Southern North Sea Harbour Porpoise Population Modelling Validation – Data Quality Control Report

Issue 03

July 2023

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SAMS ENTERPRISE

Report Title	Southern North Sea Harbour Porpoise Population Modelling Validation – Data Quality Control Report
Project Name	SPRPorpoiseB
Client/Customer	ScottishPower Renewables
SAMS Enterprise Project Reference	02564
Document Number	02564_0003

Revision History

Revision	Originator	Checked	Approved	Date
A	NvG	SB/AW	-	25/11/2019
B	NvG	SB	-	26/11/2019
C	AW	NvG	-	28/11/2019
Draft 01	AW	NvG	AW	29/11/2019
01	NvG	CA	CA	12/02/2020
02	NvG	AW	AW	29/07/2021
03	NvG	SB	AW	31/07/2023

Revision	Changes
A	First internal draft for review
B	Second internal draft for review
C	Third internal draft for review
Draft 01	First draft issue submitted to the customer
Issue 01	First formal issue to the customer
Issue 02	Final formal issue to the customer
Issue 03	Formal version for public domain

Please cite report as:
van Geel, N.C.F., Wittich, A., and Benjamins, S. (2023). Southern North Sea harbour porpoise population modelling validation – Data Quality Control Report. A report by SAMS Enterprise for ScottishPower Renewables: 28 pp.

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Acronyms & Abbreviations

ADD	Acoustic Deterrent Device
C-POD	Continuous Porpoise Detectors
DC	Direct Current
EA1	East Anglia ONE
EC	European Commission
FBW	Full bandwidth
FCS	Favourable Conservation Status
iPCoD	Interim Population Consequences of Disturbance
ITT	Invitation to tender
JNCC	Joint Nature Conservation Committee
kHz	Kilo Hertz
kU	Kilo Units
MU	Mega Units
ms	Milliseconds
OSC	Ocean Science Consulting Ltd.
OWF	Offshore Wind Farm
PM	Project Manager
QC	Quality Control
s	Seconds
SAC	Special Area Conservation
SAMS	Scottish Association of Marine Science
SPR	ScottishPower Renewables
UTC	Coordinated Universal Time
UXO	Unexploded Ordnance
WP-A	Work Package A
WP-B	Work Package B

1 INTRODUCTION

1.1 Project Background

The harbour porpoise (*Phocoena phocoena*) is the smallest and most commonly observed cetacean species found in UK waters. Due to its overlapping distribution with, and susceptibility to, anthropogenic pressures, the species is protected under UK and international regulations, most notably the EU Habitats Directive (originally transposed into UK law through the Conservation [Natural Habitats, &c.] Regulations 1994, and subsequently by the Offshore Marine Conservation [Natural Habitats &c.] Regulations 2007 [as amended] for waters beyond 12 nautical miles). These regulations require that the Favourable Conservation Status (FCS) of the species be maintained or restored through appropriate conservation measures. As harbour porpoise is listed under Annex II of the Habitats Directive, there is an additional need under the regulations to establish a network of Special Areas of Conservation (SACs) for the species. ScottishPower Renewables' (SPR) East Anglia ONE (EA1) Offshore Wind Farm (OWF), the focus of the current project, sits within the currently designated Southern North Sea SAC.

Cetaceans such as harbour porpoise are known to be sensitive to anthropogenic noise pollution, such as produced by offshore construction activities involving pile-driving (e.g. Brandt et al., 2016; Carstensen et al., 2006; Teilmann and Carstensen, 2012). Considerable amounts of pile-driving are either ongoing or forecast throughout the North Sea related to continued expansion of the offshore wind renewable energy sector over at least the next decade. Concerns about auditory injury, acoustic masking and disturbance imposed upon animals through pile-driving are increasing and have driven calls for more detailed assessment of how local disturbances might impact porpoise populations across larger spatial and different time scales, as well as likely cumulative effects.

The interim Population Consequences of Disturbance (iPCoD; Harwood et al., 2014; King et al., 2015) and DEPONS (Nabe-Nielsen et al., 2018 & 2021) models have been specifically developed to predict potential effects of the construction and operation of offshore renewable energy devices in the North Sea region. These models represent a promising approach to allow regulators to assess the potential for long-term, cumulative effects of marine industrial activities and undertake strategic spatio-temporal planning, with a view to minimise impacts on harbour porpoise populations and not affect their FCS, as required under the Habitats Directive and derived national legislation.

1.2 Project Objectives

Ultimately, the current project seeks to clarify the consequences of the construction of the East Anglia ONE OWF on the wider North Sea harbour porpoise population. Underpinned by harbour porpoise presence (C-POD) and acoustic full bandwidth data collected during various stages of the construction process, SAMS Enterprise (previously SAMS Research Serviced Ltd.) aims to apply the two currently available population consequence modelling approaches developed for the North Sea. SAMS Enterprise will assess applicability of the iPCoD and DEPONS models and evaluate their limitations and sensitivities to varying parameters, so that population consequence outputs, together with uncertainty in results, can be considered comprehensively.

The project aims to:

- Determine how harbour porpoises respond to pile-driving activities at a local scale in and around the East Anglia ONE OWF, on the basis of data collected through Work Package-A (ITT-752262);
- Compare the suitability and sensitivity of iPCoD and DEPONS model approaches to assess population consequences to disturbance from pile driving;
- Run available model frameworks using project specific input data to assess potential larger-scale or cumulative impacts; and
- Assess the use of collected acoustic data as a proxy for behavioural responses of porpoises towards OWF construction, which could improve input parameters for future model applications.

1.3 Document purpose

The Data Quality Control report is part of a series of documents produced for SPR as part of the delivery of the Southern North Sea harbour porpoise population modelling project.

The raw acoustic data (derived from WP-A) were received from Ocean Science Consulting Ltd. (OSC) via SPR, and were subsequently copied onto SAMS Enterprise's data server for back-up. Likewise, the C-POD harbour porpoise presence data were also stored onto SAMS Enterprise's server. This document describes the quality control process undertaken on the raw acoustic full bandwidth and C-POD data after completion of the back-up process. The report provides an overview of the data available for the project, and highlights issues encountered during the quality control inspection. No comprehensive assessment will be made in the present document about data suitability and subsequent consequences of data exclusion.

In addition to the current report, further project outputs are presented in the 'Acoustic Processing' and 'Population Impact Modelling' reports (van Geel et al., 2023 a & b).

2 METHODOLOGY

In 2018, SPR had contracted two scopes of work outlined in the tenders ITT 752262 (WP-A) and ITT 752263 (WP-B), which collectively sought to investigate the consequences of the construction of the East Anglia ONE OWF on the wider North Sea harbour porpoise population, and assess applicability of currently available population consequence models developed for the North Sea.

In brief, WP-A focused on the collection of acoustic harbour porpoise presence (C-POD) and acoustic full bandwidth (RTSYS) data during the pre-, during- and post-construction stages of EA1, which was carried out by OSC between February 2018 and June 2019. C-PODs (Version 1; Chelonia Ltd.) were deployed at 12 sites at varying distances from the piling locations. C-PODs were programmed to record continuously; default settings were applied (including a pre-set detection capacity limit of 4,096 clicks per minute), and the devices were set to record independent of orientation in the water column. Deployment followed the acoustic-release anchoring design developed under the SAMBAH project (Amundin, 2016). RTSYS EA-SDA14 acoustic recorders, connected to either a SPARTON PHOD-1 or a RESON TC4014 hydrophone (sensitivities of -156 and -186 dB re 1 V/µPa respectively), were deployed simultaneously at six of the aforementioned 12 sites, collecting data at a sampling rate of 156 kHz, adhering to a 10/14 hour on/off duty cycle during the first two deployments followed by a 6-hour on/off duty cycle in subsequent deployments. SAMS Enterprise's input into the data collection process was limited to implementing the change to the 6-hour on/off duty cycle for the full bandwidth recordings; SAMS Enterprise did not have any other involvement in the data collection design, methodology or equipment used.

The work presented here falls within the scope for WP-B, while building upon the data collected under WP-A. A summary of the monitoring information provided by OSC is presented in Table 1. OSC terminology is continued throughout this report, with 'Leg' describing the deployment number, and specific deployments are indicated by the combination of their Leg and OSC mooring location. For example, 05_03 refers to the monitoring undertaken during Leg 5 at mooring location 03.

