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Combining Hazardous Location Practices and Technologies in a Large Capital Project

Introduction

- Global Competitiveness Requires Innovation
- Primary Objectives
  - Capital Cost Reductions
  - Without Compromising Safety
- Blending North American and IEC Practices
  - Installation Methods
  - Electrical Equipment
    - Certified to North American and IEC Based Standards

Reality of the Global Economy

- Industry Must Be More Competitive to Survive
- Both Existing and New Facilities
  - Must Re-examine How Electrical Installations Are Designed, Constructed, Operated, and Maintained
- Rapid Advancements in Technology
  - Cost Benefits of Major Developments Must Be Examined and Incorporated Faster
- Changes Must Be Implemented Without Compromising Safety

Reality of the Global Economy

- Electrical Installations Not the Same Everywhere
- Multiple Electrical Wiring Codes, Recommended Practices and Product Standards Exist
  - Properly Applied, All Result in Safe Installations
- Underlying Objective of All Codes and Standards Organizations, Owner Operators and Regulators
  - Ensure Electrical Safety
  - Protect Workers
  - Protect Property
  - Ensure Reliability

Reality of the Global Economy

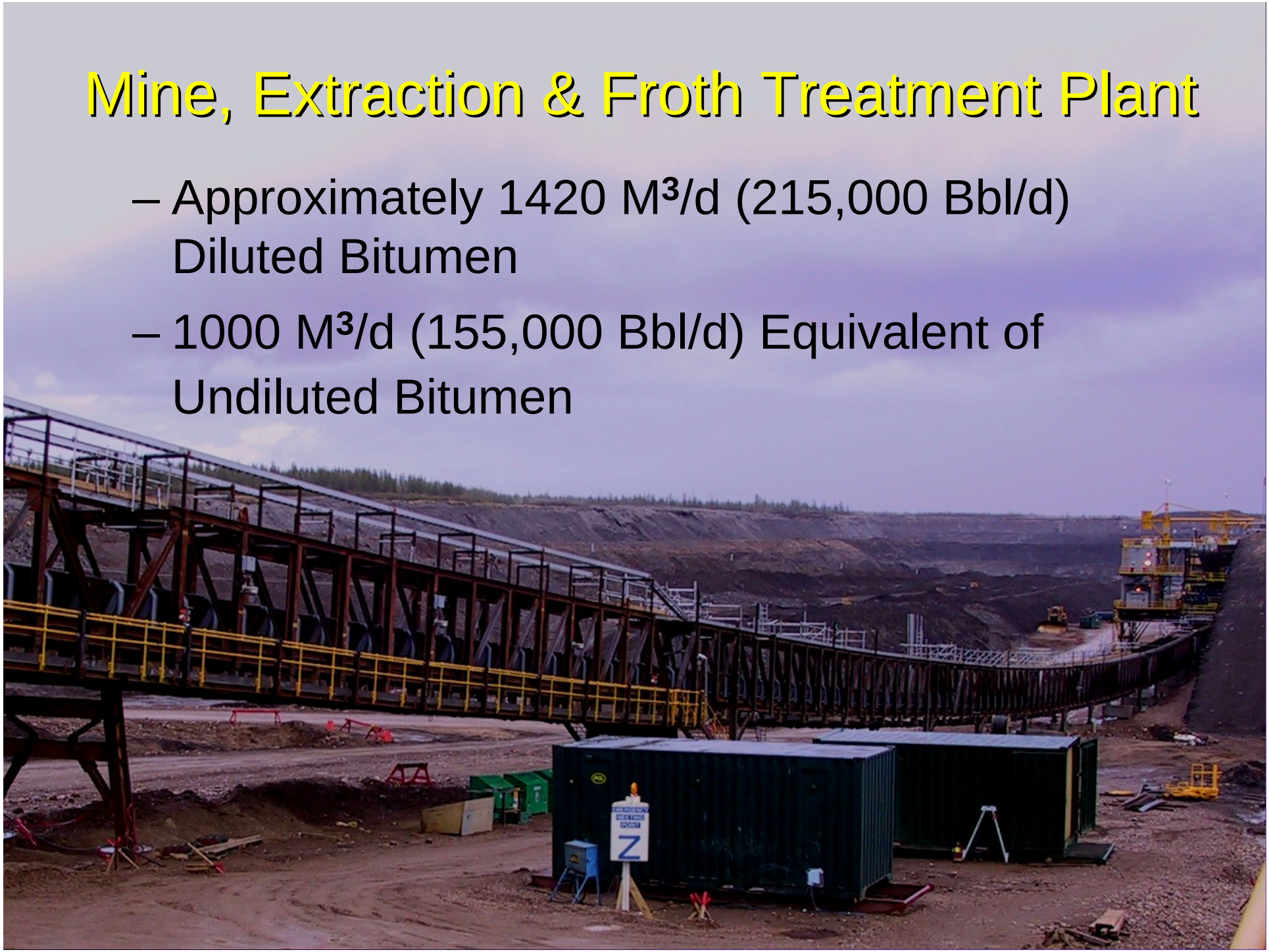
- No Single Set of Electrical Codes and Standards
  - Is Absolutely the Best
  - Is the Most Cost Effective
- Many do Have Cost Effective Elements
- In A Perfect World We Would
  - Select the Best Practices From Multiple Documents
  - Determine the Most Cost Effective Solutions

