
 - efficiency
 - ratings
 - nameplate information
3. Explain the operating principles of AC generators.
 - i) Three-phase generators
 - wye connection
 - delta connection
 - stator windings (formed coil)
 - ii) Methods of AC generation
 - revolving field
 - revolving armature
 - iii) Amortisseur windings
 - iv) Field discharge circuits
 - v) Ventilation and cooling
4. Describe the construction and operation of brushless synchronous generators.
 - i) Construction
 - frame, rotor, field pole, etc.
 - exciter

- rectifier assembly
 - ii) Operation
 - iii) Static voltage regulation
 - iv) Voltage sensing
 - v) Compensation for parallel operation
5. Describe the procedures used to control the output voltage and frequency of AC generators.
- i) Prime mover relationship
 - ii) Excitation
6. Describe the procedures used to install, maintain and troubleshoot AC generators.
7. Describe the procedures used to connect AC generators in parallel.
- i) Generator requirements
 - voltage relationships
 - frequency relationships
 - in-phase relationships
 - phase sequence relationships
 - ii) Load sharing
 - iii) Synchronization
 - one-dark, two-bright method
 - three-dark method
 - synchrosopes
 - iv) Hunting
8. Identify alternative power systems.
- i) solar
 - ii) wind
 - iii) thermal

Practical Projects:

Practical skills enhance the apprentices' ability to meet the objectives of the unit.
Practical Projects include:

- 1. Connect, operate, test and troubleshoot
 - AC generators in parallel
 - AC generators

ER-2260

EMERGENCY STAND-BY UNITS

Outcomes:

Upon the successful completion of this unit the apprentice will be able to install, maintain and troubleshoot emergency stand-by systems and their associated devices as per code requirements.

Objectives and Content:

1. Determine the requirements of emergency stand-by power units according to applicable codes and standards.
 - i) National Building Code (NBC)
 - ii) Canadian Electrical Code (CEC)
 - iii) Canadian Standards Association (CSA)
2. Describe the procedures used to install a generator stand-by emergency power unit.
3. Describe the procedures used to install manual and automatic transfer switches.
 - i) Neutral transfer switches
 - ii) Optional controls for transfer switches
 - iii) Two source system
4. Describe the construction and operation of uninterruptable power supplies.
 - i) Power line problems
 - ii) UPS system configurations
 - iii) UPS selection
5. Describe the procedures use to troubleshoot stand-by power systems.
 - i) Storage battery units
 - ii) Uninterruptable power supplies
 - iii) Engine generator sets
 - iv) Transfer switches
6. Describe the construction and operating principles of primary and secondary batteries.
7. Describe the cell characteristics of nickel-iron and nickel-cadmium batteries.
8. Identify battery stand-by power system units and describe the procedures used to size and install as per CEC requirements.
 - i) Cell/battery ampere/hour ratings
 - ii) Effects of temperature
 - iii) Room location/requirements

- iv) Rack assemblies
 - v) Cell interconnections
9. Describe the procedures used to maintain stationary battery systems.
- i) Condition of charge
 - ii) Use of float hydrometer
 - iii) Variation with temperature
 - iv) Variation with electrolyte level
 - v) Loss after water addition
 - vi) Correcting low specific gravity
 - vii) Charge indicators
 - viii) Open voltage test
 - ix) Measuring cell voltage under load
 - x) Ampere hour measurements
10. Describe the procedures used to connect and set-up battery chargers.
- i) Charging process
 - ii) Charging cycle
 - iii) Safety conditions
 - iv) Cleaning
 - v) Initial charge
 - vi) Constant voltage method
11. Identify solar energy charging systems and describe their use.
- i) Solar cells
 - ii) Photovoltaic cells

Practical Projects:

Practical skills enhance the apprentices' ability to meet the objectives of the unit.

Practical Projects include:

- 1. Classroom exercise as determined by the instructor.

ER-2270 EMERGENCY LIGHTING SYSTEMS

Outcomes:

Upon the successful completion of this unit the apprentice will be able to install, maintain and troubleshoot emergency lighting systems.

