

A GUIDE  
TO GOOD  
ENGINEERING PRACTICE  
FOR  
M&E ENGINEERS

LEMBAGA  
JURUTERA



BOARD OF  
ENGINEERS

M A L A Y S I A

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## **SUMMARY OF GUIDE**

### **A) Introduction**

The need for a proper guide to good practice in Mechanical and Electrical (M&E) engineering discipline has become a necessity due to the rapid pace and wide extent of Malaysia's national development over the past decades and the foreseeable future. These advanced developments have resulted in extensive increase in the content and importance of M&E engineering systems and installations. In tandem with increasing M&E prominence, public awareness and expectation for proper performance of the M&E sector have also risen, but unfortunately, so has the opportunities to abuse in the implementation of M&E services from both within and outside the M&E sector.

When dealing with the M&E sector, it is inevitable that practising M&E engineers (i.e. those engineers offering consultancy services) will be at the forefront of any scrutiny. The action of others not registered as consulting M&E engineers will seldom be questioned since their level of performance will normally not be expected to be that of practising M&E consulting engineers. On the other hand, strict and faithful adherence to the code of ethics and code of professional conduct are expected of practising M&E consulting engineers in their field of expertise to safeguard the interest of the public. Such an expectation is regularly reflected in complaints received by the Board of Engineers.

The objective of this guide is to expand on and show how the code of professional conduct should apply to M&E engineers (both consulting and other registered M&E engineers) to achieve good engineering practice. The flip side of the coin relating to complaints of unfair or non-ethical practices of practising consulting engineers by the general public (especially the owners), will be separately addressed, to give a balanced view of engineering as a noble profession in the care of the Board of Engineers.

This guide is intended to address all aspects of the work and duties of M&E engineers that have a direct impact on the industry. This guide covers aspects ranging from demonstrating good engineering practice to professionalism at the various stages of work as listed in the following pages.

### **B) Procurement**

Procurement encompasses preparation of proper technical specifications; conditions of contract; and implementation schedule. The procurement process should involve adopting proper methodology for selection of suitable tenderers in terms of capability, capacity and experience - more commonly termed QBS (Quality Based Selection); and establishing proper criteria for evaluating tenders. Also addressed are the frequent complaints of unreasonably high tendering fees and delayed refunds.

### **C) Contract Administration**

Contract administration deals with the need for well-prepared contract documentation complete with design and interfacing details. Appropriate plans and procedures to ensure better and smoother contract execution are also covered together with adoption of systematic and simple

reporting formats. Timely certification of progress claims, change orders and extension of time approval are addressed. Issues that may serve to compromise good engineering practice at this stage of project implementation are discussed and the need for conformance enforcement highlighted.

#### **D) Certificate of Practical Completion / Closing of Accounts**

Timely issuance of documentation supporting the issuance of Certificate of Practical Completion (CPC) should be the norm.

This certification of payment should take into account the remedial work yet to be carried out so that there remains a sufficient sum withheld with any retention money. In conjunction with this completion stage, M&E consulting engineers are urged to initiate action with other associated parties involved, especially the prevalent abuse by Main Contractors of arbitrarily imposing charges on M&E trade contractors for items such as clearing of site debris, water and electricity charges, site security charges, and toilet facilities charges etc., which if left unchecked, will affect the performance of M&E trade contractors and ultimately the quality of installations thereby jeopardizing good engineering practice.

#### **E) Installation Drawings & Training**

The purpose of Installation Shop drawings, As-Built drawings, Operation & Maintenance Manuals and Testing & Commissioning records is explained together with the rationale for their endorsement or otherwise by Professional Engineers.

#### **F) Preferential Engineering**

The abuse of preferential engineering and overseas factory visits that are deemed as unproductive are highlighted. Good engineering practice dictates that engineers should educate and discourage owner's representatives from such exploits.

#### **G) Continuing Professional Development**

Continuing Professional Development programmes should be pursued by all M&E engineers to keep abreast of updated technologies when specifying or purchasing products, and designing systems.

#### **Conclusion**

It is hoped that this guide to good engineering practice, will enhance better understanding and practice of M&E engineering services to meet the exacting challenges of the future.

## **1.0 Introduction**

### **1.1 Background Issues**

In February 2002, an engineer from a contracting firm wrote to the Board of Engineers Malaysia (BEM) to seek clarification of the principles governing the need for Contractor's Professional Engineer (PE) to endorse Mechanical & Electrical (M&E) shop drawings, manufacturer's design drawings as well as as-built drawings.

The enquiry arose as a result of a dispute within a particular development project where some consultants insisted on contractor's PE endorsement whereas others did not.

The Professional Practice Committee (PPC) of the Board of Engineers (BEM) responded to the enquiry as follows:

"As the person who submits the certificate of completion is fully responsible for the completed works, it is not unreasonable for him to want to be assured that components of the works have been properly carried out. The degree of assurance will naturally depend on the nature of the component in question and will also vary from submitting person to submitting person. It is thus up to his discretion whether or not to want the endorsement of a Professional Engineer in whatever way or form he thinks fit; and hence this is a contractual matter between him and the provider of the component service.

It would be prudent for the submitting person to have the public safety aspect of the completed works well in mind in exercising his discretion in the discharge of his duties".

Apart from this particular enquiry, other enquiries and/or complaints of a similar nature relating to the question of 'good engineering practice' had been received over the years. This included a memorandum on 'General observation and recommendation' by an Investigating Committee of the BEM's PPC after concluding their investigation into the conduct of a consulting practice on a project design and supervision failure.

### **1.2 Objective of BEM's Guide to Good Practice**

The BEM subsequently directed the PPC to form a Working Group to come up with a guide to "Good Engineering Practice for M&E Engineers" to cover all areas relating to the practice of M&E engineering.

## **2.0 Procurement**

### **2.1 Introduction**

Procurement involves the process of planning, tender, evaluation and award of contracts to secure products and services normally from outside the owner's organization. The extent and method of procurement differ depending on the nature and scale of the project. Different types of contracts are appropriate for different types of procurement. Contracts generally fall into one of the following four broad categories:

- a. Fixed price or lump-sum contracts
- b. Cost reimbursable contracts

- c. Unit price contracts
- d. Cost plus contracts

In this Guide, only fixed price or lump-sum contracts are discussed, as they are commonly used in M&E contracts. This Guide will only touch on the more complex procurements involving tenders. Small procurements involving simple requisitions are excluded.

## 2.2 Procurement Planning

Procurement planning is the process of identifying project needs, method of procurement and timing of procurement.

### 2.2.1 Problems

Potential problems normally encountered as a result of this initial phase of procurement are:

- a) Ill-prepared specification with incomplete design, contradictory design or ambiguous design giving rise to disputes and demands from both the employer and contractors.
- b) Using the wrong type of contract to carry out the works, for example;
  - An installation contract in which the supply of materials and equipment is by the main contractor who then sublets to many different parties without proper and appropriate coordination. Also a turnkey contract in which the main contractor procures materials and equipment from fabricators, manufacturers and suppliers and then providing them on free-issue basis to a sub-contractor who in turn sub-contracts out various erection packages.  
  
Problems encountered here will include late delivery; incomplete delivery; dimensional problems resulting in fitting-up problems; difficult resource planning due to inconsistent and unpredictable deliveries as well as insufficient guidelines on the scope of work.
  - Design and build contract without proper definitions and terms of reference with interference from employer or his representatives. The general design concept is often subject to disputes with different interpretations at various stages, which are made worst by change of personnel during project implementation.
- c) Reduced time for actual physical implementation as a result of poor planning.

### 2.2.2 Recommended solutions to the problems:

- a) Specification  
All project requirements should be considered and the design should be complete based on relevant applicable standards. Effort should be made to avoid ambiguities and the subsequent need to interpret (guess) the design intent.
- b) Contract conditions  
Due consideration should be given to appropriate selection of the type of contract suited to the requirements of the organizational resources available in,

and commitments to the project so that the levels of responsibility and supervision are properly defined in the hierarchy of project works.

- c) Implementation time  
Good planning, taking into account all factors and requirements including finance, authorities, work sequences, deliveries of long lead items, etc. are essential.

## 2.3 Tender

The tender exercise involves listing of prospective tenderers, pre-qualification, shortlisting and evaluation of bids and proposals from tenderers.

Generally, there are two kinds of tender viz. open tender and closed tender. The former involves placing advertisements in general circulation publications such as newspapers. Closed tender is based on tendering by invitations extended by the employer through his/her consultant.

### 2.3.1 Problems

Problems encountered in the industry are:

- a) Levy of high tender document fee (especially where fees are non-refundable).
- b) Late return of returning tender bond or earnest money to unsuccessful tenderers.
- c) Insistence on certain format of tender bond that most tenderers cannot comply with.
- d) Unrealistically short tender period that does not give sufficient time for tenderers to obtain quotation for indent items, etc.
- e) Lack of guideline on tender validity period which is often extended.
- f) High expenses and man-hours incurred in the preparation of design and tender documents.
- g) No fixed time for the refund of documentation fee after project has been awarded.
- h) Tender documentation fees not refunded for frivolous reasons including documents not returned in proper condition.

