Risk Based Land-Use Planning in the Edmonton Area

Presented by:
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Engineering Safety and Risk Management Program
Faculty of Engineering
University of Alberta
the Edmonton Area
Spread of the MIACC Criteria

- Strathcona County
- City of Edmonton
- Sturgeon County
- Energy and Utilities Board (emergency planning only)
MIACC Criteria

Annual Individual Risk

100 in a million
\(10^{-4}\)

10 in a million
\(10^{-5}\)

1 in a million
\(10^{-6}\)

Risk source
No other land use
Manufacturing, warehouses, open space (parkland, golf courses, etc.)
Commercial, offices, low-density residential
All other uses including institutions, high-density residential, etc.

Allowable Land Uses
Density - versus- Distance from Risk Source (MIACC Criteria)

At one point in the evolution of the Strathcona County bylaw they developed an equation for an “equivalent person” but dropped it as being too controversial.
So What Distances to Set in Law?

- MIACC criteria
- Emergency response timeliness
- Industry options
- Fits with planning scenarios
- Quality of life issues (nuisance)
Here we were looking at the actual risks of fatalities.
**EPA-RMP Toxic Cloud Distances of Threshold Quantities**

*(Using the latest ERPG & IDLH numbers.)*

*(Table - 2a)*

<table>
<thead>
<tr>
<th>Compound</th>
<th>Threshold Quantity (lbs)</th>
<th>Molecular Weight</th>
<th>Airborne Quantity over 10 min. (per EPA-RMP)</th>
<th>ERPG 1 (ppm)</th>
<th>Minimum Odour Distance (meters)</th>
<th>ERPG 2 (ppm)</th>
<th>Minimum Hazard Distance (meters)</th>
<th>IDLH (ppm) Old value in ()</th>
<th>Minimum Hazard Distance (meters)</th>
<th>Estimated Distance from the closest Industrial Source (meters)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NH3 Ammonia</td>
<td>10,000</td>
<td>17.03</td>
<td>1,000</td>
<td>25</td>
<td>4,319</td>
<td>150</td>
<td>1,763</td>
<td>300 (500)</td>
<td>1,246</td>
<td>3,700/5,200</td>
</tr>
<tr>
<td>Cl2 Chlorine</td>
<td>2,500</td>
<td>70.91</td>
<td>250</td>
<td>1</td>
<td>5,296</td>
<td>3</td>
<td>3,056</td>
<td>10 (30)</td>
<td>1,673</td>
<td>5,400/6,900</td>
</tr>
<tr>
<td>HF Hydrogen Fluoride</td>
<td>1,000</td>
<td>20.01</td>
<td>100</td>
<td>2</td>
<td>4,456</td>
<td>20</td>
<td>1,729</td>
<td>30</td>
<td>1,150</td>
<td>4,000/5,500</td>
</tr>
<tr>
<td>H2S Hydrogen Sulfide</td>
<td>10,000</td>
<td>34.08</td>
<td>1,000</td>
<td>15</td>
<td>3,491</td>
<td>30</td>
<td>2,787</td>
<td>100 (300)</td>
<td>1,526</td>
<td>4,000/5,500</td>
</tr>
<tr>
<td>SO2 Sulphur Dioxide</td>
<td>5,000</td>
<td>64.06</td>
<td>500</td>
<td>0.3</td>
<td>14,366</td>
<td>3</td>
<td>4,542</td>
<td>100</td>
<td>787</td>
<td>4,000/5,500</td>
</tr>
<tr>
<td>Formaldehyde</td>
<td>15,000</td>
<td>30.03</td>
<td>1,500</td>
<td>1</td>
<td>19,916</td>
<td>10</td>
<td>6,298</td>
<td>20 (30)</td>
<td>4,453</td>
<td>3,700/5,200</td>
</tr>
<tr>
<td>VAM Vinyl Acetate Monomer</td>
<td>15,000</td>
<td>86.09</td>
<td>1,500</td>
<td>5</td>
<td>5,260</td>
<td>75</td>
<td>1,358</td>
<td>ND</td>
<td>--</td>
<td>5,800/7,300</td>
</tr>
<tr>
<td>HCl Hydrogen Chloride</td>
<td>15,000</td>
<td>36.46</td>
<td>1,500</td>
<td>3</td>
<td>10,434</td>
<td>20</td>
<td>4,041</td>
<td>50 (100)</td>
<td>2,556</td>
<td>3,700/5,200</td>
</tr>
</tbody>
</table>

