

Directive 086 (released December 2016)

Stakeholder Feedback and AER Response



Feedback – Issue	Submitter	AER Response
1. Safety Factors and Planned Relief Mechanism		
<p>We request that AER reconsiders whether a 1.25 safety factor is appropriate given the potential enormity of loss events.</p>	<p>First Nations and Métis</p>	<p>As indicated in RC-03, Development of the Maximum Operating Pressure Formula for Steam-Assisted Gravity Drainage Schemes in the Shallow Thermal Area (one of the technical documents available on the directive’s webpage), historically a safety factor of 0.9 of the fracture pressure has been used in setting MOPs for conventional waterfloods and water disposal schemes. Steam injection involves a greater number of unknowns and potentially more severe consequences of caprock failure. Therefore, a more conservative safety factor of 0.8 was chosen.</p> <p>In addition, the fracture pressure used in conventional waterfloods and water disposal schemes are determined from step rate injection tests, which provide the fracture initiation and propagation pressure. Fracture initiation and propagation pressures are always greater than the fracture closure pressure, and therefore using fracture closure pressure in the MOP formula as proposed in this directive is more conservative.</p> <p>In the case of the Total Joslyn project, a 0.9 safety factor was used in calculating the maximum operating pressure (MOP), and the depth at which the MOP was calculated was the depth of the injector (90 m), resulting in a pressure of 1700 kPag.</p> <p>The AER has moved to the safety factor of 0.8 being calculated at the base of the caprock (28.2 m), which would now result in a maximum operating pressure of 474 kPag for that particular well pad, if it were still operating.</p> <p>This change in methodology results in a total reduction of 1226 kPag (72%) to the MOP and a more conservative injection pressure with greater safety to ensure caprock integrity is maintained.</p> <p>An additional contributing factor to the Total Joslyn failure was the exceedance of the allowed maximum operating pressure, which resulted in steam injection at or very close to the fracture pressure of the reservoir, and well above the fracture pressure of the overlying caprock.</p>

Feedback – Issue	Submitter	AER Response
		<p>For more information, refer to the AER staff report regarding the Joslyn failure at: http://www.aer.ca/documents/reports/ERCB_StaffReport_JoslynSteamRelease_2010-02.pdf</p> <p>For more information, refer to the Total Joslyn report at: http://www.aer.ca/documents/reports/Total_Canada_Report_JoslynSteamRelease_2010-02.pdf</p> <p>The AER notes that a safety factor of 0.8 of the fracture pressure is also used for hydrocarbon storage in underground formations.</p>
<p>We request that the AER requires that each well has a planned “release mechanism” or pathway that will, without fail, be the path of least resistance prior to any sort of caprock failure.</p> <p>We request that AER requires this same “release mechanism” approach to all existing SAGD wells in the defined shallow area.</p> <p>We request that, until an existing well has a “release mechanism” in place, the pressure factor for that well will be limited to 0.7 (Safety Factor = $1/0.7 = 1.43$); when the well has in place a “release mechanism,” well pressure can be relaxed to the AER safety factor.</p>	First Nations and Métis	<p>The AER is not aware of any “release mechanism” that can be devised that would, without fail, be the path of least resistance prior to any sort of caprock failure.</p> <p>The AER notes that all operating schemes are required to closely monitor the operating pressure and, should an exceedance occur, take immediate action to attempt to lower the pressure. The AER is satisfied that the current combination of MOP limitation, monitoring, modelling, and alarm systems is sufficient to maintain caprock integrity.</p> <p>The AER has implemented a compliance assurance plan to reduce the risk of having another steam release event like Total Joslyn. The compliance assurance plan initiates surveillance and audits on steam injection pressures of SAGD operations in Alberta, especially SAGD operations in the shallow area.</p>

Feedback – Issue	Submitter	AER Response
2. Existing Facilities		
<p>We request that AER requires all existing wells to meet a conservative safety factor of 143% (pressure limit factor of 0.7) immediately:</p> <p>MOP (bottomhole) (kPa) = Safety factor of 0.7 × Caprock fracture closure gradient (kPa/m) × Depth at shallowest base of caprock (m TVD), where kPa is kilopascals and m TVD is metres true vertical depth.</p>	First Nations and Métis	<p>With approximately 15 years of continuous operations at Suncor Mackay River project, no adverse impacts to reservoir containment have been observed. Suncor operated with a safety factor of approximately 0.9 from the beginning of operations to 2014. Since 2014, a 0.8 safety factor has been used project wide.</p> <p>This methodology has been field proven; there have been no reservoir containment issues since the Total event in the shallow area since the informal introduction of the methodology in 2008 using a 0.8 safety factor at the base of the caprock.</p> <p>Therefore the AER is confident that a 0.8 safety factor is sufficiently conservative and appropriate.</p> <p>The AER has implemented a compliance assurance plan to reduce the risk of having another steam release event like Total Joslyn. The compliance assurance plan initiates surveillance and audits on steam injection pressures of SAGD operations in Alberta, especially SAGD operations in the shallow area.</p>
<p>We request that the AER develop a plan to consider the particulars of each existing well to account for previous pressure and temperature history and formation restraining properties. Upon finalization of the shallow SAGD directive, if the safety factor is different than 1.43 then wells can operated at the allowable pressure to meet the safety factor in the directive.</p>	First Nations and Métis	<p>The AER does not currently collect this data because it is not used for ongoing geomechanical modelling. However, the AER audits data on injection pressures on a periodic basis.</p> <p>With approximately 15 years of continuous operations at Suncor Mackay River project, no adverse impacts to reservoir containment have been observed. As stated previously, the AER is confident that the 0.8 safety factor is sufficiently conservative and appropriate.</p>

3. Resource Recovery Schemes and Downhole Chemistry

<p>We request that AER de-rates allowable pressures from 80% to 60% for wells using chemicals, solvents or compressed gases until research otherwise proves a more suitable pressure de-rating factor.</p>	<p>First Nations and Métis</p>	<p>Based on numerous field applications of chemicals, solvents, and gases in thermal in situ schemes, the AER has not seen any evidence that the injection of these materials would be detrimental to caprock integrity. There is no incremental risk associated with the injection of chemical solvents and compressed gases because variations of these can be present in the reservoir under natural conditions.</p>
<p>We request that AER immediately de-rates allowable pressures from 80% to 60% for EXISTING OPERATING wells using chemicals, solvents or compressed gases.</p>		

