MINIMUM JOB STANDARDS AND SPECIFICATIONS FOR THE PRINCIPAL JOBS IN THE ELECTRICAL APPARATUS AND APPLIANCES INDUSTRY

電機工業
主要職務之工作標準與規格

November 1971
一九七一年十一月

Prepared by the Electrical Apparatus and Appliances Industrial Committee of the Industrial Training Advisory Committee
工業訓練諮詢委員會屬下之電機工業委員會編製

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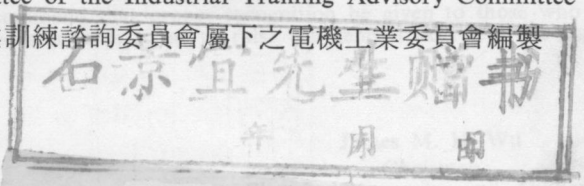

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FOREWORD

Hong Kong's electrical apparatus and appliances industry is moving gradually but inevitably into more sophisticated fields. In order to maintain its position in an increasingly competitive and discerning world, the industry would need to increase its productivity as well as to improve the design and quality of its products. This would in turn call for well-trained workers, both craftsmen and technicians, who are well-grounded not only in practice, but also in related theory.

In view of this, we have prepared job standards and specifications for the 17 principal jobs in the industry and put them together in this manual for the following purposes:—

(i) to establish generally acceptable standards of skill for the principal jobs in the electrical apparatus and appliances industry;

(ii) to provide guidelines for relevant technical courses at educational institutions or vocational training centres operated by Government, private organizations or voluntary agencies;

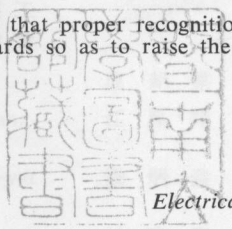
(iii) to help managements in the industry in preparing systematic and practical on-the-job training programmes;

(iv) to help managements in assessing the competence of the existing workers in a particular job; and

(v) to standardize the nomenclature already in use in the industry.

We have recommended that workers should be trained through a balanced programme of practical on-the-job training and technical education. We firmly believe that both elements of training are essential if the trained worker is to be adaptable to new needs arising from advancing technology.

Finally, we recommend that proper recognition be given to those who have attained the required standards so as to raise the general skill level of workers in the industry.



James M. H. Wu
Chairman
Electrical Apparatus and Appliances
Industrial Committee
of the
Industrial Training Advisory Committee

前　言

鑒於目前形勢，香港電機工業在技術方面必然漸趨精巧。處此競爭日烈之世界，本工業如欲保持其地位，必須增加生產力及改進產品之設計與品質。故對曾受良好訓練且在理論及實務方面均優之技術人員需求甚殷。

本委員會有見及此，特爲本工業之十七類主要工作製訂標準及規格，編成此册，以期達到下列目的：——

甲、 爲本工業各主要工作制定一廣泛接受之技能標準；

乙、 規定各項標準，以供政府，私人團體或志願機構所設立之院校或訓練所作爲編訂有關工藝課程之參考；

丙、 協助經理部門訂立廠內實務在職訓練課程；

丁、 協助經理部門甄別工人是否勝任該類工作；

戊、 劃一本行業現用之辭彙。

本委員會建議技術人員之訓練必須工藝教育與在職訓練均衡配合，蓋欲使曾受訓練之工人能適應日新月異科技所產生之需求，則理論與實務之訓練均不可或缺。

最後，吾人深盼凡已達所需標準之技術人員，其地位應獲承認，以冀提高電機工人之技能。

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電機工業委員會主席
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CONTENTS 目 錄

Job Title : Supervisor
工作類別：管理員

(I.L.O. Classification: 7-00.10 & 7-00.55)
國際勞工組織職業分類編號

Job Level : Technician 技能程度：技術員

Job Description : 工作簡述：

Supervises, inspects, plans and designs work; prepares job estimates; takes charge of installation and/or maintenance of complex equipment; organizes on-the-job training and gives lectures and demonstrations on training courses.