*Note 1: ND = Not Determined*

*Note 2: HCl is included as it is a typical maintenance chemical used in cleaning processes. It is not a listed chemical for SIA members.*

*Note 3: The distances from the centre of the heavy industrial site where a product is produced to Baseline Road / Boulevar Drive and Sherwood Drive / Baseline Road intersections is approximate.*

*Note: Threshold Quantity: the quantity above which it is determined could have an adverse effect on human health and the environment if it is accidentally released. The Act requires EPA to promulgate an initial list of at least 100 substances that, in the event of an accidental release, are known to cause or may reasonably be anticipated to cause death, injury, or serious adverse effects to human health or the environment. Toxic substances were included on the list based on their toxicity, physical state, vapor pressure, production volume, and accident history. Threshold quantities were set for toxic substances based on a ranking method that considers toxicity and volatility of the chemicals. EPA assigned identical thresholds to chemicals with similar ranking scores, ranging from 500 pounds to 20,000 pounds. Similarly, the threshold quantities established today may not always represent a level below which no hazard exists.*
Again here we were looking at the actual risks of fatalities.

### EPA-RMP Toxic Cloud Distances of Threshold Quantities for Flammable Vapours

(Using the latest ERPG & IDLH numbers.)

(Table - 2c)

<table>
<thead>
<tr>
<th>Compound</th>
<th>Threshold Quantity (lbs)</th>
<th>Molecular Weight</th>
<th>Airborne Quantity over 10 min. (per EPA-RMP)</th>
<th>ERPG 1 (ppm)</th>
<th>Minimum Odour Distance (meters)</th>
<th>ERPG 2 (ppm)</th>
<th>Minimum Hazard Distance (meters)</th>
<th>Estimated Distance from Industrial Source (meters)</th>
</tr>
</thead>
<tbody>
<tr>
<td>C2H4 Ethylene</td>
<td>10,000</td>
<td>28</td>
<td>1,000</td>
<td>400</td>
<td>687</td>
<td>3,000*</td>
<td>307</td>
<td>7,500</td>
</tr>
<tr>
<td>CH4 Methane</td>
<td>10,000</td>
<td>16</td>
<td>1,000</td>
<td>15,000</td>
<td>181</td>
<td>25,000*</td>
<td>141</td>
<td>3,700</td>
</tr>
<tr>
<td>C3H8 Propane</td>
<td>10,000</td>
<td>44</td>
<td>1,000</td>
<td>2,100 (LEL)</td>
<td>293</td>
<td>2,100*</td>
<td>293</td>
<td>4,000</td>
</tr>
<tr>
<td>C3H6 Propylene</td>
<td>10,000</td>
<td>42</td>
<td>1,000</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>5,800</td>
</tr>
<tr>
<td>C4H10 Butane</td>
<td>10,000</td>
<td>56</td>
<td>1,000</td>
<td>2,400</td>
<td>198</td>
<td>2,400*</td>
<td>198</td>
<td>4,000</td>
</tr>
</tbody>
</table>

*Note 1: LEL = Lower Explosive Limit.
*Note 2: * = TED value. (A "Temporary Emergency Exposure Limit" if an ERPG is not available.)
*Note: Threshold Quantity: the quantity above which it is determined could have an adverse effect on human health and the environment should it be accidentally released. The Act requires EPA to promulgate an initial list of at least 15 substances that, in the event of an accidental release, are known to cause or may reasonably be anticipated to cause death, injury, or serious adverse effects to human health or the environment. Toxic substances were included on the list based on their toxicity, physical state, vapor pressure, production volume, and accident history. Threshold quantities were set for toxic substances based on a ranking method that considers toxicity and volatility of the chemicals. EPA assigned identical thresholds to chemicals with similar ranking scores, ranging from 500 points to 20,000 points. Similarly, the threshold quantities established today may not always represent a level below which no hazard exists.
Here we were looking at the criteria for “quality of life”.