4. Maximum Operating Pressure

<p>We request that the AER explains how the maximum operating pressure (MOP) formula applies in case geomechanical tests indicate that shear failure is more likely to occur than tensile failure.</p>	<p>First Nations and Métis</p>	<p>The maximum operating pressure (MOP) formula applies to tensile failure only. However, if geomechanical modelling indicates that a lower operating pressure is necessary to avoid a loss of containment due to shear failure, the AER will require the project to lower its operating pressure accordingly.</p>
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We request that the AER explain how it determines consistently a “valid” fracture closure gradient, and “representative” injection tests, given the inconsistent minifrac test results between service providers. Does the AER have a database to compare with different test results?

First Nations and Métis

The AER has made the following revision to the directive:

Section 8.3:

- Changed the wording “Acquire representative micro fracture injection tests for the caprock and the reservoir in the development area and subsequently for any future expansions to the development area” to “Acquire a minimum of one representative caprock micro fracture injection test for every two sections of proposed development area. Should an applicant identify an area of geological features such as faults, incising channels, and localized subsidence features that may compromise the caprock integrity, the AER will require the applicant to have representative tests in the vicinity of these features.”

Although the AER acknowledges that there are inconsistencies in the minifrac interpretations, the AER takes a conservative approach to determine the validity of minifrac test results. According to section 5.1 of this directive, the lowest valid caprock fracture closure gradient obtained from representative micro fracture injection tests must be used. Validity of a test is determined by the AER based on a number of parameters, including test location, test intervals, test procedure used, and the resulting interpretation of the test.

The AER receives fracture closure gradient data as part of the application process but does not have a formal database.

<p>We request that the AER explain why it does not take into account the impact of horizontal stress reduction, although it is recommended by scientific research.</p>	<p>First Nations and Métis</p>	<p>The potential impact of horizontal stress reduction is evaluated by geomechanical modelling.</p> <p>As stated in RC-03, Development of the Maximum Operating Pressure Formula for Steam-Assisted Gravity Drainage Schemes in the Shallow Thermal Area (one of the technical documents available on the directive’s webpage), horizontal stress reduction at the base of caprock only becomes a concern if all of the following occur:</p> <ul style="list-style-type: none"> • steam reaches a caprock that is still at or near the initial temperature; • caprock stress reduction is high enough to reduce the horizontal stress below the vertical stress, thereby reducing the tensile failure pressure; and • steam injection pressure is equal to or greater than the stress-reduced tensile failure pressure.
<p>It is unclear if the pressure (kPa) is to be represented in gauge or absolute pressure. The AER MOP formula should specify kPa(g) or kPa(a). CAPP recommends the use of kPa(a).</p>	<p>CAPP</p>	<p>The maximum operating pressure (MOP) formula results in a steam injection pressure that is significantly below the tensile failure pressure at well depth, reducing opportunities for steam to find a localized pathway and rise rapidly to the base of caprock. The likelihood of steam migrating to the caprock under circumstances where all three of the above conditions are met is low. The pressure calculated by the MOP formula is sufficiently conservative. Hence the pressure does not need to be decreased because of possible stress reduction.</p> <p>Since most micro-fracture injection tests are reported in gauge pressures and all measurements of pressures during steaming operations are gathered in gauge pressures, the AER has determined that gauge pressure is more appropriate to use. We have updated the directive to indicate this (e.g., using “kPag”).</p>
<p>The AER is requiring the use of a “micro-fracture injection test.” Industry uses a variety of terminology for testing and there may be different interpretations of what this test represents. This term/test should be defined or broadened to include minifrac or DFIT.</p>	<p>CAPP</p>	<p>The AER acknowledges that there are different terminologies for referring to this type of test. Use of the phrase “micro-fracture injection test” is meant to avoid trademarked names or the appearance of vendor bias.</p>

<p>Consider explicitly requesting that any legacy development and wells must be considered in the risk assessment.</p>	<p>Total E&P Canada Ltd</p>	<p>As stated in section 1.1 of the directive, this directive does not deal with wellbore aspects of fluid containment since these are addressed in AER directives 013, 020, and 051. All AER scheme approvals in the oil sands areas have a requirement to ensure thermal compatibility of all wells within the development area occurs before steaming can commence.</p>
<p>The MOP formula, while it has a safety factor, does not take into account the effect of legacy wells, either oil and gas wells or exploration auger wells that could be drilled to the top of the McMurray formation, without a licence.</p>		

5. Short-Term Exceedance of Maximum Operating Pressure

Given the higher risk of safety for SAGD at shallow depths, and based on lessons learned from Total Joslyn Creek catastrophic failure, we propose that the steam pressure should not be allowed to exceed maximum operating pressure in shallow SAGD areas at any time.

First Nations and Métis

In the case of the Total Joslyn project, a 0.9 safety factor was used in calculating the maximum operating pressure (MOP), and the depth at which the MOP was calculated was the depth of the injector (90 m), resulting in a pressure of 1700 kPag.

The AER has moved to the safety factor of 0.8 being calculated at the base of the caprock (28.2 m), which would now result in a maximum operating pressure of 474 kPag for that particular well pad, if it were still operating.

This change in methodology results in a total reduction of 1226 kPag (72%) to the MOP and a more conservative injection pressure with greater safety.

The AER will only consider short-term MOP exceedances for limited pressure (below the fracture closure pressure) and duration. At shallower depths, the tolerance for short-term exceedances becomes less. The AER also considers other factors, including geological setting, geomechanical properties and modelling, monitoring and operational and operator history.

