Amendment of Environmental Assessment of Multiklient Invest Newfoundland Offshore Seismic Program, 2018–2023

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Prepared for:

Multiklient Invest AS

and

TGS-NOPEC Geophysical Company ASA

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Amendment of Environmental Assessment of Multiklient Invest Newfoundland Offshore Seismic Program, 2018–2023

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1.0 Introduction

This document is an Amendment of the Environmental Assessment (EA) of Multiklient Invest Newfoundland Offshore Seismic Program, 2018–2023 (LGL 2018a), and the associated EA Addendum (LGL 2018b) and three EA Updates (LGL 2018c, 2019, 2020). The EA Update for 2021 is currently being prepared (LGL in prep.). The proposed change to the Project activities assessed in this Amendment involves the testing of a new seismic surveying technique called eSeismic.

2.0 Testing of a Modified Airgun Array

As indicated in Section 2.6.6 of the Multiklient Invest (MKI) EA (LGL 2018a), MKI outlined the parameters of its seismic energy source:

> *"The sound sources for the proposed 2D/3D/4D survey program will consist of one, two or three airgun arrays. For any sound source that consists of either two or three airgun arrays, the arrays will be discharged alternately (i.e., multiple airgun arrays will not be discharged simultaneously). In 2018, 3D seismic surveys will be conducted using two airgun arrays, each consisting of six subarrays. The total volume of an airgun array may range from 3,000–6,000 in^3. The airgun array(s) will be deployed at depths ranging from 6–15 m, and the airguns will be operated with compressed air at pressures ranging from 2,000–2,500 psi. The peak-to-peak sound source level will be ~100–200 bar-m (~260–266 dB re 1 µPa ·m $_{p-p}$)."*

In 2021, MKI is proposing to test a modified activation procedure of the airguns called eSeismic. This technology involves the activation of individual airguns in a pseudo-random pattern every 200 ms or every 1–2 m along a seismic survey line. As such, only one airgun is activated at a time, but the airguns are activated on a near continuous basis versus every 10–12 seconds in a conventional seismic survey. The sound pressure level (SPL) of the source is reduced due to smaller airgun volumes being activated at once (Figures 2.1 and 2.2). Other parameters of the seismic procedures and equipment remain unchanged. Table 2.1 summarizes the key parameters of eSeismic relative to the airgun arrays used in the conventional MKI/PGS seismic surveys. The survey speed and number of streamers will be within the parameters outlined in the EA (LGL 2018a).

MKI is proposing to test eSeismic in a 75 km^2 area within Exploration License (EL) 1156 (i.e., Cambriol MC3D Survey Area; Figure 2.3). The exact test area location is yet to be defined. The eSeismic test would occur after the completion of conventional seismic data acquisition in the Cambriol MC3D Survey Area, which is scheduled to occur in July. The duration of the eSeismic test would be approximately 5–7 days.

