Issues Matrix for Draft Protocol on Hazard and Risk Analysis

We promised to keep you informed on the progress made in addressing Recommendations 17, 18 and 19, which related to the development and maintenance of a standard methodology for dispersion modelling and risk analysis of sour gas developments. The following table presents the comments received by the EUB on the draft Protocol for Hazard and Risk Analysis. We have also responded individually to each stakeholder whom has commented and have included the EUB responses in the table as well as any follow-up discussions.

By its very nature, the development of the Protocol involves individual technical discussion with various experts and stakeholders. An objective of this matrix is to ensure we have documented all comments so that the development process is as open and visible as possible to all stakeholders. Secondly, we have used the matrix to identify those issues that require further discussion at the June 20, 2002 workshop. The issues on which the EUB seeks workshop discussion are identified (✓) under the last column, "WS".

Process for Selecting Workshop Participants

We have invited all those whom have specifically commented to the June workshop. The workshop will focus on the technical details of the Protocol with the objective of further discussing the issues that have been raised so that the EUB can make an informed decision on the way ahead. It is planned to include the results of those discussions in the matrix as well. Further, we have also invited additional stakeholders to participate in the workshop based on their individual expertise and/or the stakeholder groups that they represent. In this way we hope to achieve a balanced workshop that covers all stakeholder sectors.

Hazard Analysis Versus Risk Analysis

Many of the concerns that were voiced are related to probabilities, risk and the pursuit of obtaining "realistic" values. One of the main objectives of the Protocol is to provide a standard hazard analysis for the purpose of calculating an Emergency Planning Zone. As a result of the comments we have received, the EUB is concerned that by mixing "worst case" hazard analysis with quantitative risk analysis the credibility of the hazard analysis model could be tarnished. The EUB has decided to split the draft Protocol into two separate documents, one for hazard analysis and one for risk analysis. The EUB believes segregating "worst case" hazard analysis from risk analysis will address much of the public and industry confusion (a key reason for raising Recommendations 17 and 18). The EUB notes that by having two separate protocols, completion of Recommendations 17, 18, and 19 may be deferred because of the risk component. To reduce this delay, it is planned to use a parallel process as much as possible.

Process for EPZ Determination

There has also been confusion over what is actually meant by the spreadsheet nomograph and the Screening Hazard Analysis. Due to stakeholder feedback and further discussion, we have revised the Protocol to make it simpler to understand and apply.

The original draft Protocol potentially involved a 2-step process for determining an EPZ. The first step was to use a spreadsheet-based nomograph with conservative simplifying assumptions. If this resulted in an EPZ that was too large for that particular situation, a second step could be applied to refine some of the conservatisms to calculate a refined EPZ. It is important to note that this does not mean that the refined EPZ is not protective of the public. Rather, global conservatism has been replaced by local conservatism for the specific case.

The draft Protocol also allowed for the submission of an alternative hazard analysis - with certain rules - along with the screening hazard analysis to provide a means for comparison. However, alternate approaches were not allowed to refine the EPZ further. This led to the question as to why an alternative approach was allowed – the answer was so that new science could be introduced ensuring a process by which the Protocol could be changed to accommodate new methods.

As a result of the above issues, the draft Protocol has been changed:

- The determination of an EPZ is now a single stage process. Instead of having a simplified spreadsheet nomograph, the Protocol will require the application of a site-specific hazard analysis. To ensure the objective of having a simple tool, the hazard analysis spreadsheet will only require a user to provide input parameters to derive an EPZ. The running of the FLASH and dispersion model will be automated and not require file manipulation by the user.
- An alternate hazard analysis can now be submitted for EUB review and approval of its EPZ providing the approach meets the criteria defined by the Protocol. In addition, the EUB Hazard Analysis detailed above must still be submitted for benchmarking purposes.
- The process to revise the Protocols regularly will fall to the Hazard and Risk Analysis Advisory Group – a team to be created comprising of EUB, Industry and Public representatives.

The revised process of the Protocol for Hazard Analysis in sour gas developments is shown in Figure 1. A similar process will be defined for risk analysis.

Dispersion Coefficients

A concern has been raised that the SLAB model uses dispersion parameters developed by F. Pasquill some 40 years ago. The EUB agrees that the dispersion parameters have a significant influence on concentration predictions and are aware of alternate parameters that are available. However, the EUB believes that standardized regulatory screening dispersion parameters provide the consistency required for approval purposes. The SLAB parameters are similar to the USEPA default parameters, thus similar levels of dispersion turbulence will be used to assess ignited (modelled using ISC3 etc) and un-ignited releases (modelled using SLAB). Using the SLAB model with default, regulatory dispersion parameters allows us to provide a 'conservative worst-case' estimate of the hazard footprint. Regardless, the EUB will have a process for considering alternate approaches.

Jet Expansion

It was pointed out that using an isenthalpic expansion from initial conditions results in higher than expected estimates of gas temperatures and density at expanded atmospheric conditions.

An isenthalpic expansion from the initial low velocity conditions provides the stagnation enthalpy (no kinetic energy, i.e. a velocity of zero) and density at the R plane, yet the release is assigned a high velocity at the R plane. Although it appears that the release is given extra kinetic energy at the R plane, the SLAB model (as do most other integral plume rise models) does not account for kinetic energy in the solution of the conservation equations. Hence, the proposed inputs to the dispersion model conserve mass, momentum and energy from initial to final conditions.

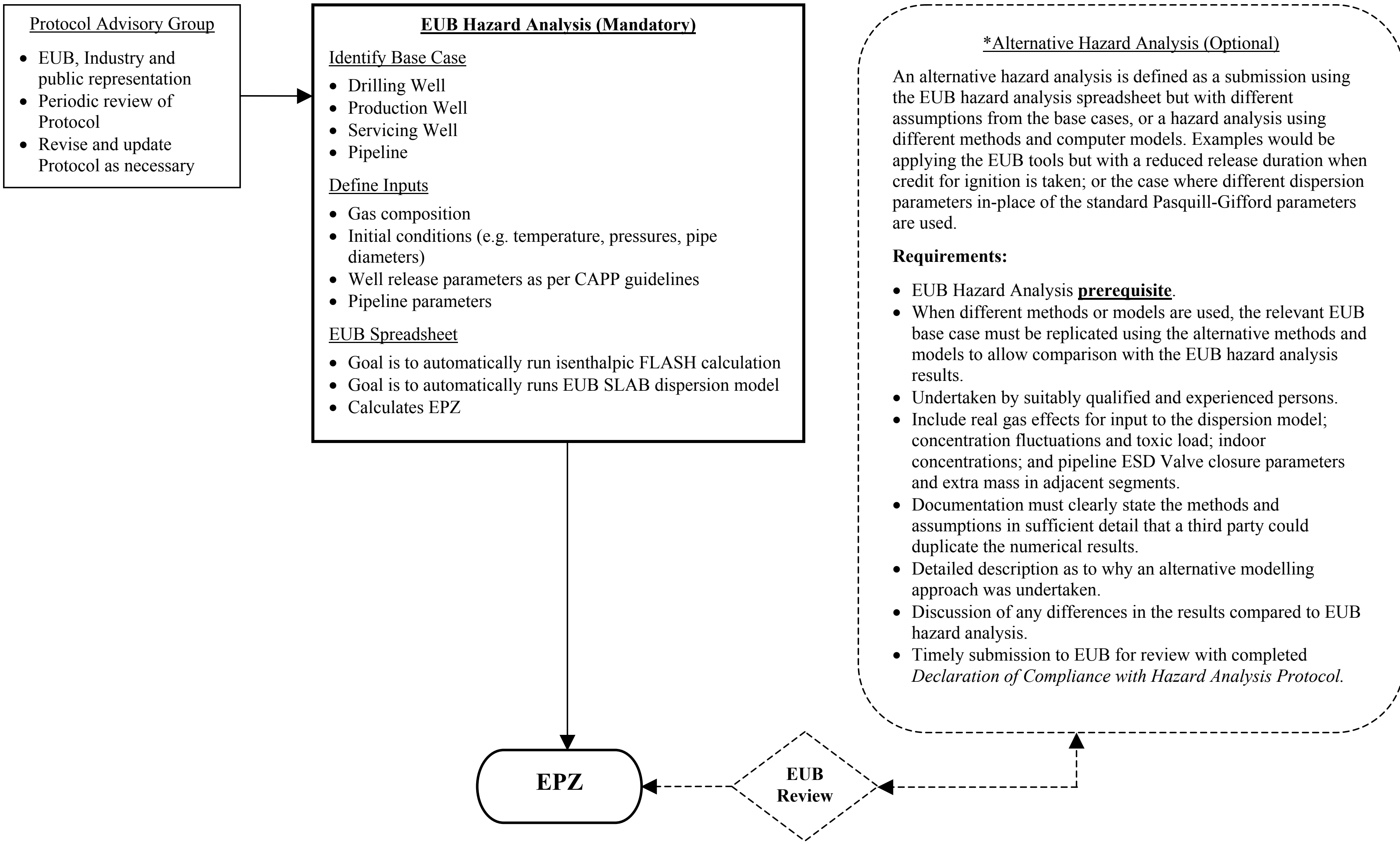
By using the stagnation enthalpy rather than the static enthalpy (the stagnation energy less kinetic energy), we are using a warmer, lighter release with fewer liquids as the input to the dispersion model. However, momentum not buoyancy, dominates the initial trajectory of the release. It can be shown that when about 10 parts of air are entrained into the release, the difference between the exact and proposed approach mixture enthalpies and densities are insignificant. Using the stagnation enthalpy makes the R plane flash calculation independent of the release rate and assumed drag, thus simplifying the calculation process. The stagnation density is also the correct value to use in the plume rise equations.

Well Release Duration

The source duration for an un-ignited H_2S release from a well is 3 hours, the maximum expected persistence of meteorological conditions. It was noted that the statement may be very valid, but requires more justification since it is a major input into the modelling.

This is a conservative worst case that assumes a continuous release rate and indicates the maximum extent of the hazard zones if no control/mitigative action was taken. The hazard zone changes because the dispersion conditions change. A preliminary review of Alberta Environment's meteorological data set for Calgary indicates that a 3-hour meteorological persistence for F stability class, 2 m/s wind speeds (i.e. unchanging stability class and wind speed within a 22.5 degree sector) occur 2-3% of the time. To model the release within SLAB, the source duration and meteorological averaging time are set to 3 hours. A 3-hour exposure time is also used to calculate the toxic load.