擔任管理，檢查，計劃及設計工作，擬就工作估計，主持較複雜設備之裝置或維修，組織在職訓練並兼任訓練班課程之講授及示範。

Trade Skill : 行業技能：

A. **Essential :**

In addition to all the skills listed in the job standard and specification for a foreman, both essential and desirable, a supervisor must have the ability to:—

1. Apply servicing procedures or in the case of production line or installation, techniques such as breakdown of operations (number of operators for a specific assembly requirement), sub-assembly operations required, inspection and test points necessary, efficient flow of materials, production aids (jigs and fixtures, lighting and general working conditions).
2. Keep adequate production records for checking output per machine per worker.
3. Discuss with relevant departments the problems caused by changes in design.
4. Recommend changes in layout in his department to effect improvement and saving.
5. Estimate and control financial expenditure by keeping and making use of cost records.

A. 必須具備之技能：

一個管理員除具有管工之工作標準及規格內所指定必須具備及宜兼備之各項技能外，尚要具有下列之技能：——

1. 運用保養工作程序或應用生產或安裝技術例如作業分析（即担任某項裝配工作所需之操作人數），所需之裝配操作程序，產品檢查及試驗，物料順利流動，及生產輔助裝備（例如夾具，燈光及工作環境等）。
2. 製作適當之生產記錄表以檢查每台機器及每一工人之工作成績。
3. 與有關部門討論因設計改變而產生之問題。
4. 提供改善所屬部門之排列方法以達成改善及節省開銷之目的。
5. 製作及應用成本記錄表以估計經費及節制開銷。

6. Organize planned preventive maintenance programmes for machines and equipment.

6. 編製各項機器及裝置之有系統預防及保養計劃。

7. Forecast manpower requirements for his department by calculating the total man-hours required from work schedules.

7. 根據工作計劃統計所需之工時總數以預測人力需求。

8. Determine training requirements.

8. 決定訓練需求。

9. Organize and conduct on-the-job training programme and give lectures to trainees or apprentices.

9. 負責制定及推行在職訓練課程並向練習生或學徒講授有關課程。

10. Effect liaison with the various operational departments and management.

10. 與各別操作部門及管理部門保持聯絡。

11. Delegate authority and responsibility.

11. 分派權力與工作。

12. Maintain good company image especially when dealing with customers.

12. 保持廠號之良好聲譽，尤與顧客商洽爲然。

B. **Desirable :**

Ability to carry out job evaluation in his department.

B. 希望兼備之技能：

能負責所屬部門內之工作評定。

Trade Theory : 行業理論：

Knowledge of:—

具有下述知識：——

1. All the trade theory listed in the job standard and specification for a foreman, both essential and desirable.

1. 具備管工之工作標準及規格內所指定必須具備及希望兼備之知識。

2. Job evaluation.

2. 工作評定法。

3. Time and motion study.

3. 時間及動作研究。

4. Work scheduling methods.

4. 策劃工作時間表之方法。

5. Quality control methods.

5. 品質管制方法。

Training : 訓練：

A. **Type :**

2-year on-the-job training in factories as an assistant supervisor with attendance at part-time day-release or evening courses in supervisory studies.

A. 種類：

受訓者需在廠內接受兩年助理管理員之在職訓練並修讀日間部份時間給假或夜間上課之管理學課程。

B. **Entry Requirements :**

1. Age: Minimum 21 years.

2. Qualification and aptitude: Either

   (A) (i) Completion of an organized technician apprenticeship plus at least 2 years post apprenticeship experience.

   (ii) Possession of at least a higher certificate in a relevant branch of engineering.

   (iii) Leadership.

   or

   (B) (i) Completion of an organized craft apprenticeship plus at least 5 years post apprenticeship experience.