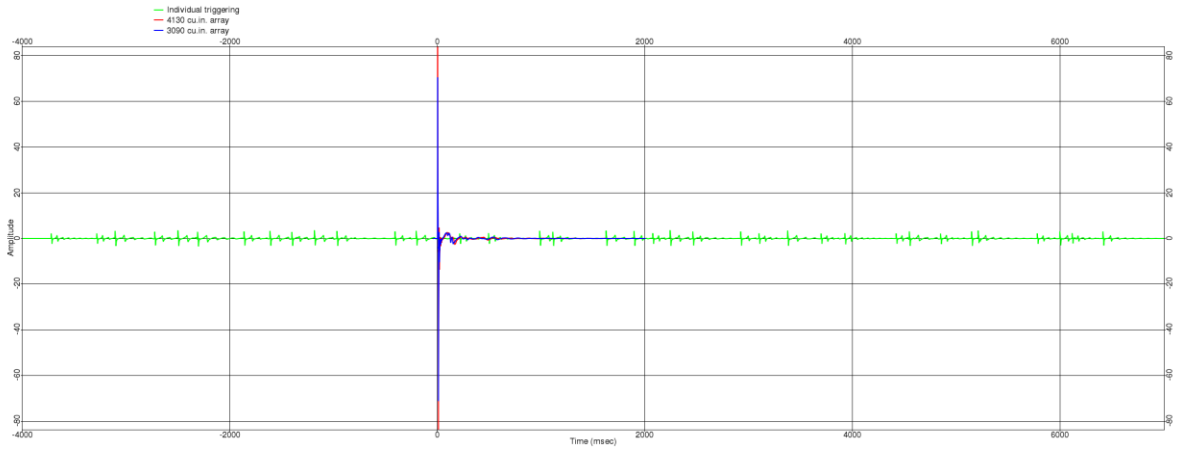

Figure 2.1. Amplitude (bar-m) as a function of time (msec) for the PGS 4130 in^3 airgun array (red curve), 3090 in^3 airgun array (blue curve) and when triggering one airgun at a time approximately every 200 msec (green curve). [Provided by PGS—based on Figure 12 in Hegna et al. 2019.]

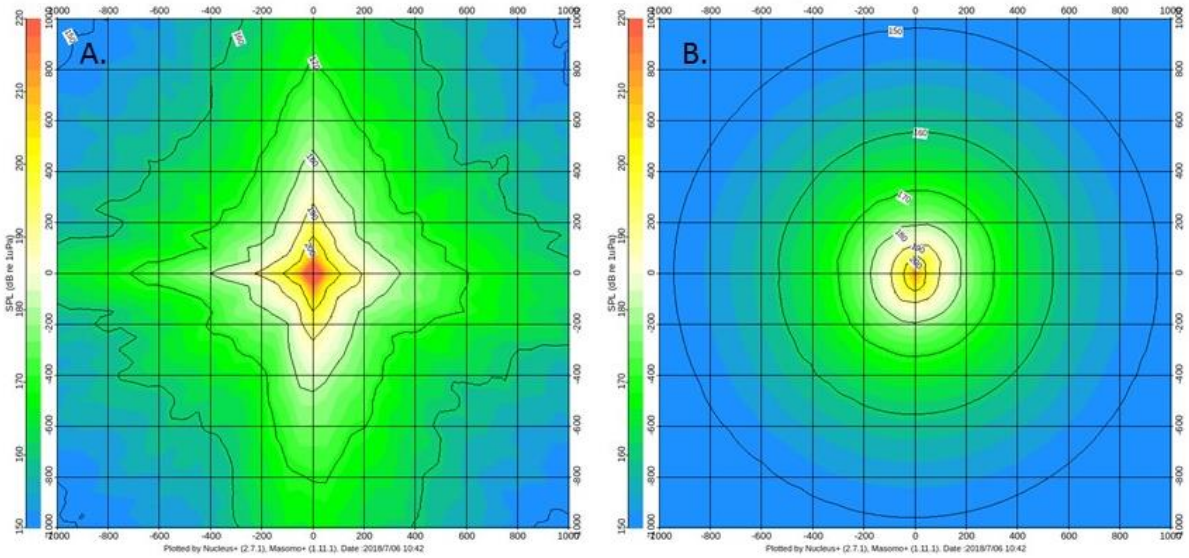

Figure 2.2. Peak sound pressure levels (in dB re 1 µPa) as a function of inline and cross-line distances in metres from the geometrical center of the source at a depth of 10 m (4 m below the source depth) for a conventional 4130 in^3 airgun array (A) and when triggering individual airguns in a near-continuous fashion (B). [Provided by PGS—based on Figure 13 in Hegna et al. 2019.]

Table 2.1. Summary of key parameters of eSeismic and conventional MKI/PGS seismic survey.

Parameter	eSeismic	Conventional Array
Total volume/sub-array	560 in^3	4130 in^3
Pressure	2000–2500 psi	2000–2500 psi
Source depth	6–15 m	6–15 m
Shot point interval	200 ms	10–12 s
No. of airgun arrays	1	2–3
No. of sub-arrays per array	6	2–3
Max no. of airguns active at one time	1	36
Volume range of airguns	40–150 in^3	40–250 in^3
Peak-to-peak sound source level	~10–20 bar m	~100–200 bar m

