WESTERN GRAY WHALE ADVISORY PANEL NTF-9

NOISE TASK FORCE

REPORT OF THE NOISE TASK FORCE AT ITS 9TH MEETING

19-20 NOVEMBER 2015

MOSCOW, RUSSIAN FEDERATION

CONVENED BY THE INTERNATIONAL UNION FOR CONSERVATION OF NATURE

CONTENTS

ACRONYMS

AUAR	Automated Underwater Acoustic Recorder
BG	Biodiversity Expert Group of the Environmental Council under the auspices of the Sakhalin Oblast Governor
CC	Command Centre
Company	Sakhalin Energy Investment Company
CPA	Closest Point of Approach
dB	Decibel
EIA	Environmental Impact Assessment
ENL	Exxon Neftegas Limited
HD	High-Definition
IO	Independent Observer
IR	Infra-Red
IUCN	International Union for Conservation of Nature
IWG	Interdepartmental Working Group on the Conservation of the Okhotsk-Korean (Western Gray) Whale Population (IWG) of the Russian Federation
Joint Programme	Sakhalin Energy/ENL Joint Programme on Gray Whale Monitoring and Research
M-C	Mother-Calf
MMO	Marine Mammal Observer
MMP	Monitoring and Mitigation Plan
MVA	Multivariate Analysis
NGO	Non-Governmental Organization
NTF	Noise Task Force
OBN	Ocean Bottom Node
PAM	Passive Acoustic Monitoring
Panel	Western Gray Whale Advisory Panel
Photo-ID	Photo Identification
POI	Pacific Oceanological Institute
PML	Perimeter Monitoring Line
PS-energy	Energy of reflected acoustic shear or S-waves as recorded by an Ocean Bottom Node converted from compressional or P-waves as generated by a seismic source
RMS	Root-Mean-Square
RT	Real Time
Sakhalin Energy	Sakhalin Energy Investment Company Ltd.
SEL	Sound Exposure Level
SEZ	Source Exclusion Zone
SP	Shot Point
SPL	Sound Pressure Level
VHF	Very High Frequency
WGW	Western Gray Whale
WGWAP	Western Gray Whale Advisory Panel

1 INTRODUCTORY ITEMS

1.1 Chairman's opening remarks

The 9th meeting of the Noise Task Force (hereafter NTF) was held at Crown Plaza / World Trade Centre, Moscow, Russian Federation, 19-20 November 2015, under the chairmanship of Greg Donovan. The list of participants is given as Annex A.

The Chair explained that the primary focus of the meeting was to review the practical implementation of the 2015 Piltun-Astokh seismic survey and Monitoring and Mitigation Plan (MMP) undertaken by Sakhalin Energy Investment Company Ltd. (hereafter Sakhalin Energy or the Company) and identify lessons learned that could be applied to future surveys. Given the short time between the end of the 2015 survey and this NTF meeting, he recognised that few initial results would be available to allow detailed discussion of future analyses but it was important to begin to discuss these, particularly in light of the fact that two major survey programmes had been conducted in 2015 (Sakhalin Energy and Exxon Neftegas Limited (ENL)/Rosneft).

Efforts to develop an MMP for the 2015 survey began at NTF-5 in October 2013 when it was agreed that the basis of the MMP would be that developed for the 2010 survey. It was not until October 2014 at NTF-7 that the first information was received that ENL intended to carry out a major seismic survey in adjacent waters in the same year. ENL would also be carrying out a seismic survey on behalf of Rosneft. After considerable effort, NTF-8 in November 2014 produced its final report on the 2015 survey and proposed an MMP, although noting that additional logistical work (especially with respect to training of personnel and testing of equipment and protocols) was required. This report was submitted to the Western Gray Whale Advisory Panel (hereafter WGWAP or Panel) which developed its recommendations in December 2014 at WGWAP-15 (a 'virtual' meeting). Those recommendations and the Company's responses are posted on the WGWAP website[1]. The Panel also provided a statement of concern on 8 May 2015 (and a supplementary technical note on 16 May 2015) and the Company's response was provided on 23 May 2015. These are also available on the WGWAP website[2].

To provide geographical context for the present report, Fig. 1 is repeated below from the NTF-7 report.

The Chair noted that the only change to the MMP developed at NTF-8 and agreed by the full Panel at WGWAP-15 was that if the survey went ahead, relaxation of the 2010 behavioural shutdown rule such that it would apply only to mother-calf (M-C) pairs rather than to all gray whales, was applicable only until 15 July (by which time the Panel estimated that around 75% of the animals would have arrived in the Piltun feeding area).

With respect to the Company, the changes incorporated in its final MMP[3] from the MMP recommended by the Panel related to completing the survey as quickly as possible whilst taking into account the agreement with ENL:

(1) *Date for behavioural shutdowns* – to apply to all whales after 1 August not 15 July;

(2) *Start date* – not ice melt but completion of the ENL Odoptu survey;

(3) *Exclusion zone* – exclusion zone for gray whales was set at 2km rather than estimated in the field;

(4) *Mitigation gun usage* – not used during the Piltun Astokh survey;

(5) *Shooting A-lines in poor visibility* – allowed if pre-dusk scan undertaken to confirm no M-C pairs in the A zone (rather than shooting all A-lines in good visibility conditions as in the Panel MMP).

[1] The WGWAP-15 recommendations and the initial Sakhalin Energy response of December 2014 http://cmsdata.iucn.org/downloads/report_wgwap_15___15_dec_2014_final__recs_summary_w_Sakhalin Energy_response_v2.pdf with subsequent updates to the response in 2015 available on the WGWAP Recommendations Database: http://ow.ly/Xj1os

[2] http://iucn.org/wgwap/wgwap/meetings/wgwap_wm/

[3] http://cmsdata.iucn.org/downloads/mmp_2015_piltun_astokh_4d_seismic_en.pdf

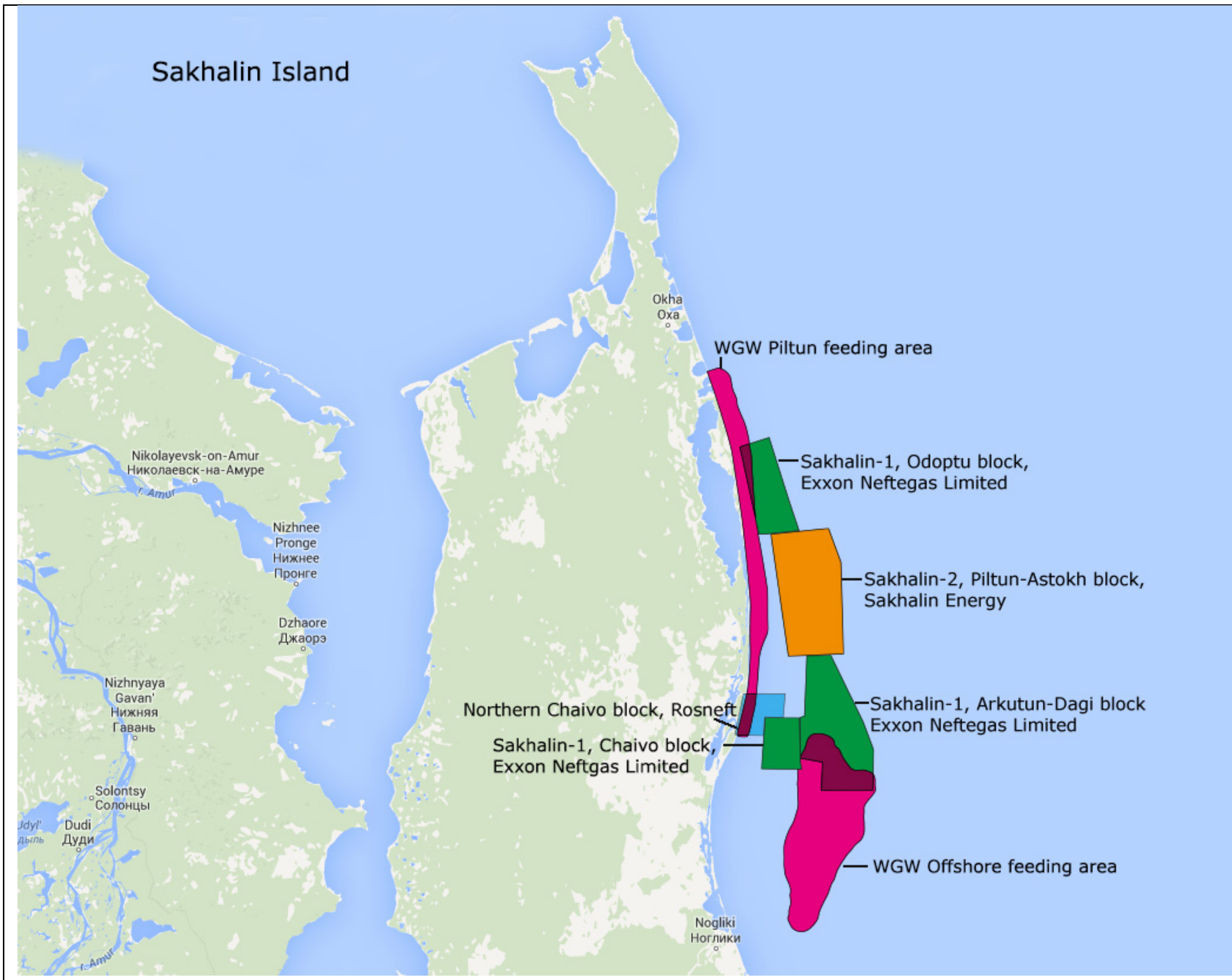

Figure 1. Schematic showing the approximate development blocks where seismic surveys were carried out in 2015 on and near the gray whale feeding areas off north-eastern Sakhalin

(Note: This schematic is based on publicly available information and included only for illustrative purposes. The designation of areas in this map and the presentation of the material, do not imply the expression of any opinion whatsoever on the part of IUCN or NTF concerning the legal status of any area, or of its authorities or operators, or concerning the delimitation of its boundaries. Coordinates, boundaries etc. on the schematic are not exact and therefore should not be used as such.)

1.2 Adoption of agenda

The agenda is given as Annex B.

1.3 Available documents/materials

The list of documents and presentations, along with information on their availability, is given as Annex C. All of the NTF and Panel reports can be found on the WGWAP website.[4]

For its review of the implementation of the 2015 seismic survey, the NTF had three valuable sources of information:

[4] http://www.iucn.org/wgwap

(1) the Company's Central Commander's report;

(2) the Company's overview; and

(3) the report of the IUCN Independent Observer (IO).

The NTF thanked the Company for providing its documents ahead of the meeting to allow members to familiarise themselves with the contents and provide early requests for additional information.

2 PROGRESS REPORT ON THE 2015 SEISMIC SURVEY(S)

2.1 Narrative

2.1.1 Company presentation

On behalf of the Company, Van der Veen provided the following general overview of the 2015 survey (confidential document NTF-9/3).

As part of its reservoir management strategy, Sakhalin Energy has conducted 4D seismic surveys to monitor oil and gas extraction and water injection. A 4D survey obtains an up to date seismic image of producing reservoirs. This image can be compared against baseline survey images, to track changes happening over time. In 2010, a 'pilot' survey was recorded across the Astokhskoye area of the Piltun-Astokhskoye field. Following this successful pilot, the Company surveyed all of its assets with the 2015 4D seismic survey. The Piltun-Astokhskoye field is situated in what is considered an environmentally sensitive area near the Piltun Bay (Lagoon), which is a recognised summer/autumn feeding area for the Critically Endangered gray whales.

For the purpose of the discussion below, Sakhalin Energy defined the following objectives for the 2015 Piltun-Astokhskoye 4D seismic survey.

