

Technical Advisor's to the Pike River Families Committee

A method for safe re-entry of Pike River Mine Drift

A new hybrid approach



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With comments by Solid Energy

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1. Introduction	Solid Energy Comments
<p>Once instructed by the government to determine if re-entry of the Pike River drift was feasible and safe, SENZ (Solid Energy New Zealand) initiated a detailed investigation, design and risk assessment exercise. The senior engineers subsequently announced a plan which they considered met the government criterion for proceeding which they were executing until the Board of SENZ instructed a cessation. The NZ Chief Inspector of Mines also considered the SENZ plan safe and feasible.</p>	<p>The Steering committee of management and advisors (“senior engineers”?) concluded that re-entry was not safe and this was their recommendation to the Board. The Board considered the report and concluded that the residual risks were at a level that re-entry should not proceed.</p> <p>The Chief Inspector has left and in any case has no formal role in the decision process, except to hold the right to prohibit it.</p>
<p>The technical advisors to the Families, and others, remain convinced that risks can be satisfactorily controlled to allow safe recovery of the Drift. A new hybrid scheme is proposed combining the advantages of staged recovery and the substance of the method adopted by SENZ. The key factor is that no person will enter the drift until a fresh air atmosphere has been established and measures are in place to control major hazards. The entry plan has been reviewed and agreed as credible by independent experts (Attached).</p>	<p>The main benefit (ignoring other issues) of a staged re-entry would be that an inert atmosphere is maintained until the whole drift is reclaimed. This scheme does not achieve that.</p> <p>The main benefit of the SE scheme was that the mine workings are sealed off by a remote plug prior to reventilation. This scheme does not achieve that.</p> <p>It is hard to see how the hybrid scheme combines advantages.</p> <p>The assertion that “measures are in place to control major hazards..” seems inconsistent with the method that has no controls in place to separate the drift from the old workings</p>
<p>We accept that the SENZ Board will not agree ours or even their own re-entry plan. Only direct action by the New Zealand Government can decide the outcome. It would appear that re-entry would only proceed if SENZ no longer had any responsibility for the mine. A new ownership structure under government will therefore be required to allow re-entry to proceed.</p>	<p>Agreed - Solid Energy has carefully and comprehensively evaluated drift re-entry and concluded it is not safe to do so. And therefore will not undertake any such re-entry.</p>

2. Aim of the report	Solid Energy Comments
The aim of this report is to provide a succinct summary of:	See detailed comments below.
1. What has physically changed since the first recovery plan outlined by the technical advisors to the Families that will help to ensure the mine can be accessed safely.	
2. The positive benefits of re-entry.	
3. Legality under current Health and Safety legislation.	
4. The vast amount of data, information and analysis available for detailed hazard identification, planning and risk control.	
5. The current status of activities at the mine.	
6. The principles which will guide the methodology for re-entry management, planning and execution.	
7. The institutional arrangement needed to proceed.	