Objectives and Content:

1. Determine the requirements of emergency lighting systems according to applicable codes and standards.
 - i) National Building Code (NBC)
 - ii) Canadian Electrical Code (CEC)

2. Describe the procedures used to install self-contained lighting units.
 - i) Batteries
 - ii) Battery chargers
 - iii) Cabinets
 - iv) Industrial emergency lighting units

3. Describe the procedures used to install central-powered emergency lighting units.

4. Determine exit sign requirements according to NBC.
 - i) Types
 - nuclear powered
 - conventional powered
 - ii) Applicable regulations

5. Identify types of inverters and converters used on emergency lighting systems and describe their operation.
 - i) Types
 - inverter
 - converter
 - cyclo-inverter
 - ii) Characteristics of solid state inverters/converters
 - iii) Configurations
 - iv) Circuit description
 - v) Accessories
 - overcurrent protection
 - open-circuit
 - sine wave
 - vi) Output, regulated output
 - vii) Fluorescent inverters

6. Determine conductor requirements for remote lighting units according to the CEC.
 - i) Voltage drop
 - ii) Sizing conductors according to distance

Practical Projects:

Practical skills enhance the apprentices' ability to meet the objectives of the unit.
Practical Projects include:

ER-2300 DISTRIBUTION SYSTEM CONDITIONING

Outcomes:

Upon the successful completion of this unit the apprentice will be able to describe the procedures to improve power quality.

Objectives and Content:

1. Describe the significance of power quality.
 - i) Sensitive loads
 - ii) Technological complexity
 - iii) Disturbance-producing equipment

2. Identify the reactive power needed to raise power factor.

3. Describe different meters used in power measurements.
 - i) Wattmeters
 - ii) Power factor meters
 - iii) Phase angle meters

4. Describe the procedures used to install power factor correction equipment.
 - i) Capacitor banks
 - characteristics
 - ratings and tolerances
 - considerations for installation
 - temperature and ventilation
 - fusing
 - conductor size
 - disconnecting means
 - capacitor life
 - capacitor PCB considerations and safety
 - ii) Synchronous motors
 - iii) Locating of power factor correction equipment
 - individual
 - group
 - central correction units

5. Describe power system harmonics and their effects.
 - i) Harmonics theory
 - Triplen
 - linear loads
 - non-linear loads
 - ii) Effects of harmonics on:
 - phase conductors and conduit

- circuit breakers
 - neutral conductors
 - neutral-to-ground voltage at receptacles
 - neutral bus bar and neutral lug
 - transformers
 - power factor correction capacitors
 - kW and kVar meters
 - multi-meter readings
6. Describe the methods of reducing power system harmonics as per CEC requirements.
- i) Shunt harmonic filters
 - ii) Series harmonic filters
 - iii) Wye-delta zero sequence harmonic trap
 - iv) Zig-zag autotransformer zero sequence harmonic trap
 - v) Wye-delta with tuned capacitor zero sequence harmonic trap
7. Describe abnormal voltage fluctuations in power distribution systems.
- i) Tingle voltage
 - ii) Swell
 - iii) Transient
 - iv) Sustained power interruption
 - v) Momentary power interruption
 - vi) Brownout
 - vii) Lightning
8. Describe the mitigating equipment used to correct voltage problems.
- i) Transient suppressors
 - lightning arrester
 - line clamp (surge suppressor)
 - ii) Power line filters
 - linear (passive)
 - hybrid
 - tingle voltage
 - iii) Isolation transformers
 - iv) Line voltage regulators
 - ferroresonant transformers
 - tap switching transformers
 - v) Power line conditioners
 - linear amplifier
 - ferroresonant
 - tap switching
 - motor-generator
 - vi) Uninterruptible Power Supply System (UPS)
 - on-line
 - rotary

- static
- continuous
- line-interactive
- vii) Standby Power Supply System (SPS)
 - off-line
 - static
 - simple
 - ferroresonant

Practical Projects:

Practical skills enhance the apprentices' ability to meet the objectives of the unit.
Practical Projects include:

1. Lab Projects as Required by the Instructor.

ER-2310

FURNACE CONTROLS

Outcomes:

Upon the successful completion of this unit the apprentice will be able to install wiring and controls for fossil-fuel residential central heating units.

Objectives and Content:

1. Describe the function of combustion control on furnaces.
 - i) Control Systems
 - ii) Power Wiring
 - iii) Emergency Switches
 - iv) Control Wiring
 - v) Low-voltage thermostats

2. Describe types of controls installed on a forced-air heating unit and their operation.
 - i) System controls
 - ii) Limit Switches
 - iii) Temperature Settings
 - iv) Types of Limit Switches
 - v) Installation of Limit Switches
 - vi) Primary Controls
 - vii) Thermal Operated Primary Controls
 - viii) Thermal Control Operation
 - ix) Visual Primary Controls
 - x) Operation of Cad Cell Primary Control

3. Describe types of controls installed on a hydronic heating system and their operation.
 - i) System Controls
 - ii) Combination Controls
 - iii) Temperature Settings
 - iv) Zone Valves

4. Describe controls installed on a combination heating system and their operation.
 - i) Wood/oil Furnaces
 - ii) Solid Fuel Combustion Control
 - iii) Interlock Relays
 - iv) Wood/electric Combinations

5. Describe the procedures used to troubleshoot furnace control and associated wiring.
 - i) Low-voltage Wiring and Controls

- ii) Line-voltage Wiring and Controls
6. Describe the procedures used to interpret schematic diagrams for furnaces and controls.