The Project Referenced

- Large Oil Sands Resource In Northern Alberta
  - High Quality, Well-defined Mineable Ore Body
  - 1.5 Billion M^3 (9 Billion Barrels) of Bitumen
    - Recoverable Through Surface Mining
- Project Facilities
  - Mine and Extraction Plant
  - Pipelines
  - Upgrader, and Refinery Modifications
  - Cogeneration Plants

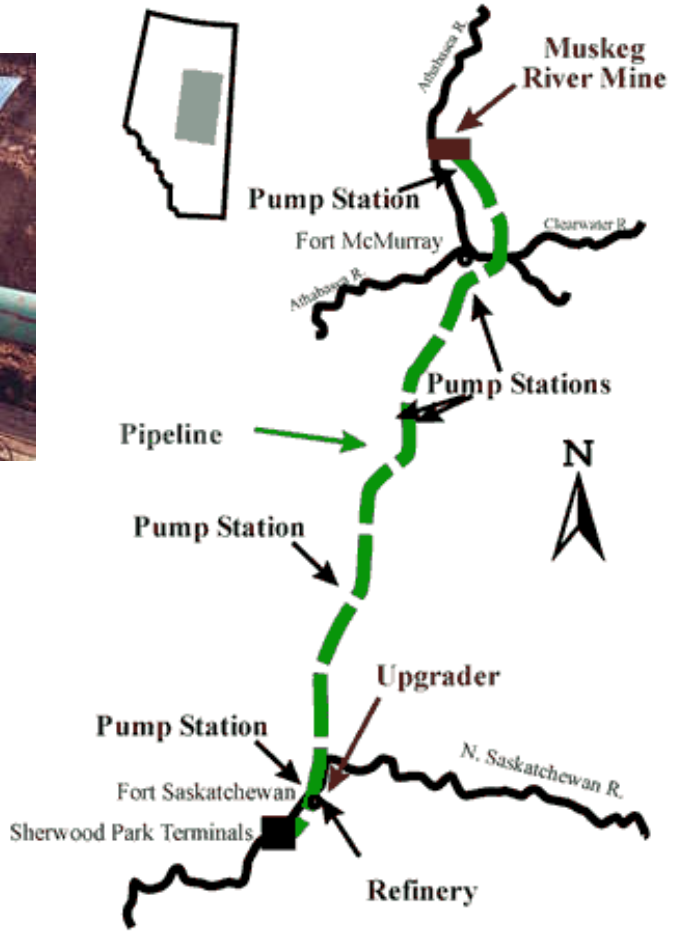
Mine, Extraction & Froth Treatment Plant