3. What has changed?	Solid Energy Comments
<p>Since the mine was first visited by the advisors to the Families, the following changes have occurred, and experience gained, which will enable the access process to be simplified:</p>	
<ul style="list-style-type: none"> <li>The main ventilation shaft has been sealed which has stabilised gas concentrations and thus the underground gaseous environment can be controlled effectively.</li> </ul>	<p>Agreed this has helped to stabilize the mine atmosphere. And the type 'C' seal has further stabilized the atmosphere.</p>
<ul style="list-style-type: none"> <li>SENZ has demonstrated the principle that the drift can be effectively degassed using a Venturi/flame trap arrangement to extract gas through borehole No. 48.</li> </ul>	<p>This demonstration was a substantial operation involving multiple staff, correct barometric conditions, suitable aviation weather windows and a number of hours, just for 10 metres degassing. There are no monitoring points between 170m and borehole 35 to allow monitoring of a controlled degassing of the whole drift. The timeframe would be substantially longer than the potential weather windows available. The existing boreholes are likely too small for degassing the whole drift.</p>
<ul style="list-style-type: none"> <li>The workings have been gas-filled and therefore oxygen-free for some four years removing spontaneous combustion concerns.</li> </ul>	<p>We remain concerned that fire is still a material risk, especially with the introduction of air during reventilation at the top end of the drift. International experience clearly indicates that the risk of spon com or more probably rekindling of the fire continues for many years.</p>
<ul style="list-style-type: none"> <li>There is evidence to suggest that the drift could be substantially more stable than originally thought by SENZ including absence of any physical deterioration between the Portal mouth and 170m stopping, and verbal evidence from an inspection to 300m by the Rescue Services prior to emplacement of the 170m stopping in 2011.</li> </ul>	<p>No inspections of roadway conditions have been able to occur for 5 years other than the first 170 metres. It is highly improbable that the drift could be more stable than originally thought; experience would indicate it can only deteriorate with time.</p>
<ul style="list-style-type: none"> <li>Additional boreholes have been drilled into the mine associated with the SENZ proposal to inject a "Rocksil" seal providing potential to increase nitrogen purge and ventilation flow prior to re-entry.</li> </ul>	<p>Only 2 holes have drilled into drift, both inbye DH 48 and the furthest inbye identified that the roadway roof had collapsed.</p> <p>(For completeness, DH 49 was drilled into flooded South section as a potential pumping site for water management once 'rocsil' plug in place – it is now sealed.)</p>
<ul style="list-style-type: none"> <li>SENZ has completed detailed studies and risk assessments of various drift entry methods and this detail can be used to underpin the new approach.</li> </ul>	<p>Studies have been completed and the decision is not to go any further. How can the advisors presume that the information will 'underpin' the new approach rather than debunk it?</p>
<ul style="list-style-type: none"> <li>It is a fact that our original re- entry plan was staged re- entry in a non-respirable atmosphere and which required rescue workers to wear breathing apparatus for sustained periods. This however, is not now the case. We would simply wish the Mines Rescue to provide the usual</li> </ul>	<p>The original re-entry plan was for staged re-entry.</p> <p>After the last round of consultation between SE and Families experts, the Families experts agreed the SE remote plug option was preferable.</p>

rescue back up of emergency cover. They would, as always, be in direct management control of their own officers.

They are now advocating a 'hybrid' proposal which does not offer the key benefits of either of the first two.

Regarding having Mines Rescue back-up it is unclear what they can usefully do in an emergency unless they are permanently on site on standby. The construction of the rated seal with the unventilated mine immediately inbye would probably require Mines Rescue for construction.

4. Why re-enter the Drift?	Solid Energy Comments
<p>Re-entry would allow detailed examination of the Drift and help in establishing what exactly happened and how such tragedies could be better avoided in the future and, in particular, would:</p>	<p>It is known due to Daniel Rockhouse's escape, that there was little or no damage to the drift as the explosion must have been further inbye than where he was. The subsequent extensive fires and explosions would likely have erased any possible initial indicators if indeed there were any.</p>
<ul style="list-style-type: none"> <li>• Allow recovery of any bodies encountered in the drift, and a decent burial.</li> </ul>	<p>The Royal Commission investigated the likely location of all mine workers at the time of the initial explosion. None were identified as being in the drift.</p>
<ul style="list-style-type: none"> <li>• Inspect the condition of the Drift and provide factual information to facilitate decision making.</li> </ul>	<p>What decision making? Re-entry of the whole mine?</p>
<ul style="list-style-type: none"> <li>• Reduce uncertainty in understanding the fateful events and their impact and thus help some Families of the bereaved to achieve closure.</li> </ul>	<p>Need to consider the likelihood of finding meaningful information in the drift.</p>
<ul style="list-style-type: none"> <li>• Allow forensic examination of the mine insofar as it can be safely accessed to identify sources of ignition, post explosion damage, flame pathway and impact on mine roadway stability.</li> </ul>	<p>This reiterates the main goal expressed by the experts in their 2014 plan; ie re-entry of the mine as a whole. The drift re-entry is just the first stage in their proposal. The explosion did not occur in the drift.</p> <p>For forensic examinations we presume the drift will have to be open and ventilated for a reasonable time period and be suitable for general visitor type personnel. Further, the forensic work would presumably have to precede re-support (unacceptable for basic safety reasons), installation of ducting and pipelines to avoid disturbance of the scene. General query about who will have the capability to do this, and time it will take.</p>
<ul style="list-style-type: none"> <li>• Raise understanding of how to manage gas ignitions, explosion control and survival rates in coal mines (the volume of gas involved was comparable to that in some longwall goafs so the lessons would have wide relevance).</li> </ul>	<p>The only way to 'manage' gas ignitions or explosions is to not have any.</p>
<ul style="list-style-type: none"> <li>• Assist in preventing fatalities in mines elsewhere as a result of the technical lessons learned.</li> </ul>	<p>While the precise fact set of the Pike River initial explosion is unknown, the requirements to prevent a recurrence are well known, were recommended by the Commission and have been implemented.</p>