Figure 1 - Protocol for Hazard Analysis in Sour Gas Developments



#	Topic	Comment	EUB Response	Follow-up	Action	WS
1	Utilization	The wording in Section 1 and the title of Figure 1.1 uses the word "Relationship", which implies that the chart is a relation. Section 1.1 (paragraph after point 9) uses Figure 1.1 as a process. This is confusing. It is suggested that the wording and the chart be crisper. The chart title should refer to it as a process showing the relationship of the various process steps to the recommendations 17, 18, and 19 etc.	The intent of Figure 1.1 was to show both the process flow of the Protocol and the interrelationship between Recommendations 9, 52, 58 and 62. The title of Figure 1.1 will be revised to make this clear.	Stakeholder accepted EUB reply.	Figure 1.1 to be revised. Further update: given the significant rethinking and restructuring on the process, the process depicted in Figure 1 attached to this matrix plus a similar process for risk analysis will take the place of the original Figure 1.1 in the Draft Protocol.	✗
2	Hazard Analysis	Section 1.2 Screening Risk Analysis Protocol "specialized computer models that are proprietary have been used to perform the risk calculations. The use of a proprietary model is not consistent with the objective of having protocols so that anyone (operator, EUB, public) can replicate the calculations and arrive at the same result. It is suggested that alternate software must be found or the proprietary software must be made freely available.	The intent is to have all the tools freely available on the EUB Web site (i.e. a modified SLAB, FLASH calculation package and spreadsheet). We were cautious in stating exactly what would be placed on the EUB Web site in the draft Protocol at the time of publication because a number of issues had to be resolved. The isenthalpic FLASH package will only be an executable with the source code owned by the vendor. (This is a requirement of the licence agreement.)	Stakeholder believes the source code of any program used must be available. It is important that the source code be able to stand up to technical scrutiny by users and peers. Otherwise it may lead to unnecessary technical debate at public hearings. EUB post-meeting follow-up – The FLASH code will be accompanied by documentation that explains the basis for its calculations. The EUB believes this will enable the parties to asses the performance of the code. All other codes can be viewed in their entirety. There will be no proprietary software used for the risk analysis.	There is no action required following a meeting with the stakeholder.	✗
3	Risk Analysis	Section 2: Probabilistic Risk. The definition of the word risk already includes probability and the term "Probabilistic Risk" is awkward. It is suggested that "Quantitative Risk" is used.	We agree with your comment. The term "probabilistic risk" was used to be consistent with the terminology of the Provincial Advisory Committee on Public Safety and Sour Gas. On pages 7 (paragraph 4) and 10 (paragraph 2) the term "quantitative risk" is defined. We will clarify this issue in the revised draft of the Protocol document.	Stakeholder accepted EUB response.	Terminology in Protocol will be clarified.	✗
4	ERP/EPZ	Last paragraph of section 3 states, "analysis of chronic risks is not within the scope of the project". This statement is supported, however, others may not understand that the ERP is intended to protect the public from immediate life threatening danger. It is suggested this statement is emphasized so that is very clear to all users that chronic effects will not be used in ERP planning.	A sentence will be added to emphasize that an ERP is produced to protect the public if an accident were to occur, and that chronic effects are not going to be considered.	Stakeholder suggested that the endpoints for hazard analysis for public safety should be defined. Stakeholder recommends endpoints for H_2S/SO_2 similar to the criteria specified by U.S. EPA, e.g. ERPG3. The EUB advises that the Protocol will apply whatever endpoint criteria are the standard of the day. We do not want to cite criteria within the Protocol to avoid having to make changes if the criteria change. The Protocol will be developed based on the existing endpoints – this can be easily be changed to input new parameters as required. Recommendation 9 will review H_2S and SO_2 criteria. This information will be considered when updated criteria are developed.	Develop spreadsheet based on existing health effects endpoints – can be easily changed to apply whatever endpoints are current. Review results of Recommendation 9 when complete. The methodologies for hazard and risk analysis can be developed independent of the specific endpoints. Further, focussing on endpoints could bias the development of the methodologies. Endpoints will not be considered at the workshop.	✗
5	Hazard Analysis	Section 4.2 Hazard Identification and Incident Selection There are many more hazards other than H_2S and SO_2. It is suggested that is made clear, perhaps in the summary, that this document is a protocol for H_2S and SO_2 releases only.	Page 26 (paragraph 2) talks about other hazards. Consideration will be given to including this within the summary of the Protocol to emphasize that the Protocol is concerned only with the hazard from H_2S and SO_2.	Stakeholder accepted EUB response	Emphasize in Protocol that only H_2S and SO_2 hazards are considered.	✗
6	ERP/EPZ	Section 4.3.2 Wells, and Table 4.3	Please supply clarification of the issue. Is the concern the duration of the release or the duration of the meteorological conditions? The modelling is	The concern being raised by the stakeholder is the duration of the meteorological conditions.	Further discussion is required to decide on an appropriate release duration and	✓

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		"the source duration for an unignited H_2S release is 3 hours, the maximum expected persistence of meteorological conditions." The statement may be very valid, but requires more justification since it will become a major input into the modelling. It suggested that the justification is included as an appendix and make it a topic of discussion at the workshop.	to assume a continuous release from wells with a 3-hour meteorological persistence. We will improve the wording of the document to avoid confusion. For the refined EPZ defined in the Protocol, the EUB believes this is a reasonable assumption. Note that the refined EPZ is derived from using less conservative assumptions than the default EPZ case. The 'refined' EPZ is not a 'reduced' EPZ. The determination of a 'reduced' EPZ is beyond the scope of the Protocol and will be a topic considered as part of the planned EPZ review (Recommendation 58). (Update note: there is now no longer a "default/nomograph" EPZ case and "refined" EPZ case. Instead, there is now simply the one EUB Hazard Analysis outlined in the attached Figure 1.)	The stakeholder would like to understand the justification for choosing 3 hours. As mentioned before, the implications on the modelling results could be very significant. Stakeholder would like this issue addressed either prior to or at the workshop. Following a meeting with the stakeholder, it was agreed that a meteorological persistence of 3-hours could be credible for Alberta. A preliminary review of one of the Alberta meteorological data sets indicated that a 3-hour meteorological persistence (i.e. unchanging stability class and wind speed within a 22.5 degree sector) occurs for 2-3% of the time. A further issue is what averaging time do we assume. Although the weather may not change for 3-hours is this reasonable to assume because of the effect of averaging time on concentration predictions. There is also the factor that the actual release may be less because of measures taken to control and stop the release.	averaging times. This topic will be discussed at the technical workshop.	
7	Assumptions	Table 4.3 Pipeline configuration of Horizontal Jet with Drag, and Section 4.3.3 Pipelines "the maximum release from a pipeline is the result of a guillotine break…" A horizontal jet does not seem to be consistent with a guillotine break. One would expect a guillotine break to be an upward jet. Combining a guillotine break with a horizontal jet seems unrealistic and far too conservative. Unless the EUB pipeline database can demonstrate that a guillotine break coupled with a horizontal jet has happened in the past, it is suggested using a more realistic case of a guillotine break coupled with an upward jet.	The EUB pipeline rupture experiments done in the late 1970s produced almost horizontal jets when there was a guillotine rupture induced by an explosive charge that blew away a short section of a buried line (a metre or so long), and left two separated ends with jets directed at each other. As shown on video records of the tests, the jets from the two sides could blow horizontally past each other as the disconnected ends of the rupture were pushed slightly out of direct alignment with each other. These horizontal jets were then deflected upward at about 30 degrees by the crater walls, but the emerging jets at ground level deflected downward and attached to the ground soon after reaching the surface. This downward deflection of a jet near a solid surface is well known, and is called the Coanda effect. It seems reasonable to use a horizontal jet in the "worst case" screening hazard analysis. Of course, for probabilistic risk assessment, a whole range of release directions (upwind, downwind, and crosswind horizontal, and at various angles including vertical) could be considered, each with a probability of occurrence with appropriate justification. Further discussion will be considered for inclusion within the Protocol.	Stakeholder accepted EUB response.	EUB to provided further discussion in the Protocol.	✗
8	Assumptions	Section 4.4.2 Isenthalpic Expansion from Initial Conditions. The concern is that the methodology outlined will result in higher than expected estimates of gas temperatures at expanded atmospheric conditions. Technical details can be presented at the workshop, but it would be preferable that the focus for resolution be shifted to a group of	The concern expressed was not specific enough to pinpoint the scientific reason for the concern. However, assuming that the concern is that the jet has significant kinetic energy that has not been converted into temperature: the isenthalpic jet emerging from the rupture accelerates outside the rupture to supersonic speeds that are about Mach 2 (twice the speed of sound at the local jet temperature) and is very cold. This supersonic jet rapidly entrains air, and within about 50 to 200 pipe diameters from the release point the mixture of air and pipeline gas will	Further discussion has taken place between the experts. The rapid expansion of the sour gas mixture emerging from the well or pipeline rupture cools as it expands from the initial high pressure to atmospheric pressure. We model this rapid expansion as an isenthalpic expansion – meaning	EUB will provide more explanation and justification for this assumption in the Protocol. Presentations and discussions on this subject will take place at the technical workshop.	✓