The AER has replaced the wording in Section 5.3 with “The AER is prepared to consider an exceedance of the MOP during certain operations, including start-ups and maintenance. For any proposed MOP exceedance lasting less than 48 hours and having an operating pressure below fracture closure pressure of caprock, the operator must get permission from the AER by emailing Directive086@aer.ca. Any other proposed MOP exceedances must be applied for through an amendment to the scheme approval and will be assessed on a case-by-case basis.”

<p>As a minimum, MOP exceedance should not be allowed for areas where data gathered under section 8 indicate possibilities of features (i.e., karst, faults, non-lithified caprock) that might potentially cause weaknesses in the caprock.</p>	<p>First Nations and Métis</p>	<p>The AER has replaced the wording in Section 5.3 with “The AER is prepared to consider an exceedance of the MOP during certain operations, including start-ups and maintenance. For any proposed MOP exceedance lasting less than 48 hours and having an operating pressure below fracture closure pressure of caprock, the operator must get permission from the AER by emailing Directive086@aer.ca. Any other proposed MOP exceedances must be applied for through an amendment to the scheme approval and will be assessed on a case-by-case basis.”</p>
<p>Where geological features are present, the applicant needs to justify the appropriate setbacks and how the proposed development strategy mitigates the possible impacts of these features on caprock integrity. The AER reviews and assesses the appropriateness of the application request based on the result of geomechanical modelling, evaluating the potential for shear failure at the requested injection pressure.</p>		
<p>As a given, the MOP calculation utilizes the fracture closure pressure. Using fracture closure pressure is a conservative approach. If the injection pressure remains below fracture closure pressure of the caprock, any existing fractures cannot open, no new fractures can form, and therefore neither can transmit injected steam out of the reservoir.</p>		
<p>6. Caprock Criteria</p>		
<p>The AER is suggesting small-scale field tests to demonstrate equivalent caprock. Please clarify. There is no mention of the requirement for core sampling, lab measurements, and simulation modelling before any field tests.</p>	<p>Husky</p>	<p>The AER discussion of small-scale testing was in regard to field testing of the potential equivalent caprock. Before any field testing could occur, a proponent would undertake core sampling and lab measurements before performing a field test.</p>
<p>It is unclear if the applicant has to use the regional stratigraphy in figure 3 of the draft directive. Recommend to allow the applicant to use their own regional stratigraphy.</p>	<p>Husky</p>	<p>Figures 2 and 3 are meant to illustrate the AER’s interpretation of the regional stratigraphy across the shallow area. If applicants have a different interpretation, they may provide it and the AER will consider it.</p>

<p>The AER notes that a caprock in the shallow thermal area must meet the following criteria:</p> <ul style="list-style-type: none"> • be a minimum of 10 m thick; • be composed of clay-rich bedrock of the Clearwater Formation, with a gamma-ray value greater than 75 API units or a demonstrated equivalent; and • be laterally continuous across the project area. <p>These caprock characteristics are specific to the Lower Clearwater shale in the shallow area. The AER will evaluate the requests to calculate the maximum operating pressure at the base of other geological units on a case-by-case basis.</p> <p>The AER should specify that the below criteria are only applicable for caprocks based on the Clearwater Formation.</p> <p>These characteristics will not be typical of caprocks outside of the thermal area or for other demonstrated caprocks in the shallow area.</p>	<p>Canadian Natural Resources Limited (CNRL) and Canadian Association of Petroleum Producers (CAPP)</p>	<p>The AER has made the following revisions to the directive:</p> <p>Section 3:</p> <ul style="list-style-type: none"> • Changed the title to “Caprock Criteria for the Clearwater Formation”. • Removed Clearwater Formation and reference to demonstrated equivalent from bullet 2. <p>Section 4:</p> <ul style="list-style-type: none"> • Removed the word “Demonstrating” from the title. • Added the following sentence: The AER is prepared to consider a demonstrated equivalent to the Clearwater caprock (i.e., one that effectively contains injected steam and heated reservoir fluids).
<p>Add</p> <p>3. Caprock Criteria for the Clearwater Formation Caprocks in the shallow thermal area depicted in figure 1 must meet the following criteria:</p> <ul style="list-style-type: none"> • be a minimum of 10 m thick; • be composed of clay-rich bedrock of the Clearwater Formation, with a gamma-ray value greater than 75 API units or a demonstrated equivalent; and • be laterally continuous across the project area. 	<p>First Nations & Métis</p>	<p>Although the directive allows for an applicant to demonstrate equivalent caprock, currently the AER does not recognize a caprock of less than 10 m as adequate. The AER will not approve development in areas that do not meet the requirements of the directive. The opportunity to present evidence of equivalent caprock allows for future innovation.</p>
<p>We request further information on what AER will do for portions inside the project area that might not have the 10 m thickness requirement for the caprock.</p>	<p>First Nations & Métis</p>	<p>Although the directive allows for an applicant to demonstrate equivalent caprock, currently the AER does not recognize a caprock of less than 10 m as adequate. The AER will not approve development in areas that do not meet the requirements of the directive. The opportunity to present evidence of equivalent caprock allows for future innovation.</p>

We request further information on whether AER will impose setbacks from those areas, and in that case what would be the appropriate setback distances?	First Nations & Métis	The AER will evaluate setback distances to the areas where the thickness of caprock is less than 10 m on a case-by-case basis. Evaluation criteria would include thickness of caprock, depth, geological setting and geomechanical modelling results.
We request further information on what scientific or field database AER used to fix the 10 m thickness requirement. We request that AER provides examples of projects in Alberta that have been successfully operating with only 10 m of Lower Clearwater Caprock.	First Nations & Métis	As stated in RC-02, Draft Caprock Criteria and Information Requirements for Steam-Assisted Gravity Drainage Schemes in the Shallow Thermal Area (one of the technical documents available on the directive’s webpage), in areas where the Lower Clearwater shale is at least 10 m thick, there is a high degree of confidence that the unit is laterally continuous and that the probability of caprock shear failure is minimal. Based on geomechanical modelling, shear failure can occur within the bottom 5 m of the Clearwater caprock. To reduce the risk, the AER arrived at a 10 m thickness. There are no projects with only 10 m of Clearwater caprock in the Athabasca Oil Sands Area.
We request that AER does not recognize the upper layers of the Clearwater Formation as effective caprock. Therefore, the second condition should precisely stipulate that the caprock should “be composed of the clay-rich bedrock of the Lower Clearwater Formation.”	First Nations & Métis	The AER recognizes that the upper layers of the Clearwater do not consistently meet the criteria specified for caprock and may not always be present in the shallow area. However, if the Upper Clearwater meets the caprock criteria, then it would complement the Lower Clearwater caprock thickness.
With the small thickness of overburden above the SAGD zone, we request clarification on what other geological formations AER anticipates or has identified as alternative adequate caprocks to the Lower Clearwater shale in the Shallow Thermal Area of the Athabasca Oil Sands.	First Nations & Métis	At this time the AER has not identified any geological formations as an equivalent caprock to the Lower Clearwater shale.

