

Hazardous Locations

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Hazardous Locations - Agenda

- ▶ **Canadian Electrical Code 2015 Changes**
 - What's happened
 - What's being proposed
- ▶ **Area Classification**
 - Mistakes to avoid
- ▶ **API 505**
 - Updates for 2nd Edition
 - Highlights of specific areas
- ▶ **Combustible Gas Detection**

The 2015 Canadian Electrical Code, Hazardous Locations **Has No Class** But Does Have Significant Changes

Hazardous Area Classification Systems

▶ Global Systems

–Canada – Canadian Electrical Code (CEC)

- Class/Zone System Mandatory for New Construction(Since 1998)
- Legacy Division System Permitted for Existing Facilities

–US National Electrical Code (NEC)

- Allows Option of using either
 - Class/Division
 - Class/Zone System
- 95% of US Facilities Continue to use Class/Division System

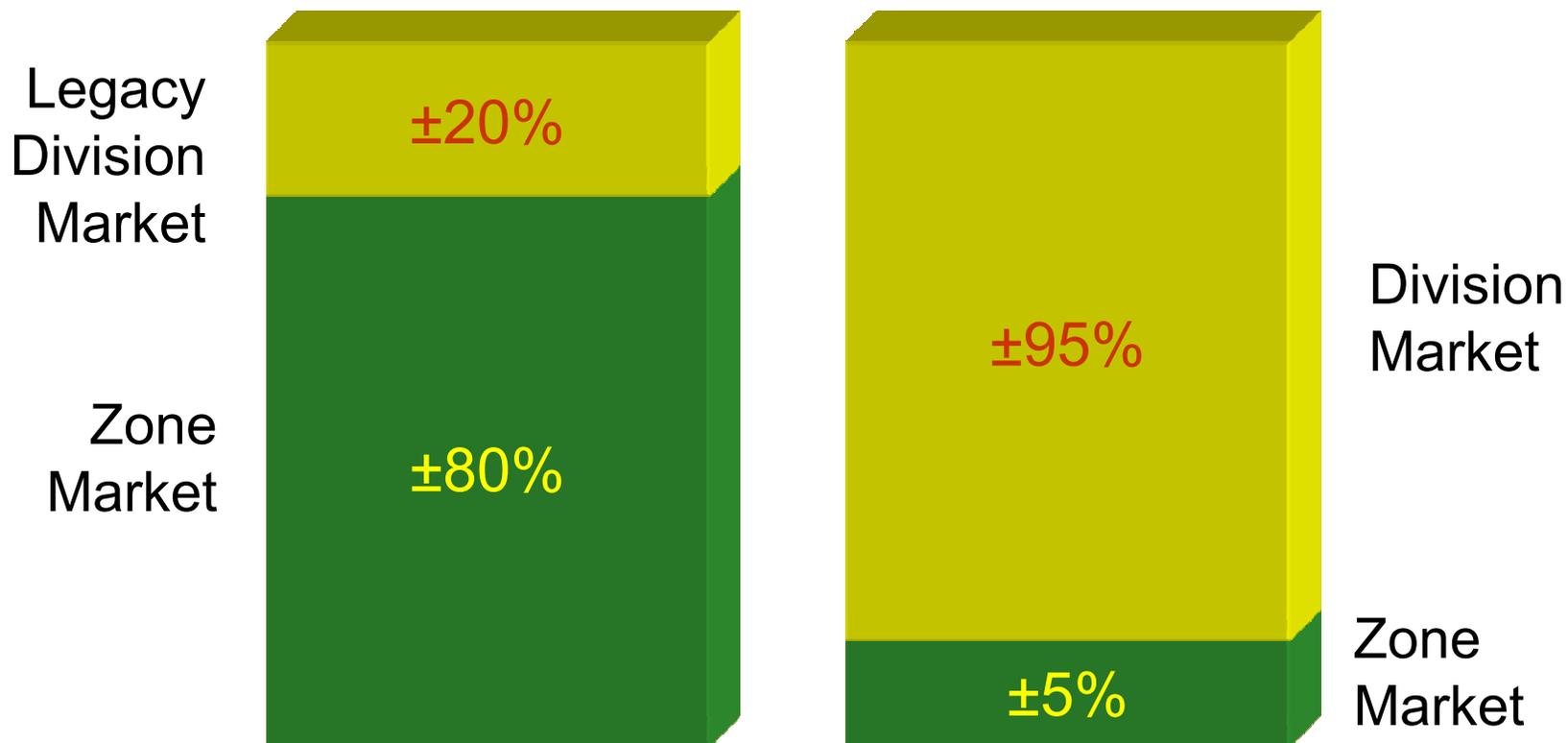
–The Rest of the World Uses

- The “Zone System”

Percentage of Hazardous Locations

Canada Zone System **Mandatory**
For New Construction

US Zone System is **Parallel**
to Division System



Percentage of Hazardous Locations

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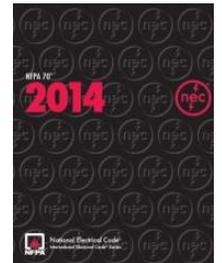
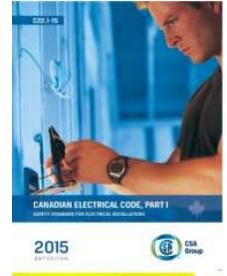
Key Elements of All Hazardous Location Electrical Systems

- ▶ **Area Classification**
- ▶ **Selection of Acceptable Products**
- ▶ **Selection of Acceptable Wiring Methods**
- ▶ **All Have The Same Objective**
 - **Strive to Prevent Fire and Explosion**
 - **Protect Personnel and Property**



Hazardous Location Electrical Equipment & Installation Rules

- ▶ **Canada – Canadian Electrical Code (CEC)**
 - Part I - Installation, Published by CSA Every 3 years
 - Latest Edition 2015
 - Mandates Certification to CEC Part II - Product Standards
- ▶ **US – National Electrical Code (NEC)**
 - Published by NFPA every 3 years
 - Latest Edition 2014
 - Requires Approval to US Product Standards (Multiple Versions)
- ▶ **Rest of The World IEC Based**
 - IEC 60079-14 Recommended Installation
 - IEC 60079 Series Product Standards



CEC Installation Requirements

Section 18 Hazardous Locations

➤ 18-000 Scope

- (3) For additions, modifications, renovations to, or operation and maintenance of existing facilities employing the Division system of classification, the continued use of the Division system of classification shall be permitted.
- (4) Where the Division system of classification is used as permitted by Subrule (3), the Rules for Class I, II, and III Locations found in Annex J18 of Appendix J shall apply.

English Translation:

- Existing Facilities can Continue to use Divisions
- **All New Construction Must Use The Zone System**
- Engineers, Users, and Installers Dealing with Multiple Facilities Will Likely Need to Understand both Systems



CEC Rules Dealing With Hazardous Locations

▶ 2015 CEC Part I

–Sections 18

- Zone System Mandatory for New Construction
- Zones Identify Explosive Gas or Dust Atmospheres
- Class I, in Appendix J/Annex J18
- Class II and Class III Rules moved to Appendix J/Annex J18

–Annex J18 (Division Rules)

- Legacy Class/Division Rules

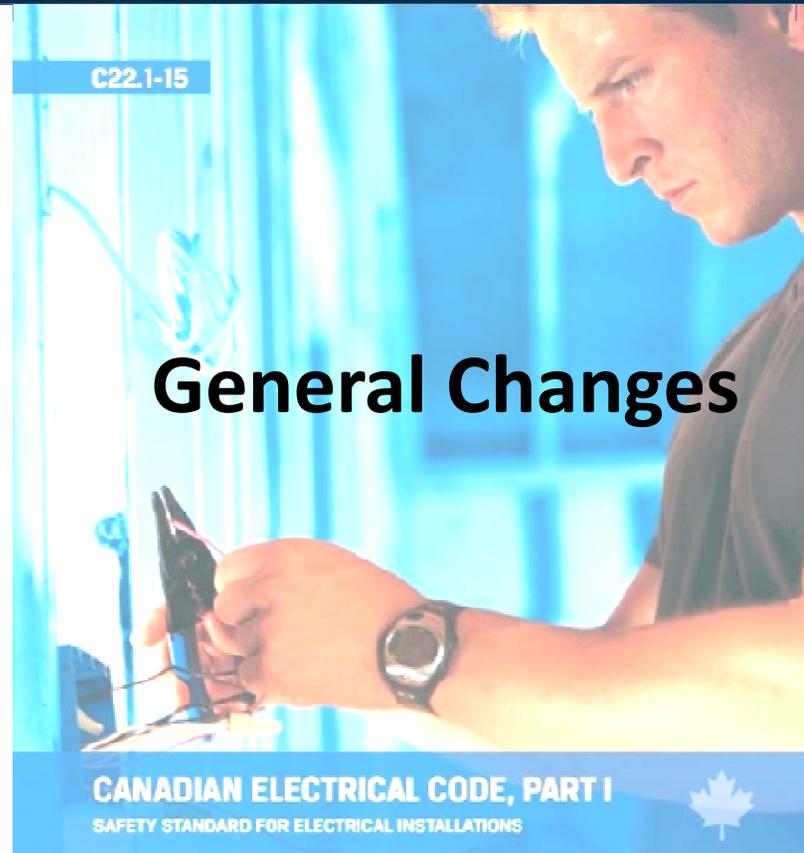
–Sections 20 (Zone Rules) and Annex J20 (Div. Rules)

