

Risk, Regulatory, and Implementation Associated with Underground Mining Applications of Hydrogen Fuelcells

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Outline



- **Project Objectives**
- **Risk Management**
- **Regulatory Approach**
- **Implementation**
- **Questions**



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Fuel Cell Locomotive Objectives



- **Safely demonstrate the successful operation of a hydrogen fuel cell locomotive in a production underground mine setting.**
- **Determine regulatory requirement for use on future fuel cell mining equipment.**
- **Determine technical issues for future application of fuel cells underground.**
- **Determine level of market acceptance and opportunities for future tests and prototypes.**



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Risk Management



- **When regulations do not dictate design, they usually require risk management:**
 - **Risk Planning (objectives, stakeholders, criteria for evaluation, and structure)**
 - **Risk Identification (what can happen and how)**
 - **Risk Analysis**
 - **Risk Response Planning**
 - **Risk Monitoring and Control**



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Risk Planning – Stakeholders



- **Project Sponsor**
- **Design / Manufacture team**
- **Management team**
- **Risk specialists**
- **Operations / end users**
- **Regulatory bodies**



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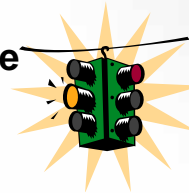


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Risk Assessment of Fuel Cell



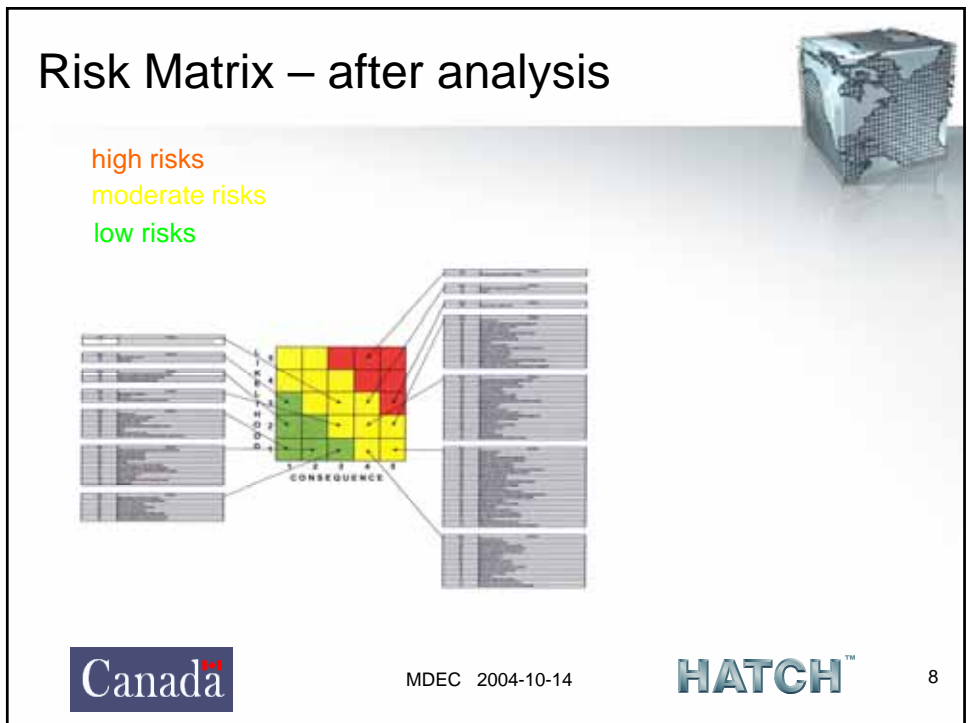
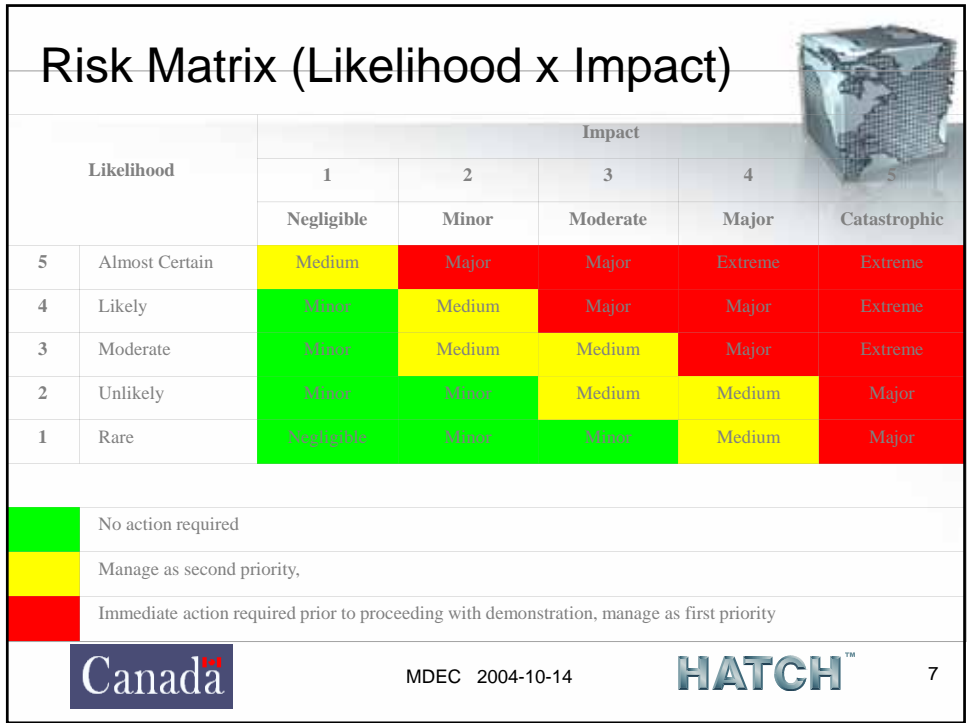
- **Risk Identification**
 - “what-if/checklist” – Center for Chemical Process Safety
 - FMEA – Failure Modes Effects Analysis
- **Risk Assessments applied to:**
 - Fuel cell system design for u/g use
 - Operating procedures.
 - Test sites