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		specialists. Access to non-proprietary software allowing for the calculation of specific requirements outlined within the protocol (e.g., isenthalpic expansion) should be made available on the EUB Web site.	slow down enough to have its Mach number reduced below 0.3 (that is, the jet speed will be only 30% the speed of sound). At this low Mach number, the enthalpy can be approximated with very good accuracy by the stagnation (zero velocity) enthalpy of the pipeline gas and air mixture. This stagnation enthalpy can result in temperatures much lower than the pipeline gas if the gas is non-ideal in its behaviour. The proposed EUB hazard analysis model approximates the jet as being at the stagnation enthalpy for its entire travel distance, and we believe this approach is an accurate assumption beyond the first 50 to 200 pipe diameters of downstream distance. For a large sour gas pipeline of 0.41m (16 inches) the range of validity of the 50 to 200 diameters assumption equates to a distance of 21m to 82m respectively from the pipeline. These distances are within the current Level 2 and Level 3 pipeline setbacks. A Level 1 setback distance is negotiated between the operator and landowner and this issue will be considered as part of the setback review of Recommendation 52. On this basis, the EUB believes an isenthalpic blowdown is a reasonable assumption to make for a screening hazard Further justification of this assumption will be considered for inclusion within the Protocol. All the needed software will be available free on the EUB Web site. The EUB are planning to purchase an isenthalpic FLASH calculation package. This will only be executable with the source code owned by the vendor.	we assume there has been no transfer of energy (i.e. heat) to the atmosphere. The concern raised was that by assuming the velocity of the jet is at the velocity of the air (i.e. ignoring kinetic energy) along its entire discharge path we are not accounting for the cooling of the jet as it accelerates, and so the temperatures and liquid fractions that are input into the dispersion model are not representative - the density of the gas could differ by 60% by ignoring this kinetic cooling effect. However, the momentum of the release is so large that the lower density does not affect the orientation of the discharge. Within 10m to 100m of the discharge point, air entrainment slows the release to the velocity of the surrounding air and the physical parameters at this point are used for input into the dispersion model. The experts now agree that using an isenthalpic expansion and ignoring the kinetic cooling is a reasonable assumption to make and a good approximation for input into the dispersion model.		
9	Risk Analysis	Section 5.3.1 Frequencies There is no mention of blowouts on wells designated as critical sour wells. Since the Lodgepole blowout and subsequent EUB Critical Well classification and Industry Recommended Practices there has not been a drilling blowout of a Critical Sour Well. Hence, should a frequency of zero be used? A frequency of zero for critical sour wells would not be tenable, but it should be a lot lower than the frequency for non-critical wells due to the extra effort (and conservatism) that goes into the design and execution of such wells.	The EUB agrees that using overall sour gas well blowout frequencies for critical sour gas wells will be conservative. Since there is no applicable (post Lodgepole) statistics for critical sour well blowouts, the level of conservatism cannot be estimated without further detailed work using basic principles such as the application of a fault tree model. However, we can say that the frequencies will provide an upper bound that is acceptable for a screening risk analysis. Also the Protocol does allow for an alternative risk analysis to be undertaken by an operator that could use fault tree models.	This material should be withdrawn out of the protocol because it is risk based. It should be revisited at a later stage with the risk protocol. Stakeholder does have a concern with the use of the current blowout frequency applied to critical wells. A more detailed analysis of rare incidents should be conducted. EUB follow-up – We agree that a fault tree analysis could be done to estimate the failure frequency for critical sour wells, but at this time the EUB are not planning on undertaking such a project. For the purposes of a screening risk analysis we still believe that the conservative value from looking at historical data for all sour wells is acceptable.	The Hazard Analysis Protocol will not include this information. The stand-alone Risk Analysis Protocol will include a conservative estimate of the blowout frequency for critical sour wells. Note that the separate Hazard Analysis Protocol and Risk Analysis Protocol are concurrent processes to maintain project completion target dates.	×
10	Risk Analysis	Section 5.3.2 Probabilities The second paragraph uses a minimum of a 15 minute unignited release. This time has a major impact on ERP planning. What is the justification for using 15 minutes? Some operators have demonstrated via drills that ignition can be accomplished in as little as 6 minutes. The time to ignition should be defined by an upper boundary of	Section 7.5.4 in the draft ERP Guide requires an operator to prepare for ignition at the earliest signs of a well control problem. The guide states that an uncontrolled release of H_2S must be ignited within 15 minutes once onsite personnel have been evacuated to a safe distance. The rationale behind using 15 minutes within the draft Protocol is to be consistent with these requirements. Since the Protocol allows an alternative hazard analysis to be performed (after performing the screening hazard analysis) an operator could submit a reduced time to ignition for consideration by the EUB.	Stakeholder does not agree that a minimum of 15 minutes should be used as the standard for the requirements of the protocol. The protocol should allow individual companies to use a lower number based upon evidence that ignition can be accomplished in a shorter time frame. Stakeholder is concerned that unnecessary conservatism is being applied to the input of the protocol.	The Protocol will be revised to better explain the process.	×

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		15 minutes, but companies should be allowed to submit an ignition program for approval by the EUB that considers the situation (e.g., drilling versus servicing) and which can be audited by the EUB.	It is also worth noting that work undertaken for Transport Canada investigating human performance in life threatening situations, shows a huge deterioration when a situation becomes very dangerous. If a practiced drill takes 6 minutes to perform under normal conditions, during a real emergency the drill could take 12 to 18 minutes with a higher chance of error leading to non-ignition. It is proposed that the 15 minutes is retained for the screening risk analysis requirements of the Protocol. Note that the refined EPZ as defined in the Protocol is derived from using less conservative assumptions than the default EPZ case. The 'refined' EPZ is not a 'reduced' EPZ. The determination of a 'reduced' EPZ is beyond the scope of the Protocol and will be a topic considered as part of the planned EPZ review (Recommendation 58). (Updated note: there is no longer a 2-step process of Screening and Refined EPZs.)	In the EUB's response it states that a reduced time to ignition can be submitted for consideration by the EUB as part of the alternative hazard analysis. However, Section 1.19 of the protocol document states clearly that an alternative hazard analysis cannot be used to refine the EPZ. The EUB's comment is confusing. Please clarify. Stakeholder would like these issues addressed either prior to or at the workshop. EUB follow-up - There appears to be confusion over what is allowed under the alternate hazard analysis. To resolve this issue, the Protocol has been revised to include a single step process to determine an EPZ based on the mandatory EUB Hazard Analysis. In addition, the rules for submitting an alternate hazard analysis will be clearly defined. This alternate analysis can be used to present an EPZ to the EUB for consideration providing compliance with the Protocol has been demonstrated. This ensures a comparison with the EUB Hazard Analysis can be made, as well as providing a process for reducing an EPZ through applying counter measures – for example the time for ignition of a release.		
11	Risk Analysis	Section 5.3.2 Probabilities The second paragraph states that there is a 1% chance of non-ignition when ignition is attempted. As this will have a significant impact on ERP planning, data is required to support this assumption. It is suggested that the 1% chance on non-ignition be eliminated unless supporting information can be provided. If supporting information exists then this should be referenced in the appendix.	The EUB agrees that there is no historical data to support a 1% chance of non-ignition and a task and fault tree analysis would be needed. At this stage all we can say is that there is a chance that there will be a failure to ignite a release on demand. (Update: see correction in EUB Follow-up; next column) For the purposes of a screening risk analysis, it is assumed that ignition will occur within the 15 minutes as prescribed in the Section 7.5.4 of the draft ERP Guide. If an operator opted for an alternative risk analysis as per the Protocol, a failure to ignite on demand would need to be determined through a task and fault tree analysis. The objective would be to show that this failure to ignite is such a small chance that it is an acceptable risk for the EUB to consider a reduced EPZ application. The EUB will not allow probabilistic methods to challenge the EPZ determined by the Screening Hazard Analysis, which will be based on a realistic worse case scenario. The determination of a 'reduced' EPZ is beyond the scope of the Protocol and will be a topic considered as part of the planned EPZ review (Recommendation 58). It is proposed to amend the text in the Protocol to include the comments above.	Stakeholder is concerned that the number chosen by the EUB is not defendable. This can lead to unnecessary technical debates at public hearings. This issue is part of the risk analysis and justification of these terms should be done as part of that analysis. EUB follow-up – the 1% chance of non-ignition is derived from a fault tree analysis and for the purposes of a screening risk analysis should be retained.	EUB to provide justification for 1% chance of non-ignition. This justification should be included in the protocol.	×
12	Risk Analysis	Section 5.3.2 Probabilities	The safety systems referred to protect only if the blowout occurs in the piping or valves above the subsurface safety valve (SSSV). Blowouts	Stakeholder continues to believe that the approach above is still too conservative. The	EUB Position: These issues deal with probability and may have a place in risk	×

#	Topic	Comment	EUB Response	Follow-up	Action	WS
		"Ignition of a producing well could be delayed for several hours so the benefits of ignition are not accounted for." Producing wells have several levels of redundancy such as a flowline ESD, master valves, subsurface safety valve, and low-pressure shutdowns, etc. Hence, the release is most likely not going to be a maximum and if it were at a maximum, the emergency system would shut-in quickly. With the information provided, the EUB approach seems far too conservative. Perhaps an approach similar to pipelines can be used, a transient release until the emergency shutdown devices are activated and the piping depressurized. Because the volume between shut-in devices is very small, this approach would result in a much smaller release than a pipeline and so it becomes a redundant case.	from failures in tubing below the SSSV, annular releases and downhole releases outside the casing would not, in general, be prevented. In addition, since these systems serve different functions they are not necessarily redundant systems, and may not work on demand or may not be activated in time. For example, master valves are usually manually operated, and we expect it would take some time for personnel to arrive on site to close them. We will investigate the data to see if we can identify the proportion of these cases compared to all blowouts. The EUB believes that the approach suggested is reasonable and not too conservative for producing wells. We will change the wording to discuss the safety measures that are in place and explain in more detail why ignition could be delayed for several hours.	casing, tubing and wellhead systems are designed for full reservoir pressure. The well bore and wellhead systems are designed with emergency shut down valves (ESD) and/or SSSV. All are designed as per the regulations. It appears that the scenario described above requires multiple failures to happen coincidentally, in order to have the blowout event take place. Stakeholder does not agree with the EUB's response and would like to have this issue addressed either prior to or at the workshop.	analysis. For the hazard analysis and an EPZ determination, the EUB believes that it is appropriate to consider a release at maximum flow rate, as per the CAPP H_2S Release Rate Guidelines. If a proponent wished to do so, a alternate analysis could be performed to model a transient release or consider the effects of safety devices on the probability of a release	
13	Risk Analysis	Section 5.4 "How likely am I to die…" Words like this will be alarming to the public. It is suggested such items are rephrased in the third person and state clinically, e.g., what is the possibility of a fatality?	We took the approach that the public are concerned in the likelihood of dying themselves. We did not want to place this within the third person for that reason, and to state this fact as simply as possible. However, we have noted the comment and will give this further consideration.	Stakeholder accepted EUB response.	None	×
14	Risk Analysis	Section 5.4.2 Individual Risk For individual risk intensity, it is unrealistic to assume that an "individual remains outdoors continuously (24 hours a day, 365 days a year)". Suggest leaving this section out as it is covered using indoor/outdoor data for rural people and urban people in section 5.3.2, last paragraph.	The text only defines IRI. It is never used as a risk estimate and is only a computational step. We will revise this section to avoid any confusion.	Stakeholder stated if IRI is not used then it should be removed.	Remove from Protocol to avoid confusion.	×
15	Utilization	Prior to the issuance of a new EUB spreadsheet, bench line modelling over a range of cases needs to be conducted to ensure the validity of the spreadsheet over the range of scenarios for which it will be applied. The issues outlined within the modelling protocol are technically complex and the application of the methods will generally remain beyond the in-house capabilities of most companies. Situations where the use of the Protocol will be required should be defined.	All the supporting software of the Protocol will be tested prior to release. The EUB plan to further test the Protocol through an independent pilot study to ensure we have a robust product for use by all stakeholders. We agree that the issues are complex, but there will be a user guide to help operators involved in the production of ERPs. A screening hazard analysis needs only be performed if the default EPZ needs refining. Alternate hazard and risk analyses will remain the domain of the consultants. EUB update: as per Figure 1, there will be one standard hazard analysis that will be required in all cases for calculating an EPZ. It is the intent of the EUB to automate the process wherever reasonably possible in order to make the process user friendly. The user guide will outline how to provide the necessary inputs to the spreadsheet-based tool.	Stakeholder supports preliminary testing of the protocol, but would like to see validation through experience prior to regulated use of the screening hazard analysis spreadsheet. Stakeholder would like to see a clear defined process for continuous improvement of the protocol and the hazard screening analysis spreadsheet.	The EUB see validation as in important part of the project to make sure the protocol is robust and can be applied to all sour gas developments. An implementation plan for the Protocol has yet to be decided, which will involve issues such as health effects end points and the results from the pilot study. Recommendation 19 requires that the Protocol be updated regularly. To accomplish this we are considering setting up a Hazard Analysis Advisory Group.	×
16	Risk Analysis	The purpose of including screening level risk estimates within the worksheet as at this time is questioned, there is no Canadian or Alberta requirement for conducting risk analysis and there are no acknowledged risk acceptability criteria. For risk to be included, there must be a clear statement of acceptable risk levels so that there will be no controversy with the public.	There is public confusion over what is the "true" risk for a particular development. We have noted in the draft Protocol (page 6, paragraph 4) that there is no uniquely right answer but there are many wrong answers resulting from erroneous calculations, inaccurate assumptions and impossible scenarios. It is this issue that the EUB are trying to resolve through a screening risk analysis. Industry and interveners in an application are allowed to undertake an alternative risk analysis providing a screening risk analysis is submitted.	Stakeholder accepted EUB response.	EUB to make sure this issue is discussed as part of the setback review.	×