   (ii) Possession of a craft certificate in the field of work for which he is responsible and has attended further up-grading courses including supervisory courses.

   (iii) Leadership.

3. Physical: Normal physique and eyesight.

B. 入訓資格：

1. 年齡： 最低二十一歲。

2. 學歷與志趣： 須具有下列兩項資格之一：

   甲項 (i) 曾受有組織之技術員學徒訓練，並具有訓練後兩年以上之工作經驗。

   (ii) 持有與工程學科有關之高級証書。

   (iii) 具有領導才能。

   或

   乙項 (i) 曾受有組織之技工學徒訓練並具有訓練後五年以上之工作經驗。

   (ii) 持有與其負責工作有關之技工證書，並曾修讀進修課程，包括管理學課程。

   (iii) 具有領導才能。

3. 體格： 體格及視力正常。

Job Title: Electrical Engineering Technician (I.L.O. Classification: 0-34.05)
工作類別：電機工程技術員 國際勞工組織職業分類編號

Job Level: Technician 技能程度：技術員

Job Description: 工作簡述：

Performs technical tasks contributory to design, development, manufacturing, installation, maintenance and repair of electrical systems and equipment either independently or under the direction and supervision of an electrical engineer.

單獨或在電機工程師指導及監督下擔任技術性工作，如從事設計，發展，製造，安裝，保養及修理電器系統與設備。

Trade Skill: 行業技能：

A. **Essential:**

Ability to:—

1. Set up and conduct experiments, make tests, take readings, adjust instruments, record observations and otherwise assist in research and development work concerning electric power generation and distribution equipment, industrial, domestic and other electrical equipment and appliances.
2. Carry out simple design according to given specifications.
3. Prepare detailed estimates of quantities and costs of materials and labour required for manufacture and installation of electrical equipment and prepare work schedules.
4. Prepare electrical and mechanical drawings including layouts and circuit diagrams.
5. Exercise technical supervision and control, and give technical guidance to workers engaged in manufacture, installation, repair and maintenance of electrical equipment.

A. 必須具備之技能：

能：——

1. 準備及進行實驗，測試，記錄測試結果，校準儀器，記錄實驗觀察所得，並協助進行關於發電配電裝備，供工業上及家庭使用之其他電力設備及電器用具之研究與發展工作。
2. 就指定之規格從事簡單之設計。
3. 根據製作及安裝電力設備之需求，詳細估計工料之數量及成本及人力之需要，並製備工作時間表。
4. 製作電力及機械繪圖包括設計圖與線路圖。
5. 對從事製作，安裝，修理與保養電力設備之工人，予以技術上之指導，監督及管制。

6. Inspect and test completed work to ensure compliance with specifications and safety standards; inspect and regulate the functioning of installed electrical plant employed for power generation, manufacturing processes, or other purposes.

6. 檢查與測試已完成之工件，以確保能符合指定規格與安全標準，負責檢查及調節爲發電製作過程或其他用途而裝設之電器設備。

7. Check and calibrate instruments and meters; maintain, repair and diagnose faults in electrical machinery, etc.

7. 核對及校準儀器與電錶，保養，修理及檢查電動機器之毛病所在。

8. Apply knowledge of electrical engineering to identify and solve problems.

8. 運用電機工程知識以識別及解決難題。

9. Carry out simple machining operations on lathes, milling machines, grinders etc. as well as simple welding operation.

9. 使用車床，銑床，磨床進行簡單之切削及銲接工作。

B. **Desirable :**

Ability to install and use electronics equipment.

B. 希望兼備之技能：

能安裝及使用電子設備。

Trade Theory :

Knowledge of :—

1. **Basic Electricity :**
   (i) Electrostatics, electromagnetism, electrolysis.
   (ii) Direct and alternating currents; voltage, amperes, resistance, inductance, capacitance, reactance, impedance; Ohm's Law.

