

**MANAGEMENT
OF
ROUTINE SOLUTION GAS FLARING
IN ALBERTA**

Report and Recommendations

of

The Flaring Project Team

Clean Air Strategic Alliance (CASA)

Edmonton

June 17, 1998

Executive Summary

The Clean Air Strategic Alliance (CASA) established the Flaring Project Team in 1997 to develop recommendations that address potential and observed impacts associated with routine solution gas flaring. The Project Team gathered and considered information on various aspects related to the management of flaring. As a result of their deliberations, the members of the Project Team reached consensus on a series of recommendations. These recommendations establish a framework for the management of routine solution gas flaring and initiate actions designed to achieve the overall goal of the eventual elimination of routine flaring of solution gas. The Project Team envisions that the management framework will be implemented by incorporating its recommendations into an Alberta Energy and Utilities Board (EUB) Informational Letter.

The management framework strives toward an overall goal of the eventual elimination of routine solution gas flaring. Although reaching this goal cannot be accomplished easily within a short timeframe, actions can be taken both immediately and in the mid-term to move Alberta toward achieving this goal. Alberta should work toward this goal through an orderly transition that balances the needs of many different stakeholders with interests in solution gas flaring. The Flaring Project Team recognizes that there will be circumstances under which flaring may be necessary.

The following policy objective hierarchy will guide decisions related to routine solution gas flaring at the provincial, regional and site-specific level:

- 1) Eliminate routine solution gas flaring.
- 2) Reduce volumes of gas flared.
- 3) Improve the efficiency of flares.

To the greatest extent possible, the higher order policy objective would be implemented before progressing to considering lower-order policy objectives.

A decision tree is the means for implementing these objectives at the regional and local level. The decision tree guides the development and approval process for new flares and for approval of existing flares. Using the decision tree, operators assess technological options and economic, social and environmental factors to decide if a flare is necessary. If a flare is required, the operators then consider other options for minimizing the volume of solution gas flared. High technology and operational practices are required to improve burn efficiencies on all remaining solution gas flares.

The Project Team recommends that the Energy and Utilities Board implements the management framework through an Informational Letter and modifies its approval process to include specific reference to flaring and opportunities for public input regarding flaring activities.

The Project Team recommends a schedule of voluntary reductions in routine solution gas flaring as measured against 1996 baseline data:

- 15% reduction in volumes flared by the end of 2000.
- 25% reduction in volumes flared by the end of 2001.

The Project Team considers these initial reductions firm and, if they are not met voluntarily by the oil industry, the EUB would impose threshold volume requirements on routine solution gas flaring.

The Project Team recommends the following targets for reductions in routine solution gas flaring beyond 2001:

- 40 – 50% reduction in volumes flared by the end of 2003.
- 60 – 70% reduction in volumes flared by the end of 2006 or 2007.

These longer-term targets are subject to review in the 2nd quarter of 2001. They require successful introduction of alternative technologies, such as mini-turbines for electricity generation. Attaining the longer-term targets also depends on restructuring of the electrical industry, the removal of disincentives (e.g. royalty treatment of otherwise flared solution gas) and development of government / industry cost sharing of uneconomic projects to eliminate or reduce flaring.

If the oil industry does not achieve the first tier of voluntary reductions, the Project Team recommends the EUB implement the following threshold volume requirements to achieve reductions of 15% and 25% respectively:

- No routine solution gas flares exceeding $2500 \times 10^3 \text{ m}^3/\text{yr}$ by the end of 2000.
- No routine solution gas flares exceeding $1500 \times 10^3 \text{ m}^3/\text{yr}$ by the end of 2001.

The corresponding flare volumes for the later reduction targets are:

$700 \times 10^3 \text{ m}^3/\text{yr}$	40%
$500 \times 10^3 \text{ m}^3/\text{yr}$	50%
$350 \times 10^3 \text{ m}^3/\text{yr}$	60%
$250 \times 10^3 \text{ m}^3/\text{yr}$	70%

These later threshold volumes will be reviewed as part of the framework evaluation in the 2nd quarter of 2001.

Several additional actions are required to make these later reductions practical and work is needed on these actions as soon as possible. These actions include:

- Operators making solution gas available to a third party if the operator / licensee of a well does not want to make use of the gas.
- Alberta Department of Energy implementing changes to facilitate the use of solution gas for electricity generation and other beneficial uses.
- Alberta Department of Energy waiving the royalty on the use of solution gas that otherwise would be flared.
- Government and industry sharing costs for non-economic schemes desired from an environmental or health perspective.
- The EUB implementing mechanisms that encourage clustering as means of facilitating reductions in flaring.
- The EUB applying flexibility in the interpretation of sulphur recovery guidelines.
- Industry employing steps to reduce flaring during plant turnaround.

All companies must meet new performance requirements for all remaining solution gas flares within three years to increase the flaring efficiency. These requirements are:

- Gas directed to a flare must have a minimum heating value of 7.45 MJ/m³. *
- A flame must be present whenever hydrocarbons are directed to a flare. *
- Liquid hydrocarbons shall not be directed to a flare. **
- Visible emissions released from a flare shall not exceed an opacity of 40% averaged over a period of six consecutive minutes.
- Flares must be designed so that ground level concentrations meet Alberta's ambient air quality guidelines.
- Radiant heat density at ground level shall not exceed 4.73 KW/m².

* Applies to solution gas flares that are capable of supporting combustion.

** Minimizing the liquid content of flare gas streams is very important in improving flare efficiency. At present, liquid drop-out technologies are used to minimize the liquid content. In the mid-term, a performance requirement could be developed based on maximum droplet size that can be passed to a flare.

In addition, it is the intent of the Project Team that efficiency standards be established as soon as possible and included as performance requirements for all flares. The EUB and industry will continue investigating development of combustion efficiency requirements applicable to solution gas flares in Alberta.

The Project Team also recommends improvements to the EUB's database regarding solution gas flaring and continued research into flaring efficiencies and the impacts of flaring.

The effectiveness of the management framework should be assessed by the EUB in the 2nd quarter of 2001 to:

- Assess the overall performance of the management framework.
- Consider whether the reduction targets for 2000 and 2001 have been met.
- Determine, based on improved information, firm future targets, time lines, and threshold volumes.
- Evaluate the royalty treatment of solution gas that would otherwise be flared and cost sharing programs, and their implications for achieving future reduction targets.
- Evaluate the approval process and determine if fixed term approvals are required.
- Review performance requirements and efficiency standards, and determine the feasibility of combustion efficiency standards for all solution gas flares.
- Assess research findings and their implications for management of solution gas flaring.

1.0 Introduction

The Clean Air Strategic Alliance (CASA) is a partnership of representatives from government, industry and non-governmental organizations, who collectively represent and report to their stakeholders. CASA, which was established in 1994, is accountable to the Alberta ministers of Energy, Environmental Protection, and Health. The Alliance shares decision-making responsibilities with the Government of Alberta for many strategic aspects of air quality.

The Alliance's Vision for Air Quality in Alberta is:

The air will be odourless, tasteless, look clear, and have no measurable short- or long-term adverse effects on people, animals, or the environment.

Since its inception, CASA has been developing strategic management plans for several high priority issues that are expected to contribute to achieving this vision. In recent years, there have been concerns expressed about the flaring of solution gas. Recent studies raised questions about the efficiency of solution gas flaring, the nature of the by-products of incomplete combustion, and the potential of emissions from flares to cause health effects in humans and animals. The Canadian Association of Petroleum Producers (CAPP) brought a statement of concern regarding flaring practices in Alberta to the November 1996 meeting of the Board of the Clean Air Strategic Alliance. This statement of concern recommended that CASA appoint a working group of interested stakeholders to prepare terms of reference for a project that addressed the flaring issue. This was done and the Alliance subsequently approved establishment of the Flaring Project Team and its terms of reference, budget and work schedule at its February 1997 meeting.

The Clean Air Strategic Alliance established the Flaring Project Team to develop recommendations that address potential and observed impacts associated with flaring, with particular focus on "upstream solution gas" flaring. The upstream industry explores for, acquires, develops, produces and markets crude oil and natural gas. Solution gas at upstream sites is "co-produced", primarily during crude oil production.

The Project Team is a multi-stakeholder committee with representatives from industry, government, the environmental community, agriculture and health (Appendix 1). The specific objectives of the Project Team are to:

- Collect and summarize information on flaring and its impact.
- Develop recommendations for short-term actions for minimizing the practice of routine flaring of solution gas.
- Develop a research strategy for better understanding flaring emissions and the effects on human, animal and environmental health.
- Develop recommendations for a longer-term strategy for actions to respond to issues associated with solution gas flaring.

2.0 Background

The Project Team gathered and considered information on various aspects of the management of solution gas flaring. This information is summarized briefly in the following paragraphs. For more detail, the reports and studies referenced may be obtained from CASA.