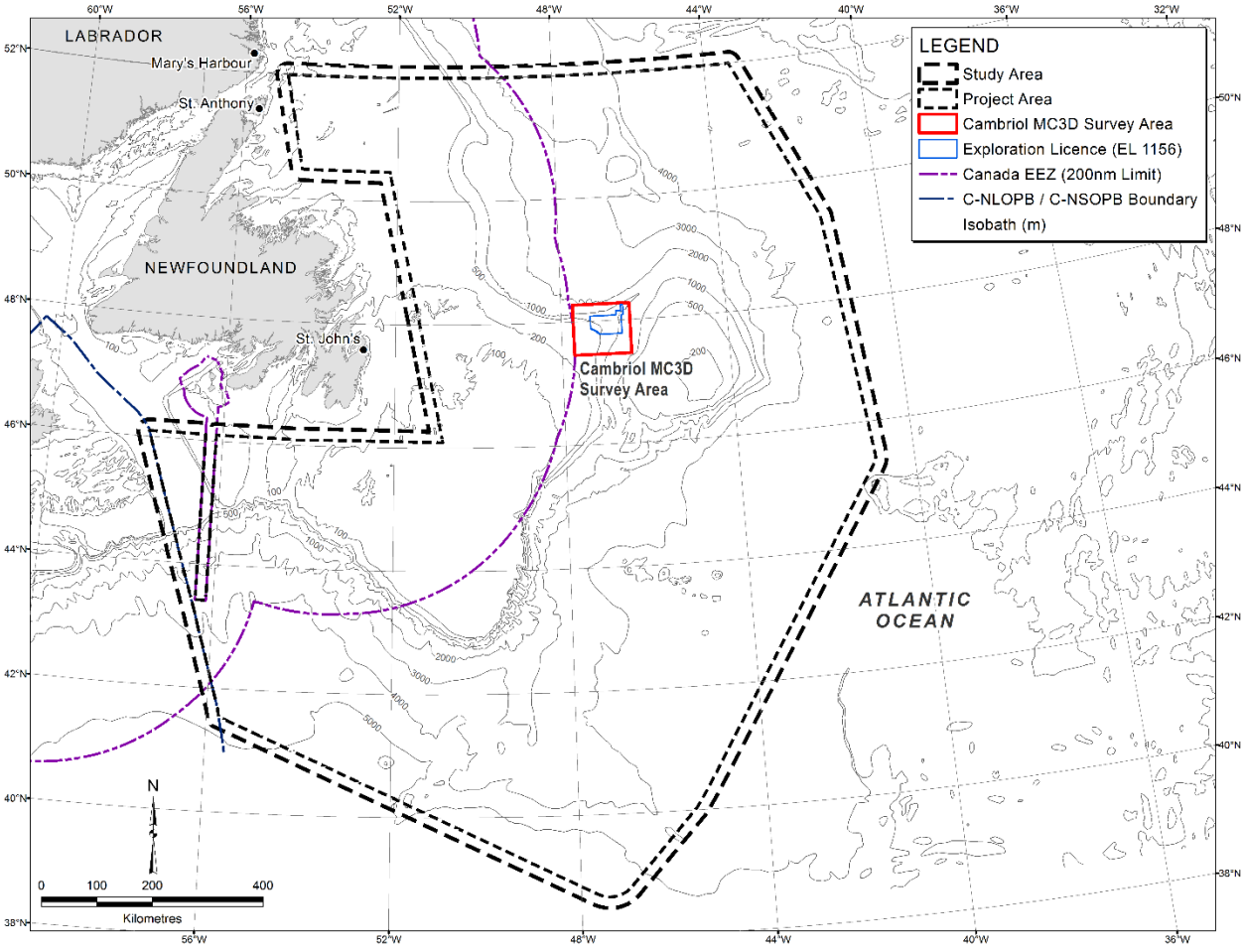

Figure 2.3. Location of the proposed eSeismic test in the MKI Project Area.

Given that eSeismic only operates a single airgun at a time, a conventional ramp up of the airguns is not possible. However, the smallest airgun (40 in^3) will be used at the start of eSeismic testing. All other mitigation measures related to airgun use will remain the same as outlined in the EA (LGL 2018a), its Addendum (LGL 2018b), and the EA Updates (LGL 2018c, 2019, 2020, in prep.).

3.0 Effects Assessment

Effects on the Valued Environmental Components (VEC), with emphasis on marine mammals, have been reviewed based on the proposed Project amendment.