Table 1. *Summary overview of WP-A monitoring effort as provided by OSC. Whilst the monitoring period covers deployment date to recovery date, some equipment was found by third parties before or after the general equipment recovery/change-over date. Additionally, the full bandwidth recorders, in particular, typically stopped collecting data at some point prior to retrieval due to lack of battery power during prolonged deployment. Mooring locations refer to OSC mooring names.*

Leg	*Monitoring period*	*Notes*
1	17/02/2018 - 11/03/2018	
2	11/03/2018 - 06/05/2018	No deployment at mooring locations 7 & 8
3	05/05/2018 - 03/06/2018	
4	03/06/2018 - 06/07/2018	No RTSYS deployment at mooring location 12
5	06/07/2018 - 13/09/2018	
6	13/09/2018 - 16/02/2019	
7	16/02/2019 - 22/03/2019	No RTSYS deployment at mooring locations 3 & 12
8	21/03/2019 - 22/05/2019	No RTSYS deployment at mooring locations 3, 7 & 12
9	22/05/2019 - 21/06/2019	No RTSYS deployment at mooring location 3

2.1 Quality Control (QC) of harbour porpoise presence and acoustic data

Upon receiving the data collected during WP-A (October 2019), these were copied onto SAMS Enterprise's server, and the original hard drives were returned to SPR. To verify receipt of all data, a data receipt protocol was implemented. This included checking the data against the overview of acoustic monitoring provided by OSC, as well as checking for any unexplained breaks in the datasets and documenting the data obtained. A subset of the sound recordings was inspected visually. Additionally, C-POD data were checked for corrupted files and the time each device spent actively recording was checked against deployment information provided by OSC.

Specifically, the following checks were carried out for the C-POD data:

- C-POD data were checked against the monitoring information provided by OSC (i.e. deployment date/time, recovery date/time and file size);
- Raw and processed C-POD data (specifically .CP1 and .CP3 files) were opened in the proprietary software CPOD.exe (Version 2.044) to check that these files were not corrupt or empty;
- Raw and processed C-POD data (specifically .CP1 and .CP3 files) were visually inspected to check for unexpected data gaps or other issues during the period the equipment was deployed;
- Data from C-PODs that were originally recorded as lost, but subsequently recovered and returned to OSC by third parties, were checked with a view to potential requirements for data exclusion. For these units, OSC had previously indicated what data they would exclude from analysis. Our preliminary assessment either agreed with these recommendations or highlighted the need for further inspection during the acoustic processing stage.

Summary descriptions of all received .wav and .txt files were created to facilitate assessment of the full bandwidth (FBW) data by performing the following checks (for full data receipt protocol for FBW data, see Appendix 1):

- Confirmation of FBW recording times, checked against deployment times provided by OSC;
- Review of file sizes (shorter files than expected may occur at the end of a duty cycle, or may indicate the presence of corrupted files);
- Identification of any data gaps within the deployment period;
- Identification of inconsistencies (e.g. duplication of files);
- Review of whether all expected accompanying mission and board files are present;
- Confirmation of sound file sample rate and bit size; and
- Visual check for corrupted files or other issues.

A selection of sound recordings was inspected visually (and aurally where required), using Raven Lite (Version 2.0.0; Cornell Lab of Ornithology) acoustic analysis software. For recordings collected during the first two Legs (10/14 hour on/off duty cycle), for each day the test subset consisted of the 2nd file (starting ~07:01 UTC), the mid-day file (~12:00 UTC) and the second-to last file (~16:58 UTC; unless the day ended earlier at the end of a Leg). For the remaining Legs (6-hour on/off duty cycle), daily checks were undertaken for the 2nd file (normally ~00:02 UTC; but at ~09:01 UTC for the 1st recording day), and the files recorded around 10:00, 14:00 and 22:00 UTC. For each Leg where a device stopped recording prior to retrieval, the final file was also checked. Additional files were inspected when potential issues were highlighted during the initial steps of the data receipt procedure, or when issues were identified during the visual checks.

Finally, whenever sounds associated with piling were encountered in the sub-sampled FBW data, these occasions were marked and the piling signals assessed as to whether these were fully captured within the dynamic range of the recorder system, by assessing whether the signals were clipped. Clipping is a distortion resulting from excessively loud signals that exceed the equipment's measurement capability, known as the dynamic range. When clipping occurs, the waveform is not fully captured, resulting in erroneous sound level measurements (see Figure 1 below).

Acoustic signals are typically visualised as waveform graphs, where signal amplitude (i.e. signal strength) is plotted versus time, or spectrograms, where amplitude is displayed as a function of frequency over a certain time period. Raven allows to view both the waveform and the spectrogram of sound files simultaneously; an example of the Raven layout is provided in Figure 1. The top panel shows the waveform, with relative signal amplitude (in kU or MU) on the vertical axis and time (in ms or s) on the horizontal axis. The stronger the signal, the larger the positive and negative amplitude response. The spectrogram is plotted on the bottom panel, with frequency (in kHz) on the y-axis and time on the x-axis. The 'loudness' of the signal is presented on a greyscale for each time-frequency combination; the higher the relative amplitude measured for a certain frequency at a specific time, the darker the colour. The time scales of these two graphs are aligned, allowing sound data to be assessed in combination and thus facilitating interpretation.

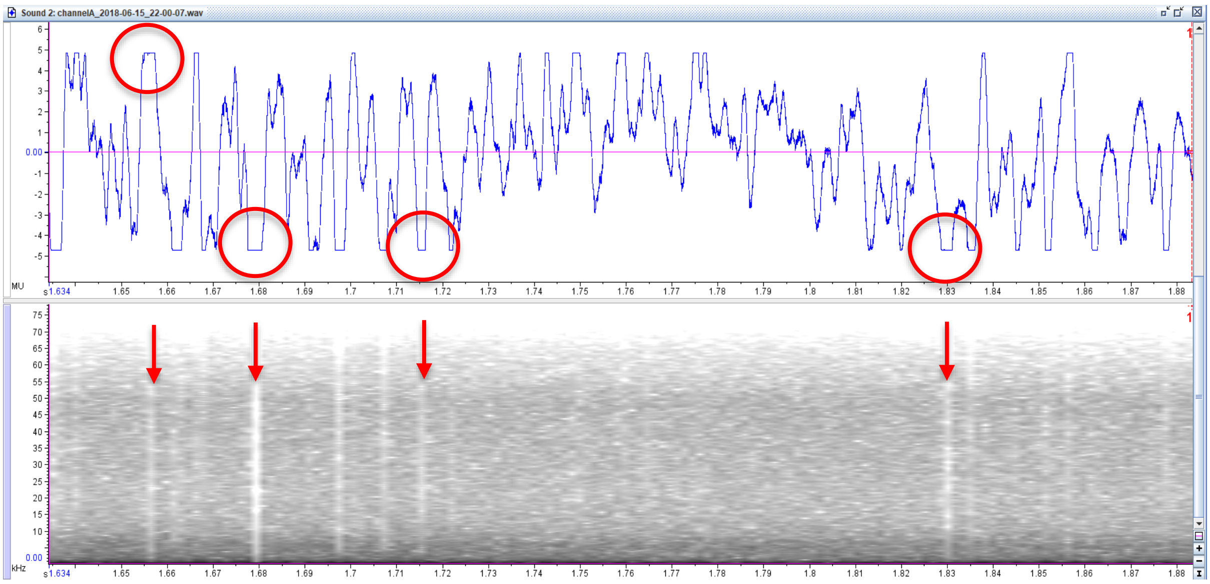

Figure 1. *Example of the waveform (top panel) and spectrogram (bottom panel) views used to visually inspect the RTSYS FBW data, covering a 0.25 s time window. The signal extends beyond the dynamic range of the recording system (~ +5 to -5 MU) on several occasions; some of the resulting clipping is indicated by the red circles and arrows.*

In this report, waveform and spectrogram visualisations are provided to highlight issues with the data, and to exemplify specific noise sources. Signal amplitude measurements made by the instruments depend on the overall system sensitivity (which is itself composed of unit-specific device sensitivity, hydrophone sensitivity and applied gain settings); therefore these un-calibrated waveforms represent relative amplitude, as system sensitivity is not yet accounted for here. As the devices deployed during WP-A have different system sensitivities, the relative amplitudes cannot directly be compared. Likewise, the amplitude colour saturation (i.e. the greyscale) of the spectrograms have occasionally been manually adjusted to highlight specific signals, in turn impeding comparison between spectrograms. The spectrograms provided in this document present data for the entire effective monitoring frequency range (i.e. 0 - 78 kHz; resulting from the 156 kHz sampling rate), over the full sound file (73 - 75 seconds long) unless specified otherwise.

3 QC RESULTS

3.1 C-POD data

3.1.1 Data availability

The data receipt for the C-POD data, covering results of the quality checks of both .CP1 and .CP3 files, is specified in Appendix 2, and provided as a separate Excel file. The spreadsheet gives an overview of the data files available for each station per deployment Leg, and specifies any issues identified.

Realised C-POD effort differed between monitoring locations and through time (see Figure 2). Overall, data are available across most of the intended monitoring period, although fewer data are available for the winter period, and the amount of pre-piling data available is comparatively limited. Due to equipment having been deployed at incorrect locations, data from the first Leg (Feb-March 2018; presented in orange) may need to be excluded or analysed independently from the rest of the dataset. It is important to note that, while Figure 2 illustrates all the C-POD data available, all these data need to be carefully reviewed to confirm actual suitability for further analysis.