<table>
<thead>
<tr>
<th>Nuisance Concern</th>
<th>Number of Complaints</th>
<th>Percentages</th>
<th>Distance Range (distance from heavy industrial zone)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Odour</td>
<td>74</td>
<td>66</td>
<td>90% within 3 km</td>
</tr>
<tr>
<td>Noise</td>
<td>14</td>
<td>12</td>
<td>70% within 3 km</td>
</tr>
<tr>
<td>Sight</td>
<td>6</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Alarms</td>
<td>8</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>Explosions</td>
<td>6</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Flare</td>
<td>2</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>4</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>114</strong></td>
<td><strong>100</strong></td>
<td></td>
</tr>
<tr>
<td>Spring</td>
<td>26</td>
<td>23</td>
<td></td>
</tr>
<tr>
<td>Summer</td>
<td>16</td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>Fall</td>
<td>31</td>
<td>27</td>
<td></td>
</tr>
<tr>
<td>Winter</td>
<td>41</td>
<td>36</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>114</strong></td>
<td><strong>100</strong></td>
<td></td>
</tr>
</tbody>
</table>
## Nuisance Reports (Alberta Energy and Utilities Board) (1996 - 1999) (Strathcona County) (Table 4)

<table>
<thead>
<tr>
<th>Nuisance Concern</th>
<th>Number of Complaints (approx.)</th>
<th>Percentages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Odour</td>
<td>1380</td>
<td>41</td>
</tr>
<tr>
<td>Noise</td>
<td>330</td>
<td>10</td>
</tr>
<tr>
<td>Flare/smoke</td>
<td>445</td>
<td>13</td>
</tr>
<tr>
<td>Public Health &amp; Safety</td>
<td>415</td>
<td>12</td>
</tr>
<tr>
<td>Lease management</td>
<td>490</td>
<td>14</td>
</tr>
<tr>
<td>Spills</td>
<td>325</td>
<td>10</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>3385</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>
Strathcona County

Nuisance Reports (County of Strathcona)  
(2000 – 2001 to date)  
(Table 5)

There were approximately 250 reported incidents through the 9-1-1 system over a 5-year period. These reported concerns are broken down as 82% odour, 6% noise and 5% light/fairies and 25% other. These do not include calls received by other agencies (e.g. RCMP).

Nuisance Reports (Alberta Environment - 2000)  
Electoral Constituency of Sherwood Park  
(Table 6)

<table>
<thead>
<tr>
<th>Nuisance Concern</th>
<th>Number of Complaints (approx.)</th>
<th>Percentages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Odour</td>
<td>45</td>
<td>69</td>
</tr>
<tr>
<td>Dust</td>
<td>1</td>
<td>1.5</td>
</tr>
<tr>
<td>Visible emissions</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Land use</td>
<td>8</td>
<td>12</td>
</tr>
<tr>
<td>Surface water</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>Waste issues</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Pesticide usage</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Miscellaneous</td>
<td>1</td>
<td>1.5</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>65</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>
Strathcona County
Strathcona County

Strathcona chose main streets in order to be simple.

They also chose 1.5 and 3.0 Km rather than 1.6 and 3.2 Km as this allowed for the same development to be on each side of the road, (quality of life).
And again here we were looking at the criteria for “quality of life”.

Strathcona County
Strathcona County

Examples of Uses Allowed between 0 - 1.5 Km

Prohibited Uses:
- All residential uses
- Schools
- Night clubs
- Hotels
- Health services
- Indoor recreational
- Religious assembly
- Spectator sports

Discretionary uses:
- Major amusement arcades
- Motels
- Gas stations
- Library and exhibits
Strathcona County

Examples of Uses Allowed between 1.5 - 3.0 Km

Prohibited Uses:
- All residential uses
- Schools
- Night clubs
- Hotels
- Indoor recreational
- Hospitals

Discretionary uses:
- Major care centres
- Private & public education activities
- Major health services but not hospitals
- Religious assembly
- Spectator sports
Strathcona County

INTEGRATED INTO STRATHCONA’S PLANNING DOCUMENTS INCLUDE THE FOLLOWING:

- **TRANSITION ZONE** - Keep the 3.0 “TRANSITION ZONE” RECOGNIZING THAT THIS DISTANCE REPRESENTS THE ACCEPTABLE RISK CRITERIA AS PUT FORWARD THROUGH MIACC.