Practical Projects:

Practical skills enhance the apprentices' ability to meet the objectives of the unit.
Practical Projects include:

- 1. Classroom exercise as determined by the instructor.

ER-2332

HEAT PUMPS

Outcomes:

Upon the successful completion of this unit the apprentice will be able to install and maintain heat pumps and their associated devices and controls.

Objectives and Content:

1. Locate and interpret information related to heat pumps and their installations.
 - i) Drawings and symbols
 - ii) Schematics
 - iii) Manufacturer's specifications
2. Describe the operating principles of heat pumps.
3. Describe the procedures used to install heat pumps and their associated equipment.
4. Describe the procedures used to maintain heat pumps.
 - i) Control circuitry
 - ii) Field devices
 - iii) Use of test equipment to verify proper operation
5. Identify regulatory requirements related to heat pumps.

Practical Projects:

Practical skills enhance the apprentices' ability to meet the objectives of the unit. Practical Projects include:

1. Classroom exercise as determined by the instructor

ER-2350

ELECTRIC SURFACE HEATING UNITS

Outcomes:

Upon the successful completion of this unit the apprentice will be able to install various types of electric surface heating units.

Objectives and Content:

1. Describe types of snow melting and floor warming cables, their characteristics and procedures for installation.
 - i) Over-temperature protection
 - ii) Controls
2. Describe the procedures used to install pipe tracing and tank heating cables.
 - i) Types of cables
 - ii) Tracing cable temperature control
 - iii) Tracing cable selection
 - iv) Tracing cable installation
3. Describe de-icing cables, their components, characteristics, applications and procedures for installation.
 - i) Loading requirements
 - ii) Controls
4. Describe types of immersion heaters and their procedures for installation.
 - i) Construction features
 - ii) Temperature control
 - iii) Bonding and grounding requirements for livestock waters
5. Describe heat tracing systems, their components, applications and procedures for installation.
 - i) Manufacturer's instruction
 - ii) Devices
 - iii) Sidewalk/driveways
 - iv) Pipes
 - v) Series and parallel

Practical Projects:

Practical skills enhance the apprentices' ability to meet the objectives of the unit. Practical Projects include:

1. Classroom exercise as determined by the instructor.

ER-2362 REFRIGERATION AND AIR CONDITIONING CONTROLS

Outcomes:

Upon the successful completion of this unit the apprentice will be able to maintain and troubleshoot electrical components and controls for refrigeration and air conditioning systems.

Objectives and Content:

1. Locate and interpret information related to refrigeration and air conditioning controls.
 - i) Drawings and symbols
 - ii) Schematics
 - iii) Manufacturer's specifications
2. Describe the operating principles of refrigeration and air conditioning units.
3. Identify and describe system components and controls.
4. Describe the procedures used to troubleshoot and maintain electrical components and controls for refrigeration and air conditioning systems.
5. Identify regulatory requirements relating to refrigeration and air conditioning units.
6. Describe safety considerations.
 - i) CFC's
 - ii) WHMIS
 - iii) Ammonia

Practical Projects:

Practical skills enhance the apprentices' ability to meet the objectives of the unit. Practical Projects include:

1. Classroom exercise as determined by the instructor.

ER-2390

FIBRE OPTICS

Outcomes:

Upon the successful completion of this unit the apprentice will be able to install and terminate fibre optic cables.

Objectives and Content:

1. Describe the fundamental principles of fibre optics.
 - i) Propagation of light through the optical fibre.
 - ii) Basic fibre construction
 - internal light reflection
 - iii) Fibre classification
 - material makeup
 - modes: multimode step index
single-mode step index
multimode graded index

2. Describe fibre optic cable structures, their construction and applications.
 - i) Main parts
 - vii) Indoor cables
 - iii) Outdoor cables
 - iv) Hybrid Cables
 - v) Characteristics
 - lengths
 - colour coding
 - loads

3. Describe the components of a fibre optic system.
 - i) Sources
 - LED's
 - lasers
 - ii) Detectors
 - PN photodiode
 - PIN photodiode
 - APD avalanche photodiode
 - iii) Transmitters and receivers

4. Describe the procedures used to install fibre optic cables.
 - i) Bending radius
 - ii) Pulling tension
 - iii) Lubrication