(1) Acquire 36 seismic survey lines in 4D mode across the Piltun-Astokhskoye license area, within budget and the allocated timeframe, without incidents, while recording data suitable for reservoir monitoring purposes (the precise business objectives are not covered here);

(2) During acquisition, protect marine mammals, with an emphasis on gray whales, by:

  a. implementing the Company's 2015 MMP to the best of Company's ability and

  b. honouring commitments made in the Russian Federation Environmental Impact Assessment (EIA) for the project.

(3) Be transparent to the external world about what the Company does by:

  a. supporting the IUCN IO to monitor and report on field activities in line with agreed the Terms of Reference (TOR) and Communications Protocol;

  b. producing the international EIA, submitting the document for approval and then publishing it on the Company's public website;

  c. Sharing the report of the 4D survey with the Inter-Departmental Working Group for the Conservation of the Okhotsk-Korean (Western) Gray Whale Population (IWG) and Russian Federation stakeholders in due course.

In the MMP, the Company committed to starting the 4D survey at Piltun-Astokhskoye as early as possible, with the practical limitation that ENL was recording a 3D survey in the adjacent Odoptu license area in June-July 2015. ENL finished its 3D survey at Odoptu on 7 July. Sakhalin Energy recorded its first shot point (SP) at Piltun-Astokhskoye on 8 July.

The Piltun-Astokhskoye survey consisted of 36 lines, with 23 lines classified as 'A-lines' according to the MMP, of which 13 were north-headed closest to shore. 13 lines were classified as 'B-lines'. The 13 north-headed A-lines were finished on 21 July. The remaining A-lines were finished on 25 July. The entire survey was completed on 29 July after 21 days. Summary statistics are provided in Table 1.

Item	Entire Survey	North-headed A-lines
Survey lines (pre-plot, no platforms)	36	13
Minimum number of passes	43	13
Actual number of passes	60	17
Minimum number of shot points (SPs)	64,152	20,023
Actual number of SPs	80,407	24,630
Number of SPs taken multiple times	16,255	3,607

Table 1. Summary statistics from the 2015 seismic survey

Following completion of the ENL 3D survey at Odoptu, the vessels contracted by ENL moved to Chayvo and Arkutun-Dagi, south of Piltun-Astokhskoye. These vessels were actively collecting seismic data in the area for the entire duration of the Piltun-Astokhskoye survey and beyond. Good coordination of the vessel schedules between the companies was established. A minimum distance of 25km between active source arrays was adhered to, avoiding excessive interference. The net standby time for Sakhalin Energy work as a result of time-sharing with ENL was 20.6 hours.

During the Sakhalin Energy's survey there were five source suspensions (shutdowns), all due to marine mammals in the applicable source exclusion zone (SEZ) (Table 2). For logistical reasons (including turn strategies), shutdowns cause an average of around 5 hours of downtime.

Date	Mammal type	Applicable Exclusion Zone
12-July	Harbour porpoise	1km
19-July	Common minke whale	2km
20-July	Pinnipeds	350m
22-Jul	Common minke whale	2km
22-Jul	Pinnipeds	350m

Table 2. Summary of shutdowns

There were no suspensions due to the presence of gray whale M-C pairs in either the SEZ or the A-zone. One unconfirmed M-C pair sighting far offshore, during a test line recorded on the first day, was not logged[5]. The total standby time logged due to marine mammals was 24.9 hours.

The Company believes that the above-stated objectives were achieved. The MMP was implemented in the field to an acceptable standard. The IUCN IO was hosted at the Central Command post during the survey. The international EIA was prepared and finalised by Mike Donaghy Associates Ltd., approved by the Lenders and published on the company website. In addition, the 2015 Piltun-Astokhskoye 4D seismic survey (and MMP) was conducted successfully in that (a) the start date was as early as practically possible given the simultaneous geophysical operations in neighbouring license areas; (b) the survey was completed in a relatively short time, close to what could have been expected as the minimum, based on pre-survey simulations; and (c) the MMP was implemented in the field to an acceptable standard, overcoming some setbacks and discussed below under the relevant parts of Item 2 below of which the number of active real-time acoustic monitoring buoys was the most striking (see Item 2.3). A detailed summary of the Company's evaluation of its performance in implementing the MMP provisions is given as Annex D.

[5] This sighting, however, was subsequently determined in the field to have been inaccurately identified.

2.1.2 Discussion

In response to questions from the NTF a number of clarifications were made by the Company.

(1) In light of the exclusion zone regulation for gray whales (2km) established by the Russian Federation, it was decided not to conduct the sound source verification experiment originally envisaged to determine this radius.

(2) Due to the actual start date, tides were unfavourable (with respect to 'feathering[6]' problems) with respect to carrying out A-lines only during daylight as originally envisioned during previous NTF meetings. In practice, the alternatives were to wait until later in the month when the tides were more favourable which would have prolonged the survey further into the peak whale period or to follow the 'dusk scan' approach and allow shooting at night. This led to almost half of the A-lines being shot at night.

(3) Although not technically optimal, rather than completely reshoot whole lines when technical problems arose or shutdowns occurred, partial lines (segments) were shot whenever possible to reduce the overall survey time. This compromise was agreed with the seismic contractors after the completion of NTF-9 and WGWAP-15 (when it was thought that whole line reshoots would be normal).

The NTF noted that some of the issues arising with respect to feathering (e.g. planning ahead with respect to tides) arose out of the unusual situation with respect to the 'sharing' process agreed with ENL. It had been agreed that ENL would undertake their Odoptu survey first (the area closest to the feeding ground). When the ENL survey was completed (estimated to be some time in the first two weeks of July) would the Sakhalin Energy survey start. The first seismic work began on 8 July, reflecting an efficient changeover but resulting in some of the feathering problems experienced due to tides and currents.

The Chair clarified that the primary mitigation measure of completing the survey 'as soon as possible' was not an absolute but related to completing it before the peak of whales had arrived. There is a trade-off between mitigating the exposure of individuals to minimising the numbers of individuals potentially affected. This is reflected in the MMP where there was a focus on mother-calf pairs in the early period (mid-late July) with a focus on all animals after that period. In other words, once many animals are present then priority changes from completing the survey as quickly as possible to applying mitigation measures to all animals – this may in fact slow down the survey.

More detailed discussions on particular topics are summarised under specific agenda items below.

2.2 Company summary of the visual monitoring components of the MMP

Sakhalin Energy presented a general overview of monitoring during the 2015 seismic survey. Key components were:

(1) behaviour and distribution teams observing from shore;

(2) marine mammal observers (MMOs) on seismic and supply vessels; and

(3) Acoustic stations.

The acoustic data are discussed under Item 2.3. All collected data and information was transmitted to the Command Centre, from which real-time decisions were made in accordance with the MMP shutdown criteria.

MMOs operated from Pioneer camp on the Piltun Lagoon North Spit and in the Sakhalin Energy temporary field camp on the South Spit, including the Command Centre and the acoustic post of the Pacific Oceanological Institute (POI). Four monitoring points with special observation towers were established at stations 7, 7(5), 9 and 10 (Fig. 2). Each behaviour and distribution team consisted of four people – two MMOs, a theodolite operator and a computer operator.

[6] Feathering: The lateral displacement of streamers due to the action of tides and currents such that they do not tow directly behind the survey vessel but rather deviate laterally from the ship track or nominal sail line.

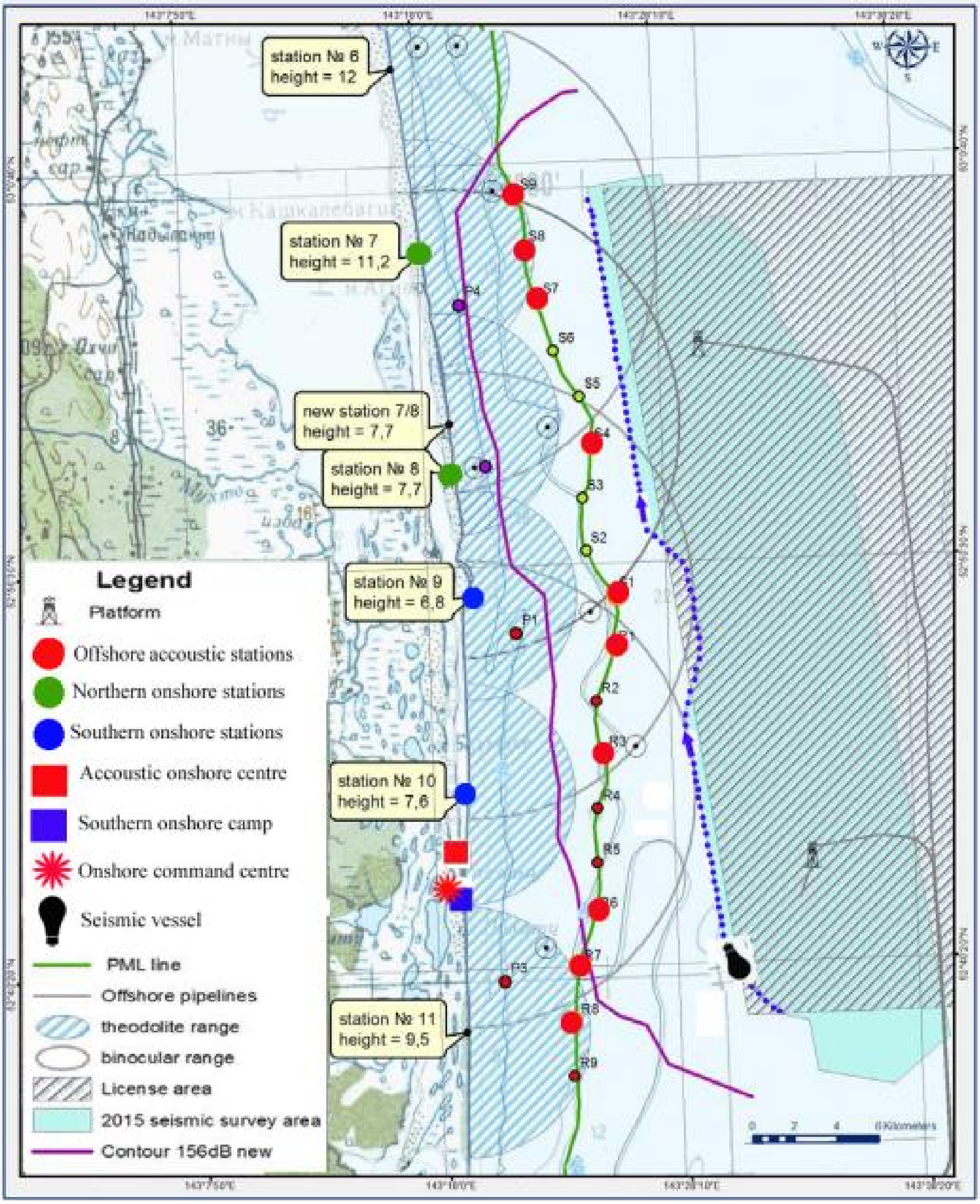

Figure 2. MMP infrastructure during the Sakhalin Energy's 2015 4-D seismic survey

Monitoring in the Piltun-Astokhskoye area started one week before and continued one week after the seismic survey. The seismic survey started on 8 July, all A-lines were finalized on 25 July and it was completed on 29 July.

The daily work schedule of the shore-based MMOs was variable and depended on the time of line acquisition by the seismic vessel. For gray whale abundance and distribution monitoring, the scanning method used in previous monitoring surveys was used. Scanning was conducted at hourly intervals from the beginning of observations (weather permitting) each day. Scanning was carried out by 2 MMOs using *Fujinon* 7x50 binoculars (with reticle scale and compass). MMOs scanned from north to south at a rate of

10° per minute (total duration 18-19 min). If a whale was detected the observers recorded: the number of whales, the angular distance between the whale and the horizon (based on reticle binoculars), the magnetic bearing and the course of whale(s). The data were recorded onto the computer using the *Pythagoras* software or on special paper forms.