The eSeismic technique has been field-tested offshore Brazil during a small-scale pilot survey and these data were compared with those collected in the same area using conventional seismic surveying methods. Based on recorded hydrophone data from a conventional 4130 in^3 airgun array versus the eSeismic technique, the peak sound pressure levels were approximately 20–22 dB lower for eSeismic whereas the sound exposure levels (SEL) were 8–9 dB lower when compared to the conventional acquisition method (Hegna et al. 2018). The SEL over a full sequence of eSeismic pulses and over a 24-hour period were not reported.

3.1 Marine Mammals and Sea Turtles

Based on available information, there is substantial environmental benefit from the lower peak source levels associated with spreading out the source signal across multiple lower-intensity shots from individual airguns that are used in eSeismic. This would reduce the risk of temporary and permanent hearing impairment in marine mammals and sea turtles. Based on modelling of eSeismic and the PGS 4130 in^3 array, at a distance of 500 m from the geometrical centre of the source (i.e., the safety zone distance for shut downs for marine mammals and sea turtles), the peak SPL when activating individual airguns is 12 dB below the conventional airgun array in the inline direction, 5.4 dB below at 45° azimuth angle, and 17.5 dB below in the cross-line direction (Hegna et al. 2019). Even though the SPL within 500 m of the sound source is much reduced, MKI will continue to implement shut downs of eSeismic during testing if an endangered or threatened marine mammal or sea turtle, as well as a beaked whale is detected visually or acoustically within 500 m of the sound source. Furthermore, initial activation of eSeismic will not occur if any marine mammal or sea turtle is detected within or about to enter the 500 m safety zone.

As stated in the EA (LGL 2018a), behavioural responses to sound by marine mammals, depend on many factors including species, state of maturity, experience, current activity, reproductive state, and time of day. Available evidence for marine mammals (and sea turtles) shows that there is much variability in observed behavioural response to conventional seismic survey sounds (LGL 2018a, 2019, 2020) and the importance of context (e.g., Ellison et al. 2012) means that we do not know how animals might respond to sounds from eSeismic. In theory, we would assume that the frequency and severity of behavioural responses to sound from a single airgun operating

on a near-continuous basis at a much lower source level would be reduced relative to the operation of a large array of airguns. However, systematic well-controlled studies of animal responses to eSeismic sounds are necessary before the relative behavioural responses from eSeismic and conventional seismic sources can be meaningfully compared.

There is some potential that eSeismic may increase the risk of masking in marine mammals. The multiple closely-spaced pulses (about every 200 ms) without multi-second-long quiet "gaps" that generally occur in conventional seismic are a negative factor. At this stage, it is unclear how the greater potential for masking, at least in terms of duty cycle, is offset by the lower received levels of the seismic signals. The short duration of the eSeismic test in a localized area as is proposed by MKI would minimize the potential for masking in marine mammals.

Based on the lower source levels of eSeismic, the short-term duration of testing (5–7 days), and mitigation measures, we predict that residual effects from testing eSeismic on the Marine Mammal and Sea Turtle VEC are *low* in magnitude for a duration of *<1 month* over a geographic area of *<1* to *101–1000 km²*. Based on these criteria ratings, the *reversible* residual effects of sound associated with MKI's proposed eSeismic test on marine mammals and sea turtles are predicted to be *not significant*. This is consistent with the findings of the EA (see Section 5.7.7.1 *in* LGL 2018a).

3.2 Fish and Fish Habitat

As with the Marine Mammal and Sea Turtle VEC, the much-reduced source level of eSeismic would serve to reduce potential effects (i.e., behavioural, physical and physiological) of seismic survey sound on the Fish and Fish Habitat VEC. Systematic well-controlled studies of animal responses to eSeismic sounds are necessary before the relative effects from eSeismic and conventional seismic sources can be meaningfully compared. We also recognize that there are still many data gaps associated with conventional seismic surveying on fish and fish habitat.

Based on the lower source levels of eSeismic, the short-term duration of testing (5–7 days), and mitigation measures, we predict that residual effects from testing eSeismic on the Fish and Fish Habitat VEC fall within the range of effects criteria predictions in the EA (LGL 2018a). Residual effects are predicted to be *low* to *medium* in magnitude for a duration of *<1 month* over an area of *<1 to 1001–10,000 km²*. Based on these criteria ratings, the *reversible* residual effects of sound associated with MKI's proposed eSeismic test on fish and fish habitat are predicted to be *not significant*. This is consistent with the findings of the EA (see Section 5.7.4.1 *in* LGL 2018a).

