Implementation of Electrical and Instrument Installation in Hazardous Area Classification

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PERTAMINA, Indonesian Flagship Integrated Energy Company, represent nation image in the energy related sectors...

- Upstream Oil & Gas
- Refineries
- Geothermal
- Fuel & Gas Stations
- Shipping & Distributions
- LNG Stations & Storage
MIGAS Joint Venture Contractor (KKKS) company operated at Offshore North West Java (ONWJ) block.

Production:
- Oil : 30,000 BOPD
- Gas : 106 MMSCFD

Oil stored to and exported from FSO Arco Ardjuna with capacity of 1 million barrels
Gas delivered from ORF Muara Karang, Tanjung Priok, Cilamaya and OPF Balongan
Operated since 1971 (ARCO), 2000 (BP), 2009 (Pertamina Hulu Energi)
High Risk Operations

Deepwater Horizon

Facts about Disaster
- 11 dead, 17 injured
- $350,000,000 cost of rig (now 5,000 ft below water)
- $350,000,000 spent so far – BP
- 200,000 gallons (5,000 barrels) leaking per day in the Gulf - $75/barrel = $375,000/day
- $2-14 billion estimated in clean-up and compensation (preliminary)
- Damage to shipping lanes, tourism, fishing/shrimping industry, and wildlife/environment
- Faulty cement casing around well; failed pressure testing hours before explosion
- Faulty blowout preventer (BOP); Kill Switch not activated
How to make PHE ONWJ safe?

**Gradual Deterioration**

**Mechanical Failure**

**Accidental Overload**

**Extreme Conditions**

**Human Error**

**Prevention/Eliminate:**
- Sustain Integrity to prevent leakage (e.g. Regular Inspection)
- Process Monitoring
- Remove Potential hazard
- Preventive Maintenance/Certification
- Operating Procedure/Risk Assessment/CoW
- Training Program
- Remove people during bad weather, drilling rigs move, start up

**Detection:**
- Ensure Fit For Purpose (Fire/Gas Detection)
- Test Primary Protection

**Control:**
- ESD/BDV Testing
- Improve Pigging
- Reduce Confinement
- Isolate
  - **Area classification**
- Test Secondary Protection

**Mitigation:**
- Fire Water/Deluge fit for purpose
- Optimize total number people and manning time
- Fire Response team

**Emergency response:**
- Drills & Training
- ERP procedure
- Live saving equipment inspection
THE FIRE TRIANGLE
The fire “Triangle of Combustion” is used as method to assist in the better understanding of the continuous required to create an ignition or explosion.
(1) There must be a fuel (the flammable gas or vapor, or combustible dust) in ignitable quantities.
(2) There must be an ignition source (energy in the form of heat or a spark) of sufficient energy to cause ignition, and
(3) There must be oxygen, usually the oxygen in the air (approx. 21% by volume in normal air)

Protection Techniques to Prevent Combustion:
a. Removal of any one or more element, e.g. Isolation or separation of the source of ignition from the gas/air mixture.
b. Allow the three element to co-exist and ensure the energy of the source of ignition is maintained below specific value.
c. Allow an explosion to take place and contain it within a robust enclosure

The above techniques is the basis of the various protection systems for electrical and instrument equipment permitted for use in Hazardous (Classified) Locations.
Area Classification

Hazardous Area is defined as:
‘An area in which an explosive gas atmosphere is present, or may be expected to be present, in quantities such as to require special precautions for the construction, installation and use of equipment’.

Non Hazardous Area is defined as:
‘An area in which an explosive gas atmosphere is not expected to be present in quantities such as to require special precautions for the construction, installation and use of equipment’.

Currently there are two systems used to classify these hazardous areas;
1. The Class/Division system, and
2. The Zone system.

The Class/Division system is used predominately in the United States and Canada, whereas the rest of the world generally uses the Zone system.
STANDARD HAZARDOUS CLASSIFIED ELECTRICAL & INSTRUMENTATION APPLICATION in PERTAMINA

DIREKTORAT HULU (UPSTREAM OIL & GAS) – Most of Standards applicable are USA, except some of Subsidiary Operation from the European Operators heritage.

DIREKTORAT PENGOLAHAN (REFINERY) – Most of Plants are USA Standards since most of the Constructors are from USA.

DIREKTORAT MARKETING & TRADING (DOWNSTREAM) – All Official Standards available due to many Subsidiaries involvement.

Moving forwards – PERTAMINA will support BSN in defining the standards.
General Principle Basic of Hazardous Area Classification

Class/Division System
Hazardous locations per the **Class/Division** system are classified according to the **Class**, **Division**, and **Group**.

Class/Division System
Hazardous locations per the **Class/Division** system are classified according to the **Class**, **Division**, and **Group**. **Class** The Class defines the general nature (or properties) of the hazardous material in the surrounding atmosphere which may or may not be in sufficient quantities.

a. **Class I**—Locations in which flammable gases or vapors may or may not be in sufficient quantities to produce explosive or ignitable mixtures.

b. **Class II**—Locations in which combustible dusts (either in suspension, intermittently, or periodically) may or may not be in sufficient quantities to produce explosive or ignitable mixtures.

c. **Class III**—Locations in which ignitable fibers may or may not be in sufficient quantities to produce explosive or ignitable mixtures.
General Principle Basic of Hazardous Area Classification

**Division**
The Division defines the probability of the hazardous material being able to produce an explosive or ignitable mixture based upon its presence.

a. **Division 1** indicates that the hazardous material has a high probability of producing an explosive or ignitable mixture due to it being present continuously, intermittently, or periodically or from the equipment itself under normal operating conditions.

b. **Division 2** indicates that the hazardous material has a low probability of producing an explosive or ignitable mixture and is present only during abnormal conditions for a short period of time.

