PERTAMINA
Energi untuk Inovasi Berkelanjutan

PERTAMINA
HULU ENERGI

Implementation of Electrical and Instrument Installation in Hazardous Area Classification

BANGKITKAN
ENERGI NEGERI

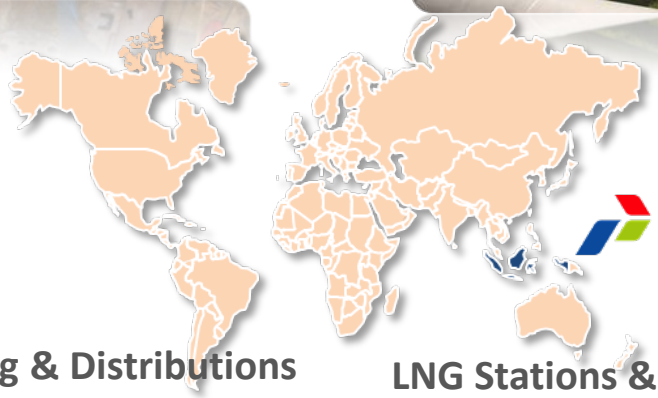
Rosihan Anwar - Pertamina Hulu Energi ONWJ

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

Upstream Oil & Gas

Geothermal

Refineries



Fuel & Gas Stations

Shipping & Distributions

LNG Stations & Storage

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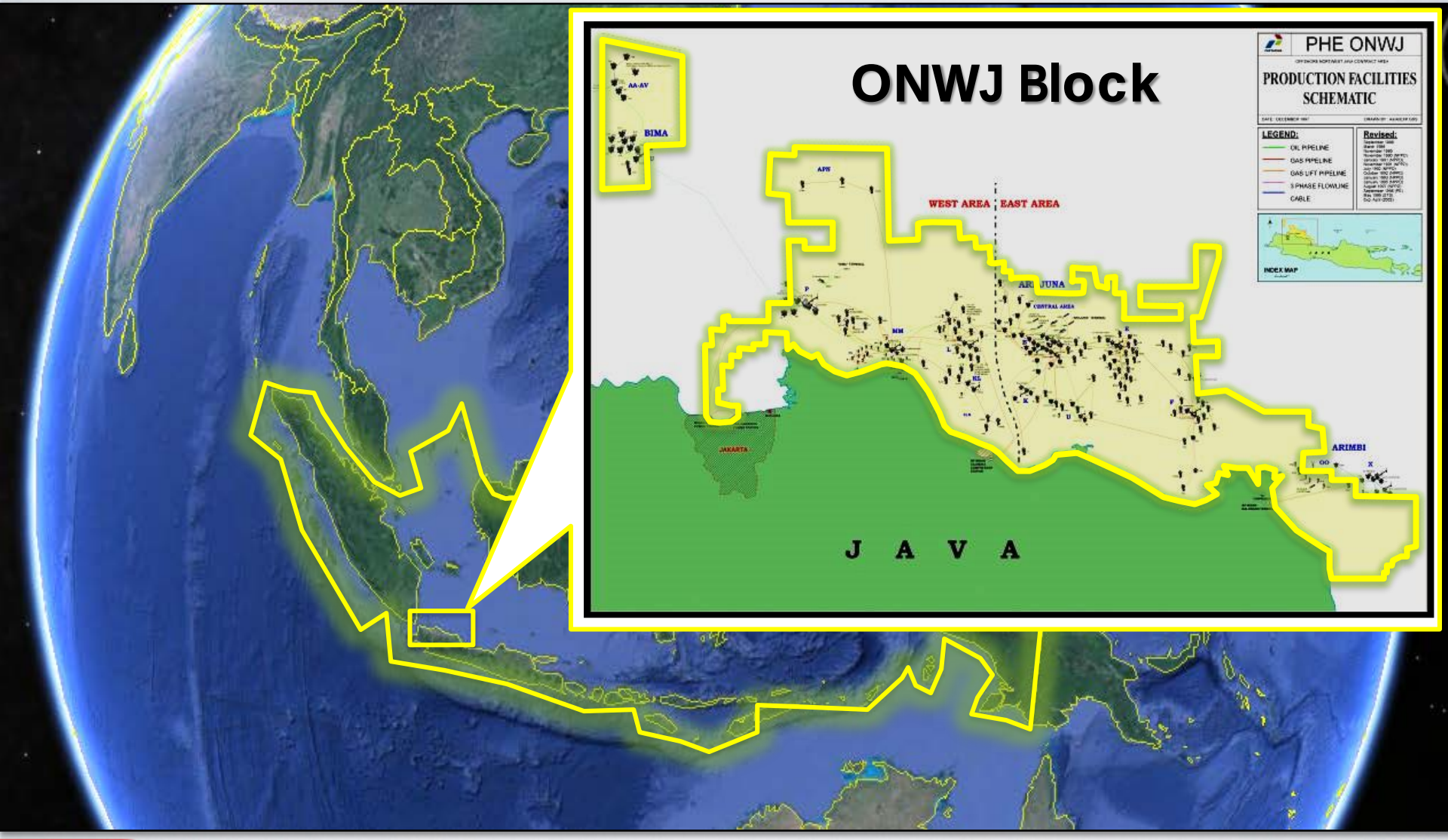
1500 000

Pertamina Hulu Energi Offshore North West Java

PERTAMINA



- 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

PHOTO: U.S. COAST GUARD, VIA GETTY IMAGES

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

7 **The fire and gas system did not prevent hydrocarbon ignition.** Hydrocarbons migrated beyond areas on *Deepwater Horizon* that were electrically classified to areas where the potential for ignition was higher. *The heating, ventilation and air conditioning system probably transferred a gas-rich mixture into the engine rooms, causing at least one engine to overspeed, creating a potential source of ignition.*

How to make PHE ONWJ safe ?

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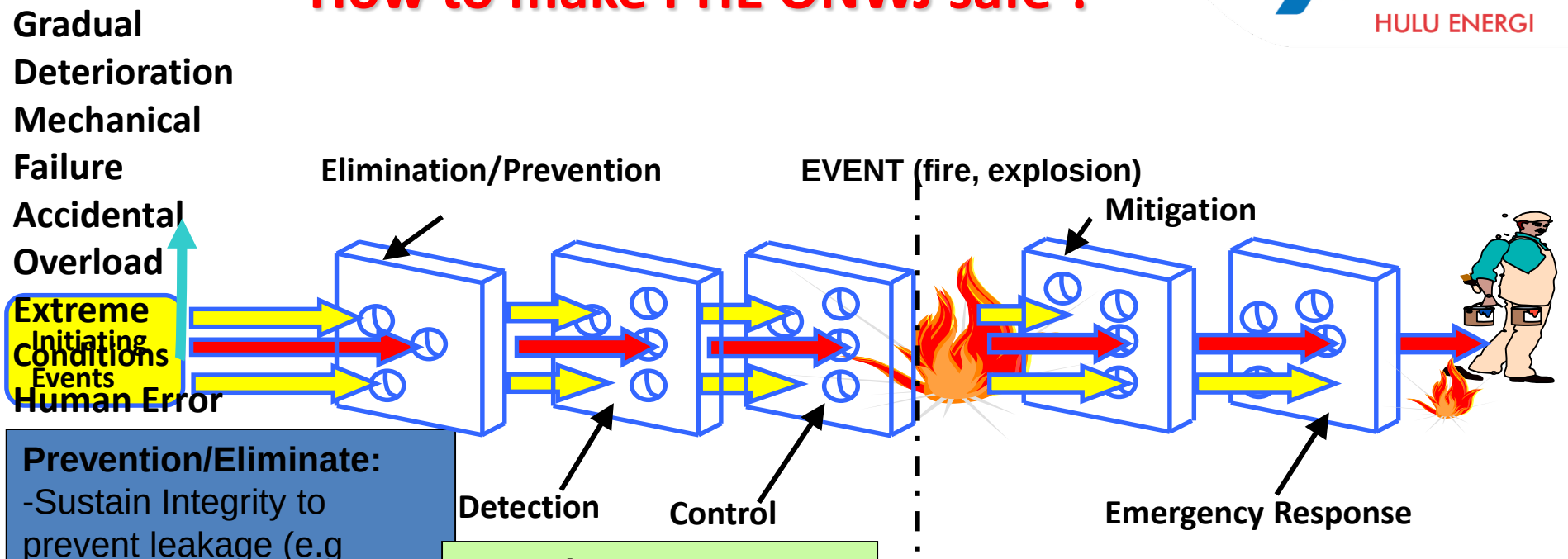

Prevention/Eliminate:
-Sustain Integrity to prevent leakage (e.g Regular Inspection)
-Process Monitoring
-Remove Potential hazard
-Preventive Maintenance/ Certification
-Operating Procedure/ Risk Assessment/ CoW
-Training Program
-Remove people during bad weather, drilling rigs move, start up

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

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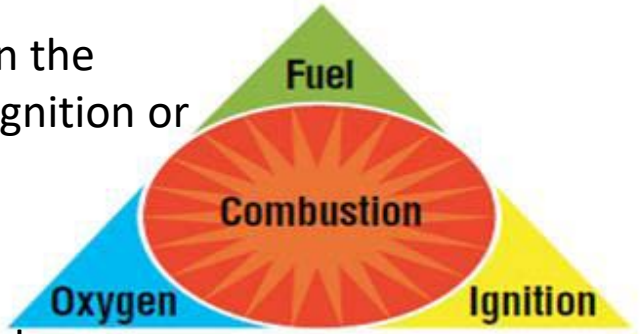
THE FIRE TRIANGLE

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.