- **EMERGENCY PREPAREDNESS** - Review the “STRATHCONA COUNTY EMERGENCY PREPAREDNESS PLAN” FOR SPECIAL RESPONSE PLANS THAT MAY NEED TO BE IN PLACE FOR THE EXISTING RESIDENCES AND BUSINESSES WITHIN THE 0-3.0 KM TRANSITION ZONE. THESE SPECIAL NEEDS SHOULD BE INCORPORATED WITHIN THE COUNTY PLAN AND KEPT CURRENT.

- **RECIPROCAL RISK ASSESSMENT FOR NEW PROJECTS** – Require new industrial and development projects, including expansions, to provide designs that will have a calculated risk equal to or have a lower risk than the 1 X 10^-6 RISK CRITERIA AT THE 3.0 KM DISTANCE.

- **RISK ASSESSMENT FOR EXISTING INDUSTRY** – Require existing industry to conduct risk assessments and to implement measures to reduce the risk to the acceptable level of 1 X 10^-6 RISK CRITERIA AT THE 3.0 KM DISTANCE. STRATHCONA ACCOMPLISHES THIS THROUGH A REVIEW OF LICENSING WHEN RENEWED BY THE AEUB.

- **BUFFER ZONES** - Require “BUFFER ZONES” ON INDUSTRIAL PROPERTIES WHERE NECESSARY.

- **SCREENING PROCESS** – Develop and adopt a screening process to evaluate the risk impact of the proposed development.
**INTERMUNICIPAL CO-OPERATION** – APPROACH THE CITY OF EDMONTON TO ADDRESS THE IMPACT EACH JURISDICTION HAS ON THE OTHER’S HEAVY INDUSTRIAL AREAS TO ENSURE PROPER SEPARATION DISTANCES AND RISK REDUCTION MEASURES ARE INCLUDED IN PLANNING ACTIVITIES.

**AMENDMENTS** – PURSUE A NUMBER OF AMENDMENTS TO THE COUNTY’S PLANNING DOCUMENTS (MDP AND LAND USE BYLAW), INCLUDING THE INTRODUCTION OF A RISK MANAGEMENT APPROACH FOR ESTABLISHING ACCEPTABLE LEVELS OF RISK TOWARDS MORE PERFORMANCE-BASED ZONING;

**TRANSITION ZONE** – MAINTAIN LIGHT/MEDIUM INDUSTRIAL AREA AND BUSINESS COMMERCIAL INDUSTRIAL AREA WITHIN THE 3.0 KM TRANSITION ZONE.

- Maintain the existing 3.0-kilometer separation distance. This separation is necessary to provide an acceptable level of public protection by ensuring an acceptable level of risk according to the MIACC Guidelines. Permitted and discretionary land uses within this 3.0 km transition zone need to be restricted given health and safety considerations. Within the 0 to 1.5 km distance, the land uses that have the following characteristics should be prohibited or at least restricted:
  - All Residential uses (except accessory dwellings to farming and industrial operations);
  - Large indoor/outdoor assemblies of people (e.g. spectator arenas, stadiums);
  - Uses, which cater to small children or the elderly (e.g. day care, senior citizens homes);
  - Uses, which cater to temporarily or permanently confined disabled people due to illness (e.g. hospitals, extended care facilities)
  - Uses, which house public emergency response organizations (e.g. fire, ambulance, police, etc.);
  - Structures or buildings, which present difficulties in the event of evacuations (e.g. hotels, high-rise office buildings); and
  - Uses, which create the potential for large numbers of people to remain on site for long periods of time (e.g. schools, recreation facilities, shopping centres, camping, outdoor amusements).
Company “X” will need to ensure any risk does not exceed $1 \times 10^{-4}$ of a fatality beyond its property line. The cumulative risk level will not exceed $1 \times 10^{-4}$ of a fatality at this boundary.
Sturgeon County
Examples of Uses Allowed between 0 - 1.6 Km

(Similar to Strathcona County)