7. Information Requirements		
<p>The AER requirement “structure and isopach maps of the Prairie Evaporite Formation, Paleozoic Era, Wabiskaw Member, and Clearwater Formation; and”</p> <p>Recommend rewording: “structure and isopach maps of the Prairie Evaporite Formation (where well control exists), sub-Cretaceous Unconformity, Wabiskaw Member, and Clearwater Formation”.</p> <p>Additional comment to the above: “Oil Sands rights limitations to the base of Cretaceous preclude drilling into the Prairie Evaporite Formation where it is deeper than the allowable 15 m of overhole.”</p>	Husky	<p>The AER has added “where well control exists” to the directive.</p> <p>With respect to the comment about limitations to drilling deeper than 15 metres beyond the base of the Cretaceous, the AER understands that an application process exists whereby operators can make requests to Alberta Energy to drill deeper than their leased formation.</p>
<p>For any mention of aquifers, suggest rewording.</p> <p>Add the word “regional” in front of the word aquifers. Clarification to exclude lean zones and local hydrogeologic zones as eligible aquifers for assessment.</p>	Husky	<p>For the purposes of this directive, the AER is only interested in aquifers that are suitable for the purpose of determining the caprock’s ability to provide hydraulic isolation and this will be determined on a project-by-project basis.</p>
<p>The AER is using assessment criteria of the shallowest aquifer underlying the caprock.</p> <p>Recommend to exclude assessment of the shallowest aquifer underlying the caprock. These aquifers can be several hundred metres below the caprock and is typically saline. Oil Sands rights limitations to the base of Cretaceous preclude drilling into this aquifer.</p>	Husky	<p>For the purposes of this directive, the AER is only interested in aquifers that are suitable for the purpose of determining the caprock’s ability to provide hydraulic isolation, and this will be determined on a project-by-project basis.</p>
<p>AER is requesting that isopach maps of any gas accumulations below the caprock be provided.</p> <p>Recommend to exclude these maps from hydrogeologic information request; typically not a hydrogeologic item.</p>	Husky	<p>The AER has moved this requirement to section 8.1 (Geology) of the directive.</p>
<p>A description of the 3D seismic or other demonstrated equivalent imaging data acquisition parameters and the methods used to process the data; AER to have consideration that some components of this data must remain confidential. Descriptions will be at a high level.</p>	CNRL	<p>The AER is currently receiving 3D seismic interpretations from industry as a part of the application process without the need for confidentiality. However, industry can apply for confidentiality if it believes this is necessary, and these requests would be evaluated on a case-by-case basis.</p>

<p>The specific aquifers and degree of assessment that is required should be dictated by/aligned with the risk assessment as opposed to being limited to those above and below the caprock.</p>	<p>CNRL</p>	<p>For the purposes of this directive, the AER is only interested in aquifers that are suitable for the purpose of determining the caprock’s ability to provide hydraulic isolation, and this will be determined on a project-by-project basis. The AER will be adding the word “suitable” in reference to aquifers used for the purpose of assessing caprock sealing capability.</p>
<p>Replace the first sentence:</p>		
<p>“Where aquifers are present above and below the caprock within the development area and subsequently for any future expansions to the development area, acquire hydrogeological data to determine whether the caprock hydraulically isolates the reservoir from aquifers above the caprock.”</p>		
<p>To include a more general reference to data requirements for water bearing intervals:</p>		
<p>“Where aquifers are present within the development area and subsequently for any future expansions to the development area, acquire hydrogeological data to determine whether the caprock hydraulically isolates the reservoir from aquifers above the caprock and any potential pathways identified in section 8.4.”</p>		
<p>Isopach maps of any gas accumulations below the caprock; this should be moved to the Geology section 8.1</p>	<p>CNRL</p>	<p>The AER has moved this data requirement to section 8.1 of the directive.</p>
<p>There is not a need to assess bottom water pressures and chemistry to address caprock integrity. Recommend that the depth of aquifer evaluation within and below the reservoir is clarified and that requirements to assess bottom water are removed as this is not applicable to caprock integrity.</p>	<p>CNRL</p>	<p>The AER has removed the reference to bottom water in section 8.2 of the directive, and the directive has been modified to only refer to the shallowest suitable aquifer below the caprock.</p>

<p>There appears to be overlap in requirements of the pending policy/directive regarding nonsaline groundwater in direct contact with bitumen. Any pending directive regarding nonsaline groundwater in direct contact with bitumen should ensure that data requirements are consistent—e.g., potentiometric surface maps in metres of freshwater equivalent head above sea level.</p>	<p>CNRL</p>	<p>Where possible/practical, the AER supports consistency between its requirements and those of other government departments.</p>
<p>Acquire representative micro-fracture injection tests for the caprock and the reservoir in the development area and subsequently for any future expansions to the development area and provide the following information for all tests conducted:</p> <ul style="list-style-type: none"> • the identification of any unexpected or unusual test results and a discussion of possible causes; <p>Remove this requirement as the interpretation should focus on the bulk of the data collected, rather than anomalies.</p> <ul style="list-style-type: none"> • the identification of any unexpected or unusual test results and a discussion of possible causes; 	<p>CNRL</p>	<p>All tests should be reviewed. If there are anomalous data, they should be explained.</p>
<p>The request for input data files used for the modelling;</p> <p>Remove the request for input data files as it is not necessary. A discussion on inputs would be sufficient.</p>	<p>CNRL</p>	<p>The discussion of input data files can vary from company to company and may not provide a complete understanding of the input data.</p>