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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**.

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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.

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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.

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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).

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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

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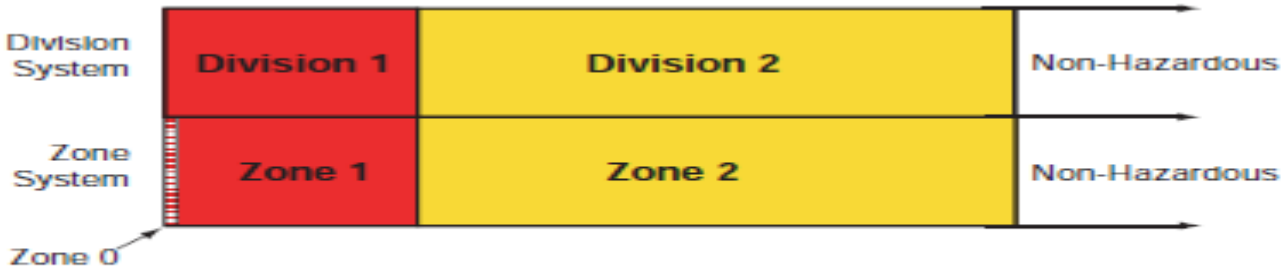
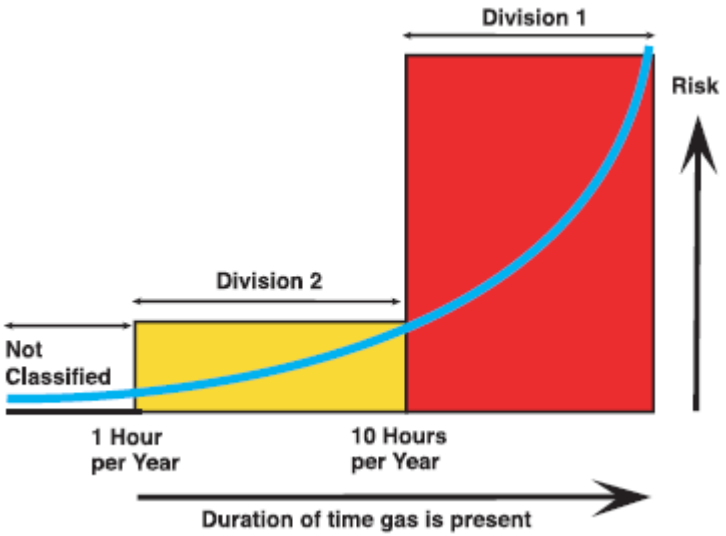
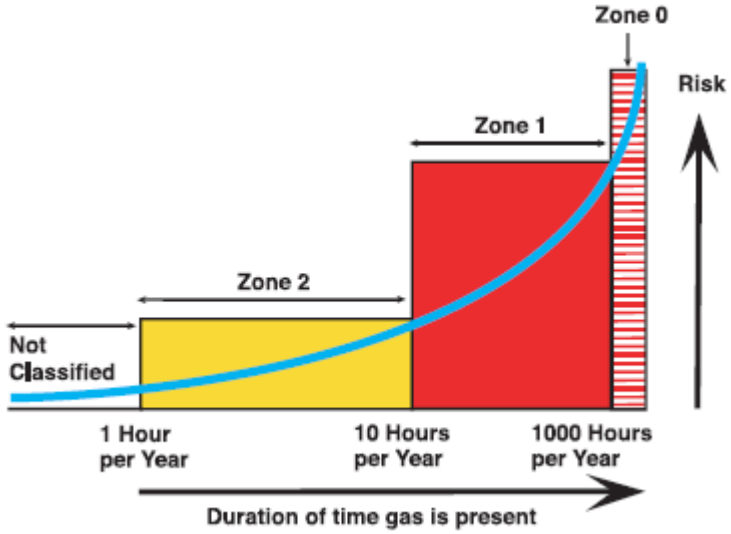
Different Divisions and Zones



Differences Between Divisions and Zones.





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General Principle Basic of Hazardous Area Classification

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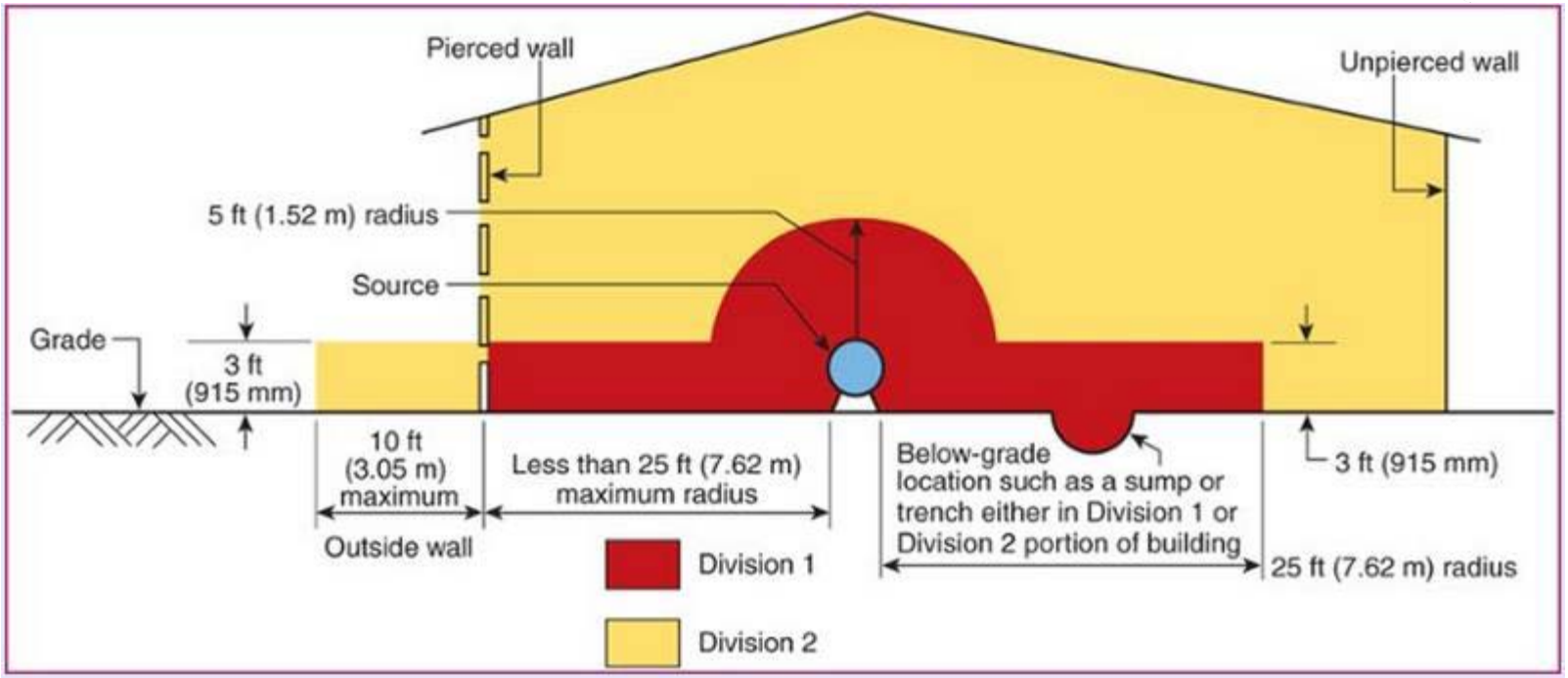