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Risk Management



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 - Risk Analysis
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 - **Risk Monitoring and Control**

Regulatory Approach



- **Regulation by jurisdiction**
 - Ontario: OHSA – O.Reg 854 – Mines and Mining Plants (“new technology”)
 - USA: MSHA – Title 30 (30 CFR)
- Ontario requires P.Eng. certification of compliance with Ontario regulations, industry standards, good engineering practices, and risk management.

Industry Standards



- Investigation
 - ◆ Compressed Gas Association (CGA)
 - ◆ CSA International:
 - CSA B51-97; Boiler, Pressure Vessel, and Pressure Piping Code;
 - CSA C22.1-02; 2002 Canadian Electrical Code; and
 - CSA M421-93; “Use of Electricity in Mines”
 - CAN/CSA-M424.1-88 - Flameproof Non-rail-bound Diesel-Powered Machines for Use in Gassy Underground Coal Mines
 - CAN/CSA-M424.2-M90 - Non-Rail-Bound Diesel-Powered Machines for Use in Non-Gassy Underground Mines
 - FC 3 - Portable fuel cell power systems

Industry Standards (continued)



- ◆ Society of Automotive Engineers (SAE)
 - SAE J2578 - Recommended Practice for General Fuel Cell Vehicle Safety
 - SAE J2579 (draft) Recommended Practice for Fuel Systems in Fuel Cell and Other Hydrogen Vehicles
- ◆ National Fire Protection Association (NFPA):
 - 52 - Compressed natural gas (CNG) vehicular fuel systems code
 - 70 – National Electrical Code
- ◆ American National Standard Institute (ANSI), and
- ◆ American Society of Mechanical Engineers (ASME)
 - Boiler and Pressure Vessel Code.

Implementation – Key factors



- Support from mine staff and management
- Perception of project
- Safety
- Timing of mine involvement (early site visits and meetings)
- Knowledge of technical aspects
- Understanding and buy-in to goals of project
- Ability of project goals to add value to operation
- Communications between overall team
- Planning and support

Implementation – Preparation



- **Early Preparation**
 - Early involvement to maintain “voice of the customer” through a Site Champion
 - Consistent and informed team needed to avoid misconceptions

Implementation – Preparation (2)



- **Site Preparation**
 - Present Overview to mine team
 - Open Q&A
 - Identify new procedures required
 - Site tour to identify test locations
- **Risk / Hazard Assessment**
 - Basis of assessment is the Test Execution Plan
 - Communicate, control, and manage risk



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Implementation – Demonstration



- **Awareness presentations prior to start**
- **Test Execution (aka “do what you planned”)**



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Recap



- **Project Objectives**
- **Risk Management**
- **Regulatory Approach**
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Summary



- **Key success points**
 - **Mine Support**
 - **Good Engineering**
 - **Management of risks**
 - **Communications within team**
 - **Technology transfer to mine staff**

Acknowledgements



- Placer Dome - Campbell Mine
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Thank You

Questions?



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