Solution gases are released when crude oil is produced to the surface. If there is enough solution gas, it can be collected, cleaned and sold. This can be done if there is a gas pipeline nearby to collect the gas and transport it to a gas plant for processing. This infrastructure can be expensive and requires a sufficiently large volume of gas to offset its costs. Injection of solution gas into an underground formation is an alternative. In some instances, the injected gas helps maintain pressure in the formation and improves recovery of oil. Solution gas also may be used as a fuel in gas processing plants or other facilities. When solution gas cannot be economically conserved and current regulations do not require collection, the gas usually is flared. This flaring or burning of solution gas is intended to manage safety concerns; however, the public has expressed concern regarding the potential effects that compounds released during the combustion process might have on human and animal health. Rural residents also complain about odour, smoke and noise, and the generally displeasing presence of a flickering flame.

Data collected by the EUB show that in 1996 about 92% of solution gases were conserved or used in some manner. The remaining 8% was flared. This amounted to 1,779 million cubic metres of solution gas flared from 5,246 battery sites (Dowsett 1997). Figure 1 shows the volume flared in 1996 by township. The annual volume flared at an individual oil battery, where oil, water and gas are separated, varies with the productivity of the well, the gas-to-oil ratio and the number of wells feeding into a battery. About half of the flares in Alberta flare less than $100 \times 10^3 \text{ m}^3$ of gas per year; however, some exceed $10,000 \times 10^3 \text{ m}^3$ per year.

The flare systems commonly used in Alberta function as a diffusion flame, which is a combustion process in which the solution gas and air are not premixed. Burning the gaseous hydrocarbons that make up solution gas produces various air emissions. The emissions depend on the composition of the solution gas that is burned, the design of the flare, the operating conditions and the atmospheric conditions. These factors affect the completeness of combustion, which may be measured as either destruction efficiency or combustion efficiency. Destruction efficiency is a measure of the destruction of a particular fuel material. Combustion efficiency measures the degree to which all fuel materials are completely oxidized, for example, hydrocarbons oxidized to carbon dioxide. Relatively little is known about the efficiency of flares or their emissions. A study of two solution gas flares by Strosher (1996) found that flaring produces a very complex mixture of over 250 different compounds. At these two flares, the measured combustion efficiency ranged from 66% to 84%; much lower than previously thought.

The Project Team commissioned the University of Calgary to investigate technological solutions to reduce flaring volumes and the impacts of flares in a cost-effective manner. Holford and Hettiaratchi (1998) analyzed solution gas flaring in Alberta and reviewed technological alternatives that are, or soon will be, available to reduce routine solution gas flaring. These alternatives included electrical generation using gas turbines or reciprocating engines; electrical generation using “mini” gas turbines, cogeneration of steam and electricity, re-injection of solution gas with produced water, oxidation, and collection and processing.

The study considered seven areas that had flares that were mostly larger than $1,000 \times 10^3 \text{ m}^3$ per year. These seven areas encompassed over 42% of the volume of solution gas flared in Alberta. The study found that 50% of the volume flared in Alberta is generated from 6% of the batteries (Figure 2). On the other hand, 50% of the batteries flare less than $100 \times 10^3 \text{ m}^3$ per year.

The study found that economic options using available technologies could reduce total volumes of solution gas flared by about 30%. Solution gas flaring might be reduced economically by an additional 30% depending on the effectiveness of evolving mini-turbine technology for electricity generation. If achieved, this use of solution gas could represent up to 200 to 300 MW of generating capacity, less than

5% of the total capacity currently installed in Alberta. Under a number of assumptions, economic solutions are currently available for as many as 428 of 5244 flaring batteries with as many as 700 sites available if mini-turbines prove reliable and cost effective. Flaring at another 700 sites may be reduced through other low-cost options. Potential capital spending of \$800 million would be needed to enable these reductions (Figure 3). Factors that affect the opportunities for economic reductions in flaring include flare size, consistency of gas rates, degree of sourness (H₂S content) and the distance from other batteries and electrical lines. The authors also concluded that elimination of all flares might not be practical. Installing high efficiency combustion equipment on the remaining flares, those that could not be eliminated economically, would involve an additional capital cost of about \$30 million.

Holford and Hettiaratchi (1998) identified several real or perceived issues preventing greater use of flare gas for electricity generation. These issues include: royalty treatment of otherwise flared solution gas, the interpretation of the Industrial Systems Policy, ability to “wheel” power, the level of standby charges, interconnected fees, the application of sulphur recovery guidelines, and capital cost allowance rates. The importance of addressing these issues in a timely manner was raised by the CASA Board in letters sent to the Provincial and Federal governments in early June 1998.

It is unclear, for example, whether there will be a royalty on solution gas used in electrical generation. Currently, producers are not required to pay royalties on flared gas: implementing a royalty on flared gas used to generate electricity may impose an economic barrier to its use. Holford and Hettiaratchi (1998) noted that requiring royalties to be paid on a resource that otherwise would be flared, resulting in environmental or health concerns, appears to send the wrong signal.

An important factor affecting the sensitive economics of generating electricity using solution gas is its treatment under the Industrial Systems Policy. The Electric Utilities Amendment Act 1998 (Bill 27) empowers the EUB to establish criteria under which generating units that use solution gas, which otherwise would be flared, to produce electricity could apply for treatment as an Industrial System. The design and interpretation of these criteria will play a significant role in determining how much flaring of solution gas will be reduced using economically viable technologies. Related issues, such as the ability for a company to “wheel” power to their operations farther from the generation source, may have an impact on achieving the reductions in flared volumes (40% and 70%) envisioned by 2003 and 2006-7 respectively.

Holford and Hettiaratchi (1998) found that the cost of providing backup power makes many potential projects uneconomic. Under current arrangements, standby service ensures that energy from the interconnected system is available as backup to an on-site generator in case of an equipment malfunction or during maintenance of customer-owned generating equipment. The Transmission Administrator has proposed that all regulated and non-regulated generators be charged for standby service under the retail service tariff of the distribution company in whose service area they are located. Holford and Hettiaratchi (1998) concluded that a consumption-based system, in which companies only pay for what they need, or the ability to purchase electricity from the electricity pool on an as-needed basis would enhance the economics of self-generated electricity.

Pooling of flared gas resources, clustering the gas from several flares into a single location, is an important part of making some flare gas recovery projects economical. Clustering could present problems if the gas is slightly sour. The combined volume of the clustered flares may trigger a need to provide sulphur recovery. This would adversely affect the economics of a project.