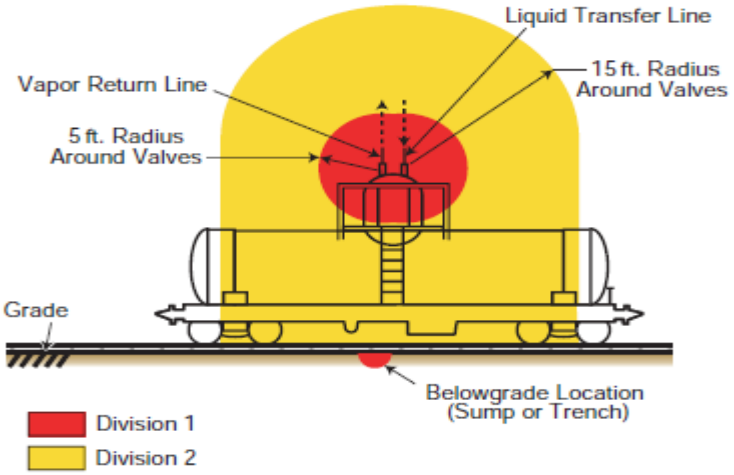

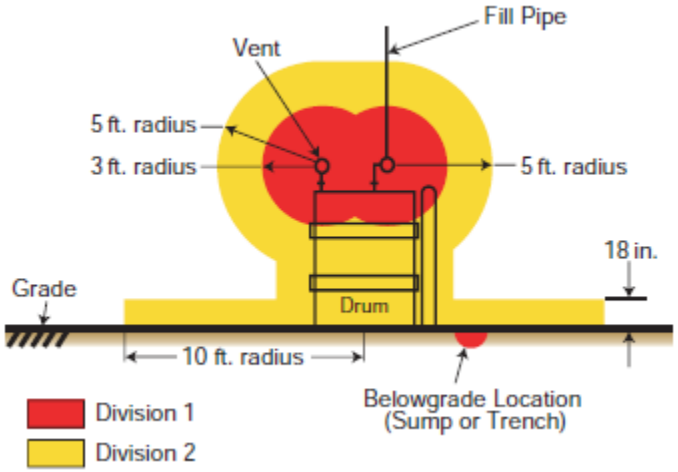

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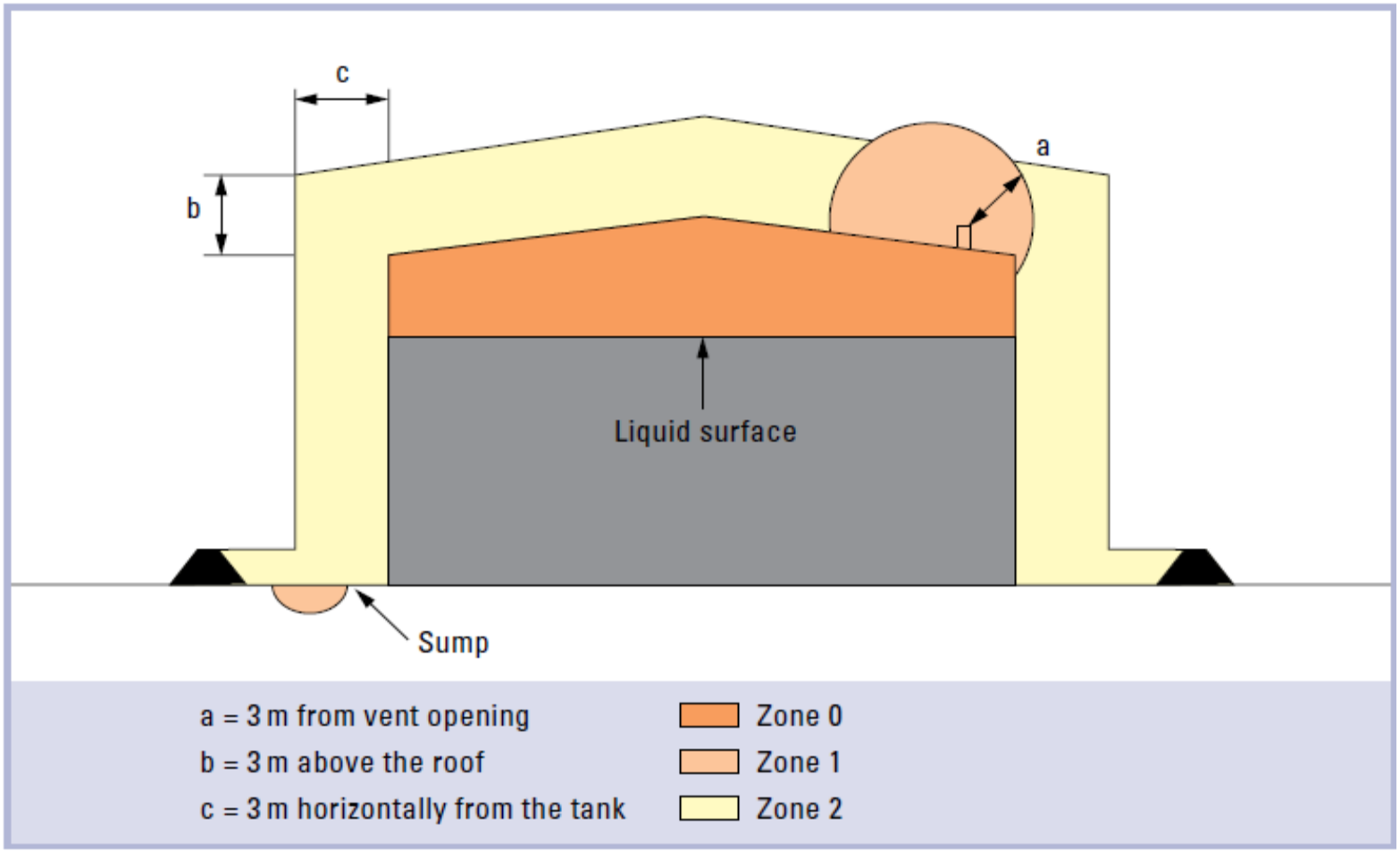
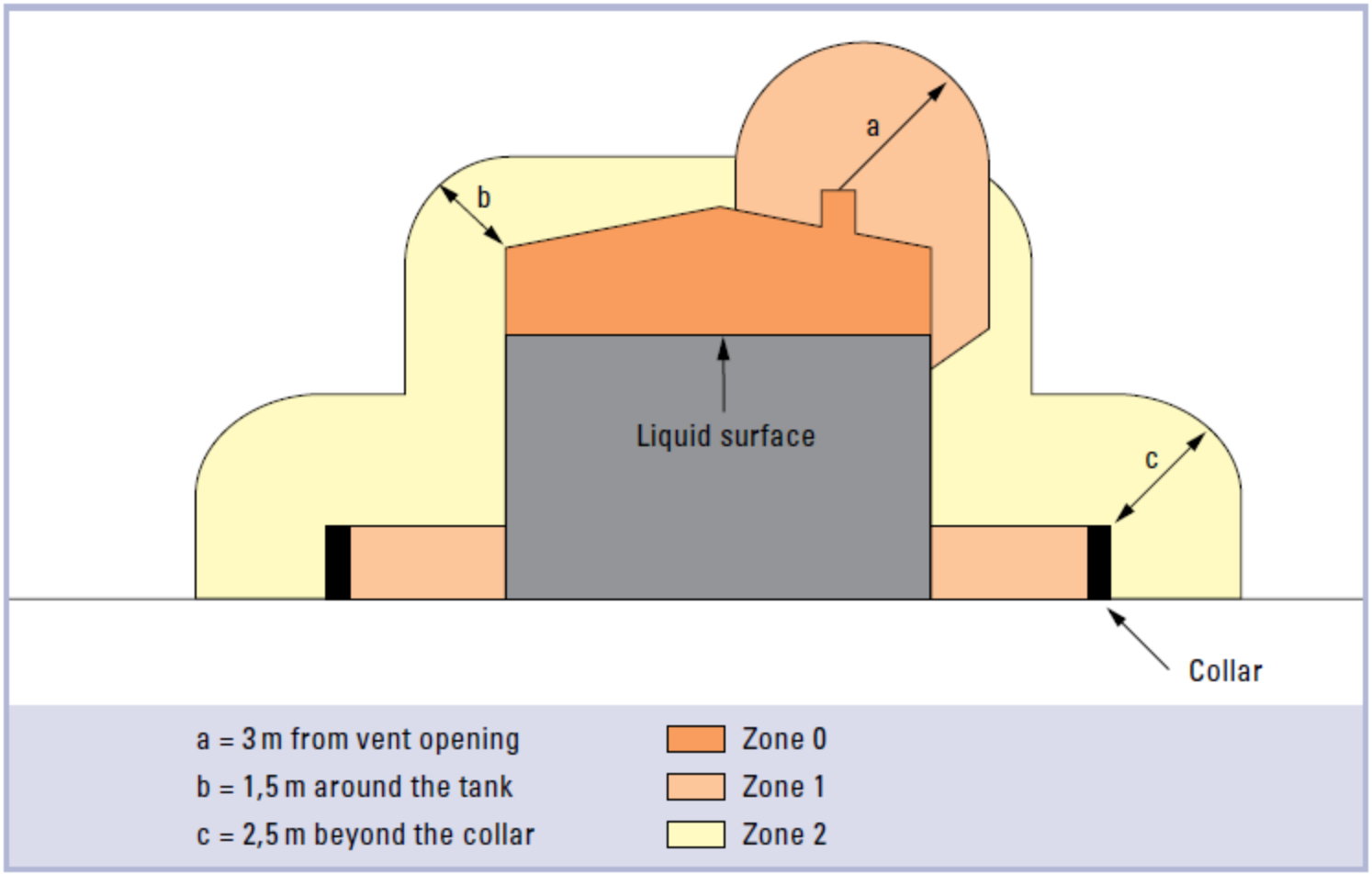
General Principle Basic of Hazardous Area Classification