### 2.3.2 Recommended solutions to the problems:

- a) Computation of Documentation fee

Suggested charges are as follows:

Document – hard copy

Size	B & W prints on paper per sheet/copy (RM)
A4	0.30 to 0.40
A3	0.50 to 0.60
A2	2.00 to 4.00
A1	9.00 to 10.00
A0	18.00 to 20.00

Document – soft copy

In any form	RM100.00 to RM500.00 each
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i) Closed Tender

For a Closed Tender i.e. where the number of invited tenderers are known, the Tender documentation fee should preferably be paid by the Owner and hence, be a fully refundable Tender document fee computed to include the cost of all tender documents and contract documents, for which only the successful tenderer's Tender Documentation fee is not refundable as this will be utilised to defray the cost of the tender exercise. There is also no need for the unsuccessful tenderers to return tender drawings which would inevitable be marked or defaced.

ii) Open Tender

For an Open Tender i.e. where the number of tenderers is unknown, the Tender documentation fee should preferably consist of two (2) parts, namely;

- 1) A non-refundable tender document fee which is computed to defray the cost of producing the document for one tenderer, and
- 2) A fully refundable Tender Document fee which is computed to defray cost to produce contract documents for the successful tenderer. Only the successful tenderer's fee for this part is not refundable. There is also no need for the unsuccessful tenderers to return tender drawings.

b) Tender bond

Tender bond or earnest money should not be retained beyond the tender validity period which should be defined. The earnest money should be a fixed round figure based on 2% of estimated tender sum and subject to a maximum amount of RM 10,000.00.

c) Format of bonds

The format of tender bond and other bonds for construction projects should be standardized and acceptable to the industry and financial institutions.

d) Tender period

A reasonable tender period that allows time to obtain quotations especially of indent items and a longer tender period should be allowed if the tender exercise involves international tenderers.

e) Tender validity period

The tender validity period should be defined. A period of 90 days is reasonable.

f) Design and build

Design and build tender for a project should only be called after confirmation of a definite and acceptable execution plan in order to minimize wasteful effort and resources. Tenderers should be properly guided with a well-documented design brief and proper design concept with provision for pre-tender clarification meeting(s) and site visit so that there is no unnecessary wasted effort.

g) To return tender documentation fee to unsuccessful tenderers within 14 working days after award of tender.

## 2.4 Source selection

2.4.1 Source selection is the process of receiving and evaluation of bids or proposals based on the procurement documents.

Inputs for source selection are:

- a) A 2-envelope system where technical and financial proposals are evaluated separately.
- b) Evaluation criteria covering system price, unit price, compliance, overall or life cycle cost, technical capability, financial capability, management approach, maintenance considerations, etc.
- c) Employer's organizational policies - his formal or informal policy may affect the evaluation of proposals.

2.4.2 Tools and techniques for source selection are:

a) Contract negotiation

Contract negotiation involves clarification and conformance to the structure and requirements set out in the procurement documents.

b) Weightage system

A weightage system may be adopted for quantifying qualitative data in order to minimize the effect of personal prejudice on source selection.

c) Screening system

A screening system may be adopted to establish minimum requirements on performance for one or more of the evaluation criteria. This method is used in the two (2) envelope system with technical and financial submissions.

d) Independent estimates

The consultant's estimates should be used as a check on the tendered pricing. Significant differences from these estimates may be an indication of inadequacies or deficiencies in the tender offers.

2.4.3 Problems in this phase of the procurement exercise are:

- a) Preconceived criterion for lowest price.
- b) Lack of understanding and instructions in the submission of the two (2) envelope system with technical and financial submissions.
- c) Tender interviews requiring on-the-spot confirmation of prices, which can give an unfair advantage to the last tenderer to be interviewed.
- d) Alternate proposals that require impartial evaluation.

2.4.4 Recommended solutions to the above-mentioned problems are the following:

- a) Criteria for selection  
Price alone should not be the criterion of selection. Emphasis on lowest pricing in the evaluation and selection process can lead to problematic contract execution and disputes. Technical offer and capability, and some sort of peer recognition (e.g. accreditation, etc.) should be given due considerations.
- b) Two envelope system  
Clear instructions to tenderers and adherence to evaluation procedures should be made known to all concerned as these are important in the two (2) envelope system.
- c) Confirmation of prices  
Confirmation of tender prices after tender interviews must always be made in writing in strict confidence (instead of verbal confirmation) in order to avoid later manipulation to gain unfair advantage.
- d) Alternate proposals  
Tender evaluation should be based on the original tender specification. The evaluation of alternate proposals requires additional effort and comparison on like-for-like basis. Their merits, where applicable, should be considered as supplementary to the original tender evaluation.

### **3.0 Contract Administration**

#### **3.1 Introduction**

Contract administration is the process of administering the contractor's work execution and ensuring that performance meets contractual requirements. A key aspect of contract administration is managing the interfaces between the various service providers and parties involved in the project. In addition to its technical roles, it is also imperative that the project team be conscientiously aware of the legal implications and possible interpretations of its administration of the contract.

#### **3.2 Elements of Contract Administration**

Contract administration involves application of appropriate project management processes to contractual relationship(s) and integration of outputs from these processes into the overall management of the project.

This integration and coordination will occur at multiple levels when there are multiple service providers.

The basic elements of properly administered contracts are:

a) **Contract document**

A properly prepared contract document is a prerequisite to contract administration.

The contract document is an important document binding an agreement between employer and contractor who is obligated to perform under the terms and conditions of the contract. It is equally important that the employer fulfils his role and obligations as defined in the contract document.

Contract administration involves interpretation and execution in accordance with the contract document.

b) **Project plan execution**

The project manager and his project management team must ensure that a well-coordinated plan is in place. They must regularly review, coordinate and direct the various technical and organizational interfaces in the project.

A properly coordinated plan will permit the contractor to concentrate on performing his work at appropriate times acceptable to all other concerned parties.

c) **Project communication**

Miscommunication or lack of communication is often the cause of contractual problems.

Project communication in the form of meetings, correspondence, memorandum, instruction and confirmation of decisions in writing is absolutely necessary in contract administration.

- d) **Performance reporting**  
Performance reporting is necessary to monitor contract cost, progress and technical performance. It involves collecting and disseminating performance information on how resources are being used to achieve project objectives. Performance reporting should comprise:
- Status reporting - describing the status of the contract
  - Progress reporting - describing what the contract has accomplished
  - Forecasting - showing the trend and predicting future status and progress
- e) **Quality control**  
Quality control is important in verifying that all works comply with contract specifications and relevant quality standards.
- f) **Change control**  
Change control procedure must be established and adhered to in order to ensure that changes are properly approved by authorized personnel.
- Timing of change order settlements should also be established and agreed upon in order to avoid unnecessary disputes and delays, which are unfair to the parties having to carry out the change order work under contractual obligations.
- g) **Payment system**  
Payment system should be defined in the contract document. Payment certification and payments should be made in accordance with the system defined in the contract document.
- h) **Extension of time**  
An important aspect of contract administration is the review, recommendation and decision on extension of time.
- A complex project involves many levels of work processes and parties or personnel. An impartial review carried out by an independent party, viz. the project consultant will be prudent in recommending extension of time on a fair basis.
- All contractual matters, changes, additional requirements, authority requirements and other factors affecting the work programme must be taken into account.
- If no extension of time is granted then it is imperative that a Certificate of Non Completion must be issued for the contract in question to facilitate any LAD to be claimed by the Employer.

### **3.3 Industry Practices**

Problems encountered in the industry are as appended below.

### 3.3.1 Contract document

- a. Lack of definitions and details of inputs, outputs and interfaces resulting in additional costs which in turn pose problems in contract administration.
- b. General conditions of contract are not made known to contractors during tender or quotation stage.

For turnkey or design and build jobs, contractors are often provided with technical or design brief only for price estimate purposes. Detailed requirements and contract conditions are made known only when contracts are awarded or about to be awarded.

#### 3.3.1.1 Recommended solutions to the problems:

- a) A well-prepared contract document complete with design and interfacing details must be provided.
- b) Enquiry documents should be complete with all requirements and conditions.

### 3.3.2 Project plan execution

- a) A project without a properly coordinated plan covering owner's requirements, authorities' requirements, interior design (ID) requirements, interfaces, etc. will affect all inter-related works and services in the project.
- b) Too many or too few project/contract programme reviews and too much or too little interference or lack of interference can have counter-productive results.

Only appropriate action depending on the significance or complexity of works should be taken.

#### 3.3.2.1 Recommended solutions to the problems:

- a) Project planning taking into account all requirements, resource allocation specially project management and supervisory resources, is necessary.
- b) Project reviews with appropriate action plans and delegation of authorities amongst team members will ensure better and smoother contract execution.