The first priority for behavioral observation was given to M-C pairs detected during scanning. The second priority was given to whales close to the seismic survey area. Theodolite tracking was used to monitor the spatial-temporal movements of gray whales (Leica theodolite, with 30x zoom and countdown accuracy of 5 seconds). The method performs horizontal and vertical angle conversion to geographic coordinates (latitude and longitude) at each recording of readings. Initially the gray whales were detected by naked eye or with binoculars. Theodolite tracking sessions were conducted on a single gray whale or on a M-C pair. Individuals were tracked continuously until the animal or pair was lost. Standard categories of behaviour (travel, feeding, feeding/travel, interaction, etc.) were recorded during each tracking session. Target observations of behavior and respiration were made on selected individual gray whales, usually simultaneously with theodolite surveys, which enabled good location information to be associated with each target observation. The observer commented verbally on the behavior and the computer operator entered this information onto the computer using the *Pythagoras* software.

2.2.1 Discussion

Discussion within the NTF focussed on the initial difficulties highlighted by the Central Commander's report and the IO report. The NTF **agreed** that exceptional efforts had been made by the field personnel to implement the monitoring component in difficult conditions. However, it noted that not all aspects of monitoring had been undertaken in full accord with the MMP. In particular, with respect to the behaviour and distribution monitoring, much of the time during the pre-seismic week (which is extremely important for detecting whether any change occurred as a result of the survey) was spent training, obtaining information on and clarifying protocols, and solving equipment problems. In addition to severely limiting the amount of pre-seismic survey data obtained, this learning period and the inevitable improvement in performance of observers over time may create analytical difficulties when it comes to assuming that the data were collected in a consistent manner.

A number of the difficulties encountered could have been lessened if recommendations made from NTF-6 onwards had been implemented more promptly, particularly the early selection of behavioural team leaders and allowing sufficient time to train behavioural MMOs (e.g. see NTF-6, Item 5.4). Leaders and observers for behavioural studies require considerable training and experience. The NTF recognised the Company's explanation that recruitment of qualified observers was made difficult by the fact that two companies were operating simultaneously and ENL was also using observers for behavioural and other monitoring. The Company noted that all the MMOs used for Sakhalin Energy's MMP implementation were experienced in basic whale observation but not necessarily in behavioural work.

The NTF agreed that the problems encountered in 2015 must be avoided in the future. This is essential if a better understanding of the effects of seismic surveys on gray whales is to be obtained which in turn will lead to improved mitigation in the future. The NTF reiterated that in the future, experienced team leaders should be appointed well in advance and ideally be in the field the year before to gain familiarity with: (1) protocols, (2) software/hardware, (3) classification of behaviour and (4) local conditions. It was also suggested that it could be valuable to hold refresher courses at either Yuzhno or in the field camp before the pre-seismic observation effort begins. There was also discussion as to whether, given the difficulties encountered, superior alternatives to *Pythagorus* were available; this should be investigated before further seismic surveys are undertaken.

The NTF also discussed the matter of shifts and schedules for offshore MMOs. This discussion focussed on the number of MMOs (there were six) and their work schedules. This had also been a focus of previous NTF discussions and concern was expressed by some members of the NTF that fatigue could have affected results given the long work-days and long (3-hour) shifts. In response, the Company noted that breaks were supervised by the lead MMO and that fatigue was not considered by them to be an issue.

The NTF agreed that for future surveys, the question of number of MMOs, suitable shifts and rest periods should be revisited, particularly in the light of the duties of the MMOs which may change in the light of possible use of new technology (see Item 2.5.2).

2.2.2 Summary of data collection methods (and validation) including difficulties, if any

The NTF noted the discussion above that consideration needed to be given to the consistency of the behavioural data collected over the period given the need for initial training and the likely improvement in performance over time. It also noted the concomitant lack of pre-seismic survey data from Sakhalin Energy's field teams but recognised that the ENL teams were operating during the early period. The importance of collaborative studies is discussed below.

2.2.3 Initial results

No initial results or data summaries were available prior to the meeting. The NTF appreciated the efforts by the Company to provide an initial summary of the datasets available but agreed that it would not be possible to make any detailed comments at this stage until further information became available.

2.2.4 Company plans for future analyses

No plans for analyses were presented but the Company indicated their willingness to work with the NTF and the Panel in this regard.

The NTF noted that 2015 represented the largest level of seismic survey activity and of monitoring effort ever experienced in a single season on the Sakhalin shelf. Sakhalin Energy was not the largest contributor to this activity nor was its survey the closest to the near-shore feeding area of the gray whales. To obtain maximum benefit from the experience gained and data collected in 2015, joint analyses with ENL are essential.

The Company stated that they were talking to ENL regarding joint analyses. They reported that both companies are positive but that there is no commitment yet. The expectation was that there would initially be separate analyses, but the intention was to conduct later joint analyses which will be made available. The NTF endorsed the need for joint analyses, reiterating that the circumstances of 2015 made this an essential component of trying to examine whether the large survey effort over a long period had affected gray whales.

The importance of examining data collected from the start of the ice-free period on the numbers of gray whales present was stressed, noting that this was a critical component of modelling cumulative effects and assessing the appropriate balance between measures aimed at minimising the exposure of the population versus protecting individual animals. The lack of early-season data in recent years as a result of changes in the timing of the Sakhalin Energy/ENL Joint Programme field season, which starts at least a month later than it did in the early years of the programme, means that the monitoring data presumably collected by ENL June-early July period in 2015 is particularly important.

2.3 Summary of the acoustic components of Sakhalin Energy's MMP

2.3.1 Company summary of methods and execution

Rutenko gave a presentation on the new acoustic monitoring equipment from the POI, first used in the field in full operational mode this year. The new devices incorporated features that had been discussed and approved by the Panel over the years. One of the main advantages of the new systems is that they consume about 15 times less power than the older design. Further energy savings can be achieved by using Iridium communications to selectively turn the radio telemetry on and off as required. The units consist of an underwater canister with separate hydrophone assembly, and a cable-tethered surface buoy with radio- and satellite-transmitting modules. In their full configuration the stations have two telemetric channels, one transmitting a digitized acoustic waveform on the marine Very High Frequency (VHF) band and the other sending precomputed acoustic metrics via Iridium satellite. The stations have on-board processing algorithms to compute in half-second increments the peak sound pressure level (SPL), the sound exposure level (SEL), and the one-third octave band spectrum between 10 Hz and 2 kHz. 120 realizations of the two metrics and the average one-third octave spectrum are transmitted every minute as a short message over the Iridium uplink. 11 of these stations were built by POI and shipped to the field; all of them had Iridium telemetry capability and five were also equipped for VHF telemetry.

During the 2015 Piltun-Astokhskoye seismic survey, a maximum of 9 stations were deployed at one time along the length of the Perimeter Monitoring Line (PML), though the recommended number was ten (see Fig. 2) and only six were deployed initially due to the failure of four units, three of which were replaced with loans from ENL; the four stations at the south end of the line were equipped with both VHF and Iridium channels. Two non-transmitting stations of older type were also deployed on the 10m bathymetry line for archival recording of pulse levels in shallow water[7]. An onshore acoustic monitoring post was equipped with directional antennas to receive data from the four VHF-equipped stations, and also had Iridium uplink / downlink capability. Because of a system failure across the units the VHF telemetry was never made functional. Rutenko stated that the Iridium telemetry worked reliably, and he showed that the received acoustic metrics matched well in post-analysis the values computed by processing of the waveform data stored on the units. He suggested that VHF telemetry could be dropped altogether in the future. Under normal circumstances the monitoring post would have received Iridium-telemetered data from the stations and issued commands to them via an e-mail-based communication protocol cleared through a high-availability server located in St Petersburg. Internet connectivity to the post was always poor, however, and as a consequence the Iridium link at the post had to be used. Rutenko showed a diagram of the fallback data flow over Iridium that was structured for automatic activation in case of internet failure in the field.

The onshore acoustic monitoring post was staffed by three members of the POI team. Rutenko pointed out that this year his institute mobilized to the field a total of 23 people supporting Sakhalin Energy's and ENL's monitoring programs, but his own laboratory has a staff of only 9. Additional personnel new to the project were trained over the months of May and June. For deployment and maintenance of the telemetric stations, personnel from POI operated from a vessel-of-opportunity normally assigned to Sakhalin Energy support operations. Rutenko showed photographs of equipment readying and deployment activities aboard the vessel and on a small craft launched from it, and pointed out that working space was not optimal due to crowding of the limited deck area with equipment. The onboard personnel had to perform maintenance or replacement of the deployed units on different occasions. At the beginning of the operations the southernmost station (R8) drifted from its location and was lost; its replacement also drifted in a storm but was found again, however it was decided not to deploy a unit at that location any longer. Rutenko pointed out that the anchor design was based on specifications that had proven suitable in the 2010 seismic survey season. He said that insufficient weight was not the issue; the anchoring failure was caused by the tether cable to the surface buoy becoming entangled around the anchor masses, debilitating their design weight distribution over the seafloor. The problem was countered by adding three small floats along the tether cable that kept it from dragging on the bottom, thus preventing the possibility of entanglement with the mooring.

Rutenko informed the NTF that the data stored on the internal memory cards of all the units had already been verified and processed, but he sought advice regarding further analyses that the NTF might want to see included in his report. He presented examples of sound level time histories both as sonograms and as plots of acoustic levels over different passbands. He also showed the result of a detailed analysis of pulse levels for all shots along a seismic survey pass near the western (shoreward) edge in the north part of the area, as recorded at station S7. Rutenko pointed out some relevant features of the pulse levels as the source approached and moved past the closest point of approach (CPA) to the station:

(a) The pulse levels, both peak SPL and SEL, showed an alternating pattern with inter-pulse differences of up to several dB caused by the origin of alternate pulses from the two sides of a dual-array (flip-flop) source. The difference was not constant; it was minimal near the CPA and widest at a location where pulse levels rose significantly above the range trend;
(b) The pulse levels on the southern side of the CPA did not follow at all a smooth rise with closing range but rather exhibited local rises and falls of significant size that Rutenko explained were due to bottom refraction and convergence zones;

[7] The plan agreed in NTF-8 called for three of these 10-m isobath units; ENL installed a third unit and the NTF was assured that the data would be available for analyses, though see below.

(c) A sharp asymmetry in the steepness of the rise or fall of levels on the two sides of CPA. Rutenko speculated that this could be due to the hull of the seismic vessel affecting the propagation of sound towards the receiver.

2.3.2 Discussion

In discussion, the Chair advised that the initial focus of the current discussion should be on practical issues and difficulties in the field and how to minimise difficulties in future. Issues related to modelling would be dealt with under Item 2.3.3. The NTF needed *inter alia* to look at failures and consider matters such as system redundancy to ensure that problems do not reoccur in future operations.

With respect to the equipment failures, Nowacek raised the point that even the full (prescribed) arrangement of 10 stations along the PML (with clusters of three stations in the south and north) would have been a minimum requirement in terms of density and redundancy of units to ensure robust selection of model offset at the start of lines and reliable model match verification along their length. He also said that having almost half of that configuration effectively unusable for a significant portion of the survey represented poor performance; backup units should have been available. Rutenko noted that the failure had been in the training of personnel, not in the design of the systems, a point that van der Veen reiterated, observing that backup systems might not have helped if they too had been affected by the same field assembly error that incapacitated the VHF-equipped units. With properly trained field personnel and clearly documented pre-deployment procedures, the problems would not have occurred, and likely the situation will not reoccur in the future. On the positive side, van der Veen commented that the performance of the Iridium-based telemetry was flawless.

