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25 June, 2014

The Commissioner
Hydraulic Fracturing Inquiry
c/- GPO Box 4396
Darwin NT 0801

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

Re: Inquiry into Hydraulic Fracturing in the Northern Territory

Dear Dr Hawke

Armour Energy Ltd (Armour) is the holder of granted petroleum exploration tenements in the Northern Territory and therefore has an interest in this Inquiry.

We welcome the opportunity to provide a submission to the inquiry and attach it for your review.

Yours sincerely

Robbert de Weijer
Chief Executive Officer

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

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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 in the Northern Territory cover the Borroloola and McArthur River region and areas to the south with a total area of approximately 120,000 km^2. 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 be enough to significantly impact supply; for example enough to feed multiple LNG production facilities.

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 fracturing

Armour has carried out hydraulic fracturing in Queensland, in similar geological formations to those underlying Armour's acreage in the Northern Territory. Our experience outlined in this 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 fracturing 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 fracturing is required. Armour is also exploring for conventional gas and oil which does not require hydraulic fracturing.

The technology associated with hydraulic fracturing has come a long way since the beginning of hydraulic fracturing around 60 years ago in the USA. In Australia, Santos has been performing hydraulic fracturing 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 fracturing

A hydraulic fracturing operation takes up to a week for each well. Prior to the hydraulic fracturing operation, the well pad and ponds for water fluid management are constructed. After the hydraulic fracturing operation is completed the flow back of fluids will be managed and the site will be rehabilitated leaving only the operating well-head facility.

Like many things that are done in society, there are environmental impacts associated with hydraulic fracturing. Over the last few years there has been a lot of publicity around the impact from hydraulic fracturing on groundwater. In Armour's view, the perception that this risk is high is uninformed and unjustified. It is up to

the industry and the government to play a key role in explaining that the real level of these risks is low and to outline how industry can act to mitigate these risks.

Below, and in no particular order, we make comment regarding perceived risks in relation to hydraulic fracturing operations and how these are able to be mitigated.

To what extent does increased traffic pose any risks? There is a volume of traffic involved with any hydraulic fracturing operation. The traffic is typically semi-trailer trucks and light vehicles which are common in the region of Armour's Northern Territory acreage. Traffic management plans should be implemented to address any increase in traffic and to manage and mitigate associated risks. Such issues are appropriately managed on projects of different types across the globe.

Does fraccing impact our beautiful landscape? Exploration for gas and oil involves drilling wells before any hydraulic fracturing takes place. Drilling wells involves clearing of land for well pads and, where access is not already available, clearing access tracks to get to the well pads. Armour only clears the minimum land required to safely perform drilling and hydraulic fracturing 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 fracturing 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 following hydraulic fracturing 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 data is gathered prior to drilling and hydraulic fracturing 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.

We recognise 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.

Do the chemicals used for fraccing contaminate aquifers? As part of the drilling process and before hydraulic fracturing 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 fracturing operation is such that the fracturing of the rock does not extend beyond the boundaries of the target formation. This design prevents any contamination of aquifers. The hydraulic fracturing process involves pumping a mixture of water, proppant (usually sand) and some chemicals at high pressure into the target rock formation. A typical hydraulic fracturing 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 fracturing program is provided in Appendix 1 of this submission. This fluid mixture is pumped down the well bore inside steel casing pipe below any aquifers and into the target formation where the hydraulic fracturing occurs.

The fluid that flows back to the surface is contained and handled to avoid ground and water course contamination.

Of the fracturing fluid which is pumped down the well bore, 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.

Can the hydraulic fractures penetrate and therefore damage aquifers? The design of hydraulic fracturing operations is done so that the fracturing of the rock does not extend beyond the boundaries of the target formation. This keeps the hydraulic fracturing 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 fracturing 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, at best.

Does water used for fraccing deplete aquifers? Water is required for hydraulic fracturing. The amount required will vary depending on the hydraulic fracturing design for each well.

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.

There is also potential for recycling of water. When a project is in production mode and multiple wells are being hydraulically fractured, the fluid that flows back to surface can be re-used for the next hydraulic fracturing operation. This minimises the quantity of water to be obtained for ongoing hydraulic fracturing activities.