5. Legality under health and safety legislation	Solid Energy Comments
<p>There is no 'legal' barrier to prevent recovery of this Drift under a specified 'emergency' health and safety management system.</p>	<p>This is not an emergency.</p>
<p>Reference: Reg 170, in particular Reg 170 (3)(a) ....no requirement for a second egress if work is being conducted "under the health and safety management scheme" .... i.e. to recover the Drift, or, Reg 170 (3)(b) .... in a single- entry drive (which the Drift is).</p>	<p>This appears to be a rather convenient reading of regulation 170.</p> <p>The 2 exemptions are for :-</p> <p>“an inspection is being carried out under the mining operations health and safety management system and no other mine worker is working in the ...” – clearly there will be other mineworkers to do re-support, ventilation, pipelines etc; or</p> <p>“Where the ERZ1 is located in a single-entry drive or shaft that is being sunk” - The drift is already driven, so is not a drive.</p>



6. Hazard identification and risk management	Solid Energy Comments
<p>The planning team would identify the Principal Hazards associated with Drift Recovery (ground control, irrespirable atmospheres, spontaneous combustion, equipment fire and explosion being the most significant) and produce Principal Hazard Management Plans (PHMP) as part of the legislative submission to WorkSafe High Hazard Unit (Mines Inspectorate).</p>	
<p>In terms of the baseline risk assessments, the staged re-entry and remote seal risk assessments, as public documents will be available. These will provide a sound foundation for preparing comprehensive risk appraisal documentation and designing safe systems of work for the new hybrid recovery scheme.</p>	<p>We have already done this for our preferred method and judged it unsafe. The only way that a different conclusion can be reached is for a party with a higher risk tolerance to take over the site and task.</p>
<p>The Ventilation Study commissioned by SENZ shows that all the necessary gas and ventilation controls to allow for safe entry can be achieved.</p>	<p>The re-ventilation (with Rocsil plug in place) required a significantly larger diameter borehole to be drilled at the inbye end of the drift as recommended by Roy Moreby. This was never drilled.</p>
<p>All equipment used underground will be certified as safe for use in mines where flammable gases are likely to be present.</p>	<p>Vehicular access requires the removal of the Type C seal, airlock, weirs, barriers and the re-establishment of a seal immediately inbye this area unless these are all assumed to be removed once re-ventilated and before any further access is possible.</p>
<p>All mobile and fixed equipment will be strictly maintained in accordance with manufacturers' instructions.</p>	
<p>To ensure all expert views were heard an INCIDENT CONTROL COMMITTEE would be established with all decisions fully discussed, agreed and recorded.</p>	<p>Rationale not clear for this structure compared to normal mine management structure</p>