- Special Occupancies (Commercial Facilities)

–Sewage Treatment Facilities

- Section 22 – *for Hazardous Locations, References Section 18*

The 2015 Canadian Electrical Code Zone System



2015



Hazardous Location Definitions

► Explosive Atmosphere

- a mixture with air, under atmospheric conditions, of flammable substances in the form of gas, vapour, dust, fibres, or flyings which, after ignition, permits self-sustaining propagation

– Explosive Gas Atmosphere

- *(Existing definition shown here for clarity)*
- a mixture with air, under atmospheric conditions, of flammable substances in the form of gas, vapour, or mist in which, after ignition, combustion spreads throughout the unconsumed mixture.

– Explosive Dust Atmosphere

- mixture with air, under atmospheric conditions, of flammable substances in the form of dust, fibres, or flyings which, after ignition, permits self-sustaining propagation

Areas of Use

- ▶ **Group I** – Underground Mines susceptible to firedamp
 - The CEC does not Address Mining
- ▶ **Group II** – Surface Industries with an explosive **gas** atmosphere other than mines susceptible to firedamp
- ▶ **Group III** – Surface Industries with an explosive **dust** atmosphere other than mines susceptible to firedamp

Areas of Use

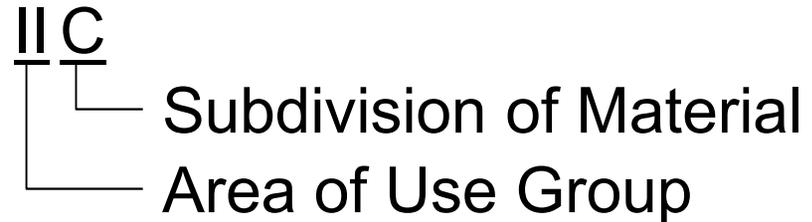
▶ Group II and III are Further Subdivided Based on Material Properties

–Gas

- IIC, IIB, IIA

–Dust

- IIIC, IIIB, IIIA



Identification of Hazardous Location Equipment

- ▶ **Equipment Protection Level (EPL)**
 - Level of protection assigned to equipment based on its likelihood of becoming a source of ignition and distinguishing the differences between explosive gas atmospheres, explosive dust atmospheres, and the explosive atmospheres in mines susceptible to firedamp

Equipment Protection Level

Gas “G”

➤ EPL Ga

- equipment for explosive gas atmospheres, having a "very high" level of protection, which is not a source of ignition in normal operation, during expected malfunctions or during rare malfunctions

➤ EPL Gb

- equipment for explosive gas atmospheres, having a "high" level of protection, which is not a source of ignition in normal operation or during expected malfunctions

➤ EPL Gc

- equipment for explosive gas atmospheres, having an "enhanced" level of protection, which is not a source of ignition in normal operation and which may have some additional protection to ensure that it remains inactive as an ignition source in the case of regular expected occurrences (for example failure of a lamp)

Equipment Protection Level Dust “D”

➤ EPL Da

- equipment for explosive dust atmospheres, having a "very high" level of protection, which is not a source of ignition in normal operation, during expected malfunctions, or during rare malfunctions

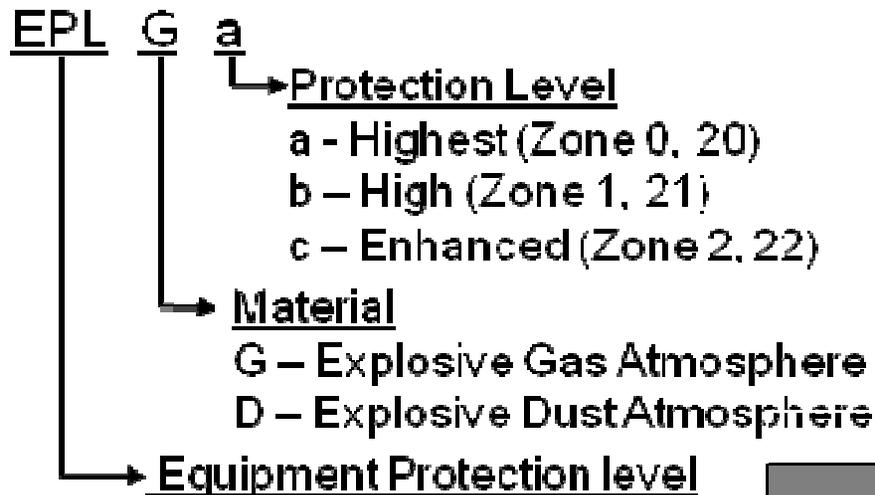
➤ EPL Db

- equipment for explosive dust atmospheres, having a "high" level of protection, which is not a source of ignition in normal operation or during expected malfunctions

➤ EPL Dc

- equipment for explosive dust atmospheres, having an "enhanced" level of protection, which is not a source of ignition in normal operation and which may have some additional protection to ensure that it remains inactive as an ignition source in the case of regular expected occurrences (for example failure of a lamp)

Equipment Protection Level



How does EPL relate to the Location equipment may be installed in?

Equipment Protection Level

| EPL | Zone Suitability | Division Suitability |
|-----|------------------|--------------------------|
| Ga | Zone 0 | Class I, Division 1 |
| Gb | Zone 1 | Class I, Division 2 |
| Gc | Zone 2 | Class I, Division 2 |
| Da | Zone 20 | Class II/III, Division 1 |
| Db | Zone 21 | Class II/III, Division 2 |
| Dc | Zone 22 | Class II/III, Division 2 |

Legacy Hazardous Locations

▶ Class I

–Flammable Gases and Vapours



▶ Class II

–Combustible Dusts



▶ Class III

–Easily Ignited Fibres and Flyings



Main Changes to CEC Section 18

- ▶ **Removed the Word “Class” from Body of CEC**
 - Except for a Few Specific References to Appendix J
- ▶ **Updated Requirements for Gases and Vapours**
- ▶ **Re-write of Requirements for Dusts**

Essentially Full Harmonization with IEC

Changes in CEC for Explosive Dust Atmospheres

- ▶ **The most Significant Change in Decades**
 - CEC Introduced the Class System in 1939
 - Class I, II, III and IV
 - It Introduced Groups
 - For Both Gases and Dusts
 - Gas Groups A, B, C and D
 - Dusts Groups E, F and G
- ▶ **The 1947 CEC introduced the Division System**
 - Classes I, II, and III
 - Class IV (Fibre and Flyings became Class III, Div 2)
- ▶ **1998 CEC Introduced Zones for Class I Areas**

Changes to CEC for Areas Containing Explosive Dust Atmospheres

- ▶ **Historically, far fewer changes in Class II and III rules than for Class I**
 - e.g. **Primary Class II Product Standard for Enclosures (C22.2 No. 25) – Last Updated in 1966**
 - No Major Dust Users on CEC Section 18**
- ▶ **The 2015 CEC Completely Changes Everything About Class II and Class III**

Changes to CEC Areas Containing Explosive Dust Atmospheres

- ▶ **Class II and Class III Rules moved to Appendix J (Annex J18)**
 - Class I, Division System, moved in 1998
- ▶ **Class II and Class III Appendix B Notes on Rules, moved to Annex JB**
- ▶ **Existing Division Facilities Can Continue to use Annex J18**

Changes to CEC Areas Containing Explosive Dust Atmospheres

- ▶ **Class II and Class III were combined into Explosive Dust Atmospheres**
 - Zones 20, 21 and 22
 - Groups E, F and G do not apply
 - Class III becomes Group IIIA

CEC Rules for Explosive Atmospheres

| Explosive Atmosphere | CEC Division System | CEC Zone System |
|-----------------------------------|---------------------|---|
| Gases and Vapours | Class I | Explosive Gas Atmospheres Zone 0, 1, 2 |
| Combustible Dusts | Class II | Explosive Dust Atmospheres Zone 20, 21, 22 |
| Easily Ignited Fibres and Flyings | Class III | |