5. Describe the procedures used to terminate fibre optic cables.
 - i) Splicing, termination and test equipment
 - tube splitter
 - stripper cleaver
 - fusion splicer
 - optimiser
 - stable light source
 - variable optical attenuator
 - photodyne optical power meter
 - Identifibre (fibre status tester)
 - ii) Splicing materials and accessories
 - preparation kit
 - splice packs
 - closures
 - filling kits
 - installation kits
 - filled splice protector assembly
 - fibre splice protectors
 - fibre splice organizer trays
 - iii) Termination assemblies and components
 - optical fibre terminating cable
 - optical fibre patch cords
 - optical fibre pigtails
 - fibre interface panel
 - fibre patch panel assembly
 - small office termination assembly
 - optical connector assemblies
6. Describe safety precautions when working with laser light sources.
7. Locate and interpret CEC rules and regulations concerning fibre optic cables.

Practical Projects:

Practical skills enhance the apprentices' ability to meet the objectives of the unit.
Practical Projects include:

1. Terminate, splice and test fibre optic cables.

ER-2420

HVAC ELECTRICAL SYSTEMS

Outcomes:

Upon the successful completion of this unit the apprentice will be able to install and maintain HVAC electrical systems.

Objectives and Content:

1. Locate and interpret information related to HVAC electrical systems.
 - i) Drawings and symbols
 - ii) Schematics
 - iii) Manufacturer's specifications
2. Describe the operating principles of HVAC electrical systems.
3. Describe the procedures used to install and maintain HVAC electrical systems.
 - i) Clean
 - ii) Inspect
 - iii) Lubricate
 - iv) Replace components
 - v) Calibrate
 - vi) Test
4. Identify regulatory requirements relating to HVAC systems.

Practical Projects:

Practical skills enhance the apprentices' ability to meet the objectives of the unit.
Practical Projects include:

1. Classroom exercise as determined by the instructor.

ER-2440

HIGH VOLTAGE WIRING

Outcomes:

Upon the successful completion of this unit the apprentice will be able to install, maintain, splice and terminate high voltage cables and their breakers and starters.

Objectives and Content:

1. Identify types of high voltage circuit breakers and motor starters and describe their characteristics and applications.
 - i) Ratings of circuit breakers
 - ii) Types of operating mechanisms
 - iii) Air circuit breakers
 - iv) Oil circuit breakers
 - v) Air blast circuit breakers
 - vi) Vacuum circuit breakers
 - vii) Gas circuit breakers
 - viii) Reclosers
 - ix) Multi-speed starters
2. Describe the procedures used to operate high-voltage circuit breakers and motor starters.
 - i) Approved line tools
 - ii) Safety inspections
 - iii) Voltage testing
 - iv) Key interlock systems
 - v) Safety lockout procedures and grounding
3. Locate and interpret CEC requirements concerning high voltage protective equipment.
 - i) Service equipment and disconnecting means
 - ii) Indoor installations
 - iii) Outdoor installations
4. Describe the features of high voltage cables.
 - i) Cable types
 - ii) Types of dielectric
 - iii) Dielectric strength
 - iv) Conductor shielding
 - v) Electric field around an energized conductor
 - vi) Insulation levels

5. Describe the construction and ratings of concentric neutral type of cables.
 - i) Cable layers and parts
 - ii) AWG sizes
 - iii) Voltage and current ratings
 - iv) Applications

6. Describe the termination and splicing of non-shielded cables.
 - i) Preparing the conductor
 - ii) Making a splice or termination

7. Describe the termination and splicing of shielded cables.
 - i) Preparing the cable
 - iv) Making a splice or termination
 - v) Hipot test

8. Locate and interpret CEC requirements concerning wiring methods for high voltage installations.
 - i) Conductors, cables and raceways
 - ii) Radii of bends
 - iii) Shielding
 - iv) Spacing and support of conductors
 - v) Joints and terminations
 - vi) Torquing requirements

9. Describe the procedures used to terminate parallel runs.

Practical Projects:

Practical skills enhance the apprentices' ability to meet the objectives of the unit. Practical Projects include:

1. Prepare high voltage cable and complete splice on shielded cable.
2. Prepare high voltage cable and complete termination on shielded cable
3. Prepare high voltage cable and complete splice on non-shielded cable.
4. Prepare high voltage cable and complete termination on non-shielded cable.

REQUIRED RELATED COURSES

CM 2150 WORKPLACE CORRESPONDENCE

Description:

This course is designed to give students the opportunity to study the principles of effective writing. Applications include letters, memos, and short report writing.