7. The current situation	Solid Energy Comments
<p>The Owners and Operators of the Pike River Mine have had an Improvement Notice served upon them by the Enforcement Authority that requires them to make the Pike River mine “safe”. The mine is currently safe with a rated ‘type C’ seal completed. A massive monolithic seal was intended to provide a permanent barrier to allow the mine site to be abandoned. For reasons outlined below, this is no longer representative of the ‘current state’.</p>	<p>The existing seal arrangement is technically reversible, with an airlock in place.  The seal comprises 4.2m of concrete with low strength bulk fill outbye.  Unclear what is meant by representative of the “current state”.</p>
<p>Prior to the final seal being placed the existing methane rich atmosphere against the 170m. stopping was migrated 10m further into the drift to allow the door of the stopping to be opened in a fresh-air environment and the rear of the stopping examined for any accumulation of water or debris. This partial re ventilation was achieved by extracting methane from the mine using a venturi/flame trap arrangement sited at the top of borehole PRBH 48. We believe this door has been fastened back and will remain permanently open. When the activity had been completed the venturi arrangement at the top of the borehole was turned off.</p>	<p>The 170m seal outbye airlock door came off when pulled back fully, inbye door is restrained – so cannot be simply closed.</p>
<p>When the families of the deceased found out what had occurred their obvious question was “if you can ventilate 10m” then why not the drift? They withdrew their previous agreement to the mine being finally sealed. Prior to this event we believe that the majority of the families were in agreement with this action.</p>	<p>There is a substantial difference between 10m and 2300m in terms of time frames and risks. In particular the stable barometric conditions and fine weather for flying people onto the mountain where the boreholes are.</p>
<p>Given these recent developments in conjunction with the considerable time lapse of some six years from the initial event the Families advisors consider that a re - evaluation of present circumstances is required.</p>	<p>In our view nothing has fundamentally changed except for the shaft sealing being completed and the type ‘C’ seal being in place</p>
<p>However, it is accepted that SENZ, the Owners/Operators of the mine, do not wish to open the mine for body recovery and forensic examination. They emphasise that they do not wish to place any person at undue risk to recover the Drift. We fully support them in this matter, as neither do we.</p>	<p>How does one justify the risk to life of sending people into a potential irrespirable atmosphere or a ventilated drift that backs onto an unsealed mine, when there are no lives at risk - other than those sent into the mine?</p>

8. Recovery plan framework	Solid Energy Comments
<p>The drift itself is 2.3km. in length formed to 4.5m high by 5.5m width. The drift was won mainly by drill and blast methods. The drift was and remains a single-entry driveage.</p>	<p>Nominally. Many areas have overbreak or were formed to larger dimensions.</p>
<p>To re- establish work in the mine an Emergency Operating Plan would be implemented which would control and limit the numbers of persons working in the mine to absolute minimums for the work being undertaken.</p>	<p>This isn't an emergency. However many people are permitted, they are still exposed.</p>
<p>A nitrogen plant would be established at the mine to provide inert gases as required. The proposed methodology would not involve the use of overland nitrogen pipes or injection of a "Rocsil" plug.</p>	<p>The idea to use bore holes as returns to reventilate the entire drift is an idea we would need convincing of. We planned to de-gas in favourable barometric conditions and allocated quite a few hours for moving 10 metres. Assume 2300m and you could estimate weeks. It is unlikely that you would be conducting the degassing in stable barometric conditions. Potentially personnel are required "on the hill" throughout the re-ventilation process, at least for emergency shutdown if required.</p>
<p>Surface boreholes would serve as "return airways" and venturi/flame trap arrangements would be installed at the PRDH48 and PRDH35-Grizzly boreholes.</p>	<p>Need analysis to calculate quantity that can be emitted through the boreholes. SENZ plan (Moreby report) had a larger borehole for reventilation.</p>
<p>The 170m stopping would be ventilated and air / or nitrogen allowed into the mine using a combination of methane buoyancy, natural ventilation pressure and positive fan pressure at the portal to displace and dilute the methane. The gas compositions at the ventilation boreholes would be monitored to establish when a respirable atmosphere existed in the drift.</p>	<p>It is not clear what has been opened at the portal end to support the reventilation or what infrastructure has been removed e.g. water pipes and new airlock only or is Type C seal totally removed.</p> <p>It suggests that the forcing ducting is not advanced at all through the reventilation process as no personnel are in the drift. But rather opening bore holes and pushing air and/or nitrogen into bottom of the drift with a fan</p> <p>The reventilation using ducting sequentially extended occurs as a later stage.</p>
<p>Auxiliary fans, (main fan and back up), would be established at the drift entrance fitted with a controllable de gassing unit to control air flow into the mine. The auxiliary ventilation system would be capable of ducting around 20m<sup>3</sup>/s of air to a distance of 2.3km, more than double the quantity of air required to dilute the measured methane flow to a safe 1% methane in air. The ducting would be extended in increments ensuring positive air flow and removing methane layering (nitrogen pockets) as required.</p>	<p>This appears to read that the drift will be ventilated without any seal against the mine workings - so there is actually no control on ventilation entering into the mine workings. So in effect, the mine workings that are known to be heat affected are uncontrollably exposed to oxygen.</p>
<p>Special attention would be given to the maintenance bays at 1900m which are offset to the drift. Such areas will require positive de gassing under</p>	<p>This will require some thought and effort with 12 intersections and 16 lengths of tunnel in this area.</p>