Materials

- ▶ **Separated into Divisions or Zones Based on Probability of Sufficient Material Being Present to form an Explosive Atmosphere**

Division System

“Severity of the Hazard”

- ▶ **Probability of Sufficient Material Being Present in the Atmosphere for an Explosion to Occur**
- ▶ **Division 1**
 - *Normal Condition*
 - Hazard Is Expected to Be Present
- ▶ **Division 2**
 - *Abnormal Condition*
 - Hazard Not Expected to Be Present



Zone System

“Severity of the Hazard”

- ▶ **Probability of Sufficient Material Being Present to form an Explosive Gas Atmosphere**
- ▶ **Zone 0**
 - Areas Where an Explosive Gas Atmosphere is *Continuously Present* or Present for Long Periods of Time
- ▶ **Zone 1**
 - Areas Where an Explosive Gas Atmosphere is *Likely to Occur in Normal Operation* or can be Expected to be Present Frequently
- ▶ **Zone 2**
 - Area Where an Explosive Gas Atmosphere Is *Not Likely to Occur in Normal Operation* and if it does will only Exist for a Short Period of Time

Zone System

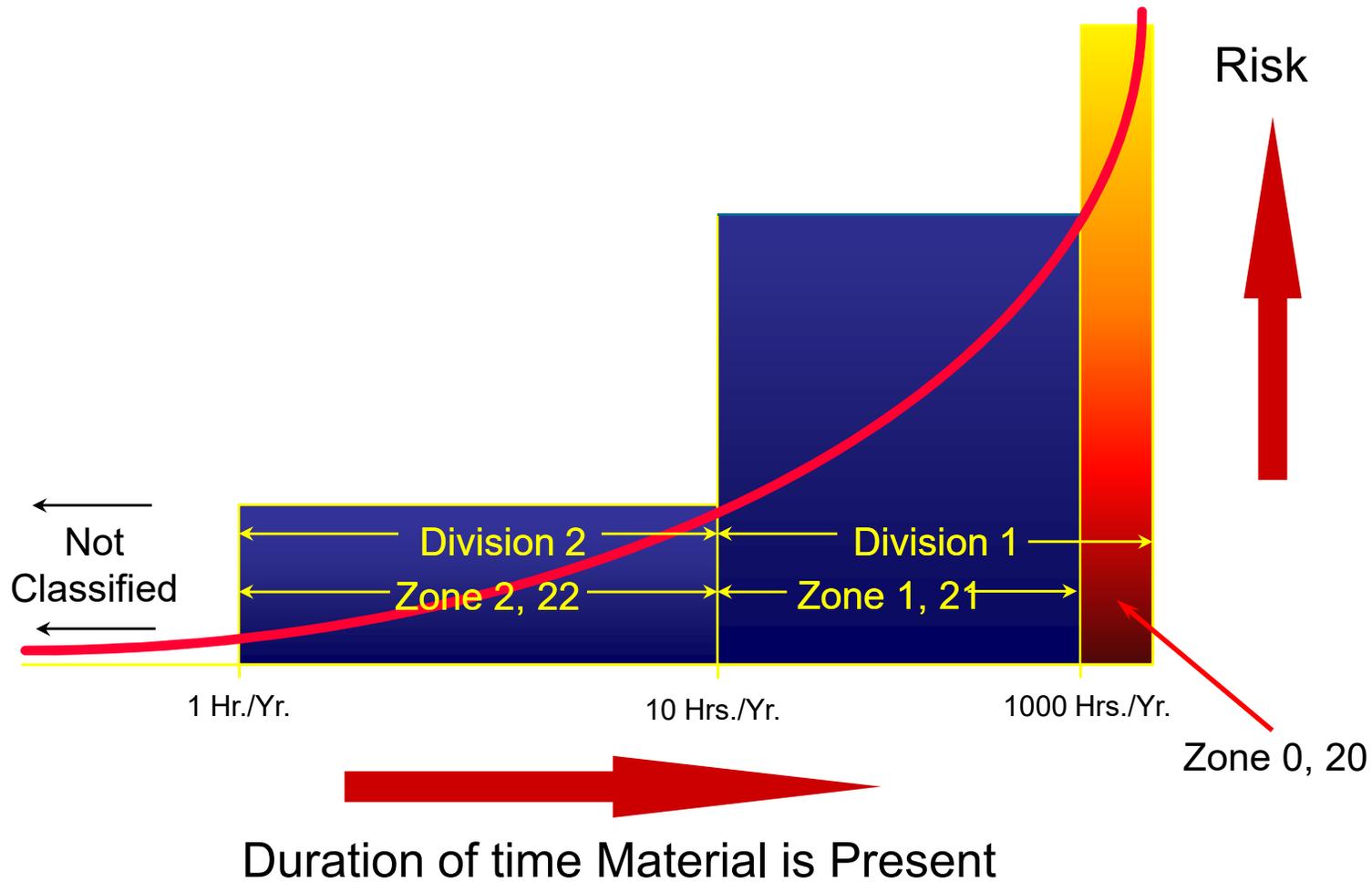
“Severity Of The Hazard”

- ▶ **Probability of Sufficient Material Being Present to form an Explosive Dust Atmosphere**
- ▶ **Zone 20**
 - Area in which an explosive atmosphere in the form of a cloud of combustible dust in air is *present continuously*, or for long periods or frequently
- ▶ **Zone 21**
 - Area in which an explosive atmosphere in the form of a cloud of combustible dust in air is *likely to occur in normal operation* occasionally.
- ▶ **Zone 22**
 - Area in which an explosive atmosphere in the form of a cloud of combustible dust in air is *not likely to occur in normal operation* but, if it does occur, will persist for a short period only

CEC Rules for Explosive Atmospheres

| Frequency of Occurrence | CEC Division System | CEC Zone System |
|--|----------------------------------|-------------------|
| Continuous, Intermittent, Periodically | Class I, II & III, Division 1 | Zone 0 Zone 20 |
| | | Zone 1 Zone 21 |
| Abnormal Condition | Class I, II & III, Division 2 | Zone 2 Zone 22 |

Comparing Divisions to Zones – Risk Assessment



Basics of Material Groups

- ▶ **Explosive Gases Based on**
 - Ability to Propagate Through a Gap
 - Energy Required to Ignite a Mixture
- ▶ **Explosive Dusts Based on**
 - Particle Size
 - Conductivity

How Division and Zone Gas Groups Compare

| Representative Gas | Division Gas Group | Zone Gas Group |
|--------------------|--------------------|-----------------------------|
| Acetylene | Group A | Group IIC |
| Hydrogen | Group B | |
| | Groups B + C | (Group IIB+H ₂) |
| Ethylene | Group C | Group IIB |
| Propane | Group D | Group IIA |

How Division and Zone Gas Groups Compare

| Type of Dust | Division Dust Group | Zone Dust Group |
|---------------------|-----------------------|-----------------|
| Conductive Dust | Class II, Group E | IIIC |
| Non-conductive Dust | Class II, Groups F, G | IIIB |
| Combustible Flyings | Class III Locations | IIIA |

How Division & Zone Temperature Codes Compare

| Zone Temperature Codes | Division Temperature Codes | Maximum Surface Temperature |
|------------------------|----------------------------|-----------------------------|
| | | °C |
| T1 | T1 | 450 |
| T2 | T2 | 300 |
| | T2A | 280 |
| | T2B | 260 |
| | T2C | 230 |
| | T2D | 215 |
| T3 | T3 | 200 |
| | T3A | 180 |
| | T3B | 165 |
| | T3C | 160 |
| T4 | T4 | 135 |
| | T4A | 120 |
| T5 | T5 | 100 |
| T6 | T6 | 85 |

Changes to Wiring Rules for Explosive Atmospheres

Changes to CEC for Areas Containing Explosive Gas Atmospheres

▶ Zone 0 locations

–Updated Acceptable Types of Protection

- Added Type of Protection Ex ma (Encapsulation)

previously only Type of Protection Ex ia (Intrinsic Safety) was permitted

–Sealing

- While some seals are still required to minimize the passage of gas, vapour, or dust under normal operating condition
 - they no longer need to be explosionproof or flameproof “d” (unless connected to that type of equipment)
 - Be identified as minimizing transmission of the materials
 - Be accessible