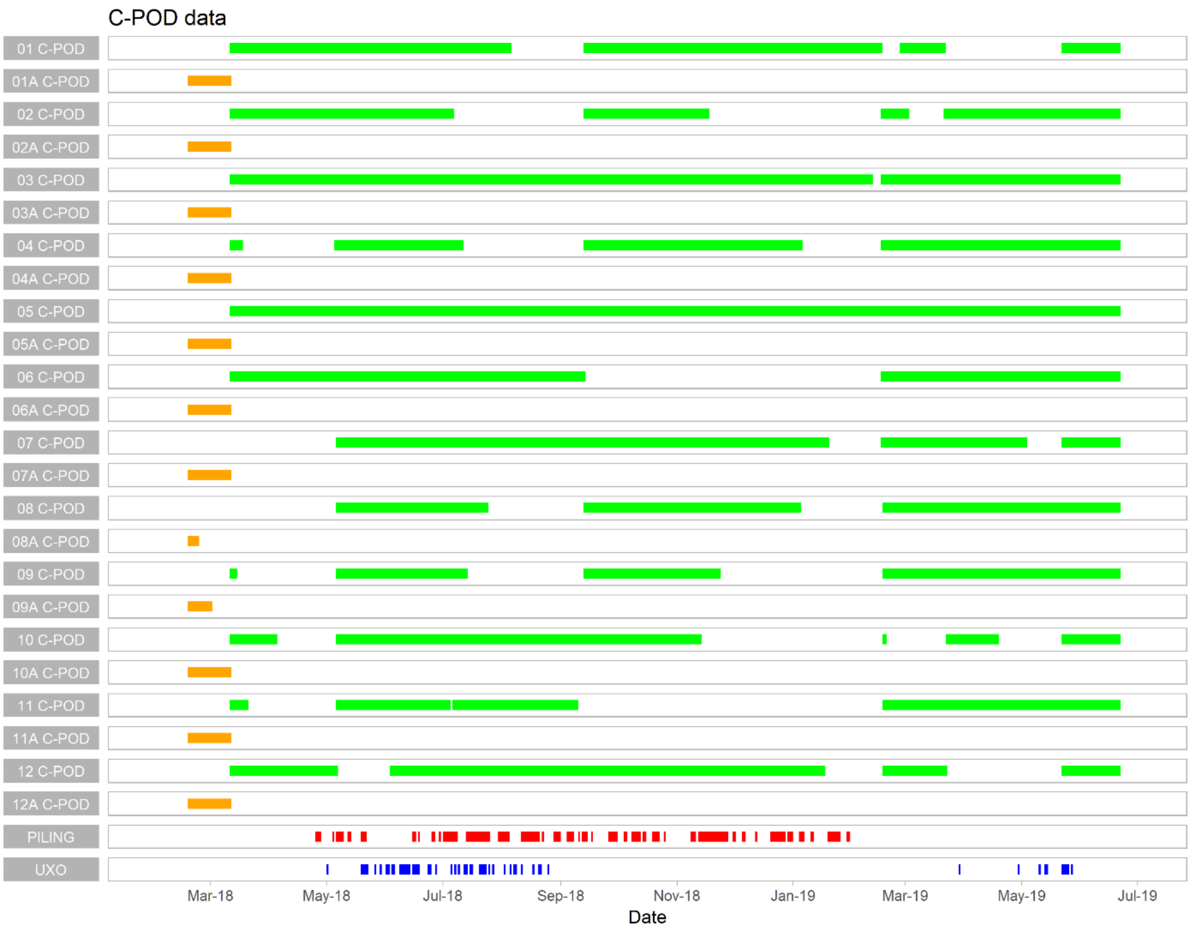

Figure 2. *Summary of C-POD data availability in relation to realised EA1 piling and Unexploded Ordnance (UXO) detonation activity. Data presented cover the time period from C-POD deployment to retrieval, unless OSC*

reported that units had broken free earlier. NB: This figure does not represent data suitability for inclusion in further analysis.

3.1.2 Identified data issues

A small number of data issues were identified during the data receipt process:

- One .CP3 file was empty, however this was re-created by re-processing the original .CP1 file;
- One C-POD was set-up with the wrong 'Year' information (2010 instead of 2019). As the day and month information are correct, this will not be an issue for further analysis;
- The C-POD file sizes did not correspond to information on file sizes provided by OSC, but all data were accounted for.

The main point to mention here is that, based on initial inspection, a more conservative cut-off than the one proposed by OSC may be required with regards to inclusion of data from devices reported as lost but subsequently recovered. Seven occasions (deployments 05_03, 06_03, 06_04, 06_07, 06_09, 06_12, and 07_02) are highlighted for more detailed assessment during the subsequent acoustic processing stage, as it appears the units may have broken free earlier than indicated by OSC. If confirmed, this would result in a greater proportion of C-POD data being excluded than had previously been assumed. An initial overview of data that may be excluded is provided in Table 2, but final decisions will be made during the acoustic processing stage.

Table 1. *Overview of C-POD monitoring data that may be excluded from further analysis. Mooring locations refer to OSC mooring names.*

Leg & location	***Data potentially excluded from further analysis***	***Notes***
05_03	28/08/2018 – 31/01/2019	
06_03	15/01/2019 – 11/02/2019	
06_04		Check OSC specified cut-off 05/01/2019
06_07	16/09/2018 – 19/01/2019	
06_09		Check OSC specified cut-off 23/11/2018
06_12	18/10/2018 – 17/01/2019	
07_02	28/02/2019 – 02/03/2019	

Another point to highlight is that C-PODs require specification of number of clicks that can be logged in any one minute. It had originally been decided to collect the data using the default setting of 4,096 clicks per minute. Under particularly noisy conditions, such as in a tidal environment or in areas with lots of vessel traffic, this limit may be reached prior to completing a full minute of monitoring, at which point the C-POD stops recording until the onset of the next minute, resulting in reduced effort during minutes where this 'buffering' occurs (Figure 3). The twelve deployment locations were both influenced by tides and visited by vessels, both of which have the potential to induce such 'buffering'; this has resulted in different amounts of C-POD monitoring effort between monitoring locations and through time. Although this 'buffering' problem does not prevent analyses of C-POD data, it does impede immediate comparisons between monitoring stations and within stations through time, which will need be taken into consideration during the acoustic processing stage.

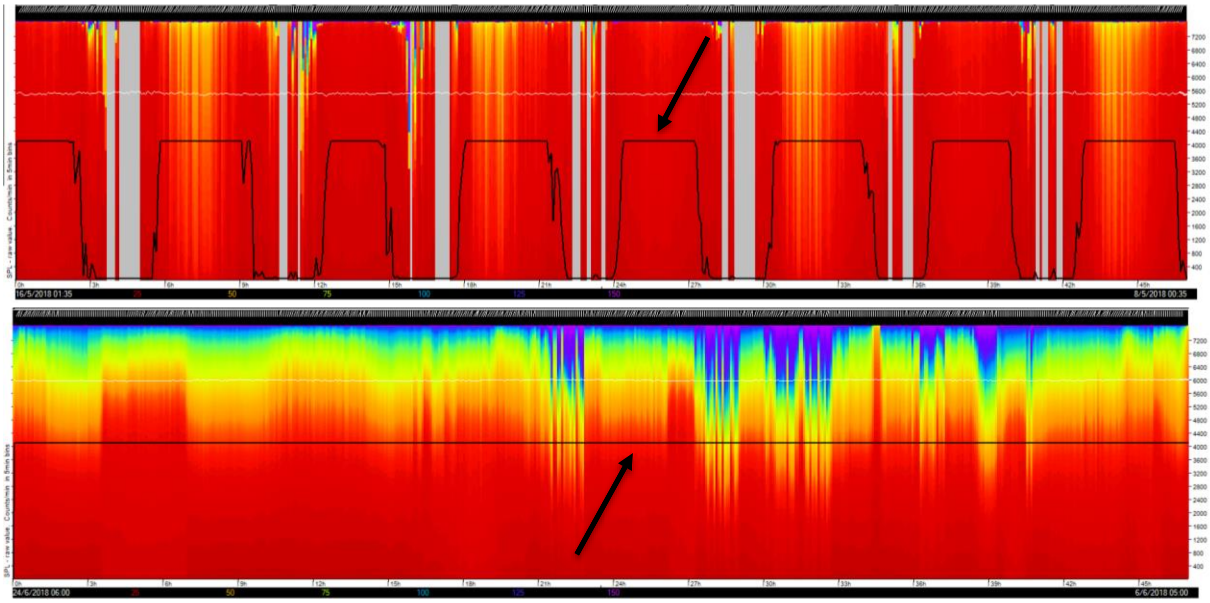

Figure 3. *C-POD examples of occasions where the allowed number of clicks limit is reached (sections with horizontal black line) as a result of tidal influence (top) and vessel presence (bottom).*

3.2 Full bandwidth recordings

3.2.1 Data availability

The associated data receipt files for the FBW data are specified in Appendix 2; for each Leg, data receipts are attached for all monitoring stations for which acoustic FBW data were provided. The Excel spreadsheets provide an overview of the files received, and specify any issues identified.

Realised FBW monitoring effort differed between monitoring locations and through time. Per Leg, data were available from 1 (Leg 8) to 6 locations (Leg 5), whilst available data ranged between 4 Legs (stations 3, 7 and 12) to 7 Legs (location 5) (incorrect deployments excluded; Figure 4). As for the C-POD monitoring, limited data were available pre-piling, as well as for the winter period. Similarly, data from the first Leg (Feb-March 2018; in orange in graph below) may have to be excluded, or analysed independently from the rest of the FBW dataset. In contrast to the C-POD data, coverage of the post-construction period is restricted for FBW data.