Prohibited Uses:
- All residential uses
- Schools
- Night clubs
- Hotels
- Health services
- Indoor recreational
- Religious assembly
- Spectator sports

Discretionary uses:
- Major amusement arcades
- Motels
- Gas stations
- Library and exhibits
DRAFT – EDMONTON’S RISK MANAGEMENT APPROACH: DRAFT REQUIREMENTS

The City of Edmonton has adopted a risk management approach to development proposals where an industrial land use involving hazardous goods or materials, is proposed near residential areas or near other particularly susceptible uses. Such uses include hospitals, seniors’ residences, activities with large gatherings of people or facilities which would be difficult to evacuate in the event of an industrial accident. The risk management approach also applies to those situations where new residential development or development of other susceptible uses is proposed near to an existing source of risk or a potential source of risk that would be permitted through zoning. Typical examples include heavy industry, rail lines, pipelines, etc.

As part of the development approval process, proponents will be asked to submit a risk assessment. The purpose of the risk assessment is to demonstrate to City Council that a development involving potentially hazardous substances or activities will be situated at a satisfactory distance from residential and other susceptible uses, such that the risk to the adjacent population would be within acceptable limits.

Information requirements

The intent of a risk assessment report is to answer the questions: “What can go wrong?” “How likely is it?” and ‘What are the consequences?”

- Identify the source of risk – A description of the land use, facility, activities and operations.
- Identify and investigate the potential hazards – hazardous substances, quantities, their use, transportation, storage, transfer points.
- Investigate the likelihood of an incident occurring – frequency analysis may be based on a historical review of the operation of the facility, other typical examples and/or research on industrial or transportation accidents.
- Analyze the consequences of an incident. Analysis could include: the type of failure, uncontrolled release, exposure to hazardous materials, routes of exposure to risk, characterization of harm, the number of people affected, expected property damage, impact on environment, mitigating factors, duration of event.
- Discussion of information limitations, where appropriate
- Assessment of risk and comparison of risk to that of other activities
- Proposed risk mitigation measures. These might include buffers, building design, site layout, operating procedures, evacuation routes, etc.
- Emergency planning and response provisions

Some variation of these requirements may be appropriate, depending on the particular application. Risk assessments for pipelines, rail lines and potential industrial uses allowed by zoning may differ from this outline because of limitations on available information. Proposals for residential development near areas zoned for heavy industry or shown as a heavy industrial area in ‘Plan Edmonton’ will deal with a range of possible risks based on potential uses. An examination of existing uses and their possible expansion would be a starting point.

Note the City of Edmonton references MIACC and the fact they meet MIACC criteria.
The City’s guideline will ask for a risk assessment to be done when a development proposal is within 1.5 Km of heavy industry. It is not uniformly applied and the results appear to be due-diligence related and not specific to land use planning purposes.
City of Edmonton

One approach used for a risk assessment for the City was to determine the maximum amount of hazardous chemicals could be located in a heavy industry zone to the south. The table below shows some of the quantities.

Not a lot.

<table>
<thead>
<tr>
<th>Hazard Distance to the IDLH Concentration</th>
<th>( \text{H}_2\text{S} ) Kg</th>
<th>( \text{SO}_2 ) Kg</th>
<th>( \text{Cl}_2 ) Kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Km</td>
<td>979</td>
<td>1,748</td>
<td>203</td>
</tr>
<tr>
<td>2 Km</td>
<td>3,915</td>
<td>6,991</td>
<td>811</td>
</tr>
<tr>
<td>3 Km</td>
<td>8,808</td>
<td>15,729</td>
<td>1,825</td>
</tr>
</tbody>
</table>

Resulting Probability (high end) = \( 4.15 \times 10^{-5} \)

A camp for underprivileged children almost run year round. At most 1,000 people there at one time.
The City was willing to accept this but in doing so they have limited the amount and type of “heavy industry” that can be located in the area.

It may be just as well as the encroachment of medium and light industry as well as commercial and residential is already happening in the area surrounding the heavy industrial zoned area.
Reference to MIACC criteria for setting Emergency Planning Zones (EPZ’s)

Reference to Z 731-03 for emergency planning (ERP’s)

Reference to Sheltering in Place

Note the MIACC content in what is taking place here.
Any Questions?