Changes to CEC for Areas Containing Explosive Gas Atmospheres

- ▶ **Class I, Zone 1 installation rules were removed**
 - **18-102 Transformers and capacitors**
 - **18-104 Meters, instruments, and relays**
 - **18-110 Switches, motor controllers, circuit breakers, and fuses**
 - **18-112 Control transformers and resistors**
 - **18-120 Utilization equipment, fixed and portable**
 - **18-124 Receptacles and attachment plugs**
 - **18-128 Signal, alarm, remote control, and communication systems**
 - **18-130 Live parts (moved to rule 18-076)**

Changes to CEC for Areas Containing Explosive Gas Atmospheres

- ▶ **Acceptable to use ordinary location space heaters in Motors for Zone 2 Areas (to deal with condensation)**
 - Providing they are
 - Non-arcing
 - Operate below the Ignition Temperature of the Area
 - Do Not use Temperature Limiting Controls
 - Require a Separate Heater Nameplate on the Motor Enclosure
- ▶ **This Harmonizes with the NEC Requirements**
 - Except that Surface Temperatures up to 100% of the Ignition Temperature is Used vs. 80% in The NEC

Changes to CEC for Areas Containing Explosive Gas Atmospheres

- ▶ **The use of Ex e (Increased Safety) cable connectors is permitted for cables entering Ex e enclosures**
- ▶ **Now acceptable in Zones 1 & 2, to use flexible cords if other methods don't provide sufficient movement for fixed or mobile electrical equipment**
- ▶ **Rigid Reinforced Thermosetting Resin Conduit (RTRC) Type XW is now permitted in Zone 2**

Changes to CEC for Areas Containing Explosive Dust Atmospheres

- ▶ **Class II Combustible Dusts**
 - Only Minor changes to the Class II Rules were made
- ▶ **Explosive Dust Atmospheres**
 - Zones 20 & 21 use same Rules as Class II, Division 1
 - Zone 22 use same Rules for Class II, Division 2

Changes to CEC for Areas Containing Explosive Dust Atmospheres

- ▶ **Class III Easily Ignited Fibres and Flyings**
 - **Significant Change for Industry**

- ▶ **Explosive Dust Atmospheres Group IIIA**
 - **What was Class III, Division 1**
 - **Now uses same Rules as Zones 20 and 21**
 - These had been Similar to Class II, Division 2 previously
 - **What was Class III, Division 2**
 - **Now uses the Same Rules as Zone 22**
 - These had been more Relaxed previously

Changes to Equipment Requirements

Product Standards and Certifications

Product Standards

We Became Familiar with the old (Methods) Types of Protection from the IEC

▶ Zone 0

- Intrinsic Safety (i, ia)

▶ Zone 1

- Flameproof (d)
- Increased Safety (e)
- Encapsulation (m)
- Oil Immersion (o)
- Pressurized (p)
- Intrinsic Safety (ia, ib)
- Sand Filled (q)

▶ Zone 2

- Non-Sparking (nX)
 - nR, nL, nA, nC

▶ Ex nX contained multiple Types of Protection

- Restricted Breathing, Low Energy, Non-Sparking, Enclosed Break
 - This was a problem for maintaining the Standard
 - Never the right people for the topic

Product Standards

▶ So the IEC Changed it...

- Zone 2 Requirements Removed from IEC 60079-15 and inserted appropriate to IEC 60079 Series Concept Standards
- New IEC Standards for Types of Protection have Levels of Protection, Aligning with the EPLs
 - a – Very High (Zone 0, 20)
 - b – High (Zone 1, 21)
 - c – Enhanced (Zone 2, 22)
- If you weren't confused before, you will be now

What Changes?

Original Marking

Ex e
└───┬───┘
Type of Protection

New Marking

Ex e b
└───┬───┘
└───┬───┘
Level of Protection
Type of Protection

The following is from Table J1.2 in Appendix J

- Includes updates proposed for 2018 CEC
(*currently under discussion at Section 18 Subcommittee*)
 - Proposed: clarifications for Gas, and addition of Dusts
- This Table is normative, listing acceptable equipment in Zones and Divisions

CEC Table J.1: Acceptable equipment comparison for explosive atmospheres

| <i>Zone system</i> | | <i>Division system</i> | | |
|--|---------------------|------------------------|---------------------------------------|--|
| Intrinsic safety | i, ia | Zone 0 | | |
| Encapsulation | ma | | | |
| Flameproof | da* | | | |
| EPL | Ga | | | |
| Equipment acceptable in Zone 0 | | Zone 1 | Class I, Division 1 ** | |
| Equipment Acceptable in Class I, Division 1 | | | | Equipment acceptable in Zone 0 Class I, Division 1 Equipment Pressurization type X, Y |
| Flameproof | d, db | | | |
| Intrinsic safety | ib | | | |
| Increased safety | e, eb | | | |
| Pressurized | p, px, pxb, py, pyb | | | |
| Encapsulation | m, mb | | | |
| Powder filling | q, qb | | | |
| Oil immersion | o or ob | | | |
| EPL | Gb | | | |
| Equipment acceptable in Zone 1 | | Zone 2 | Class I, Division 2 | |
| Equipment acceptable in Class I, Division 2 | | | | Equipment acceptable in Zone 2 Equipment acceptable in Class I, Division 1 Class I, Division 2 equipment Non-incendive Pressurization type Z Other electrical apparatus *** |
| Type of protection n | nA, nC, nL, nR | | | |
| Pressurized | pz or pzc | | | |
| Intrinsic safety | ic | | | |
| Flameproof | dc | | | |
| Increased safety | ec | | | |
| Oil immersion | oc | | | |
| Encapsulation | mc | | | |
| EPL | Gc | | | |
| Other electrical apparatus *** | | | | |

CEC Table J.1 (continued): Acceptable equipment comparison for explosive atmospheres

| <i>Zone system</i> | | <i>Division system</i> | | |
|---|---|------------------------|--|---|
| Intrinsic safety By Enclosure Encapsulation EPL | i, ia ta ma Da | Zone 20 | Class II & Class III, Division 1 ** | |
| Equipment acceptable in Zone 20, Equipment acceptable in Class II / III, Division 1 Intrinsic safety By Enclosure Pressurized Encapsulation EPL | ib tb p, px, pxb, py, pyb mb Db | Zone 21 | | Equipment acceptable in Zone 20 **** Class II / III, Division 1 equipment |
| Equipment acceptable in Zone 21 Equipment acceptable in Class II / III, Division 2 Intrinsic safety By Enclosure Pressurization Encapsulation EPL Other electrical apparatus *** | ic tc pz, pzc mc Dc | Zone 22 | Class II & Class III, Division 2 | Equipment acceptable in Zone 22 Equipment acceptable in Class II / III, Division 1 Class II / III, Division 2 equipment Non-incendive Other electrical apparatus *** |

* Applies to sensors of combustible gas detectors only

** Division 1 equipment is not allowed in Zone 1 or Zone 21, as Division 1 encompasses the equivalent of Zone 0 for Gas and Zone 20 for Dust

*** Complying with the requirements of a recognized standard for industrial electrical apparatus that does not in normal service produce arcs/sparks or ignition capable hot surfaces, and also makes reference to equipment or systems currently acceptable as alternative means of protection

**** For use in Class II and Class III, such (Zone acceptable) equipment is subject to the limitation of Rules J18-054(2) or J18-054(3) respectively.

Product Standards

▶ Zone 0

- **Intrinsic Safety (Ex ia)**
- **Encapsulation (Ex ma)**
- **Flameproof (Ex da)**
 - **Application limited to combustible gas detector sensors only**
- **Other Products suitable for EPL Ga**

Product Standards

▶ Zone 1

- Equipment acceptable in Zone 0,
- Equipment acceptable in Class I, Division 1
- Flameproof (Ex d) or (Ex db)
- Intrinsic Safety (Ex ib)
- Increased Safety (Ex e) or (Ex eb)
- Pressurized Enclosure (Ex p), (Ex px), (Ex pxb), (Ex py) or (Ex pyb)
- Encapsulation (Ex m) or (Ex mb)
- Powder filling (Ex q) or (Ex qb)
- Oil immersion (Ex o) or (Ex ob)
- Other Products Suitable for EPL Gb