<p>controlled conditions. Temporary stoppings would be placed as exposed conditions required.</p>	
<p>We consider that the drift can be re ventilated by this combined free flow/auxiliary system and the initial de-gassing does not require any persons to be below ground.</p>	<p>Unclear how: "this combined free flow/auxiliary system and the initial de-gassing does not require any persons to be below ground...." fits with the statement: "The ducting would be extended in increments ensuring positive air flow and removing methane layering (nitrogen pockets) as required."</p>
<p>Once the Drift is re ventilated the next stage is to isolate the inbye workings to remove any risk of heating and to reduce gas emissions. This would be achieved by erecting a rated seal and purging the up-dip side with nitrogen to maintain an inert atmosphere. By this time some 47% of the workings will have been degassed thus simplifying continuing gas control. The preferred site for the seal would be the location previously selected for the "Rocksil" plug.</p>	<p>So as best we can follow the proposal:</p> <ol style="list-style-type: none"> <li>1 Seal opened and nitrogen forced in until methane forced out of borehole – no-one underground</li> <li>2 Air is then forced in to purge the nitrogen - no-one underground</li> <li>3 People then re-enter the drift and:</li> <li>4 Extend ductings down drift to clear methane or nitrogen layers or pockets and the 'maintenance bays'</li> <li>5 Roof is checked and resupported as required</li> <li>6 Road is cleared of obstructions to allow machinery for resupport work</li> <li>7 When have progressed up past the pit bottom in stone, a rated stopping is built to isolate the mine from the drift at the 'rocksil' location.</li> </ol> <p>In our view this is fundamentally flawed in that the end of the drift with its methane make and fire risk is semi-ventilated, is not sealed and the entry could take weeks at least. During this time a significant amount of work requiring people underground is required including diesel vehicles.</p>
<p>As the drift is entered, roof, wall and floor conditions would be inspected before men proceed. In any areas where the drift condition creates concern, additional support will be installed. Camera evidence shows a fall of strata in the Spaghetti Junction area and strata monitoring indicated 180mm. of movement on the Hawarra fault some 180m inbye. Areas can therefore be identified which cannot be traversed until made safe. This type of work is considered normal mining practice and would typically involve the installation of passive supports to whatever standards were necessary.</p>	<p>At least 2 roof falls in the top end of the drift are known.</p> <p>Spaghetti junction is behind the fall in the drift</p> <p>Cannot determine how the rated seal is going to be built at DH48 and the time it will take to get to that point while managing the drift atmosphere via the venturi(s) and eventually advanced auxiliary ventilation. This also requires going past the Hawera fault and therefore potential poor ground (previously identified by experts) so roadway support could be required and debris fields navigated.</p> <p>The time taken to get to the inbye end of the drift has to consider; services would be required: air, water, nitrogen. Removal of Jugonaut LHD unless only walking past it only (but then would have to carry all material for rated seal and plant and equipment past it and inbye to seal site. Single entry requirements would remain in effect.</p>
<p>Major obstructions such as the Juggernaut and floor debris will be removed to minimise hazards to miners in transit and to allow use of vehicular</p>	<p>Single entry type conditions, guidelines would still apply – increasing the service</p>