### 3.3.3 Project communication

- a) Contract administration involves a lot of communication but unfortunately, a lot of communication is verbal. Written communication is often not practised.
- b) Written communication is deemed to be a burden especially to small-scale contractors.
- c) Written communication is sometimes deemed to be a rude and offensive behaviour in the local culture.

3.3.3.1 Recommended solution to above-mentioned problem:

- a) Written communication especially following verbal discussions and requests should be practised.

3.3.4 Performance reporting

Performance reporting is deemed to be a burden in small contracts as it involves an additional process and hence, additional resources.

3.3.4.1 Recommended solution to the problem:

- a) Basic reporting under certain format can be developed and used with ease.

3.3.5 Quality control and milestone certification

- a) There is a lack of quality control especially in areas where Malaysian Standards are available because of poor enforcement.
- b) Severe price competition has affected the quality of products and services.
- c) M&E systems have many phases of works that require recognition and certification of their physical completion.

3.3.5.1 Recommended solutions to the problems:

- a) The development of Malaysian Standards and conformance enforcement should be promoted.
- b) It should be recognized that price war is detrimental to the industry and the achievement of good engineering practice.
- c) Recognition of milestone events and their completion after satisfying certain criteria should be established.

3.3.6 Change control

- a) There is a lack of consistency as well as adherence to change control procedures resulting in many disputes in payment settlement.
- b) Payments for works on change orders do not follow the normal time for contract certification and payment, and often take a long time to settle.

It is common practice among paymasters to delay the settlement of change orders until a contract close-out.

3.3.6.1 Recommended solutions to the problems:

- a) Change control procedure and authorization need to be taken seriously, properly established and observed by all parties concerned.

- b) Change orders duly authorized and executed should be paid promptly instead of delaying until contract close-out.
- c) A "Pay-when-paid" clause in contract document has a detrimental chain effect and has hurt the M&E industry. Its practice is now outlawed under the Construction Industry Payment and Adjudication Act 2012 (Act 746) (CIPAA) where such clauses are null and void even if they are inserted in the contract document.

### 3.3.7 Payment systems

- a) "Turn-around" time in payments for some projects can be unreasonably long and can vary from 90 to more than 120 days in some instances. Some organizations have long payment certification processes.
- b) Payment to M&E contractors is subject to further processing by main contractors for NSC contracts.
- c) Amount of retention sum varies but is commonly 10% subject to a limit of 5% of contract sum. The 5% retention sum is normally held back for six months and is partially released with 2 ½% being retained for a further 6 months.

This arrangement changes with extended period of defects and liabilities.

#### 3.3.7.1 Recommended solution to the problems:

- a) A reasonable "turn-around" time for payment certification and issuance of payments should not exceed 45 days from the date of submission or 30 days from the date of S.O.'s certification, whichever comes first.
- b) In order to avoid unnecessary delay, payment to NSC M&E contractors should be encouraged to be effected directly by the employers after the acknowledgement of satisfactory completion of the work by the main contractor's authorized personnel.
- c) The maximum period for withholding payment of retention money should be strictly 12 months from the date of practical completion, irrespective of whether the defects liability period is extended beyond the 12 month period or not.

## 4.0 Certificate of Practical Completion / Closing of Account

### 4.1 Introduction

The practice in the construction industry is such that when the whole work is substantially completed and any remaining incomplete work or defects in the work are deemed to be of a minor nature by the Superintending Officer (SO), and provided that the main Contractor is required contractually to give, or has given a written undertaking to complete the remaining minor works within a specified time (and all documentation, staff training, operation and maintenance manuals as well as as-built

drawings have been complied in accordance with the contract), the SO will issue a Certificate of Practical Completion (CPC) upon the Contractor's application in writing.

In the context of M & E work, M & E trade contractors do not get an explicit CPC from the SO although the process of obtaining CPC by the Contractor requires their inputs and full cooperation. The notification of successful CPC in writing often depends on the main Contractor. For domestic contracts, the notice of successful CPC can be slow in coming or is given low priority. The delay in obtaining CPC can be due to there being still outstanding variation on Interior Designer's works to be carried out, which are beyond the control of M & E sub-contractors.

## 4.2 Post CPC

The defects liability period which commences upon the issuance of CPC requires the M & E sub-contractors to make good all defects in accordance with the schedule of defects as advised by the main Contractor for domestic contracts and by the consulting engineers for NSC contracts. Upon completion, these remedial works are inspected and tested.

Problems encountered in this phase of the contract are:

- a) The commencement of equipment warranties does not coincide with the date of CPC. This problem is further compounded when there is earlier partial possession by the Employer.
- b) Sub-contractors are reluctant to make good defective items due to non-payment by Employer or main contractor.
- c) M & E sub-contractors often find the rectification of defective items a long and tedious process. In the preparation for obtaining CPC, they are normally required by the main Contractor to clear their job sites including removing their construction equipment and scaffolding. Site activities would normally have been scaled down with limited lifting facilities. Difficulties also arise when remedial work involves other trades as some of these sub-contracting groups may have demobilised. The making good of defects is made even more difficult if there are on-going ID works in place and also when the Employer takes partial possession.
- d) Variation works asked for by the Employer during this phase will hinder the progress of rectifying defective items.

### 4.2.1 Recommended solutions to the problems:

- a) Warranties of equipment or systems should commence upon successful testing and commissioning, on-site functional testing witnessed by relevant parties, and certified handing-over of equipment or systems.

This will help to avoid disputes on warranties and rightful usage of completed systems, e.g. air-conditioning systems, lifts, etc. This may help to expedite the tail-end works as it is beneficial for system installers to complete and hand-over

early instead of the present situation where CPC is beyond the control of M & E sub-contractors.

- b) Timely certification and payment to sub-contractors during this phase should be the norm.

Certification of payment should take into account the remedial works to be carried out and deduction, if any, towards the retention sum.

- c) Professionalism and commitment need to be inculcated amongst all contractors as well as developers.
- d) Good planning is required to avoid late order for variation works. The procedure to order variation work needs to be reviewed so that variation works are not unreasonably issued.

### **4.3 Extension of Time**

It is a common practice that a fair and reasonable extension of time is granted to the contractor for any delay, which is duly assessed and considered reasonable by the Engineer or the Architect. This extension of time is normally passed down to the sub-contractors.

Problems encountered in the extension of time are:

Site access to install M & E work is constrained by the C & S and ID work. Priority is normally given to builder's work, which may be delayed. It is common that M & E sub-contractors would not be granted any extension of time on the original schedule, but are normally instructed to increase their workforce and extend their working hours to catch up with the schedule.

A common problem in the construction industry is the shying away from putting things down in writing for the record as it is in our in-built culture of not offending people.

In M & E works, it is common to have design changes due to employer's new requirements, architectural changes, structural changes and authorities' requirements. Progress of M & E works is also affected by employer's selection and changing equipment; changes in site, level, road building, etc.; and changes in priorities of work areas, all of which may result in shortage of materials. Changes in ID works can also cause abortive work.

### **4.3 Closing of Account**

The finalisation of final account should be carried out within three (3) to six (6) months after the date of the Certificate of Making Good Defects in accordance with PAM's condition of contract. But in practice, the timing in closing of account is left to the main Contractor and the Employer.

Problems in closing of accounts are:

It is a common practice that the main Contractor would impose his charges on clearing of site debris, use of water and electricity, cost of site security, etc. on sub-contractors.

Main Contractors have also been known to make deductions for the provision of possible LAD. Sub-contractors are also subject, under duress, to agree to a discount on the final balance of payment before it is released.

## **5.0 Installation Shop Drawings etc. & Training**

### **5.1 Introduction**

Submission of installation shop drawings, as-built drawings, O&M Manuals and T&C records are normally the contractual requirements on the M&E sub-contractors, and these are normally priced as separate items in the contract documents. This section examines the purpose of such drawings/documents, the submission procedures and the rationale for the endorsement by Professional Engineers on such drawings or documents.

### **5.2 Shop Drawings**

5.2.1 Contractors are required to submit the following installation shop drawings for approval by the Consultants.

a) Equipment Fabrication Details

With information on the make, model, capacity, dimensions, components, and other relevant technical matters.

b) Methodology

With detailed drawing showing how certain equipment/system is to be installed at site.

5.2.2 The purpose of drawings and method statements, if required, are:

a) For the Employer/Consultant to check that what is to be fabricated or manufactured complies with contract specifications. This is to pre-empt contractual disputes if any equipment is found to be not in compliance with specifications later on in the project.

b) For ensuring that adequate space is allocated for the installation of the equipment.

c) As a means for checking for any potential clash of services and for coordination at site.

d) To ensure that good installation practice will be adopted.