- Approximately 1420 M³/d (215,000 Bbl/d) Diluted Bitumen
- 1000 M³/d (155,000 Bbl/d) Equivalent of Undiluted Bitumen



Pipelines

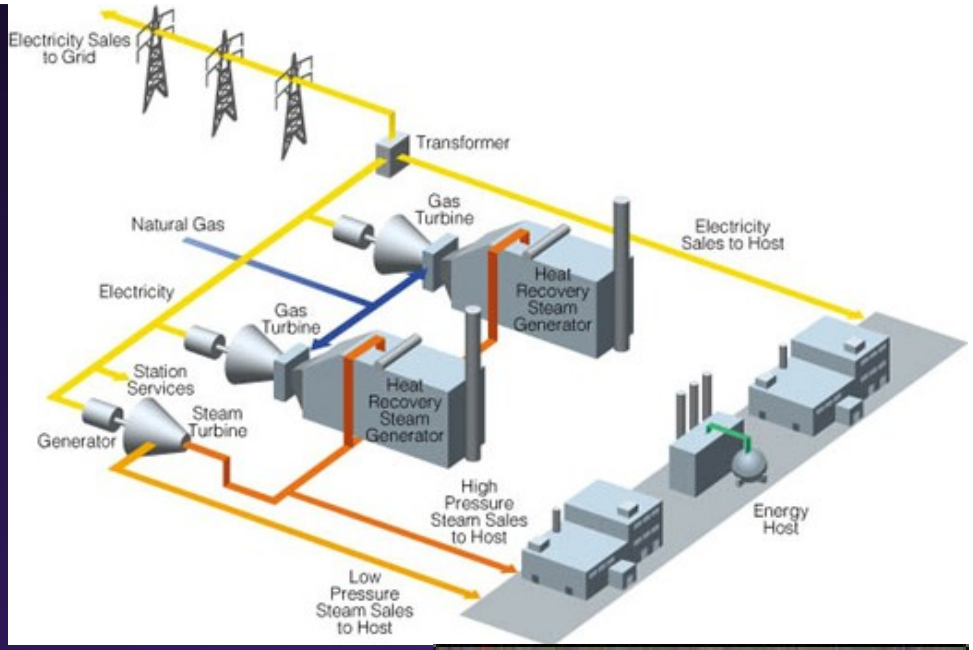
- Transports Diluted Bitumen 470 Km From Mine to Upgrader
- Return Recovered and Make-up Diluent to Mine
- Expanded Pipeline Facilities Between Refinery and Shipping Terminals
  - Feed Supply, Product Delivery, Diluted Bitumen Bypass



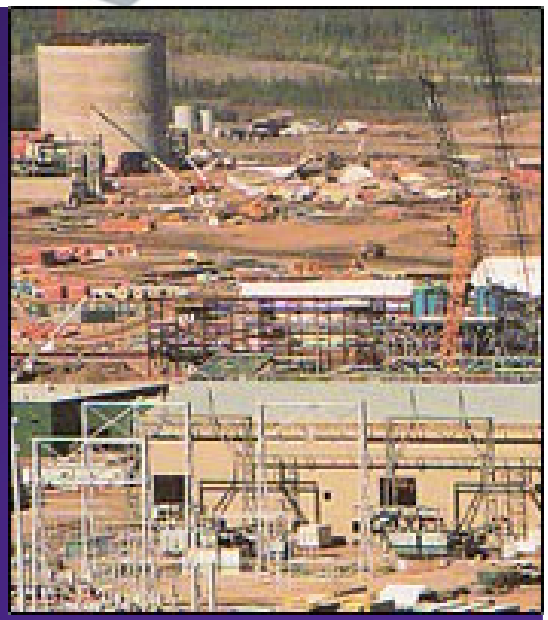
Upgrader

- Upgrade Bitumen From Mine to Synthetic Crude, 1420 M^3/d (215,000 Bbl/d)
- Refinery Modifications
  - Necessary to Integrate Upgrading Process to Refinery Process