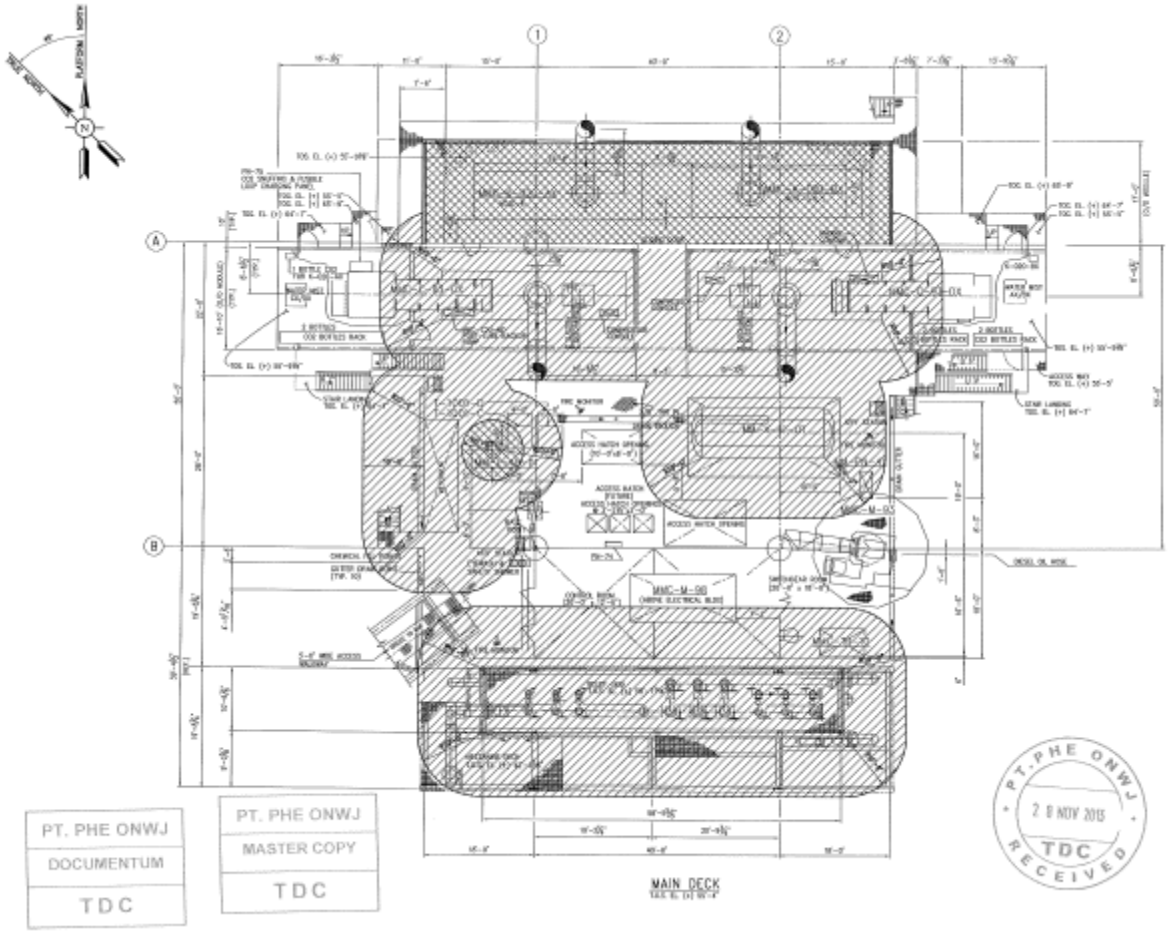


General Principle Basic of Hazardous Area Classification



General Principle Basic of Hazardous Area Classification

PERTAMINA HULU ENERGI



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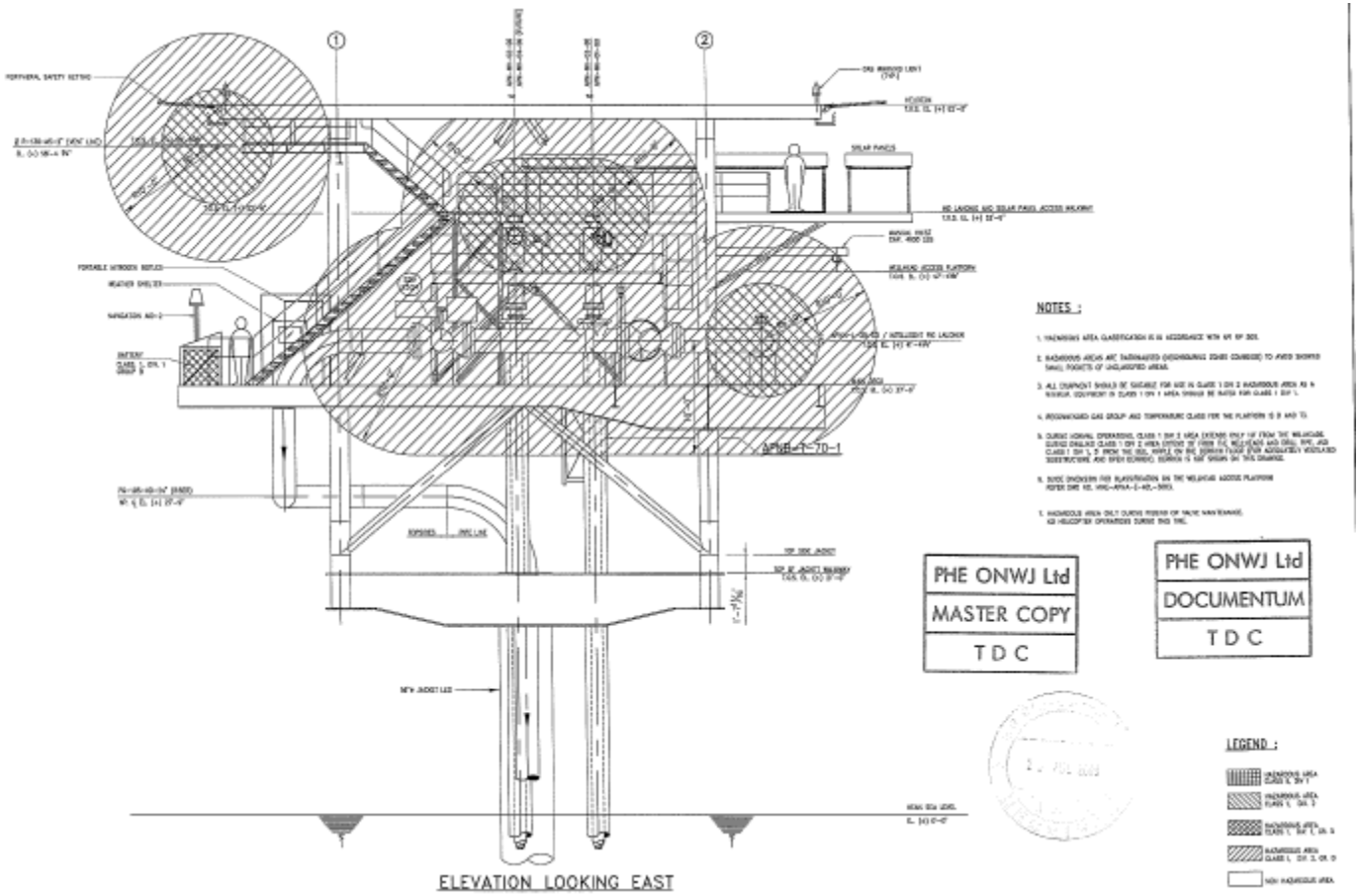
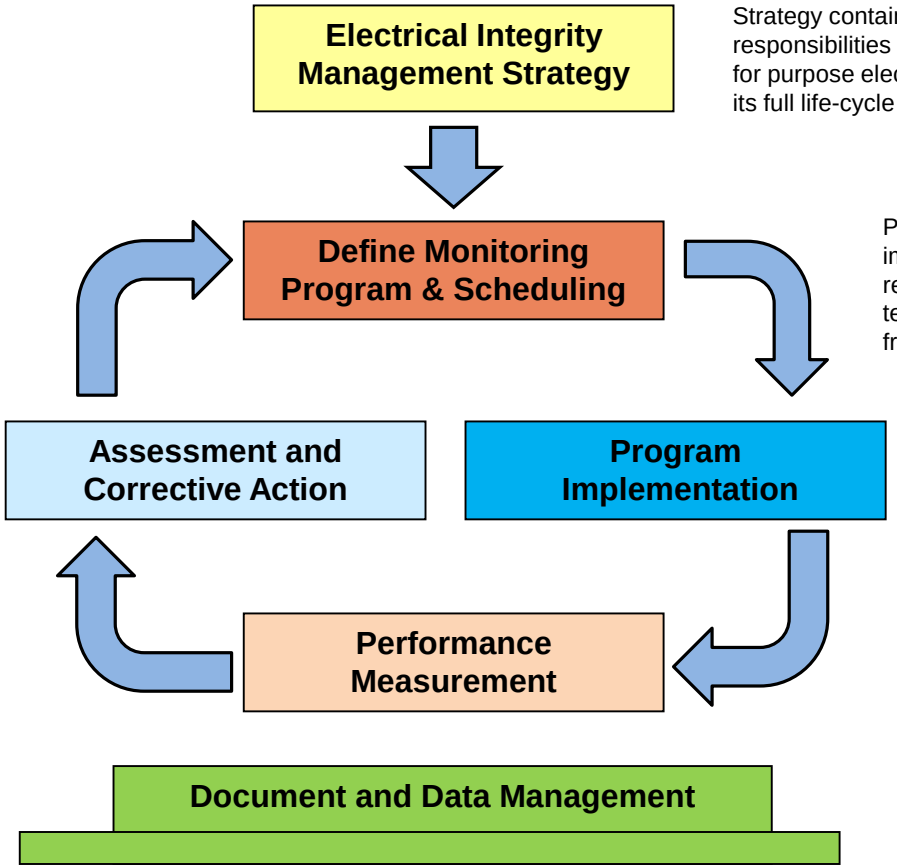
General Principle Basic of Hazardous Area Classification