- 5.2.3 Method statements should only be required for installation of complicated systems in order to enhance the understanding and confidence in regard to how the system is to be installed. Method statements for straightforward installations especially for single piece and/or simple equipment should not be necessary.
- 5.2.4 On receiving the said drawings and documents, the Consulting Engineer should discharge his professional duties by proceeding to:
- a) Stamp the drawings or method statements as "Reviewed", or "Reviewed with Comments", or "Not Accepted, Revised and Resubmit" and return them to the Contractor for further action.
  - b) Use the reviewed shop drawings as a basis for factory inspections of equipment to verify compliance.
  - c) Forward one set of reviewed drawings and method statements (if applicable) to the resident site supervisory team for them to monitor installations at site.

Engineer's review of Shop Drawings is for sole purpose of ascertaining conformance with the general design concept and for general arrangement only. This review shall not be construed to mean that the Engineer accepts the detail design inherent in the Shop Drawings, responsibility for which shall remain with the Contractor. The Contractor is responsible for errors or omissions in the Shop Drawings and for meeting all requirements of the Contract, including the responsibility for the confirming and correlation of dimensions at the job site, for information that pertains solely to the fabrication processes or to techniques of construction and installation and for the coordination with the work of other trades. Final comment on the Shop Drawings shall be contingent upon the complete submission of all calculations, documentation, certifications, approval, samples, mock up and test reports.

- 5.2.5 On the question of endorsement of installation shop drawings/method statements by Professional Engineer with Practising Certificate (PEPC):
- a) There is no necessity for the Contractor in a traditional contract to endorse the drawings or method statements with a PEPC stamp in submission of such documents to the Employer/Consultant for approval. Shop drawings are normally prepared by equipment vendors and/or installation contractors, and method statements by installation contractors. They are all 'fit for purpose' in nature. To require a Professional Engineer, whose liability is only for reasonable care and due diligence, to take responsibility for such 'fit for purpose' works would be considered to be beyond the call of his duty and hence deemed inappropriate.
  - b) However, the Employer could insist that the turnkey contractor's consultant Professional Engineer endorses the installation shop drawings before submitting to the Employer or Employer's representative. This action is only for the purpose of ensuring that the Consultant of the turnkey contractor has carried out his duties of checking the drawings before the turnkey Contractor forwards them to the Employer. This should, therefore, be strictly an administrative matter.

- c) There is also no necessity for the Consultant in a traditional contract to endorse the drawings when forwarding drawings he has approved or commented on to the Employer unless it is required contractually by the Employer for the Consultant to do so. The Consultant is already duty bound in his service contract to the Employer to carry out this responsibility with reasonable care and due diligence with no other attendant statutory requirements. Asking for endorsement of installation shop drawings by a PEPC to his Employer is hence considered a superfluous requirement.

### **5.3 As-built Drawings and O&M Manuals**

- 5.3.1 It is the norm in the industry that for M& E works, the responsibility to come up with the As-built Drawings and Operations & Maintenance (O&M) Manuals lies with the contractor and it is often a priced item in the contract with the Employer. This practice is preferred as the contractor who had carried out the installation should be able to accurately record what had been installed on site. However, there are Employers, though rare, who are willing to employ surveyors and Cad Operators on site to be included in the Consultant's resident site supervisory team to carry out the preparation of As-built drawings.

It is thus, in such cases, the responsibility of the supervising Consultant to check the accuracy of the said As-Built Drawings before forwarding to the Employer.

- 5.3.2 The purpose of As-built Drawings is:
  - a) to be used by the maintenance staff and for troubleshooting and audit.
  - b) to be used by renovation/extension contractor for extension or renovation of existing facilities.
  - c) to be used by future purchaser of the facilities in evaluating the property.
- 5.3.3 The common problem associated with As-built Drawings is the long delay in having them submitted and, when finally submitted, are not accurate and often only a reproduction of the original Tender drawings with hardly any updates on them. This problem is compounded when Consultants do not have any resident site supervisor or inadequate site supervision to monitor and verify changes at site.
- 5.3.4 Endorsement of As-built Drawings consists of two types: -
  - a) The Contractor's endorsement is to vouch for the accuracy of the As-built Drawings. The endorsement shall be by the Contractor's firm and not the Contractor's Professional Engineer as this is a contractual matter between Employer and Contractor. It is deemed inappropriate to involve the Contractor's engineer in his capacity.
  - b) The Consultant's endorsement with his PEPC stamp is to certify that he has carried out his duties, as the Submitting Person and that the As-built drawings are accurate, and only if such As-built drawings are required to be submitted to Authorities/Agencies. For As-built drawings not required to be submitted to Authorities/Agencies, there is no necessity to endorse such drawings, and the

consultant's ECP cover letter approving the As-built drawings/documents will suffice, unless the consultant is contractually bound to use his PEPC stamp for such endorsement. In a turnkey contract, the Turnkey Contractor's Consultant takes on this responsibility as the Submitting Person.

- 5.3.5 To overcome the problems and responsibility of the Consultant in endorsing As-built Drawings and O&M Manuals, the measures recommended are:
- a) The Consultant should insist that the Employer engage sufficient resident site supervisory staff (Inspector of Works) reporting directly to the Consultant whose duty is to ensure the Contractor's site team continually updates As-built records as installation progresses. Resident site staff seconded to the Consultant for this purpose must also be under the Consultant's effective control.
  - b) For large projects, the Employer should deploy a site team under the control of the Consultant dedicated to recording As-built installations.
  - c) To limit the long delay in preparation and submission of As-built drawings and O&M manuals by Contractors, the submission should be a condition for the issuance of Practical Completion Certificate (CPC), preferably within one month of CPC which will be backdated not more than one month prior to the day acceptable As-built Drawings and O&M Manuals are received.

## **5.4 Training**

5.4.1 Training is required for the operation and maintenance team to be familiar with the various building systems prior to their taking over the M&E installations. However, the problem often encountered is Employer's staff is not available for the training at the time when the installation is completed before the issuance of CPC. This problem is compounded when specialised equipment is involved and foreign expertise is only available for a limited time.

### **5.4.2 Recommended Solutions**

- a) The Consultant should advise the Employer to employ the required operation and maintenance personnel early in the building project to understand the design issues before being trained for the operation and maintenance work.
- b) The training manual should include the basic minimum information on:
  - i) Conceptual system design
  - ii) Systematic start up and shutting down of the various components
  - iii) All functional features and setting of parameters (especially for software e.g. Building Management System)
  - iv) Proper safety procedures or do's and don'ts.
  - v) Emergency procedures

- vi) Optimizing equipment operation with a view to energy savings.
- vii) First level maintenance procedures.

## **6.0 Preferential Engineering**

### **6.1 Introduction**

#### **6.1.1 Professional Ethics**

‘Preferential Engineering’ ostensibly flies in the face of the professional engineer's ethical standing which enjoins the said professional:

- a) to be impartial in his selection of engineering system and product, and specifying as far as possible ‘open’ system or product; and
- b) to advise the client on the best system with regards to engineering safety, quality and price (in that order).

PEPCs are required to declare their interest (direct or indirect) in any of the engineering system or product under consideration so as to avoid potential conflict of interest arising from the ethical issues described in this section.

#### **6.1.2 The Case for ‘Preferential Engineering’**

In spite of ethical issues standing in its way Preferential Engineering (PE) can be, and is, allowed as a method in specifying and/or approving a specific or preferred engineering system or product. Three major reasons for and instances where PE is employed are:

- a) **Alternative Design to Base Specification**

In keeping with ethical and professional standards, most engineering system and products are specified on a generic, brand neutral basis, which is frequently ‘open’. However for many engineering system especially in the field of M&E, alternative systems or designs may be proposed by specialist suppliers, vendors or contractors which may deviate from the base specification of the consultant engineer.

- b) **Branding**

Branding is where a particular brand and/or model of engineering product is preferred.

- c) **Made in Malaysian Products**

Policy recommendation for use of Made in Malaysian products may prompt the inclusion of this issue as a special case for Preferential Engineering.

## 6.2 Methods of Preferential Engineering

### 6.2.1 Alternative Design to Base Specification

6.2.1.1 PE should, in most cases, be avoided because of its bias towards a particular product or engineering system which is usually (though not always) proprietary. The disadvantages attributed to PE are:

- a) The proprietary nature of Preferential Engineered System (PES) usually results in a higher capital cost as against the 'open' system;
- b) Future operation and maintenance will be restricted towards a limited component vendor and specialist maintenance contractor leading to higher maintenance and operation cost.

In general the consultant engineer should within his professional competency specify or design systems which are clearly 'open' and supplier-neutral (i.e. not bias towards one or few vendors, contractors or suppliers). Most M&E systems and products are usually amenable to the 'open' system and it is only in some cases where PE may be appropriate.

'Open' system or product is most effectively specified or designed using Malaysian Standards (MS) and design codes (or international standards and design codes where MS are not available) without the need to resort to PE.