<p>The AER requirement to describe all the potential pathways is not necessary.</p> <ul style="list-style-type: none"> • a description of all the potential pathways by which reservoir containment could be lost and identify the potential receptors; <p>Focus should be on the significant and likely pathways by which reservoir containment could be lost that were identified in the risk assessment.</p> <p>Replace ‘all’ with ‘significant’:</p> <p>a description of the significant potential pathways by which reservoir containment could be lost and identify the potential receptors;</p>	<p>CNRL</p>	<p>The AER has removed the word “all” in section 8.4 of the directive in regards to potential pathways.</p>
<p>Provide the details of the proposed monitoring program.</p> <p>It is recommended that a conceptual monitoring program is acceptable at the application phase and that the specific details of the monitoring program be required prior to steaming.</p>	<p>CNRL</p>	<p>The AER contends that leaving details of a monitoring plan to just prior to commencing steam injection would be too late for the AER to request changes if needed.</p>
<p>Section 8.1 and 8.3 geological, geophysical and geomechanics data acquisition requirements are prescriptive and directive should provide flexibility to allow operators to propose the appropriate level of data acquisition.</p> <p>Seek to minimize prescriptive data acquisition requirements and focus on objective of application deliverable of addressing caprock integrity.</p> <p>If a suitable data is available outside of the initial development area (i.e., micro-fracture injection tests), the directive should allow for operators to demonstrate the data is suitable for application purposes.</p>	<p>CNRL</p>	<p>Since the shallow area is a higher-risk area, the AER requires data to be acquired from within the development area to ensure that the data is representative of site-specific geological variations.</p>

<p>The requirement to provide “... a description of the 3-D seismic or other demonstrated equivalent imaging data acquisition parameters and the methods used to process the data;” may not be reasonable given some the data and methods may be proprietary in nature.</p>	<p>CAPP</p>	<p>The AER is currently receiving 3D seismic interpretations from industry as a part of the application process without the need for confidentiality requirements. However industry can apply for confidentiality if it believes this is necessary and these requests would be evaluated on a case-by-case basis.</p>
<p>AER to have consideration that some components of this data must remain confidential. Descriptions will be at a high level.</p>		
<p>The ability to map the Prairie Evaporite may be limited and will rely on control well information and ties to 2D seismic.</p>	<p>CNRL & CAPP</p>	<p>The AER has added the words “where well control exists” to section 8.1 of the directive.</p>
<p>Add: “(where well control exists)” following the requirement for isopach mapping of the Prairie Evaporite.</p>		
<p>structure and isopach maps of the Prairie Evaporite Formation (where well control exists)...</p>		
<p>The specific aquifers and degree of assessment that is required should be dictated by/aligned with the risk assessment as opposed to being limited to those above and below the caprock.</p>	<p>CAPP</p>	<p>For the purposes of this directive, the AER is only interested in aquifers that are suitable for the purpose of determining the caprock’s ability to provide hydraulic isolation and this will be determined on a project-by-project basis. The AER has added the word “suitable” in reference to aquifers used for the purpose of assessing caprock sealing capability.</p>
<p>Replace the first sentence: “Where aquifers are present above and below the caprock within the development area and subsequently for any future expansions to the development area, acquire hydrogeological data to determine whether the caprock hydraulically isolates the reservoir from aquifers above the caprock.” To include a more general reference to data requirements for water bearing intervals: “Where aquifers are present within the development area and subsequently for any future expansions to the development area, acquire hydrogeological data to determine whether the caprock hydraulically isolates the reservoir from aquifers above the caprock and any potential pathways identified in section 8.4.”</p>		

<p>The requirement for isopach maps of any gas accumulations below the caprocks would be more fitting in the Geology section.</p>	<p>CAPP</p>	<p>The AER has moved this data requirement to section 8.1 of the directive.</p>
<p>Move requirement to the section 8.1.</p>		
<p>The term “quality” is subject to interpretation. Using hydrochemical interpretation will provide clarity on what comparison is required.</p>	<p>CAPP</p>	<p>The last bullet of section 8.2 the AER has changed “water quality” to “water chemistry.”</p>
<p>Replace “quality” with hydrochemistry in the bullet:</p> <ul style="list-style-type: none"> • representative laboratory analyses of groundwater from each aquifer and an interpretation of water hydrochemistry <p>quality differences between aquifers.</p>		
<p>AER is requesting the submission of the “raw test data” with a project application in the shallow thermal area. Future use and analysis of this data would be better supported if a standard data format was specified. The AER should specify a standardized data format for any raw data submitted.</p>	<p>CAPP</p>	<p>The AER is not in a position to standardize the data format at this time.</p>
<p>The AER requirement to describe all the potential pathways is not necessary. <i>a description of all the potential pathways by which reservoir containment could be lost and identify the potential receptors;</i></p>	<p>CAPP</p>	<p>The AER has removed the word “all” in section 8.4 of the directive in regards to potential pathways.</p>
<p>Description of the potential pathways is sufficient. Focus on the significant and likely pathways by which reservoir containment could be lost that were identified in the risk assessment. Remove ‘all’.</p>		
<p>The AER requirement “a discussion of how operations will be monitored to determine whether the MOP is not being exceeded ...” is not clear.</p>	<p>CAPP</p>	<p>The AER has changed the wording to “a discussion of how operations will be monitored to ensure compliance with the proposed MOP.”</p>
<p>Use the following wording: “a discussion of how operations will be monitored to ensure compliance with the proposed MOP.”</p>		

