INTRODUCTION

1. **Prediction Emission Monitoring System (PEMS) is a software base data acquisition system systems for continuously monitoring emissions by means of industrial plant process data. It interfaces with the industrial plant process control by utilizing input from the combustion or pollution control process to determine the emission rates of various pollutant that are regulated. PEMS also does not need any gas analyzers. By employing historic paired emission and selected process data of the industrial plant (e.g. load, fuel composition, flow, pressure and temperature data, environmental conditions, steam turbine of power plant and boiler settings or variable of the flue gas pollution control system) a model is generated, which allows determining the actual industrial plant emission for compliant purposes.**

   PEMS maybe use as an alternative to Continuous Monitoring Systems (CEMS) for all gas or oil fired plant (steam turbines, boilers, heater, etc) for components like NOx, SO_2, CO, O_2, CO_2 but also for NH_3, H_2S, HC, VOC). It needs to emphasis that PEMS cannot be applied for solid fuel such as coal fired plant or incinerator. Special emphasis has been put on quality assurance of the PEMS results whereby it is applied USEPA 40 Code of Federal Regulation (40CFR) Part 60 Standard of performance for new stationary sources; Appendix B to Part 60 (for any fuel burning equipment that does not generate power such as boiler, after burner, thermal oxidizer); and USEPA 40 Code of Federal Regulation (40CFR) Part 75 Continuous emission monitoring; Subpart E – alternative monitoring system (for power generation plant). It is worth mentioning, PEMS also known as Smart CEMS or software base CEMS.

2. **Currently, strong motivations to replace CEMS with PEMS are due to:**

(i)   **cost saving due to lower capital cost capital expenditure**

(ii)   **lower operational and maintenance cost**

3. **There are different types of PEMS in market, such as:**

(i)   **Prediction or Parametric or First Principle PEMS**

(ii)   **Statistical hybrid**

(iii)   **Neuro network**

4. **Selection of PEMS for industrial use in Malaysia is very critical for the following reasons:**

(i)   **Prediction or Parametric PEMS is suitable for flares emission reporting. However, Neuro Network PEMS is more complex system and usually not user friendly because any changes to input parameters such as any changes to fuel quality may require frequently reprogramming the model for PEMS quality assurance. As a result it also need specialist to reprogram the model and obtain new certification (RATA – Relative Accuracy Test Audit).**

(ii)   **Statistical- Hybrid PEMS is more preferable due to its robustness, user friendly and easily customize for industrial use. In this case, it just need to fill in input data through a standardize template.**

CRITERIA FOR PEMS APPROVAL BY DOE

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1. **General Requirements For Overall PEMS Application in Malaysia**

   (a) Application for PEMS Approval must be submitted through DOE registered PEMS Consultant.

   (b) Application for PEMS is limited to gases (SO_2, NO_2, CO, HCl, HF, NMVOC) monitoring only.

   (c) PEMS is not allowed for monitoring of particulate matters (dust).

   (d) Application for PEMS is restricted for fuel burning equipment that using liquid or gas fuel with known properties particularly on the sulphur content.

   (e) Application for PEMS is allowable for submission to DOE provided it has gone through the process of feasibility study.

   (f) Application for PEMS approval must comply with:-

   (i)   performance specification (PS-16); and
   (ii) USEPA 40 Code of Federal Regulation (40CFR) Part 60: Standard of performance for new stationary sources; Appendix B to Part 60 (for any fuel burning equipment that does not generate power such as boiler, after burner, thermal oxidizer); or
   (iii) USEPA 40 Code of Federal Regulation (40CFR) Part 75: Continuous emission monitoring; Subpart E – alternative monitoring system (for power generation plant).

2. **Specific criteria for PEMS Consultant Endorse by DOE**

   Three options are given to endorse PEMS Consultant and PEMS Software by DOE:

   (a) **Option 1: Criteria for Registration of PEMS Modeler and PEMS Software**

   (i) **PEMS modeler must have technical knowledge on industrial process whereby PEMS to be installed such as thermodynamic data, statistical method of analysis and an insight understanding of the PEMS software principle. PEMS modeler with a degree in engineering is most preferable.**

   (ii) **Features of software:**
   - **Software must be robust and stable for at least 99 percent of the time.**
   - **Software must not be easily tampered and should incorporate features to control unauthorized changes.**
   - **The software should be able to show operating envelope of input parameters for audit purpose.**
   - **The software should able to detect input failure and to alert the plant operators.**
   - **The software should have redundancy for data storage in case of hard disk failure.**
   - **The software operating manual must be made available for user reference.**
   - **The modeler must ensure the PEMS software should be able to predict by using First Principle or using Statistical Hybrid prediction method.**