Course Outcomes:

Upon completion of the course, students will be able to:

- understand the importance of well-developed writing skills in business and in career development.
- understand the purpose of the various types of business correspondence.
- examine the principles of effective business writing.
- examine the standard formats for letters and memos.
- writing effective letters and memos.
- examine the fundamentals of informal reports and the report writing procedure.
- produce and informal report

Required Knowledge and Skills:

1.0 Review of Sentences and Paragraph Construction

- 1.1.1 Define a sentence and review the four types.
- 1.1.2 Identify the essential parts of a sentence, particularly subject and predicate, direct and indirect object.
- 1.1.3 Differentiate among phrases, clauses, and sentences.
- 1.1.4 Explore the major concepts related to subject-verb agreement.
- 1.1.5 Apply rules and principles for writing clear, concise, complete sentences which adhere to the conventions of grammar, punctuation, and mechanics.

1.2 Examine and Apply Principles of Paragraph Construction

- 1.2.1 Discuss the basic purposes for writing.
- 1.2.2 Define a paragraph and describe the major characteristics of an effective paragraph.
- 1.2.3 Write well-developed, coherent, unified paragraphs which illustrate the following: A variety of sentence arrangements; conciseness and clarity; and adherence to correct and appropriate sentence structure, grammar, punctuation, and mechanics.

2.0 Business Correspondence

- 2.1 Examine the Value of Business Writing Skills

- 2.1.1 Discuss the importance of effective writing skills in business
- 2.1.2 Discuss the value of well-developed writing skills to career success
- 2.2 Examine Principles of Effective Business Writing
 - 2.2.1 Discuss the rationale and techniques for fostering goodwill in business communication, regardless of the circumstances
 - 2.2.2 Review the importance of revising and proofreading writing
- 2.3 Examine Business Letters and Memos
 - 2.3.1 Differentiate between letter and memo applications in the workplace
 - 2.3.2 Identify the parts of a business letter and memo
 - 2.3.3 Explore the standard formats for business letters and memos
 - 2.3.4 Examine guidelines for writing an acceptable letter and memo which convey: acknowledgment, routine request, routine response, complaint, refusal, and persuasive request, for three of the six types listed
 - 2.3.5 Examine samples of well-written and poorly written letters and memos
- 3.0 Informal Report
 - 3.1 Examine the Fundamentals of Informal Business Reports
 - 3.1.1 Identify the purpose of the informal report
 - 3.1.2 Identify the parts and formats of an informal report
 - 3.1.3 Identify methods of information gathering
 - 3.2 Apply Informal Report Writing Skills and Oral Reporting Skills
 - 3.2.1 Gather pertinent information
 - 3.2.2 Organize information into an appropriate outline
 - 3.2.3 Draft a five minute informal report
 - 3.2.4 Edit, proofread, and revise the draft to create an effective informal report and present orally using visual aids.

MR 1220

CUSTOMER SERVICE

Description:

This course focuses on the role of providing quality customer service. It is important to have a positive attitude and the necessary skills to effectively listen and interpret customer concerns about a product, resolve customer problems, and determine customer wants and needs. Students will be able to use the skills and knowledge gained in this course to effectively provide a consistently high level of service to the customer.

Course Outcomes:

Upon successful completion of this course, students will:

- know and understand quality customer service
- know why quality service is important
- know and understand the relationship between “service” and “sales”
- understand the importance of and to demonstrate a positive attitude
- recognize and demonstrate handling of customer complaints

Required Knowledge and Skills:

1. Providing Quality Service
 - Define quality service
 - List the types of quality service
 - Define Service vs. Sales or Selling
 - Explain why quality service is important
 - Identify the various types of customers
 - Define customer loyalty
2. Determining Customers Wants and Needs
 - List four levels of customer needs
 - Identify important customer wants and needs
 - Identify ways to ensure repeat business
3. Demonstrating a Positive Attitude
 - List the characteristics of a positive attitude
 - Explain why it is important to have a positive attitude
 - List ways that a positive attitude can improve a customer’s satisfaction
 - Define perception
 - Explain how perception can alter us and customers
 - Understand how to deal with perception

4. Effectively Communicating with customers
 - Describe the main elements in the communication process
 - Identify some barriers to effective communication
 - Define body language
 - Explain how body language would affect customers
 - Determine why body language is important
 - Define active listening and state why it is important
 - Describe the four components of active listening
 - Contrast good and bad listeners
 - List and discuss the steps of the listening process

5. Effectively using Questioning Techniques
 - List questioning techniques
 - Write two examples of an open question
 - Perform a questioning and listening role play

6. Using the Telephone Effectively
 - List the qualities of a professional telephone voice
 - Explain why telephone skills are important
 - Demonstrate effective telephone skills

7. Asserting Oneself: Handling Complaints and Resolving Conflict
 - Define assertiveness
 - Define communication behaviours
 - Relate assertions to effective communication
 - Practice being assertive
 - Understand the process of assertive guidelines for action
 - Practice giving an assertive greeting
 - Acknowledge multiple customers