<p>The draft directive requires that the deepest aquifer overlying Clearwater or other approved caprock is assessed as well as the shallowest underlying (non-saline) aquifer. In addition to the list of information provided in section 8.2 page 7 of the draft directive, we request that the details of what must be reported in the assessment includes:</p> <ul style="list-style-type: none"> i) clarification that “aquifers” means nonsaline (fresh) aquifers as well as saline aquifers; ii) the extent to which aquifers are connected to nearby surface waters; including groundwater-dependent wetlands and fens; and in the case of saline aquifers, the extent to which saline aquifers are connected to nonsaline aquifers and surface waters; iii) whether or not aquifers included under this assessment requirement are proposed to be used for water supply or waste disposal purposes; and if used, whether or not groundwater diversions will alter the pressure regime in overlying or underlying caprock units; and iv) the baseline water chemistry of each aquifer and a proposed plan to monitor groundwater levels and groundwater quantity in the aquifers. 	<p>First Nations and Métis</p>	<ul style="list-style-type: none"> i) The AER agrees that aquifers may be either nonsaline (fresh) or saline. ii) The hydrogeological requirements in section 8.2 provide minimum requirements for an application with a focus on determining whether or not the caprock provides hydraulic isolation. Applicants will be required to evaluate pressure and salinity to determine whether or not there is a hydraulic connection between suitable aquifers above and below the caprock. Surface water is outside of the scope of this directive. iii) For the purposes of this directive the AER’s interest is focused on the isolation of reservoir fluids from any overlying aquifers not for monitoring purposes. The impact of aquifers used for source or injection would need to be evaluated on a case-by-case basis. iv) Where applicable, baseline hydrochemistry will be acquired for the suitable aquifers above and below the caprock.
<p>We request that the map of shallow SAGD areas also includes a map showing existing, approved and planned oil sands leases and projects, and existing regional groundwater monitoring wells (NAOS monitoring network).</p>	<p>First Nations and Métis</p>	<p>A map of existing and approved SAGD projects is available on the Government of Alberta website at http://osip.alberta.ca/map/. This map provides the location of the project, including interactive data for each project detailing which phases are in operation and associated approvals.</p> <p>Because the NAOS is not administered by the AER, the AER cannot provide that information.</p>

<p>We request:</p> <p>i) that the directive explicitly requires that caprock data presented in the application is organized into regional and project-specific data sets and that for information and assessment purposes the “project area” also includes an area beyond the immediate footprint of the bitumen pay zones; and</p> <p>ii) confirmation in the application that all boreholes within the project area are either thermally compliant or have been decommissioned.</p>	<p>First Nations and Métis</p>	<p>i) Application data is project specific and not intended to represent a regional study. The ability of applicants to gather caprock data from lands for which they do not have mineral rights to is limited.</p> <p>ii) This directive does not deal with the wellbore aspects of fluid containment since these are addressed in AER <i>Directive 013: Suspension Requirements for Wells, Directive 020: Well Abandonment, and Directive 051: Injection and Disposal Wells – Well Classifications, Completions, Logging, and Testing Requirements</i>. All AER scheme approvals in the oil sands areas have a requirement to ensure thermal compatibility of all wells within the development area before steaming can commence.</p>
<p>8. Risk Approach</p>		
<p>We request that AER provides its Risk Acceptance Criteria (RAC) for public viewing.</p>	<p>First Nations and Métis</p>	<p>The AER is not able to provide this at this time. The common risk management framework used by the AER is a government of Alberta risk assessment tool and the AER does not have control over its external release. Discussions with the government of Alberta regarding the release of the framework are ongoing.</p>
<p>We request that AER engages those exposed to the risk, specifically regional First Nations and Métis, in the validation or modification of the RAC.</p>	<p>First Nations and Métis</p>	<p>The common risk management framework used by the AER is a government of Alberta risk assessment tool, and the AER does not have control over its modification.</p>
<p>We request that AER performs a risk assessment of shallow SAGD in the context of the RAC.</p>	<p>First Nations and Métis</p>	<p>The AER has previously performed a risk assessment of the shallow area in accordance with the common risk management framework.</p>
<p>We request that AER de-links economics from risk mitigation—the free market and Alberta’s culture of innovation will determine when, where and how individual reservoirs will be developed to meet the risk requirements society considers acceptable.</p>	<p>First Nations and Métis</p>	<p>The AER has determined the safety factor based on the evaluation of safety and environmental impact. An assessment was then conducted to evaluate the economic impact of the proposed requirements. The AER recognizes that with current technology, many leases within the shallow area may not be developed due to the economic impact of the caprock criteria and MOP requirements.</p>
<p>9. Public Notification & Emergency Response</p>		
<p>We request that AER requires existing operators to immediately identify and post all shallow SAGD lands underlain by existing high-pressure steam chambers.</p>	<p>First Nations and Métis</p>	<p>All steam-assisted gravity drainage (SAGD) pads and facilities are posted in accordance with Part 6.020 of the <i>Oil and Gas Conservation Rules</i>. Due to the dynamic nature of steam chamber growth, the surface footprint for signage will always be changing. In addition, operators may have limited ability to post signage on lands for which they do not have surface rights.</p>