ELEVATION LOOKING EAST

Electrical Integrity Management System



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

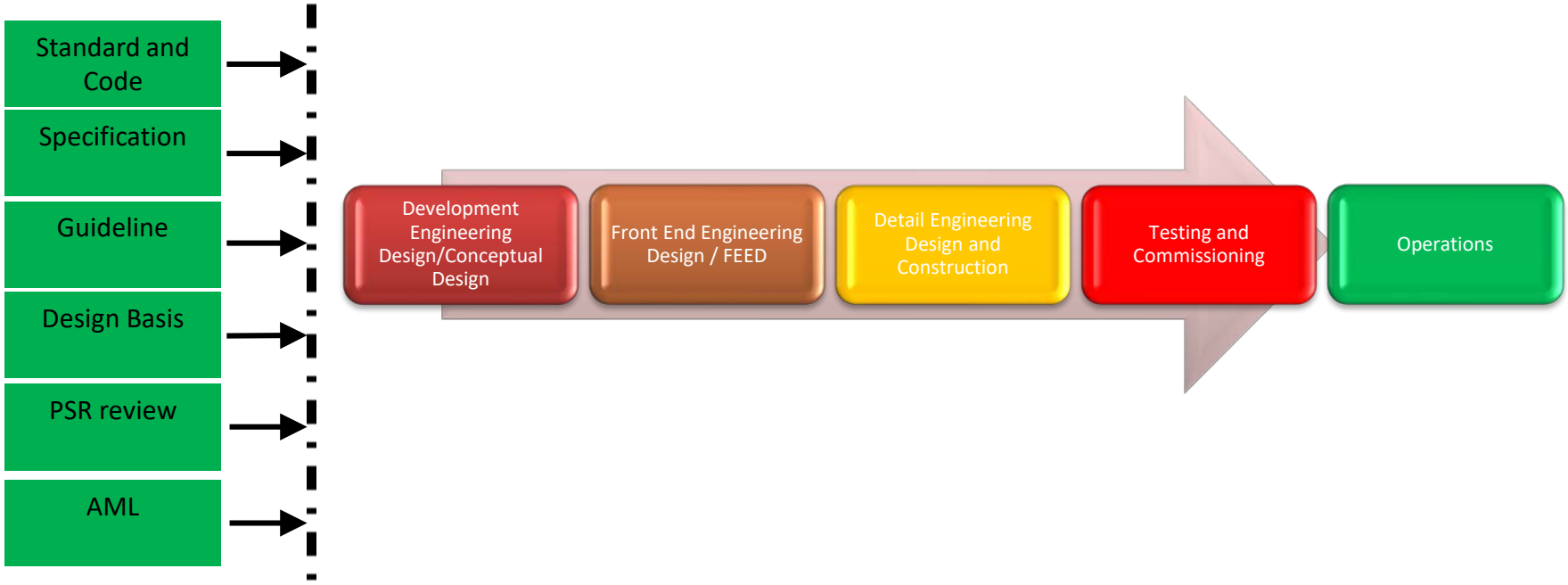
- Inspection & Maintenance

- Completion vs Target
- SCE WO Monitoring System

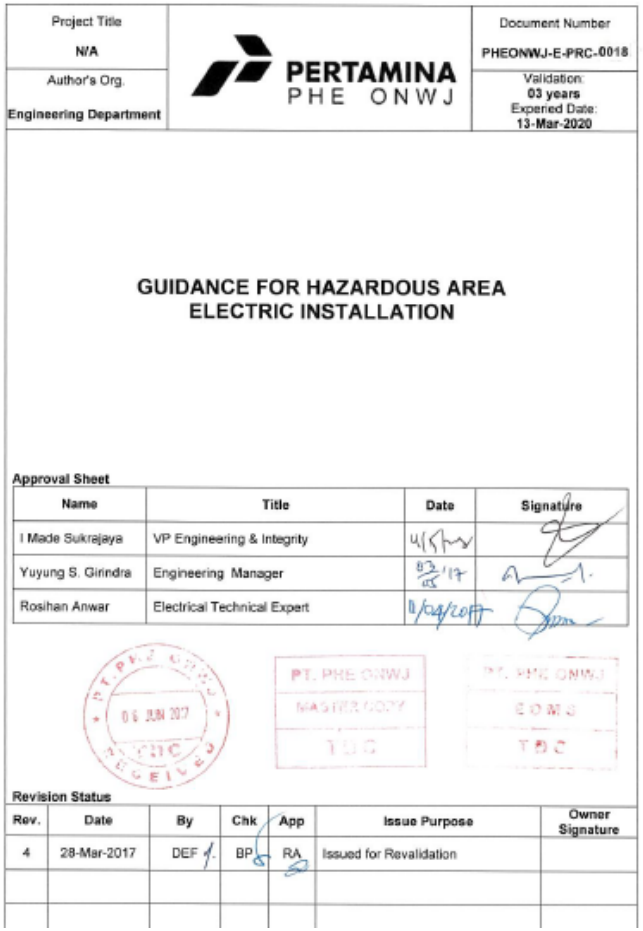
- Anomaly evaluation
- Integrity assessment
- Maintenance & Repair

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



Project Title		Document Number
N/A	PERTAMINA PHE ONWJ	PHEONWJ-E-PRC-0018
Author's Org.		Validation: 03 years Experied Date: 13-Mar-2020
Engineering Department		

GUIDANCE FOR HAZARDOUS AREA ELECTRIC INSTALLATION

Approval Sheet

Name	Title	Date	Signature
I Made Sukrajaya	VP Engineering & Integrity	4/5/17	
Yuyung S. Girindra	Engineering Manager	03/05/17	
Rosihan Anwar	Electrical Technical Expert	11/04/2017	

06 JUN 2017

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PT. PHE ONWJ COMS TBC

Revision Status

Rev.	Date	By	Chk	App	Issue Purpose	Owner Signature
4	28-Mar-2017	DEF	BP	RA	Issued for Revalidation	

1. SCOPE

This document provides guidance for electrical installations in hazardous areas to insure 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 dated 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.

PHE ONWJ

PHEONWJ-E-SPE-0011 Specification for Electrical Installation and Construction

American Petroleum Institute (API)

API RP 14F	Recommended practice for design and installation of electrical systems for fixed and floating offshore petroleum facilities for unclassified and class I, division 1 and division 2 locations
API RP 500	Recommended practice for classification of locations for electrical installations at petroleum facilities classified as class I, division 1 and division 2
API 616	Gas turbines for petroleum, chemical and gas industry services

International Electrotechnical Commission (IEC)

IEC 60079 – 0	Electrical apparatus for explosive gas atmospheres: Part 0 – General introduction
IEC 60079 – 10	Electrical apparatus for explosive gas atmospheres: Part 11 – Intrinsic safety "e"
IEC 60079 – 14	Electrical apparatus for explosive gas atmospheres: Part 14 –Electrical installations in explosive gas atmospheres (other than mines)
IEC 60079 – 17	Electrical apparatus for explosive gas atmospheres: Part 17 – Recommendations for inspection & maintenance of electrical installations in hazardous areas
IEC 60079 – 19	Electrical apparatus for explosive gas atmospheres: Part 19 – Repair and overhaul for apparatus used in explosive atmospheres
IEC 60529	Degrees of protection provided by enclosures

Institute of Electrical and Electronic Engineers (IEEE)

National Fire Protection Association (NFPA)

NFPA 30	Flammable and combustible liquids code
NFPA 37	Standard for the installation and use of stationary combustion engines and gas turbines
NFPA 70	National electrical code (NEC)
NFPA 497	Recommended practice for the classification of flammable liquids, Gases, or vapours and of hazardous (Classified) locations for electrical installations in chemical process areas

National Electrical Manufacturer Association (NEMA)

NEMA 250 Enclosures for electrical equipment (1000 volts maximum)

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Hazardous Area Standard, Code, Specification and Guideline

SPECIFICATION FOR
GENERAL ELECTRICAL - OFFSHORE

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.

Approval Sheet

Name	Title	Date	Signature
Ani Surakhman	Sr. Manager Engineering and Integrity	9/10/17	
Mefredi	Operations Technical & Maintenance Manager	11/10/2017	
I Made Sukrajaya	Engineering Manager	10/8/17	

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 consider for design:

Zone	Identification Letters	Permitted in division	Permitted in zone	Principle
Flameproof	d	2	1 or 2	Containment
Intrinsic Safety (Zone 0)	ia	1 or 2	0. 1. 2	Energy limited
Intrinsic Safety (Zone 1)	ib	2	1 or 2	Energy limited
Pressurization	p	1 or 2	1 or 2	Expels Vapours
Increase safety	e	2	1 or 2	No Arcs
Immersed in oil	o	1 or 2	1 or 2	Arcs Immersion
Filled with powder/sand	q	2	1 or 2	Hermitec Seal
Apparatus with "n" protection *)	n	2	2	No Sparkling

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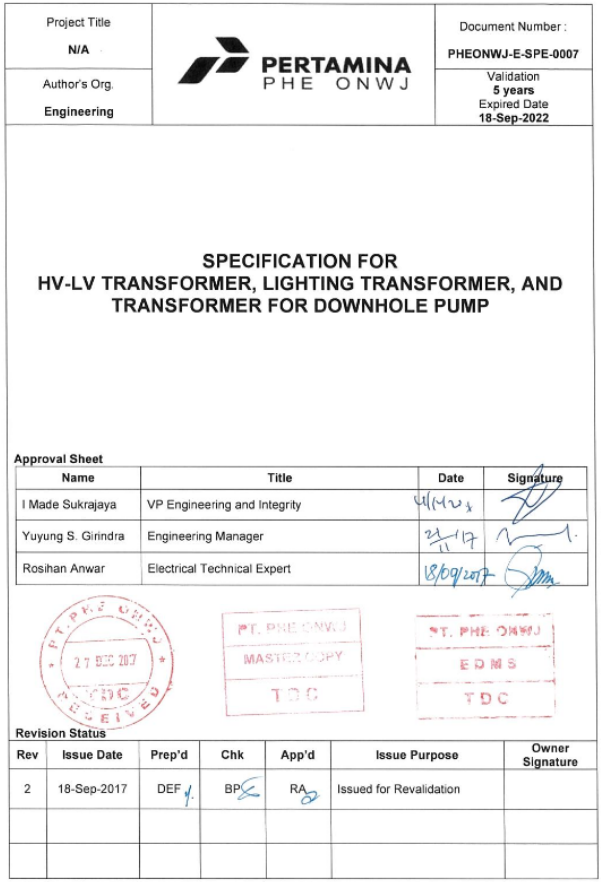
Hazardous Area Standard, Code, Specification and Guideline