8. Dealing with Difficult Customers
 - Describe how you would deal with anger
 - Complete a guide to controlling feelings
 - Determine how you would feel dealing with an upset customer
 - Suggest some techniques that might control your own feelings
 - Understand leadership styles and the nature of organizations
 - List ways to dealing with conflict / customer criticism
 - Be aware of certain guidelines when confronting customers
 - List ways of preventing unnecessary conflict with customers
 - Review current skills and knowledge of customer service
 - Develop a customer satisfaction improvement plan

SP 2330 QUALITY ASSURANCE/QUALITY CONTROL

Description:

This course is designed to give students an understanding of the concepts and requirements of QA/QC such as, interpreting standards, controlling the acceptance of raw materials, controlling quality variables and documenting the process. It includes information on quality concepts, codes and standards, documentation, communications, human resources, company structure and policy, teamwork and responsibilities.

Course Outcomes:

Upon completion of this course, students will be able to:

- develop the skills and knowledge required to apply quality assurance/quality control procedures
- develop an awareness of quality management principles and processes

Required Knowledge and Skills:

1. Describe the reasons for quality assurance and quality plans.
2. Explain the relationship between quality assurance and quality control.
3. Describe quality control procedures as applied to the production and checking of engineering drawings in applicable occupations.
4. Describe quality control procedures as applied to the acceptance and checking of raw materials.
5. Explain the role of communications in quality management.
6. Explain why it is important for all employees to understand the structure of the company and its production processes.
7. Explain how human resource effectiveness is maximized in a quality managed organization.
8. Explain the role of company policy in quality management.
9. Explain the purpose of codes and standards.
10. Explain the concepts of quality
 - a. cost of quality
 - b. measurement of quality
 - c. quality control and quality assurance

- d. elements of quality
 - e. elements of the quality audit
 - f. quality standards
 - g. role expectations and responsibilities
11. Explain the structure of quality assurance and quality control
- a. Define quality assurance, quality control and documentation terminology
 - b. Describe organizational charts
 - c. List the elements of a quality assurance system
 - d. Explain the purpose of the quality assurance manual
 - e. Describe quality assurance procedures
 - f. Explain the key functions and responsibilities of personnel
12. Complete quality assurance/quality control documentation
- a. Describe methods of recording reports in industry
 - b. Describe procedures of traceability (manual and computer-based recording)
 - c. Identify needs for quality control procedures
13. Apply quality control to projects
- a. Follow QA/QC procedures for drawings, plans and specifications in applicable occupations.
 - b. Calibrate measuring instruments and devices in applicable occupations.
 - c. Interpret required standards
 - d. Follow QA/QC procedures for accepting raw materials
 - e. Carry out the project
 - f. Control the quality elements (variables)
 - g. Complete QA/QC reports

MC 1050 INTRODUCTION TO COMPUTERS

Description:

This course is designed to give the student an introduction to computer systems. Particular emphasis is given to word processing, spreadsheet, e-mail and the Internet.

Course Outcomes:

Upon completion of this course, students will have a basic understanding of:

- computer systems and their operation.
- popular software packages, their applications and future trends in computer applications

Required Knowledge and Skills:

1. Microcomputer System Hardware and Software Components

1.1 Microcomputer Hardware

1.1.1 System Components

1.1.1.1 Identify major components of a computer system.

1.1.2 Function of each Component

- 1.1.2.1 Describe the function of the microprocessor.
- 1.1.2.2 Describe and give examples of I/O DEVICES.
- 1.1.2.3 Describe primary storage (RAM, ROM, Cache).
- 1.1.2.4 Define bit, byte, code and the prefixes k.m. and g.
- 1.1.2.5 Describe secondary storage (diskettes and hard disks, CD ROMS, Zip Drives etc).
- 1.1.2.6 Describe how to care for a computer and its accessories.

1.2 Microcomputer Software

1.2.1 Software Definition and Types

- 1.2.1.1 Define software.
- 1.2.1.2 Describe, operational and application software used in this course.
- 1.2.1.3 Define file and give the rules for filenames and file extensions..