<p>We request that AER requires operators to remove signage only once pressures are reduced to 70%.</p>	<p>First Nations and Métis</p>	<p>All steam-assisted gravity drainage (SAGD) pads and facilities are posted in accordance with Part 6.020 of the <i>Oil and Gas Conservation Rules</i>. Signage is required regardless of the operating pressures.</p>
<p>We request that AER requires existing operators to have in place emergency response to adequately meet the needs of dealing with a large, sudden and enormous release of energy.</p>	<p>First Nations and Métis</p>	<p>The AER agrees that it is essential that operators have an emergency response plan in place to account for unexpected emergency situations. The emergency response for a loss of reservoir containment is covered by each operator’s corporate emergency response plan, as required by <i>Directive 071: Emergency Preparedness and Response Requirements for the Petroleum Industry</i>. Any emergency response plan for a steam-assisted gravity drainage facility would include an emergency response to an explosive event.</p>
<p>The shallow thermal area of the Athabasca Oil Sands Area completely surrounds the Urban Service Area of Fort McMurray and the outlying communities of Saprae Creek Estates, Anzac, Gregoire Lake and Fort MacKay. Steam-assisted gravity drainage projects are forecasted to approach each of these communities.</p>	<p>Regional Municipality of Wood Buffalo</p>	<p>The AER ensures the safe, efficient, orderly, and environmentally responsible development of hydrocarbon resources over their entire life cycle. Safety in this context means ensuring that facilities, operations, and related industry activities do not pose an imminent danger to individuals. Ensuring safety does not, however, extend the AER’s mandate to all aspects of human health, and the AER is not the human health regulator in the province of Alberta; Alberta Health (AH) and Alberta Health Services (AHS) are Alberta’s human health regulators. The AER supports those organizations when questions arise about the impact of energy resource development on individuals, or on environmental receptors to which individuals are exposed. The three organizations have separate but complementary mandates and expertise: the AER is the expert on responsible energy resource development, and AH and AHS are the human health experts.</p>
<p>This section should be expanded upon and clarified to make it explicit that safety means human health and safety. That should be specified and perhaps environmental protection and conservation of the bitumen resource should be added.</p>		<p>In cases where an event occurs that may be a risk, according to <i>Directive 071: Emergency Preparedness and Response Requirements for the Petroleum Industry</i>, the licensee must notify the local authority, the RCMP/police, the local RHA, other applicable government agencies, and support services required to assist with initial response.</p>
<p>The Regional Municipality of Wood Buffalo must be notified immediately by an in situ operator in the event that it appears to it that human health and safety might be placed at risk.</p>		<p>All operators are obligated to meet Government of Alberta requirements related to human health and safety.</p>

10. Surety

We request that AER requires all existing and prospective well operators to post surety (bonds) to cover any and all potential economic impacts associated with caprock failure.

First Nations and Métis

The AER does not accept surety bonds for security deposit requirements, only cash and letters of credit. Security deposits are required under *Directive 024* as outlined in Appendix 1 for facilities in the oil sands area with production levels greater than 5 000 m³/d. For facilities with production levels less than 5 000 m³/d, security deposits are required under *Directive 006*.

11. Geology and Geomechanics

We request that AER explains how the MOP formula will be applied in areas where the caprock is potentially weakened by faulting, karsting and dissolutions in the underlying Devonian layers, knowing that localized geomechanical tests might not be representative of these weaknesses.

First Nations and Métis

The AER has made the following revision to the directive:

Section 8.3:

- Changed the wording “Acquire representative micro fracture injection tests for the caprock and the reservoir in the development area and subsequently for any future expansions to the development area” to “Acquire a minimum of one representative caprock micro fracture injection test for every two sections of proposed development area. Should an applicant identify an area of geological features such as faults, incising channels, and localized subsidence features that may compromise the caprock integrity, the AER will require the applicant to have representative tests in the vicinity of these features.”

In addition to the requirement of having representative caprock micro fracture injection tests in the vicinity of geological features, the AER requires applicants to submit geomechanical modelling result to investigate the possibility of failure due to potential geological features. The MOP formula uses the lowest pressure obtained through the performance for minifrac test and is conservative, and it will account for these geological features.

While the maximum operating pressure (MOP) formula is not modified to account for these factors, as stated in section 8.1 of the directive, where any geological features exist, the applicant must provide an explanation of how the proposed development strategy mitigates the possible impacts of these features on caprock integrity over the life of the project (e.g., setback and MOP).

<p>We request that AER explains how the safety factor of 0.8 will be adjusted to account for these macro-structural weaknesses that might not be seen at the core level.</p>	<p>First Nations and Métis</p>	<p>The maximum operating pressure (MOP) may be adjusted based on results obtained from geomechanical modelling. Structural weaknesses are accounted for through the use of fracture closure pressure, which is a conservative approach. If the injection pressure remains below fracture closure pressure of the caprock, any existing fractures cannot open, no new fractures can form, and therefore neither can transmit fluids out of the reservoir. The 0.8 safety factor further reduces the operating pressure by an additional 20 percent from the fracture closure pressure.</p>
<p>Based on lessons learned from Total Joslyn failure, we request that AER explains how the safety factor will be adjusted when data indicates that the caprock is not lithified in parts or an entire project area.</p>	<p>First Nations and Métis</p>	<p>Caprock lithification was not determined to be a contributing factor in the Joslyn failure by either Total or the AER; therefore, an adjustment to the 0.8 safety factor based on caprock lithification is not necessary. The nonlithified nature of the Clearwater Formation is consistent across all of Athabasca; it is not a site-specific variable that could contribute to the failure at Joslyn.</p>
<p>12. Monitoring</p>		
<p>We request that AER provides specific guidelines for monitoring, including minimum parameters that must be monitored (i.e., ground temperature, ground movements, groundwater, micro-seismicity or hydraulic pressure) and requirements for minimal spatial interval and frequency, to ensure that monitoring standards are met.</p>	<p>First Nations and Métis</p>	<p>The AER requires monitoring, and the applicant’s proposed monitoring program is evaluated at the time of application. Due to the high variability between projects, the AER does not have specific monitoring requirements; however, applicants must submit monitoring program that the AER evaluates for appropriateness based on various factors including base of caprock depth of each project, geological setting, and geomechanical properties and modelling.</p>
<p>We request that the directive explicitly requires annual monitoring and performance reporting.</p>	<p>First Nations and Métis</p>	<p>The AER agrees with the need for annual monitoring and performance reporting. This is currently required as per AER Directive 054: Performance Presentations, Auditing, and Surveillance of In Situ Oil Sands Schemes (section 3.1.1).</p>

The AER has referenced shear failure specifically at numerous locations within the directive where it would be more appropriate to focus on the containment.

CNRL

Page 5 "...done to assess shear failure of the caprock."
 Page 8 "With respect to potential shear failure..."
 Page 8 "...including the pressure at which shear failure of the caprock is predicted..."

The overall focus of the modelling work should be to support containment of the reservoir fluids and competency of the caprock system.

Rational: As shown in the Primrose FTS study, shear failure played a negligible role in bitumen emulsion flow path mechanisms within the Grand Rapids, Colorado Group and the Quaternary formations

Page 5

Replace "...done to assess shear failure of the caprock." with "... done to assess containment."