**Group**
The Group defines the type of hazardous material in the surrounding atmosphere. **Groups A, B, C, and D are for gases (Class I only)** while groups E, F, and G are for dusts and flying's (Class II or III).
General Principle Basic of Hazardous Area Classification

Zone System
The Zone defines the probability of the hazardous material, gas or dust being present in sufficient quantities to produce explosive or ignitable mixtures.

Gas
Zone-0  Ignitable concentrations of flammable gases or vapors which are present continuously or for long periods of time.
Zone-1  Ignitable concentrations of flammable gases or vapors which are likely to occur under normal operating conditions.
Zone-2  Ignitable concentrations of flammable gases or vapors which are not likely to occur under normal operating conditions and do so only for a short period of time.

In API RP 505, the total duration of gas releases on an annual basis for the different Zones is given as:

- Zone-0 - over 1000 hours
- Zone-1 - 10 – 1000 hours
- Zone-2 - 0 – 10 hours
General Principle Basic of Hazardous Area Classification

Different Divisions and Zones
General Principle Basic of Hazardous Area Classification

Diagram showing hazardous area classification with different divisions based on the location and radius of sources, walls, and other features.
General Principle Basic of Hazardous Area Classification

Liquid surface

a = 3 m from vent opening
b = 3 m above the roof
c = 3 m horizontally from the tank

Zone 0
Zone 1
Zone 2

Sump
General Principle Basic of Hazardous Area Classification

- **Zone 0**: a = 3 m from vent opening
- **Zone 1**: b = 1.5 m around the tank
- **Zone 2**: c = 2.5 m beyond the collar
General Principle Basic of Hazardous Area Classification
Electrical Integrity Management System

- Anomaly evaluation
- Integrity assessment
- Maintenance & Repair

Electrical Integrity Management Strategy

Program Implementation

- Inspection & Maintenance
- Completion vs Target
- SCE WO Monitoring System

Document and Data Management

Performance Measurement

Assessment and Corrective Action

Define Monitoring Program & Scheduling

Strategy containing scope, roles & responsibilities and IMR to achieve fit for purpose electrical equipment over its full life-cycle

Program that could be implemented with available resources (people, tools & technology) within a planned time frame
Implementation Hazardous Area PHE ONWJ

During Design and Construction: DED, FEED, Detail Engineering & Construction, Testing & Commissioning:
To ensure each step of the cycles during design -> shall meet with standard and code, specification, guideline, design basis, PSR review and AML
Hazardous Area Standard, Code, Specification and Guideline

GUIDANCE FOR HAZARDOUS AREA ELECTRIC INSTALLATION

1. SCOPE

This document provides guidance for electrical installations in hazardous areas to ensure that plant electrical equipment complies with applicable codes, standards and contract documents.

2. NORMATIVE REFERENCES

The following normative documents contain requirements that, through reference in this text, constitute requirements of this guidance. For detailed references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this guidance are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies.

- American Petroleum Institute (API)
  - API RP 14F
  - API RP 503
  - API 516

- International Electrotechnical Commission (IEC)
  - IEC 60079-0
  - IEC 60079-10
  - IEC 60079-14
  - IEC 60079-17
  - IEC 60079-19
  - IEC 60029

- Institute of Electrical and Electronic Engineers (IEEE)
  - National Fire Protection Association (NFPA)
    - NFPA 30
    - NFPA 37
    - NFPA 73
    - NFPA 497
  - National Electrical Manufacturer Association (NEMA)
    - NEMA 200

Approval Sheet

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Revision Status

Rev. Date By Chk App Issue Purpose Owner Signature
4 29-Mar-2017 DEF EP RA Issued for Revalidation
6.4. Area Classification

1. Plant or facility areas shall be initially classified in accordance with API RP-500 (Division Method).

2. All installations shall meet the requirements of NFPA 70 (NEC) as a minimum.

3. The equipment installed outdoor: it may be located in hazardous area class I, division 1 or division 2 and therefore it shall require particular care in their selection and installation.

4. All electrical equipment installed in classified areas shall have approval from recognized notifying bodies such as UL. ATEX, CENELEC. KEMA, IECEx for use in the NEC category specified for the area.