#	Topic	Comment	EUB Response	Follow-up	Action	WS
			We recognise that there are no Albertan or Canadian risk criteria. The definition of acceptable risk criteria will be considered as an important part of the setback review.			
17	Stakeholder Engagement	Concerned that there are many technical issues addressed within the draft protocol that will require further examination and dialogue that are beyond the scope of a two-day public workshop. It is suggested that the EUB needs to establish a process that will address the technical issues in detail before the final protocol is issued. It is recommended that a group of specialists (with representatives from both the EUB and industry) be established to work over a short period of time to find consensus on any unresolved technical issues.	The EUB also acknowledges that due to the technical nature of this work, there may be a need for further dialogue beyond the planned workshops to resolve some of the issues. Initially, we plan to try and resolve concerns separately with the parties whom have commented. By adopting this approach, we hope to focus on those issues that will require more detailed discussion between the EUB and the relevant experts. We are considering undertaking an independent pilot study to test the Protocol after the first technical workshop. A further workshop after this has been completed may be held.		Continue to involve stakeholders through individual working meetings and through workshops.	×
18	Utilization	Concerned that the complexities with the protocol will potentially make it difficult for operators to utilize	The tools to apply the Protocol, i.e., the computer codes and spreadsheet, will be available for free on the EUB Web site. There will also be an accompanying comprehensive workbook/user guide with example cases. In addition, the Protocol will include default emergency planning zones (EPZs) that can be used in a similar way to the current series of nomographs.		Produce user friendly User Guides/Workbook and Tools to apply the protocol. Get users to test the Protocol before full implementation. (Note the EUB is no longer planning to develop a nomograph or screening hazard analysis. Having multiple levels (screening and refined) of hazard analysis raised confusion with several stakeholders. Also, there was disagreement related to the conservatism that would be necessary to simplify the analysis. This additional conservatism would lead to two sets of values for the two approaches, and may lead to further confusion. Instead, the EUB will have one standard Hazard Analysis protocol. Rather than developing a second, simplified tool, the effort will be focused on making this analysis tool more user friendly through automation and user guides.)	×
19	Hazard Analysis	Overall the protocol is well written. It distinguishes between well and pipeline releases by assuming a steady-state 3-hour release duration for the former and a method to calculate the rate and duration for the latter. A spreadsheet approach is proposed to obtain the release rate for pipe or well releases by specifying the upstream stagnant conditions. Publicly available dispersion models are recommended, but other models are not excluded. It appears that for dense gas, a "modified" version of SLAB is recommended and for buoyant or neutral gas dispersion, the US EPA ISCST3 is recommended.	To clarify, for unignited H_2S releases, a modified version of SLAB is proposed. For ignited SO_2 releases, the U.S. EPA models identified in the Draft Protocol are acceptable.			×
20	Hazard Analysis	The issue of dispersion modeling of un-ignited H_2S releases in complex terrain has not been suitably addressed. The impact of complex terrain must be acknowledged and addressed.	For screening purposes, the assumption of "parallel airflow" is considered to be adequate for releases of H_2S with little or no plume rise, i.e., ground-based. The complex terrain criterion for ground-based, un-ignited H_2S releases is the effective stack height of near zero. All elevated terrain would therefore be complex. The U.S. EPA simple elevated terrain approach is the same as the parallel airflow approach for ground based releases.			×

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21	ERP/EPZ	Alternate approaches to the Screening Hazard Analysis to refine an EPZ must be considered when the surrounding terrain elevations exceed the complex terrain criteria.	For screening purposes, the assumption of "parallel airflow" is considered to be adequate for releases of H_2S with little or no plume rise, i.e., ground-based. The complex terrain criterion for ground-based, un-ignited H_2S releases is the effective stack height of near zero. All elevated terrain would therefore be complex. The U.S. EPA simple elevated terrain approach is the same as the parallel airflow approach for ground based releases. The Protocol addresses complex terrain and ignited SO_2 releases using models that meet the Alberta Air Quality Model Guidelines.			×
22	Hazard Analysis	The protocol discusses a "modified" version of SLAB to handle the transient nature of pipeline releases, but on page 17 refers to a method to approximate the transient release rate with an equivalent "mass consistent" steady state release for dispersion model.	To clarify, a modified version of SLAB will be made available. However, the modifications are not for the purpose of addressing the transient release; the modifications address other subjects. The approximation of the transient pipeline release from a steady state release will be addressed by a separate methodology, which will also be provided.			×
23	Hazard Analysis	The protocol includes an equivalent time of 15 minutes for toxic load estimation to compare steady state and transient releases. There appears to be no justification for choosing the 15-minute duration and refer the method of calculating the toxic load to latter times. The protocol also proposes to consider a factor of two concentration above the predicted concentration for toxic load calculations. This may not be the best approach. The protocol should give consideration to the manipulation of the averaging time to prevent the smearing of the peak concentration to obtain the "pockets" of high concentration.	The purpose of the 15-minute reference time proposed in the protocol is to allow comparison of exposures to H_2S from steady and transient releases, based on the equivalent toxic load. This is not intended to imply that the exposure is only 15 minutes long. Justification is not provided for the reference exposure time, as it is arbitrary; the reference time may be adjusted based on the health effects study. For calculating toxic load, the exposure time, not the reference time, will be used. The protocol accounts for concentration fluctuations rather than just using average concentration predictions. This addresses the "pockets" of high concentration that could otherwise be "smeared" by averaging. The fluctuated toxic load accounts for concentration fluctuations from the average concentration. We then calculate a steady concentration over the reference time that yields the same toxic load.			×
24	Assumptions	The jet expansion regions for toxic and combustion plane are not following the "norm" in literature. What we see usually for jet expansion are two regions. Immediately above the source, is a region of flow establishment in which the intense shear between the jet and the ambient flow results in air entrainment and deceleration of the flow. At the end of this region, a Gaussian profile is established in the flow. The second region is the region of established flow. In this region, the velocity and concentration profile have a definite Gaussian shape. The position of the combustion plane in the EUB report cannot be justified.	The jet expansion region follows the GASCON2 model approach the EUB developed (see ERCB 90-B report series). The E, Q, D and R planes are calculation planes based on the conservation equations. At the R-plane, the release is fully expanded and travelling at near sonic velocities. These conditions are input to SLAB which accounts for the air entrainment due to the intense shear between the jet and the ambient air (your region 1), and the established flow zone where passive dispersion due to ambient turbulence occurs (your region 2). SLAB uses a Gaussian concentration profile to predict ground level concentrations. The position of the C plane is based on the U.S. EPA approach for flares and is considered adequate for SO_2 dispersion modelling (it may not be suitable for thermal radiation modelling from the jet fire).			✓
25	Assumptions	We were unable to identify a reference in the protocol to account for changes in surface roughness.	The protocol will use a constant surface roughness value. The value has not been selected yet.			×
26	ERP/EPZ	While other models than those listed are not excluded, the EUB should consider a stance similar to the EPA, where both public domain and private sector models that meet protocol criteria are listed in addition to the public domain methods. Provisions should be made for submission of model criteria to the EUB, up to and including full working copies and model documentation for evaluation. This would identify and improve the adoption of	The protocol is being revised to address some of your concerns regarding Alternative Hazard Analysis submitted for review and approval by the EUB. At this time we propose the following. The EUB Hazard Analysis is a prerequisite for undertaking an alternative hazard analysis and must be submitted every time; this will be required for benchmarking purposes. An alternative hazard analysis is defined as either using the EUB hazard analysis spreadsheet but with different assumptions from the			×

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		hazard analysis and emergency response tools by operators that could facilitate and streamline the determination of EPZ's and improve quality decision making when incidents occur.	base cases, or a hazard analysis using different methodology and computer models. The alternative hazard analysis must: • Be undertaken by suitably qualified and experienced persons. • Reproduce the relevant base case defined in the EUB Hazard Analysis for comparison. • As a minimum include the features of the EUB hazard analysis (pipeline ESD valve closure parameters and extra mass in adjacent segments, real gas effects on release properties input to dispersion model, concentration fluctuations and toxic load, and indoor concentrations). • Include justification of the methodology and models used. Documentation must clearly state the methods and assumptions in sufficient detail that a third party could duplicate the numerical results. Models must be fit for purpose. • Detailed description as to why an alternative modelling approach was undertaken. • Differences in the assumptions from the mandatory EUB hazard analysis must be presented and a discussion of any differences in the results. • Be submitted to the EUB in a timely manner for review with the completed form *Declaration of Compliance with Hazard Analysis Protocol*.			
27	Assumptions	The application of ignition factors in the risk assessments needs to be included. At the present time, the default assumptions about immediate ignition have not been substantiated in practice. There has never been a well-blow out ignited immediately, or within 10 minutes. The fastest ignition time that we know of is 4 hours. This has been a point of argument in hearings.	Currently the Draft Protocol does include ignition factors. The chance of *non*-ignition is assumed to be 100 percent (i.e. chance of ignition is zero, as it is assumed that no attempts to ignite are being made) for the first 15 minutes. This 15-minute period represents what we consider to be an appropriate assumption *(for a risk analysis)* of the time required before the first ignition attempt is made. After 15 minutes, the probability of non-ignition is 1 percent. For *Emergency Planning Zone* determination however, a continuous un-ignited release is assumed as the base case. Ignition timing may be considered as a mitigative measure in Emergency Response Planning.			×
28	Hazard Analysis	It is understood that the GASCON2 model is appropriate for sour gases with a composition that is similar in composition for which the model was tested, i.e., gases without the heavier ends. For gases with heavy ends, if the front expansion of the gas calculations are done outside of the GASCON2 model, and then plugged into the GASCON2 model, very similar dispersion results are obtained with GASCON2 and SLAB.	The passive dispersion modules of GASCON2 were tested during the Field Measurement Program using air. The source modules were not tested. The integral plume rise modules employed by SLAB and GASCON2 are similar. However, the EUB has also found the GASCON2 model to be limited in its ability to handle some of the non-ideal realities that may complicate a vapour/aerosol release. We feel this can be a significant issue in some cases. The inputs to GASCON2 can be "faked' to obtain similar results as SLAB but this is not the approach the EUB has adopted.			×
29	Hazard Analysis	In general, the inclusion of concentration fluctuations is a very important addition to the risk assessment process and should be maintained. In addition, the Wilson (ERCB 1990 volume 7) paper should be considered. However, some explanation should be provided for the inclusion of the lethality function. For the purposes of emergency response planning the function does not have application - for example - currently the 100 ppm, 20 ppm, and 1 ppm H_2S isopleths are used	We agree that the inclusion of concentration fluctuations is an important addition to the process. We believe that including this concept is a significant step toward capturing the latest scientific knowledge. You recommended that the Wilson paper (ERCB 1990 Volume 7) be considered. Dr. Wilson is providing technical advice on the development of this protocol and we are confident this will capture not only his previous work but also his subsequent work on concentration fluctuations.			×