Figure 2: Cumulative Gas Flared Vs. Cumulative # of Batteries

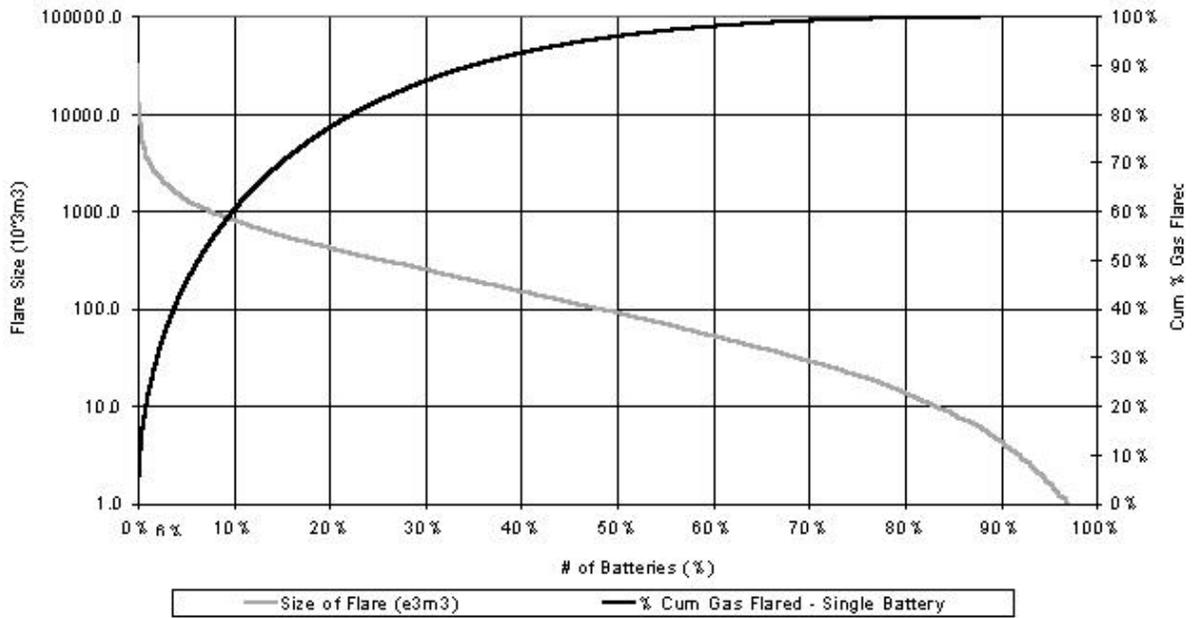
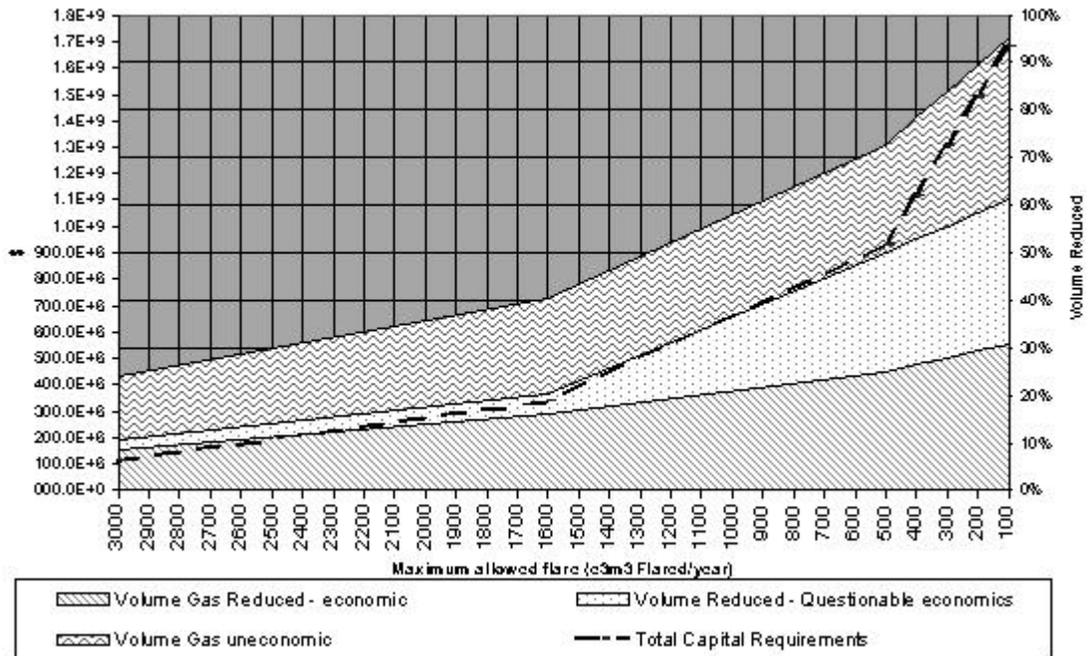


Figure 3: Total Flare Gas Reductions - Total Cost



Holford and Hettiaratchi (1998) commented on three concerns related to data collection. First, for ease of data collection, gas that is vented from multiple, single heavy oil wells is reported as a battery flare, although no battery actually exists. Second, much of the solution gas from heavy oil wells is vented, not flared, but is included in the flaring data. Third, in many heavy oil areas, solution gas is reported on the basis of gas-to-oil ratios, which, in some cases, leads to higher amounts being reported than if solution gas volumes were actually measured. As well, no differentiation is made between routine solution gas flaring and emergency or non-routine flaring. This is evident because 10 of the 30 largest flaring sites typically conserve solution gas; therefore, the amounts reported as flared likely are the result of non-routine flaring.

Other impediments noted by Holford and Hettiaratchi (1998) relate to perceptions. Electrical generation and other uses of solution flare gas are not part of the core business of the oil and gas industry and are not given high priority. In addition, the industry is inclined to invest capital in producing and exploring for oil and gas and not in other projects that appear to have poorer economics. The oil and gas industry is competitive, and collaboration between companies to make flare gas recovery projects feasible is uncommon. Removing these impediments requires significant effort to educate the oil and gas operators and gain momentum to resolve the issue of solution gas flaring. This is especially important because many of the technologies under consideration are not fully proven.

Alberta Health (1998) conducted a study of human health administrative data, and socioeconomic and environmental factors, including solution gas flaring data, to determine possible correlation between these factors. Included in the report is an explanation of the strengths and limitations that must be considered when drawing conclusions from this type of study.

Information from 1994 to 1996 on population demographics, physician claims and hospitalizations collected from Alberta Health databases was compared to data on solution gas flaring activities obtained from the EUB. The health disorders that were investigated were asthma, bronchitis, pneumonia, respiratory infections and all respiratory disorders combined. Figure 4 is an example of the data on solution gas flaring activities and physician claims for asthma mapped at the postal code level. Analysis of these maps found no obvious correlation between flaring activities and physician claims for asthma.

The scatter plot of postal codes (Figure 5) provides another look at the correlation between the volume of solution gas flared and physician claims for asthma in the same postal code area. Again, these data show no obvious correlation between solution gas flaring and physician claims for asthma.

This type of study has important strengths and limitations:

Strengths

- This was the first ecological study exploring the relationship between the environment and health outcomes in Alberta based on areas as small as the postal code level. These smaller areas were an advantage in attempting to identify localized effects.
- Multiple measures of correlation between the health outcomes and flaring activities increased the study's validity. The study used rate of physician visits in rural and urban areas for the entire population, in the rural area for Aboriginal and non-Aboriginal populations, and in the rural area for children of Aboriginal and non-Aboriginal origin, as well as the rate of hospitalization in the rural and urban areas. Using these measures together compensated for the limitations of each single measure. No measure was found to be correlated with solution gas flaring activity.

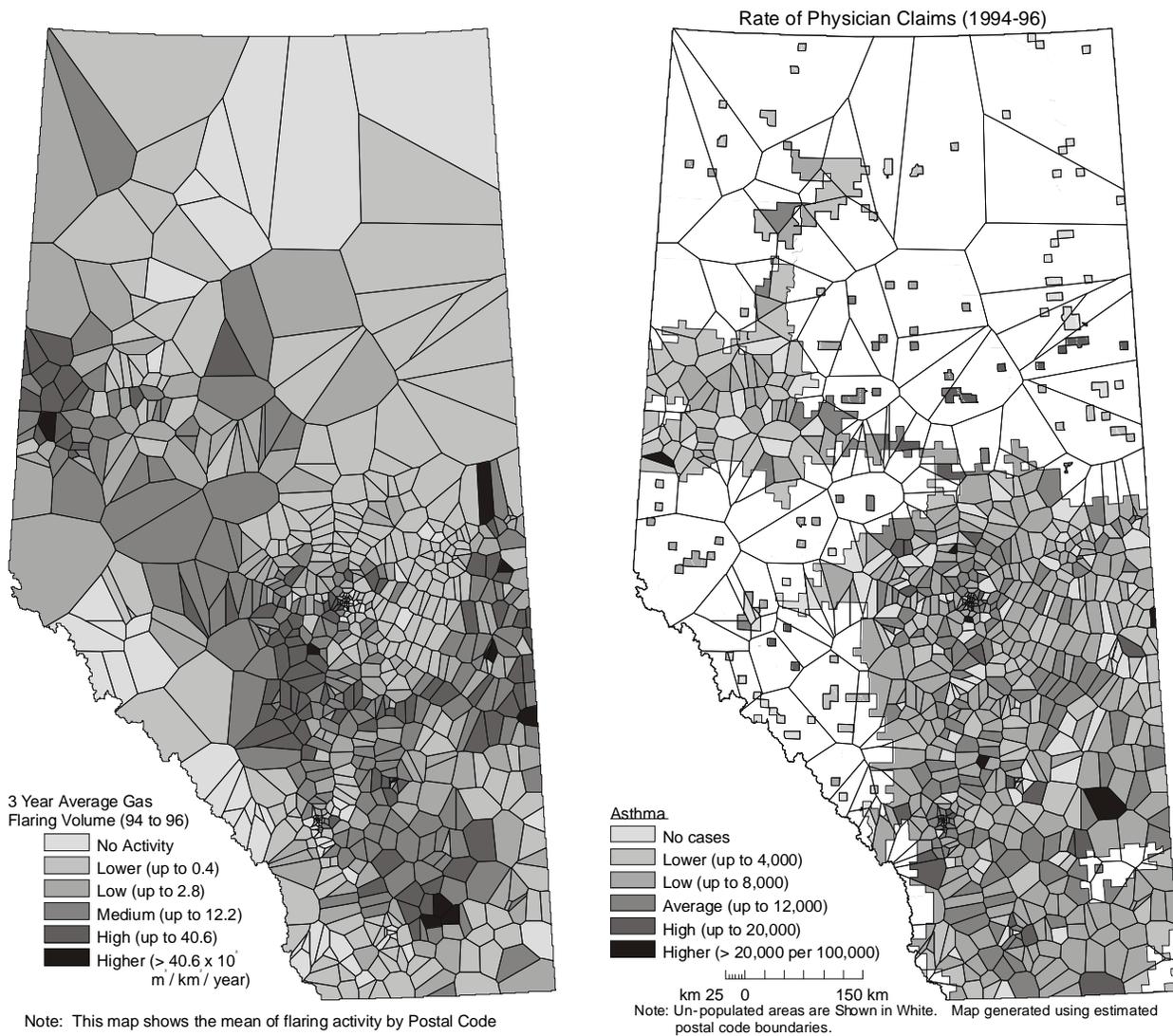


Figure 4: Volumes of Solution Gas Flared and Rate of Physician Claims for Asthma by Postal Code