6.2.1.2 Instances where Preferential Engineering is applicable particularly in M&E engineering system or product are:

- a) Absence of Dominant Open Standard

Where industry practice do not, at the time of writing the specification, support a universal accepted 'open' standard or multiple 'open' standards PES may be proposed and/or accepted; examples of such instances are:

- i) in data networking technology including data network switching technology (Gigabit, ATM, Frame Relay etc.) and associated data networking topology.
- ii) in control and automation systems and components such as Programmable Logic Controllers (PLC), System Control and Automated Data Acquisition System (SCADA), Building Management System (BMS), Building Automation System (BAS), soft start and soft switching system and other types of control and automation at the device and system level.
- iii) in energy System and Energy Efficient System which include district cooling and thermal storage system, co-generation, renewable energy system, adsorption chillers and other cutting edge technologies under this category.

- iv) in other systems or components which can be proven to fall under this category.

b) Technical Efficacy and Cost Efficiency

In cases where the vendor or contractor or supplier can clearly and unambiguously prove that the PES or its component:

- i) has similar or higher technical efficacy;
- ii) is similar or more capital cost effective; and
- iii) is more cost effective in operation and maintenance;

than the specified system or component, PES may be proposed to the owner or client for adoption.

At least two or all the reasons listed above may be cited as reasons for adoption of PES at the discretionary professional judgement of the responsible consultant engineer. Such judgement should however take cognizance of ethical principles.

c) Conscious Decision by the Owner or Client

In some cases, a conscious decision may be made by the owner or client to opt for PE; examples of such reasons include:

- i) corporate policies favouring specific product brand or model;
- ii) economy of scale for large engineering works or plant especially located across diverse geographical sites; cross-corporate synergy with subsidiary or 'related' company; or consistent spare part inventory and maintenance procedure.

d) Complexity of System Design

In some M&E systems the design factors are complex or exceed industry or practice norms, for example:

- i) complex design factors in large engineering systems or complicated engineering systems or engineering systems with proprietary technology forming a component or the heart of the system; and/or
- ii) where design requirements exceed normal standards such as higher operating characteristics, requirement for higher quality of service (or low breakdown or downtime capabilities), onerous operational or ambient conditions, or exceptional operational requirement (e.g. military or hospital application);

## 6.2.2 Branding

### 6.2.2.1 Avoid 'Branding'

PE in the form of 'branding' should in most cases be avoided as branding restricts the right of choice and impinges on the principles of fair and free bidding for all vendors, suppliers and contractors.

In general the consultant engineer should, within his professional competency, specify products which are clearly 'open' and brand-neutral (i.e. not bias towards one or a few vendors, contractors or suppliers). Most M&E products are usually amenable to the 'open' system and it is only in some cases where 'branding' may be appropriate.

'Brand-neutral' products are most effectively specified under the following circumstances:

- a) For proper and correct application of design and product standards which are 'open' and adopted as Malaysian Standards (MS) or International Standards where MS are not available.
- b) Where local and internationally acceptable 'open standards' are not available in the market, proper and correct application of performance-based specification may be resorted to, provided that the consultant engineer is competent in the drafting of such performance based specification.
- c) Where insistence on submission of product certification for quality and safety standards and/or 'product listing' by national and internationally recognised and accredited certification laboratories or agencies is a standard procedure in the Quality Control and Quality Assurance (QC/QA) procedure of the consultant engineer's approval process. The application of this procedure will obviate the necessity for 'branding' in most cases.

#### 6.2.2.2 Instances Where Branding may be Applicable

Instances where branding may be applicable in M&E systems products are:

- a) Specific Requirements of Preferential Engineered System

In cases where the nature of the adopted PES requires the application of specific components or model for reason of component compatibility or best system function, branding including the specification of particular model may be adopted.

- b) Quality Benchmarking

Branding or the specification of a particular brand is a common method for quality benchmarking.

It should however be emphasised that the correct application of design and product standards in specification or bid documents could obviate the need for quality bench-marking by 'branding'.

Quality benchmarking by 'branding' may be resorted to in cases where product specification including local and international product specification cannot describe aspects of quality such as:

- i) aesthetic,
  - ii) particular requirement of ergonomic design e.g. a specific ergonomic design due to particular requirement of operator such as for blind or handicapped person,
  - iii) particular requirement of human-machine interface (HMI); e.g. Client HMI characteristics commonly favoured include a specific layout of control panels and/or the presence of certain HMI-based control functions,
  - iv) product requirements exceeding normal standards such as higher operating characteristics, higher quality of service (or long service capability), onerous operational or ambient conditions, or exceptional operational requirement (e.g. military or hospital application);
- c) Absence of Dominant Open Standard

Where industry practice, do not, at the time of specifying or designing, support a universally accepted 'open' standard or multiple 'open' standards in the market, 'branding' may be proposed and/or accepted; examples of products which can be categorised under this sub-section usually refers to products with cutting edge technology such as:

- i) Products with automated controls or components with Programmable Logic Controllers (PLC) or Intelligent Electronic Devices (IED),
  - ii) Other components or products which can be proven to fall under this category.
- d) Conscious Decision by the Owner or Client

In some case, a conscious decision may be made by the owner or client to opt for specific 'brand' or model due to reasons which may include:

- i) corporate policies favouring specific product brand or model;
  - ii) reasons of economy of scale for large engineering works or plant especially located across diverse geographical sites;
  - iii) cross-corporate synergy with subsidiary or 'related' company;
  - iv) consistent spare part inventory and maintenance procedure; and
  - v) familiarity with a particular product brand or model.
- e) Higher Operational Requirement

In some M&E systems the design factors require components or products with standards exceeding industry or practice norms, such as:

- i) higher operating characteristics,
- ii) requirement for higher quality of service (long life or higher duty rating capacity),
- iii) onerous or severe operational or ambient conditions, or
- iv) exceptional operational requirement (e.g. military or hospital application);

And especially where local and/or international standards do not support such standards, 'branding' may be resorted to as a means of ensuring compliance to the technical intent of the specification.

### 6.2.3 Malaysian Product

#### 6.2.3.1 Specifying Malaysian Products

The policy of specifying Malaysian Products as a practice is a method in procurement procedure and may be defined as the restriction of engineering products and/or systems to Malaysian or local makes. This practice should not be confused with restricting supply of engineering products or systems only to suppliers or vendors domiciled in Malaysia, and what follows hereunder will only deal with the Malaysian or made in Malaysia products.

#### 6.2.3.2 Reasons for Specifying Malaysian Products

Specifying Malaysian Products is usually mandated or recommended under the following instances:

- a) Government procurement policies;
- b) Client's policy; and
- c) Particular policy of the responsible specifying engineer (who may be the consultant of the turnkey contractor).

#### 6.2.3.2 Engineering Issues Arising from the Policy of Specifying Malaysian Products

The specifying of local or Malaysian made products, though an ostensibly simple issue is however complex and fraught with administrative hitches:

- a) The definitions of 'Malaysian' or 'Local' product(s) is not sufficiently laid out (not even a simple definition with basic criteria of local-content is available) and neither is there a mechanism for ascertaining and certifying conformance to definition of Malaysian or local products. As a result, some complaints and/or confusion arising from this policy are:
  - i) Certification by SIRIM QAS Sdn Bhd and IKRAM QA Services Sdn Bhd do not ascertain the local content of a product.

- ii) Products which are clearly imported (not even locally assembled) have been claimed to be Malaysian products.
  - iii) Products with no or very low local content but assembled locally and in some cases only assembled at the final stage are claimed to be Malaysian products.
  - iv) Malaysian products under (iii) above, are aggressively marketed but at prices which are markedly higher than imported products.
- b) Concerns are raised where restricting the choice to Malaysian products only, especially where such products may have very limited vendor-base and/or model-selection, may compromise the quality and even the integrity of engineering design and performance.

### **6.3 Practice in Preferential Engineering**

#### **6.3.1 Requirements**

Where PE is adopted under any of the instances described above, the following requirements should in all cases be complied with:

- a) Consent or Request of Owner

The consent of the owner or client must be sought; or where the owner or client specifically requests the adoption of PE or PES.

- b) Awareness of Owner of the Facts

The owner or client must be made fully aware of the cost and technical disadvantages, advantages or operational implication of PE and PES. If the owner or client is not aware of such facts, then the responsible Professional Engineer should fully brief and make known the facts to the owner or client.

- c) Compliance to Principles of Professional Ethics

The responsible consultant engineer is satisfied as to the technical safety, viability and cost effectiveness of such systems under broad principles of ethical standards.