1.2.2 System Software (Windows 95)

- 1.2.2.1 Getting Started with Windows
- 1.2.2.2 Start and quit a Program
- 1.2.2.3 Get Help
- 1.2.2.4 Locate a specific file using the **find** function of Win95
- 1.2.2.5 Changing system settings: wall paper, screen saver, screen resolution, background.
- 1.2.2.6 Starting a program by using the Run Command
- 1.2.2.7 Shutting down your computer

1.2.3 File Management Commands (Windows 95)

- 1.2.3.1 View directory structure and folder content
- 1.2.3.2 Organizing files and folders
- 1.2.3.3 Copy, delete, and move files and folders
- 1.2.3.4 Create folders
- 1.2.3.5 Maximize and minimize a window
- 1.2.3.6 Print directory/folder content
- 1.2.3.7 Describe the Windows 95 taskbar

2. Word Processing

2.1 Keyboarding Techniques

- 2.1.1 Identify and locate alphabetic and numeric keys
- 2.1.2 Identify and locate function keys: special keys, home keys, page up key, page down key, numeric key pad, shift keys, punctuation keys, tab key

2.2 Word Processing

2.2.1 Understanding word processing

- 2.2.1.1 The Windows Component
- 2.2.1.2 The Menu Bar
- 2.2.1.3 Menu Indicators
- 2.2.1.4 The Document Window
- 2.2.1.5 The Status Bar
- 2.2.1.6 The Help Feature
- 2.2.1.7 Insertion Point Movements

2.2.2 Create a document

- 2.2.2.1 Change the Display
- 2.2.2.2 The Enter Key

2.2.2.3 Enter Text

2.2.3 Save, Open and Exit a document.

- 2.2.3.1 Save a document
- 2.2.3.2 Close a document.
- 2.2.3.3 Start a new document Window
- 2.2.3.4 Open a document
- 2.2.3.5 Exit Word Processor

2.2.4 Edit a Document

- 2.2.4.1 Add New Text
- 2.2.4.2 Delete text
- 2.2.4.3 Basic Format Enhancement (split and join paragraphs, insert text)

2.2.5 Understand Hidden Codes

- 2.2.5.1 Display Hidden Codes
- 2.2.5.2 Delete Text Enhancements

2.2.6 The Select Feature

- 2.2.6.1 Identify a Selection
- 2.2.6.2 Move a Selection
- 2.2.6.3 Copy a Selection
- 2.2.6.4 Delete a Selection
- 2.2.6.5 Select Enhancements
- 2.2.6.6 Save a Selection
- 2.2.6.7 Retrieve a Selection

2.2.7 Change Layout Format

- 2.2.7.1 Change layout format: (margins, spacing, alignment, paragraph indent, tabs, line spacing, page numbering)

2.2.8 Change Text Attributes

- 2.2.8.1 Change text attributes: (bold, underline, font, etc.)

2.2.9 Use Auxiliary Tools

- 2.2.9.1 Spell Check

2.2.10 Select the Print Feature

- 2.2.10.1 Select the Print Feature: (i.e; number of copies and current document)
 - 2.2.10.2 Identify various options in print screen dialogue box
3. Electronic Spreadsheet
- 3.1 Spreadsheet Basics
 - 3.1.1 The Worksheet Window
 - 3.2 Operates Menus
 - 3.2.1 Use a Menu Bar
 - 3.2.2 Use a Control Menu
 - 3.2.3 Use a Shortcut Menu
 - 3.2.4 Save, Retrieve form Menus
 - 3.3 Create a Worksheet
 - 3.3.1 Enter Constant Values and Formulas
 - 3.3.2 Use the Recalculation Feature
 - 3.3.3 Use Cell References (relative and absolute references)
 - 3.4 Use Ranges
 - 3.4.1 Type a Range for a Function
 - 3.4.2 Point to a Range for a Function
 - 3.4.3 Select a Range for Toolbar and Menu Commands
 - 3.5 Print a Worksheet
 - 3.5.1 Print to the Screen
 - 3.5.2 Print to the Printer
 - 3.5.3 Print a Selected Range
 - 3.6 Edit a Worksheet
 - 3.6.1 Replace Cell Contents
 - 3.6.2 Insert and Delete Rows and Columns
 - 3.6.3 Change Cell Formats
 - 3.6.4 Change Cell Alignments
 - 3.6.5 Change Column Width
 - 3.6.6 Copy and Move Cells

4. Electronic Mail and the Internet

4.1 Electronic Mail

- 4.1.1 Compose and send an e-mail message
- 4.1.2 Retrieve an e-mail attachments
- 4.1.3 Send an e-mail message with attachments
- 4.1.4 Retrieve and save e-mail attachments
- 4.1.3 Print an e-mail message
- 4.1.4 Delete an e-mail message

4.2 The Internet

- 4.2.1 Overview of the World Wide Web
- 4.2.2 Accessing Web sites
- 4.2.3 Internet Web Browsers
- 4.2.4 Internet Search Engines
- 4.2.5 Searching Techniques

SD 1700

WORKPLACE SKILLS

Description:

This course involves participating in meetings, doing safety inspections, completing employment insurance forms, writing letters of employment insurance appeal, and filing a human rights complaint. Includes information on formal meetings, unions, worker's compensation, employment insurance regulations, worker's rights and human rights.