Project Title		Document Number :
N/A	PERTAMINA PHE ONWJ	PHEONWJ-E-SPE-0007
Author's Org.		Validation
Engineering		5 years
		Expired Date
		18-Sep-2022

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

Approval Sheet

Name	Title	Date	Signature
I Made Sukrajaya	VP Engineering and Integrity	4/11/17	
Yuyung S. Girindra	Engineering Manager	27/11/17	
Rosihan Anwar	Electrical Technical Expert	18/09/2017	

27 DEC 2017 PHE ONWJ RECEIVED

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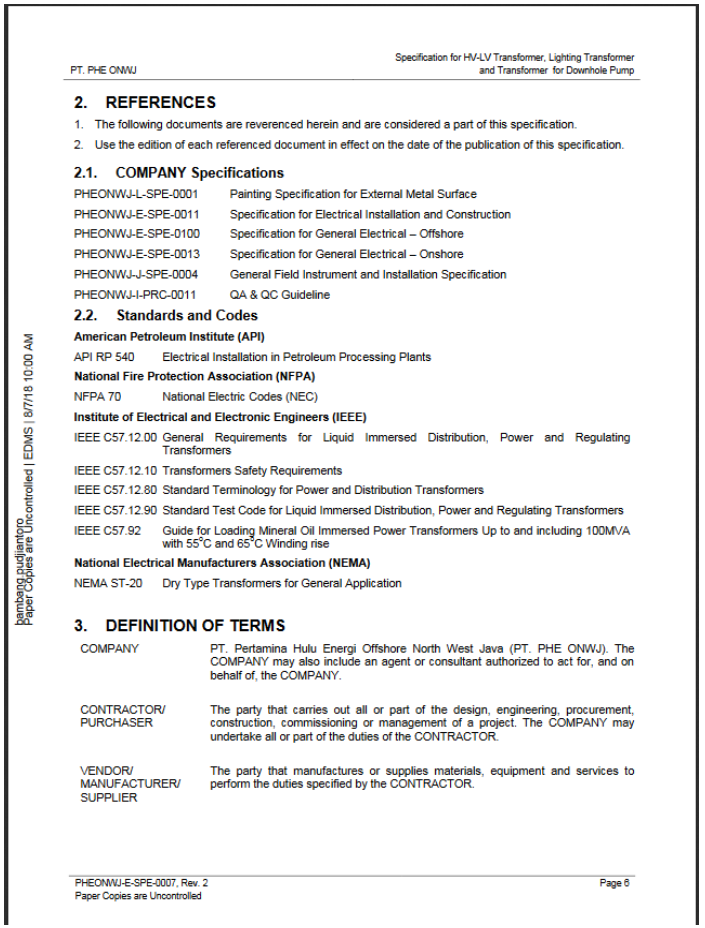
Revision Status

Rev	Issue Date	Prep'd	Chk	App'd	Issue Purpose	Owner Signature
2	18-Sep-2017	DEF	BP	RA	Issued for Revalidation	



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2. REFERENCES

1. The following documents are reverenced 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-L-SPE-0001	Painting Specification for External Metal Surface
PHEONWJ-E-SPE-0011	Specification for Electrical Installation and Construction
PHEONWJ-E-SPE-0100	Specification for General Electrical – Offshore
PHEONWJ-E-SPE-0013	Specification for General Electrical – Onshore
PHEONWJ-J-SPE-0004	General Field Instrument and Installation Specification
PHEONWJ-I-PRC-0011	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 Codes (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 C57.12.90 Standard Test Code for Liquid Immersed Distribution, Power and Regulating Transformers

IEEE C57.92 Guide for Loading Mineral Oil Immersed Power Transformers Up to and including 100MVA with 55°C and 65°C Winding rise

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/ PURCHASER	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/ MANUFACTURER/ SUPPLIER	The party that manufactures or supplies materials, equipment and services to perform the duties specified by the CONTRACTOR.

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Hazardous Area Standard, Code, Specification and Guideline

SPECIFICATION FOR CUBICLE AND PANEL BOX

Approval Sheet

Name	Title	Date	Signature
Ani Surakhman	Sr. Manager Engineering and Integrity	27/11/12	
Benny Nuryadi	Operations Technical & Maintenance Manager	9/11/2012	
I Made Sukrajaya	Engineering Manager	Nov 9	

5.11. Panel box that be utilized as terminal control and junction box shall be comply with the following requirements:

- For indoor non-hazardous areas boxes shall be NEMA 1.
- For Class 1. Division 2 areas boxes containing arcing or high temperature devices shall be NEMA 4X and NEMA 7. Where internal components do not exceed T2 (572^{0}F) and there are no internal arcing 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 copper-free aluminum. NEMA 4X boxes over 2 cubic feet internal volume shall be stainless steel or cast copper-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.

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Approved Manufacturer List (AML)

Project Title		Document Number
N/A	PERTAMINA PHE ONWJ	PHEONWJ-G-VPI-0001
Author's Organization: Engineering and Integrity		Validation: 3 Years, Expired Date: 20-Oct-2018

APPROVED MANUFACTURER LIST

Approval Sheet

Name	Title	Date	Signature
Irwansyah	President/ GM PHE ONWJ	7/12/2015	

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Revision Status

Rev	Issue Date	By	Chk	App	Issue Purpose	Owner Signature
2	08-Mar-2012	HSW	PML	IMS	Re-Issued for Approval (Revised for Pipe, Fitting, Flanges-CS, All Instruments & Electrical)	
3	28-Jan-2014	HSW	EH	RP	Updated status for all categories	
4	20-Oct-2014	DY	EH	RP	Incorporated AML Hulu	
5	20-Oct-2015	HSW	YUD	RP	Revalidation and Revised to be AML	

Enclosure, Electrical (Explosion proof)

ABB
Appleton Electric Company
Crouse-Hinds Company
Hubbel-Killark
O-Z/Gedney
Stahl
Allen Bradley

Junction Boxes Metalic Explosionproof

Appleton Electric Company
Crouse-Hinds Company
Hubbel-Killark
Klippon
O-Z/Gedney
Stahl
Hawke
Weidmuller

Detectors, Temperature, Fire (Hazardous Area)

Kidde-Fenwall
TYCO-Thorn Security
Ansul
Chubb
Detronic
M S A

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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

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- 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

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Hazardous Source List

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

HAZARDOUS AREA CLASSIFICATION LIST
(GGA NUI PLATFORM)

APPROVED
FOR
CONSTRUCTION
GG PROJECT

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

- 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

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Typical – Hazardous Area Classification

Lighter than air (Hydrogen) Compressor Shelter

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- 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

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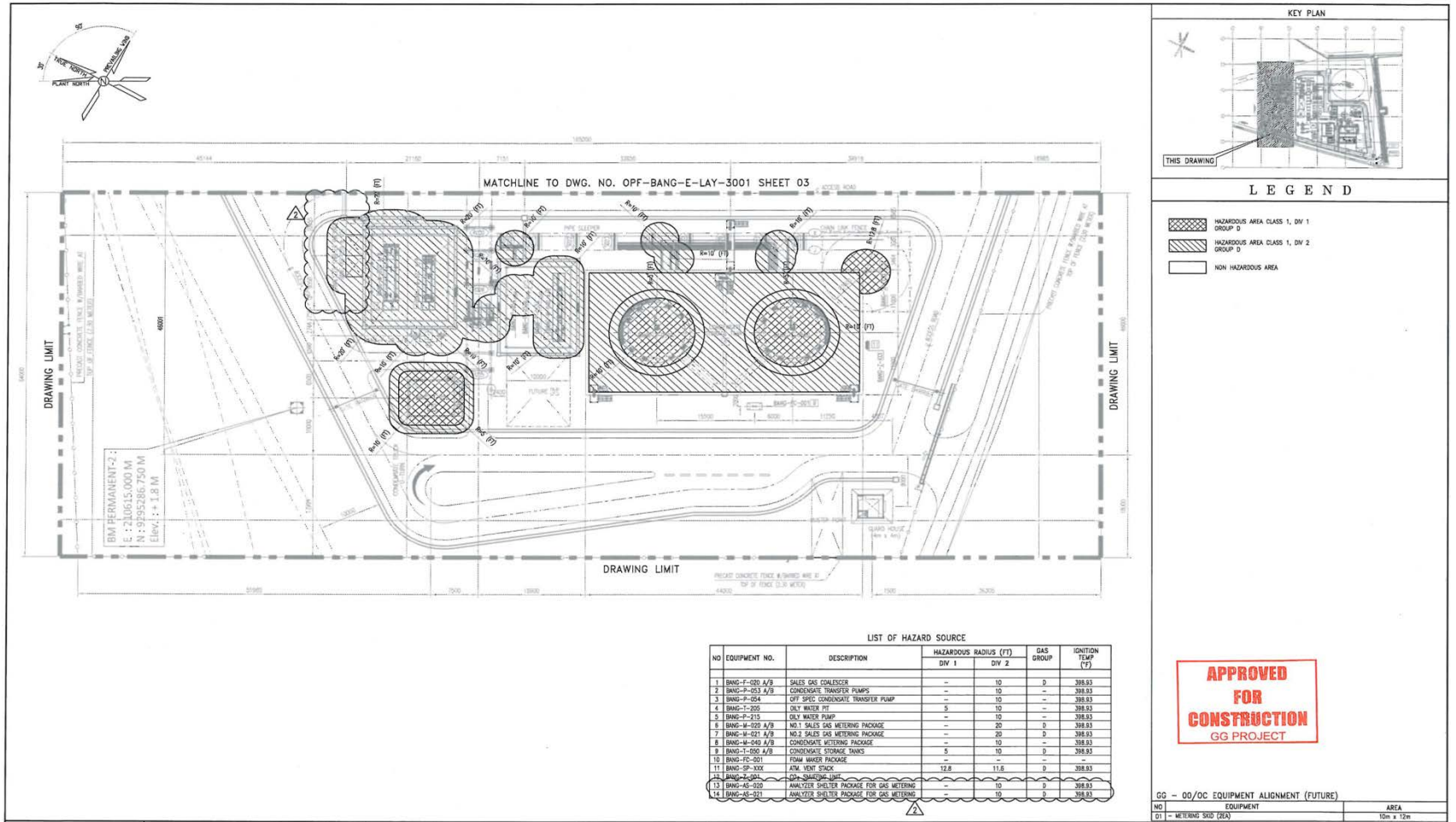
Hazardous Area Classification Plot