5. Protection techniques recognized by IEC and NEC standards as below table should be considered for design:

<table>
<thead>
<tr>
<th>Zone</th>
<th>Identification Letters</th>
<th>Permitted in division</th>
<th>Permitted in zone</th>
<th>Principle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flameproof</td>
<td>d</td>
<td>2</td>
<td>1 or 2</td>
<td>Containment</td>
</tr>
<tr>
<td>Intrinsic Safety (Zone 0)</td>
<td>iA</td>
<td>1 or 2</td>
<td>0, 1, 2</td>
<td>Energy limited</td>
</tr>
<tr>
<td>Intrinsic Safety (Zone 1)</td>
<td>iB</td>
<td>2</td>
<td>1 or 2</td>
<td>Energy limited</td>
</tr>
<tr>
<td>Pressurization</td>
<td>P</td>
<td>1 or 2</td>
<td>1 or 2</td>
<td>Excludes Vapours</td>
</tr>
<tr>
<td>Increase safety</td>
<td>e</td>
<td>2</td>
<td>1 or 2</td>
<td>No Arcs</td>
</tr>
<tr>
<td>Immersed in oil</td>
<td>O</td>
<td>1 or 2</td>
<td>1 or 2</td>
<td>Arc Immersion</td>
</tr>
<tr>
<td>Filled with powder/sand</td>
<td>a</td>
<td>2</td>
<td>1 or 2</td>
<td>Hermetite Seal</td>
</tr>
<tr>
<td>Apparatus with “n” protection *)</td>
<td>n</td>
<td>2</td>
<td>2</td>
<td>No Sparking</td>
</tr>
</tbody>
</table>
Hazardous Area Standard, Code, Specification and Guideline

SPECIFICATION FOR HV-LV TRANSFORMER, LIGHTING TRANSFORMER, AND TRANSFORMER FOR DOWNSHOLE PUMP

2. REFERENCES

1. The following documents are referenced herein and are considered a part of this specification.
2. Use the edition of each referenced document in effect on the date of the publication of this specification.

2.1. COMPANY Specifications

- PHEONWJ-SPE-001: Painting Specification for External Metal Surface
- PHEONWJ-SPE-002: Specification for Electrical Installation and Construction
- PHEONWJ-SPE-003: Specification for General Electrical – Offshore
- PHEONWJ-SPE-004: General Field Instrument and Installation Specification
- PHEONWJ-PRC-001: QA & QC Guideline

2.2. Standards and Codes

- American Petroleum Institute (API)
- API RP 540: Electrical Installation in Petroleum Processing Plants
- National Fire Protection Association (NFPA)
- NFPA 70: National Electric Code (NEC)
- Institute of Electrical and Electronic Engineers (IEEE)
- IEEE C57.12.00: General Requirements for Liquid Immersed Distribution, Power and Regulating Transformers
- IEEE C57.12.10: Transformers Safety Requirements
- IEEE C57.12.80: Standard Terminology for Power and Distribution Transformers
- IEEE C57.12.5: Standard Test Codes for Liquid Immersed Distribution, Power and Regulating Transformers
- IEEE C57.12.30: Guide for Loading Mineral Oil Immersed Power Transformers Up to and Including 1250kVA with 56°C and 65°C Winding Rises
- National Electrical Manufacturers Association (NEMA)
- NEMA ST-20: Dry Type Transformers for General Application

3. DEFINITION OF TERMS

- COMPANY: PT. Pertamina Hulu Energi Offshore North West Java (PT. PHE ONWJ). The COMPANY may also include an agent or consultant authorized to act for, and on behalf of, the COMPANY.
- CONTRACTOR: The party that carries out all or part of the design, engineering, procurement, construction, commissioning or management of a project. The COMPANY may undertake all or part of the duties of the CONTRACTOR.
- VENDOR: The party that manufactures or supplies materials, equipment and services to perform the duties specified by the CONTRACTOR.
5.11. Panel box that be utilized as terminal control and junction box shall be comoly with the following requirements:

- For indoor non-hazardous areas boxes shall be NEMA 1.
- For Class 1. Division 2 areas boxes containing arcinc or high temperature devices shall be NEMA 4X and NEMA 7. Where internal components do not exceed T2 (572°F) and there are no internal arcinc devices. boxes in Class 1. Division 2 areas shall be NEMA 4X.
- NEMA 4X Boxes 2 cubic feet internal volume and smaller shall be non-metallic, stainless steel or cast cooper-free aluminum. NEMA 4X boxes over 2 cubic feet internal volume shall be stainless steel or cast cooper-free aluminum.
- For Class 1. Division 1 areas boxes shall be NEMA 4X and NEMA 7.
- Boxes with covers weighing over 10 pounds shall be hinged and provided with a flexible bonding jumper in accordance with NFPA 70.
- NEMA 7 Boxes 0.5 cubic feet and larger shall be provided with one breather and one drain. minimum.
Hazardous Area Classification
Engineering Procedures

• Preparation of Hazardous Source List
  Request to prepare the List to Process engineers

• Typical Hazardous Area Classification
• Hazardous Area Classification Map
• Explosion-proof Equipment Selection
  For lighting Fixture, Motor, PB, JB to be used in Hazardous Area
• 1 Preparation of Hazardous Source List
  Request to prepare the List to Process engineers

• 2 Typical Hazardous Area Classification

• 3 Hazardous Area Classification Map

• 4 Explosion-proof Equipment Selection
  For lighting Fixture, Motor, PB,JB to be used in Hazardous Area
Hazardous Source List

Substance/Operating Condition/Flash Point/Gas density/
Auto-ignition Temp./H2 volume content/Gas Group/Temp. Class/
Hazardous Radius

3.2. Release Sources
The first step in the area classification of the plant is the identification of credible release sources from where flammable fluid may be released, representing a potential flammable hazard.