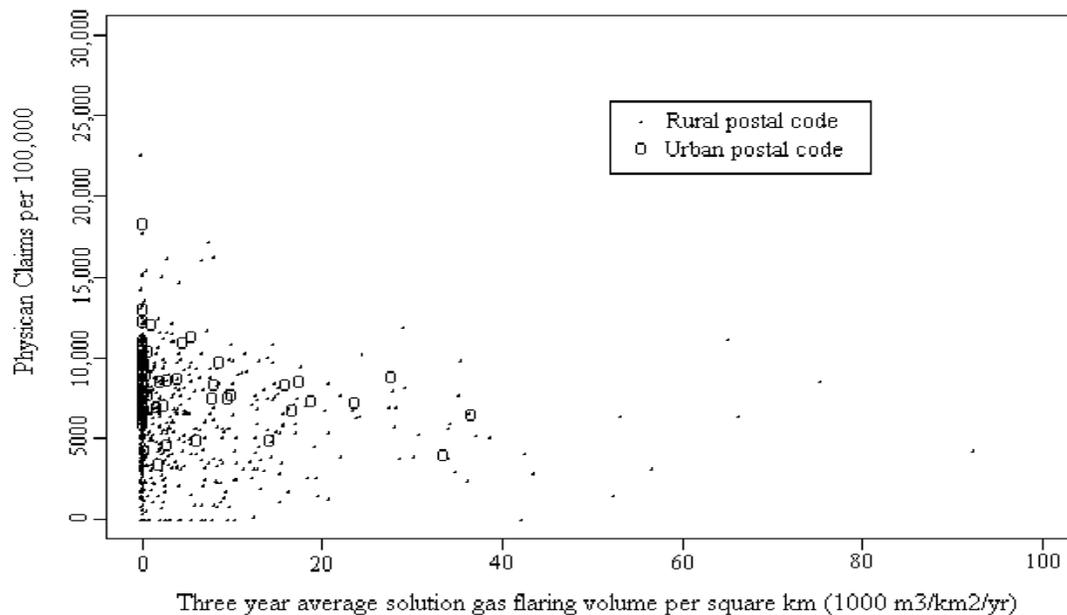


Figure 5: Plot of Physician Claims for Asthma vs. Solution Gas Flaring Activities

- The study was quite sensitive with the smallest detectable flaring effect being less than 10 additional physician claims among 1000 average rural residents for all disorders investigated.

Limitations

- Ecological fallacy or the bias that may occur because an association observed between variables on an aggregate level does not necessarily represent the association existing at an individual level.
- Characterizing personal exposure to air pollutants by proximity to regional flaring activities can result in individuals who are not exposed to flaring emissions counted as such or the reverse.
- Site-specific situations or localized impacts in areas smaller than postal codes may not be detected.

The lack of positive correlation does not exclude the possibility of human health effects below the detection limit of the study. The detection limit of the analysis was investigated. Upper respiratory infections proved the most sensitive disorder for detecting flaring effects with only a 1.88% increase in claims required for detection. That is, the smallest flaring effect detected through this analysis would require at least a 1.88% increase in claims for upper respiratory infections that must be distributed according to flaring levels. The other three disorders investigated were less sensitive: asthma required a 10.6% increase in claims, bronchitis 10.9% and pneumonia 13.3% for flaring effects to be detectable. The smallest detectable flaring effect would result in less than 10 additional physician claims among 1000 average rural residents for all disorders investigated.

The Project Team investigated existing information to compare rates of occurrence of asthma in Alberta to rates in other jurisdictions. This information (Table 1) shows that Alberta is fifth among the provinces in terms of hospitalization rates for asthma. The Project team did not pursue further analysis of the issue.

Table 1: Hospital Separation Rates (per 100,000 population) of Asthma by Sex and Province

Province	Males Year				Females Year			
	86/87	88/89	91/92	92/93	86/87	88/89	91/92	92/93
B.C.	209	238	229	200	208	244	224	199
Alta.	316	321	300	277	282	290	284	268
Sask.	359	344	395	362	314	311	335	328
Man.	220	206	247	228	215	193	221	220
Ont.	262	257	221	218	242	250	213	204
Que.	192	195	168	172	160	174	147	159
N.B.	365	370	363	337	361	379	374	367
N.S.	336	363	320	351	353	387	345	357
P.E.I.	654	862	749	760	496	733	718	692
Nfld.	251	220	188	172	254	234	224	215
Canada	252	255	233	224	231	243	231	215

Source: Statistics Canada, 1995

3.0 Recommended Management Framework

The Project Team considered the available information and developed a management framework and package of recommendations that lays out a balanced approach to addressing issues related to routine flaring of solution gas. These recommendations are the consensus of the interests represented on the Project Team and on the Clean Air Strategic Alliance – industry, non-governmental organizations and government. These recommendations establish a management framework for solution gas flaring and initiate actions designed to achieve the overall goal of the eventual elimination of routine flaring of solution gas. These recommendations will work toward meeting the needs of all interests with respect to addressing the impacts of solution gas flaring.

The Project Team reported to the CASA Board on December 4, 1997 (Flaring Project Team 1997). At that time, the Alliance approved the recommended Flaring Management Framework and ongoing work to develop and implement the report's recommendations. This included a recommendation that the Flaring Project Team present its recommendations to the Alberta Energy and Utilities Board for consideration and implementation through an EUB Informational Letter. The Project Team now presents this report and the following recommendations to the Alberta Energy and Utilities Board for its consideration and implementation.

The management framework strives toward an overall goal of the eventual elimination of routine solution gas flaring (Figure 6). It recognizes that achieving this goal requires a long-term commitment and that there are circumstances under which flaring may be necessary. Therefore, the framework includes short- and long-term targets for reductions in solution gas flaring and requirements for improvements in flaring efficiencies for the remaining flares. The EUB grants approvals for oil batteries. The Project Team

considers this approval process as a central mechanism through which the industry is encouraged to consider alternatives to flaring of solution gas. Applications for approvals of flaring activities should include consideration of options to reduce routine flaring of solution gas and provisions for public contact with respect to the impacts of flaring on local residents.

Implementation of the Project Team's recommendations will ensure that routine solution gas flaring is managed in a way that minimizes emissions and their impacts on human and animal health and the environment. The management framework presents an economically efficient, voluntary approach that is supported by regulatory action in the form of volume restrictions on solution gas flares, if necessary. Voluntary, economic and regulatory tools work together to achieve, over the longer term, the goal of elimination of routine solution gas flaring. At the same time, the management framework incorporates flexibility to respond to regional and local conditions and the site-specific characteristics of individual situations. Implementation of the management framework will work toward achieving CASA's vision for air quality and its goals for air quality management:

- To protect the environment
- To optimize economic performance and efficiency
- To seek continuous improvement

3.1 Goal

The Project Team recommends that:

Alberta adopt the following goal: Alberta's goal is to work toward elimination of routine solution gas flaring.

Although reaching this goal cannot be accomplished easily within a short timeframe, actions can be taken both immediately and in the mid-term to move Alberta toward achieving this goal. Alberta should work toward this goal through an orderly transition that balances the needs of many different stakeholders with interests in solution gas flaring. The Project Team recognizes that there will be circumstances under which flaring may be necessary.

