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Hydraulic Fracturing Inquiry
GPO Box 4396
Darwin NT 0801

Via email: *fracking.inquiry@nt.gov.au*

Scientific Inquiry into Hydraulic Fracturing of Unconventional Reservoirs in the Northern Territory

Dear Madam Chair,

Thank you for your correspondence of 27 February 2017.

As you are aware, Armour Energy Ltd is the holder of a number of petroleum exploration tenements in the Northern Territory and therefore has an interest in this Inquiry.

We provided a submission to the Hawke inquiry and attach that submission for your review.

Yours sincerely

Roger Cressey
Acting CEO

Encl: Armour Energy Submission regarding the Inquiry into Hydraulic Fracturing in the Northern Territory

About Armour Energy

Armour Energy is a junior gas and oil exploration company. Armour listed on the ASX in April 2012 and is based in Brisbane, Queensland.

Armour's tenements (granted and under application) in the Northern Territory cover the Borroloola and McArthur River region and areas to the south with a total area of approximately 120,000 km2. Armour also has tenements in north-west Queensland and Victoria.

Armour's Northern Territory acreage contains multiple geologic basins, being the MacArthur Basin, the Georgina Basin, the Carpentaria Basin, and the South Nicholson basin. These basins include proven petroleum systems and we believe the overall potential of the area is significant in terms of potential gas reserves and possibly oil. Armour's Northern Territory onshore shale gas reserves are estimated to be 24 Tcf of prospective resources and potentially contain 2.2 billion barrels of liquids. Even if only a small portion of these numbers are ultimately developed, it will provide a significant amount of energy for local and overseas markets.

Armour's acreage is close to infrastructure which provides it with good commercialisation opportunities.

We are focused on the discovery and development of world class gas and associated liquids resources in northern Australia.

Armour understands that local communities and other external stakeholders have questions about hydraulic fracturing. These questions need to be answered through effective consultation with external stakeholders.

Proposed use of hydraulic stimulation

- Armour has carried out hydraulic stimulation in Queensland, in similar geological formations to those underlying Armour's acreage in the Northern Territory. Our experience outlined in our submission is based on our Queensland experience, as well as other experiences which have been had by senior and experienced personnel working at Armour.
- To date, Armour has not carried out any hydraulic stimulation in the Northern Territory. However, the target formations for our exploration involve unconventional gas and oil, otherwise known as shale or tight gas and oil reservoirs. In order to make tight gas or oil reservoirs a commercially viable resource, hydraulic stimulation is required. Armour is also exploring for conventional gas and oil which does not require hydraulic stimulation.
- The technology associated with hydraulic stimulation has come a long way since the beginning of hydraulic stimulation around 60 years ago in the USA. In Australia, Santos has been performing hydraulic stimulation since 1967 in the Northern Territory with no issues or major problems reported, and has been providing a source of energy for customers and jobs in the communities in which it operates.

Environmental outcomes and impacts of hydraulic stimulation

- To what extent does increased traffic pose any risks?

There is a volume of traffic involved with any hydraulic stimulation operation. The traffic is typically semi-trailer trucks and light vehicles which are common in the region of Armour's Northern Territory acreage.

Armour implements traffic management plans to address any increase in traffic and to manage and mitigate associated risks. Such issues are appropriately managed on all sorts of activities and projects of different types across the globe.

Environmental outcomes and impacts of hydraulic stimulation

- Does hydraulic stimulation impact our beautiful landscape?

Exploration for gas and oil involves drilling wells before any stimulation takes place. Armour only clears the minimum land required to safely perform operations. The selection of locations for well pads is done to minimise the amount of clearing of vegetation. Any land clearance is only carried out after obtaining native title approval, landowner agreement and Cultural Heritage clearance to do so.

Hydraulic stimulation generally requires the construction of ponds or dams for water and fluid management. These ponds or dams are lined to avoid any contamination of soil and water courses. Fluid that flows back to surface following hydraulic stimulation operations is stored in these lined ponds or dams, then treated to remove contaminants (using reverse osmosis or other processes) to be of a quality suitable for discharge locally or it is transported to a location away from the site where it is treated. After wells have been hydraulic fractured and placed into production, the area surrounding the well, including the ponds or dams, is rehabilitated so that only a small area immediately surrounding the wellhead remains for the operations.