Course Outcomes:

Upon completion of this course, students will be able to:

- Participate in meetings (conduct meetings).
- Be aware of union procedures
- Be aware of workers' compensation regulations.
- Be aware of occupational health and safety regulations.
- Be aware of employment insurance regulations
- Be aware of workers' rights.
- Be aware of human rights

Required Knowledge and Skills:

1. Meetings
 - a. Explain preparation requirements prior to conducting a meeting
 - b. Explain the procedures for conducting a meeting.
 - c. Explain participation in meetings.
 - d. Explain the purpose of motions.
 - e. Explain the procedure to delay discussion of motions.
 - f. Explain how to amend and vote upon a motion.
2. Unions
 - a. Why do unions exist?
 - b. Give a concise description of the history of Canadian labour.
 - c. How do unions work?
 - d. Explain labour's structure.
 - e. Describe labour's social objectives.
 - f. Describe the relationship between Canadian labour and the workers.
 - g. Describe the involvement of women in unions.
3. Worker's Compensation
 - a. Describe the aims, objectives, benefits and regulations of the Workers Compensation Board.
 - b. Explain the internal review process.

4. Occupational Health and Safety
 - a. Describe the rules and regulations directly related to your occupation.
5. Employment Insurance Regulations
 - a. Explain employment insurance regulations
 - b. Describe how to apply for employment insurance.
 - c. Explain the appeal process.
6. Worker's Rights
 - a. Define labour standards.
 - b. Explain the purpose of the Labour Standards Act.
 - c. List regulations pertaining to:
 - i. Hours of work.
 - ii. Minimum wages.
 - iii. Employment of children.
 - iv. Vacation pay
7. Human Rights
 - a. Describe what information cannot be included on an application.
 - b. Describe what information cannot be included in an interview
 - c. Why is there a Human Rights Code?
 - d. Define sexual harassment.
8. Participate in meetings.
 - a. Follow the form of getting a motion on the floor
 - b. Discuss a motion
 - c. Amend a motion
 - d. Vote on a motion.
9. Complete a safety inspection of your shop.
10. Complete an employment insurance application form.
11. Write a letter of appeal.
12. Analyze a documented case of a human rights complaint with special emphasis on the application form, time frame, documentation needed, and legal advice available.

SD 1710

JOB SEARCH TECHNIQUES

Description:

This fifteen-hour seminar is designed to give students an introduction to the critical elements of effective job search techniques.

Required Knowledge and Skills:

Examine and Demonstrate Elements of Effective Job Search Techniques

- Identify and examine employment trends and opportunities
- Identify sources that can lead to employment
- Discuss the importance of fitting qualifications to job requirements
- Discuss and demonstrate consideration in completing job application forms
- Establish the aim/purpose of a resume
- Explore characteristics of effective resumes, types of resumes, and principles of resume format
- Explore characteristics of and write an effective cover letter
- Explore, and participate in a role play of a typical job interview with commonly asked questions and demonstrate proper conduct
- Explore other employment related correspondence
- Explore the job market to identify employability skills expected by employer
- Conduct a self-analysis and compare with general employer expectations

SD 1720 ENTREPRENEURIAL AWARENESS

Description:

This fifteen-hour seminar is designed to introduce the student to the field of entrepreneurship, including the characteristics of the entrepreneur, the pros and cons of self-employment, and some of the steps involved in starting your own business.

Required Knowledge and Skills:

1. Explore Self-Employment: An Alternative to Employment
 - Identify the advantages and disadvantages of self-employment vs. regular employment
 - Differentiate between an entrepreneur and a small business owner
 - Evaluate present ideas about being in business

2. Explore the Characteristic of Entrepreneurs
 - Identify characteristics common to entrepreneurs
 - Relate their own personal characteristics with those of entrepreneurs.
 - Evaluate their present ideas about business people

3. Identifying Business Opportunities
 - Distinguish between an opportunity and an idea.
 - List the existing traditional and innovative business ventures in the region.
 - Explain the general parameters between which business ventures should fit.
 - Summarize the role of such agencies Regional Economic Development Boards, Business Development Corporations, etc.
 - Identify potential business opportunities within the region.

4. Demystifying the Entrepreneurial Process.
 - Explain the entrepreneurial process
 - Describe the purpose of a business plan
 - Identify the main ingredients of a business plan
 - Summarize the role of such agencies as BDC's, ACOA, Women's Enterprise Bureau etc.
 - List other agencies where assistance - financial and otherwise - is available to those interested in starting a business venture.