There was some discussion regarding the number of archival stations that had been deployed on the 10m bathymetry contour. Rutenko indicated that his team on the Sakhalin Energy project had deployed only the southern (P1) and northern (P2) stations of the system, i.e. only two of the three intended in the operation design. It was confirmed by the Company that ENL had agreed to make available over the period of the Piltun-Astokhskoye seismic survey the data from a unit deployed by at Sakhalin Energy/ENL Joint Programme location PA-B-10. Rutenko, however, warned that PA-B-10 would not provide a full set of data over the Piltun-Astokhskoye survey period because of a problem with insufficient SD cards storage (an installation error) during its first deployment that caused it not to record for part of July. This problem also left the acoustic monitoring below that envisioned and agreed.

In conclusion, several suggestions were put forward for improving the situation in the future:

(a) suitably qualified and fully trained personnel should be assigned to the various tasks;
(b) equipment should be tested under conditions fully representative of the eventual mission location, and ideally at the very site of the mission;
(c) redundancy, whether at the unit level or in the critical subsystems within a unit, should always be implemented to avoid downtime in case of equipment failure;
(d) although the collaboration between the two companies was noteworthy, the situation of two companies working concurrently on projects drawing on the same technical resources and equipment should never occur when a capacity issue would result;
(e) human error can undermine the functionality of even the best equipment, and the risk of failure must be minimized through design features, training and documentation of procedures.

These suggestions were taken forward in the development of recommendations (see Item 2.5).

2.3.3 Comparison of model estimates with real-time measurements from the PML stations

Racca presented a set of examples (screen shots) of the types of measurements taken to model comparison plots that the JASCO team used in the field to verify the ongoing accuracy of the sound exposure footprint estimates being used for real-time mitigation, and to correct them if necessary as a result of changes in the propagation conditions. He pointed out that for the 2015 operation, the modelling project team had decided to use a single set of modelling parameters reflecting the established geo-acoustic environment and the hydrological conditions likely to be encountered during the period of the seismic survey (an isovelocity water column) and to rely only on a dB offset to bring the model into alignment with measured levels as required. This choice was driven by the outcome of a similar exercise during the 2010 Astokhskoye seismic survey that had shown the paradigm adopted at the time, with three model parametrizations plus a dB offset, to lead to ambiguities in the selection while essentially providing no better match than a single ‘base case’ and offset adjustment.

The screen shots exemplified the components of the comparison plot, which included:

(a) A trace representing the model prediction of received level at a given PML acoustic station as a function of vessel progress along a seismic line, with an added offset if required;
(b) A trace running parallel to the first at a fixed +3dB shift, defining the maximum tolerance for measured levels to exceed the model before an adjustment would be introduced; and
(c) Clusters of dots, each representing an acoustic level reading as telemetered by the station as a function of vessel progress.

Racca explained that because of the nature of the algorithm used on the POI acoustic stations to compute the levels to be transmitted by Iridium satellite, the telemetered values would be scattered between periodic maxima representing the sound level of seismic pulses and a continuum of intervening levels. The JASCO software contained a discriminator that rejected the majority of the latter, but could not always eliminate all sub-pulse levels; as a consequence the plotted values still contained some vertical spread and had to be interpreted visually by taking the upper envelope of the dots ‘cloud’ as the pulse levels.

In the course of the seismic survey monitoring the field team visualized the comparison curves for a single station at a time, switching to the next available station as the seismic source came nearer to it in its progress along the PML. This was done in concomitance with the switching on and off of the Iridium telemetry so that generally only the station closest to the seismic source would be providing real-time data. To give a comprehensive view of the match along a full survey line, most of the examples shown by Racca were composites in which segments of traces for the region of closest approach to successive stations were pieced together along the length of the line (e.g. see Fig. 3).

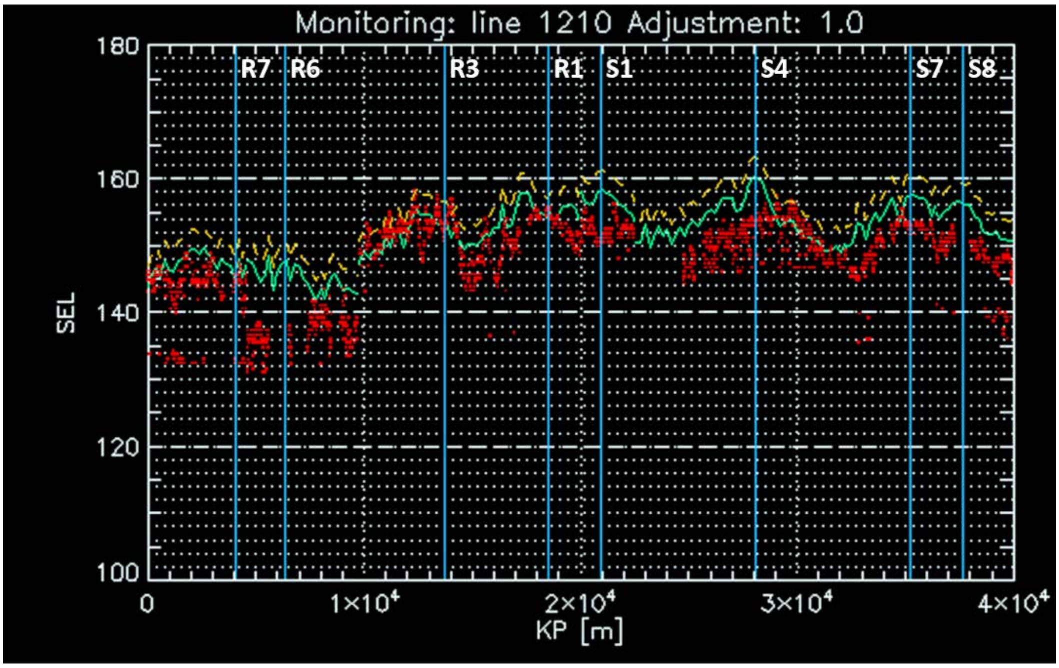

Figure 3. Composite in which segments of traces for the region of closest approach to eight successive stations have been pieced together along the length of a northbound survey line acquired on 19 July 2015

Racca showed examples of lines monitored at different dates during the length of the seismic survey, for both northbound and southbound lines; in the earlier cases the match was satisfactory with a no-offset model trace, whereas at a later period a +1dB offset was applied to the model to match an increase in sound propagation observed in the measured levels. In all the examples shown, the +3dB tolerance limit was never exceeded for more than very short transients. Depending on the line the measured levels could be in places up to a few dB lower than the model estimate, a situation that affected station R6 very consistently in a near repeat of what was observed at that location in 2010 (attributed to a small-scale seafloor ridge that remained stable over time). Whilst any overestimation of levels by the model is not optimal as it could lead to excessive mitigation, Racca pointed out that the emphasis in the matching was to avoid underestimates that would have less precautionary.

In addition to the single-line examples of model-to-measurements comparison, Racca presented a set of geospatial maps depicting the discrepancy of the model estimates relative to the measured levels at a particular station as colour-coded dots placed at the source position for that measurement, for all the shots in the survey for which real-time data were received (e.g. see Fig. 4). This form of rendering enables the viewing of the model error as a function of range and direction of the source from a given receiver. The maps for individual stations were merged in the composite map (Fig. 4), where the model error is shown for the 'region of competence' of each station, i.e. the segment of the survey area facing that receiver. This comprehensive rendering confirmed some of the observations that were made for individual lines, such as the anomalously low received levels at R6 leading to consistent overestimates, and highlighted a few regions where the accuracy of the model may need to be improved either through better seafloor parameterisation or the introduction of full 3D effects in the acoustic solution algorithm.

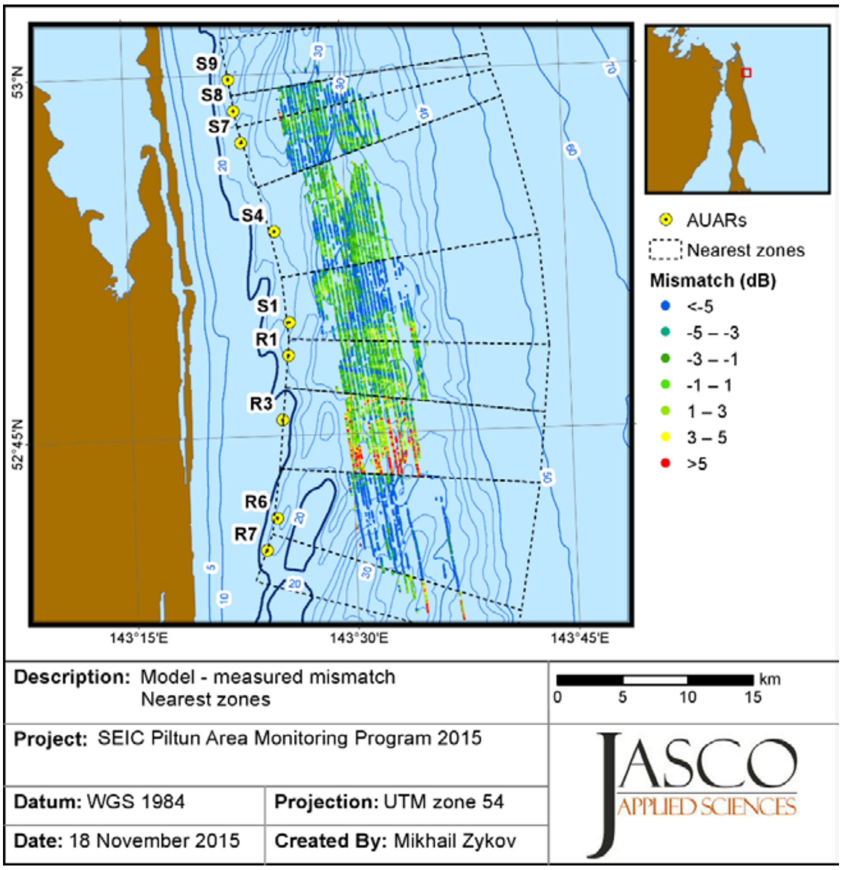

Figure 4. Map showing the discrepancy of the model estimates relative to the measured levels at a particular station as colour coded dots placed at the source position for that measurement, for all the shots in the survey for which real-time data were received

2.3.4 Discussion

The NTF thanked Racca for this informative presentation. In his earlier presentation, Rutenko had suggested that the complex dependence of acoustic propagation on the features of the physical environment made modelling a difficult and elusive task. In response, Racca pointed out that the current pre-season modelling, while by no means perfect, already could account realistically (especially in terms of the objectives of the MMP) for the types of propagation anomalies that Rutenko's example had shown, although he recognised the difficulties the environment could present. There was some discussion of whether the pulse issue referred to under Item 2.3.1 was incorporated into the modelled results. It was noted that the modelling of received energy is broadly accurate but that there could be scope to examine the pulse shapes to ensure that the frequencies are properly accounted for. The NTF **agreed** that this worth further consideration and encouraged Racca to investigate it.

2.3.5 Plans for future analyses

In terms of possible future analyses of the acoustic data, the NTF noted that in terms of metrics for use in multivariate analysis (MVA) or similar, these had been discussed extensively in the past and agreed; scientific papers describing such analyses for the Sakhalin Energy 2010 seismic survey monitoring data are due to appear shortly in a peer-reviewed journal (Muir *et al.*, 2015; 2016; Gailey *et al.*, 2016). It endorsed these metrics, recognising that further consideration may be required as more information becomes available on all the data, not simply the acoustic data, which are available (see the general recommendation under Item 2.6).

However, the NTF also **agreed** that some work can begin, using the information already available to Sakhalin Energy, particularly with respect to calculating cumulative acoustic exposure in the gray whale feeding area using the received level data recorded by all of the deployed bottom-mounted receivers. A recommendation to this effect developed by a small group under Nowacek is provided under Item 2.5.2.