2. **Circuits :**
   a.c. and d.c. circuits and network theorems; power and power factors, power factor correction; single and multiphase circuits, star and delta connections.

3. **Measurements :**
   Moving-coil and moving-iron instruments for a.c. and d.c. use; dynamometers, wattmeters; instrument calibration; power measurement in single and polyphase circuits; use of current and potential transformers and resulting errors; VA burden on current transformers.

行業理論：

具有下述知識：——

1. 基本電學：
   (i) 靜電學，電磁學，電解。
   (ii) 直流電及交流電，電壓，安培，電阻，電感應，電容，電抗，阻抗，歐姆定律。

2. 線路：
   交流電，直流電線路及電路網之定理，功率及功率因數，功率因數之校正法，單相及多相電路，星及三角聯接。

3. 量度法：
   交流電及直流電使用之動線圈，與電磁式測量儀器，測力表，瓦特表，儀器之校準，單相及多相電路之功率量度法。變流器及變壓器之使用法，與此等儀器可能產生之錯誤，變流器之伏安負荷量。

4. **d.c. machines :**

d.c. motors and generators; shunt and series, their construction, characteristics and uses; losses and efficiency, parallel operation.

5. **a.c. machines :**

(i) **Synchronous :**

Generators and their construction; parallel operation, load and power factor and effect of: motor operation, maximum torque condition, starting, hunting.

(ii) **Induction :**

Single and multi-phase motors, characteristics and control of motors (starting and speed); synchronous induction motors; induction generator; induction regulators.

(iii) **Other Machines :**

3-phase commutator motors, Selsyns, cross field generators.

6. **Transformers :**

Single and multi-phase, parallel operation of single phase transformers; effect of power factor and conditions for maximum efficiency; auto transformers and instrument transformers.

7. **Supply :**

Generation, transmission and distribution of electrical power, power supply systems; protective systems.

8. **Industrial Electronics :**

Knowledge and applications of: C.R. oscilloscopes, amplifiers and oscillators, high frequency amplifiers, photo-electric equipment, etc.

9. **Basic Electronics :**

Thermionics; vacuum tubes and their characteristics; gas-filled valves and their characteristics, mercury arc rectifiers; semi-conductors and their characteristics, transistors.

4. 直流電機器：

直流電動機及發電機，分流器及串聯之構造，特性與用途，電能損失與功率，並行操作。

5. 交流電機器：

(i) 同步機：

發電機及其構造，並行操作，負載因數與功率因數及電動機操作，最大扭矩狀態，起動及擺動之影響。

(ii) 電感應：

單相及多相發動機，發動機之特性與控制（起動及速率），同步感應發動機，感應發電機，感應調節器。

(iii) 其他機器：

三相整流子發動機，自動同步機，交义磁場發電機。

6. 變壓器：

單相及多相系統，單相變壓器之平行操作，功率因數之影響，最大効率之條件，單圈變壓器及儀器變壓器。

7. 電力供應：

發電，輸電及配電，電力供應系統，保險系統裝置。

8. 工業用電子學：

對下述儀器有所認識並知悉其使用法，陰極射綫示波器，放大器及振盪器，高頻放大器，光電設備等。

9. 基本電子學：

熱電子，電子管及其特性，充氣電子管及其特性，汞氣整流器，半導體及其特性，晶體管。

Applications of electronics devices; simple valves and semiconductor circuits.

10. **Mathematics :**

(i) Algebra: Series of different functions (trigonometric, logarithmic, exponential), Fourier Series, complex numbers, De-Moivre's theorem, determinants.

(ii) Calculus: Integration, ordinary and partial differentiation, ordinary differential equations applied to circuitry.

(iii) Trigonometry and co-ordinate geometry.

11. **Engineering Science :**

(i) Applied mechanics.

(ii) Basic thermodynamics.