3.2 Objective Hierarchy

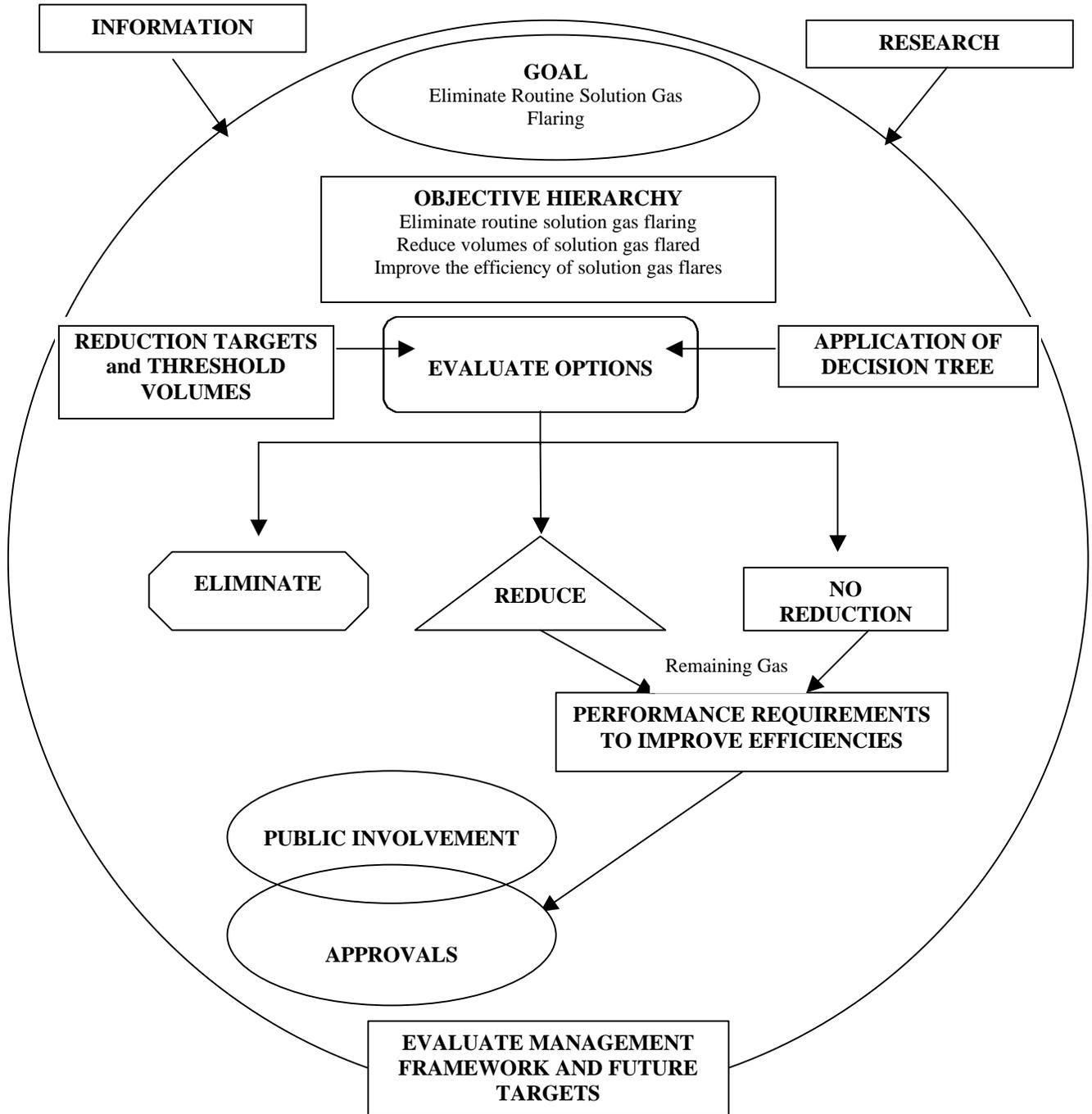
The Project Team recommends that:

Alberta use the following policy objective hierarchy to guide flare management in Alberta:

- 1) Eliminate routine solution gas flaring.*
- 2) Reduce volumes of gas flared.*
- 3) Improve the efficiency of flares.*

This hierarchy guides decisions at the provincial, regional and site-specific level. To the greatest extent possible, resource managers and company operators should implement actions that achieve the higher order policy objective before progressing to considering lower-order policy objectives.

Figure 6: SOLUTION GAS FLARING MANAGEMENT FRAMEWORK



3.3 Decision Tree

The Project Team recommends that:

The Energy and Utilities Board (EUB) and industry adopt the decision tree for assessment of options for solution gas management at the regional and local level.

The decision tree (Figure 7) is a means for implementing the objectives for solution gas management at the regional and local level. The decision tree guides the proposed approval process for new flares and approvals of existing flares. Using the decision tree, operators would assess technological options of having no flare by evaluating conservation of solution gas, re-injection, and other economic or low-cost technologies to decide if a flare is necessary. The operators also would consider economic, social and environmental factors in deciding if a flare should be eliminated. If flaring is the appropriate option, the operators would consider alternatives, such as generation of electricity, for minimizing the volume of gas that is flared. Industry would be required to use high technology and operational requirements to improve burn efficiencies on all remaining solution gas flares. Venting is not an acceptable alternative to flaring. Wherever there is gas, which is capable of supporting combustion, being directed to the atmosphere from a facility, this gas shall be burned.

The Project Team recommends that:

The following questions be asked in applying the decision tree:

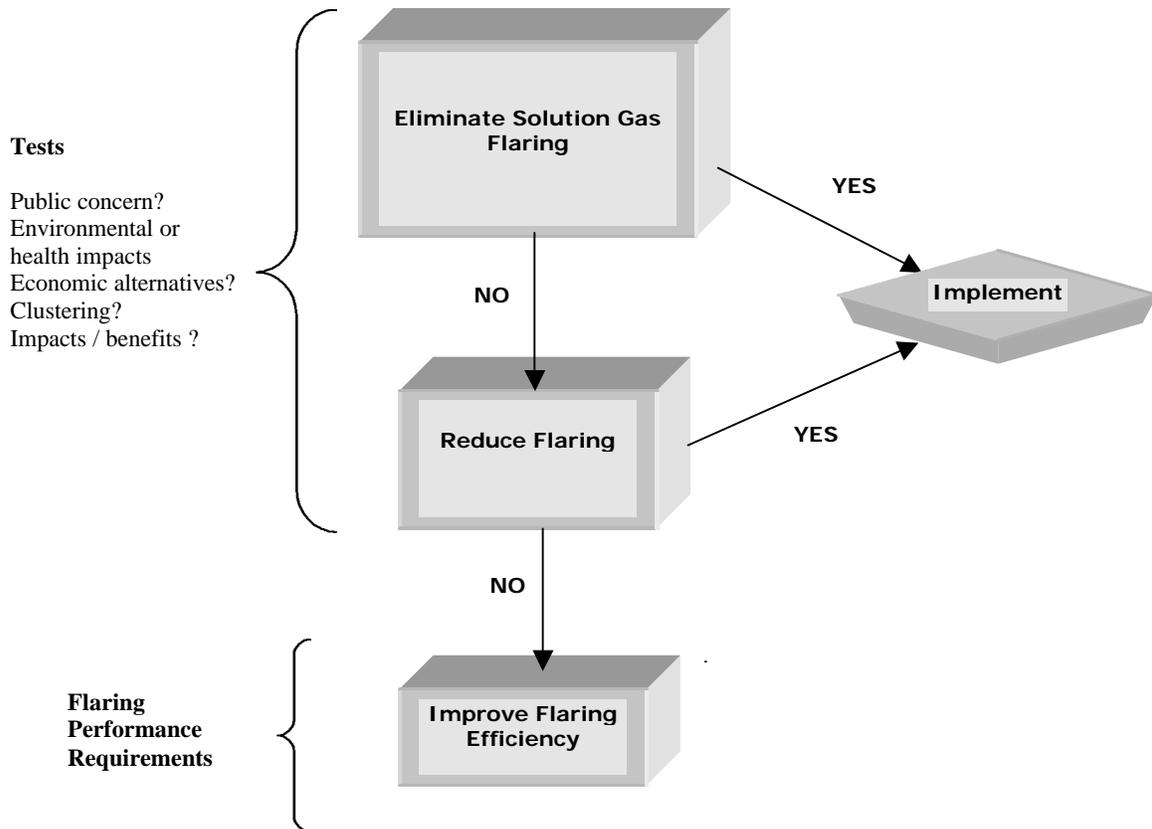
- *Is there public concern?*
- *Are there environmental or health impacts?*
- *Are there economic alternatives to flaring?*
- *Would clustering of flares create an economic project?*
- *Are the environmental impacts of eliminating or reducing the flare greater than the environmental benefits?*

3.4 Implementation

The Project Team recommends that:

The Energy and Utilities Board implement the recommendations of the CASA Flaring Project Team through the issuance of an Informational Letter.