Whilst the figure below indicates all data available, detailed further analysis will reveal actual data suitability for further analysis.

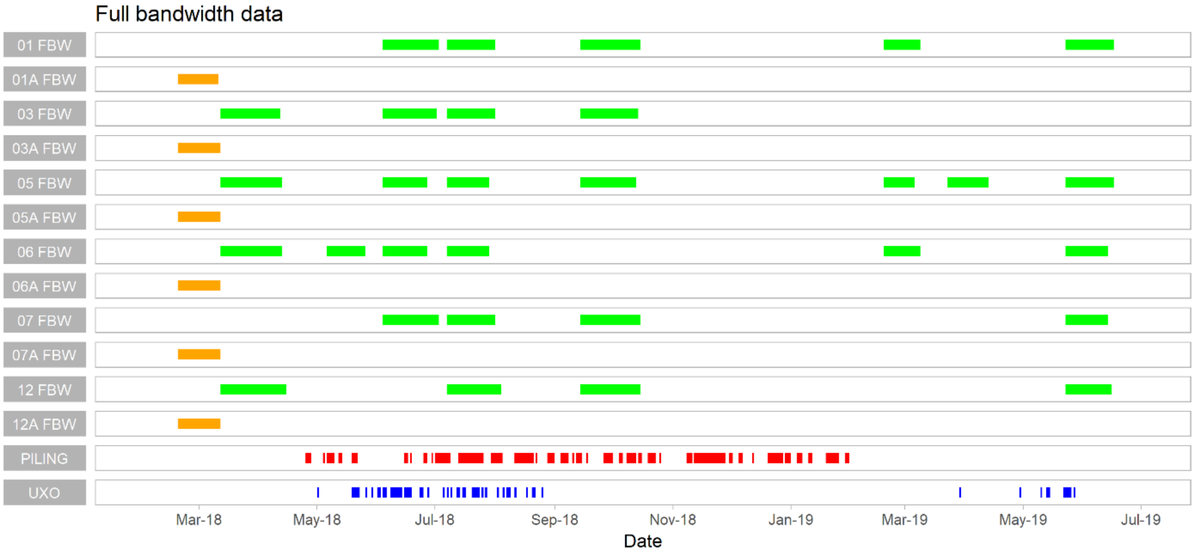

Figure 4. *Summary of full bandwidth data available in relation to realised EA1 piling and UXO detonation activity Data presented cover the time period of acoustic FBW data present, independent of any issues encountered. As such, this figure does not represent data suitability for inclusion in further analysis.*

3.2.2 Identified data issues

An overview of issues identified within the FBW sound files through visual inspection of the waveforms and spectrograms is provided below, as well as other identified events worth mentioning here:

- Recorder/signal issues: Figure 5a is an example of substantial signal issues present throughout one of the deployments, where the signal completely disappears within sound recordings. Another signal issue is exemplified in Figure 5b, where there is intermittent interference; this may be battery related as this started several hours before the unit powered down. Finally, some files revealed lop-sided amplitude responses (i.e. the positive and negative responses were not balanced; occasionally also resulting in unbalanced clipping), and the amplitude was not always centred around 0 (referred to as a DC [direct current] offset). Jumps in the DC offset did occur both between and within sound files during a few deployments (Figure 5c). To some extent, data manipulation would still allow for these data to be processed and included. However, considering the vast amount of data available, it is likely that there will be no need to use data that requires manipulation before processing. A careful assessment will be undertaken to incorporate the best data available and whether any adjustments are necessary to deliver on the overall project. The need for comprehensive further assessment has been identified for four deployments, specifically 01_07, 04_05, 05_12, and 06_12.

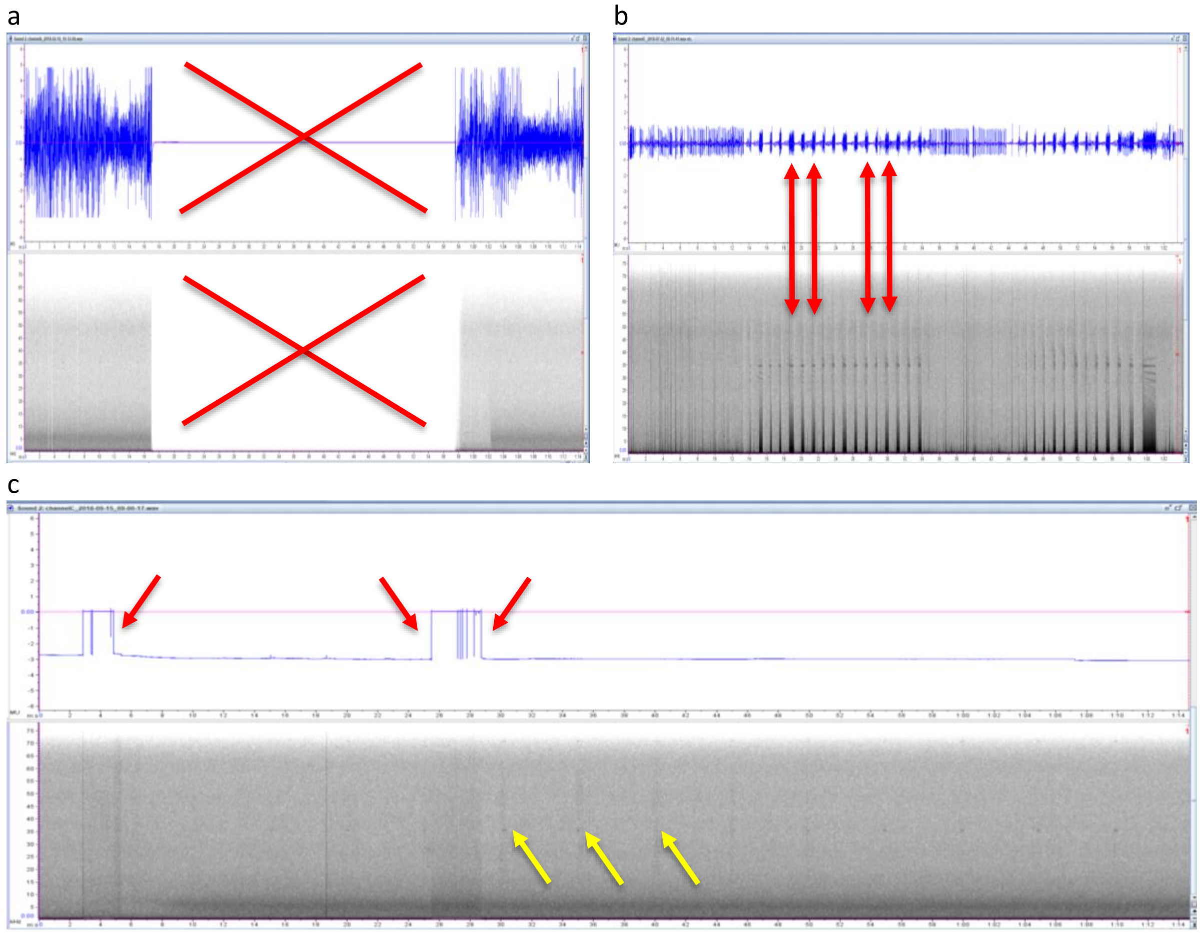

Figure 5. *Examples of waveform (top panel) and spectrogram (bottom panel) of recorder/signal issues identified in the full bandwidth data: a & b) signal issues; and c) jump in DC offset (also note the 35 kHz signal every 5 s as referred to below and indicated by yellow arrows, sometimes accompanied by a broadband signal spanning several tens of kHz).*

- Potential migration (i.e. movement) of the recorder/mooring (06_07): The data collected did not align with those collected simultaneously by other units. Moreover, no piling was recorded, providing further indication that the FBW data (and, based on an initial examination, the C-POD data) were not collected at the intended monitoring location. Further inspection of these data will take place during the acoustic processing stage.
- Signal response: The signal response for one specific recorder (04_05) appeared lower compared to other recorders deployed simultaneously and with the same type of hydrophone, following a change of hydrophone connection channel and associated gain settings. This issue requires further inspection.
- As previously indicated by OSC, the gain settings for the 1st and 2nd deployments were incorrect, resulting in substantial clipping (Figure 6).
- A very small number of corrupt files were found within the data. These were mainly identified through their reduced file size.