(b) **Option 2: Criteria for Registration of Consultant/Stack Tester Using Mobile CEMS equipment application in data collection**

(i) The equipment for CEMS data collection should be certified by MCERTS or TUV and fulfill requirements under European standards:

- **EN14181: Stationary source emission – quality assurance of automated measuring system;**
- **EN15267: Air quality – certification of automated measuring systems**
  - **Part 1: General principle;**
  - **Part 2: Initial assessment of the AMS manufacturers quality management system and post certification surveillance for the manufacturing process; and**
  - **Part 3: Performance criteria and test procedures for automated measuring systems for monitoring emissions from stationary source.**

(ii) The mobile CEMS analyzer must be equipped with automated gas calibration system and connected to calibration gas tank.

(iii) The tank should be filled up with gas at all time. Concentration of the calibration gas must be suited with the measuring range of the analyzer and it should not be expired.

(iv) The mobile CEMS analyzer should be able to measure low and high range of gas concentration.

(v) Only extractive type of mobile CEMS analyzer is accepted.

(vi) Temperature of heated sampling line must be maintained at 180ºC.

(vii) Mobile CEMS analyzer must be operated by competent persons certified by manufacturer or DOE.

(c) **Option 3: Criteria for Registration of PEMS Modeler and PEMS Software with Application of Mobile CEMS equipment in data collection**

The conditions for PEMS registration of Option 3 is based on requirements mentioned in Option 1 and Option 2.

3. **Requirements for PEMS installation and approval**

(a) Engage registered PEMS consultant

(b) Submit PEMS feasibility report to DOE. The basic information for the report should include the following:

(i) Type of fuel burning equipment
(ii) Type of fuel
(iii) Rate of fuel consumption
(iv) Explanation on fuel burning equipment process
(v) Availability and reliability of process sensors

(c) Data collection for PEMS model development on existing facilities should use CEMS with operation time of 720 hours. However, for existing and new facilities running without CEMS need to use mobile CEMS for the data collection at minimum operation time of 1440 hours (data collection for both operation times 720 hours and 1440 hours should comprise of load variations low, normal and high).

(d) **To ensure representative samplings are carried out at appropriate points, the sampling probe should be installed taken into account the followings:**

    (i)   **stack velocity profile**
    (ii)   **heated sampling line and check leak test for sampling line**
    (iii) **gas conditioning system (moisture removal)**
    (iv) **gas flow rate 2 L/min**

(e) **CEMS analyzer must comply specification as mentioned in paragraph 2 (b)(i) .**

(f) **Gas calibration must be carried out on site**

(g) **Conduct initial RATA to ensure a minimum of 27 runs at three levels (i.e. at 9 runs for each level) in which :**

    (i)   **Between the minimum safe and stable level and 50% of the maximum level (low load)**
    (ii)   **Between 80% of the maximum level and the maximum level (high load)**
    (iii) **At the normal operating level or evenly-spaced interval between the minimum safe and stable level and the maximum level if the normal level is within a specified range (10% of the maximum level) of the minimum safe and stable level or the maximum level (normal load)**