Typical release sources are as follow:
- Drain points;
- Vents;
- Small bore piping;
- Sample points;
- Open drains;
- Flanges;
- Valves;
- Spill collection surfaces;
• 1. Preparation of Hazardous Source List
   Request to prepare the List to Process engineers

• 2. Typical Hazardous Area Classification

• 3. Hazardous Area Classification Map

• 4. Explosion-proof Equipment Selection
   For lighting Fixture, Motor, PB, JB to be used in Hazardous Area
Typical – Hazardous Area Classification

Lighter than air (Hydrogen) Compressor Shelter
1. Preparation of Hazardous Source List
Request to prepare the List to Process engineers

2. Typical Hazardous Area Classification

3. Hazardous Area Classification Map
   - Class 1  -------- Gas /Vapor
   - Division 1 or 2  --------
     Exist during Normal operation  Div. 1
     Exist only in case of breakdown  Div. 2
   - Group C and D or B

4. Explosion-proof Equipment Selection
   For lighting Fixture, Motor, PB, JB to be used in Hazardous Area
Hazardous Area Classification Plot

ELEVATED STORAGE TANK OR PRESSURE VESSEL
[FIGURE 9G OR APP 8G IX (G)]

NOTE 45

AS BUILT
GO PROJECT
Explosion-proof Equipment Selection – Ex Marking

Equipment certified as providing a method of protection for use in hazardous location

**Typical North American Marking**

- **Class I, Division 1, Groups A&B T4**
- **Class I, Zone 0, AEx ia IIC T4**

- Hazard Class
- Area Classification
- Gas Group
- Temperature Class
- Hazard Class
- Area Classification
- Protection Concept Code
- Gas Group
- Temperature Class

**Typical ATEX and IECEX Marking [ATEX only]**

- CE
- II 2 G Ex d IIC T4 Gb

- Complies with European Directive
- Specific Marking for Explosion Protection
- Equipment Category
- Environment
- Explosion Protection
- Type of Protection
- Gas Group
- Temperature Class (T1-T6)
- Equipment Protection Level

**Figure 1.** An explosion-proof motor

**Figure 2.** This nameplate indicates that the motor in Figure 1 is rated for use in a Class I, Group D location and has a T-code rating of T3B. Note that the motor is also rated for use in a Class II environment.
Installation

**Cable Gland** are used when terminating cable into electrical equipment. They must be selected according to the methods of explosion protection and environmental conditions. The requirement cable gland include:

a. To firmly secure the cable entering the equipment
b. To maintain the ingress protection of the equipment
c. To maintain earth continuity between the equipment and any cable armouring
d. To provide a seal onto the inner and outer sheaths of a cable
e. To ensure containment of an internal explosion in flameproof equipment
f. To prevent gas passing from flameproof enclosure back up the cable
g. To maintain the integrity of restricted breathing equipment.
Installation

Selection of Cable Gland

The correct selection of cable gland is very important. Factors considered include:
- Type of cable
- Type of Ex Protection
- IP rating of the enclosure onto which the gland is to be fitted
- Earth continuity and support of cable entering the equipment
- Environment
Installation

Selection of Cable Gland

- NEC: Class I, Groups A*, B, C, D
  - Class II, Groups F, G
  - Class III, Div. 1 and 2 (except when used with Tray Cable)
  - Article 334, 340, 501-4(b), 502-4(b), 503-3(a)

- CSA Standard C22.2 No. 18-M1987
  - Class I, A, B, C, D SL
  - Class II, E, F, G
  - Class III, Enc. 4 locations

- NEMA: FB1-1989
- UL Standards: 514B, 886
- Fed. Spec.: W-F-406B

<table>
<thead>
<tr>
<th>NPT Thread Size</th>
<th>Armor O.D. Range</th>
<th>Non-Hazardous Cat. #</th>
<th>Hazardous Cat. #</th>
<th>Optional Cold Shrink® Kit Cat. #</th>
</tr>
</thead>
<tbody>
<tr>
<td>½</td>
<td>.440 to .650</td>
<td>TMC165</td>
<td>TMCX165</td>
<td>TMC-K1</td>
</tr>
<tr>
<td>¾</td>
<td>.600 to .850</td>
<td>TMC285</td>
<td>TMCX285</td>
<td>TMC-K2</td>
</tr>
<tr>
<td>1</td>
<td>.800 to 1.120</td>
<td>TMC3112</td>
<td>TMCX3112</td>
<td>TMC-K3</td>
</tr>
<tr>
<td>1¼</td>
<td>1.100 to 1.400</td>
<td>TMC4140</td>
<td>TMCX4140</td>
<td>TMC-K4</td>
</tr>
<tr>
<td>1½</td>
<td>1.330 to 1.610</td>
<td>TMC5161</td>
<td>TMCX5161</td>
<td>TMC-K5</td>
</tr>
<tr>
<td>2</td>
<td>1.570 to 2.060</td>
<td>TMC6206</td>
<td>TMCX6206</td>
<td>TMC-K6</td>
</tr>
<tr>
<td>2½</td>
<td>1.930 to 2.470</td>
<td>TMC7247</td>
<td>TMCX7247</td>
<td>TMC-K7</td>
</tr>
<tr>
<td>3</td>
<td>2.450 to 3.020</td>
<td>TMC8302</td>
<td>TMCX8302</td>
<td>TMC-K8</td>
</tr>
<tr>
<td>3½</td>
<td>2.950 to 3.520</td>
<td>TMC9352</td>
<td>TMCX9352</td>
<td>TMC-K9</td>
</tr>
<tr>
<td>4</td>
<td>3.500 to 4.020</td>
<td>TMC10402</td>
<td>TMCX10402</td>
<td>TMC-K10</td>
</tr>
</tbody>
</table>