Cogeneration



- Independent Power Producer
- All Process Steam and Electrical Power Requirements
- Excess Power Sold to Provincial Electrical Grid
  - Back-up Power Available From Grid
- Mine Facility
  - 180 Mw – Two 90 MW GTG
- Upgrader Facility
  - 180 Mw – 90 MW STG & One 90 MW GTG



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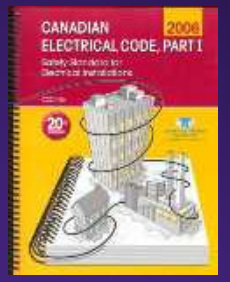
Canadian Regulatory Environment

- Very Similar to the NEC
- Canadian Electrical Code
  - Canadian Electrical Code (CEC) Part I
    - Electrical Installation Rules
    - Adopted Individually by All Jurisdictions in Canada
  - Part II Product Standards
    - CEC (Part I) Requires All Electrical Products Installed Be Certified to Part II Standards
- Both Are Written and Administered by CSA



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Canadian Regulatory Environment

- Following The CEC Was mandatory
  - CEC Required The use of CSA Approved Products
- Any Deviations to This Required Special Approval From The Authority Having Jurisdiction (AHJ)
  - Most Deviation Requests Were Refused
    - Due to Undefined “Safety Concerns”
    - No Appeal Process Available
    - Uncertainty of Obtaining Approval Discouraged Use

Change In Regulatory Environment

- Alberta Passed The Safety Codes Act,
  - New System Went Into Effect In 1996 That Changed The Way The CEC Was Applied
- Corporations Were Permitted To Become "Accredited" To Self Inspect Their Facilities
  - Requires A Quality Management Plan
  - Use Certified Safety Codes Officers For Inspection

Quality Management Plan

- Identifies How The Requirements Of CEC Are Met
- Includes A Variance Policy
  - Allows Deviations To
    - Installation Rules
    - Product Standards (I.E. Certification To CSA)
  - Deviations To The CEC
    - Must Provide Equivalent Or Improved Safety
    - Must Include Detailed Documentation

Inspection

- Safety Codes Officers (SCO)
  - Accredited By The Province
    - Role Is The Same As Provincial/State Inspector
  - Can Be Corporation Staff Or Independent Third Party
    - Operate At Arm's Length
  - Most Corporations Use Third Party

Safety Codes Officers (SCO)

- Worked Proactively With EPC Engineering Teams
  - Assisted Engineering in Development of Variances
- Worked With Supply Chain to Ensure Correct Hazardous Location Equipment Certification Requirements Were Met
- Inspection Vendor “Packages” at Facilities to Ensure Code and Quality Compliance Prior to Delivery to Site
  - Provided Assistance in the Field to Interpret Rules
  - Assisted in Obtaining Approvals And/or Variances for Equipment That Was Delivered to Site With the Wrong Certifications.
- The SCO Agency Developed and Maintained Project’s Records for Codes Variances and Inspection Records

Engineering and Design

- Zone Area Classification System
  - Over 97% of Areas Classified As Zone 2
  - Both Zone and Division Style Equipment Acceptable
- Fundamental Principle
  - Equal or Better Safety Compared to Existing CEC

Engineering and Design

- Traditional Mindsets Challenged
  - Engineers And Designers Encouraged To Apply Knowledge And Experience Towards Innovative And Cost Effective Approaches
    - Explore Alternatives That Are Cost Effective
    - Researched Global Practices For Specific Situations
  - Without Compromising Safety
- Variances Written If Design Outside CEC
  - Involve SCO To Understand And Approve