2.4 Other data collected

2.4.1 Environmental and other data

There was a short discussion about environmental and other data that might prove useful in examining the gray whale distributional/behavioural data in the context of the 2015 Sakhalin Energy seismic survey. However, it was considered premature to specify such analyses until better information becomes available on the data that are available.

It was agreed that the following 'environmental' information might prove useful in future analyses (e.g. as potential explanatory variables): bathymetry; sea surface temperature; salinity; visibility and weather conditions; benthic sampling data.

The Company noted that some plankton data have been collected since around 2000 in response to Russian Federation requirements, perhaps related to consideration of potential damage to fish (some 'unusual surface behaviour' had been reported).

The NTF also noted that the locations and activities of other vessels had proved valuable in previous analyses (e.g. of the 2010 Astokhskoye seismic survey). It was agreed that the Company would enquire as to what information on other vessels might be available (including that from other operators).

2.4.2 Use of new technology including thermal/infrared imaging

COMPANY SUMMARY

During discussions at NTF-7 and 8, remote sensing techniques were discussed as a means to complement hand-held binoculars for marine mammal detection, identification and range estimation during periods of poor visibility. Such systems were available on the seismic vessel during the 2015 4D survey.

Van der Veen provided the following summary.

In addition to the standard 7x50 MMO binoculars, the following equipment was available:

(a) High-Definition/Infra-Red (HD/IR) camera - a rented system was installed on the main survey vessel;

(b) Sea-Hawk Radar - this was a permanently installed system with the primary function of detection of floating ice, however it was also capable of detecting other slow-moving objects at the water surface;

(c) Big-Eyes binoculars – these were temporarily installed on the seismic vessel, providing 25x magnification with 150mm lenses (and 2.7 degree field of view).

The MMOs aboard the seismic vessel had been tasked with testing the various tools and systems. The tests were conducted during the Lunskoye seismic survey preceding the Piltun-Astokhskoye survey. For the tests, known reference points such as support vessels, work boats and streamer gear were used under a range of visibility conditions. Opportunistic sightings of whales were used as well, but there were few if any of these during the Lunskoye survey.

The different systems tested by the MMOs provided a mix of benefits and drawbacks for detecting marine mammals and other objects. The MMOs concluded that using a mix of equipment at different times of the day and under different environmental conditions would give the best results. A summary, based upon the MMO perceptions, of the preferred equipment use (in order of preference) is provided in Table 1.

Conditions	Preferred Equipment Selection	Maximum Range
Daytime Clear	1) Binoculars 2) BIG Eye 3) IR Camera	3km ~5km 3km
Daytime Fog	1) SeaHawk Radar 2) Navigational Radar 3) Binoculars	>5km >5km <500m
Daytime Rain	1) Binoculars 2) BIG Eye 3) IR Camera	3km ~5km 3km
Night time Clear	1) IR Camera 2) SeaHawk Radar 3) Navigational Radar	3km >5km >5km
Night time Fog	1) SeaHawk Radar 2) Navigational Radar	>5km >5km
Night time Rain	1) SeaHawk Radar 2) Navigational Radar	>5km >5km
Dusk Clear	1) Binoculars 2) BIG Eye 3) IR Camera	3km ~5km 3km
Dusk Fog	1) SeaHawk Radar 2) Navigational Radar 3) Binoculars	>5km >5km <500m
Dusk Rain	1) Binoculars 2) BIG Eye 3) IR Camera	3km ~5km 3km
Dawn Clear	1) Binoculars 2) BIG Eye 3) IR Camera	3km ~5km 3km

a

Table 3. Summary of equipment limitations and preferred selections based on time of day and environmental conditions

Other conclusions drawn by the MMOs included:

(a) light levels between daytime, dusk and dawn did not significantly affect capability of equipment detection/ranging – of course, Big Eyes and hand-held binoculars were not useful at night;

(b) foggy conditions presented the worst situation as only radar systems provided coverage[8];

[8] radar systems are the equipment that could be used at all times of the day and in any weather conditions.

(c) under foggy conditions and with no horizon in sight, ranging with binocular reticules/hand-held ranging sticks was inaccurate and the HD/IR cameras could not focus;

(d) Seahawk Radar was useful for large and slow-moving objects but was deemed unlikely to be useful for marine mammals;

(e) Big Eyes were extremely useful for viewing objects at distance, however their field of view is much reduced and they provided no range estimation capability.

The MMOs also indicated a number of concerns related to the equipment tested, as follows:

HD/IR CAMERA

(1) One HD/IR was mounted facing the source which was being towed 350m behind the vessel in accordance with manufacturer specifications. Due to this configuration, there was no visibility of the cameras forward of the vessel. A second camera facing forward would alleviate this problem;

(2) The camera was of no use during foggy conditions. During those conditions (i.e. where visibility is patchy or slightly reduced), the camera was unable to establish the horizon and therefore unable to settle at a fixed point;

(3) Despite this, during normal atmospheric conditions the IR was considered a good option for nighttime operations, preferred over radar systems. However, some significant drawbacks were noted with the specific system deployed aboard the vessel –

  a. The system was volatile and difficult to use, even after some help from the manufacturer. The team developed little confidence in the stability of the system;

  b. The cameras were susceptible to ‘freezing’ which required a complete system restart. The time spent doing this would be time spent not observing and that could be critical during pre-watch, for example;

  c. There appeared to be differences on the order of 200-250m between the range estimation on the HD camera and the infra-red camera, despite ranging the same objects within 1-2 mins.

RADAR

(1) Although suitable for slow or stationary objects, there was a concern that the radar might miss fast-moving targets. Several scans of the radar (over approx. 20-30 seconds) are required before a detailed target can be plotted. In theory, this could mean that gray whale M-C pairs, which may spend significant time ‘logging’ or resting at the sea surface, can be detected and identified but diving or quickly moving individuals cannot;

(2) During the night when detections cannot be verified by visual observation, it would be difficult to accurately identify the type of marine mammal. The team considered that large whales (>10m), pods of whales and, in particular, M-C pairs should give a significant target return on the Sea Hawk radar, if present at the surface for a period of time. However individual marine mammals are unlikely to be accurately identified on the radar.

The MMOs made a number of conclusions and recommendations for the future. Although it was not tested, based upon previous experience they recommended use of Passive Acoustic Monitoring (PAM) during future surveys. This would not be useful for gray whales, which are not known to produce sounds consistently in this area, but would be useful for some other species.

In general, the MMOs preferred to use binoculars over the remote sensing tools, because binoculars allow not only detection but also identification of marine mammals to species, whereas species identification proved difficult using the HD/IR camera and even more so using the radar. No marine mammals were seen within the applicable exclusion zones at night and the MMOs recommended searching the daily MMO reports for marine mammal detections during periods of poor visibility.

Van der Veen concluded that the remote sensing tools used aboard the vessel provided no ‘silver bullet’ for detection, identification and range estimation of marine mammals, but a combination of tools such as High Resolution radar and HD/IR camera provided a useful addition to hand-held binoculars, as the latter are not useful during periods of poor visibility. In future, Passive Acoustic Monitoring would be a logical addition to the suite of tools to be deployed.

DISCUSSION

There had been considerable discussion (from NTF-5 onwards) about the use of 'blended-vision' technology (primarily infrared although later – at NTF-7 - active sonar was mentioned) to improve whale detections, especially under poor/no visibility conditions. The potential value of this had been recognised by the NTF (and the Panel) but it had been recommended that before such technology is adopted, formal evaluations need to be conducted under field conditions. It had been noted that problems could arise due to false positives as well as false negatives.

Whilst welcoming the report from the Company, much of the discussion at NTF-9 focussed upon the fact that no formal trials had been conducted. The information provided appeared to be based only upon MMO preferences from their experience at Lunskoye where no whale sightings were made during the trials. The value of rear-facing HD/IR cameras as a mitigation tool was also considered and the NTF noted the MMO suggestion of also having a forward-facing camera. However, the NTF reiterated its view that it remains essential for a quantitative evaluation of equipment to be made before any future seismic survey, following the Panel's previous recommendations. It also recognised that the use of such equipment may have implications for the number of MMOs and their experience/training. A recommendation on this matter is provided under Item 2.5.

2.4.3 Data collected by other organisations, if any (e.g. NGOs etc.)

No information on data collected by other organisations was available to the meeting.

2.5 NTF Advice and Recommendations for analyses (including joint analyses with ENL)

2.5.1 Data availability and joint analyses

The NTF noted the earlier discussions on the importance of conducting analyses that take into account the entire ice-free season. That necessarily involves either joint analyses or data sharing with ENL.

The NTF agreed that it would be premature to develop detailed plans for future analyses until better information was available on: (a) the quantity of data available from Sakhalin Energy; (b) the quality of the data and its consistency over time (both within the 2015 season as discussed under Item 2.2 and amongst 2010, 2012 and 2015), especially with respect to the behavioural teams; and (c) the availability of data from the ENL/Rosneft seismic surveys (see Item 2.2.4) and the Sakhalin Energy/ENL Joint Programme.

The NTF **recommends** that the Company provides such information, initially in a summary or synthesis form, as soon as it becomes available and certainly well before the next scheduled NTF meeting. Upon receipt, the NTF or Panel may request additional information if it feels this would assist discussions in the NTF towards developing detailed plans for analyses, at least of the Sakhalin Energy data. However, the NTF reiterates the importance of considering the whole season's data given the scale of the two survey programmes in 2015, and the enormous monitoring effort by both companies.

The NTF recognised the inherent difficulty of obtaining agreement for data sharing and joint analyses with ENL but emphasised that such analyses would greatly benefit both companies and lead to improved mitigation. It **urges** that an expert group from both companies is formed that should meet to discuss the nature and objectives of such analyses and develop mechanisms and safeguards for data holders to facilitate the analyses. The NTF would be pleased to participate in such discussions. It noted that the MVAs undertaken with the monitoring data from the 2010 Astokhskoye 3D survey (e.g. Gailey et al. 2016) would provide a useful starting point for discussions but that new approaches and analyses should be considered. The NTF also highlighted the value of analysing data across as well as within seasons to increase sample sizes.

2.5.2 Initial analyses

As discussed under 2.3.5, some initial work on the acoustic data can usefully be undertaken before the next NTF meeting. The NTF **recommends** that the Company arranges that for all available sensors for all time periods, the 5-minute averaged SEL is calculated for the following frequency bands: 10-100 Hz, 10-1000 Hz, 10-15000 Hz (or up to the Nyquist frequency). Although immediate analyses of potential impacts may focus on areas where visual data (e.g. whale distribution data) were collected, undertaking the calculations for all sensors should entail only a minor addition of time since the time-consuming step is setting up the analyses in the first place. Furthermore, having these data from all sensors in the area will be useful for future analyses of potential impacts on an annual basis. This work should be accomplished before the next NTF meeting. The NTF also noted that such analyses may be undertaken with previous seasons' data once the process is established.

2.6 NTF overview of the monitoring and mitigation plan

2.6.1 Report of the IUCN Independent Observer

The full report of the IUCN IO, Grisha Tsidulko, can be found on the IUCN website[9]. He was present on-site at Sakhalin for 26 days during the 2015 seismic survey. Overall, Tsidulko noted that significant efforts were made by Sakhalin Energy to facilitate his work at the Temporary Whale Observation Camp throughout the observation period and to enable him to obtain a comprehensive overview of the onshore component of the MMP (logistics prevented him from spending time offshore) including some visits to the visual platforms. Tsidulko thanked Company personnel for their help and support. He commended them and the Central Commander on their inclusive attitude and on their successful implementation of an extremely complex communications system connecting the various field components. Inevitably there were some practical problems at times, especially at the start, but everyone worked hard under difficult circumstances. Tsidulko noted that it would be helpful in the future for the IO to be able to communicate directly with offshore personnel at times when it would not interfere with their primary responsibilities. He suggested that additional consideration be given prior to the seismic survey to logistics of IO transportation and permits (e.g. safety certificates) needed to undertake visits to all onshore stations, recognising the need for full compliance with Company safety standards.