Armour recognise that other industries, land users and communities require water and they rely on their existing water supplies. For hydraulic fracturing, water sources would include existing water courses, dams and bores where the quantities obtained would be limited to not impact 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 fracturing is causing impacts on water levels on those various existing water sources, including aquifers. Water obtained for hydraulic fracturing is limited from existing water sources used by others so as not to impact other users.

Consultation and relationships

It is Armour's view that the Government, the oil and gas industry, other industries and communities need to engage in ongoing consultation to share understanding and knowledge of all parties and across all parties.

In Queensland, a GasFields Commission was established as an independent statutory body with powers to review legislation and regulation; obtain and disseminate factual information; advise on coexistence issues; convene parties to resolve issues; and make recommendations to government and industry. For Queensland, agricultural and onshore gas industries are a significant part of the economy, and the GasFields Commission has, in our view, made a big difference in the understanding of various industry and community needs and desires through facilitating communication and consultation. The outcome being improved relationships, an ability to work together and for parties to mutually benefit from each other's industry.

Armour considers that a similar independent body would be good for the Northern Territory but it is important to ensure that personnel appointed to such a body are open, honest and able to communicate effectively across all industries with the aim to improve co-existence.

Conclusion

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 potentially thousands of jobs to providing a very significant additional revenue stream for the government that can be used for building roads, schools, hospitals etc. The benefits can be very significant and if properly managed, they can be delivered in a transparent and sustainable way. In order to do this we recommend the following:

1. Government should demonstrate strong leadership by consistently reinforcing to the public that the industry is needed and will be developed in a way that is transparent and sustainable.

2. A regulatory framework that is robust and established in a way that requires industry to deliver world leading practices; and because technologies are constantly improving the regulatory requirements need to be flexible to enable current leading practices to be implemented. Also, the regulator needs to be adequately resourced to manage the likely growth in activity across the Territory in the foreseeable future.
3. Industry should show strong leadership through engaging with external stakeholders, being transparent, ensuring that local communities benefit from industry activities, respecting Cultural Heritage, and minimising impact on the environment.
4. The Northern Territory Government should consider the establishment of a Commission similar to what has been done in Queensland known as the GasFields Commission. It is critically important that an appropriate person is engaged as the Commissioner to enable such a body to be effective, and selecting the right team members is also very important.

Armour is a member of APPEA and this submission provides Armour's views in addition to and in support of the submission provided by APPEA to this Inquiry.

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

Wet chemical components	Application in frac	Common uses
Guar gum (this is the largest chemical component)	Gelling Agent	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.	Used in detergents
Water in Products	Product carrier	water
Choline chloride	Clay Stabilization Agent	form of salt, found in chicken feed
Alcohols, C10-16, ethoxylated propoxylated	Product stabilizer and / or winterizing agent.Surfactant.	Used in detergents.
Acetic acid	Solvent	The main component in vinegar
Phosphonium, tetrakis(hydroxymethyl)-, sulfate	Eliminates bacteria in the water that produces corrosive by-products. Biocide.	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	Used in hair products
Polyethylene glycol (PEG)	Product stabilizer and / or winterizing agent. Carrier for the alchohols.	Compound with many applications from industrial manufacturing to medicine: • basis of many skin creams • used in a number of toothpastes, detergents and soaps

Wet chemical components	Application in frac	Common uses
Sodium hydroxide	pH-control	Lime, naturally occurring, used on gardens
Hydrochloric acid	Helps dissolve minerals and initiate cracks in the rock	pH Control and neutralization used in: • swimming pools • purification of common salt • household cleaning
Sodium persulfate - Na2S2O8	Breaker, allows delayed breakdown of the gel	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.	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.	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	Freeze dried coffee (as used to make coffee in the home)
Hemicellulase enzyme	Breaker	It is used as a baking enzyme (cake mixes); used in the production of fruit juices, spirits and wine
Sodium sulfate - Na2SO4	Salt	Salt; other uses for sodium sulfate include de-frosting windows, in carpet fresheners, starch manufacture, and as an additive to cattle feed