Code and Product Variances

- Numerous Variances to CEC Used Throughout the Project
  - Where Significant Cost Advantage Gained
- Key Determining Factors In Applying for Variances
  - System Reliability
  - No reductions in Safety
    - Only Equal or Higher Level

Key Variances
Non-approved Equipment

- CEC Code Requirement
  - Only Equipment Certified to CSA Part II Standards
- Variance
  - Allow Equipment Approved to Non-CSA Standards
  - Typically Slight Differences
- Benefits
  - Significant Cost And/or Schedule Savings
- Caution
  - Substandard Equipment Was Found As “Certified”

Key Variances
Non-approved Cables

- CEC Code Requirement
  - Only CSA Certified Cables
- Variance
  - Allow the Use of UL/NEC Approved Cables
- Benefits
  - Depending on the Type of Cable Used
    - Material Savings Of 10%-50%
    - Labour Savings Of 15-50%

Key Variances
Minimum Voltage Drop

- CEC Code Requirement
  - Branch Circuits - Maximum of 3% Voltage Drop
- Variance
  - Permit Higher Voltage Drops
    - Within Rating of Equipment
- Benefits
  - Reduced Cable Size
  - Approx 17% Savings on Applicable Cable Costs

Key Variances
Random Fill of Cable Trays

- CEC Code Requirement
  - Significant De-rating of Cables
    - When Cable Spacing in Trays Is Not Maintained
- Variance
  - Use of Load Diversification Factors
    - Allowed Non-maintained Spacing Without De-rating
- Benefits
  - The Estimated Savings to the Project Exceeded 50% of the Applicable Cable Costs

Key Variances
Tray Cable Protection by Location

- CEC Code Requirement
  - Tray Cables Must Be Protected by Approved Raceway To End Devices
- Variance
  - Raceway Was Not Required Where Cables Were Protected by Their Location
- Benefits
  - Savings of 16% for the Applicable Cables Were Realized

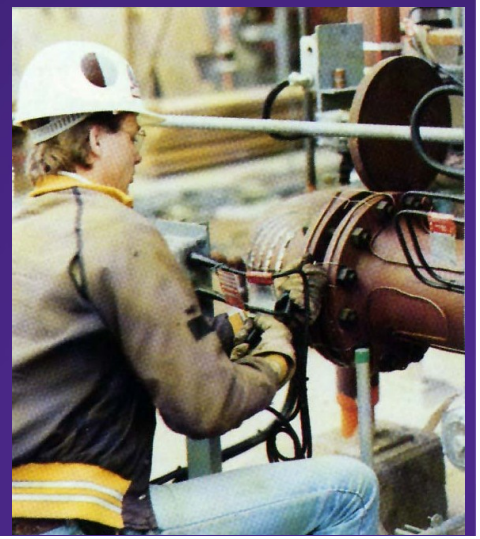
Tray Cable Protection by Location

Key Variances
IEEE Ampacities

- CEC Code Requirement
  - Defines Maximum Conductor Ampacities
- Variance
  - Allowed IEEE Ampacities for Power Cables
- Benefits
  - Estimated Savings Approx. 14%
    - On Main Feeder Cables

Key Variances
Maximum Temp. For Heat Tracing

- CEC Code Requirement
  - Sheath Temperature Must Be Below the Auto-ignition Temperature in Hazardous Locations
- Variance
  - Allowed Sheath Temperature to Maximum of Pipe Temperature in Zone 2 Areas
- Benefits
  - Savings of up to 50% for Tracing Circuits Where Variance Was Applied



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Key Variances
Bonding to Ground of Instruments in Hazardous Locations