NO	EQUIPMENT NO.	DESCRIPTION	HAZARDOUS RADIUS (FT) DIV 1	HAZARDOUS RADIUS (FT) DIV 2	GAS GROUP	IGNITION TEMP (°F)
1	BANG-F-020 A/B	SALES GAS COALESCER	–	10	D	398.93
2	BANG-P-053 A/B	CONDENSATE TRANSFER PUMPS	–	10	–	398.93
3	BANG-P-054	OFF SPEC CONDENSATE TRANSFER PUMP	–	10	–	398.93
4	BANG-T-205	OILY WATER PIT	5	10	–	398.93
5	BANG-P-215	OILY WATER PUMP	–	10	–	398.93
6	BANG-M-020 A/B	NO.1 SALES GAS METERING PACKAGE	–	20	D	398.93
7	BANG-M-021 A/B	NO.2 SALES GAS METERING PACKAGE	–	20	D	398.93
8	BANG-M-040 A/B	CONDENSATE METERING PACKAGE	–	10	–	398.93
9	BANG-T-050 A/B	CONDENSATE STORAGE TANKS	5	10	D	398.93
10	BANG-FC-001	FOAM MAKER PACKAGE	–	–	–	–
11	BANG-SP-XXX	ATM. VENT STACK	12.8	11.6	D	398.93
12	BANG-Z-001	CO2 SMOKING UNIT	–	–	–	–
13	BANG-AS-020	ANALYZER SHELTER PACKAGE FOR GAS METERING	–	10	D	398.93
14	BANG-AS-021	ANALYZER SHELTER PACKAGE FOR GAS METERING	–	10	D	398.93

NOTES :
1. ALL DIMENSIONS IN MILIMETERS U.N.O
2. FLOOR GROUND LEVEL (FGL) : +0.00=EL.1.8M
3. ALL HAZARDOUS AREA CLASSIFICATION LAYOUT SHALL REFER TO HAZARDOUS EQUIPMENT LIST DWG. NO. OPF-O-LST-0201-REV.0

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REV.	BY	DATE	DESCRIPTION	DRFT'G	CHECKED	APPROVED
1	JEN	28/05/14	RE-ISSUED FOR CONSTRUCTION	JEN/UM	RR/JH	CK
0	BYB	08/05/14	ISSUED FOR CONSTRUCTION	JEN/UM	RR/JH	CK
A	JEN	04/04/14	ISSUED FOR APPROVAL	JEN/UM	RR/JH	CK
B	JEN	12/02/14	RE-ISSUED FOR REVIEW	JEN/KMD	RR/JH	CK
C	BHN	22/11/13	RE-ISSUED FOR REVIEW	BHN/KMD	RR/JH	CK

ENGINEERING APPROVAL	BY	DATE
PROJECT		
STRUCTURAL		
PROCESS		
MECHANICAL		
ELECTRICAL	DEPT.	3/6/'14
INSTRUMENT		
ARCHITECT		
FIRE & SAFETY		

PT PHE ONWJ APPROVAL
MARGARETHA.T
DATE: 3/6/14
CONTRACTOR APPROVAL
AV. CHINNAKUMAR
DATE:

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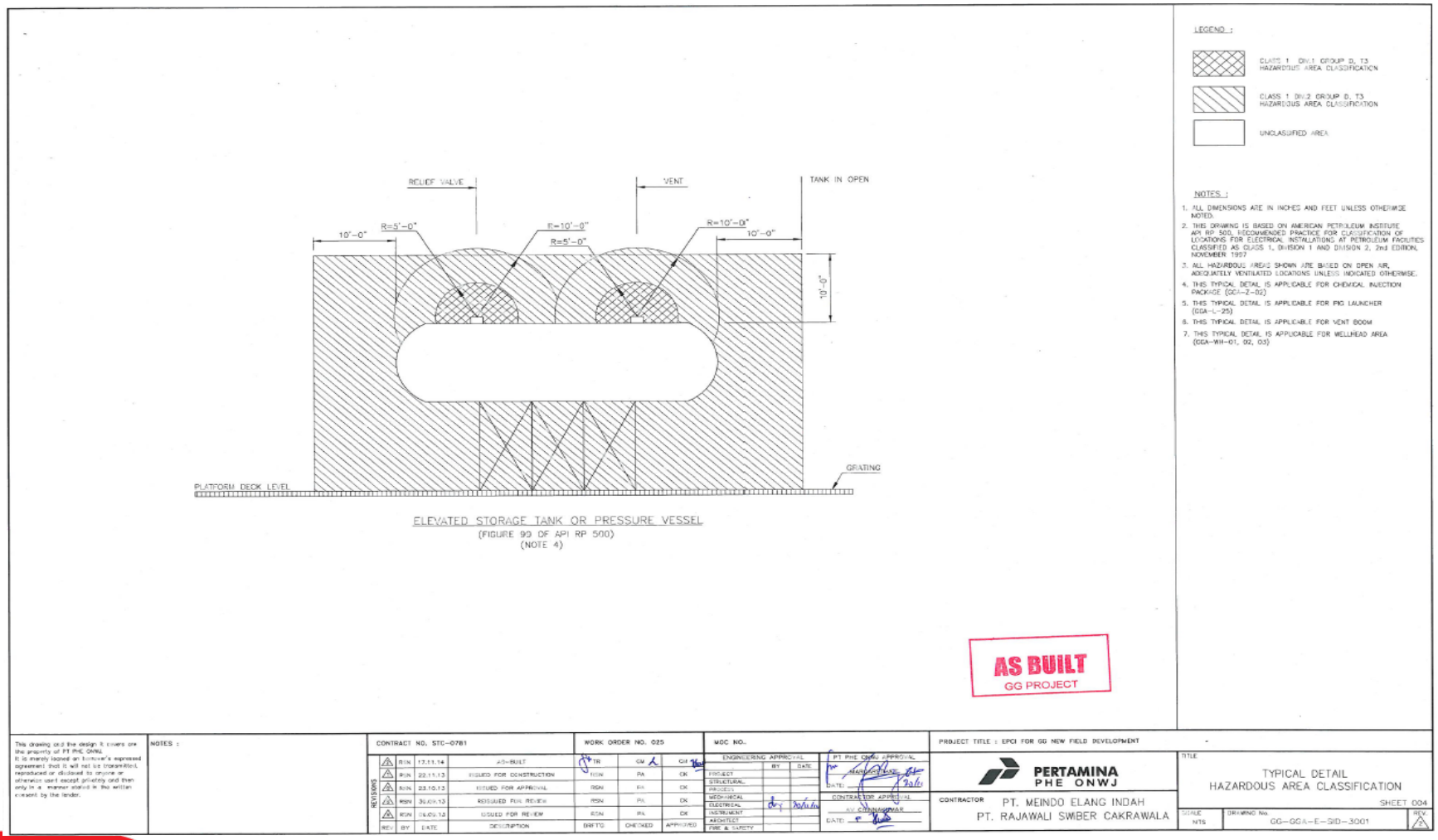
Hazardous Area Classification Plot



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Explosion-proof Equipment Selection – Ex Marking

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

Typical North American Marking

NEC® 500	NEC® 505
Class I, Division 1, Groups A&B T4	Class I, Zone 0, AEx ia IIC T4
Hazard Class	Hazard Class
Area Classification	Area Classification
Gas Group	Approved to US Standards
Temperature Class	Protection Concept Code
	Gas Group
	Temperature Class

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

Typical ATEX and IECEx Marking [*ATEX only]

CE 0359 Ex II 2 G Ex d IIC T4 Gb

- CE 0359: *Complies with European Directive; *Notified Body Number
- Ex: *Specific Marking for Explosion Protection
- II: *Equipment Group
- 2: *Equipment Category
- G: *Environment
- Ex: Explosion Protection
- d: Type of Protection
- IIC: Gas group
- T4: Temperature Class (T1-T6)
- Gb: Equipment Protection Level

▲ **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 :

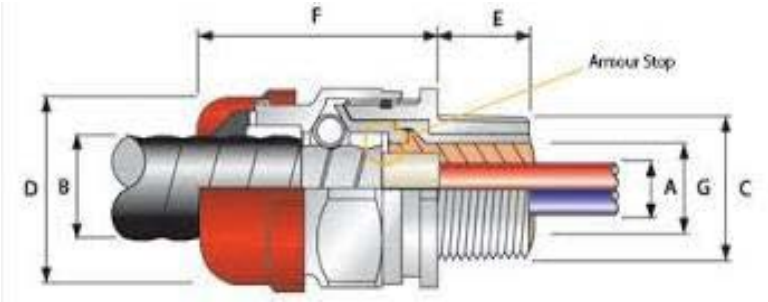
a. To firmly secure the cable entering the equipment
b. To maintain the ingress protection of the equipment
c. To maintain earth continuity between the equipment and any cable armouring
d. To provide a seal onto the inner and outer sheaths of a cable
e. To ensure containment of an internal explosion 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