With regard to mitigation, Tsidulko noted that from his land-based perspective, the mitigation effort appeared sufficient, and the mitigation aspects of the Company's MMP had been fully and successfully implemented. The shutdown timing was extremely efficient. He also noted the practical approach developed for A- and B-lines and the great improvement achieved by 'line segment acquisition' which ensured that the survey was completed as quickly as possible. He stressed that it was important for the Company to seriously consider improvements related to equipment and gear, including that available to the offshore MMOs, in the future. He also identified some positive lessons and potential solutions that could be incorporated into future surveys and mitigation planning with respect to A-line acquisition in poor visibility.

With regard to monitoring, Tsidulko commended the efforts of the field teams, and in particular those by the behavioural teams to overcome initial difficulties and those by the acoustic team to address the problems and failures with acoustic equipment. A careful assessment of the data collected would be required before determining how successful these components were. He highlighted a number of areas that could be improved in the future, particularly related to (1) ensuring that the specific goals, objectives and methods of the monitoring are better understood by everyone involved in the planning stages, so that these are accounted for in personnel and equipment selection and in training, (2) ensuring sufficient backup of key equipment (e.g. acoustic buoys) and (3) ensuring that sufficient trained personnel are available.

Tsidulko concluded that it is important to recognise that each survey is different, and that any MMP needs to be developed taking account of the specific circumstances and conditions, as was the case in 2015.

DISCUSSION

The NTF thanked Tsidulko for his excellent work and also the Company for the support extended to him. It was noted that in addition to his formal duties, Tsidulko provided valuable technical advice and assistance to the Company in the field. The 2015 experience shows that the IO role will continue to be an important element of MMPs for future seismic surveys. Ideally, the IO's time in the field should be extended to cover the full MMP implementation period.

[9] http://cmsdata.iucn.org/downloads/wgwap_16___14_io_report_final_v7_20_11_2015.pdf

Many of the points and suggestions raised in the IO report served as valuable input to the discussions elsewhere in this report so they are not repeated here.

2.6.2 Discussion and conclusions on the mitigation component

Overall, the NTF concurred with the Company and the IO that despite some initial technical difficulties, the mitigation component *as specified in the final Company MMP* was 'implemented satisfactorily' in that the shutdown procedures were followed efficiently and effectively, A-lines were completed more quickly than had been anticipated and the Advisory Group established by the Panel to provide rapid advice during the survey (see later) worked well.

However, a number of important lessons were identified. These related primarily to the use of new technology under poor visibility conditions, problems with acoustic equipment with respect to choice of model variants, and the number and scheduling of MMOs on the vessels.

There has been considerable discussion previously (from NTF-5 onwards) about the use of 'blended-vision' technology (primarily infrared although later – at NTF-7 - active sonar was mentioned) to improve whale detections, especially under poor/no visibility conditions. The potential value of this was recognised by the NTF and the Panel but it was recommended that before such technology is adopted, formal evaluations need to be conducted under field conditions. It was noted that problems could arise due to false positives as well as false negatives. Although the blended-vision equipment was purchased and installed, only a qualitative evaluation of its effectiveness was made during 2015, and this was based solely upon MMO preferences from their experience at Lunskoye where no whale sightings were made during the trials. The NTF agreed that it was essential for a quantitative evaluation to be made before any future seismic survey, following the Panel's previous recommendations.

An important component of the MMP was to ensure that whales (initially the focus was on M-C pairs) were not subject to ensonification beyond the behavioural threshold. Determination of this relies on a combination of the JASCO model (and offset variants) and verification by real-time data obtained from buoys along the PML. The MMP identified the number and positioning of buoys (and what to do if they failed) but equipment failure meant that the full number was not available. Real-time examination of data from available buoys showed that, on this occasion, the model was sufficient for mitigation purposes, particularly as the M-C pairs were all close to shore. However, the NTF agreed that it was essential in the future that (1) full field testing of complete systems occurs well before seismic surveys begin; (2) sufficient backup equipment is available; and (3) experienced acoustic engineers are available to conduct or oversee equipment installation and fully tested installation protocols are developed well before operations. It was recognised that with respect to (3), the problem in 2015 was not related to the lack of an experienced engineer but rather to human error and the lack of a fail-safe mechanism to ensure proper installation.

Finally, with respect to mitigation, the NTF agreed that (as had been recommended by the NTF and the Panel prior to this survey) there needs to be early consideration of the number of offshore MMOs, their duties (including use of new technology) and their time schedules.

2.6.3 Monitoring

The NTF agreed that exceptional efforts had been made by the field personnel to implement the monitoring component in difficult conditions. However, it noted that not all aspects of monitoring had been undertaken in full accord with the Company's MMP. In particular, with respect to the behaviour and distribution monitoring, much of the time during the pre-seismic week (which is extremely important for detecting whether any change occurred as a result of the survey) was spent training, obtaining information on and clarifying protocols, and solving equipment problems. In addition to severely limiting the amount of pre-seismic survey data obtained, this learning period and the inevitable improvement in performance of observers over time may create analytical difficulties in being able to assume that the data have been collected in a consistent manner.

A number of the difficulties encountered could have been minimised if recommendations made from NTF-6 onwards had been implemented more promptly, particularly with respect to the early selection of behavioural team leaders and the need for sufficient time to train behavioural MMOs (e.g. see NTF-6, Item 5.4). The NTF **reiterates** that the observers for behavioural studies require considerable training and experience.

However, it also recognised that in 2015 it was difficult to recruit qualified observers due to the competing needs by ENL as it was undertaking similar behavioural and other monitoring. The NTF agreed that such problems must be avoided in the future. This is essential if a better understanding of the effects of seismic surveys on gray whales is to be obtained. Such understanding should lead to improved mitigation. The NTF reiterated that in the future, experienced team leaders should be appointed well in advance and ideally be in the field the year before to gain familiarity with (1) protocols, (2) software/hardware, (3) classification of behaviour and (4) local conditions. It was also suggested that it could be valuable to hold refresher courses at either Yuzhno or in the field camp before the pre-seismic observation effort begins.

2.6.4 General

Overall, the NTF agreed that Company field personnel made every effort to implement the MMP. Given the complexity of the operations and the remoteness of the area, the NTF recognised that there will always be a need for some *in situ* fixes, and thus it commended the efforts of all concerned. That being said, it also agreed that it was essential to learn lessons in order to minimise problems in the future, especially in terms of field planning, recruitment, testing and training.

2.6.5 Lessons learned and recommendations for the future

The Company produced a document (NTF-9/7) summarising its views on the 2015 MMP and lessons learned. It noted that, as a general point, the MMPs apply only to seismic surveys conducted by Sakhalin Energy near Piltun during the Sakhalin summer season. The MMPs are a key product of discussions between the Company and WGWAP, primarily at NTF meetings.

The first MMP was developed for a 4D survey of 145 km^2 conducted in 2010 across the Astokhskoye area. The 2010 MMP was adapted for use with the 2012 2D Hi-Res seismic across South Piltun. The third and most recent MMP was developed for the 2015 4D seismic survey of the entire Piltun-Astokhskoye field, using the 2010 MMP as the starting point.

During preparations for the 2015 survey, it became apparent that application of the original (2010) MMP would lead to significant downtime for the seismic survey early in the season, extending the 2015 survey duration and thereby causing noise exposure to more whales as it is later in the season during the peak abundance. To avoid this, the Company and Panel managed to prioritise the mitigation measures from the original MPP, while retaining the key intentions of that plan.

The Company proposed that there is room for further improvement, in particular in the following areas:

(1) The process of developing an MMP for a specific survey can be improved (e.g. agility of advisory arrangements). Additionally, the MMP could be designed to achieve the desired level of protection more efficiently.

(2) Maximising the impact of the allocated mitigation and monitoring resources. The Company proposes to do an ‘open’ cost-benefit analysis of the measures, to identify and retain those that create the greatest relative gains, while seeking more effective alternatives for those that yield relatively little effect at significant cost. It is believed that such a cost-benefit analysis has not been carried out before.

There was considerable discussion of these and associated ideas within the NTF. It was agreed that more time was required to consider them in detail in the context of a specific survey, rather than in the ‘abstract’.

There was considerable discussion about what factors might be taken into account in any ‘cost-benefit analysis’ and in particular how to define ‘benefit’ (and to what or whom the benefit was applicable e.g. company, whales, science etc.) and how to account for components of any MMP that might be mandated by the Russian Federation irrespective of their actual cost. The point was made that the responsibility of the Panel was primarily to provide its best advice on limiting and reducing potential impacts on whales, not to assess costs; effectiveness of measures in protecting whales is the Panel’s priority – after which costs can of course be considered. It was also recognised that the task force approach allows for the invitation of additional expertise to supplement the membership if that is considered necessary, and this could include MMOs who have participated in previous seismic survey MMP implementation. It was also pointed out that both the Company and the Panel had held up the 2010 MMP as the starting point for discussions, recognising that the prevailing conditions for an individual seismic survey, and the results of analyses from previous surveys as well as new general developments regarding the effects of noise on cetaceans, must be taken into account each time. Similarly, new techniques to obtain the same or better data need to be kept under review and evaluated (e.g. drones, D-tags etc.). With respect to the introduction of new criteria, it was noted that past data could be used to investigate the potential effects of such criteria on the conduct of surveys (e.g. time to completion).

The idea of formalising a small advisory group to provide practical advice to the Company after the last Panel advice has been provided prior to the start of a seismic survey was discussed; this would be, in effect, a matter of extending the remit of the small group that provides advice during the survey to the lag period between the most recent Panel meeting and the survey start time. The NTF agreed that there were benefits to this approach provided that careful Terms of Reference were developed. The intention is that this would be at a practical, operational level, and should not be seen as a substitute for doing as much as possible in NTF and Panel meetings.

The NTF agreed that these matters should be kept under consideration when developing new MMPs. It stressed that it was premature to consider major changes until data analyses from 2015 were completed. Any proposed changes will require review in the light of (1) benefits or loss of benefits to the whales, (2) new data and analyses including analyses of potential cumulative effects and incorporation of data from all years, (3) details concerning the nature of specific surveys, (4) evaluations of new technology and (5) the relative costs of different approaches.

With respect to more specific recommendations, the NTF **agreed** that for any future seismic survey, the Company should ensure that:

(1) if new acoustic equipment is to be used, (a) full field testing of complete systems occurs well before the survey begins, (b) sufficient backup equipment is available in the field and (c) experienced acoustic engineers are available to conduct or oversee installation following well-tested protocols;

(2) if additional technology (e.g. night-vision or passive acoustic monitoring equipment) is to be used so that operations can continue in poor visibility (including at night), the effectiveness of that technology must be objectively and quantitatively evaluated, in field conditions comparable to those in which it will be used, prior to its inclusion as part of an MMP;

(3) experienced team leaders are appointed well in advance and ideally they are deployed in the field the year before to gain familiarity with (a) protocols, (b) software/hardware, (c) classification of behaviour and (d) local conditions. It was also suggested that it may be valuable to hold refresher courses at either Yuzhno or in the field camp before the pre-seismic monitoring effort begins.

The NTF also highlighted and **welcomed** several positive lessons from the 2015 survey including: the ability to use data from partial lines rather than having to reshoot whole lines, the importance of the IO, and the value of the approach of using a small Panel Advisory Group to give quick-turnaround feedback immediately before and during the survey.

Finally, the NTF reiterated that 2015 represented the largest level of seismic survey activity ever on the Sakhalin shelf and the largest monitoring effort. Sakhalin Energy was not the largest contributor to this activity nor was its survey the closest to the near-shore feeding area of the gray whales. Therefore to obtain maximum benefit from the experience gained and data collected, joint analyses with ENL are essential as discussed under Item 2.5.