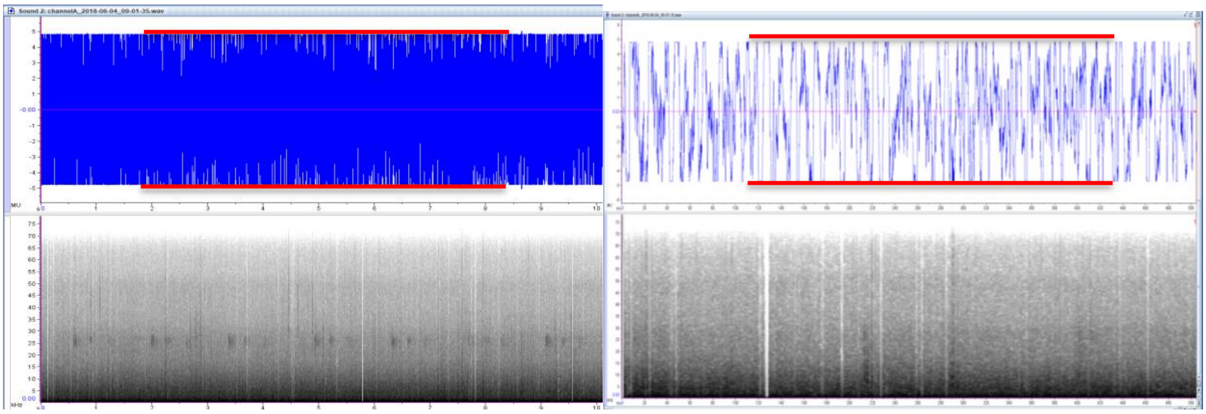

Figure 6. *Example of substantial clipping as visible in the waveform (top panel) and spectrogram (bottom panel) over a 10-s period (left) and zoomed in covering a 0.5-s time period (right).*

Other points to consider in terms of quality control include the following:

- From initial alignment of the piling schedule to acoustic FBW data that should contain pilling noise, there appears to be some inconsistency regarding time synchronisation relative to UTC. Some deployments appeared to be 1 or 2 hours off when assessed in relation to the piling schedule provided by SPR, as well as when comparing between recorders. This will be investigated more comprehensively during the acoustic data processing stage.
- As mentioned earlier, the monitoring equipment was deployed at the wrong locations during the 1st Leg. The resulting data are thus not part of the locational time-series, and may need to be excluded or analysed separately.
- From the 3rd deployment onwards, the gain settings were adjusted, substantially reducing the potential for clipping. Nevertheless, while the majority of sounds associated with piling events were within the dynamic range of the recording system, on several occasions the piling signals were still clipped (Figure 7). Clipping of sounds originating from the mooring systems (e.g. strumming) also continued, albeit infrequently.
- Final deployment files are empty (i.e. when the recording units close down due to insufficient remaining battery power).
- The RTSYS recorders produce an internal 35 kHz signal that appears to be associated with storing data. This is present in several acoustic files on a 5-s repetition rate, but sometimes also occurs nearly continuously (potentially associated with data being written to the hard drive). An associated broadband signal, spanning a wide range of frequencies, may also be present (Figure 5c). RTSYS was not aware of this issue, but the provision of a few examples will allow them to investigate and address the interference. The presence of these signals will have no impact on the project.

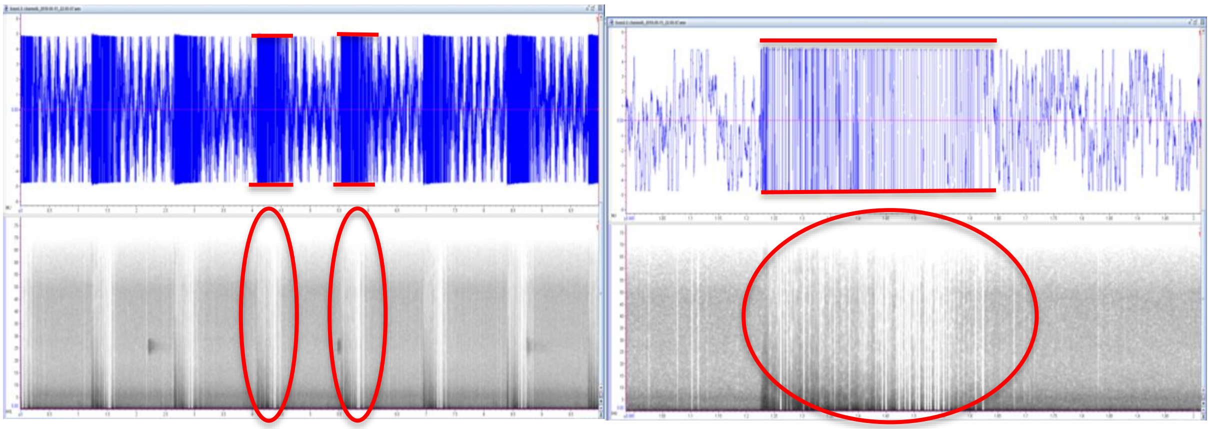

Figure 7. *Waveform (top) and spectrogram (bottom) example of clipped piling over a 10-s period (left), and zoomed to present a 1-s window (right).*

3.2.3 Examples of identified noise sources

Various different noise sources were present in the sound files inspected to date. The most commonly identified sources include shipping (with and without obvious echo-sounders present), piling, and pre-piling Acoustic Deterrent Device (ADD) transmissions. UXO detonations were also identified. Examples are shown in Figure 8.

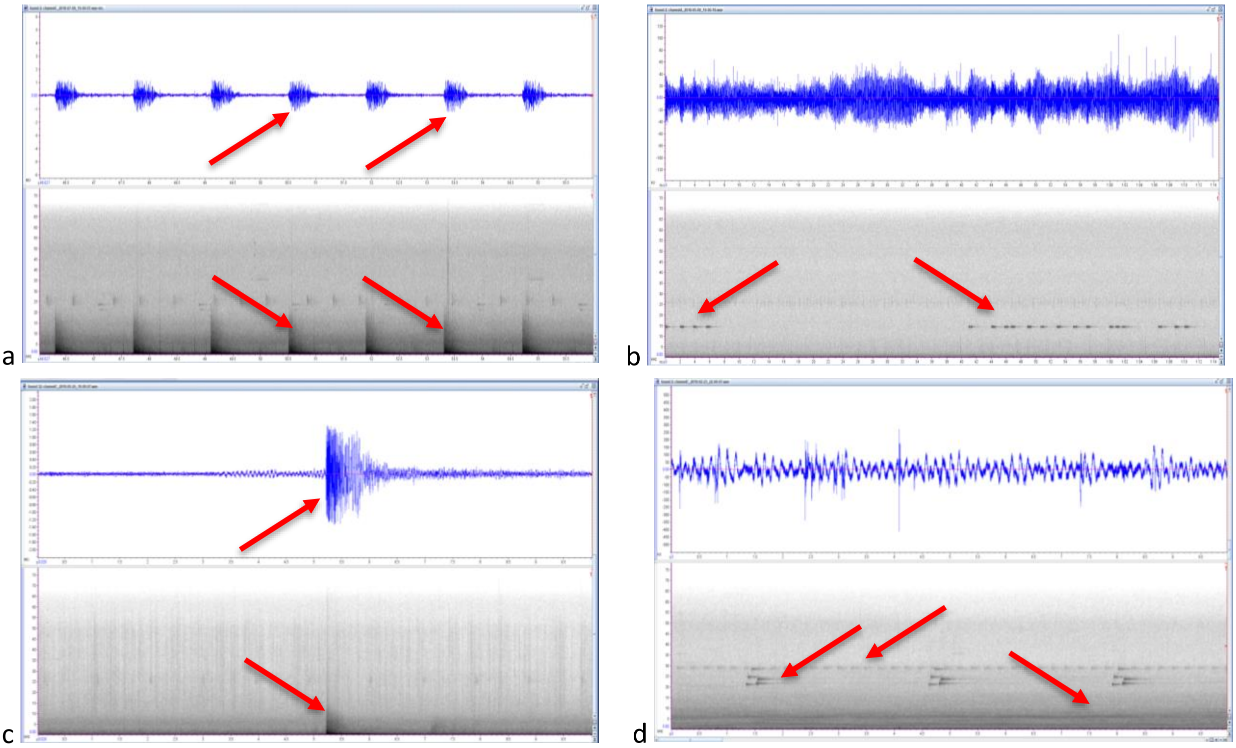

Figure 8. *Examples of different noise sources identified in the checked sound files: a) piling ~every 1.5 s (10-s window); b) pre-piling Acoustic Deterrent Device transmission; c) UXO detonation (10-s window), and d) vessel traffic (dark band at the bottom) and two different echo-sounder signals (10-s window).*

3.3 Data gaps and questions checked with OSC

3.3.1 Data gaps

Various data gaps were identified during the QC process. A subsequent check with OSC revealed that most of these were caused by low remaining battery power prior to the recorder shutting down. On one occasion, the relatively short-term absence of data was related to the device switching from storing the data onto the SD card to storing onto the hard drive. Table 3 below provides an overview of remaining data gaps.

Table 3. *Overview of full bandwidth data gaps.*

Leg	*OSC Location ID*	*Date*	*Notes*
1	6	09/03	Missing 1st file, and various small data gaps between successive sound files throughout the day. Battery related.
2	12	12/04	Various gaps between successive files throughout the day. Related to low remaining battery power.
4	1	01/07	Various gaps between successive files throughout the day. Related to low remaining battery power.
4	6	23/06	Data missing (10:19:14 to 11:15:15). Related to data storage.
5	3	26/07	Data missing after 23:02:22.
5	5	26/07	Many data gaps (up to ~30 min in duration) throughout the day. Presumably battery related.
5	5	27/07	No data available. Battery related.
5	5	28/07	Data availability from 22:01:21 to 22:11:19 inclusive only). Battery related.
5	12	30/07	No data prior to 12:24:33. Battery related.
5	12	31/07	Only a single file (22:48:40) available. Battery related.
5	12	01/08	No data prior to 01:40:30. Battery related.