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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)
- NEMA: FB1-1989
- UL Standards: 514B, 886
- Fed. Spec.: W-F-406B
- CSA Standard C22.2 No. 18-M1987
  Class I, A,B,C,D SL
  Class II, E,F,G
  Class III, Enc. 4 locations

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

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

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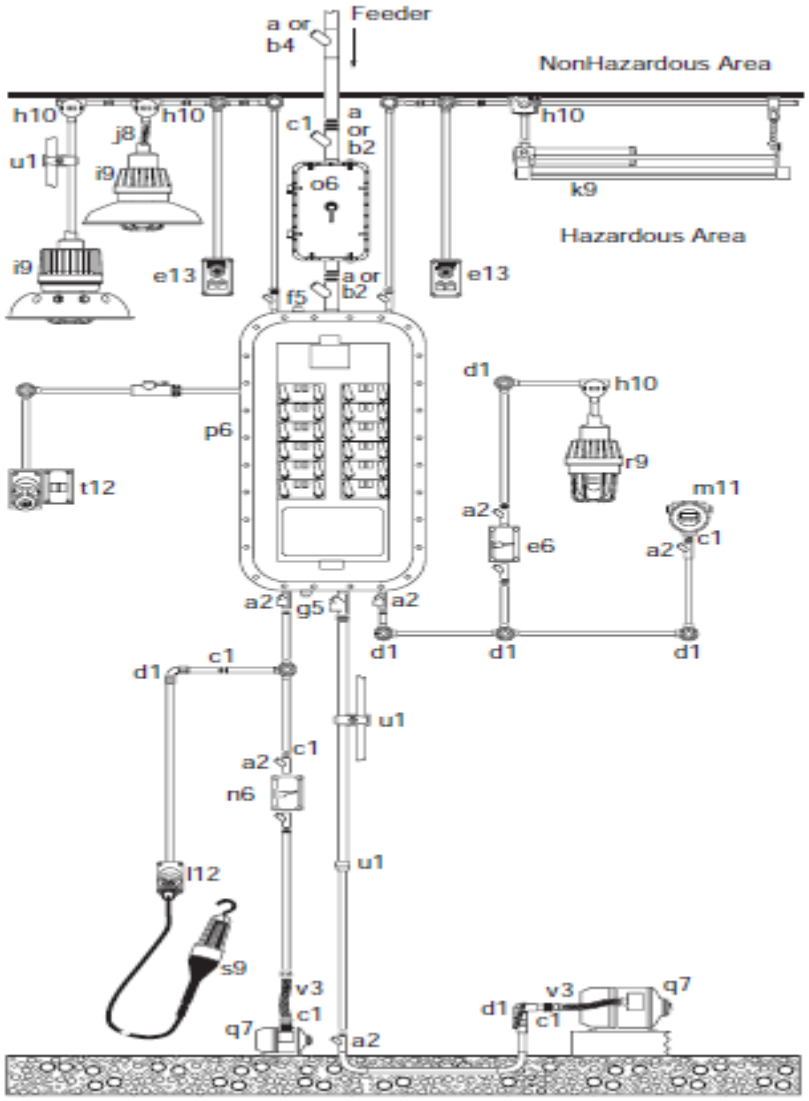
Installation

Lighting (Rigid Conduit) Installation, Class I, Division 1



(a) EY, ENY, EYD, or EYS Sealing fitting used with vertical conduits

(b) ENY or EYS Sealing fittings used with vertical or horizontal conduits

(c) GUF/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

(m) HK Instrument Enclosure

(n) XSD, XSX, Non-Factory Sealed or FXSD, FXSX Factory Sealed Manual Line Starter

(o) B7C Prism Circuit Breaker

(p) B7L or B7P Prism Panelboard

(q) Hazardous Location rated Motor

(r) ESXR Strobe Light

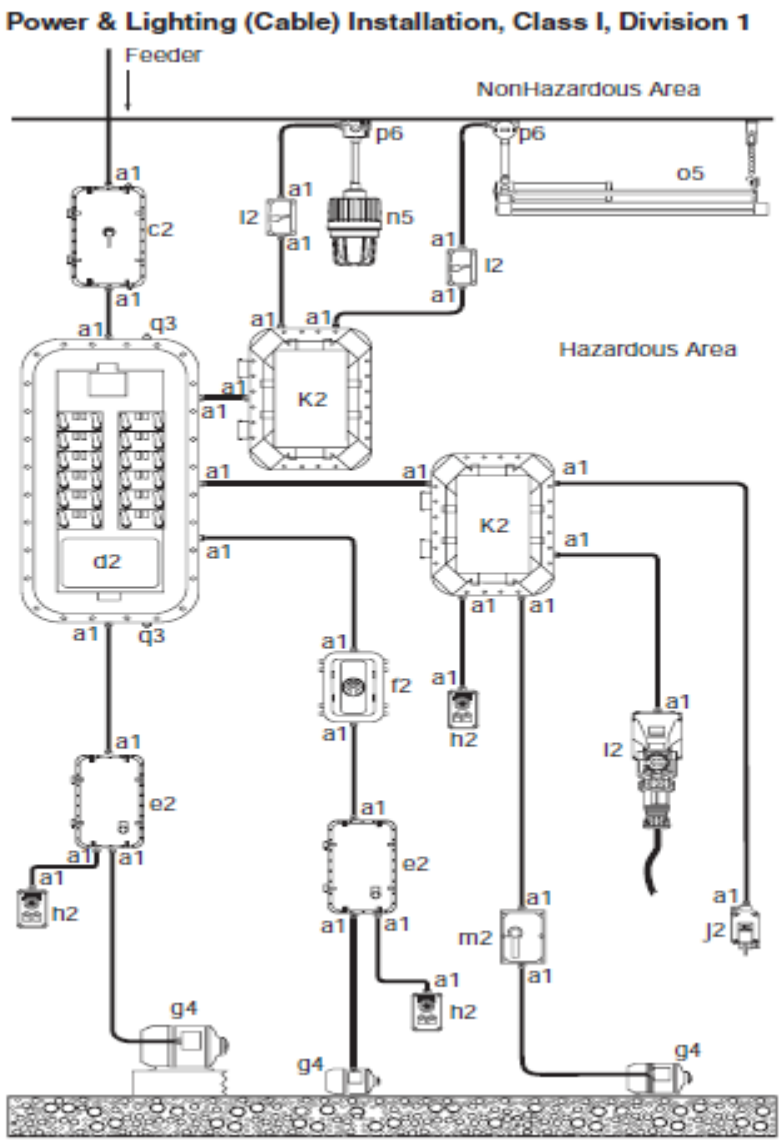
(s) XHL Explosionproof Handlamp

(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) XCS Non Factory Sealed or FXCS 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, XSX, 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

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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

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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

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CompEx certified personnel

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- **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**

ATTS Singapore CompEx Licensed Centre No.02

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Inspection and Maintenance

Documentation

Required documentation of the following items is vailable 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

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Inspection and Maintenance

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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 '**visua**l' 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.

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Inspection and Maintenance

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Inspection Schedule

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

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

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Inspection and Maintenance

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Inspection Schedule

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

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

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

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Inspection and Maintenance

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Inspection Schedule

Table 43: **Inspection schedule for Ex 'i' installations**

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

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Inspection and Maintenance

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Inspection Schedule

Table 44: **Inspection schedule for Ex 'p' or "pD" installations**

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

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Inspection and Maintenance

PERTAMINA HULU ENERGI

Ex Equipment Inspection & Maintenance Procedure

Project Title: Maintenance & Reliability Management System	PERTAMINA PHE ONWJ	Document Number: PHEONWJ-U-SOP-0187
Author's Organization: Operations Technical & Maintenance		Validation: 5 Years, Expired Date: 23 Mar 2020

STANDARD OPERATING PROCEDURE
INSPECTION AND MAINTENANCE OF
HAZARDOUS / Ex EQUIPMENT

Approval Sheet

Name	Title	Date	Signature
Mefredi	Operations Technical & Maintenance Manager	31/3/2015	
Heri Haruman	Electrical Maintenance Lead	26/3/2015	

Revision Status

Rev	Issue Date	By	Chk	App	Issue Purpose	Owner Signature
0	23 Mar 2015	LLF/IR	AIH/UPR	MEF	Issued For Approval	

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Ex Equipment Inspection/Audit

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Scope of inspection / audit :

- General
- Switchgear Building
- Junction Box
- Push Button
- Receptacle
- Paging System
- Fire & Gas Equipment
- Lighting
- Motor
- Turbine Generator
- Engine Generator
- Conduit

3.1.3.3 Fuel Gas Heater Control Panel

Fuel Gas Heater Control Panel yang terpasang di Mike-Mike F/S memiliki proteksi Ex d, dan kondisi serta instalasi junction boxnya masih bagus hanya perawatan dan kebersihan junction boxnya kurang terjaga, sebagian junction box sudah mulai corroded.

3.1.3.4 Electrical instrument Junction box (EIJB)

Electrical instrument Junction box yang terpasang di Mike-Mike F/S memiliki proteksi Ex e, dan kondisi instalasi junction boxnya masih bagus hanya perawatan dan kebersihan junction boxnya kurang terjaga, sebagian junction box sudah mulai corroded

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Follow-up Actions

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4.4.2 Program Rencana Perbaikan Mike-Mike F/S

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

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