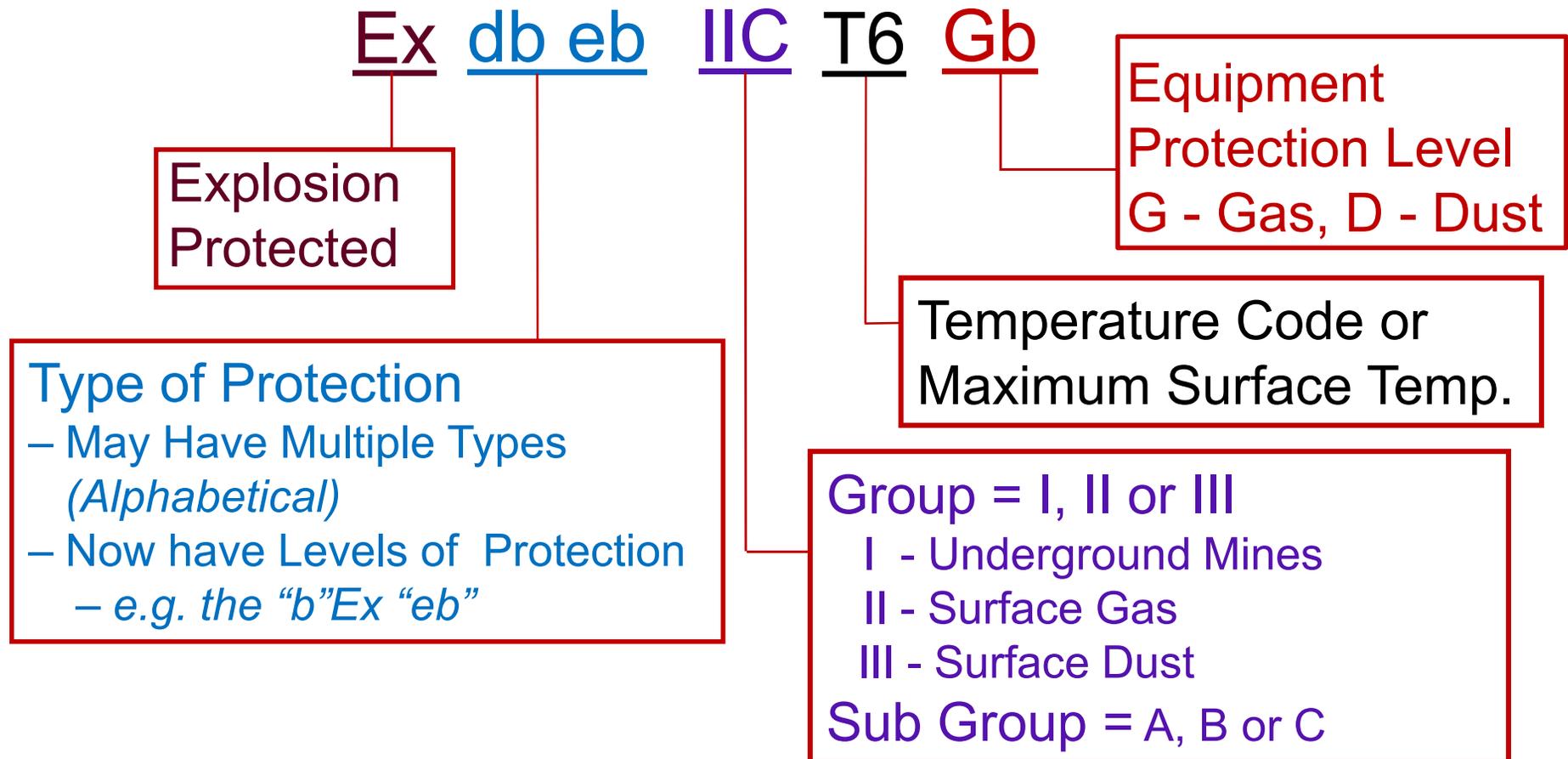
Product Standards

▶ Zone 2

- Equipment acceptable in Zone 0 or Zone 1
- Equipment acceptable in Class I, Division 1 or Division 2
- Type of protection n (Ex nA), (Ex nC), (Ex nL), or (Ex nR)
- Pressurized (Ex pz) or (Ex pzc)
- Intrinsic Safety (Ex ic)
- Flameproof (Ex dc)
- Increased safety (Ex ec)
- Oil immersion (Ex oc)
- Encapsulation (Ex mc)
- Other Products Suitable for EPL Gc
- Other electrical apparatus*

* *Complying with the requirements of a recognized standard for industrial electrical apparatus that does not in normal service produce arcs/sparks or ignition capable hot surfaces, and also makes reference to equipment or systems currently acceptable as alternative means of protection*

Zone System Equipment Marking



Product Standards

- ▶ **Explosive Dust Atmospheres are Similar**
- ▶ **Zone 20**
 - Intrinsic Safety (Ex i) or (Ex ia)
 - Protection by Enclosure (Ex ta)
 - Encapsulation (Ex ma)



Product Standards

▶ Zone 21

- Equipment acceptable in Zone 20,
- Equipment acceptable in Class II or III, Division 1
- Intrinsic Safety (Ex ib)
- Pressurized (Ex p), (Ex px), (Ex pxb), (Ex py) or (Ex pyb)
- Protection by Enclosure (Ex tb)
- Encapsulation (Ex mb)



Product Standards

▶ Zone 22

- Equipment acceptable in Zone 21
- Equipment acceptable in Class II or III, Division 2
- Intrinsic Safety (Ex ic)
- Pressurization (Ex pz) or (Ex pzc)
- By Enclosure (Ex tc)
- Encapsulation (Ex mc)
- Other electrical apparatus*



* *Complying with the requirements of a recognized standard for industrial electrical apparatus that does not in normal service produce arcs/sparks or ignition capable hot surfaces, and also makes reference to equipment or systems currently acceptable as alternative means of protection*

Equipment Marking Challenges

- ▶ **Desire for “Global” Markings on Single Product**
 - CEC, NEC, ATEX, IECEx, Country Specific
- ▶ **National Differences in Standards**
 - Canadian Adoptions of IEC 60079 Standards require additional markings
 - Warning Markings, CEC Requires English and French
- ▶ **Certification for Broader Range of Applications**
- ▶ **Global Product is not always Practical**

Equipment Marking Challenges



EPL Gb Ex db IIC T6
IECEX FMG15.1111X
IP 66

WARNING – DO NOT OPEN WHEN AN
EXPLOSIVE ATMOSPHERE IS PRESENT



II 2 G 1 M Ex d IIC T6
SIRA 15ATEX1234X
IP 66

WARNING – DO NOT OPEN WHEN AN
EXPLOSIVE ATMOSPHERE IS PRESENT

Class I, Zone 1, AEx d IIC T6
Class I, Division 2, Gr. A, B, C, D
Class II, Division 2, Gr. F, G
Class II, Zone 22, AEx tb IIIC T120°C
Class III
Type 3, 4, 4X
IP 66
Warning: Disconnect Power Before Opening



Ex d IIC T6 Gb
Class I, Division 2, Gr. A, B, C, D
Ex tb IIIC T120°C Db
Class II, Division 1, Gr. E, F, G
Class III
Type 3, 4, 4X,
IP 66
Warning: Area should be cleared of
hazardous materials prior to opening



Closing Comments

Marty sits down, Tim stands up

CEC Appendix L

- ▶ **Rule 18-004 Requires Classification of Hazardous Locations, which is a Design requirement**
 - There is a general lack of understanding on how to meet this rule by many Code Users
 - Appendix B, Notes on Rules, was deemed inadequate to address
 - Appendix L, Engineering guidelines for determining hazardous area classifications, was added to the 2015 CEC
 - Topics covered
 - Intent, Involvement of Multiple Disciplines and Stakeholders, Responsibilities, Engineering Authentication, Documentation, Inspection, Management of Change and Listing of Information Sources and References

Future Activities

There is Need for more Changes, *most in progress*

- EPL of some equipment can be Lower than Type of Protection: EPL takes Precedence – **Addition**
- Table J1.2 - **Update for Clarification, and Addition of Dusts**
- Non-incendive - was Deleted from Zone 2 – **Reinstate**
- Appendix F, Recommended Installation Practice for Intrinsically Safe & Non-incendive Systems – **Update**
- Appendix H, Recommendations for Combustible Gas Detectors in HazLoc - **Update**
- Section 20 *HazLoc on Commercial Facilities* – **Update/Harmonize with Section 18**
- Re-define Explosive Gas Atmosphere, and LEL/UEL becomes LFL/UFL - **Update**
- References to Class/Division in Rest of CEC – **Correct/Update**
- Engineering Involvement for Classification, Rule 18-004 – **Addition**
- Types of Protection – **Correct Terms**
- 18-068 Appendix B Note, Combustible Gas Detectors – **Clarify**
- 18-052 Appendix B Note, Ambient Temperature - **Clarify**

Challenges

- ▶ **The 2015 CEC comes into effect in all Canadian Jurisdictions within the next year, currently In-force in AB, SK and BC**
- ▶ **The Zone 0, 1, 2 adoption in 1998 was an easier transition as most participants were Oil & Gas who had some familiarity**
 - Not the same with Dusts, and it will be a shock to some in all areas; Classification, Installation and Equipment
- ▶ **Users, Designers, Installers, Inspectors and Maintainers Will require extra knowledge**
 - In general, more Equipment Availability, but will require extra knowledge for Selection, Application and Understanding Markings
 - Some Zone Equipment requires Documented Maintenance programs
 - New Installation rules, especially in some of the “Dust” areas

Summary/Conclusions

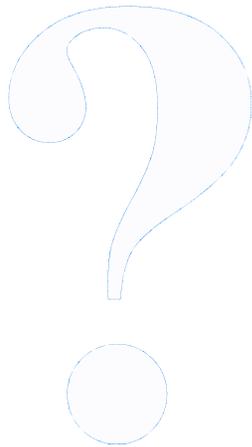
- ▶ **CEC Haz-Loc has Changed (*and will continue to do so*)**
 - Largely Harmonized with IEC
 - Some are Significant, e.g. Dusts
- ▶ **Zones are Mandatory for All New Construction**
 - In-Force between ~Now – 1 Year Later, All Canada
 - Class/Division Allowed Only for Existing Installations

We'll Need to Get Ready for it !