* Hazardous location fittings are supplied with sealing compound for one termination. Additional compound may be ordered separately. See following page.
Installation

(a) EY, ENY, ÉÝD, or EYS Sealing fitting used with vertical conduits
(b) ENY or EYS Sealing fittings used with vertical or horizontal conduits
(c) GLF/UNF Female-Female or GUM/UNY Male-Female Series Explosionproof Unions
(d) Explosionproof Junction Boxes Series GE, GEB, X, XALB, GR, JL, JAL, or Elbow
(e) XS Non-Factory Sealed or FXS Factory Sealed Switch or Factory Sealed Control Station
(f) KDB or KB1B Breather
(g) KDB or KB1D Drain
(h) HXB or XFH Fixture Hanger
(i) EMI/EBF LED, Medium Base H.I.D and PL Fluorescent or EZ Mogul Base H.I.D.
(j) EKJ Flexible Fixture Hanger
(k) HFX LinearLite Fluorescent Fixture
(l) HK Instrument Enclosure
(m) XSD, XSX, Non-Factory Sealed or FXSD, FXSX Factory Sealed Manual Line Starter
(n) B7C Prism Circuit Breaker
(p) B7L or B7P Prism Panelboard
(q) Hazardous Location rated Motor
(r) ESXR Strobe Light
(s) XHL Explosionproof Handlamp
(t) UGRF GFI Protected Receptacle
(u) Conduit Clamp or Reducer
(v) ECF or EKJ Explosionproof Flexible Coupling
Installation

(a) Clencher CMX Explosionproof Metal Clad Cable Connector
(b) Clencher CMC Metal Clad Cable Connector
(c) B7C Prism Circuit Breaker
(d) B7L/B7P Prism Panelboard
(e) B7 Prism Magnetic line starter
(f) B7NFD Disconnect Switch
(g) Hazardous Location rated Motor
(h) XGS Non Factory Sealed or FXGS Factory Sealed Push-button, Pilot Light or other Control Station
(i) VSI Switched Plug and Receptacle
(j) XAL Fire Alarm Station
(k) EXB Junction Box with Terminal Boxes
(l) XS Non-Factory Sealed or FXS Factory Sealed Switch
(m) XMSW, XSD, XSS, Non-Factory Sealed or FXSD, FXSX Factory Sealed Manual Motor Starter
(n) EZ, EML, EBF, EMM, EMS, or EMH Series LED, Fluorescent, or H.I.D. Lighting Fixture
(o) HFX Series Fluorescent Lighting Fixture
(p) XFH, HXB, JL, or JAL Series Fixture Hangers
(q) KB1B Breather, KB1D Drain, or KDB-1 Combination Drain and Breather
(r) MC Type Metal Clad Cable Installation
Inspection and Maintenance

Introduction
- Inspection and Maintenance should be carried out on a regular basis to enable detection of potential faults early enough to prevent major breakdown occurring, minimize downtime and loss of production and also possible injury the personal.
- A maintenance program based on the result of inspection surveys can then implemented, which will allow continued reliability and safe operations of the equipment.
- Equipment will only remain approved / certified if it is maintained in accordance with the recommendation provided by manufacturers and the relevant standards.

Standard
IEC 60079-17 : 2007 -- Electrical Installation, Inspection and Maintenance
NFPA 500B -- Recommended Practice for Design and Installation of Electrical Systems for Off-Shore Petroleum Platforms
Inspection and Maintenance

Safe Isolation

• Before any inspection, maintenance or other work that involved opening equipment in the operating plant located in hazardous area is performed, the equipment must be safely isolated.
• Permit to work must be employed and the plant certified to gas free
• All incoming supplies, including neutral connection must be isolated and locked off and tagged with the appropriate caution notice.
• Isolation is normally achieved by switching off the Circuit Breaker, rack-out (for draw out type) and applying a locking device, under PTW system. An alternative method is by means of and isolator and the removal of fuses and neutral link (if applicable)
• Once the isolation has been done, the circuit to be worked on should be prove dead by using the 3-step method TEST – PROVE – TEST
  ✓ Test the tested on a known supply
  ✓ Prove the circuit is dead
  ✓ Re-test the tester on a known supply
Inspection and Maintenance