3.3.2 Raised Questions

During the data receipt procedure, the following questions were identified and checked with OSC:

- It was confirmed by OSC that the RTSYS data were collected in UTC.
- SAMS Enterprise noticed that during various Legs, not all 6 RTSYS recorders were always deployed. Cases where fewer recorders were deployed include the following:
    - At locations 12 during Leg 4;
    - At location 3 & 12 during Leg 7;
    - At locations 7 & 12 during Leg 8;
    - At location 3 during Leg 9.

  OSC clarified that equipment availability was the reason why there were no deployments of RTSYS recorders at these times and locations. During the data collection period, some devices were lost. When/if they were returned, they were put back into the field. However, SPR requested that noise recorders were not put in locations where they had previously been lost. As such, deployment locations of the noise recorders (i.e. the RTSYS devices) changed periodically throughout the survey. SPR/MCC also specified where and when moorings were not to be deployed owing to operations.

- The deployment sites are all influenced by tidal currents and encounter a reasonable amount of shipping. Such noisy environments frequently cause the C-POD's click recording limit to be reached before the end of any given minute, resulting in a temporary loss of recording capability until the onset of the next minute. This can result in significantly reduced monitoring effort in these circumstances and, if unaccounted for, can impede direct assessment of harbour porpoise presence. SAMS Enterprise wondered whether an increase of the click buffer limit (factory default setting is 4,096 clicks per minute) was considered at any point, to reduce the risk of monitoring effort loss? As expected, OSC specified that it is standard practice (and recommended by the C-POD manufacturer, Chelonia) that the click threshold of 4,096 is used for all C-POD deployments, as this a) allows comparability between different studies, b) prevents the SD card from filling up too quickly with useless noise and potentially stopping recording before recovery, and c) because trains cannot be picked out of very noisy data. Use of this threshold has been confirmed as appropriate by Nick Tregenza – proprietor of Chelonia and C-POD developer.
- OSC confirmed that the Handheld GPS longitude location for deployment 05_09 should be 2°30.378 (instead of 2°23.378), with location information provided in degrees, decimal minutes format (i.e. 2°30.378').
- OSC confirmed that, at present, SAMS Enterprise should not expect to receive any outstanding data from equipment that has been returned since the hand-over meeting on 21/09/2019. SPR and SAMS Enterprise will be informed if any additional devices are returned.

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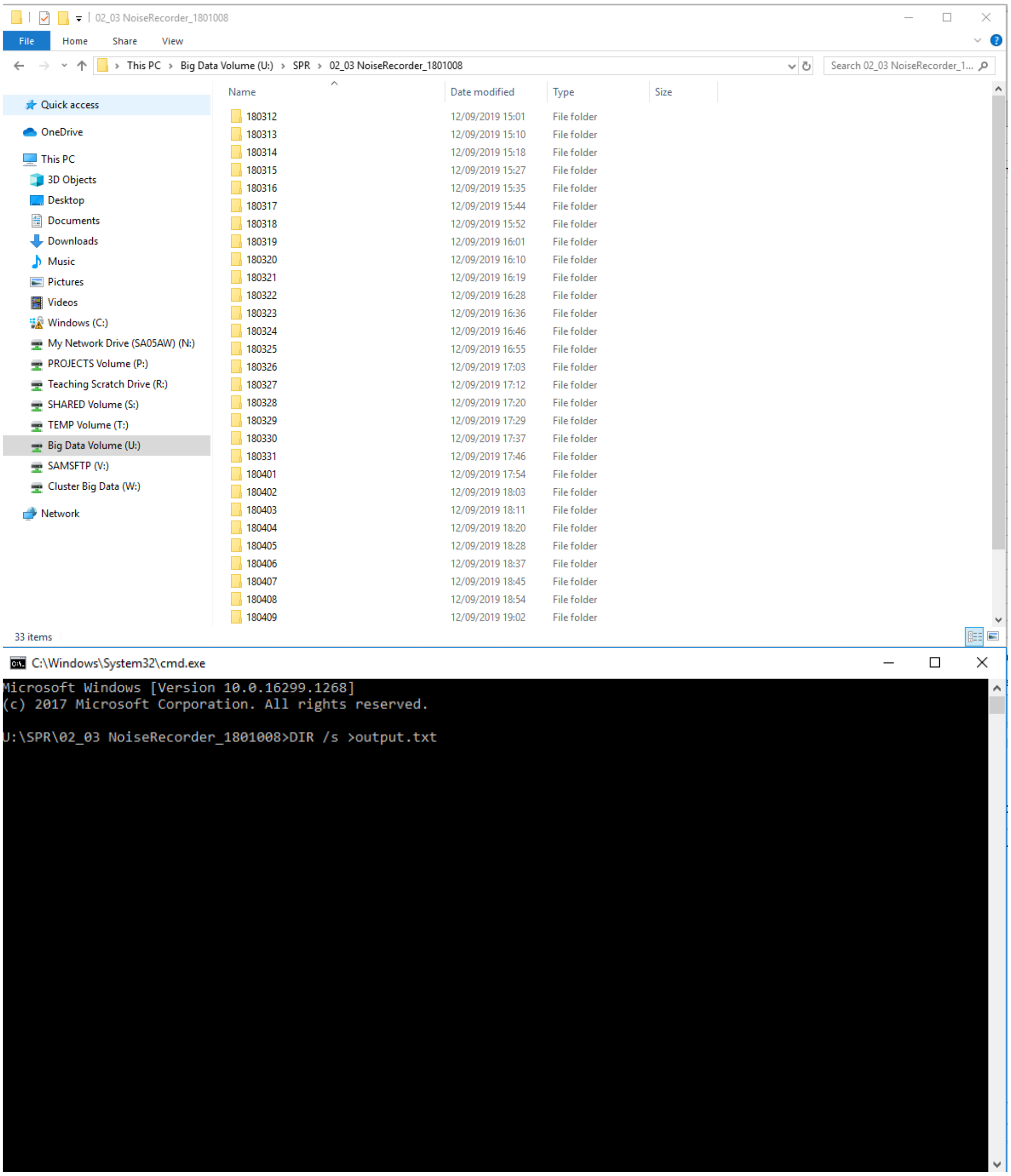
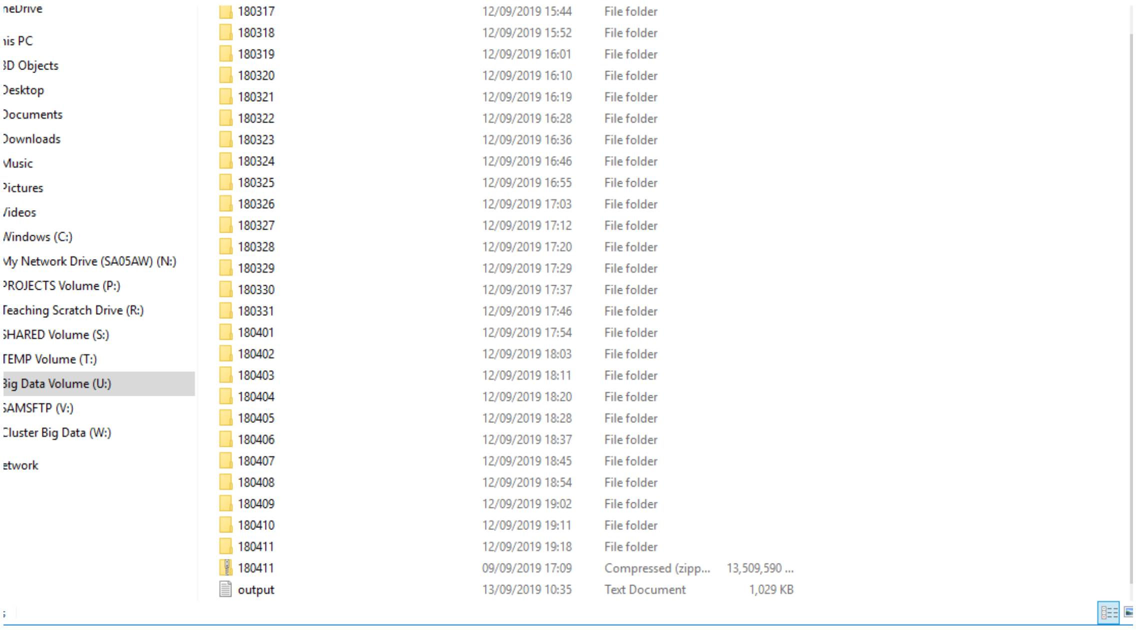
5 APPENDIX 1 – DATA RECEIPT PROTOCOL FOR FBW DATA