3 MITIGATION AND MONITORING PLANS FOR FORTHCOMING SURVEYS

3.1 Overview of Sakhalin Energy's plans Sakhalin Energy

3.1.1 Considerations for future 4D surveys: Streamer versus OBN

Blonk provided a detailed presentation of the current situation. He began by showing monitoring results from the 2010 Astokhskoye 4D seismic survey, including the identification of an infill-well location, and discussed key technical drivers for continued 4D monitoring in view of prudent reservoir management. Some of these drivers are: (1) monitoring flood fronts from injected water and aquifer water influx, (2) assessment of reservoir connectivity, and (3) identifying targets for future producer and injector wells.

He then discussed a number of possible options involving streamer and/or Ocean Bottom Nodes (OBN) technology with their pros and cons for a next 4D seismic monitoring survey over Piltun-Astokhskoye notionally planned for 2018. Survey objectives will be similar to previous 4D surveys, namely:

(1) acquiring quality 4D seismic within budget and time, and without incidents;

(2) using new acquisition or processing technologies that allow seismic monitoring and imaging beneath the platforms and through gas clouds;

(3) protecting marine mammals during acquisition, with emphasis on gray whales;

(4) being transparent to the external world about the acquisition activities.

It was argued that while 4D streamer acquisitions have demonstrated their applicability and value combined with effective environmental risk mitigation and monitoring, the transition to OBN is preferred from both a technical and environmental perspective. The key reasons are (see also Table 4):

(1) OBN being a proven technology offers the critical ability to acquire data near and under the platforms and to improve 3D and 4D imaging (e.g. potentially seeing through gas clouds);

(2) OBN offers opportunities to reduce the environmental footprint through potentially reduced source strength, limiting the survey area, and improved vessel maneuverability, with the latter points expected to lead to a shorter time in the field.

	Pros	**Cons**
Streamer	- Proven value over P-A area - Proven environmental mitigation procedures - Proven contractor capability	- Availability of future appropriate streamer vessels at risk - Difficult to scale or reduce footprint - Complex operations to ensure 4D-repeatability - No signal near and under the platforms - Little to no signal through gas cloud areas
OBN	- Ability to acquire near and under the platforms - Ability to see through gas clouds (using PS-energy) - Large improvement in future 4D-repeatability allowing detection of more subtle signal - Scalable footprint (targeting specific areas) - Flexibility in shooting area adjustment in presence of marine mammals - Scope to reduce source size - Development of long-life nodes opening opportunity to substantially reduce time in field	- No easy access to proven OBN operator in the region - Risk that newest node technology not accessible in the region (political situation, remoteness, harsh climate) - Risk of poor 4D-repeatability with 1997-2010-2015 streamer surveys - Initially likely requiring more time in the field than a streamer acquisition

Table 4. Pros and cons for using streamer and OBN. Note: PS-energy in this context refers to energy of reflected acoustic shear or S-waves as recorded by an Ocean Bottom Node converted from compressional or P-waves as generated by a seismic source.]

However, the transition to OBN carries its own complications, key ones being:

(1) the risk that OBN data could not be properly matched to 2015 streamer data;

(2) the potential for complications in gaining access to a capable OBN operator in the region; and

(3) the first OBN survey likely taking longer than a corresponding streamer survey.

Therefore several acquisition options were discussed with their pros and cons (see Table 5) varying from a full-field OBN (1997 size), a smaller-scale targeted OBN, a streamer-OBN hybrid, to falling back on a streamer acquisition again. A hybrid option would allow moving more gradually into replacing streamer with

OBN, while protecting 4D repeatability with past surveys, but at a cost of being operationally more complex and expensive.

For each option, environmental risk mitigation and monitoring measures could follow the model successfully used in 2015 after implementing key learnings from 2015 operations. Starting early in the season had been identified as a main mitigation measure. For the next survey an earliest possible start date would again be targeted, while no delays related to other operators like those encountered in 2015 would then be expected (although this cannot yet be guaranteed). Ways to deploy nodes faster are being assessed, which would minimize the time in-field for a first OBN survey, even though it is still expected to take longer than a comparable streamer survey.

At this stage, the most viable acquisition option cannot yet be identified, although a full-field (1997 size) survey does not seem feasible, and a 2015-like streamer repeat would not be preferred. Insights from NTF members were discussed on additional environmental OBN benefits, acquisition alternatives and corresponding mitigation measures. In selecting the most appropriate option, Sakhalin Energy will continue to work with key stakeholders as the NTF and WGWAP to evaluate ways to limit the environmental impact of future seismic surveys. Furthermore, the NTF will be engaged when more specifics are known about key parameters like possible source strength reduction for an OBN acquisition.

	Pros	**Cons**
1. Full-field OBN	- All advantages of OBN utilization (refer to Table 1) - Proper OBN-baseline for future OBN surveys, even including potential future development to the South/East	- All disadvantages of OBN utilization (refer to Table 1) - Likely prohibitively long duration in the field - High costs
2. Reservoir-focused OBN	- All advantages of OBN utilization (refer to Table 1) - Proper OBN-baseline for future OBN surveys	- All disadvantages of OBN utilization (refer to Table 1) - Longer duration than streamer only
3. Gap-focused OBN	- Assessment of 3D imaging through gas clouds - Assessment of feasibility of streamer to OBN matching - Cost-effective way of testing key uncertainties - Likely duration comparable to streamer only - Providing limited OBN baseline for future OBN surveys	- Potentially no direct reservoir monitoring value - Potentially only restricted-area OBN-baseline value - No easy access to proven OBN operator in the region - Risk that newest node technology not accessible in the region (political situation, remoteness, harsh climate)
4. Hybrid streamer-OBN	- Highest chance of proper 4D monitoring both outside and inside the current data gaps - Assessment of 3D imaging through gas clouds - Assessment of feasibility of streamer to OBN matching - Providing some limited OBN baseline for future OBN surveys	- Logistically complex - Longer duration than streamer only - Only limited area imaged through gas clouds - Only limited-area guaranteed OBN baseline for future OBN surveys
5. Full-field streamer	- All advantages of streamer utilization (refer to Table 1)	- All disadvantages of streamer utilization (refer to Table 1) - Risk that later transition to OBN not feasible anymore

Table 5. Pros and cons for the different acquisition scenarios

3.1.2 Discussion

The Chair thanked Blonk for a providing a thorough presentation. He welcomed the information that the Company was seriously considering options for replacing streamer surveys and that it was engaging the Panel at an early stage in the process, as has previously been recommended by the NTF and the Panel.

In discussion, the NTF also welcomed the Company's desire for the Panel to participate in the process. It recognised that considerably more evaluation and planning was needed and that any consideration of future options must follow the same rigorous process as previous streamer surveys, e.g. with respect to modelling noise footprints and looking at other possible sources of disturbance including deployment of the OBNs.

A number of issues that need to be considered arose, including the need to:

(1) examine information on OBN surveys elsewhere to determine how much investigation could be 'desk-top' and whether there would be a need for experimentation at Sakhalin itself;

(2) consider new developments in other approaches, including marine vibroseis, that might be effective in shallow waters;

(3) consider future interactions with other companies' activities;

(4) examine all components of OBN deployment as well as operations in the context of potential disturbance to gray whales and their habitat (e.g. bottom disturbance and alteration from node deployment, whale entanglement in cables).

The NTF stressed that its contributions centre on the potential impacts on whales and not the relative merits of different technologies in relation to the Company's business objectives. It welcomed the early provision of information by the Company and agreed that it would share with the Company any relevant papers or reports on developments in new technology. In terms of developing an MMP for 2018, the NTF **reiterated** that it is essential to begin planning as soon as possible, within both the Panel and especially within the NTF, and to allow sufficient time to avoid problems similar to those encountered during the lead-up to the 2015 survey. It also referred to the lessons learned discussion under Item 2.6.5.

3.2 Workplan and timeline to provide advice on future surveys

The Company informed the NTF that a future survey (of whatever type) would be most likely to occur in 2018. ENL operations expected in 2017 make a seismic survey then infeasible but later than 2018 would make it more difficult to interpret observed changes.

4 OTHER BUSINESS

The NTF recognised there are a number of standing items that, had time been available, it would have liked to address, e.g. outstanding noise-related recommendations, minimising chronic (non-seismic survey-related) noise, cumulative impacts. However, given the lack of time, it **recommends** that sufficient time be allocated at the next NTF meeting to allow these to be discussed.

5 ADOPTION OF FINAL REPORT

The concluding sections of the report were agreed in draft form at the end of the meeting. It was agreed that Donovan would provide a NTF Chair's summary meeting to the subsequent Panel meeting (WGWAP-16) taking place 22-24 November 2015 at the same venue. The report itself would be developed after the meeting by the NTF Chair in collaboration with other members and circulated to the full NTF for agreement by email.

In concluding the meeting, the NTF Chair thanked all of the participants for their hard work and co-operative spirit. It was a long and complex agenda and the time was very limited; that was a lesson for the future. He particularly thanked the Company for providing a considerable amount of information on the 2015 survey despite the short time between the end of the 2015 field season and the NTF-9 meeting. He stressed the importance of maintaining the momentum towards data validation and analysis. In particular, he stressed the willingness of Panel members to provide advice on joint analyses and welcomed the Company's willingness to liaise with ENL. Finally, he thanked IUCN, the rapporteur and the interpreters for providing excellent support.

6 REFERENCES

Gailey, G., Sychenko, O., McDonald, T., Racca, R., Rutenko A. and Bröker, K. 2016. Behavioural responses of western gray whales to a 4-D seismic survey off northeastern Sakhalin Island, Russia. *Endangered Species Research* 30:53-71

Muir JE, Ainsworth L, Joy R, Racca R Gailey G, Vladimirov V, Starodymov S, Bröker K. 2015. Distance from shore as an indicator of disturbance of gray whales during a seismic survey off Sakhalin Island, Russia. *Endangered Species Research* 29: 161-78.

Muir JE, Ainsworth L, Racca R, Bychkov Y Gailey G, Vladimirov V, Starodymov S, Bröker K. 2016. Gray whale densities during a seismic survey off Sakhalin Island, Russia. *Endangered Species Research* 29: 211-27.