In order to assess whether or not there are any impacts as a result of field operations, baseline environmental data is gathered prior to drilling and hydraulic stimulation activities, and this is compared to data obtained during ongoing monitoring activities. Baseline data is collected in respect of water quantity and quality and soil.

Environmental outcomes and impacts of hydraulic stimulation

- Do the chemicals used for stimulation contaminate aquifers?

Not contaminating aquifers is a key objective. As part of the drilling process and before hydraulic stimulation work starts, the well has cement pumped into the annulus between the outside of the steel casing pipe and the well bore, thus isolating all aquifers from the well so no contamination occurs. In addition, the design of the hydraulic stimulation operation is such that the stimulation of the rock does not extend beyond the boundaries of the target formation. This design prevents contamination of aquifers. The hydraulic stimulation process involves pumping a mixture of water, proppant (usually sand, or can be ceramic) and some chemicals at high pressure into the target rock formation. A typical hydraulic stimulation fluid makeup could be about 96% water, about 3.5% or more of proppant and about 0.5% or less of chemical additives. The chemical additives used these days are generally found in some form in household items. An example of the chemicals used in a hydraulic stimulation program is provided in Appendix 1 of our submission. This fluid mixture is pumped down the well bore inside steel casing pipe to below any aquifers and into the target formation where the hydraulic stimulation occurs.

Of the stimulation fluid which is pumped down the well bore, an industry rule of thumb suggests that around 60% flows back to the surface. Some of the remaining fluid may come to the surface over time during gas production and the rest will remain contained in the formation. Fluid that comes to the surface during production is contained and treated to ensure no contamination of ground or water courses occurs.

Environmental outcomes and impacts of hydraulic stimulation

- Can the hydraulic fractures penetrate and therefore damage aquifers?

The design of hydraulic stimulation operations is done so that the stimulation of the rock does not extend beyond the boundaries of the target formation. This keeps the hydraulic stimulation fluid contained within the target formation and the well bore, thus keeping it away from other rock formations and aquifers.

Also, target rock formations for tight and shale gas are usually much deeper than any aquifer meaning there are many hundreds of metres and multiple layers of impervious rock between the hydraulic stimulation operation and any aquifer. Armour's target rock formations are from approximately 1500 metres to 3000 metres below the earth's surface.

Aquifers are typically no more than around 300 to 500 metres deep, and generally much shallower than that. This means that, typically, at least 500 metres, and usually more, of impervious rocks exist between the hydraulic fractures and any aquifer. The likelihood therefore of a hydraulic fracture penetrating an aquifer is extremely low or negligible, at best.

Environmental outcomes and impacts of hydraulic stimulation

- Does water used for hydraulic stimulation deplete aquifers?

Where proper water management is not implemented, there is a risk of depletion of aquifers. Proper water management includes hydrological studies to understand the relation between surface water and groundwater, baseline studies on water quantity and ongoing monitoring to monitor water levels. Armour recognises the importance of water management particularly in dry regions such as parts of the Northern Territory, and Armour will carry out proper water management procedures.

There is potential for recycling of water. This provides opportunity to minimise the quantity of water to be obtained for ongoing hydraulic stimulation activities.

Armour recognise that other industries, land users and communities require water and they rely on their existing water supplies. For hydraulic stimulation, water sources would include existing water courses, dams and bores where the quantities obtained would be limited to ensure no impact to other users. Other water sources would potentially include bores accessing aquifers not currently used by other parties, and these aquifers would likely be deeper than those traditionally drilled by communities and graziers for water supplies. As part of water management activities, ongoing monitoring of water levels (and quality) in existing water courses, dams and bores provides an understanding of whether or not water being sourced for hydraulic stimulation is causing impacts on water levels on those various existing water sources, including aquifers. Water obtained for hydraulic stimulation is limited from existing water sources used by others so as not to impact other users.