Qualification of Personnel

- Who involved in the inspection and maintenance of explosion protected shall possess, to the extent necessary to perform their task, the following:
  - An understanding of the general principles of explosion protection.
  - An understanding of the general principles of the various type of explosion protection and marking.
  - An understanding of those aspect of design which affect the protection concept.
  - An understanding of the importance of Permit to Work systems and safe isolation of in relation to explosion protection.
  - Familiarity with the particular techniques to be employed in the inspection and maintenance of equipment referred to in this standard.
  - Practical understanding of explosion protection principles and techniques.
  - Working knowledge and understanding of relevant standards in explosion protection, particularly IEC 60079-10, -14 & -19.
  - Basic knowledge of quality assurance, including principles of auditing, documentation, traceability of measurement and instrument calibration.
CompEx certified personnel

- HAZARDOUS AREAS CompEx Competence Based Course / Certification (Certification Body that offers UKAS accredited certification for personnel who work in explosive atmospheres)

- Appointed personnel who are responsible in the selection, installation and inspection of equipment used in hazardous areas
Inspection and Maintenance

Documentation

Required documentation of the following items is available before inspection and maintenance can be performed:

- Area classification and if include required Equipment Protection Level (EPL)
- For gases, Equipment group (IIA, IIB or IIC) and T-class
- Equipment characteristics, e.g. temperature rating, type of protection, IP rating.
- Records such as equipment lists and location, spares, certificate, technical information, etc.
- Copy of previous inspection reports
Inspection and Maintenance

Inspection Type
There are three type specified, *Initial*, *Periodic* and *Sample* inspection, and define as follow:

**Initial Inspection:** An installation, including its systems and equipment, should subjected to an initial inspection before being brought into services, to establish the suitability of the type protection selected and their method of installation. The grade of inspection shall be “detailed”.

**Periodic Inspection:** Should be implemented to verify that the installation is being maintained in an appropriate condition for continued use in the hazardous area. The grade of inspection for periodic inspections may ‘visual’ or ‘close’. Depending outcome from visual and close inspection, it may necessary to carry out further ‘detailed’ inspection. Factors having an influence on the frequency and grade of periodic inspections are: type of equipment, manufacturers recommendation, environmental conditions, zone of use and result of previous inspection. For fixed equipment does not exceed 3 years, for movable equipment at maximum 12 month.

**Sample Inspection:** Interim sample inspection may be implemented to either support or modify the frequency of periodic inspection, and may be *visual*, *close* and *detailed* grade.
## Inspection Schedule

**Table 42: Inspection schedule for Ex ‘d’, Ex ‘e’ and Ex ‘n’ installations**

<table>
<thead>
<tr>
<th>Check that:</th>
<th>Ex ‘d’</th>
<th>Ex ‘e’</th>
<th>Ex ‘n’</th>
</tr>
</thead>
<tbody>
<tr>
<td>A EQUIPMENT</td>
<td>D</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 Equipment is appropriate to area classification (EPL or zone)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 Equipment group is correct</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 Equipment temperature class is correct</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 Equipment circuit identification is correct</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 Equipment circuit identification is available</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 Enclosure, glasses and glass-to-metal sealing gaskets and/or compounds are satisfactory</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7 There are no unauthorised modifications</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8 There are no visible unauthorised modifications</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9 Bolts, cable entry devices (direct and indirect) and blanking elements are of the correct type and are complete and tight</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Physical check</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Visual check</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10 Flange faces are clean and undamaged and gaskets, if any, are satisfactory</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11 Flange gap dimensions are within maximal values permitted</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12 Lamp rating, type and position are correct</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13 Electrical connections are tight</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14 Condition of enclosure gaskets is satisfactory</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15 Enclosed-break and hermetically sealed devices are undamaged</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16 Restricted breathing enclosure is satisfactory</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>17 Motor fans have sufficient clearance to enclosure and/or covers</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18 Breathing and draining devices are satisfactory</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Inspection Schedule

**Table 42: Inspection schedule for Ex ‘d’, Ex ‘e’ and Ex ‘n’ installations**

<table>
<thead>
<tr>
<th>Check that:</th>
<th>Ex ‘d’</th>
<th>Ex ‘e’</th>
<th>Ex ‘n’</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>INSTALLATION</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 Type of cable is appropriate</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>2 There is no obvious damage to cables</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>3 Sealing of trunking, ducts, pipes and/or conduits is satisfactory</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>4 Stopper boxes and cable boxes are correctly fitted</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>5 Integrity of conduit system and interface with mixed system is maintained</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>6 Earthing connections, including any supplementary earthing bonding connections are satisfactory (e.g. connections are tight and conductors are of sufficient cross-section)</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>– Physical check</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>– Visual check</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>7 Fault loop impedance (TN system) or earthing resistance (IT system) is satisfactory</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>8 Insulation resistance is satisfactory</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>9 Automatic electrical protective devices operate within permitted limits</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>10 Automatic electrical protective devices are set correctly (auto-reset not possible)</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>11 Special conditions of use (if applicable) are complied with</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>12 Cables not in use are correctly terminated</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>13 Obstructions adjacent to flameproof flanged joints are in accordance with EN 60079-14</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>14 Variable voltage/frequency installation in accordance with documentation</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td><strong>ENVIRONMENT</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 Apparatus is adequately protected against corrosion, weather, vibration and other adverse factors</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>2 No undue accumulation of dust and dirt</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>3 Electrical insulation is clean and dry</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
</tbody>
</table>