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		for emergency response planning. For predicting and protecting people from lethality, the 100 ppm H_2S isopleth should be used. If an accurate prediction of lethality is required, then the triple-shifted Rijnmond seems appropriate. However, there exists serious disagreement about its actual meaning as the meaning of the probit was changed from the ERCB 1990 reports and in some places of the 1994 advisory committee report (note not in all places). In ERCB 1990 Dr. Rogers said it was an "accurate predictor of lethality", whereas in 1994 technical document contradicts this statement without any re-analysis of the data and suggests further that it also covers irreversible health effects without any technical analysis. This discrepancy has been the basis for heated debates in hearings. In the Canadian 88 hearing Dr. Rogers testified that he does not have any information to contradict the ERCB 1990 data. However, the Board decision did not support the triple-shifted Rijnmond rather it stated the threshold for lethality is 500 ppm H_2S. How has this discrepancy been resolved?	The lethality function is used only for the risk analysis. For emergency response planning, the results from Recommendation #9 (health effects information) will likely affect the endpoints for the planning zone determination. Your recommendation of a 100-ppm H_2S isopleth for predicting and protecting people from lethality is noted, as is your support of the triple-shifted Rijnmond probit parameters. You also identified the need to clarify the meaning of the triple-shifted Rijnmond probit parameters. For the purposes of the Draft Protocol, the triple-shifted Rijnmond probit parameters are used as an indicator of lethality. Your final point in this section was that Board Decision 99-16 (Canadian 88 Lochend, Application 970473) did not support the triple-shifted Rijnmond probit parameters and instead supported a lethality threshold of 500 ppm for H_2S. We disagree with this point. The Board did approve Application 970473 and we can only infer that based on this approval you believe that the Board supports the 500 ppm threshold presented by the applicant and does not support the triple-shifted Rijnmond Probit Parameter put forward by the intervener. Allow us to highlight the following excerpts from Decision 99-16: "Given the work that has been done in Alberta to date, the Board believes that a probit approach with triple-shifted Rijnmond parameters is helpful in evaluating risk from sour facilities." "The Board notes that the lethal threshold of 500 ppm of H_2S presents different results to those using the triple-shifted Rijnmond parameters. The Board also notes that Cdn 88 had redone the SLAB risk assessments using a triple-shifted probit parameter approach. Although the Board observes that this approach presents a somewhat higher risk, it does not alter the conclusion that the facility can be operated safely." In other words, the Board supports the use of the triple-shifted Rijnmond parameters. In the case of Decision 99-16, the risk presented by the facility was considered acceptable based on either approach.			
30	Hazard Analysis	There should be a calculation of both the average downwind concentrations of H_2S and SO_2 but also some estimate of the distance for the initial release of gas during well blow-outs or pipe-line breaks. It is understood based on information provided to the technical committee that the initial release can result in high concentrations at significant distances from the release in very short time frames. These calculations are necessary for understanding the emergency response time required and the ability to actually respond to an incident.	For pipelines, the Draft Protocol captures the transient nature of a release, thus the initial high concentrations are determined. For wells, the Draft Protocol adopts the CAPP H_2S Release Rate Guidelines that provide a constant steady release; transient behaviour is not modelled. The EUB will investigate the significance of the transient approach and the feasibility of including this approach in the Draft Protocol. With respect to the time frame in which these concentrations can occur, the release is carried by the wind speed so the time to a downwind distance can be calculated. The minimum evacuation time will be provided in the spreadsheet.		EUB to investigate the significance of the transient approach for initial release from wells and the feasibility of including this approach in the Draft Protocol.	×
31	Hazard Analysis	In section 4.5.4, the calculation of indoor concentrations based on a leaky home is valuable for determining if sheltering will be affective safety measure. However, the leaky home does not accumulate as much gas as a tight home. The calculation for a tight home should be part of the risk assessment process. The main reason for doing this calculation is determining the concentrations of gas in a home and the length of time the sour	We disagree with your position that a "leaky house" does not accumulate as much gas as a "tight house". First, either building would have lower concentrations indoor than those experienced outdoor while the release is passing by. The leaky building would reach higher indoor concentrations than the tight building during a temporary release. In fact, if a building were absolutely tight (i.e. infiltration equals zero), no H_2S would enter the building and the indoor concentration of H_2S would be zero.			×

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		gas may remain in a home after an incident. Providing some information on the gas entrained in a home will be useful for advising people when returning to their homes after evacuation. We suggest a triangular distribution of 0.1, 0.5, and 1.0 be used rather than just 1.0 or 0.5.	Although a building with less infiltration (i.e. tight) would see a slower decline in indoor concentrations after plume has passed, the tighter building would still not reach as high of an indoor concentration as the leaky building to begin with. Simply, the "leakiness" that lets the concentrations in also lets the concentrations out after the plume has passed. We feel that we are considering the worst case by considering a "leaky house". We will consider predicting how long it takes for H_2S levels to decline in order to determine when it is safe to return to the homes.			
32	Hazard Analysis	There should be an explicit discussion on the dispersion coefficients that are going to be used. This has been a point of argument in the hearings.	The selection of "regulatory" dispersion coefficients is an issue we are currently considering. This topic has been identified for further discussion at the technical workshop in June. The intent of this discussion will be either to select the "regulatory" dispersion coefficients, or determine a methodology by which they will be determined. The resulting coefficients will be incorporated into the protocol and will be accompanied by a discussion of how they were selected.			✓
33	ERP/EPZ	For H2S ignited releases, the health risks associated with polycyclic aromatic hydrocarbons should also be included as well as SO_2 health risks. There is a substantial literature discussing carcinogenic impacts from "one time exposures" (Calabrese EJ and Blain RB. The single exposure carcinogenic database: assessing the circumstances under which a single exposure to a carcinogen can cause cancer. Toxicol Sci. 1999; 50:169-185). There are approximately 209 studies of such incidents for PAHs. A complex mixture reference dose for PAHs that compares very well with the Strosher data is the Ontario Ministry report (Mueller PM. Scientific Criteria Document for multimedia standards development for PAHs. Part 1. Hazard Identification and Dose Response. Ministry of Environment and Energy, Ontario, February 1997). This document was used for the Shell Ferrier well by Cantox and David Thompson Health Region to assess the risks.	Currently, the intent of the protocol is to address the acute impacts to public safety (i.e. fatality) from H_2S (unignited release) and SO_2 (ignited release). Your recommended references are noted should the EUB decide to address health risks in this protocol.			×
34	Risk Analysis	The societal risk has not been included. This is necessary for determining if the hazards are manageable. Societal risk is the total number of people involved in a particular incident. This is particularly relevant for sour gas assessment near densely populated areas.	We agree with your comments and will be including societal risk estimates in the revised risk protocol.			×
35	Utilization	The specific reason and purpose of the modelling exercise should be clearly spelled out, i.e., a technical basis for emergency response planning, hazard analysis of particular applications and probability assessment. This should be clearly separated from acceptability of particular applications. The discussion of risk acceptability is not comprehensive and what is present in the document is a simple technical conception. In the risk management section, there is no discussion of risk acceptability from a health perspective or from the public perspective; there are no clear "community-used risk thresholds". In the objective section (2.2) it is assumed that lethality should be the basis for land-use planning; this assumption has not been accepted by stake-holders. The document would be much stronger if it did not stray into areas that are not the actual focus, i.e., a protocol for the technical evaluation of sour gas facilities.	You identify the need for a greater explanation of the purpose of the modelling exercise. We will review the Draft Protocol and consider whether improvements could be made to subsequent drafts. Some explanation of the objective is contained in Section 2.2 of the Draft Protocol. We would welcome any more specific feedback you are able to provide. The Draft Protocol on Risk Analysis states that the process of risk assessment and the topic of risk acceptability are not within the scope of the protocol. Currently we are focusing on developing credible methodologies for calculating hazard distances and quantifying risk. The analysis of hazard and the quantification of risk can be approached objectively in a mathematical manner whereas risk acceptability can be more subjective. Risk acceptability will need to be considered in		EUB to review document and consider improvements on explanation of purpose.	×