The 2015 Canadian Electrical Code for Hazardous Locations

May Have No Class

- But we're now "in the Zone"



**Break Time,
10 min.**

2016 API RP505, 2nd Edition

Still Has Class

But Also Has Significant Changes

Recommended Practice for Classification of Locations
for Electrical Installations at Petroleum Facilities
Classified as Class 1, Zone 0, Zone 1, and Zone 2

Intent – Cover significant items and changes

Note – This is Gas only, i.e. doesn't cover Dusts

Revisions – API RP505

- ▶ **Have been in progress since last issue of API 500**
 - December 2012
- ▶ **Term “Class” has been left in – to match the NEC**
 - Was discussed at NEC, decided to leave in the code
- ▶ **Scope**
 - Not a change, but need to highlight this statement in 1.1.1
“This publication is only a guide and requires the application of sound engineering judgment” (note – also same statement in RP500)
 - **It is a guide/recommended practice, i.e. not mandatory**
 - Shall’s are used throughout the standard and are considered strong recommendations. Should’s are also used, so not as strong as Shall’s
 - **Requires the use of Engineering Judgment, in many areas of the standard**

References

- ▶ **References have been split between Normative in section 2 and Informative in Bibliography (at the end)**
- ▶ **CSA CEC referenced (and in the Scope)**
- ▶ **IP 15 is now EI 15, Energy Institute**
- ▶ **ISA Standards maintain their name, e.g. ANSI/ISA-60079-10-1**
 - but management of standards has moved to UL

Terms, Definitions, and Acronyms

- ▶ **Numerous small changes**
- ▶ **Where Ignition Temp. is mentioned in standard, now consistently referred to as Autoignition Temp. (AIT)**
- ▶ **Zone 0, 1, 2 definitions match the NEC**
 - *Small difference to CEC*
 - **Have additional subrules 2 & 3 for Zone 1, similar for Zone 2**
 2. in which ignitable concentrations of flammable gases or vapors may exist frequently because of repair or maintenance operations or because of leakage; or
 3. in which equipment is operated or processes are carried on, of such a nature that equipment breakdown or faulty operations could result in the release of ignitable concentrations of flammable gases or vapors and also cause simultaneous failure of electrical equipment in a mode to cause the electrical equipment to become a source of ignition; or

Terms, Definitions, and Acronyms

- ▶ **“Explosive” changed to “Flammable” Gas Atmosphere**
 - Mixture with air, under atmospheric conditions, of flammable substances in the form of gas or vapor, that is capable of igniting easily, burning intensely, or spreading flame rapidly.

- ▶ **Flammable (Explosive) Limits changed to Flammable Limits or Explosive Limits, LFL/UFL or LEL/UEL**
 - Explanation given on difference between flammable and explosive, and that the “wider Flammable range” should be used for Area Classification
 - Flammable Limits are a material property, and have the wider range
 - Explosive Limits also depend on other factors, such as geometry and igniter energy
 - ***Flammable and Explosive Limits are not interchangeable !***
 - Throughout the standard, wherever “Explosive” is used, it is replaced by “Flammable or Explosive”, *so worst case applies*

Zone 2 Considerations

- ▶ **6.5.4.2 probability of simultaneous failure of electrical equipment and a gas release is very small**
 - Example conservative calculation is provided in an explanatory Note that the chance of this occurring in the same hour is 1 in 64 million
- ▶ **New clause 6.5.4.6 for unattended, unmonitored facilities**
 - Normally considered Zone 1 as a release would not meet the Zone 2 “short period” definition, even if designed as Zone 2
 - Gas detection recommended as a way to monitor and maintain Zone 2
 - A response to a Gas Detection is still necessary, such as activate ventilation or shutdown



Grade of Release / Zone Classification

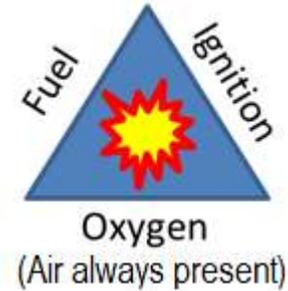
- ▶ **Clauses 6.5.8.1 - .3 contain Tables 2 & 3 (combined below) showing the approximate relationship between Grade of Release, Presence of Flammable Mixtures and Zone designation**
 - Source is from Energy Institute EI 15 (formerly IP 15)
 - Hours/year is a “rule-of-thumb”
 - Normally Continuous Release leads to Zone 0, etc. but not always
 - Other factors such as ventilation, dual grades of release, etc. need to be considered

| Grade of Release | Flammable Mixture Present | Zone |
|------------------|----------------------------------|------|
| Continuous | 1000 or more hours/year | 0 |
| Primary | 10 hours/year to 1000 hours/year | 1 |
| Secondary | less than 10 hours/year * | 2 |

* *Expect to be several small duration releases over a year*

Comparing Divisions to Zones - Risk Assessment

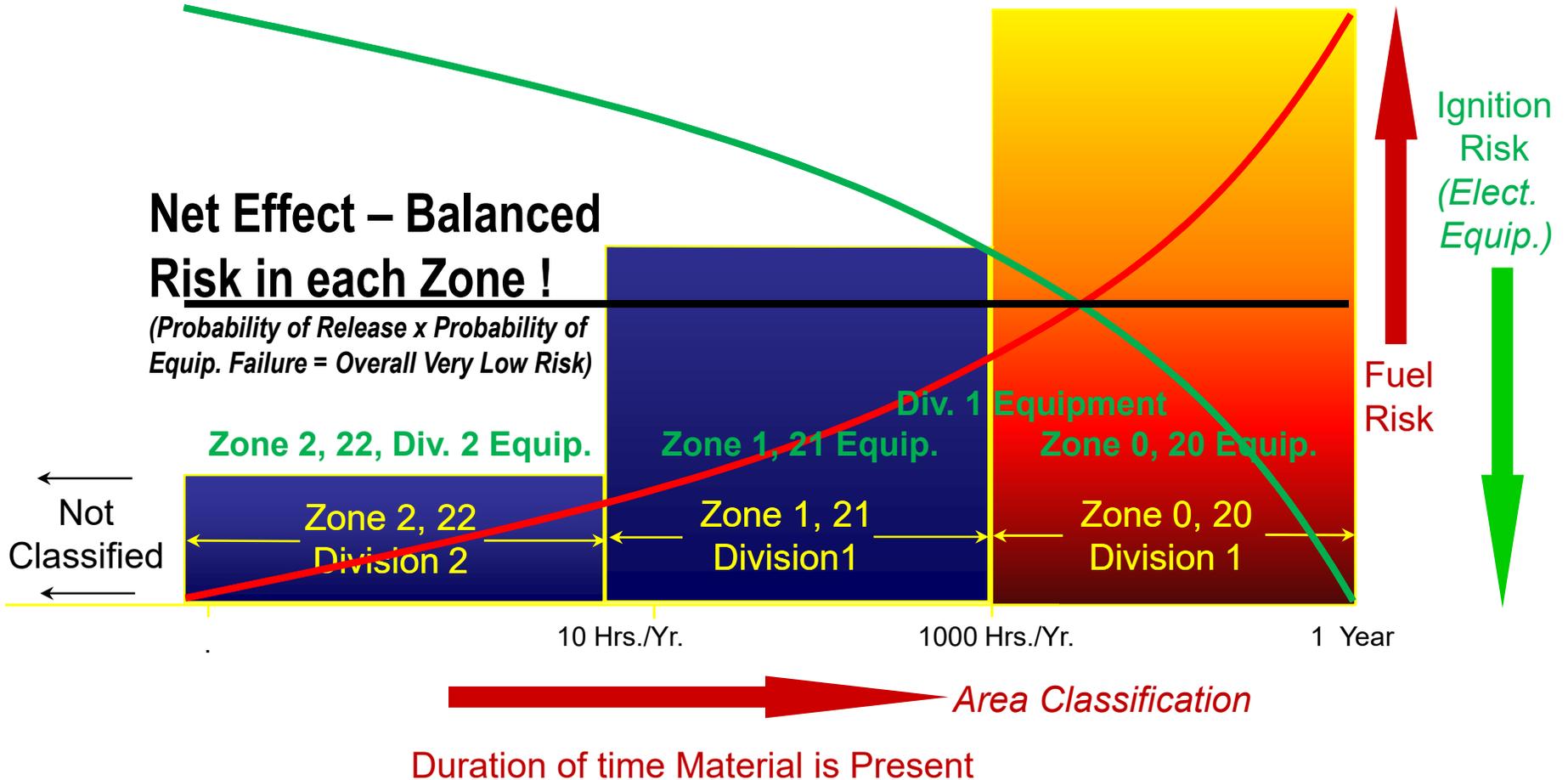
Gas



Elect. Equip.