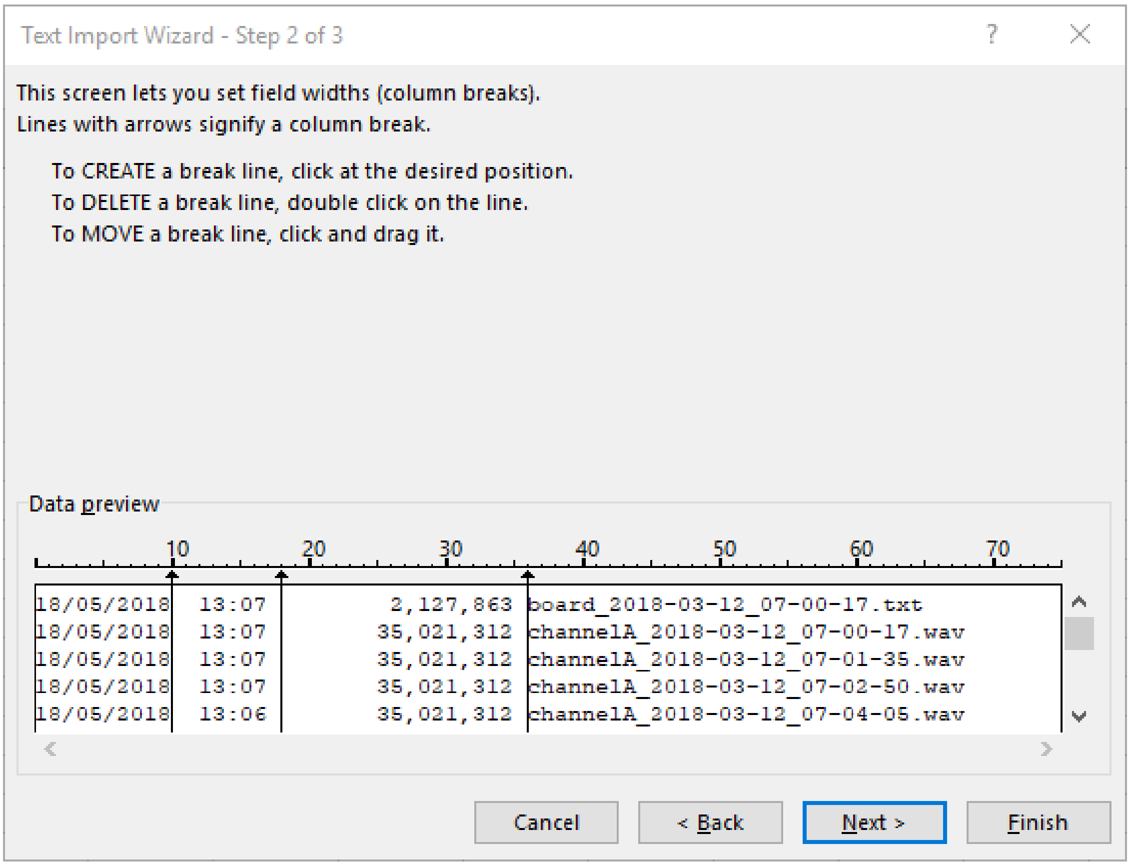
1. A data receipt template (Data Receipt_LegX_IDX_2019XXXX) was used for this process consisting of the following tabs:
    a. Read me (overview of who checked the data and what was checked)
    b. Metadata (time period, channel, number of files, etc.)
    c. Working sheet (placeholder sheet to copy data)
    d. .txt Data (sheet to perform QC checks)
    e. .wav Data (sheet to perform QC checks)
    f. Reference.xlsx (copy of relevant data from OSC_2019_SPR_EA1_PODSettingsDeployment_SAMS_5.0)
2. Follow steps described below (and in document 'Data Receipt Protocol for FBW data') for each monitoring location per Leg.
3. Open data receipt folder on server (P drive for project 02564_SPRPorpoiseB>work in progress>Data receipt) and create subfolder for each Leg. Copy data receipt template for monitoring location used to carry out data receipt protocol and change file name accordingly.
4. Open the template for data receipt and fill in the 'read me' tab.
5. Open spreadsheet OSC_2019_SPR_EA1_PODSettingsDeployment_SAMS_5.0 as well and copy the corresponding record line from the OSC spreadsheet over to the 'Reference'.xlsx tab.
6. Fill in the 'Metadata' tab using the raw data files.
    a. Use file names to fill in start and end times. Open the first sub-folder to get the start date and start time and open the last sub-folder to get the end date and end time.
    b. Right click on the noise folder and click on 'Properties'. Use this information to fill in the information on number of folders and files, size etc. Usually, each sub-folder will have 2 or 4 text files depending on duty cycle (one mission and one board file per cycle), so calculate accordingly what you would expect based on the number of days and applied duty cycle for the monitoring location.
7. To get a summary of the folder structure of the raw data please use the following approach: https://www.experts-exchange.com/questions/27689537/Export-folder-and-file-structure-to-Excel.html
    a. go to the raw data folder. Put the following command in the command line and press enter: DIR /s >output.txt



b. A text ‘Output’ file should appear at the bottom in that folder.



8. Open a blank Excel spreadsheet. Open that .text file (make sure it says 'All files' rather than 'All Excel files' in the Open window as you are opening a .text file). Use the text import wizard which automatically should launch in Excel. Carry out the following steps:
   a. Fixed width>NEXT
   b. Scroll to check that the tabs are correct for the .wav files>Next
   c. Leave General>Finish

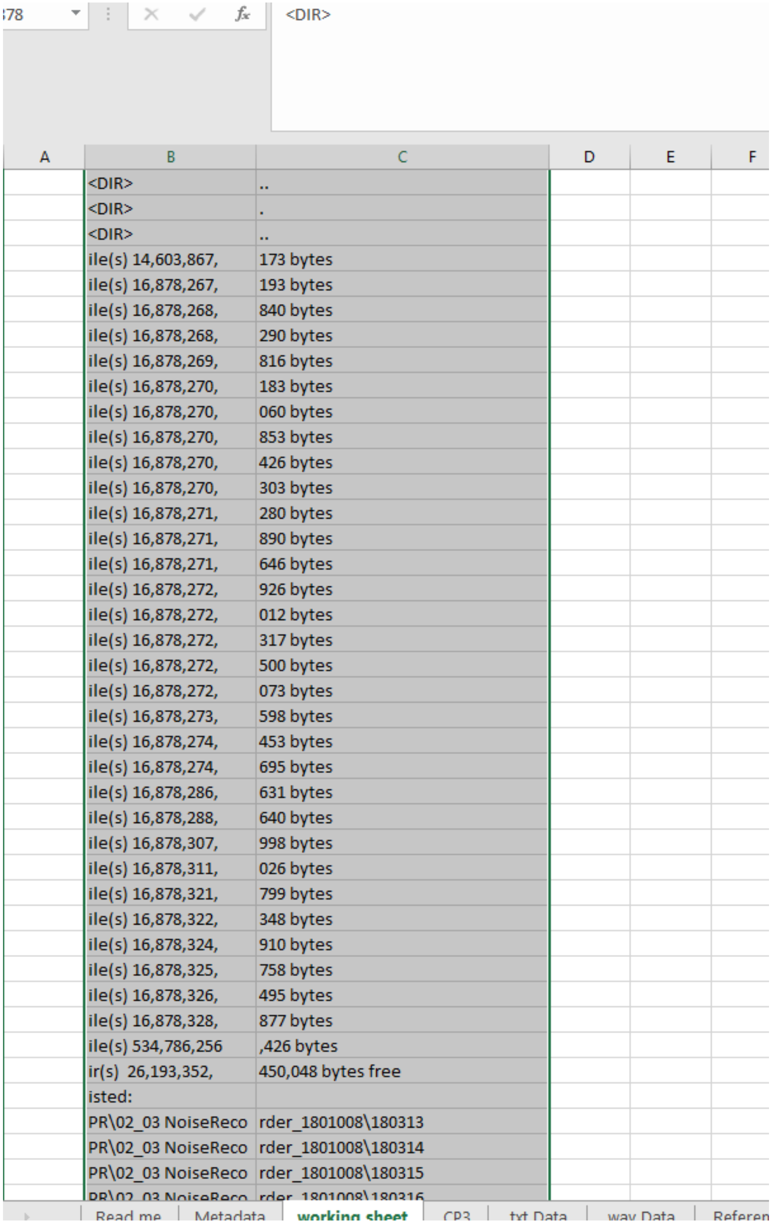


9. Delete sub-folders on the top until you get the first board text file. Copy Column C (size) and column D (file name) to the sampling receipt spreadsheet working sheet tab.