3.3 Fisheries

As reviewed in the EA (LGL 2018a), behavioural changes relating to catchability of commercial species, and conflict with harvesting activities, fishing gear and lost fishing time are the key types of effects on the Fisheries VEC from seismic surveying. The substantially lower source levels of eSeismic should decrease the likelihood and severity of behavioural responses of fish and

invertebrates to sound and thereby decrease potential effects on fisheries. Given that the seismic gear that will be deployed during eSeismic from the source vessel will remain unchanged from the conventional seismic survey, the risk of seismic gear interacting with fisheries remains the same.

Based on the lower source levels of eSeismic, the short-term duration of testing (5–7 days), and mitigation measures, we predict that residual effects from testing eSeismic on the Fisheries VEC fall within the range of effects criteria predictions in the EA (LGL 2018a). Residual effects are predicted to be *negligible* to *medium* in magnitude for a duration of *<1 month* over an area of *<1 to 1001–10,000 km²*. Based on these criteria ratings, the *reversible* residual effects of MKI's proposed eSeismic test on fisheries are predicted to be *not significant*. This is consistent with the findings of the EA (see Sections 5.7.5.1 and 5.7.5.2 *in* LGL 2018a).

3.4 Marine-Associated Birds

As described in the EA (Section 5.7.6.1 *in* LGL 2018a) and its Updates (LGL 2018c, 2019, 2020), there is limited information to indicate that underwater sound from seismic surveying affects marine-associated birds.

Based on the lower source levels of eSeismic, the short-term duration of testing (5–7 days), and mitigation measures, we predict that residual effects from testing eSeismic on the Marine-Associated Bird VEC fall within the range of effects criteria predictions in the EA (LGL 2018a). Residual effects are predicted to range from *negligible to low* in magnitude for a duration of *<1 month* over an area of *<1* to *1–10 km²*. Based on these criteria ratings, the *reversible* residual effects of an eSeismic test on the Marine-Associated Bird VEC are predicted to be *not significant*. This is consistent with the findings of the EA (see Section 5.7.6.1 *in* LGL 2018a).

3.5 Species at Risk

The nature and magnitude of effects of eSeismic sound on Species at Risk are predicted to be like those summarized for marine mammals/sea turtles, fish/fish habitat, and marine-associated birds in Sections 3.1, 3.2, and 3.4, respectively. Mitigation measures for minimizing the effects of eSeismic sound on marine mammal and sea turtle Species at Risk will be the same as those for conventional seismic surveying. As noted in Section 2.0, the ramp-up procedure will be modified because only a single airgun is active during eSeismic. Residual effects of the eSeismic test on Species at Risk are predicted to be *not significant*. This is consistent with the findings of the EA (see Section 5.7.8 *in* LGL 2018a).

3.6 Sensitive Areas

The conduct of the eSeismic test during summer 2021 is not expected to increase effects on the Sensitive Areas relative to conventional seismic surveying assessed in the EA (LGL 2018a) and in

consideration of new information presented in the EA Updates (LGL 2018c, 2019, 2020, in prep.). The eSeismic test will be of short duration (5–7 days) and the effects of underwater sound from the operation of the single airgun is not predicted to significantly affect biological VECs which occur in the Project Area including the Cambriol MC3D Survey Area. Residual effects of the eSeismic test on Sensitive Areas are predicted to be *not significant*. This is consistent with the findings of the EA (see Section 5.7.9 *in* LGL 2018a).

4.0 Conclusion

In consideration of the proposed eSeismic test, all predictions of significance of the residual effects of underwater sound and the VECs remain the same as predicted in the EA (LGL 2018a,b). Mitigation procedures intended to minimize the potential effects of routine Project activities associated with MKI's seismic surveys are discussed in detail in Sections 5.5 and 5.9 of the EA and its Updates (LGL 2018a,c, 2019, 2020, in prep.) and remain unchanged except for modification of the ramp-up procedure. This modification was necessary given that the eSeismic source only activates one airgun at a time. In conclusion, there will be *no significant* residual environmental effects resulting from the proposed Project activity change in this Amendment.

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