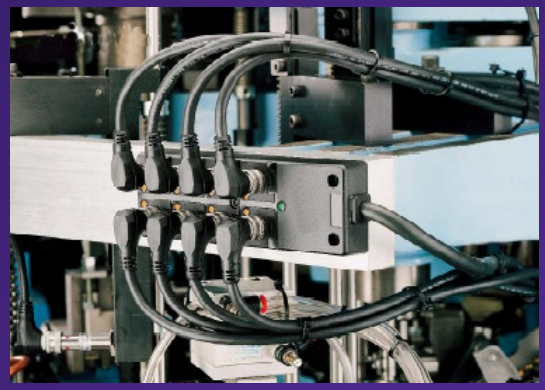
- CEC Code Requirement
  - Non Current Carrying Parts of Electrical Equipment Must Be Effectively Bonded to Ground
- Variance
  - Instruments Were Effectively Bonded to Ground by Their Connection to the Process Piping and Mounting
- Benefits
  - Reduced Cabling and Termination Costs

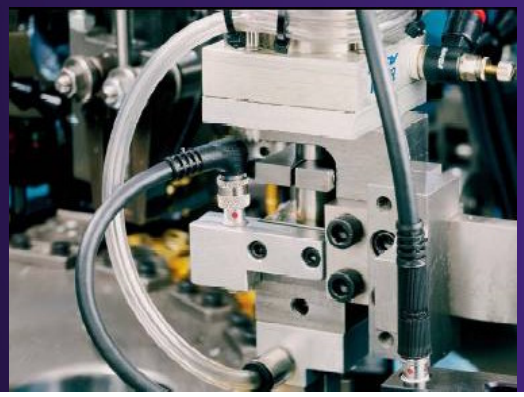
Key Variances
Motor Feeder Sizing Reduced to 115% FLA

- CEC Code Requirement
  - Motor Feeders Be Sized to 125% FLA
- Variance
  - Motor Feeders for MV Motors Reduced to 115% FLA
    - Electronic Overload Units Can Be Accurately Set to Protect the Motor Feeder Cables at This Level
- Benefits
  - Recognized Too Late to Be Used on Project

Installation and Wiring Methods Plug and Play Concept

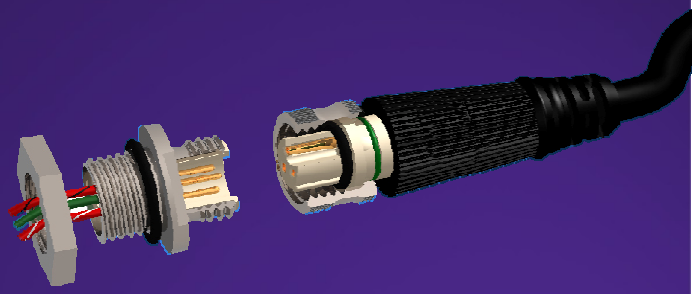
- Modular Wiring System
  - Not New To “Industry”
  - Just New To The “Hazloc Industry”
- Extensively Used In
  - Automotive Manufacturing
  - Packaging
  - Robotics