(h) **All RATA data must be evaluated for bias, F-Test and correlation analysis**
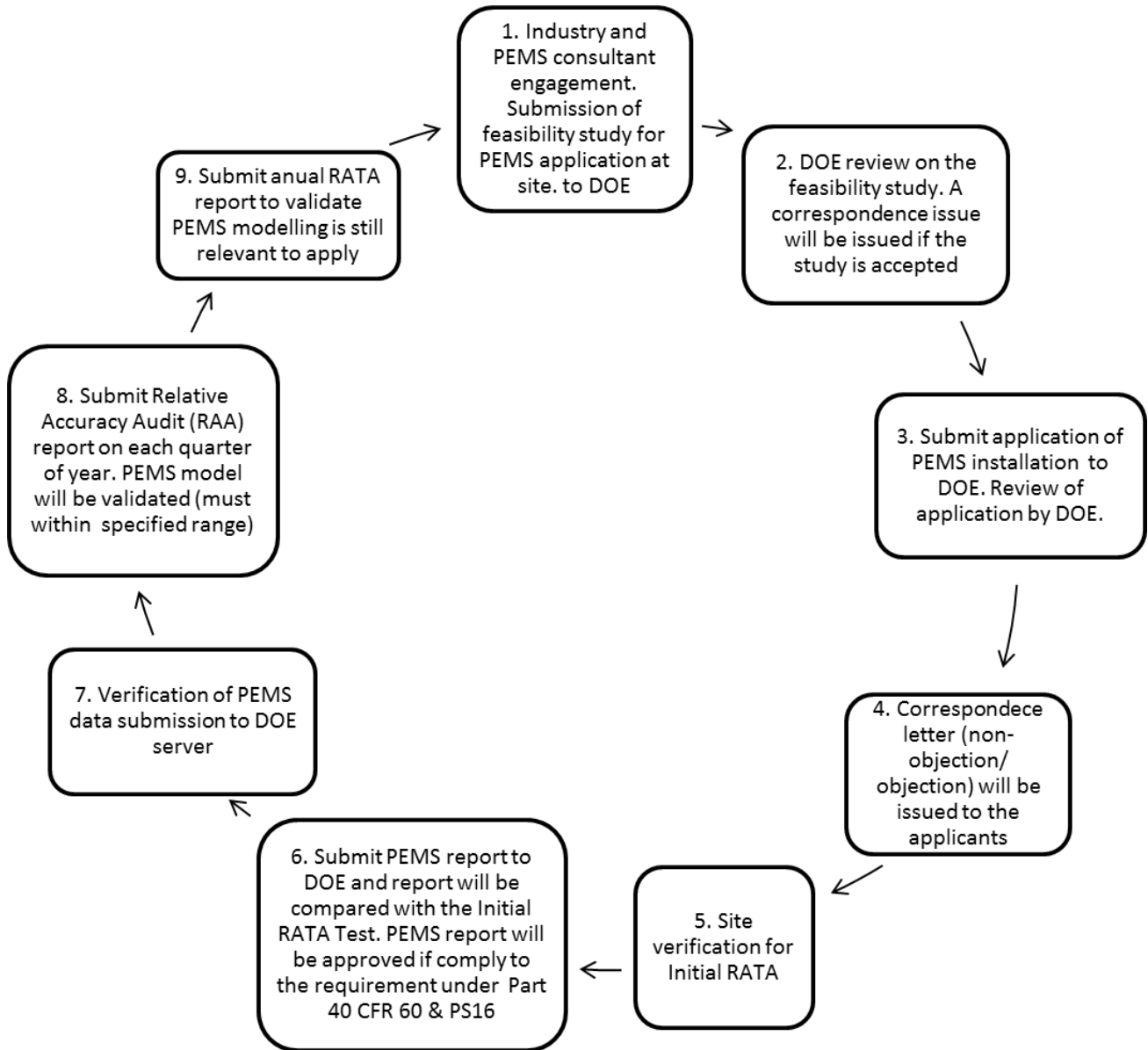
(i) The practical performance requirements for PEMS should comply to the followings:

(i) Should produce best model fit to indicate the plant process operating

(ii) Should conduct sensor validation system in determining whether there is availability of defective and erroneous process sensor and inputs. Under PS 16 requirement, daily sensor validation (once per minute) should be carried out. Redundant sensors and analysis of reliable inputs should be made available.

(iii) Accuracy and precision should follow PS-16/ sub Part E/ CEMS standard

(iv) Measurement frequency should be at least 1 second

(v) Response time 99.9% less than 1 second

(vi) Data availability 99% plus

(vii) Standard server and workstation hardware should be executable

(viii) Visualization (graphic user interface- GUI) by means of a data acquisition systems should be made simple with graphic representation

(ix) Ensure prevention of data manipulation and unauthorized reproduction of license, e.g. log file recording, immutably all modification of software all model , model encryption , new revision number, license key etc.

(x) Standards interface (e.g. OPC, ModBUS, Profibus etc.) should be applied

4. Flow chart for PEMS application

1. Industry and PEMS consultant engagement. Submission of feasibility study for PEMS application at site. to DOE

2. DOE review on the feasibility study. A correspondence issue will be issued if the study is accepted

3. Submit application of PEMS installation to DOE. Review of application by DOE.

4. Correspondece letter (non-objection/ objection) will be issued to the applicants

5. Site verification for Initial RATA

6. Submit PEMS report to DOE and report will be compared with the Initial RATA Test. PEMS report will be approved if comply to the requirement under Part 40 CFR 60 & PS16

7. Verification of PEMS data submission to DOE server

8. Submit Relative Accuracy Audit (RAA) report on each quarter of year. PEMS model will be validated (must within specified range)

9. Submit anual RATA report to validate PEMS modelling is still relevant to apply

GUIDELINES FOR PREDICTIVE EMISSION MONITORING SYSTEM (PEMS) APPLICATION AND APPROVAL PROCEDURES FOR THE USE OF CONSULTANTS AND INDUSTRIES

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