Page 8

Delete

"including the pressure at which shear failure of the caprock is predicted to occur and how the results support the proposed operating pressure"

The AER has made the following revisions to the directive:

Section 5.2:

- Changed the wording "shear failure of the caprock" to "shear failure of the caprock leading to a loss of containment".

Section 8.3:

- Changed the wording "including the pressure at which shear failure of the caprock" to "including the pressure at which shear failure of the caprock leads to a loss of containment".

In the case of the Primrose study, the Grand Rapids, Colorado Group, and the Quaternary formations are much higher in the stratigraphic column; whereas, in the shallow area, the Clearwater Formation is immediately above the steam chamber and could be more susceptible to shear failure, which is evaluated and mitigated by geomechanical modelling and monitoring.

<p>The AER has referenced shear failure specifically at numerous locations within the directive where it would be more appropriate to focus on the containment.</p> <p>Page 5 "...done to assess shear failure of the caprock." Page 8 "...including the pressure at which shear failure of the caprock is predicted..."</p> <p>The overall focus of the modelling work should be to support containment of the reservoir fluids and competency of the caprock system.</p> <p>Page 5 Replace "...done to assess shear failure of the caprock." with "... done to assess containment." Page 8 Delete "including the pressure at which shear failure of the caprock is predicted to occur"</p>	<p>CAPP</p>	<p>The AER has made the following revisions to the directive:</p> <p>Section 5.2:</p> <ul style="list-style-type: none"> Changed the wording "shear failure of the caprock" to "shear failure of the caprock leading to a loss of containment". <p>Section 8.3:</p> <ul style="list-style-type: none"> Changed the wording "including the pressure at which shear failure of the caprock" to "including the pressure at which shear failure of the caprock leads to a loss of containment".
<p>Proponents of SAGD projects in the shallow thermal area should be directed to consult on their monitoring program with the Municipality and area residents that are interested in consultation.</p> <p>Monitoring data should be shared with and explained (e.g., plain language) to the Municipality and interested area residents on an annual basis or immediately, in the event that the data discloses a potential risk to human health and safety, for the life of the project.</p> <p>The risk assessment and management plan should be revisited and revised, if necessary, on a regular basis.</p> <p>Consultation should occur with the Municipality and residents on a regular periodic basis so that updates and revisions to the monitoring program and data are known to stakeholders and input can be obtained from stakeholders.</p>	<p>Regional Municipality of Wood Buffalo</p>	<p>The AER expects proponents of SAGD projects to respond and engage in a meaningful way with any party that has raised a concern or has questions regarding the project and to make reasonable efforts to address concerns raised. Section 4 of <i>Directive 023</i> provides guidelines for stakeholder engagement.</p> <p>It is the AER's intent that the monitoring data would be publicly available.</p> <p>The AER reviews the risk assessment and management plan, as necessary.</p> <p>The AER supports proponents providing regular updates to interested stakeholders.</p>

13. Cost of Implementation		
<p>The requirements in the proposed directive will require additional upfront investment and time prior to filing the project application and subsequently acquiring the OSR approval.</p> <p>As a result these costs should be a consideration with respect to PNCB requirements as they will likely occur more than 3 years prior to obtaining the OSR approval for the project. Recommendation would be to work with DOE and AER to revise the PNCB requirements.</p>	CNRL	<p>Prior Net Cumulative Balance (PNCB) is under the jurisdiction of the Department of Energy (DOE), so industry should discuss any issues with the timing of these costs with the DOE.</p>
14. Figures		
<p>The use of the term “Base Drift” has been recently removed from the recognized AGS nomenclature. Use “BASE QUATERNARY” to align with the updated AGS table of formations.</p>	CAPP	<p>The AER has changed the wording to “BASE QUATERNARY”.</p>
<p>Map [figure 1] does not include mines and setback from mines.</p> <p>Include any mines and mine MSLs on the map, as thermal development is not possible within 500 m of any mining area. This should be added to the map or there could be a requirement for a new section called “Existing Developments.”</p>	Total E&P Canada Ltd	<p>This is out of the scope of this directive. The mining areas can change over time and keeping these boundaries up to date in this directive would be onerous.</p>

15. Risk Assessment and Management Plan		
<p>Proponents of SAGD projects in the shallow thermal area should inquire to see if consultation on the creation of their risk assessment and management plan is desired by the Municipality and its area residents.</p> <p>Proponents of SAGD projects in the shallow thermal area should inquire of the Emergency Management Branch of the Municipality to determine if Emergency Management wishes to receive a copy of the risk assessment and management plan.</p> <p>The risk assessment and management plan should be revisited and revised, if necessary, on a regular basis.</p> <p>Consultation should occur with the Municipality and residents on a regular periodic basis so that updates and revisions to the risk assessment and management plans are known to stakeholders and input can be obtained from stakeholders.</p>	<p>Regional Municipality of Wood Buffalo</p>	<p>The AER reviews the risk assessment and management plan, as necessary.</p> <p>The AER expects proponents of SAGD projects to respond and engage in a meaningful way with any party that has raised a concern or has questions regarding the project and to make reasonable efforts to address concerns raised. Section 4 of Directive 023 provides guidelines for stakeholder engagement.</p> <p>The AER supports proponents providing regular updates to interested stakeholders.</p>
16. Setbacks		
<p>The directive should include setback requirements from developments and waterbodies.</p>	<p>Total E&P Canada Ltd</p>	<p>Setback requirements from developments and waterbodies are out of the scope of this directive. Setback requirements would be addressed at the time of scheme application on a case-by-case basis.</p>
17. Definitions		
<p>The directive requires a definition section.</p> <p>Net Bitumen as per AER, is not defined. Define and differentiate between SAGD, thermal, and in situ development.</p>	<p>Total E&P Canada Ltd</p>	<p>The AER does not see the need to define net bitumen pay because the pay being considered is simply where it is greater than zero. This zero edge is consistent with ST98 where a 6% weight bitumen cut-off is used.</p> <p>The AER has removed the references to “thermal” and “in situ development” in the directive.</p>