Figure 7: DECISION TREE



3.5 Approvals

The Project Team recommends that:

The Energy and Utilities Board modify, in the following ways, its application process and the application of Guide 56 for new facilities with solution gas flares:

- *Include specific reference to flares and flaring in the Guide and on the application form to ensure that flares are considered as part of an application for approval of a well or multi-well facility.*
- *Increase the distance specified in Guide 56 for personal consultation for single, sweet oil wells and flares to 300 m. from 200 m.*

- *Require companies to include in the information they provide for public contact specific reference to flaring, where appropriate, as well as information about an individual's right to object and the process for so doing.*
- *Require companies to carry out cumulative dispersion modeling and address cumulative effects and broad area impacts that might result from approval of the flare*
- *Develop a template notification and information form indicating the information to be provided to landowners, occupants and residents and include this form in the proposed Informational Letter on solution gas flaring.*

At present, approvals are issued without a term. The Project Team deliberated, but did not reach agreement on, the use of term approvals for flaring facilities. Nevertheless, the Project Team agreed that it is important for the public to understand changes that are occurring in solution gas management and to have an opportunity to have input into the management of existing flares. The public should also know of the opportunity provided under the Energy Resources Conservation Act (Sec. 42) to object to the continued operation of an approved facility. The need for term approvals is a topic that will be reassessed during the evaluation of the management framework in 2001.

The EUB requires companies to conduct public notification and consultation programs in advance of applying for new developments or when significant changes in existing developments are contemplated. Guide 56, Table 1.3 specifies the requirements for public consultation (Appendix 2) and, except for the changes recommended above, would remain the same. The EUB expects companies to communicate and consult with those members of the public who may be affected by the proposed project with the intent of avoiding conflict.

The Project Team recommends that:

Where no approval currently is required from the Energy and Utilities Board, operators do not need to get an approval for facilities, including flares. However, the operators of these facilities must maintain records and be able to demonstrate compliance with the requirements.

At present, the EUB does not issue approvals for single, well batteries. That is, papers do not have to be filed with the EUB and an approval issued. However, companies must fulfill the application requirements spelled out in Guide 56 "Energy Development Application Guide and Schedules" and be able to show that public concerns were resolved.

The Project Team recommends that:

Companies maintain a log detailing complaints concerning flaring and the company's responses to them. The Energy and Utilities Board may audit this log as part of its broader program for enforcing the IL.

As operators apply the decision tree to the operation of existing flaring facilities, they shall contact residents, landowners and occupants within 500 m. of the flare and determine if there are any flare-related objections to continuing its existing approval. If there is no objection, there is no need to file papers with the EUB and obtain a new approval; however, information required by Guide 56 must be available for audit. If there are unresolved, flare-related objections, a non-routine application for the flare must be submitted to the EUB. The facility may continue to operate while the application is decided.

Application for approval shall be required when a company proposes any significant changes to its facility or to flaring at a site.

CAPP and SEPAC work with the industry, non-government organizations and government to develop an information package for use by the industry in public contacts concerning solution gas flaring.

This information package would help to ensure consistency and completeness in the information provided to the public by the individual companies. Among other information, it should provide background on solution gas flaring, the flaring performance requirements and the approval process. It also should provide information on the requirements for public notification and the opportunities for local residents and interested public to comment on or object to an application.

4.0 Eliminating or Reducing Flaring

4.1 Reduction Targets

The Project Team recommends that:

Alberta adopt the following schedule for voluntary reductions in routine solution gas flaring:

15% reduction in volumes flared by the end of 2000.

25% reduction in volumes flared by the end of 2001.

These reductions are a consensus agreement of the stakeholders represented on CASA of reductions in the volume of solution gas flared in Alberta. Reductions in flared volumes will be measured against 1996 baseline data. These reductions are considered firm and, if not met voluntarily, the EUB would require the proposed threshold volumes on flare size. The reductions apply province-wide: the specific reductions that occur in any particular area will depend on the distribution, density and size of flares in the area and the opportunities for, and economics of, flare elimination and reduction for those flares.

In determining these reduction targets, the Project Team recognized the time lag required to complete the EUB Informational Letter, inform and educate the oil and gas industry about the management options, and mobilize the financial and technical resources to take action on flare reduction. The Project team also recognized that there is a high level of awareness of the issue and that the industry is already reducing flaring of solution gas. Data for 1997 indicate that routine solution gas flaring was 7.5% below the volumes flared in 1996. For example, conservation of solution gas in the Caroline area was 95.1% in 1997 and solution gas flaring / venting dropped from 23 000 x 10³ m³ per year in 1996 to 15 000 x 10³ m³ per year in 1997, a 35% reduction.

The Project Team recommends that:

Alberta adopt the following targets for reductions in routine solution gas flaring beyond 2001:

40 – 50% reduction in volumes flared by the end of 2003.

60 – 70% reduction in volumes flared by the end of 2006 or 2007.

These longer-term targets would be re-assessed in the 2nd quarter of 2001 (see Sec. 6.0). They depend on successful introduction of alternative technologies, such as mini-turbines for electricity generation, deregulation of the electrical industry, and development of government mechanisms to adjust economic yardsticks through cost sharing initiatives and royalty structures. In the 2nd quarter of 2001, the targets

and schedule for reductions beyond 2001 would be reviewed and firm commitments for reductions made based on improved data collection, and information on technologies and opportunities.

4.2 Threshold Volumes

The Project Team recommends that:

The Energy and Utilities Board, by the end of 2000, does not permit routine solution gas flares exceeding $2500 \times 10^3 \text{ m}^3/\text{yr}$ and, by the end of 2001, does not permit routine solution gas flares exceeding $1500 \times 10^3 \text{ m}^3/\text{yr}$, unless the voluntary reduction targets have been met.

These threshold volumes are based on analysis by Holford and Hettiaratchi (1998) of the information available for solution gas flaring in 1996. This analysis showed that reducing all existing flares to less than $2500 \times 10^3 \text{ m}^3/\text{yr}$ would reduce flaring by 15% and reduction of all flares to less than $1500 \times 10^3 \text{ m}^3/\text{yr}$ would reduce flaring by 25%.

Corresponding flare volumes for the later reduction targets are:

$700 \times 10^3 \text{ m}^3/\text{yr}$	40%
$500 \times 10^3 \text{ m}^3/\text{yr}$	50%
$350 \times 10^3 \text{ m}^3/\text{yr}$	60%
$250 \times 10^3 \text{ m}^3/\text{yr}$	70%

The review in the 2nd quarter of 2001 will include these latter threshold volumes.

4.3 Exemptions

A flare may be exempt from the threshold volume requirements if the operator can demonstrate that the environmental impacts of eliminating the flare are greater than the environmental benefits. Environmental impacts may include impacts to air quality, aquatic ecosystems, terrestrial ecosystems or wildlife that result, for example, from the need for a long tie-in pipeline in order to conserve gas that currently is flared.

4.4 Achieving Reductions

4.4.1 Electricity Generation

The Project Team recommends that:

The Government assess and, if feasible, implement, changes required to facilitate the use of solution gas for electricity generation and other beneficial uses.

Using solution gas to generate electricity is an important option for eliminating or reducing flaring in Alberta. Calculations by Holford and Hettiaratchi (1998) indicate the potential to use about 50% of the volume of solution gas that currently is flared for the generation of electricity. If achieved, this would represent approximately 200 to 300 MW of generating capacity, less than 5% of the current, total installed capacity in Alberta. Electrical generation equipment including gas turbines or reciprocating engines could be used at the larger flares – those with flare volumes of approximately $1\,600 \times 10^3 \text{ m}^3$ per year or more. Near-future electrical generators, which are roughly one-tenth the size of present units, could have

considerably reduced capital costs and may be able to handle gas flows as low as $160 \times 10^3 \text{ m}^3$ per year. These units, often termed mini-turbines, are just being field tested in 1998.

Open access to power generated from solution gas is critical to realizing the significant reductions in solution gas flaring proposed by the Project Team. The two year deferral of full “Customer Choice” may have the unintended, but unfortunate side effect of hampering the petroleum industry’s ability to achieve the proposed reduction targets in a timely and economically-efficient manner. The Project Team encourages the Department of Energy to ensure that customers will have the opportunity to enter into financial arrangements with generators of electricity from solution gas and with retailers to manage the financial risk associated with pool price. Other changes that should be assessed relate to standby charges for electricity generation, fees for interconnected application, operating agreement or interconnection, metering, and capital cost allowance write-offs.

The Project Team recommends that:

When establishing criteria for the designation of industrial systems facilities, the EUB consider the scale of potential electricity supply that could be generated as well as the social and environmental benefits that may result from a reduction in the volumes of solution gas flared.

The designation of an industrial system is described under the Electric Utilities Amendment Act 1998 (Bill 27). This bill lays out principles and criteria that the EUB must regard in considering an application for designation. The EUB may also make regulations pertaining to the criteria to be met where a generating unit uses solution gas that would otherwise be flared to produce electricity (after the Board has assessed the impact on Alberta’s electricity customers of the costs associated with making the designation and regulation).

The economics of technological alternatives to solution gas flaring are very sensitive to several factors, including their treatment under the industrial systems policy, if flared gas is to be used to generate electricity.

The Project Team recommends that:

The Alberta Department of Energy pursue with Alberta Treasury and the federal government, the feasibility of getting small electrical turbines into Class 43.1, which has a 30% capital cost allowance write-off.