Net Effect – Balanced Risk in each Zone !

(Probability of Release x Probability of Equip. Failure = Overall Very Low Risk)



Unclassified

▶ Same clauses exist

- All-welded closed piping, tubing without valves, etc.
- Adequately ventilated equipment with continuous flames
- Previous versions of 500 and 505 allowed not classifying where an open flame exists



- No longer accepted except for immediate vicinity of flare tips and unprotected fired vessels (where Elect. Equip. not usually energized)
- Stresses that Area Class is based on presence of flammable mixtures (not on presence of ignition sources)

Ventilation

- **Several small changes made**
 - E.g. alarming on loss of mechanical ventilation
- **Adequate Ventilation (*normally Zone 1 becomes Zone 2*)**
 - **6 Air Changes per Hour (ACPH) usually not practical in colder climates**
 - Will lead to high heating costs
 - Can lead to freezing of process lines, especially near inlet louvers
 - **Recirculation with Makeup Air using Gas Detection**
 - **Not a fully enclosed building (*also not practical in colder climates*)**
 - **Fugitive Emissions calculations per Annex B**
 - Below 3 ACPH, continuous monitoring by Gas Detection recommended
 - **Verifying by use of Permanent and Portable Gas Detection of existing facilities (not described in API)**
 - NFPA 30 Flammable and Combustible Liquids Code - outlines a method
 - NFPA 497 RP for Classification of Chemical Process Areas

Gas Detection, API 505

- ▶ **Significant change; clause 6.8, Use of Gas Detection allows *(which now matches partially with CEC 18-068)***
 - An inadequately ventilated Zone 1 area containing Sources can have Zone 2 Rated Equip. installed
 - Not recommended where normal releases are expected unless ventilation is provided
 - A Zone 2 building not containing Sources, with Vapourtight walls where connecting to Zone 2 area, can have Non-HazLoc Equipment installed
 - Area Classification Documentation to include the basis of Equip. selection
- ▶ **Relaxation not recommended for Zone 0**
- ▶ **Previous versions allowed the Area Classification designation to be changed**

Gas Detection

- ▶ **CEC 18-068 allows Non-HazLoc Rated Equip. in a Zone 2 area, and Zone 2 Rated Equip. in a Zone 1 area**
 1. **Only where No Suitable Elect. Equip. is Available, and**
 2. **Normal operation of the Equip. does not produce sparks or hot surfaces capable of causing ignition**

- ▶ **API 505 - the above criteria is not required (*other than hot surfaces*)**

- ▶ **Both API 505 and CEC 2015 have criteria for the Gas Detection**
 - **Alarming, activating extra ventilation, de-energizing the Elect. Equip.**
 - **API has extra requirements**
 - **Performance Tested, Adequate No. Sensors, No Open-Path, Calibration & Maintenance (with references made to Performance, Installation, Operation and Maint. Standards)**
 - **The CEC has Informative Appendix H - a revision has been initiated**
 - **Revision could be made Normative, hasn't been decided yet**

Gas Detection

- ▶ **NEC permits the use of Gas Detection to install electrical equipment in a hazardous location, in the following situations**
 1. Inadequate ventilation
 2. Interior of a building
 3. Interior of a control panel
- **New standard ANSI/ISA-TR12.13.03 Guide for Combustible Gas Detection as a Method of Protection, is referenced by the NEC for these**
- **This has the potential to allow manufacturers to take this approach, in particular option 3., rather than appropriately certifying equip.**

Gas Detection

- **Gas detection technology has significantly improved**
 - **Accuracy and Reliability**
 - **3 Types are normally used out of 9 available, summarized below**
 - **Note – Open Path type detection systems are not acceptable for the purpose of allowing non-suitably rated electrical equip. to be installed**
 - **Averages over a distance, providing a lower LFL reading than at a specific Release point**

| Technology | Advantages | Disadvantages |
|---------------------|---|--|
| Catalytic, Point | <ul style="list-style-type: none"> - Low initial cost - H₂ detection - Versatile, broad range | <ul style="list-style-type: none"> - Frequent calibration cycle - Susceptible to poisoning - Not fail safe, monthly degradation |
| Infrared, Open Path | <ul style="list-style-type: none"> - Large area coverage - Fail safe - Infrequent calibration - Low maintenance | <ul style="list-style-type: none"> - Alignment challenges - LEL-m read out - Expensive |
| Infrared, Point | <ul style="list-style-type: none"> - Environmental superiority - Fail safe - Low cost of ownership - High reliability | <ul style="list-style-type: none"> - No H₂ detection |

Section 8 Common Applications

- ▶ **8.2.5.1 allows for not classifying fuel systems to prime movers, up to 862 kPa (125 psi)**
 - References fuel piping to meet NFPA 37 (also NFPA 850)
 - **Caution note that this pressure criterion is for this application only**
- ▶ **Several updates for Lab rooms and Analyzer buildings**

Section 9, Refineries

› Clause 9.1.5 left as-is

- Experience has shown that the occurrence of flammable material liberation from some operations and apparatus is so infrequent that it is not necessary to classify the surrounding areas.
- An example of such an area is an adequately ventilated location where flammable substances are contained in suitable, well maintained closed process piping systems that include only the pipe, fittings, flanges, meters, and small valves.

(This is not included in Production, rather it has increase reqt., see Slide 91)



Refineries typically
Highly congested
Process areas

Section 10, Production & Drilling

- ▶ **Pressure adjustment factors added, as was included in latest edition of API RP500**
 - Table 4 factors were based on Dispersion modeling described in EI 15
 - Base “Extent Distances” would be multiplied by the Adjustment Factor based on the maximum operating pressure
 - *Note: already included in the Alberta Oil & Gas Code for Elect. Installations*

| Description | Typical Services | Pressure Range (psig) | Adjustment Factor |
|-----------------|---|--|-------------------|
| Low pressure | LP separation, free water knock out, bad oil tank, vapor recovery unit, fuel system, etc. | 0 to 740 (0 kPa to 5102 kPa) (Typical ANSI 300 Class flange and below rating at 100 °F) | 1.0 |
| Medium pressure | Intermediate pressure (IP) separation, gas compression, etc. | 741 to 1440 (5109 kPa to 9928 kPa) (Typical ANSI 600 Class flange rating at 100 °F) | 1.5 |
| High pressure | HP separation, manifold, Flow Line, gas compression, dehydration, metering, export, etc. | > 1440 (9928 kPa) (Typical ANSI 900 Class and above flange ratings at 100 °F) | 2.5 |

Section 10, Production & Drilling

- **10.15.2.1 – extent distances were increased for screwed connections, flanges, block valves and check valves in non-enclosed adequately ventilated areas**
 - Unclassified for low pressure
 - Zone 2 for 50 cm, for medium and high pressure
 - Engineering judgment for extending this distance



Production Facilities generally more remote, less congested

Tim sits down

George stands up

Over-conservative A/C design

- ▶ **Often see this when design done by inexperienced person**
- ▶ **Over-conservative Area Classification design leads to excessive installation and long term operations costs**
- ▶ **You can't just look at the pictures! You need to know what you are doing.**
 - API 505 states “This publication is only a guide and requires the application of sound engineering judgment.”