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			Recommendations that will follow the development of this protocol. For example, Recommendation #52 seeks to review current criteria for sour gas setbacks. As part of this review, the EUB will need to explore risk thresholds.			
36	Hazard Analysis	It is puzzling as to why the GASCON2 model is no longer supported by the EUB. Rather the EUB appears to favour the SLAB model. It is believed that in disowning the GASCON2 model the EUB may be in danger of "tossing the baby out with the wash water".	The EUB acknowledge that the GASCON2 model contains some excellent components, some of which are not available in other models. However, the EUB has also found the model to be limited in its ability to handle some of the real gas effects that may complicate a vapour/aerosol release. We feel this can be a significant issue in some cases. In searching for a model, we have found no single model to contain all of the elements we desire. We considered modifying GASCON2 to include the real gas effects and the evaporation of liquids, and to better estimate the rise, but have chosen to modify SLAB instead. We consider the SLAB model's ability to deal with liquids and dense gas effects to be superior to and more robust than the perfect-gas assumptions of GASCON2. We recognise that the SLAB model also has some limitations that we will address. Our desire is to capture the strengths of each model into a new protocol while tailoring the approach to our expected applications. Many of the concepts from GASCON2 such as concentration fluctuations, indoor concentrations, double exponential pipeline blowdown and additional mass due to emergency shutdown valve closure time are planned as part of the new protocol. In addition, SLAB will be modified to include plume rise limitations similar to the ISC3 model. Another consideration is that the EUB is also responsible for other facilities such as high vapour pressure pipelines and acid gas injection lines. These facilities have the potential to release dense mixtures containing a large fraction of liquids. By using SLAB we hope to have a consistent regulatory model that uses the same assumptions o assess the hazards.			×
37	Hazard Analysis	It is noted firstly that the integral plume rise modules employed in SLAB and GASCON2 are similar. Both may be used to assess the plume rise behaviour of heavier-than-air gases. The GASCON2 model however should not be employed to evaluate the behaviour of a gas (or gas + aerosol mixture) if it is appreciably heavier than air following the plume rise stage. This caveat however may be of little practical importance. Experience has shown that the dilution of gases (or gases + aerosols) exiting from well blowouts, which occurs as a result of decompression to atmospheric pressure and the entrainment accompanying high exit velocities, is very appreciable. The dilution is such that gases which may exit well orifices in a heavier-than-air state tend to be neutrally or even positively buoyant following termination of the self-entrainment process. It appears for this reason that for all practical purposes the GASCON2 model should be applicable to the assessment of most sour gas well blowout in Alberta. If this is indeed the case then the GASCON2 model has a distinct advantage over the SLAB model insofar as it allows for the incorporation of site specific plume dispersion parameters. The SLAB model, in	The GASCON2 model does allow the use of site-specific plume dispersion parameters whereas SLAB does not. Standardized regulatory screening dispersion parameters provide the consistency required for approval purposes. The SLAB parameters are similar to the USEPA default parameters, thus similar levels of dispersion turbulence will be used to assess ignited (modelled using ISC3 etc) and un-ignited releases (modelled using SLAB). Regardless, the EUB will have a process for considering alternate approaches. The EUB believes that the door must be left open for alternative approaches and valid scientific arguments to be brought forward. The issue of what alternatives there are to the standard screening parameters is an example of the topics we hope to discuss at the June 20th and 21st Workshop.			✓

#	Topic	Comment	EUB Response	Follow-up	Action	WS
		contrast uses dispersion parameters obtained as the result of pioneer work performed by F. Pasquill some 40 years ago in Porton England. Pasquill recommended that these values be employed only as a last resort. This should not currently be necessary given the appreciable advances made in the understanding of atmospheric physics over the last four decades.				
38	Hazard Analysis	The issue of atmospheric plume dispersion is of importance because downwind distances to the 20 and 100 ppm H2S isopleths associated with blowouts from large critical sour gas wells are usually predicted to be in the order of 5 to 10 km. Predictions of these downwind distances for a given H2S discharge, which are important to the definition of EPZs, are much more sensitive to assumed dispersion parameters than to the characteristics of the exiting source fluid.	The EUB agrees that the dispersion parameters assumed have a significant influence on concentration predictions. The EUB also sees value in more accurately modelling the characteristics of the exiting source fluid. We are responsible for protecting the public near the facilities where the characteristics of the exiting source fluid are important and further away where the assumed dispersion parameters are important. Using the SLAB model with default, regulatory dispersion parameters allows us to provide a 'conservative worst-case' estimate of the hazard footprint.			✓
39	Assumptions	p5. par 2. Will further mathematical details be given regarding uncertainty or is p33 the complete uncertainty analysis? Will a Monte Carlo analysis be performed in order to determine the level of uncertainty and to assess the sensitivity of the contribution of each variable?	No additional details will be provided regarding uncertainty. Testing will be done to identify the sensitivities, but a Monte Carlo study is not proposed.			×
40	Assumptions	p8. par 7. Who would be making the assumptions in the mathematical models - have these assumptions already been made in the development of the spreadsheet or will individual modellers be making them?	The assumptions made are clearly stated in the Protocol.			×
41	Hazard Analysis	p20. par 5. In light of the current lack of endorsement of the results of the GASCON2 model will there be an option for previous EUB decision to be revisited?	Past decisions will not be reviewed as many other factors besides GASCON2 predictions were considered. It is also worth noting that many of the concepts presented in the GASCON2 model are included in this protocol.			×
42	Hazard Analysis	p21. par 5. How will precipitation and surface entrainment of contaminant by vegetation in heavily treed areas be included in the SLAB model?	Precipitation and surface entrainment are not accounted for. This assumption will err on the conservative (safe) side because it will maximize the prediction of the airborne contaminant. The assumption will also simplify the modelling process and required inputs.			×
43	Hazard Analysis	p22. par 1. In the initial calculation do all cases utilize the same meteorological conditions with the site or region specific conditions being included in the hazard and risk analyses?	The EPZ, hazard and risk analysis will all be based on a standardized set of dispersion conditions.			×
44	Hazard Analysis	p22. par 3. Can the average concentrations generated through dispersion models be modified using uncertainty factors in order to give a potential maximum concentration?	Model predictions are adjusted based on averaging time but we are using a more rigorous approach.			×
45	Hazard Analysis	p27. par 4. Can the factor of 4.6 between average toxic load and average concentration be integrated into any documentation for maximum exposure to explain to affected residents peaks in concentration and differences in modeled gas dispersions?	Documentation of the how the average toxic load calculation captures the peak concentration will be provided.			×
46	ERP/EPZ	p4. par7. Is the triple shifted Rijmond data still the best method for the calculation of population vulnerability after the recent re-evaluation of the data?	Please clarify which re-evaluation of the data are you referring to. This task is not within the scope of Recommendation #9.			×
47	ERP/EPZ	p2. Is it correct that all previous EPZ calculation equations (ID97-6) and nomographs (ID2001-5) have been discarded?	The current EUB approach for EPZ calculations and nomographs (ID97-6, ID 2001-5) is still in effect. This will be replaced with the protocol approach, once it is implemented.			×
48	ERP/EPZ	p2. (also p4. par 3) What is the status of the Health Effects study (#9)? How will the data generated affect the EPZ calculations or will the basis of the EPZ calculations be so conservative that only drastic findings, of acute (not chronic) harm at low levels, would change the methodology?	The Health Effects study will provide summaries of the effects at various levels of exposure. This data will be used to select endpoints for Emergency Response Planning. The Protocol provides a realistic approach to modelling the dispersion of the release and is independent of the endpoint. The resulting EPZ will be strongly dependent on the			×

#	Topic	Comment	EUB Response	Follow-up	Action	WS
			selected endpoints.			
49	ERP/EPZ	p8. par 5. This states that the EPZ could be calculate within several hours while on p1. it is indicated that the EPZ could be derived in about an hour - are these the same process?	Yes they are the same process. We have eliminated the nomograph EPZ and our goal is to determine the EPZ using the hazard analysis protocol in about an hour.			×
50	ERP/EPZ	p10. par 8. Is the investigation of chronic health risks a later part of Recommendation #9? If not has this area been given an option for further study? This is very often identified as a huge issue at public meetings where resident understand that they will be evacuated during an acute H2S exposure but the low level exposures on a daily basis may become background air contamination.	Recommendation #9 is investigating the effects of H2S at concentrations from 1 to 100 ppm. The endpoint selected for the Emergency Planning Zone will be determined as part of Recommendation #58.			×
51	ERP/EPZ	p13. par 1. If the screening hazard analysis is for effective EPZ planning, how does the previous calculation of the EPZ prior to the screening hazard analysis fit?	The nomograph EPZ calculation has been eliminated from the process. The EUB has found that given the many inputs being considered in the Protocol, it is not reasonable to simplify the relationships into a single nomograph. Instead, there will be one spreadsheet-based tool (EUB Hazard Analysis) for performing calculations. Efforts will be made to simplify the use of this tool, in place of a simple nomograph. The goal is to obtain more exact estimates for EPZs while still having a user-friendly tool.			×
52	ERP/EPZ	p13. Table 4.1 Output 2. This is difficult to understand as it appears to be a circular statement.	The statement is not intended to be circular. To clarify, this protocol will calculate distances to concentrations. As part of Recommendation #58, a threshold concentration will be determined for defining an EPZ. The Protocol will then be used to calculate the distance to this concentration. This distance would form the EPZ.			×
53	ERP/EPZ	p14. par 6. How do seasonal /temporal population distributions affect the "incidents with the greatest potential effects"? Are combined or conditional probabilities used?	The population distribution does not affect the incident with the greatest potential effect, as the area is assumed to be occupied by the public.			×
54	ERP/EPZ	p17. par 3. Are the selected incident mentioned those base cases, which will be utilized in the determination of the initial EPZs?	This section on initial behaviour of releases applies to all incidents modelled.			×
55	ERP/EPZ	p32. par 6. While the completion of an alternate risk analysis will obviously require seasoned judgment and experience can a risk assessment neophyte expect to be able to follow through the spreadsheets for the EPZ, the hazard screening and the risk analysis in order to generate meaningful results?	Our goal is to automate the Hazard Analysis so that an emergency response planner can do determine the EPZ. The risk calculations will require more understanding of the calculations in order to generate meaningful results.			×
56	Assumptions	p3. par 4.(also p16 par 4. and p19 par 3.) Will a spreadsheet or a calculation for the isenthalpic expansion be included in the TA? Details of its inclusion are not consistent throughout the document.	The Technical Appendix will provide documentation on how the program does the isenthalpic expansion. The calculations will be done in a separate program with inputs generated by the spreadsheet. All programs and spreadsheets will be provided.			×
57	Assumptions	p18. par 4. Will the isenthalpic calculation provide a realistic model of the sour fluid releases?	Yes, we believe that an isenthalpic expansion is a reasonable way to characterize a release for input to the dispersion model.			×
58	Risk Analysis	p4. par 8. (also p8. par 1.) Will the release frequencies be a stand alone document or will subscription to the EUB EIS system be required in order to access this information?	The release frequencies will be a stand-alone document available on the EUB website.			×
59	Risk Analysis	p10. par 4. Are the event trees that are mentioned different from those included in ERCB report 90-B or can the same (or similar) trees be utilized?	The fault trees will be similar to those in the ERCB 90-B report.			×
60	Risk Analysis	p28. par 1. Will frequencies be updated on an annual basis and reviewed for trends to indicated better equipment, monitoring or reduced failure frequencies or will historical data be included in order to err on the side of being conservative with the thought that years of lower failures will dilute the effect of historically higher failure rates?	Release frequencies are reviewed regularly by the EUB. Since so few releases occur, the average rate must be used.			×
61	Hazard	p4. par 6. Are these "specialized computer models that are	Since the specialized computer models that have been used to perform			×