#### **6.3.2 Responsibilities of the Consultant Engineer**

Where PE is adopted, the responsibilities of the consultant engineer shall extend to:

##### **6.3.2.1 Statutory Responsibility**

- a) The consultant engineer shall fully discharge his statutory responsibilities specified under the law notwithstanding the execution of design or specification of particular products by others. These responsibilities include:

- i) compliance to safety standards particularly safety of the public;
  - ii) compliance to particular requirement(s) of local authorities (district council, municipal council, city hall, health department etc.), regulating agencies (Energy Commission, Department of Civil Aviation, Department of Environment, Department of Occupational Safety & Health etc.) and utility companies having jurisdiction; and
  - iii) professional endorsement on certificate of completion, certificate of fitness or design where such endorsement is a matter of requirement on the consultant engineer as the competent submitting person recognised under the relevant law or regulation ('Street, Drainage & Building Act' and 'Uniform Building By-Laws').
- b) In discharging his statutory responsibilities the consultant engineer shall act in the following manner (where applicable):
- i) take all reasonable steps to ensure that PES are substantially in compliance with requirements;
  - ii) professional endorsement should only be effected when the consultant engineer designated by law as the competent submitting person is satisfied as to the compliance of the said PES to the requirements of 6.4.2 A) a) i) and ii) above;
  - iii) where the technical competence of the consultant engineer designated by law as the competent submitting person does not extend to proper auditing of the PES with regards to compliance to requirements, then the said consultant engineer may:
    - 1) **EITHER** discharge himself as the competent submitting person provided that such action of termination is in accordance with the relevant laws and regulations;
    - 2) **OR** provide the required professional endorsement where the consultant engineer is reasonably satisfied as to the professional competency of the principal proposer of the PES and the said principal proposer provides professional endorsement as a guarantee of his professional competency and the compliance of the said PES.
- Such 'third party' endorsement shall constitute a 'back-to-back' professional guarantee for the competent submitting person and the said consultant engineer should be fully cognisant of his liability under statutory law though such liability may be ameliorated or diminished by virtue of the said third party guarantee.
- iv) where reasonable doubts exist as to the compliance of PES, the consultant engineer shall take all reasonable steps to inform the owner or client of such doubts and where, despite such information, the owner or client proceeds to adopt the said PES, then the consultant engineer

shall forthwith discharge himself as the competent submitting person and such termination should be effected in accordance with the relevant laws and regulations.

#### 6.3.2.2 Duty of Care

- a) In discharging his responsibility, the consultant engineer owes a duty of care to his client which assumes liabilities which are commercial in nature. Some duties will assume a measure of ethical dimension where it impinges on professional code of conduct listed under the ‘Registration of Engineers Act; Registration of Engineers Regulation’. Responsibilities under ‘duty of care’ include:
- i) ensuring compliance with technical standards specified or is normally applicable (if not clearly or adequately specified) for the engineering system or component or product;
  - ii) reasonable assurance that the best engineering systems at the best price is effected to the best interest of the owner and/or client;
  - iii) professional endorsement on certificate of completion where such endorsement is required by the owner and/or client as a matter of requirement under terms of appointment between the client and the consultant engineer;
- b) In discharging the responsibilities listed under this sub-section the consultant engineer shall act in the following manner (where applicable):
- i) take all reasonable steps to ensure that PES are substantially in compliance with requirements;
  - ii) where ‘branding’ is adopted as a means of quality benchmarking, then the consultant engineer should provide some avenue for alternatives by listing **at least three brands** or, where not reasonably possible, inserting ‘OR EQUIVALENT’ after listing the particular brand or model in his specification and/or bid document;
  - iii) where professional endorsement is required it should only be effected when the consultant engineer is satisfied as to the compliance of the said PES to ‘duty-of-care’ responsibility.
  - iv) where the technical competence of the consultant engineer does not extend to proper auditing of the PES with regards to compliance, then the said consultant engineer may:
    - 1) **EITHER** *discharge* himself as the competent person responsible under ‘duty of care’ to his client for the performance of the PES, and provided that requirements are not compromised, he may still discharge his responsibility as the competent submitting person. In terminating his professional responsibility under ‘duty of care’ to the owner and/or client, the consultant engineer shall take all reasonable steps to inform the owner and/or client of

such termination and properly adhere to the relevant conditions in the terms of appointment between the client and consultant engineer.

*Example: The consultant engineer may discharge himself from professional responsibility for specialist works such as energy efficient sub-systems, data networks etc. if he does not have the competency in such fields. However, he may still continue to discharge his responsibility as a competent submitting person for the whole engineering system as energy efficient sub-systems and data networks do not impact on public safety and are not included as requirements for Certificate of Completion and Compliance.*

- 2) **OR** provide the required professional endorsement where the consultant engineer is reasonably satisfied as to the professional competency of the principal proposer of the PES and the said principal proposer provides professional endorsement as a guarantee of his professional competency and the compliance of the said PES.

Such 'third party' endorsement shall constitute a 'back-to-back' professional guarantee for the consultant engineer and the said engineer should be fully cognisant of his (commercial) liability to the owner and/or client under 'duty of care' responsibility though such liability may be ameliorated or diminished by virtue of the said third party guarantee.

- v) where reasonable doubts exist as to the compliance of PES, the consultant engineer shall take all reasonable steps to inform the owner and/or client of such doubts and where despite such information the owner or client proceeds to adopt the said PES, then the consultant engineer shall forthwith discharge himself as the engineer responsible under 'duty of care'. In terminating his professional responsibility under 'duty of care' to the owner and/or client, the consultant engineer shall take all reasonable steps to inform the owner and/or client of such termination and properly adhere to the relevant conditions in the terms of appointment between the client and consultant engineer shall be observed.

### 6.3.3 Responsibilities of the Contractor, Vendor or Supplier

Where PE is adopted, the responsibilities of the contractor, vendor or supplier of PES shall extend to the following:

#### 6.3.3.1 The Principal Proposer of PES

Due to the differing mode of procurement, procurement contract and complicated contractual relationship between the principal parties of engineering works (owner, client, consultant, contractor, sub-contractor, specialist contractor or PE contractor etc.), a principal point of responsibility has to be identified in the implementation or

adoption of PE or PES. The ‘Principal Proposer’ (or ‘PP’) of PE or PES shall in this context:

- a) be the contractor or sub-contractor or vendor having direct contractual relationship with the client; AND
- b) assume responsibility for the performance of the PES under principles of ‘fit-for-purpose’ and duty-of-care.

#### 6.3.3.2 The Responsibility of Principal Proposer

- a) The ‘PP’ of PE or PES shall fully discharge his responsibilities in the following manner where applicable:
  - i) ensure that the PES comply to safety standards particularly safety of the public;
  - ii) ensure that the PES comply to particular requirement of local authorities, regulating agencies and utility companies having jurisdiction; and
  - iii) provide professional endorsement of design and design drawings.
- b) In discharging the responsibilities listed under this sub-section the PP of PE or PES shall act in the following manner (where applicable):
  - i) take all reasonable steps to ensure that PES are substantially in compliance;
  - ii) give professional endorsement in ALL cases where such endorsement shall constitute professional verification of compliance of the PES.
  - iii) take cognisant of the fact that every one of professional endorsement, depending on the extent of professional endorsement by the engineer, constitute:
    - 1) direct warranty to the owner and/or client, OR
    - 2) third party warranty through the consultant engineer for the PES under principles described in preceding sections .
  - iv) assume the additional responsibility as the competent submitting person where the consultant engineer discharges himself as the competent submitting person, and take cognisant of his liability under statutory laws.

#### 6.3.4 Best Practice for Specifying Malaysian Products

Addressing the concerns arising from the implementation of a ‘Malaysian Product’ policy, the best practice recommendations are:

- a) The specifying engineer should clearly spell out the requirement of this policy in the tender documents (of the consultant) or procurement documents (of the contractor) including any qualification to this policy.
- b) In ascertaining qualifying criteria for Malaysian-made product in the approval process the following guidelines may be adopted:
- i) notwithstanding certification by SIRIM or IKRAM, Malaysian products should at least be assembled in Malaysia;
  - ii) the product should be promoted by principals who are domiciled in Malaysia, maintain technical support office and spare parts warehousing in Malaysia and have qualified technical personnel well versed and knowledgeable in the product permanently based in Malaysia;
- Note: The last criterion (technical personnel) is frequently lacking in some products that claim to be made in Malaysia. Lack of technical expertise with the right knowledge is a serious impediment to developing Malaysian products and shows the lack of commitment on the part of the commercial entity claiming protection under the Malaysian product policy.*
- iii) the product should possess conformance certification(s) to internationally recognised technical standards which is specific to Malaysian operation or factory or is at least supported with proof that ongoing efforts are being implemented to obtain such certification(s);
- Note: Many products claim to possess the necessary conformance certification, but which are in actual fact only conformance certificates of their principal (foreign) technology provider. Conformance certificates are in most cases factory-site specific and are not transferable despite claims to using 'similar' technology or branding. Possession of conformance certification also serves to indicate the commitment (or lack of commitment) of the manufacturer in promoting and developing Malaysian products.*
- iv) due to the lack of a framework for ascertaining local-content, no practical recommendations on local-content can be made at this juncture;
- c) Foreign or imported products may be approved for use provided the following criteria are complied with:
- i) where there is no local made or assembled product available or where there is a national shortage of Malaysian product;
  - ii) where the local made product does not comply with the technical specification or where no local product can be found to take the place of the product specified; and