**Notes**
- General: the checks used for apparatus using both types of protection ‘e’ and ‘d’ will be a combination of both columns
- Items B7 and B8: account should be taken of the possibility of an explosive atmosphere in the vicinity of the apparatus when using electrical test equipment
### Inspection Schedule

**Table 43: Inspection schedule for Ex ‘i’ installations**

<table>
<thead>
<tr>
<th>Check that:</th>
<th>Grade of inspection</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Detailed</td>
</tr>
<tr>
<td><strong>A. EQUIPMENT</strong></td>
<td></td>
</tr>
<tr>
<td>1. Circuit and/or apparatus documentation is appropriate to area classification (EPL and zone)</td>
<td></td>
</tr>
<tr>
<td>2. Equipment installed is that specified in the documentation - Fixed apparatus only</td>
<td></td>
</tr>
<tr>
<td>3. Circuit and/or apparatus category and group correct</td>
<td></td>
</tr>
<tr>
<td>4. Equipment temperature class is correct</td>
<td></td>
</tr>
<tr>
<td>5. Installation is clearly labelled</td>
<td></td>
</tr>
<tr>
<td>6. Enclosure, glasses and glass-to-metal sealing gaskets and/or compounds are satisfactory</td>
<td></td>
</tr>
<tr>
<td>7. There are no unauthorised modifications</td>
<td></td>
</tr>
<tr>
<td>8. There are no visible unauthorised modifications</td>
<td></td>
</tr>
<tr>
<td>9. Safety barrier units, relays and other energy limiting devices are of the approved type, installed in accordance with the certification requirements and securely earthed where required</td>
<td></td>
</tr>
<tr>
<td>10. Electrical connections are tight</td>
<td></td>
</tr>
<tr>
<td>11. Printed circuit boards are clean and undamaged</td>
<td></td>
</tr>
<tr>
<td><strong>B. INSTALLATION</strong></td>
<td></td>
</tr>
<tr>
<td>1. Cables are installed in accordance with the documentation</td>
<td></td>
</tr>
<tr>
<td>2. Cable screens are earthed in accordance with the documentation</td>
<td></td>
</tr>
<tr>
<td>3. There is no obvious damage to cables</td>
<td></td>
</tr>
<tr>
<td>4. Sealing of trunking, ducts, pipes and/or conduits is satisfactory</td>
<td></td>
</tr>
<tr>
<td>5. Point-to-point connections are all correct</td>
<td></td>
</tr>
<tr>
<td>6. Earth continuity is satisfactory for non-galvanic isolated circuits (e.g. connections are tight and conductors are of sufficient cross-section)</td>
<td></td>
</tr>
<tr>
<td>7. Earth connections maintain the integrity of the type of protection</td>
<td></td>
</tr>
<tr>
<td>8. The intrinsically safe circuit is isolated from earth and the earthing is sufficient</td>
<td></td>
</tr>
<tr>
<td>9. Separation is maintained between intrinsically safe and non-intrinsically safe circuits in common distribution boxes or relay cubicles</td>
<td></td>
</tr>
<tr>
<td>10. As applicable, short-circuit protection of the power supply is in accordance with the documentation</td>
<td></td>
</tr>
<tr>
<td>11. Special conditions of use (if applicable) are complied with</td>
<td></td>
</tr>
<tr>
<td>12. Cables not in use are correctly terminated</td>
<td></td>
</tr>
<tr>
<td><strong>C. ENVIRONMENT</strong></td>
<td></td>
</tr>
<tr>
<td>1. Equipment is adequately protected against corrosion, weather, vibration and other adverse factors</td>
<td></td>
</tr>
<tr>
<td>2. No undue accumulation of dust and dirt</td>
<td></td>
</tr>
</tbody>
</table>
## Inspection and Maintenance