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	Analysis	proprietary which have been used to perform the risk calculations" then included in the TA spreadsheet?	the risk calculations are proprietary, we can not include them. However the approach will be defined in the Technical Appendix and implemented in the spreadsheet (which are not proprietary)			
62	Hazard Analysis	p23. par 5. Will the mathematics behind the toxic load calculation be available or will the contents of the spreadsheet be proprietary?	The toxic load calculations will be made available. The contents of the spreadsheet will not be proprietary.			×
63	Risk Analysis	p1. par 6. What risk thresholds are used now, are they occupational levels or historical evacuation levels or 20 ppm and will their values be included in the Technical Appendix (TA) or could they be summarized in the body of the text for completeness?	Risk thresholds are not within the scope of this project and will be reviewed as part of recommendation #52.			×
64	Risk Analysis	p6. par 6. Are the Alberta Environment models referenced also probabilistic risk assessment models?	The Alberta Environment models are not probabilistic risk assessment models.			×
65	Risk Analysis	p10. par 1. The definition of risk also requires a time element.	You are correct. Public safety risks are expressed as chances of fatality per year, while public health risks are on a lifetime basis.			×
66	Risk Analysis	p10. par 7. Is too much risk ever an option?	Risk thresholds and risk acceptability are not within the scope of this project. The Protocol will only define a methodology for calculating risk; criteria for risk acceptance will need to be considered in other Recommendations. The EUB must balance the risk-cost-benefit issues.			×
67	Risk Analysis	p12. How does this diagram fit with the previous diagrams and documentation? Risk Analysis is not mentioned in Fig 3.1? Could you further differentiate between risk analysis and risk estimation?	Figure 3.2 shows the risk analysis portion (consisting of hazard identification, consequence analysis, frequency analysis and risk estimation) of the risk management process shown in Figure 3.1. Risk analysis is the overall process of determining the risk. The output is the risk determined by combining the consequence, frequency and receptor information in the risk estimation step.			×
68	Utilization	It is understood that a proponent would determine an EPZ from a generic calculation and if that was acceptable to them then no further calculations would be required; if however the proponent wanted a reduced EPZ from the calculation then the Screening Hazard Analysis would be undertaken. The purpose of the hazard analysis is to generate specific details regarding the dispersion of the gas and to provide a basis of discussion for reduction of the EPZ. The Screening Risk Analysis would then be completed if further details were required to substantiate the reduced EPZ argument by documenting the lethality and consequences of the dispersion as generated in the hazard analysis. The option to complete an alternate risk analysis is also available for further substantiation of the reduced EPZ as long as the EUB requirements have been completed.	The draft protocol uses the term refined EPZ, not reduced EPZ. The refined EPZ term has now been eliminated from the process as the nomograph EPZ is no longer provided and there are not multiple levels of analysis. Now, only the EUB Hazard Analysis will be provided. Reduced EPZ calculations will follow the protocol but with variations on the inputs such as a 15 minute source duration due to ignition.			×
69	Assumptions	The draft protocol presents a new approach to modeling jet expansion, discussed in section 4.4.1. By this approach, the conditions at the E, Q, D, and C planes are calculated assuming ideal gas behaviour (as is done in GASCON2) and real fluid effects are considered through the introduction of a new fluid plane (the so-called R-plane). It is not understood why this new R-plane is required. It seems that the most physically realistic approach is to simply evaluate the fluid conditions at the various fluid planes using a real fluid equation of state, such as the Peng-Robinson equation. It is suggested that this should be the approach adopted by the new protocol. The new protocol asserts that no air entrainment occurs until the fluid decelerates to the surrounding wind speed at the R-plane. This does not appear to me to be a realistic assumption.	We understand that the conservation equations could be set-up using the Peng-Robinson equation of state, but that an iterative solution is required and a program is not publicly available. Perhaps you can provide us more information on this subject. Ideal gas behaviour allows us to simply estimate the velocities at the E, Q and D plane. At the R plane, the release is travelling at the same velocity as the D plane, and the real gas properties based on an isenthalpic expansion are assigned to correct for the ideal gas assumptions up to this point. An isenthalpic expansion from the initial low velocity conditions results in no kinetic energy (a velocity of zero) at the R plane, yet the release is assigned the near sonic velocity at the R plane. Although it appears that the release is given extra kinetic energy at the R plane, the SLAB model (as do most other integral plume rise models) does not account for kinetic energy in the solution of the conservation equations. Hence, the inputs to the dispersion model conserve mass, momentum and			✓

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			energy from initial to final conditions. I agree that assuming no air entrainment occurs until the fluid decelerates to the surrounding wind speed at the R plane is not realistic. As discussed above, however, the fluid at the R plane is assigned the near sonic velocity of the D plane, not the wind speed. The SLAB dispersion model then allows for the very significant jet entrainment of air that occurs while the fluid decelerates to the surrounding wind speed and the subsequent dispersion due to atmospheric turbulence.			
70	Hazard Analysis	The other step that this protocol deals with is the dispersion model. There are many models that reasonably predict the concentration of the gas at a particular distance from the release based upon the release conditions. We need to pick one and stick with it. Changing these models does not significantly change the real level of risk to a member of the public. If there are flaws in particular models, they are usually accounted for by being conservative in other ways, or safety factors applied after the calculations are all done. Improving the models will probably not improve the credibility of the process, as experts in all fields will continue to debate the factors influencing the flow of the released gas. There are too many variables and combinations of them to make an all inclusive/perfect dispersion model. Risk would not be reduced from what we perceive it to be, by having this model. Pick a model, use it, and upgrade it as reality proves that it needs to be changed. Everyone must use the same model when making an energy development application so that projects can at least be compared on a relative basis. With the mortality concentration established and a dispersion modelling process chosen we can now conclude our consequence analysis by calculating the hazard zone(s), also known as Emergency Planning Zone, and Emergency Awareness Zone, and Public Awareness / Impact Zone(s). Melding this with frequency / probability estimations of failure, we can now come up with a level of risk. Determination as to whether or not this is a tolerable risk is strictly a personal choice. It can become a collective standard by developing a simple risk matrix process that all stakeholders have input to. What we are dealing with is a hazard with potential to cause extreme consequences, at extremely low probability. (It is the nuclear power plant phenomena. An extremely safe operation, thus a low probability of failure, but extreme consequence if failure occurs) The process suggested in this protocol is far too academic. Doing more detailed calculations does not effectively reduce the risk to the surrounding public. We need a simple process that anyone with a good understanding of risk and a high level of understanding of the operations to be conducted and knowledge of the area and people in which the project is being built. If the current 20ppm isopleth is not valid, then change it. There is no value in performing a forensic risk assessment process, as it will not impact the level of risk to the public.	You emphasize the need for the EUB to "pick a (dispersion) model, use it, and upgrade it as reality proves that it needs to be changed. Everyone must use the same model when making an energy development application so that projects can at least be compared on a relative basis". We support your position; this is why we are developing the protocol. The EUB has searched for a single model that it considers to be applicable to the many applications we consider. We have found a few models that contain elements we find attractive for creating a realistic simulation of the phenomena that occur following a release. No single model contained all of the characteristics and abilities we seek, thus we are at the stage of "upgrade it as reality proves that it needs to be changed". The final protocol will combine the strengths of several models into one tool. As emphasized in your comments, everyone would be required to use the same model. This would provide consistency and the ability to compare project applications on a relative basis. The EUB acknowledges that it is taking a very academic approach to developing the new protocol for hazard and risk analysis. We believe that this will lead to more accurate and appropriate emergency planning zones, and will raise the understanding of how various factors (gas composition, temperature, pressure, ESD valve settings, etc.) affect the extent of the possible hazard. The Protocol does not deal with assessing the acceptability of the risk. Risk assessment will be considered in Recommendation #52 as part of the criteria for determining sour gas setbacks. You recommend that if the current isopleths are not valid, then change them. This will be investigated as part of recommendation #58 using the health effects information from Recommendation #9. The EUB believes that this detailed academic approach and the resulting hazard analysis tool will play a part in making a better determination of isopleths and assessing the EPZ criteria.			×

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		A different model for calculating dispersion and thus the EPZ is probably OK. The 20ppm isopleth for public safety is also probably OK, as acute effects (except for sensitives) usually don't start until 100ppm. Thus there is already a factor of 5 built into the process. Performing a highly technical risk assessment is of little value, as we are mostly dealing with perceived risk.				
71	Hazard Analysis	The document could be simplified by sorting out its components. Hazard identification is not a problem, as H2S and SO2 are the known hazards. Hazard analysis consists of determining how far the hazard can spread under the known physical conditions at the particular concentration that can kill humans at the 1% mortality concentration. It was thought that 0.0001% or 1 in a million was the common acceptance level for public mortality related to man made problems, not 1%. We need to agree on what concentration of H2S and SO2 would cause this phenomenon. Is it the 100ppm isopleth, the 200ppm isopleth, or 50ppm isopleth.	You identify an apparent inconsistency between a 1% mortality concentration and 0.0001% or 1 in a million probability of public mortality. To address the inconsistency you have highlighted, it should be noted that these are two different concepts that cannot be compared directly. A 1% mortality concentration would refer to a *concentration* of a substance at which 1% of the population would be fatally affected. This concentration level is independent of how likely an accident is to occur. A 0.0001% *probability* of public mortality would be the probability of mortality due to variables such as frequency of an accident, meteorological conditions, wind direction, distance, etc. The 0.0001% probability of mortality considers whether a fatal exposure would even occur due to probabilities of accidents, equipment failure, wind direction at the time, etc., while the 1% mortality concentration presumes that the population is already exposed to a concentration significant enough to fatally affect 1% of the population. (Note: while "1 in a million" is a common criteria for acceptable probability of public fatality in some jurisdictions, it should be pointed out that the EUB does not have a criteria for risk acceptability.) The question of what values we should be using for H_2S and SO_2 concentrations is being investigated as part of recommendations of the Provincial Advisory Committee on Public Safety and Sour Gas (Section 4.3 Health Effects, and Recommendation #9). One of the goals of this work is to update the current understanding of health effects associated with the constituents of sour gas mixtures and the combustion products of sour gas, including SO_2. The intent is for this latest understanding of the health effects to be incorporated into a review of the approach for determining Emergency Planning Zones (Recommendation #58). While this update of health effects data is being completed, the methodologies for modelling hazard and risk can be developed. The health effects data (i.e. H_2S and SO_2 criteria concentrations) can then be incorporated once they are available.			×
72	Hazard Analysis	The term Screening Hazard Analysis is used. This would apply that certain things are screened out. In this case there is nothing screened out, there is an H2S release and we are just trying to determine how far the hazard at the concentration threshold will spread. Drop the term "screening" from the language.	You expressed objection to the use of the term "screening". Often in modelling, the terms "screening" and "refined" are used to describe two levels of conservatism. The Air Quality Model Guidelines published by Alberta Environment provide a definition of these two levels of assessment: *Screening assessment is utilized to determine a specific event or the likelihood of a specific event (e.g., to predict the worst-case concentration)* *Refined assessment, because of its higher level of sophistication, more closely estimates actual air quality impacts.* A screening assessment may use simplifying assumptions to reduce the amount of work required. However, these simplifying assumptions must err to the conservative (i.e. protective) side. If a screening assessment predicts an acceptable result, then further modelling is not required. The end result is a hazard prediction that may be over-conservative and was		Rather than having a Screening Analysis and a Refined Analysis, the EUB will develop one standardized Hazard Analysis. This will be a requirement in all cases. This Hazard Analysis will be based on the Refined Analysis originally proposed. Often, screening analysis tools require less effort and time to use. In place of developing the simplified screening version, future efforts will be directed at automating the Hazard Analysis and making it more user friendly. The EUB believes this will result in more accurate analyses than would have been produced by the Screening	×