Currently, small electrical turbines (mini-turbines) attract a 6% capital cost allowance write-off. This is not high enough when the economic life of the unit is approximately 4.5 years. These units should attract a 30% write-off, which is on par with high efficiency gas turbines and development drilling. The Project Team believes that these small electrical turbines should be included in Class 43.1. This Class already includes energy efficiency investments in wood waste, landfill gas, digester gas and co-generation.

The Project Team recommends that:

The Alberta Department of Energy pursue with Alberta Treasury and the federal government adjustments to the federal tax act that would allow for the broader availability of flow-through shares of development capital expenditures for those technologies qualifying for Class 43.1 inclusion.

Currently, there is no viable mechanism available through our tax system to encourage investment in electricity generation from the use of solution gas that otherwise would be flared. Flow-through shares are currently available only on the Canadian Exploration Expense (CEE) or exploratory risk expenditures associated with Class 43.1 technologies. These have recently been included in the Income Tax Act as Canadian Renewable and Conservation Expenses (CRCE). The inclusion of electricity generation using flared solution gas in Class 43.1 and, hence, available for CRCE treatment would improve the viability of electricity generation from flared solution gas.

4.4.2 Open Market

The Project Team recommends that:

Industry and government work together to facilitate development of an open market for solution gas.

The Project Team supports making solution gas available to a third party if the operator / licensee of a well does not want to make use of the gas. The intention is to encourage alternative uses of solution gas that might otherwise be flared. The Project Team believes that, if the availability of this gas is made known publicly, the market may identify economic alternatives to flaring without a need for government intervention. An open market should attract a broader range of interests for using the gas. These might include companies whose core business is not the production of oil and gas, for example, greenhouse operators and gas aggregators. These companies may have different financial requirements and view favourably projects that do not meet the interests of the oil and gas industry.

Analysis by the Project Team found no significant impediments to the transfer of gas to a third party. Terms of supply and service agreements, including payment of royalties, if any, would be negotiated between the operator of the well and the third party.

4.4.3 Royalty Charges

The Project Team recommends that:

The Alberta Department of Energy waive the royalty on existing flared solution gas and investigate a waiver or reduction of royalty for future solution gas, which is otherwise flared.

At present, the Department of Energy applies a royalty of zero to solution gas that is flared. The Project Team wishes to facilitate the use of this gas and the resulting elimination or reduction in flaring. Economic analysis has demonstrated that royalty on solution gas is a significant component of cash flow in electric turbine projects. Waiving of solution gas royalty may significantly improve the economics of gas fired electric generation turbines that employ solution gas. The waiver of royalty on existing flared solution gas will not result in significantly lower Crown resource revenues because this gas is already being flared and no royalty is paid.

The Project Team also supports the waiver or reduction of royalties on otherwise flared solution gas that is made available for use by a third party.

4.4.4 Cost Sharing

The Project Team recommends that:

Alberta Department of Energy develop a government / industry cost sharing program to reduce the amount of solution gas being flared in areas where environmental concerns have been identified.

The Project Team supports introduction of government / industry cost sharing to assist in cases where it may not be economic to eliminate or reduce the flaring of solution gas. While the most economic options for eliminating or reducing routine flaring of solution gas should be pursued, there may be instances when the elimination of flaring is uneconomic yet desired from an environmental or health perspective.

4.4.5 Clustering

The Project Team recommends that:

The EUB and industry continue to develop mechanisms that encourage clustering as a means of facilitating reductions in routine solution gas flaring.

Clustering is one means of reducing the potential impacts of flaring and creating potentially viable projects for the use of solution gas. Clustering involves collecting gas from several flares into one location. Through clustering, sufficient volumes of gas may become available to encourage conservation or other uses. Clustering is an important part of dealing with numerous small flares and its importance likely will increase as industry strives to reach the higher reduction targets.

4.4.6 Sulphur Recovery Requirements

The Project Team recommends that:

Each flare with potential sulphur emissions between 1 and 5 TPD should be assessed on a case-by-case basis by Alberta Environmental Protection and the EUB and a decision made on requirements for sulphur recovery and cost sharing opportunities.

The Project Team encourages clustering of flares to make elimination or reduction of flaring more economic. Clustering should increase the opportunities for conservation and alternative uses of the solution gas by improving access to a significant volume of gas. Clustering may also increase the reliability of flow of gas to the flare.

The Project Team does not want sulphur recovery requirements to be a deterrent to clustering. It suggests that the sulphur recovery requirements for new solution gas flares be the same as for gas plants, except in the range of 1 to 5 TPD inlet sulphur. Above 5 TPD (tonnes per day) of sulphur inlet, sulphur recovery would be required, while below 1 TPD of sulphur inlet, recovery would not be required. This is consistent with EUB IL 88-13. Between 1 and 5 TPD sulphur inlet, recovery probably is not economical and cost sharing may be required similar to that provided for by EUB IL-88-13. Each flare between 1 and 5 TPD should be considered on its own merits concerning the need for sulphur recovery and cost sharing. As part of the review, nearby residents should be notified and provided an opportunity to express any concerns. If there are no impacts and nearby residents agree, sulphur recovery may not be required. If sulphur recovery is required, it may be eligible for cost-sharing similar to that available under the current Sulphur Emission Control Assistance Program (EUB IL-88-13).

The Project Team's analysis of information on flare volumes and sulphur content suggests that few flares will be affected by these requirements for sulphur recovery.

4.4.7 Flaring during Plant Turnaround

The Project Team recommends that:

The industry consider ways to reduce flaring during plant turnaround.

Solution gas flared during plant turnaround is included in the 1996 baseline data. Holford and Hettiaratchi (1998) noted that approximately 10% of the gas flared in 1996 appeared to be related to flaring during an upset at a gas plant or during turnaround at these plants. Finding ways to deal with solution gas during turnaround may offer substantial opportunities to reduce the volume of gas flared. These reductions would contribute to achieving the provincial targets for reduction in solution gas flaring.

Alternatives to flaring during plant turnaround might include:

- Re-injection,
- Sending solution gas to another, nearby plant that was not in turnaround,
- Shortening plant turnaround times to a minimum,
- shutting in oil production during plant turnaround,
- Better planning and coordination between oil and gas producers, and
- Scheduling additional maintenance on the oil side so that production is down during turnaround at the gas plant.

5.0 Improving Flaring Efficiency

5.1 Flare Performance Requirements

The Project Team recommends that:

The Energy and Utilities Board require all solution gas flares to meet the following performance requirements:

- *Gas directed to a flare must have a minimum heating value of 7.45 MJ/m³. **
- *A flame must be present whenever hydrocarbons are directed to a flare. **
- *Liquid hydrocarbons shall not be directed to a flare. ***
- *Visible emissions released from a flare shall not exceed an opacity of 40% averaged over a period of six consecutive minutes.*
- *Flares must be designed so that ground level concentrations meet Alberta's ambient air quality guidelines.*
- *Radiant heat density at ground level shall not exceed 4.73 KW/m².*

* Applies to solution gas that is capable of supporting combustion.

** Minimizing the liquid content of flare gas streams is very important in improving flare efficiency. At present, liquid drop-out technologies are used to minimize the liquid content.

In the mid-term, a performance requirement could be developed based on maximum droplet size that can be passed to a flare.

The Project Team recommends that:

The Energy and Utilities Board and industry continue development of appropriate performance requirements that result in significant improvements in efficiency of solution gas flaring.

Ongoing research may identify performance requirements that would improve flaring efficiencies significantly. For example, research may lead to development of specific requirements related to optimum droplet size for liquid hydrocarbons and improve liquid removal. If there are advancements in flaring technology that significantly improve flaring efficiencies, such as technologies that mitigate the effects of wind shear or guttering on flare efficiency, these could be incorporated into the existing performance requirements.

The Project Team recommends that:

The flare performance requirements apply to all new solution gas flares approved after issuance of the IL and to existing flares within three years from the date of issuance of the IL. An existing flare with a demonstrable life expectancy of less than three years would be exempt from the need for an approval and from compliance with the performance requirements.

The Project Team believes the EUB should incorporate these performance requirements into the recommended approval process. As operators upgrade existing flaring facilities to meet these performance requirements, they will be required contact residents, landowners and occupants within 500 m. of the flare and determine if there are any flare-related objections to continuing its existing approval. If there is no objection, there is no need to file papers with the EUB and obtain a new approval; however, information required by Guide 56 must be available for audit. If there are unresolved, flare-related objections, a non-routine application for the flare must be submitted to the EUB. The facility may continue to operate while the application is decided. For new flares, operators will be required to demonstrate that they are able to meet the requirements. These performance requirements will be reviewed during the evaluation of the management framework in the 2nd quarter of 2001.