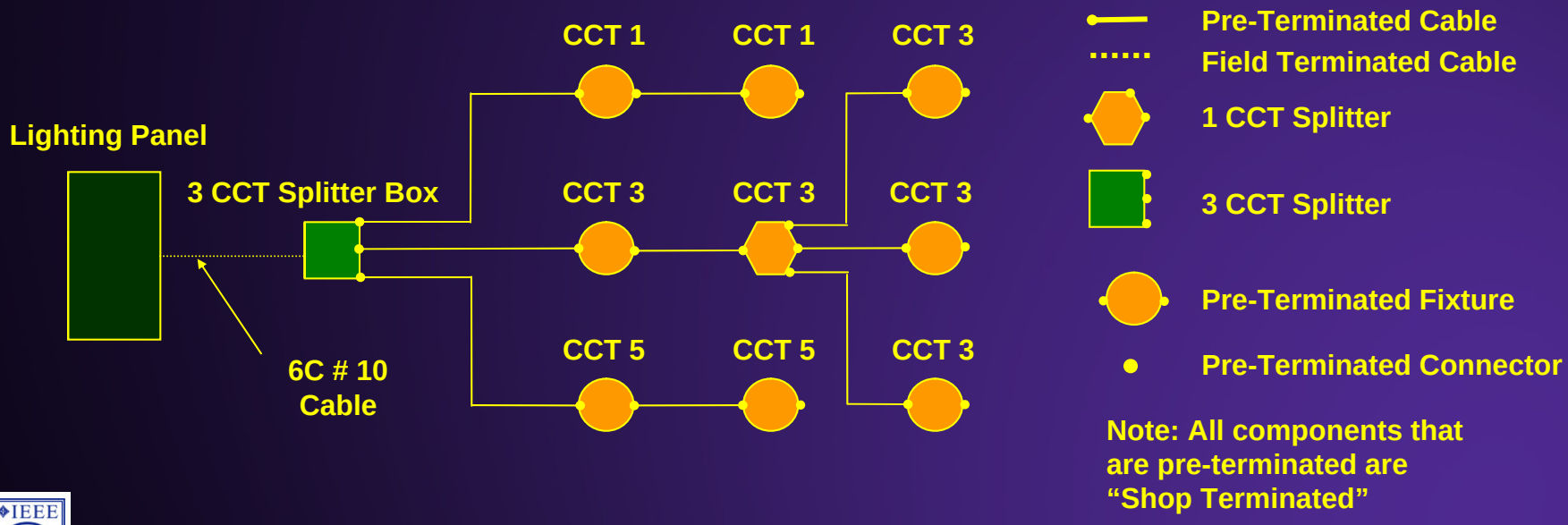
Installation and Wiring Methods Plug and Play Concept

- Concept
  - Pre-terminated Cables
  - End Devices With Suitable Receptacles
  - For Industrial Installations
- Original Concept
  - Minimize Construction Costs
- Reality
  - Significant Maintenance
  - Operation Savings
  - Safety Enhancements



Installation and Wiring Methods Plug and Play Concept

- Cables Connecting Lights And Boxes Fabricated Off Site In Pre-terminated Lengths Of 5, 10, 15, And 25 Meters



Installation and Wiring Methods Plug and Play Concept

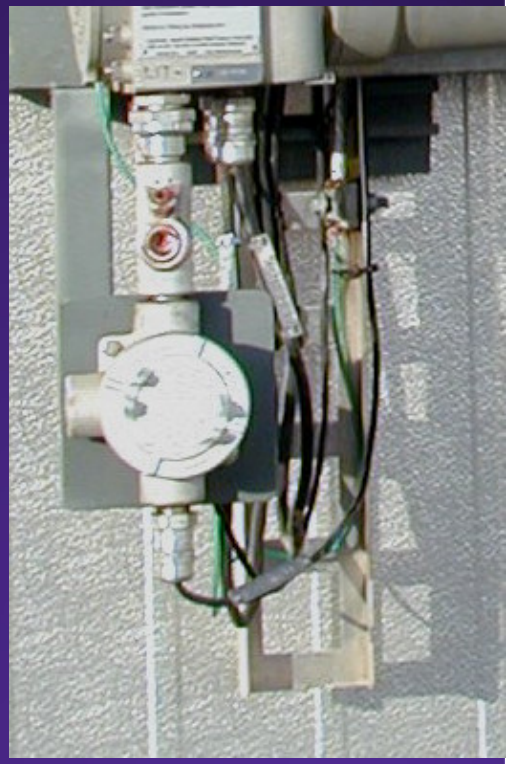
- Faster installation
- Easier maintenance

Installation and Wiring Methods

- Non-metallic Enclosures
  - FRP Enclosures & Non-metallic Cable Glands Used
    - More Corrosion Resistance Than Traditional Metal Products
  - Eliminated the Need for Bonding Conductors
    - When Tray Cables Without Grounding Conductors Were Used
  - Savings in Material and Labour Costs
    - Ranged From 35% to 50% for the Applicable Enclosures