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			achieved with less effort than is required for a refined assessment. If the applicant has no objection to utilizing the predictions of the screening assessment, the EUB would likely not object to the over-conservative predictions. A refined assessment requires greater work to derive more exact estimates of the input variables. In doing so, it would arrive at a more exact estimate of hazard distances (isopleths) but at the cost of this greater effort. Your point that the term "screening analysis" implies that certain things are screened out is correct. In the case of modelling, a screening analysis is used to screen the scenarios that can result in acceptable concentration predictions while using conservative simplifying assumptions rather than requiring more exact values and a more demanding analysis.		Analysis. Also, it will improve the clarity of the process (one analysis instead of two) and will provide more consistent results.	
73	Risk Analysis	It begins by using a term called probabilistic risk, which appears to be redundant and confusing. There is a perfectly acceptable definition of risk (page 10) in the terms definition section, where risk is defined as a function of the consequence of a hazard getting loose, and the probability / frequency that it will get loose. The word probabilistic should be dropped from the document. Also, in the instances of sour well blowouts, the probability is so low, that it is not understood why this word would be added. It does not add to the understanding of the real risk.	You point out the redundancy of the term "probabilistic risk". You are correct. For the sake of consistency, the term "probabilistic risk" was adopted from Page 19 of the Final Report by the Provincial Advisory Committee on Public Safety and Sour Gas. We agree that probability is an inherent part of risk and we just use the term "risk" in the rest of the document.			×
74	Risk Analysis	The second last paragraph on page 33 is liked, so why do we not estimate risk on a relative basis using a risk matrix process rather than a rigorous calculation method with virtually no improvement in the resulting risk assessment.	You make a good point in your final statement regarding the use of relative risk rather than absolute risk. This approach does warrant further consideration. Our focus thus far has been to develop a methodology for producing accurate and consistent calculations, which would then be used for comparison. While this does embody some of the concept of relative risk, your point is taken and will be considered further.			×
75	Utilization	It is not abundantly clear as to what is the purpose of this document. It mixes hazard assessment with risk assessment and dispersion modelling. After reading it, it is believed that its real purpose is to determine a valid model for dispersion modelling that can be accepted by all stakeholders. Please reflect this in the title. Put risk assessment into the Emergency Management Requirements document.	You have identified that the purpose of the Draft Protocol is not clear. The EUB has decided to separate the protocols on Hazard Analysis and Risk Analysis in an attempt to better distinguish between the two processes and provide greater clarity.		EUB to separate the protocols on Hazard Analysis and Risk Analysis to improve clarity. In the interests of not extending the timelines of the project unnecessarily, work on the two protocols will continue in parallel.	×
76	Utilization	The title of the document "protocol" suggests that there would be a method to conduct a dispersion model, and a method to conduct a risk assessment. It is presumed it will be in the future developed Appendix. Both of the processes should be easily used by industry practitioners in well planning, emergency response planning, and public consultation. The science should limit itself to determining the acceptable concentrations of these gasses on the public, and as to where this concentration would exist by dispersion modelling.	We acknowledge your point that much of the detail of the protocol is not yet apparent. You are correct in presuming that much of this detail will be contained in the Technical Appendix that has not yet been released. Our intent is to provide this Technical Appendix to the interested technical parties and also make it public (most likely via the EUB website) by the end of this summer so that interested parties may review it and provide feedback. A spreadsheet-based tool will be developed from the equations in the Technical Appendix. This will help to make the process more user-friendly, thus hopefully addressing the concern you raised.			×
77	Assumptions	A source duration for an un-ignited release of three hours seems unreasonable, especially for drilling and servicing operations when the rig is manned 24 hours a day and there are several on-site ignition systems. Such an assumption will lead to overly conservative results that have the potential to unduly alarm affected residents. The protocol provides the source duration for an un-ignited H_2S release but it is unclear what averaging time should be used. In	We have had questions from yourself and others on the issue of source duration. It appears that we could have been more clear in presenting this point. As is currently the expectation, a continuous release should be assumed. While it can be argued that this scenario is unlikely, emergency response planning does not consider probability. This scenario is possible and credible, thus it should be accounted for when calculating emergency response planning zones for H_2S. Three-hour averaging times are to be used for concentration predictions as the meteorology (wind direction, velocity and stability class) is assumed to persist for 3 hours.			✓

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		Section 4.5.3 an averaging time of 3 hours is mentioned whereas in Section 4.6.1 there is a discussion of short-term 3-minute averages. Will clarification be provided regarding the required averaging times for required and additional incident outcomes?	This is considered a credible worst case and we intend to verify the validity of this assumption by comparison with Alberta meteorological data.			
78	Hazard Analysis	The concern is that the EUB GASCON2 model will no longer be acceptable because we have found that in some cases consequences predicted using the GASCON2 model are more conservative than those predicted using the SLAB model. This seems to be the case for gases with a molecular weight less than that of air that have very little liquid formation when they are flashed. In such cases, SLAB predicts very high plume rise compared to that predicted using the GASCON2 model. As a result, predicted ground-level H_2S concentrations as a function of downwind distance are much lower for the SLAB model than for the GASCON2 model.	You expressed concern about the GASCON2 model no longer being accepted. The EUB has attempted to find a model that would provide scientifically defensible results for use in the many applications we are responsible for. We have found that no single model fully meets all of our requirements although some models come close or present unique strengths. GASCON2 presents many unique features. Additional models such as SLAB or ISC3 also present components that we find appealing. Our plan is to develop an approach that combines the strengths of these various models in a way that allows application to the many facilities we regulate. While this protocol would become the standard approach, there will be a means for other approaches to be brought forward. Although our intent is to achieve standardization, the EUB does not wish to close the door on valid scientific arguments. Regarding your concern about the higher plume rises predicted by SLAB as compared to GASCON2, we too are aware of this difference and share your concern. We believe that the plume rise algorithms and limitations found in other models may be more suitable to our intended applications of the protocol and will be developing a modification for the use of SLAB in our applications. This would be made freely available, as would all of the tools we propose.			×
79	Risk Analysis	There appears to be a contradiction regarding additional incident outcomes for the production case. In Table 5.2, Additional Incident Outcomes for Screening Risk Analysis, there are two production scenarios listed with 15-minute source duration. Yet in Section 5.3.2 there is the apparently contradictory statement that, “Ignition of a producing well could be delayed for several hours so the benefits of ignition are not accounted for”. Perhaps this apparent contradiction could be clarified in the final version of the protocol.	We acknowledge the contradiction you have identified between Table 5.2 and Section 5.3.2 pertaining to ignition delay and source duration. We will specifically review those sections and correct this disagreement for subsequent drafts of the protocol.			×
80	Utilization	The proposed approach to consequence and risk assessment – using a spreadsheet to calculate model inputs, manually running SLAB for each different meteorological or other scenario, and transferring model results to a spreadsheet for post-processing – has the potential to be very cumbersome, time consuming, and prone to human error. A model that performs all of these steps, including driving the SLAB model, would be much more efficient and there would be less opportunity for human error. If the EUB does not plan on automating their risk analysis approach, will there be a process whereby consultants who do so, can have their model validated and approved such that, once approved, it can be used on all subsequent projects?	You identified the potential for the protocol to be cumbersome, time-consuming and prone to human error, given the various handling of data between components. The EUB is exploring what would be required to automate the entire process. From a regulator’s perspective, this has advantages in reducing the potential for error, providing greater consistency and resulting in a tool that is more user-friendly for stakeholders. We are exploring what the cost and time requirements would be to provide this automation. If the EUB decides against totally automating the process, it is likely that some consultants would wish to develop their own automated version. The EUB would be open to this and would need to develop a process for validation and approval.			×
81	Utilization	Regarding SLAB model results, no indication could be found of whether ground-level or above-ground concentrations are to be provided. The SLAB model will predict concentrations at ground-level, at plume centreline, and also at several user-defined elevations. Concentrations predicted above ground are usually greater than those predicted at ground level. Given that the average person is taller than 1.5 m and that individuals can be located in a building with an open window several metres above	Your point regarding the effect of height on concentration predictions is valid. The issue of what height to select for concentration predictions has not yet been discussed as part of the protocol development. In an attempt to keep the protocol simple, it is preferable to select one standard height (such as 1.5 m), although different heights may be appropriate in different scenarios. This issue could be a topic for the discussions planned for the technical workshop in June.			✓

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		ground, consideration should be made of what is the appropriate elevation to predict concentrations. For example, if the maximum building height in a rural area is two stories then concentrations could be predicted at ground-level, 1.5 m, 10 m, and plume centreline. If the plume centreline height is less than 10 m, those concentrations would be selected but if it is greater than 10 m, the maximum of the concentrations predicted at different elevations would be selected.				
82	Utilization	Required outputs for screening hazard analysis of ignited releases include indoor SO2 concentrations. The standard dispersion models, such as SCREEN3, ISCST3, RTDM and CALPUFF, do not calculate indoor concentrations. Will the model output spreadsheet referred to in the protocol contain a calculation to convert outdoor to indoor SO2 concentrations? Furthermore, the protocol addresses the potential consequences of an ignited release in terms of maximum predicted ground-level SO2 concentrations but it does not address the risks associated with such releases. Will this be considered in the future?	You are correct that the commonly used models do not calculate indoor concentrations. The protocol will include a simple method for converting outdoor predictions to indoor concentration values. Currently we do not see the risk of fatality associated with SO_2 from an ignited release as being significant. However, the protocol could be expanded to include this risk if necessary. Again, this may be a topic for discussion at the technical workshop.			×