電子設置之使用，普通之電子管及半導體線路。

10. 數學：

(i) 代數：各種函數（三角，對數，指數），付里時級數，複數，De-Moivre's 定理，行列比。

(ii) 微積分：積分，常微分及偏微分，應用於電路學之常微分方程式。

(iii) 三角法及解析幾何學。

11. 工程學：

(i) 應用力學。

(ii) 基本熱力學。

Training : 訓練：

A. **Type :**

4-year organized technician apprenticeship with attendance at a part-time day-release or block release course in an institution of technical education leading to the ordinary and higher certificate in electrical engineering.

B. **Entry Requirements:**

1. Age: Minimum 17 years.

2. Minimum Education: Completion of Form 5 in the science stream, preferably in a secondary technical school.

3. Physical: Normal physique and eyesight.

A. 種類：

四年有組織之技術員學徒訓練，並於受訓期間在技術教育學院修習一項日間部份時間給假或整段時間給假上課之課程，以備考取初級及高級程度之電機工程證書。

B. 入訓資格：

1. 年齡： 最低十七歲。

2. 最低教育程度： 修畢中學五年級之理科生，若工業中學畢業者則更佳。

3. 體格： 體格及視力正常。

(I.L.O. Classification: 0-34.05 & 8-59.20)
國際勞工組織職業分類編號

Job Title: Electrical Instrument and Meter Technician
工作類別： 電機儀器技術員

Job Level: Technician 技能程度： 技術員

Job Description: 工作簡述：

Fits, assembles, services, repairs, tests and calibrates various electrical meters and instruments.

裝配，組合，保養，修理，測試及校準各種電錶及電機儀器。

Trade Skill: 行業技能：

A. **Essential:**

Ability to:—

1. Inspect, maintain, repair and calibrate indicating and recording instruments.
2. Inspect electrical and mechanical equipment.
3. Determine testing constants, etc.
4. Prepare instruments for service.
5. Check instrument and clock mechanisms.
6. Read and interpret instrument charts.
7. Dismantle and re-assemble meter components and align rotor discs.
8. Inspect, clean and lubricate meter registers; (Ultrasonic cleaning).
9. Inspect top and bottom pivots.
10. Inspect bottom jewel bearings using microscopes.
11. Maintain polyphase meters—Wattmetric elements to be balanced on F.L. unity P.F. and 0.5 lag P.F.
12. Check and adjust performance curves throughout the full load ranges.
13. Conduct dial tests on meters.

A. 必須具備之技能：

能：——

1. 檢查，保養，修理及校準指示器及記錄儀器。
2. 檢查電力及機械設備。
3. 決定計算測試常數等。
4. 製備保養儀器。
5. 核對儀器及表計結構。
6. 閱讀及理解儀器圖表。
7. 拆開及重裝電表配件及校準動子盤。
8. 檢查，潔淨及潤滑（超音波潔淨法）電表記錄器。
9. 檢驗頂樞軸及底樞軸。
10. 運用顯微鏡從事檢驗底部寶石軸承。
11. 保養多相式電表——運用全負載功率因數及 0.5 滯後功率因數以保持瓦特計元件之平衡。
12. 核對及調節全負載範圍之性能曲線。
13. 從事測試電表度盤工作。

14. Check meters on starting and minimum running loads.

15. Check meters on shunt running.

16. Prepare test chits for insertion in meter.

17. Use small hand tools and instruments such as non-magnetic tweezers, small screw drivers, pointer extractors, transformer soldering iron, sharp nose and angular pliers, B.A. spanners and standard electrical meters.