- iii) where the cost of local product(s) is high enough, as compared to the equivalent imported product(s), to impact on the cost of the project (the facts of such cost impact should be made known to the client whose approval should be sought before proceeding with or abandoning the approval of the product concerned).
- d) Notwithstanding the restriction of choice arising from this policy, the specifying engineer (who may be the consultant or the contractor) should in ALL cases take reasonable steps to ascertain that
  - i) the engineering integrity demanded under statutory responsibility and duty-of-care responsibility are not compromised;
  - ii) the engineering product or system complies with the requirement of the technical specification;

*Note: The above is anchored on the proviso that specifications adopted should be 'open' and in-line with internationally recognised best practice. The adoption of specification which is proprietary in nature tends to restrict the choice of product and should at all times be avoided. However, there have been instances where proprietary-based specification has been used as a method of avoiding, but without contravening, the policy of Malaysian product.*

  - iii) the supplier or vendor of such product has sufficient back-up technical support and maintains sufficient spare-parts for future maintenance and operation.
- e) Where the 'Malaysian product' policy is adopted and practised by the consultant engineer (principally for private project) he should take all reasonable steps to:
  - i) inform and seek the consent from his client;
  - ii) see that this policy does not compromise the fiduciary interest of the client;
  - iii) satisfy himself and his client that any restriction brought about in choice of this policy does not severely impact on engineering cost and choice of technology.

## **6.4 Factory Witness Inspection and Visit**

### **6.4.1 Witness Inspection And The Works Flow Procedure**

#### **a) Definition**

Factory visit is an elemental work procedure defined as inspection of engineering equipment, components, and/or plant at the factory of origin before delivery to site and is usually specified as a requirement in the specification or contract as a cost item in pricing.

## 6.4.2 Varying Terms

Numerous and varying terms have been used in describing, listing and specifying factory visits, some of which are the following:

- a) factory inspection,
- b) factory visit,
- c) factory inspection visit,
- d) factory witness test, or
- e) factory acceptance test

Whatever the terms used, the meaning is essentially as defined above. Subsequent discussion will use the term 'factory visit'.

## 6.4.3 Common Practice in Factory Visits

### 6.4.3.1 Reasons Cited

The reasons frequently cited for the need of a factory visit include:

- a) to ensure compliance of engineering equipment, components and/or plant to technical and performance criteria specified in the contract;
- b) to independently witness pre-delivery tests and commissioning at factory of origin;
- c) to ensure proper packing of equipment, component and/or plant before shipping and carriage;
- d) to carry out ad hoc audit of factory quality control and assurance procedures; and
- e) to ensure that major defects or shortfall detected under items a) and b) above can be rectified immediately at the factory of origin - defects or shortfall which, if detected later on site would require returning to factory of origin for rectification (and hence the insistence on inspection at factory of origin).

### 6.4.3.2 Instances Specified for Factory Visit

As factory visits can constitute a waste of money, time and effort, it is not possible or practical to specify factory visits for all or most equipment, component and/or plant. Common practice in Malaysia, at the moment specifies factory visits for:

- a) large plants or equipment with complicated performance characteristics.

- b) equipment, components or plant which are ‘mission critical’ i.e. **they are critical to the safe operation of the complete engineering works, especially in relation to public safety.**
- c) very large orders of equipment or components from one vendor.
- d) equipment or plant having higher standard of operation than the norms of the day, e.g. in :
  - i) higher operating characteristics,
  - ii) higher quality of service (long life or higher duty capacity rating),
  - iii) being better able to operate under onerous or severe operational or ambient conditions, and/or
  - iv) being better able to meet exceptional operational requirement (e.g. military or hospital application).

#### 6.4.3.3 Some Common Misconceptions and Malpractice

Prevalent examples of malpractice in the industry that have been the subject of frequently cited or lodged complaints include:

a) Unwarranted Specification of Factory Visit

An overzealous specification of factory visit for all or many equipment, component or plant which do not fall within any of the categories listed above can lead to a waste of money, time and effort with no meaningful value to the quality or the completion time of the project. Financial implications are especially pertinent where factory visits entail travel to foreign countries, where such visits become overly extensive and when too many unwarranted visits are specified. This constitutes an abuse of the normal construction procedure, and anecdotal stories of factory visits specified for standard type pumps, lifts and minor components are clear examples of such abuse.

b) Factory Visit as Study Tour or Holiday Tour

In many cases including some legitimate instances of factory visits, these visits (especially to foreign countries) have been treated as study or holiday tours without legitimate technical reasons for the visits. This constitutes an abuse of the normal construction procedure and contributes to financial resources being utilised without adding any meaningful value to the quality or the time of completion of the project.

c) Large Delegation for Factory Visit

In many cases, an overly large delegation is specified for inclusion in factory visits especially to foreign countries.

This constitutes an abuse of the normal construction procedure and contributes to financial resources being utilised without adding any meaningful value to the quality or the time of completion of the project.

d) Unqualified Person/s Delegated to Carry Out Factory Visit

Bearing in mind the technical imperatives for factory visits, it should therefore be necessary that persons delegated to carry out factory inspection should have some familiarity with (though not necessary an expert on) the technical specification of the equipment, component or plant to be inspected and the main objectives for the factory visit. In many cases persons making factory visits are unqualified for, or not properly informed of, the technical imperatives of the factory visit.

This constitutes a failure of the project work procedure leading to breakdown of the Quality Control/Assurance (QC/QA) sub-procedure.

e) Unclear Specification or Arbitrary Requirement Lodged During Factory Visit

Bearing in mind the technical imperatives of factory visit in the tender documents and their cost entered in tender bids, the following scenario should be avoided;

- i) an unclear description in the technical specification for factory visit during the tender stage (especially requirement for extra-normal factory test procedures); and/or
- ii) an unclear notion of the technical reasons for factory visit and the work-procedure implicit in the QC/QA procedure for engineering products.

Arbitrary and ad hoc demand for inspection and/or test procedures can lead to legitimate claims by contractors, especially if such procedures are unwarranted and is a waste of money, time and technical resources.

f) Specifying Factory Visit can unfairly discriminate against Local Product.

Local manufacturers and vendors have complained that specifying factory visits discriminates unfairly against local products as the result of certain parties in the project management hierarchy favouring foreign products for the prospect of the oversea tours. This constitutes an abuse with elements of ethical concern and leads to a breakdown in the procurement procedure.

#### 6.4.4 Best Practice for Factory Visit

##### 6.4.4.1 Certification and Product Listing

a) Importance of Product Certification and Listing

With the growing momentum of the international standardisation movement, submission of product certification or product listing is a major procedure for incorporation into the QC/QA procedure for the project work-process. The

degree of sophistication and amount of details available in product certification or product listing is such that many of the reasons and instances cited for factory visits can now be made unnecessary by making use of the relevant product certification and/or listing in the equipment, component and/or product approval process now available in the local and international market.

b) Understanding Certification and Product Listing

In specifying product certification and listing in the approval procedure, a basic understanding of the types of product certification and listing available in the local and international market is essential.

c) ISO Quality Procedure

The requirement of ISO quality procedure in conjunction with product certification and listing will reinforce product acceptance and the approval process as well as obviating the necessity of most factory visits.

#### 6.4.4.2 Best Practice When Factory Visit is Required

a) Basic Principles

A basic principles relating to best practice for factory visit in construction process are:

Basic criteria where factory visit is deemed necessary are only when:

i) no internationally recognised product certification or listing standards are available for the equipment, component and/or plant during the approval process;

OR

ii) though internationally recognised product certification or listing standards are available, the equipment, component and/or plant approved for acceptance do not possess the required product certification or listing;

AND/OR

iii) there is an absence of ISO quality procedure for the factory concerned.

b) Despite the prevalence of redundancy of almost all factory visits, such visit may still be a requirement, especially under the following conditions:

i) where the engineer feels uncomfortable without visiting the factory for valid reasons.

ii) where the specification calls for extra-normal tests procedures such as over-load capacity and particular performance characteristics; and

- iii) where the order is very large.

#### 6.4.4.3 Recommendations for Best Practice

Where factory visits are specified the following practice should be adopted:

- a) The requirement for factory visits should be clearly specified in the tender documents and a cost item should be included in the schedule of prices.
- b) The scope and extent of factory tests to be conducted should be clearly specified in the tender document with listing of extra - especially whether it is to be total or sample testing (at the specified rate) and the list of extra-normal tests, if any.

In the absence of specifications or brief descriptions of tests and indication of extra-normal tests or sampling rate in tender document or price schedule, the contractor or vendor will be deemed to be duty bound only to conduct tests normally required, and that ad hoc demands for extra tests during factory visits will open the owner/client to legitimate claims.