Conclusion

We recognize the beauty of the landscape in the remote parts of the Northern Territory where we have tenements. We strive to maintain a social license to operate, and to do so we must respect the environment and the communities in the region that we work. Whilst the population in the area of our tenements is low, we have provided employment to local companies and indigenous people in our early exploration activities, and we plan to continue to do this in the future.

There is significant interest by a range of companies in exploring for oil and gas in the Northern Territory. This provides the people in the Territory with an opportunity to benefit from investment by this industry in multiple ways whilst ensuring the environment is protected. Benefits range from creating many jobs providing a very significant additional revenue stream for the government that can be used for building roads, schools, hospitals etc. The benefits can be significant and properly managed, they can be delivered in a transparent and sustainable way.

In the process of exploring for and developing the potentially large energy resource across our tenements, Armour will ensure it's activities meet legislated requirements and industry best practice while we also provide transparency to stakeholders, ensure that local communities benefit from our activities, respect Cultural Heritage, and minimise impact on the environment.

Appendix 1: Example chemicals used in a hydraulic stimulation (the total volume of chemicals is <0.5% of the fluid, which is >95% water)

Wet chemical components	Application in frac	Approximate % of total volume	Common uses
Guar gum **(this is the largest chemical component)**	Gelling Agent	Less than 0.2%	The largest market for guar gum is in the food industry: • increases dough yield • it thickens milk, yogurt, kefir, and liquid cheese products • it improves the stability and appearance of salad dressings, barbecue sauces, relishes, ketchups
Alcohols, C6-12, ethoxylated propoxylated	Product stabilizer and/or winterizing agent. Surfactant.	Less than 0.2%	Used in detergents
Water in Products	Product carrier	Less than 0.2%	water
Choline chloride	Clay Stabilization Agent	Less than 0.1%	form of salt, found in chicken feed
Alcohols, C10-16, ethoxylated propoxylated	Product stabilizer and / or winterizing agent. Surfactant.	Less than 0.1%	Used in detergents.
Acetic acid	Solvent	Less than 0.1%	The main component in vinegar
Phosphonium, tetrakis(hydroxymethyl)-, sulfate	Eliminates bacteria in the water that produces corrosive by-products. Biocide.	Less than 0.1%	Biocide; it breaks down under UV light into sulfates and phosphates which are naturally occurring compounds
Monoethanolamine borate	Crosslinker; like boric acid, it cross links the guar	Less than 0.1%	Used in hair products

Appendix 1: Example chemicals used in a hydraulic stimulation (the total volume of chemicals is <0.5% of the fluid, which is >95% water)

Wet chemical components	Application in frac	Approximate % of total volume	Common uses
Sodium hydroxide	pH-control	Less than 0.1%	Lime, naturally occurring, used on gardens
Hydrochloric acid	Helps dissolve minerals and initiate cracks in the rock	Less than 0.1%	pH Control and neutralization used in: • swimming pools • purification of common salt • household cleaning
Sodium persulfate - Na2S2O8	Breaker, allows delayed breakdown of the gel	Less than 0.1%	It is used as a bleach, in hair cosmetics, and as a detergent component
Ethylene glycol	Product stabilizer and / or winterizing agent. Carrier for borate.	Less than 0.1%	It is an organic compound; is used as a raw material in the manufacture of polyester fibers and fabric industry, and polyethylene terephthalate resins (PET) used in bottling; a small amount is also used in industrial applications like antifreeze formulations and other industrial products
Maltodextrin	Used to breakdown the sugars in other components.	Less than 0.1%	Used as a food additive; produced from starch; commonly used for the production of sodas and candy; can also be found as an ingredient in a variety of other processed foods
Coffee Extract	Inhibit acid corrosion	Less than 0.1%	Freeze dried coffee (as used to make coffee in the home)
Hemicellulase enzyme	Breaker	Less than 0.1%	It is used as a baking enzyme (cake mixes); used in the production of fruit juices, spirits and wine

THANK YOU