Over-conservative A/C design

► Know the subject

- Lack of experience often leads to excessive Area Classification
- Code
 - First know and follow the basic definitions of zones from CEC section 18
- Recommended Practices
 - API 500/505 Recommended Practice for Classification of Locations for Electrical Installations at Petroleum Facilities Classified as Class I Zone 0, Zone1, and Zone 2
 - NFPA 497 Recommended Practice for the Classification of flammable Liquids, Gases or Vapors and of Hazardous (classified) Locations for Electrical Installations in Chemical Process Areas
 - IEC EN 60079-10-1 Ed. 1.0 Electrical Apparatus for Explosive Gas Atmospheres - Part 10-1 Classification of Areas – Explosive Gas atmospheres
- Figure 53 in API does not meet the definition of Zone 2 in CEC because it does not address the time issue in the definition

Over-conservative A/C design

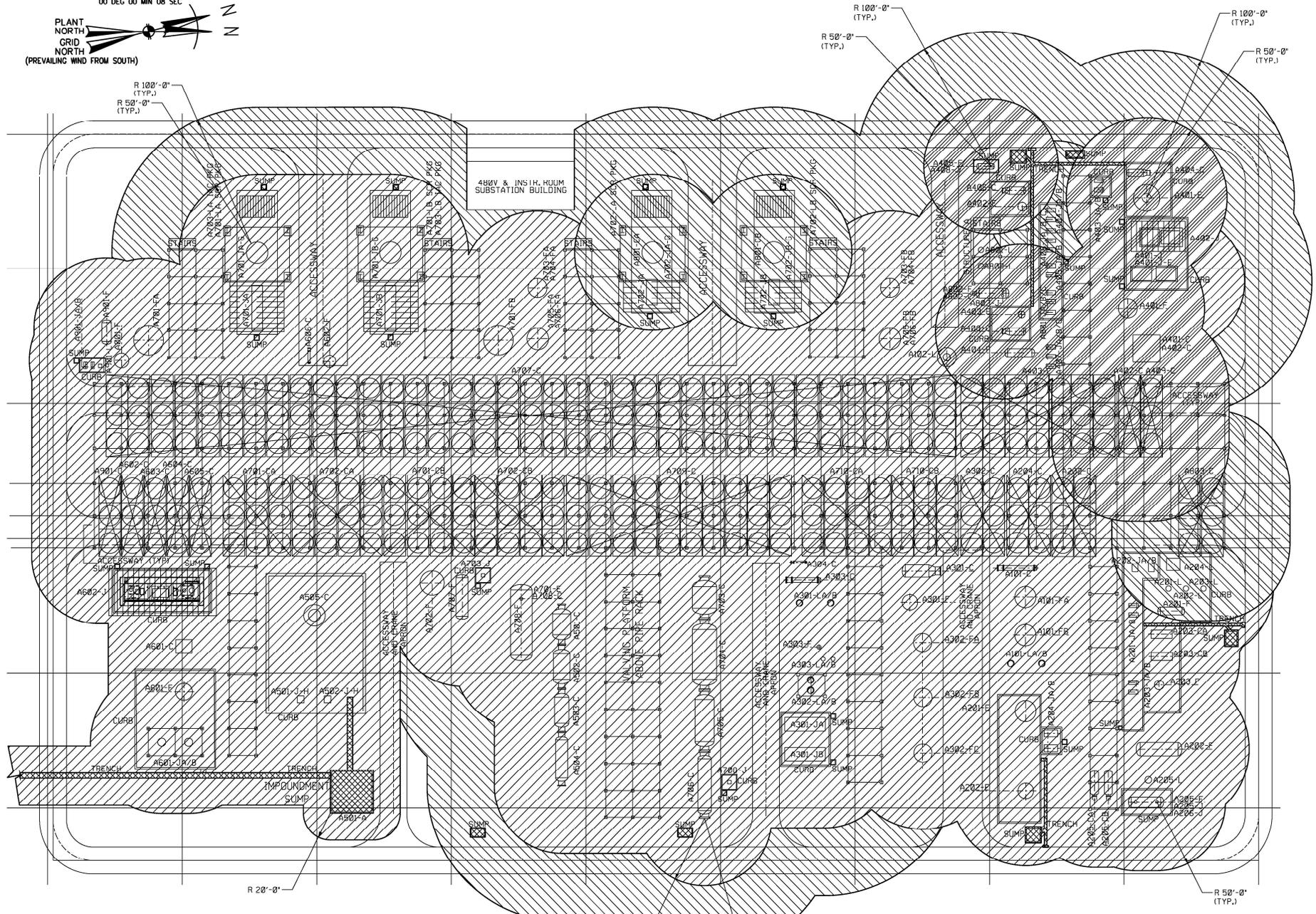
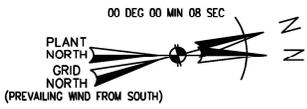
► Know the subject

- Know the process and the properties of the commodities involved
- Often need to consult with Process engineers to fully understand commodity parameters
- A working knowledge of the facility and the process is invaluable

Over-conservative A/C design

▶ Typical A/C drawing

- Note the Area Classification spills out on to the roads
- This will cause long term operations difficulties and costs
- This was caused by an over conservative design using section 9 of API 505 where section 10 should have been used.



Jan2016

Over-conservative A/C design

- ▶ **Flare Knock Out Drum**
- ▶ **Why is the whole area classified?**
- ▶ **The pressure is 2 or 3 psi (15 to 20 kPa)**
- ▶ **Possibility of a leak under normal operation practically impossible (except for seals on pump)**
- ▶ **The whole area should be unclassified except for a small area around the pump seal.**

Flammable and Combustible Liquids

▶ Classes of Liquids (from API 505)

–Class I Liquids (i.e. Gasoline)

- Any liquid having a closed-cup flash point below 37.8° C (100° F) and a vapor pressure not exceeding 276 kPa (40 psia) at 37.8° C (100° F) .

–Class II Liquids (i.e. Diesel Fuel)

- Combustible liquids having a flash point at or above 37.8° C (100° F) and below 60° C (140° F).

–Class III Liquids (Bitumen)

- Combustible liquids having a flash point at or above 60° C (140° F).

Flammable and Combustible Liquids

▶ Classes of liquids (from API)

- Class I liquids (i.e. Gasoline) usually are handled at temperatures above the liquids flash point and consequently may produce a flammable atmosphere.
- Class II liquids (i.e. Diesel fuel) are typically handled at temperatures below their flash point where they do not produce sufficient vapors to form an ignitable mixture. Normally except near points of release, Class II liquids do not produce vapors of sufficient quantity to be considered for electrical classification purposes.
- Class III liquids (i.e. Bitumen) do not produce vapors of sufficient quantity to be considered for electrical classification purposes.

Flammable and Combustible Liquids

▶ Classes of liquids (from API 505)

- NOTE: If these liquids are heated above their flash points, they will all produce vapors of sufficient quantity to be considered for electrical classification purposes. The extent of the classified location will vary.
- NOTE: Class II and III liquids in tanks may require classification of the vapor space.

Ventilation

- ▶ **Division 1 becomes Division 2 in some process buildings because history proved that explosive atmospheres just didn't exist during normal operation**
- ▶ **95%+ of the classified areas are now Zone 2 (not Zone 1 or 0) because ventilation is used to meet the requirements**
- ▶ **Adequate ventilation – to prevent the accumulation of significant quantities of mixtures in concentrations above 25 percent of the lower flammable limit (LFL)**

Ventilation

- ▶ **Use of fugitive emissions to prove that ventilation requirements are far less than the six times air changes required by API RP505 6.6.2.4.2**
 - At least six air changes per hour, can be considered as adequately ventilated.
- ▶ **Section 5.5.4 of NFPA 497 allows classification based on experience so use of actual gas measurements of similar facilities to justify Zone 2 is far more accurate than fugitive emissions calculations**

API RP505 Section 9 vs section 10

- ▶ **Section 9 – Refinery processing facilities consist of specialized equipment within which liquids, gases, or vapors are continuously processed at high rates and at elevated temperatures and pressures**
 - Both chemical and physical changes occur in these materials
- ▶ **Section 10 – locations where flammable petroleum gases and volatile liquids are produced, processed, stored, transferred, or otherwise handled**

No fired equipment in hazardous areas

- ▶ **See section 168 of OHS**
- ▶ **Do not put fired equipment into hazardous locations**
- ▶ **Electrical installations on fired equipment is often specified as Zone 2, but do this with a note on the drawings and not by classifying the area around the equipment.**

Summary

- ▶ **Area Classification is an Engineering function**
 - As such, Engineering Judgment is Required, *i.e. think!*
 - Alberta OH&S Code requires professional Engineering, except
 - Section 20 CE Code (Commercial facilities)
 - Alberta Code for Electrical Installations at Oil and Gas Facilities

Note – there is a current subject in CEC Section 18 SC, to require Engineering
 - It is not a “copy & paste” process
 - It is easy to over-classify, but this adds Cost, not Safety!

The End