B	C	D	E	F	G
2,127,863	board_2018-03-12_07-00-17.txt				
35,021,312	channelA_2018-03-12_07-00-17.wav				
35,021,312	channelA_2018-03-12_07-01-35.wav				
35,021,312	channelA_2018-03-12_07-02-50.wav				
35,021,312	channelA_2018-03-12_07-04-05.wav				
35,021,312	channelA_2018-03-12_07-05-19.wav				
35,021,312	channelA_2018-03-12_07-06-34.wav				
35,021,312	channelA_2018-03-12_07-07-49.wav				
35,021,312	channelA_2018-03-12_07-09-03.wav				
35,021,312	channelA_2018-03-12_07-10-18.wav				
35,021,312	channelA_2018-03-12_07-11-33.wav				
35,021,312	channelA_2018-03-12_07-12-48.wav				
35,021,312	channelA_2018-03-12_07-14-02.wav				
35,021,312	channelA_2018-03-12_07-15-17.wav				
35,021,312	channelA_2018-03-12_07-16-32.wav				
35,021,312	channelA_2018-03-12_07-17-46.wav				
35,021,312	channelA_2018-03-12_07-19-01.wav				
35,021,312	channelA_2018-03-12_07-20-16.wav				
35,021,312	channelA_2018-03-12_07-21-31.wav				
35,021,312	channelA_2018-03-12_07-22-45.wav				
35,021,312	channelA_2018-03-12_07-24-00.wav				
35,021,312	channelA_2018-03-12_07-25-15.wav				
35,021,312	channelA_2018-03-12_07-26-29.wav				
35,021,312	channelA_2018-03-12_07-27-44.wav				
35,021,312	channelA_2018-03-12_07-28-59.wav				
35,021,312	channelA_2018-03-12_07-30-14.wav				
35,021,312	channelA_2018-03-12_07-31-28.wav				
35,021,312	channelA_2018-03-12_07-32-43.wav				
35,021,312	channelA_2018-03-12_07-33-58.wav				
35,021,312	channelA_2018-03-12_07-35-12.wav				
35,021,312	channelA_2018-03-12_07-36-27.wav				
35,021,312	channelA_2018-03-12_07-37-42.wav				
35,021,312	channelA_2018-03-12_07-38-56.wav				
35,021,312	channelA_2018-03-12_07-40-11.wav				
35,021,312	channelA_2018-03-12_07-41-26.wav				
35,021,312	channelA_2018-03-12_07-42-41.wav				
35,021,312	channelA_2018-03-12_07-43-55.wav				
35,021,312	channelA_2018-03-12_07-45-10.wav				
35,021,312	channelA_2018-03-12_07-46-25.wav				
35,021,312	channelA_2018-03-12_07-47-39.wav				
35,021,312	channelA_2018-03-12_07-48-54.wav				

Read me | Metadata | **working sheet** | .CP3 | .txt Data | .wav Data | Reference.xlsx

10. Highlight the columns and sort by size (smallest to largest).
11. Cut the mission and board text files into the tab .txt. Sort Name to A-Z and check for any breaks. Check the formula for size and count includes all lines. Check if Number of files (Count) corresponds with the expected metadata.
12. Go to bottom of the working sheet and delete 'hidden' files and other non-wav files.



A	B	C	D	E	F
	<DIR>	..			
	<DIR>	.			
	<DIR>	..			
	ile(s) 14,603,867,	173 bytes			
	ile(s) 16,878,267,	193 bytes			
	ile(s) 16,878,268,	840 bytes			
	ile(s) 16,878,268,	290 bytes			
	ile(s) 16,878,269,	816 bytes			
	ile(s) 16,878,270,	183 bytes			
	ile(s) 16,878,270,	060 bytes			
	ile(s) 16,878,270,	853 bytes			
	ile(s) 16,878,270,	426 bytes			
	ile(s) 16,878,270,	303 bytes			
	ile(s) 16,878,271,	280 bytes			
	ile(s) 16,878,271,	890 bytes			
	ile(s) 16,878,271,	646 bytes			
	ile(s) 16,878,272,	926 bytes			
	ile(s) 16,878,272,	012 bytes			
	ile(s) 16,878,272,	317 bytes			
	ile(s) 16,878,272,	500 bytes			
	ile(s) 16,878,272,	073 bytes			
	ile(s) 16,878,273,	598 bytes			
	ile(s) 16,878,274,	453 bytes			
	ile(s) 16,878,274,	695 bytes			
	ile(s) 16,878,286,	631 bytes			
	ile(s) 16,878,288,	640 bytes			
	ile(s) 16,878,307,	998 bytes			
	ile(s) 16,878,311,	026 bytes			
	ile(s) 16,878,321,	799 bytes			
	ile(s) 16,878,322,	348 bytes			
	ile(s) 16,878,324,	910 bytes			
	ile(s) 16,878,325,	758 bytes			
	ile(s) 16,878,326,	495 bytes			
	ile(s) 16,878,328,	877 bytes			
	ile(s) 534,786,256	,426 bytes			
	ir(s) 26,193,352,	450,048 bytes free			
	isted:				
	PR\02_03 NoiseReco	rder_1801008\180313			
	PR\02_03 NoiseReco	rder_1801008\180314			
	PR\02_03 NoiseReco	rder_1801008\180315			

13. You should now be left with just the .wav files. Sort them by name by A to Z and use 'expand selection'.
14. Copy size and name over to the .wav tab.
15. Check that the formulas are being carried out. Formulas are provided.
16. Check if Size check (column D) has any highlights (e.g. pink cells). Wav files should be over 30MB in size. If you want to use 'Find and select' copy and paste as numbers. Search for "F".
17. Check if length (column M) has any 'T's. Wav files should be longer than 1 minute. This is mainly to check if there are breaks in the recordings. So time can be adapted. Run formula and then copy paste and paste as numbers. Use 'Find & Select' to search within the column for "T". Highlight any discrepancy by writing notes in **column R** and mark RED.

18. Column N (check for files larger than 01:30). Run formula and then copy paste and paste as numbers. Use 'Find & Select' to search in column for "T". Highlight any discrepancy by writing notes in **column R** and mark RED.
19. Repeat process described in 17 and 18 for Column O for duty cycle. Please note that duty cycle changed and formula needs to be adapted accordingly (e.g. 14h and 6h depending on Leg)
20. Check if the number of files in the .wav sheet corresponds to the metadata.
21. Go to last line and sum the size (column B). This will be in bytes. Then divide by 1024/1024/1024 to get GB. Check if size is in the same ballpark as in the Reference tab. Please note that number of files and size from the metadata is likely to vary a bit.
22. Check highlighted files and selected files (see method) in 'Raven Lite' and scroll through the data to check for corrupted files and any other data issues.
23. If during inspection any files come through as corrupted highlight this accordingly.
24. Mark the visually inspected files, and add notes if required / potentially useful.
25. Update 'Metadata' sheet with main findings of the process.
26. Delete the Working sheet.

6 APPENDIX 2 – DATA RECEIPT FILES

6.1 C-POD data receipt files

- DataReceipt_C-POD data_20191119.xlsx

6.2 FWB data receipt files

6.2.1 Leg 1

- DataReceipt_Leg1_ID1A_20191028.xlsx
- DataReceipt_Leg1_ID3A_20191029.xlsx
- DataReceipt_Leg1_ID5A_20191029.xlsx
- DataReceipt_Leg1_ID6A_20191029.xlsx
- DataReceipt_Leg1_ID7A_20191029.xlsx
- DataReceipt_Leg1_ID12A_20191029.xlsx

6.2.2 Leg 2

- DataReceipt_Leg2_ID3_20191029.xlsx
- DataReceipt_Leg2_ID5_20191029.xlsx
- DataReceipt_Leg2_ID6_20191029.xlsx
- DataReceipt_Leg2_ID12_20191101.xlsx

6.2.3 Leg 3

- DataReceipt_Leg3_ID6_20191106.xlsx

6.2.4 Leg 4

- DataReceipt_Leg4_ID1_20191106.xlsx
- DataReceipt_Leg4_ID3_20191106.xlsx
- DataReceipt_Leg4_ID5_20191106.xlsx
- DataReceipt_Leg4_ID6_20191106.xlsx
- DataReceipt_Leg4_ID7_20191106.xlsx

6.2.5 Leg 5

- DataReceipt_Leg5_ID1_20191106.xlsx
- DataReceipt_Leg5_ID3_20191106.xlsx
- DataReceipt_Leg5_ID5_20191106.xlsx
- DataReceipt_Leg5_ID6_20191107.xlsx
- DataReceipt_Leg5_ID7_20191107.xlsx
- DataReceipt_Leg5_ID12_20191107.xlsx

6.2.6 Leg 6

- DataReceipt_Leg6_ID1_20191108.xlsx
- DataReceipt_Leg6_ID3_20191108.xlsx
- DataReceipt_Leg6_ID5_20191108.xlsx
- DataReceipt_Leg6_ID7_20191108.xlsx
- DataReceipt_Leg6_ID12_20191108.xlsx

6.2.7 Leg 7

- DataReceipt_Leg7_ID1_20191108.xlsx
- DataReceipt_Leg7_ID5_20191108.xlsx
- DataReceipt_Leg7_ID6_20191108.xlsx

6.2.8 Leg 8

- DataReceipt_Leg8_ID5_20191108.xlsx

6.2.9 Leg 9

- DataReceipt_Leg9_ID1_20191108.xlsx
- DataReceipt_Leg9_ID5_20191108.xlsx
- DataReceipt_Leg9_ID6_20191108.xlsx
- DataReceipt_Leg9_ID7_20191111.xlsx
- DataReceipt_Leg9_ID12_20191111.xlsx