18. Make and read metering wiring diagrams.

B. **Desirable :**

Ability to :—

1. Perform flash and continuity tests on electrical components.

2. Re-draw instrument scales and re-calibrate change of current and voltage ratios.

3. Work out meter testing constants for single phase, M.V. metering and maximum demand metering.

4. Make quadrature adjustment of P.F. compensating band—single phase meter.

5. Check and prepare instruments and meters for service.

6. Test relays to settings.

7. Standardize A.L. class instruments, voltmeters, ammeters and wattmeters.

8. Check stopwatches against master clock.

9. Test current and voltage transformers for ratio and phase angles.

10. Use micro-lathe for burnishing instrument spindles.

11. Use microscopes for inspection of instrument jewel bearings.

14. 核對電表之開動及最低運轉負荷。

15. 核對電表之分流運轉。

16. 製備測試記錄以插入電表中。

17. 運用小型手工具及儀器，包括非磁性鉗，小型螺絲批，指針抽取器，變壓器錫銲鐵，尖咀鋼絲鉗，角鋼絲鉗，英國協會扳手與標準電表。

18. 製作及閱讀電表接線圖。

B. 希望兼備之技能：

能：——

1. 從事電器配件之引火點及連續性試驗。

2. 重繪儀器比例尺度及重行校準電流與電壓比率之轉變。

3. 從事計算單相電表測試常數，高電壓測量及最高需要之測量。

4. 從事單相電表功率因數補償波段正交調節之工作。

5. 檢查及預備修理儀器及電表。

6. 測試裝置件之繼電器。

7. 製作標準 A.L. 類儀器，電壓表，電流表，及瓦特表。

8. 運用總鐘表從事核對立止表。

9. 測試電流及變壓器之比率及相角。

10. 運用微動車床從事拋光儀器心軸之工作。

11. 使用顯微鏡檢查器具之寶石軸承。

12. Use stroboscopic equipment for testing of kilowatt-hour meters.

13. Use sub-standard frequency meters for checking synchroscope and frequency meters.

12. 運用頻閃觀測設備測試千瓦特電表。

13. 使用輔標準波長表進行核對同步指示儀及波長表。

Trade Theory:

Knowledge of:—

1. Fundamental theory of electricity (e.g. City and Guild Electrical Technician's course).

2. Theory of electrical instruments, meters, various types of relays and laboratory standardizing equipment.

3. Vectors, useful trigonometrical identities and the use of slide rules.

4. Engineering drawing.

5. Power factor correction relevant to KVA meters.

6. Basic electronics.

7. Safety precautions including prevention of injury to person or damage to property.

8. Public relations in dealing with customers.

行業理論：

具有下述知識：——

1. 電學之基本理論（例如倫敦城市工聯學院之電機技術員課程）。

2. 電機儀器，電表，各種繼電器及實驗室較準設備等之理論。

3. 向量，實用之三角恒等式及計算尺之使用法。

4. 工程繪圖。

5. 與千伏安電表有關之功率因數校正法。

6. 基本電子學。

7. 安全措施，包括防止人體受傷及器材損毀。

8. 招待顧客之公共關係。

Training:

A. **Type:**

Stream 1:

4-year organized technician apprenticeship with attendance at a relevant part-time day-release, block release or evening technician course in an institution of technical education.

Stream 2:

2-year practical on-the-job training.

訓練：

A. 種類：

第一類：

四年有組織之技術員學徒訓練，並於受訓期間在技術教育學院修習一項日間部份時間給假，整段時間給假或夜間上課之有關技術員課程。

第二類：

兩年之實務在職訓練。

B. **Entry Requirements :**

Stream 1 :

1. Age: Minimum 17 years.
2. Minimum Education: Completion of Form V in the science stream, preferably in a secondary technical school.
3. Physical: Normal physique and eyesight.

Stream 2 :

1. Age: Minimum 19 years.
2. Minimum Education: Possession of an ordinary diploma in electrical engineering.
3. Physical: Normal physique and eyesight.

B. 入訓資格：

第一類：

1. 年齡： 最低十七歲。
2. 最低教育程度： 修畢中學五年級之理科生，若工業中學畢業者則更佳。
3. 體格： 體格及視力正常。

第二類：

1. 年齡： 最低十九歲。
2. 最低教育程度： 持有電機工程普通文憑。
3. 體格： 體格及視力正常。