<p>transport for materials transport and rapid evacuation of miners to the surface.</p>	<p>requirements when advancing up the drift, all increasing the time factor</p> <p>Use of vehicular traffic implies removal of recent construction: Type C seal, airlock, weirs, barriers etc and the potential need to construct an interim seal inbye so these things can be deconstructed to allow vehicular access (implicit in moving Jugonaut and debris)</p>
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9. Conclusions	Solid Energy Comments
<p>The fundamental principles to be employed that will ensure risks can be satisfactorily managed in a new method for re-entering the Drift are:</p>	
<ul style="list-style-type: none"> <li>A robust and clear command structure will be established.</li> </ul>	
<ul style="list-style-type: none"> <li>All activities undertaken will be compliant with New Zealand mining laws and regulations.</li> </ul>	
<ul style="list-style-type: none"> <li>Risk-based decision making will be supported by an incident committee of experts.</li> </ul>	
<ul style="list-style-type: none"> <li>No person will enter the drift until the methane is within recognised safe concentration limits.</li> </ul>	<p>“No person will enter the drift until the methane is within recognised safe concentration limits”</p> <p>There must be a mixing zone of air/methane inbye the venturi drillholes – how is this monitored or controlled and the extent of this zone ranging into the old workings will vary as barometric changes occur. The implication of the quoted statement is actually that no-one can enter the drift.</p>
<ul style="list-style-type: none"> <li>An intermediate stage of purging the drift with nitrogen prior to ventilating is envisaged.</li> </ul>	<p>Noted and makes sense, but may need to reinstate additional power capacity</p>
<ul style="list-style-type: none"> <li>Only experienced, competent miners will be admitted underground.</li> </ul>	<p>Noted, and generally agreed. Exceptions may be required for specialist contractors and forensic investigators</p>
<ul style="list-style-type: none"> <li>The number of persons allowed underground at any time will be limited.</li> </ul>	<p>This is a minimization or mitigation strategy, not elimination</p>
<ul style="list-style-type: none"> <li>Mines Rescue will provide safety cover for the underground workforce.</li> </ul>	<p>Presume Mines Rescue are only called on in the case of an emergency and not permanently located at/near site providing safety cover. If something goes wrong, they will be hard pressed to do anything.</p>
<ul style="list-style-type: none"> <li>Auxiliary forcing ventilation will be advanced in the drift in stages to ensure any gas flowing into the drift from the former mine workings is satisfactorily diluted and dispersed, and any layered methane or gas pockets are cleared.</li> </ul>	<p>This suggests there is an explosive mixture of unknown size maintained ahead of the auxiliary ventilation. Vehicles are therefore operating in a return airway. The time to achieve this along with resupport work is the most serious concern as the end of the drift/mine is uncontrolled during this time.</p>
<ul style="list-style-type: none"> <li>Workers will be withdrawn in the event pre-set monitored parameter Trigger Action Response limits are exceeded.</li> </ul>	<p>Noted, normal practice. The lack of monitoring points may make re-entry after withdrawal problematic unless additional points are installed during the auxiliary</p>

	reventilation process.
<ul style="list-style-type: none"><li>An underground stopping will be erected at a suitable location, ideally near to the intended placement location of the "Rocksil" seal which will not be used. The mine space beyond will be inertised with nitrogen piped underground.</li></ul>	See earlier comments about how long it will take to get into the intended location all the while the area is unsealed and ventilated into the known fire area.

10. Recommendations	Solid Energy Comments
<p>There is no technical mining reason that a re- entry into Pike River Drift could not be achieved safely. A detailed plan should be developed to deliver such a result.</p>	<p>A detailed plan is still to be developed, so how can this be assessed and promoted as a safe plan as it is presented?</p>
<p>As the Families' experts and SENZ Board cannot reach a joint position then only the Government can decide what the future of this mine is. The legal implications of who the future Owners/Operators of the mine would be should be considered as soon as possible.</p>	<p>Agreed the legal position regarding re-entry eg acceptable risk, single entry-second egress, working underground with known explosive mixtures inbye and all regulatory matters need to be considered -</p>
<p>Re-entry into the drift as far as 2.1km to 2.3km as a first step should be achievable without exposure to unacceptable risk and would provide the necessary information on how to proceed. We consider that this first step at least should be sanctioned and would meet in part the Governments initial promises to the families.</p>	<p>This re-entry is identified as the "first step" in the process and "provide the necessary information on how to proceed"... to do what? It implies the pressure would then be to go further and recover the whole mine.</p>
<p>We the Families' advisors would not countenance any unacceptable exposure to risks and if evidence suggests that to progress at any stage will be too high risk then we will be the first to tell the Families that the recovery should be halted and the mine should be finally sealed.</p>	<p>Solid Energy considers this is the situation now. That is what the evidence and work suggests. This plan does not have the detail and planning necessary to show it is feasible and safe.</p>
<p>The way forward would require transfer of all responsibilities and liabilities from SENZ to a government entity. The re-entry process should be subject to the oversight of independent professionals with detailed knowledge of the mine and no direct affiliation to the Families who can professionally advise the government and work constructively with the recovery team and the technical advisors to the Families Committee.</p>	<p>Government entity needs qualified personnel who still have responsibility for the re-entry.</p> <p>There will be oversight from independent professionals – responsibility, indemnity issues will likely arise.</p>