ANNEX A – LIST OF PARTICIPANTS

Justin Cooke (WGWAP)
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Anete Berzina
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Interpreters

Alexander Danilov
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ANNEX B – AGENDA

1 INTRODUCTORY ITEMS (Chair, IUCN)

1.1 Introductions and logistics

1.2 Adoption of agenda

1.3 Available documents/materials

2 PROGRESS REPORT ON THE 2015 SEISMIC SURVEY(S)

2.1 Narrative (Sakhalin Energy) – NTF-9/3

2.2 Summary of the whale distribution components of the MMP (Sakhalin Energy)

2.2.1 Summary of data collection methods (and validation) including difficulties, if any

2.2.2 Initial results

2.2.3 Company plans for future analyses

2.3 Summary of the whale behaviour components of the MMP (Sakhalin Energy)

2.3.1 Summary of data collection methods (and validation) including difficulties if any

2.3.2 Initial results

2.3.3 Company plans for future analyses

2.4 Summary of the acoustic components of the MMP (Sakhalin Energy) – NTF-9/4; NTF-9/5

2.4.1 Summary of data collection methods (and validation) including difficulties if any

2.4.2 Comparison of actual and predicted levels during the survey

2.4.3 Company plans for future analyses

2.5 Other data collected

2.5.1 Environmental data (Sakhalin Energy)

2.5.2 Use of new technology including thermal/infrared imaging (Sakhalin Energy)

2.5.3 Data collected by other organisations, if any (e.g. NGOs etc.)

2.6 NTF Advice and Recommendations for analyses (including joint analyses with Exxon)

2.6.1 Data availability

2.6.2 Behavioural data

2.6.3 Distribution data

2.6.4 Acoustic data

2.6.5 Integrated analyses (including MVA)

2.6.6 Evaluation of new technology

2.6.7 Other

2.7 NTF overview of the monitoring and mitigation programme

2.7.1 Company conclusions and recommendations – NTF-9/6

2.7.2 Report of the Independent Observer (Tsidulko)

2.7.3 Discussion and conclusions including recommendations for the future – NTF-9/7

3 MITIGATION AND MONITORING PLAN FOR FORTHCOMING SURVEYS

3.1 Overview of plans (Sakhalin Energy) – NTF-9/8; NTF-9/9

3.1.1 Considerations for future 4D surveys: Streamer versus OBN

3.1.2 Survey scenarios and associated technical and environmental risks (incl. proposed timing, extent, equipment)

3.2 Workplan and timeline to provide advice on future surveys – NTF-9/7, 8, 9

4 OTHER BUSINESS

5 CONCLUSIONS AND RECOMMENDATIONS

6 STRATEGY FOR COMPLETION OF FINAL REPORT

ANNEX C – LIST OF DOCUMENTS

Note: The list includes documents that were also submitted to the subsequent WGWAP-16 meeting

DOCUMENT #	TITLE	LANGUAGE	STATUS
NTF-9/1	Provisional agenda of the 9th meeting of the WGWAP Noise Task Force	English	Public
NTF-9/2	List of documents distributed in connection with the 9th meeting of the WGWAP Noise Task Force	English	Public
NTF-9/3	Review of 2015 4D seismic survey at Piltun-Astokhskoye (by Marko van der Veen, Sakhalin Energy)	English	Confidential
NTF-9/4-RU	Тестирование программного обеспечения на примерах анализа акустических данных полученных во время мониторинга (Отчет ТОИ о полевых работ)	Russian	Confidential
NTF-9/4-EN	Software testing based on analysis of acoustic data received during monitoring activities (POI field report)	English	Confidential
NTF-9/5	Acoustic modelling and field analysis report: Sakhalin Energy's 2015 4D seismic survey at Piltun-Astokhskoye (by Roberto Racca and Caitlin O'Neill, JASCO Applied Sciences, 21 October 2015)	English	Confidential
NTF-9/6	Feedbacks and comments from MMP implementation on P-A 4D survey 2015 at Piltun, Sakhalin (by Antonio Di Matteo, Shell PTU/E/S)	English	Confidential
NTF-9/7	Initiating change to Monitoring and Mitigation Plan for seismic surveys (by Marko van der Veen, Sakhalin Energy-TDD-CTT, September 2015)	English	Confidential
NTF-9/8	Overview Plans for Future 4D Seismic over Piltun-Astokhskoye (by Bastian Blonk, Sakhalin Energy)	English	Confidential
NTF-9/9	Sakhalin Energy's planned offshore activities 2015-2019	English	Confidential
NTF-9/10-EN	Acoustic and Hydrological Studies on the Northeast Sakhalin Shelf June 10 through October 10, 2014	English	Confidential
NTF-9/10-RU	Акустико-гидрофизические исследования на северо-восточном шельфе о. Сахалин с 10 июня по 6 октября 2014 г.	Russian	Confidential
NTF-9/11	Report of the IUCN's Independent Report to Sakhalin Energy's 2015 4-D Piltun-Astokhskoye Seismic Survey	English	Public
NTF-9/12	Sakhalin Energy's Monitoring and Mitigation Plan for 2015 Piltun-Astokhskoye 4D Seismic Survey 2015	English	Public

ANNEX D – SAKHALIN ENERGY'S EVALUATION OF ITS PERFORMANCE AGAINST THE REQUIREMENTS FORMULATED IN ITS MMP

1.1 Fundamentals

MMP Reference	Plan	Actual
1.1-1a	Minimise Survey area	330 Sq Km (in line with plan)
1.1-1b	Minimise sound levels	2,888 cu in source, as per plan
1.1-2a	Carry out survey as early as possible. Start dates between 1-12 July were reported to WGWAP, IWG and BG during the preparation stage	ENL finished Odoptu 3D on 7-July and Sakhalin Energy started Piltun-Astokhskoye 4D on 8 July.
1.1-2b	Suspend survey activity when needed to protect whales	A-zone and Source Exclusion Zone (SEZ) implemented as per plan

1.2 Shore Based Command Center

MMP Reference	Plan	Actual
2.1-1	Command Center (CC) to be established according to sub-points 1-5	The CC was established in the same position as used in previous years, and the site was operational 28-June 2015
2.1-2	CC to be equipped for reception of real-time data and info req'd to oversee MMP implementation	Such equipment was installed and operational; as per communications protocol; fine tuning took place 29/6-7/07. Power supply identified as logistics bottleneck to communications infrastructure
2.1-3	MMP Coordinator to be appointed	Central Commander di Matteo on site 30/6-25/7, focusing on mitigation actions. Monitoring continued a week after completion of the survey as per plan.
2.1-4	Above role in shore based camp	As per plan
2.1-5	Independent Observer will be appointed by IUCN	IO / WGWAP member Tsidulko on site 30/6-25/7 in line with TOR

1.3 Acoustic Monitoring

MMP Reference	Plan	Actual
2.2.1-1	Real Time acoustic monitoring with AUARs deployed on PML during all periods of seismic source activity	Such monitoring was operational for the period of recording A-lines. Iridium systems worked, radio transmission did not work at all
2.2.1-2	10 AUAR's to be spread along the PML with two 3-cluster stations and 4 AUARs spread in between	10 Real Time (RT) buoys were deployed from 3/7. 4 (radio-equipped) buoys failed straight away. 6 (Iridium) Buoys were operational 6-Jul (2 North, 2 middle, 2 South). Two (Iridium) buoys were borrowed from ENL, bringing the number of operational buoys up to 8 on 8-Jul. 4 Failed units were repaired 11-

		12 July in Yuzhno-Sakhalinsk, shipped back and re-deployed at sea. Between 8-9 buoys were operational during 13-29 July.
2.2.1-3	Functional integrity of RT acoustic monitoring system to be maintained at all times	Not maintained at all times, see above. 48 Hour repair period not honoured, sought WGWAP advice on the same.
2.2.1-4	AUARs working before survey and for duration of survey	Yes – they were working for the duration of the survey but RT telemetry was switched off when A-lines were finished. Buoys recovery 31/07.
2.2.1-5	Radio link between RT monitoring acoustic outpost and CC	Maintained at all times during A-lines
2.2.2-1&2	Deploy Archival stations 10m isobath	2 out of 3 stations deployed. A 3rd station coincided with an ENL station, and was not separately occupied by a Sakhalin Energy station.

1.4 Visual Monitoring – Shore based

MMP Reference	**Plan**	**Actual**
N/A	Monitoring to start one week before the survey and to continue one week after the survey	Honoured; Monitoring took place 1-July to 5-August with survey taking place 8-29 July
2.3.1-1	Behavioural & Distribution monitoring from fixed stations. 4 teams with experienced specialists; theodolite operator, computer operator, two observers	4 Teams of 4 staff with recommended composition. Some team members were lacking experience and had to be trained during first week
2.3.1-2	Photo-ID effort opportunistic effort, requiring two teams split north & south	Photo-ID south. Opportunistic photos in north
2.3.1-3	Onshore teams must report to CC in timely, at least daily and immediately if required for mitigation	Fulfilled as per plan

1.5 Visual Monitoring – Vessel Based

MMP Reference	**Plan**	**Actual**
2.3.2-1	WGW monitoring from vessel; - 2 MMO distant monitoring - 4 MMO monitor source exclusion zone - Big Eyes mounted on deck giving unobstructed view of PML irrespective of whether vessel sails south or north	The MMO team consisted of 6 staff. - 4 MMO's remained on survey vessel at all times. - 2 MMO's were at times dispatched to support vessels for monitoring of PML during acquisition of A-lines & pre-dusk scans. All A-lines and A-segments acquired at night were preceded by a pre-dusk scan.

		- Big Eyes mounted on port side, giving best view of PML when sailing north. However were confirmed as useable when sailing south.
2.3.2-2	Vessel based MMOs report to CC daily and immediately if required for mitigation	Implemented as per communications protocol
2.3.2-3	Experienced MMOs will be stationed on the vessel during the survey with specifications a) to g)	Implemented according to Sakhalin Energy's 2015 MMO Manual.

1.6 Mitigation Measures

MMP Reference	**Plan**	**Actual**
4.1.1	Survey will commence and be completed as early in the season as logistically possible (incl. monitoring/mitigation in place). Actual start date dependent on ENL's Odoptu A-lines and ice/weather. A-lines finished before 1-Aug	ENL Odoptu finished 7-July. Sakhalin Energy's Piltun-Astokhskoye started 8-July. A-lines finished 25-Jul.
4.1.2	Survey duration will be as short as technically and logistically feasible. Logistics includes ensuring that all Monitoring and Mitigation measures fully implemented.	Survey duration 21 days, below Company estimate of 30 days and below Contractor estimate of 27 days. A-lines recorded in 17 days. Survey started with only 6 RT AUAR's deployed and thus strictly speaking not complying with the plan
4.2.2	Lines in A-zone should be acquired as early as possible given visibility, mitigation and monitoring requirements	A-lines were prioritised during acquisition. Port call of VG during first days of P-A meant no south bound A-lines could be acquired during that time, as these lines were all close passes to platform requiring VG on site.

1.7 Mitigation Measures – A/B zones

MMP Reference	**Plan**	**Actual**
4.2.1-1	Definition of A-zone	The "perpendiculars" were not honoured, but instead the actual 156dB contour as modelled was honoured.
4.2.1-2	Real time A-line classification	This has happened. Model remained the same throughout but applicable dB offset has changed from +3dB (precautionary offset applied at start-up), +1dB, 0dB, +1dB
4.2.1-3	Regular interval of comparison of observed and expected sound levels	This has been checked continuously
4.2.1-4	Re-classification of A-line	This has happened when switching from 0dB to +1dB offset (2 lines affected) 0dB offset: 21 A-lines +1dB offset: 23 A-lines +3dB offset: 27 A-lines

1.8 Mitigation measures – Close to vessel

MMP Reference	Plan	Actual
4.2.2-1	Ramp up procedure and extended visual search (30min) prior to ramp up	Honoured
4.2.2-2	Shut down if marine mammal within source exclusion zone	This has happened on 5 occasions, honouring Russian Federation EIA stipulated exclusion zone distances
4.2.2-3	Pre-cautionary shut down if a WGW is on a course likely to result in it entering the SEZ	There were no WGW's close to the source
4.2.2-4	Remote sensing equipment installed on-board vessel to try to detect marine mammals during poor visibility	Seismic vessel had marine radar, high res radar (Sea Hawk), thermal camera. Support vessel had marine radar, high res radar (Rutter).
4.2.2-5	Mitigation gun during line turns	Requested clarification from WGWAP. Changed advice to: disable mitigation gun if line turn > 4 hours. Mitigation guns were not used.

1.9 Mitigation measures – A-zone

MMP Reference	Plan	Actual
4.2.3-1	13 Lines closest to shore will be acquired during day. If choice between postponement and acquiring in poor visibility then choice made on the day. If acquiring at night, pre-dusk scan will take place and it must confirm that no M-C pairs are present in A-zone	The 13 lines closest to shore have been acquired in 17 passes of which 9 during day, 8 at night, in order to match feather (tidal currents). The latter was successful on all but one occasion. Pre-dusk scans have been conducted when acquiring A-segments for all A-lines acquired at night, not just the 13 closest to shore.
4.2.3-2	No acquisition will occur if M-C pairs in A-zone	There were no M-C pairs sighted in the A-zone, during the Piltun-Astokhskoye seismic survey. M-C pairs stayed within the strip <2km from shore at all times and the 156dB contours (A-zones) did not reach that far out to shore.