- c) Where factory visits to foreign countries cannot be avoided, the following practice procedure should be adopted:
  - i) where possible an independent verification agency at the country of origin (such as 'Crown Agency' in the UK) should be retained to certify factory witness-tests and inspection; OR
  - ii) the number of local personnel delegated to make such a visit should be limited to only essential/key personnel who are understanding and are familiar with the product and test the procedures.
- d) Where factory visits cannot be avoided, the following practice should be adopted in ALL cases of inspection:
  - i) the consultant engineer would normally be designated as the principal inspector making such visit and it would therefore be incumbent on him that ALL procedures listed herein are adopted and acted upon.
  - ii) the work procedure to be adopted BEFORE setting out on the factory visit should include prior approval of (not necessarily in the order listed):
    - 1) vendor and product brand through submission of type test certification, standard conformance or product safety certification, ISO certification and particular certification (such as listing by Malaysian agencies or requirement for local made product);
    - 2) shop drawings including the list of sub-components;
    - 3) factory tests procedures and inspection programme.

- iii) only person(s) qualified and competent in the product approval and certification procedure should be delegated for factory visit.
- iv) at the time of inspection, the following procedures may be adopted:
  - 1) the approved shop drawings (with approval mark clearly affixed on the drawing) should be made available during factory visit,
  - 2) a list of test procedures and inspection programme should be made available during factory visit,
  - 3) person carrying out the tests should be competent and/or qualified for the type of tests to be conducted (e.g. chargeman, wireman, technician etc.),
  - 4) only competent and qualified person(s) shall endorse tests certificates after satisfactory completion of factory tests,
  - 5) other endorsement on factory tests and inspection certificates or reports (if required, though not absolutely necessary) by owner, client, and/or consultant shall only be on a 'witnessed' basis, and
  - 6) a brief report from the principal inspector briefly describing the observations and result of the factory visit.
- v) on successful conclusion of a factory visit a report or certificate of factory tests and inspection with of product inspected and/or tested clearly labeled and serially numbered on the report should be issued by the factory of origin.
- vi) where a factory visit does not give satisfactory results the work procedure listed in (iv) above will have to be repeated and brought to a successful conclusion.

## **7.0 Local Product Listing**

### **7.1 Use of Local Materials, Goods and Services in Government Procurement**

The government may from time to time issue a Standing Instruction via a circular to all government agencies to purchase only local materials, goods and services in their procurement for the government. The latest circular on the government procurement policy should be referred and adhered to for all government projects.

### **7.2 CERTIFICATION AND PRODUCT LISTINGS**

An important procedure in the engineering works programme is the application of engineering standards which are 'open' and recognised as international standards. The correct application of standards in specifications in most cases obviates the necessity for adopting Preferential Engineering or Branding.

Concurrent with the application of standards is the demand for certification and product listing within the QC/QA procedure. The correct identification and demand for tests certification is an important procedure complementing the application of standards. Due to the advent of the international standardisation movement and associated certification procedure (of which the type, depth and diversity of tests certification have reached a high standard of sophistication compared to two decades ago), the correct identification of tests certification will in almost all cases obviate the necessity for factory inspection. However, in many cases, specifying test certification or requesting for tests procedures is hampered by the lack of understanding of certification types leading to inappropriate tests certification or request for tests procedures which are unnecessary or redundant. The type of tests and tests certification required in most cases can be obtained by a diligent study of the Technical Standard of the particular product, assembly or engineering system concerned. The type of test or test certifications recommended in all standards includes type-tests, conformance tests, factory tests and site commissioning tests.

a) Type-Tests

These are random tests on one-off samples of product and usually specify tests at extreme conditions (e.g. at very high voltage or high currents or high pressure) to ascertain the rated limits of the product.

- i) Due to the extreme limits specified in testing conditions, type tests are usually carried out by accredited laboratories with the necessary specialised equipment. Due to this type-tests are expensive to carry out.
- ii) Type tests are also usually destructive.
- iii) Certification carries mark of approval confirming that the design and manufacture of the particular product and specific model conform to the rated limits as claimed in its specification. These marks are the highest accolade to be conferred on the perceived quality performance of the product.
- iv) Type test certification is also site-factory specific and is not transferable to other factories despite claims of similarity in manufacturing process, possession of same brand name or owned by the same vendor (a common but fallacious claim by vendors practicing third party assembly or manufacture of branded products).

Some examples of type tests include short circuit ratings, impulse voltage, breakdown voltage, pressure limits on pressure vessels etc.

b) Conformance Certification

Conformance certification to designated standards is tests on random samples of product conducted by independent testing laboratories. Independent certification usually requires renewal at certain time intervals and therefore carries expiry date. Independent certification is also site-factory specific and is not transferable to other factories despite claims of similarity in manufacturing

process, possession of same brand name or owned by the same vendor. Types of independent certification are:

- i) Conformance to designated standards usually certifies broad compliance to a particular standard; the information in this certification include the basic built, nominal ratings (voltage, currents, pressure, flow rate etc.), and basic safety standards;
- ii) Conformance to safety standards typically for consumer products usually include only test procedures specified for safe operation (e.g. European-CE mark) and may not include many of the information under a) above and c) below. (Safety standards usually have a higher sampling rate and are meant for mass certification of common products);
- iii) Conformance to particular requirements of standards, which are not included in the standard conformity tests under a) above, include certification to low loss standards, high efficiency motor/ballast/transformers etc., I.P. ratings, photometric data etc.;

c) Product Listing

This refers to certification by internationally recognised agencies which act as centres of expertise for auditing, collating and recommending product certification for use by industry. Listing agencies usually do not possess any testing facilities (though some listing agencies may have limited testing facilities) and accept certification from independent recognised testing laboratories. The strength and advantage of a listing house or agency lie in their expertise in auditing and demanding particular conformance certification and their ability to identify and discriminate between the relative advantages or type-tests and conformance certification required. Listing agencies are therefore useful as reference source for approval, as the public and even some engineers may not have the expertise to interpret the usefulness of or applicability of conformance or type-test certifications for particular situation.

Listing house or agency in particular is strong in certifying products for use in conformance to installation codes or system assembly standards and application in particular situations (such as fire safety, fire hazard in marine vessels, and safety issues impacting the insurance industry). Some listing agencies especially North American agencies, such as NFPA, provide certification for total system or built-up plant conformance certification to a particular standard.

Some examples of product listing agencies include 'Underwriters' Laboratories' (UL), 'Lloyds Register', NFPA and LPCB.

d) Factory Tests

These are standard tests in the product manufacturing procedure and are usually specified as mandatory in the product specification. The type and quality of tests certification to be submitted for acceptance under the approval procedure in the construction process is a key ingredient in ascertaining the requirement for

factory visit. The types of factory test certification to be issued are specified in the particular technical standard of the product and are usually routine, non-destructive and may be carried out on all or samples of products. Tests which involve sampling depend on the type and quality class of the product (higher grade product being accorded higher sampling rate and extreme grade product such as for space vehicles requiring 100% sampling rate). Certification of factory tests depends on the product and range from the simplest QC sticker affixed to every product to factory test certification issued with larger product.

Extra normal factory tests are usually required for large built-up assembly such as chillers, generators, switch boards and can usually be taken as commissioning tests on completion of assembly of equipment, examples of these tests include loading tests, capacity and rating tests, operational tests, and performance tests.

## 8.0 Glossary

**Branding** refers to the specification of a particular brand and/or model for a product in a bid document or tender.

**Conflict of Interest** refers to the conflict which may arise between the interest of the public, the fiduciary interest of the client (which professional engineers must uphold as a matter of professional ethics) and the personal interest (frequently financial) of the consultant engineer. 'Conflict of interest' must be seen to have been avoided or resolved even if such conflicts have or had not occurred.

**Duty of Care** refers to the responsibility of the professional engineer in ensuring that the engineering works or system for which he is responsible is designed, specified and built to reasonable standards of engineering, and functions properly within reasonable standards of operational requirement. All professional engineers undertaking engineering works owe a duty of care both to the public and to his client. Duty of care responsibility towards the public principally relates to safety issues while duty-of-care responsibility towards client relates to 'fit for purpose', technical quality or product performance issues.

**Ergonomic** refers to the field of applied science dealing with designing and arranging things (usually in terms of the shape of products) such that people can interact efficiently, effectively and safely with the said product or system. Ergonomics is also sometimes called human engineering.

**Open** refers to system or product, which uses technology, which is universally known or adopted by industry and is therefore universally and easily available for design and build approach. 'Open' is the antithesis of 'Proprietary'.

**Preferential Engineering (PE) or Preferential Engineered System (PES)** can be defined as a bias towards a particular product or engineering system, which may in most case (though not absolutely necessary), be proprietary.

**Product** refers to engineering components or sub-components which may be assembled from smaller products and which when connected or integrated together form the basis of an engineering system (e.g. AHU, pumps, cables, exhaust fans etc.)

**Proprietary** refers to systems or products which are only marketed by one or a limited supplier's base due to the 'closed' or secret nature of its technology;

**System** refers to **Engineering System** which is defined as an assembly of components or products making a complete functioning system (e.g. air conditioning system, electrical system, fire alarm system etc.).

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