Barrier Gland

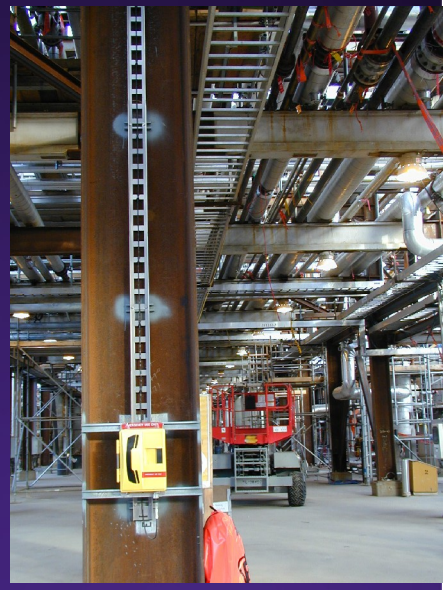
- Entry to Explosionproof or Flameproof Enclosures
- Barrier Type Cable Gland
  - For Un-armoured Tray Cables
  - IEC/CENELEC (E)Ex D
- Class 1 Division 2, Groups A, B, C, D
  - Limited By Cable Type
  - For Connecting To a Division 1 Box In Division/Zone 2



Installation and Wiring Methods

- Conventional Aluminum Cable Tray
  - Eliminated Tray Fittings (Drops, Elbows, End Plates)
    - Wherever Possible
  - 10% Savings

- Basket Tray
  - Drops Out of Main Trays and in Congested Areas
  - Significant Labour Savings Achieved



Restricted Breathing Fixtures

- Better Gasketing Restricts Fixture's “Breathing”
- Only Exterior Temperatures Considered
  - Huge Difference In T-Codes
  - Permits Use of Higher Wattages
  - Allows Flexibility in Lighting Design

High Pressure Sodium			
Wattage	**Div. 2 Unit T-Code**	**Ex nR Unit T-Code**	**Change**
400 Watt	T-2A	T-3C	120°C
250 Watt	T-2A	T-3C	120°C
150 Watt	T-2B	T-3C	100°C
100 Watt	T-3	T-4A	80°C
70 Watt	T-3	T-4A	80°C

Installation and Wiring Methods

- Division/Zone 2 Panelboards
  - EPC Input into Design
  - Factory Sealed Twin Chamber Style
  - Greater Flexibility
  - Larger Wiring Enclosures
- Later In Project
  - Zone 2 Panels
  - IEC Design
  - FRP Enclosures

Installation and Wiring Methods

- Egress Lighting
  - For Indoor, Heated Areas
- Fluorescent Fixtures
  - 120 VAC / 125 VDC
  - Central UPS System
  - Saves Costs of Individual Battery Back-up Units

Training and Education

- EPC's Needed to Better Understand Direction
- Ongoing Meetings and Training Sessions Held With Engineers, Manufacturers, Owners & SCO's
  - Adapt Hazloc Products for Use With Tray Cable
  - Highlight Design Opportunities With IEC Equipment
  - Identify Equipment Options From Traditionally Products
    - Optimize the Blend of IEC/NEC/CEC Equipment
  - Maximize Cost Savings Without Compromising Safety

Maintenance Considerations

- Significant Cost & Safety Benefits
  - Eliminate Explosionproof Equipment Where Possible
  - Use Lighting Systems That Provide Longer Life and Higher Reliability
  - Provide Some Capacity for Future Expansion
    - If Cost of Equipment Was Similar

Summary

- Concepts Discussed Saved Approx.
  - 10-15% of the Electrical System ($25 - 30 Million)
- Critical Elements
  - Trades Resistant to Change
  - Generally EPC's and Manufacturers Open to Change
  - Education and Training Essential
    - Need to Improve (Earlier and Better)
  - More Owner Involvement (With Significant Changes)
  - Opportunities Exist for Further Savings
- Paves the Way for Future Projects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