### Inspection Schedule

**Table 44: Inspection schedule for Ex ‘p’ or “pD” installations**

<table>
<thead>
<tr>
<th>Check that:</th>
<th>Grade of Inspection</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Detailed</td>
</tr>
<tr>
<td><strong>A EQUIPMENT</strong></td>
<td></td>
</tr>
<tr>
<td>1 Equipment is appropriate to area classification (EPL and zone)</td>
<td>*</td>
</tr>
<tr>
<td>2 Equipment group is correct</td>
<td>*</td>
</tr>
<tr>
<td>3 Equipment temperature class is correct</td>
<td>*</td>
</tr>
<tr>
<td>4 Equipment circuit identification is correct</td>
<td>*</td>
</tr>
<tr>
<td>5 Equipment circuit identification is available</td>
<td>*</td>
</tr>
<tr>
<td>6 Enclosure, glasses and glass-to-metal sealing gaskets and/or compounds are satisfactory</td>
<td>*</td>
</tr>
<tr>
<td>7 There are no unauthorised modifications</td>
<td>*</td>
</tr>
<tr>
<td>8 There are no visible unauthorised modifications</td>
<td></td>
</tr>
<tr>
<td>9 Lamp rating, type and position are correct</td>
<td>*</td>
</tr>
<tr>
<td><strong>B INSTALLATION</strong></td>
<td></td>
</tr>
<tr>
<td>1 Type of cable is appropriate</td>
<td>*</td>
</tr>
<tr>
<td>2 There is no obvious damage to cables</td>
<td>*</td>
</tr>
<tr>
<td>3 Earthing connections, including any supplementary earthing bonding connections are satisfactory (e.g. connections are tight and conductors are of sufficient cross-section)</td>
<td>*</td>
</tr>
<tr>
<td>- Physical check</td>
<td></td>
</tr>
<tr>
<td>- Visual check</td>
<td></td>
</tr>
<tr>
<td>4 Fault loop impedance (TN system) or earthing resistance (IT system) is satisfactory</td>
<td>*</td>
</tr>
<tr>
<td>5 Automatic electrical protective devices operate within permitted limits</td>
<td>*</td>
</tr>
<tr>
<td>6 Automatic electrical protective devices are set correctly</td>
<td>*</td>
</tr>
<tr>
<td>7 Protective gas inlet temperature is below maximum specified</td>
<td>*</td>
</tr>
<tr>
<td>8 Ducts, pipes and enclosures are in good condition</td>
<td>*</td>
</tr>
<tr>
<td>9 Protective gas is substantially free from contaminants</td>
<td>*</td>
</tr>
<tr>
<td>10 Protective gas pressure and/or flow is adequate</td>
<td>*</td>
</tr>
<tr>
<td>11 Pressure and/or flow indicators, alarms and interlocks function correctly</td>
<td>*</td>
</tr>
<tr>
<td>12 Conditions of spark and particle barriers of ducts for exhausting the gas in hazardous area are satisfactory</td>
<td>*</td>
</tr>
<tr>
<td>13 Special conditions of use (if applicable) are complied with</td>
<td>*</td>
</tr>
<tr>
<td><strong>C ENVIRONMENT</strong></td>
<td></td>
</tr>
<tr>
<td>1 Equipment is adequately protected against corrosion, weather, vibration and other adverse factors</td>
<td>*</td>
</tr>
<tr>
<td>2 No undue accumulation of dust and dirt</td>
<td>*</td>
</tr>
</tbody>
</table>
Inspection and Maintenance

Ex Equipment Inspection & Maintenance Procedure

STANDARD OPERATING PROCEDURE
INSPECTION AND MAINTENANCE OF
HAZARDOUS / Ex EQUIPMENT

Approval Sheet

<table>
<thead>
<tr>
<th>Name</th>
<th>Title</th>
<th>Date</th>
<th>Signature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mefredi</td>
<td>Operations Technical &amp; Maintenance Manager</td>
<td>8/11/2017</td>
<td></td>
</tr>
<tr>
<td>Heri Haruman</td>
<td>Electrical Maintenance Lead</td>
<td>25/3/2018</td>
<td></td>
</tr>
</tbody>
</table>

Revision Status

<table>
<thead>
<tr>
<th>Rev</th>
<th>Issue Date</th>
<th>By</th>
<th>Chk</th>
<th>App</th>
<th>Issue Purpose</th>
<th>Owner Signature</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>23 Mar 2015</td>
<td>LLP</td>
<td>RUPR</td>
<td>MIF</td>
<td>Issued For Approval</td>
<td></td>
</tr>
</tbody>
</table>
Ex Equipment Inspection/Audit

Scope of inspection / audit:
• General
• Switchgear Building
• Junction Box
• Push Button
• Receptacle
• Paging System
• Fire & Gas Equipment
• Lighting
• Motor
• Turbine Generator
• Engine Generator
• Conduit
## Follow-up Actions

### 4.4.2 Program Rencana Perbaikan Mike-Mike F/S

<table>
<thead>
<tr>
<th>No.</th>
<th>Jenis Perbaikan</th>
<th>Kategori</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Penggantian junction box dan conduit ke armor cable pada Trans Pump</td>
<td>Kategori 1</td>
</tr>
<tr>
<td>2</td>
<td>Penggantian junction box, push button, dan conduit ke armor cable pada Booster Pump</td>
<td>Kategori 1</td>
</tr>
<tr>
<td>3</td>
<td>Perawatan dan monitoring Fin Fan motor yang heavy corroded</td>
<td>Kategori 1</td>
</tr>
<tr>
<td>3</td>
<td>Perbaikan dan perawatan terhadap semua junction box yang terpasang.</td>
<td>Kategori 2</td>
</tr>
<tr>
<td>4</td>
<td>Perbaikan dan perawatan terhadap semua push button yang terpasang dan penggantian push button yang heavy corroded dan rusak</td>
<td>Kategori 2</td>
</tr>
<tr>
<td>5</td>
<td>Penggantian outdoor lighting panel di area MMJ yang heavy corroded dan terdapat modifikasi</td>
<td>Kategori 3</td>
</tr>
<tr>
<td>6</td>
<td>Melepas semua conduit dan equipment yang sudah tidak digunakan</td>
<td>Kategori 3</td>
</tr>
<tr>
<td>7</td>
<td>Mengganti conduit untuk lighting system dengan armour cable</td>
<td>Kategori 3</td>
</tr>
<tr>
<td>8</td>
<td>Perbaikan dan penggantian lampu yang rusak/mati</td>
<td>Kategori 3</td>
</tr>
</tbody>
</table>
terima kasih