5.2 Efficiency Standards

The Project Team recommends that:

The Energy and Utilities Board and industry continue investigating development of a combustion efficiency standard for solution gas flares.

The Project Team expects that the flare performance requirements outlined above will contribute significantly to improvements in destruction efficiency and combustion efficiency in solution gas flares. It is the intent of the Flaring Project Team that efficiency standards will be established as soon as possible and included as performance requirements to be met by all solution gas flares. The Project Team has recommended (Section 7.2) continuation of research into defining flaring efficiencies and developing a protocol for testing flare efficiency. This work is expected to lead to development of combustion efficiency standards. Once these standards have been determined, the EUB would apply them to all solution gas flares in Alberta. The 2001 review of the management framework would also include the feasibility of combustion efficiency standards.

5.3 Best Management Practices

The Project Team recommends that:

Industry adopt best management practices in the design, operation and maintenance of solution gas flares and take all feasible steps to reduce the amount and impact of solution gas flaring.

Application of best management practices to the operation of solution gas flares could substantially reduce emissions and public concerns about flaring. CAPP is developing a best management practices manual for the industry. This manual will provide direction on the design and operating criteria for solution gas flares and provide information for operators about the decision tree and alternatives to flaring.

5.4 Non-routine Flaring

The Project Team recommends that:

- *Non-routine flaring be reported to the EUB within 24 hours of the event (as per IL 98 01).*
- *Sensitive public in the area be notified as any non-routine flaring occurs.*
- *Interested public be notified of non-routine flaring within 24 hours of the event.*
- *Companies maintain a log, which may be subject to audit, of any complaints about non-routine flaring and their responses to them*
- *The EUB define “repeat non-routine flaring” in its IL and state its regulatory response to such flaring.*
- *The notification form for a facility’s application for approval includes the following questions: “Do you want to be notified in the event of non-routine solution gas flaring?” “Do you have any health concerns that may make you sensitive to flaring?”*

The industry already is required to report emergency flaring to the EUB within 24 hours of the event. The industry also is required to notify sensitive public in the area as flaring occurs: interested public is to be notified within 24 hours. The EUB scrutinizes repeat emergency flaring incidents.

For the purposes of managing solution gas flaring, “non-routine” flaring is a more appropriate term to apply to flaring events that are at variance with normal operations. Non-routine flaring may occur where solution gas normally is conserved or where, in the future, solution gas is flared that normally is used for other purposes such as generating electricity. It also includes flaring of unusually large volumes that exceed any variances noted in a facility’s approval. These recommendations also apply to solution gas flaring during plant turnaround.

6.0 Management Framework Review

The Project Team recommends that:

The EUB, through a CASA review team, assess the effectiveness of the management framework in the second quarter of 2001.

This review team, among other aspects, will:

- Assess the overall performance of the management framework.
- Determine whether the reduction targets for 2000 and 2001 have been met.
- Determine, based on improved information, firm future reduction targets, time lines and threshold volumes.
- Evaluate the royalty treatment of flared solution gas and cost sharing programs and their implications for achieving future reduction targets.
- Evaluate the approval process and determine if fixed term approvals are required.
- Review performance requirements and efficiency standards, and determine the feasibility of combustion efficiency standards for all solution gas flares.
- Assess research findings and their implication for management of solution gas flaring.

7.0 Information and Research

7.1 Baseline Data

The Project Team recommends that:

The Energy and Utilities Board clarify and revise the reporting requirements as practical to ensure the volumes and inlet composition of all materials directed to a flare or vented are appropriately reported.

The 1996 information provided to the EUB by well operators provides the baseline from which reductions in routine solution gas flaring will be calculated. Because the EUB collected this information for resource management purposes, refinements are needed to determine more accurately solution gas flaring volumes and rates. A more refined information base also may assist in determining the volume of gas available for alternative uses such as electricity generation.

The EUB is in the process of clarifying the reporting requirements for crude bitumen / heavy oil batteries where, for administrative purposes, production of small volumes of solutions gas from many wells may be reported as one “paper” battery. In these cases, volumes of solution gas usually are reported based on gas-to-oil ratios and, in some cases, may be overstated. The EUB also is reviewing the reporting of batteries on the basis of conserving and non-conserving batteries to assess the extent of non-routine flaring as well as the coding of battery types, requirements for measurement techniques, and estimating methods to improve consistency in reporting.

The Project Team recommends that:

The Energy and Utilities Board, Alberta Environmental Protection, Alberta Health, and Alberta Agriculture, Food and Rural Development establish processes and linkages to relate data on oil and gas wells, and solution gas flaring and venting with data on pollutants, environmental receptors, and human and animal health.

Alberta Health improve collection of human health data respecting the impacts of solution gas flaring.

Alberta Agriculture, Food and Rural Development improve the collection of animal health data respecting the impacts of solution gas flaring.

7.2 Research Needs

The Project Team recommends that:

The Energy and Utilities Board and CAPP coordinate work on defining flaring efficiencies, assessing available flaring technologies and developing a protocol for testing flare efficiency.

Alberta Environmental Protection assess the feasibility of developing methods and a protocol to monitor ambient concentrations of compounds of concern emitted by solution gas flares and, if feasible, implements ambient monitoring for these compounds.

Alberta Environmental Protection assess the feasibility and form of ambient guidelines for flaring-related compounds.

Alberta Health develop methods and, if feasible, implement a program for measuring personal exposure to compounds of concern emitted by flares and interpret the results.

Alberta Environmental Protection, working with CASA project teams, co-ordinate discussions among research bodies regarding research to fill knowledge gaps in our understanding of the effects of solution gas flaring on human and animal health, and vegetation.

The Project Team assessed existing information on solution gas flaring, including technologies, efficiencies, emissions and impacts. It also reviewed information on alternative technologies and on the biological and health effects of solution gas flaring. It considered this information, developed a list of data gaps and research needs, ranked these suggestions and used these rankings to develop its recommendations. These recommendations are directed to various government agencies for action.

8.0 Public Involvement

The Project Team recommends that:

CASA communicate with interested members of the public the solution gas management framework recommended in this report.

CASA, in its communications concerning solution gas flaring, should make broadly known the increased opportunities available for the public to comment on or object to solution gas flaring operations.

In July 1997, the Project Team sent an information package and survey to 853 individuals who had an interest in solution gas flaring in Alberta. The input obtained through the survey reaffirmed the ideas being developed by the Project Team and indicated that the Team had captured the public's view in its discussions. CASA should maintain communications with these individuals and others interested in solution gas flaring to ensure they are informed of the recommendations contained in this report and understand the opportunities that will be available to comment on solution gas flaring operations.

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Appendices

Appendix 1: CASA Flaring Project Team Membership

Bart Guyon	Alberta Association of Municipal Districts and Counties (AAMD&C)
Ralph Christian	Alberta Agriculture, Food and Rural Development
Joe Kendall	Alberta Agriculture, Food and Rural Development
Gary Sargent	Alberta Cattle Commission
Brent Lakeman	Alberta Department of Energy
Hal Knox	Alberta Energy and Utilities Board
Lawrence Cheng	Alberta Environmental Protection
Bill Macdonald	Alberta Environmental Protection
Herman Schwenk	Alberta Federation of REAs/Agriculture Industry
Tim Whitford	Alberta Forest Products Association
Dennis Prince	Alberta Health
James Tweedie	Bert Riggall Environmental Foundation/NGO
Mark Burley	Canadian Association of Petroleum Producers/Imperial Oil
Dave Pryce	Canadian Association of Petroleum Producers
John Lilley	Clean Air Strategic Alliance
Mike Kelly	Clean Air Strategic Alliance
Dana Atwell	CPPI/Shell Oil
Rod Frith	Environment Canada
Ron Schmitz	Husky Oil
Martha Kostuch	Prairie Acid Rain Coalition/NGO
Tom Marr-Laing	Pembina Institute/NGO
John Squarek	SEPAC/First Star Energy Ltd.
Henry Pirker	South Peace Environment Association/Agriculture-Industry
Jennifer Bocock	Wild Rose Agricultural Producers/Agriculture-Industry

Members Prior to June 1998

Bob Anderson	Alberta Association of Municipal Districts and Counties (AAMD&C)
Ian Dowsett	Alberta Energy and Utilities Board (EUB)
Randy Angle	Alberta Environmental Protection
Shannon Flint	Alberta Department of Energy
Stephan Gabos	Alberta Health
Cathy Good	Alberta Lung Association
Kim Johnson	Canadian Association of Petroleum Producers (CAPP)/Shell
Murray Ellis	Clean Air Strategic Alliance
Mark Holford	Husky/University of Calgary

**Appendix 2: EUB Guide 56, *Energy Development Application Guide and Schedules*, Table 1.3 –
Public Contact Requirements**