ROV Jason Reson Seabat 7125 Survey Checklist

Part 1: Survey Design Discussion (for *Jason* and science party personnel)

It is likely that before the cruise this document was provided to the science PIs to support pre-cruise estimation of survey times and the development of a survey plan. The PIs would have been encouraged to use existing bathymetry to estimate survey waypoints, and to arrive at the ship with the bathymetric data (not just images) and a waypoint list. *Jason* personnel, be prepared to offer guidance to the Chief Scientist/PIs as she/he/they refine a survey design as most will desire or require input from the *Jason* team. She/he may need to be more informed about the operating characteristics of the vehicle and sonar than this document provides. Be familiar with the following guidelines in preparation for at-sea discussion.
At sea the *Jason* data processor and lead navigator will work with the PIs to develop underlays with waypoints and survey lines for use with real-time navigation software.

Forward speed: The vehicle's historically routine survey speed is 0.25 m/s (0.5 kn). Higher speed is possible but only at the discretion of the expedition leader (during AT18-12-Nooner we successfully performed ~60m altitude surveys with Jason driving at 0.75 kn and being towed at up to 1.5 kn). Less speed provides benefit only if flying at unusually low altitudes or if the DVL achieves better bottom lock (as was once the case in rough knife-edged terrain while using the 1200 kHz DVL). At a ping rate of 2Hz and a speed of 0.25 m/s, the fore-aft footprint of a series of pings from the Seabat 7125 covers each patch of bottom a couple times or better when altitude is >25m.

***From the Reson FAQs:* How do I calculate beam Footprint?**
The footprint is the size of the area on the sea floor. It may be calculated by multiplying the tangent of the beam angle (in °) by the depth (in m). As an example, a 7125-400kHz has a receiver centre beam of 0.5° and an along-track projector beam of 1°. The area on the sea floor created by this intersection is (Tan 0.5°X depth) X (Tan 1° X depth). In 25m water depth then the footprint is approximately 0.22m X 0.44mNote that on a flat array the beam spreads as the steering angle is increased. A system like 7125 with a 0,5° beam at nadir will have a 1° beam at steering angles of ± 60° (0.5*(1/Cos(Steering angle)).

Altitude: Limits are controlled by two sensors.

1. The Seabat 7125, which has a maximum range on individual beams of about 130 meters. Outer beams will be affected by this limitation first.
2. The DVL, which must maintain bottom lock for survey navigation to be useful. The maximum range at which the DVL will maintain bottom lock depends on its operating frequency. A 1200 kHz unit is limited to ~25 meters, a 600 kHz unit to ~110 meters, and a 300 kHz unit to about 200 meters. *Jason* will usually employ the 300 kHz unit.

A 1200 kHz DVL will be the altitude-limiting sensor when in use. Otherwise, the slant range limit of 130m of the Seabat 7125 will limit altitude. If the wedge geometry is set to the full 128°, outer beams will start to drop out at altitudes above 65 meters.

Dana used to fly *Sentry* at 80 meters, but he realized that the outer beams were being lost and dropped the standard *Sentry* survey altitude to 65 meters. This yields about the same swath width while improving resolution of the measurements. *Jason* offers the advantage of being able to observe operation in real-time and you should make use of it.

In early usage we collected data during photo survey runs, altitude ~5 meters. Cursory examination showed very good results.

So, the altitude range can be considered to be 5-65 meters.

Swath width is a function of altitude and wedge geometry.
Jason's Reson system has demonstrated excellent performance in early usage (in part due good sound velocity compensation via a Reson sound velocity probe) and up to 120° of the multibeam wedge will probably be good data. When the wedge angle is 120°, a pair of 30°-60°-90° triangles are formed and the magic ratios of 1-2-$\sqrt{3}$ apply. This translates into a good swath width of 3.4 times altitude. Nevertheless, outer beams are usually at a highly oblique angle and have a large, low-resolution footprint. It's probably better to use a maximum swath width of 3.0-3.2 times altitude, and less if survey/time allows or if generous overlap is wanted.

The wedge of the *Jason* system can be narrowed by the S7kControlCenter software, which puts the same number of beams over a smaller sea bottom footprint and gives tighter spatial resolution. Trigonometric calculations will yield a different (higher) maximum altitude. Swath width is of course reduced.

Other considerations:
There is a time skew issue somewhere in the bathymetric and/or navigation pipelines. We have not yet found the means to eliminate this skew, and so a correction (lag) will have to be applied in post-processing. As of Oct 2011 we continue to advance the remediation of this skew. Lacking this information, the *Jason* data processor will have only a little time to approximate a value. The science multibeam processor will have to plan on doing a rigorous analysis as part of improving the map. Ask this person to get back to us with that lag value to help future users. In winter 2010-2011 we installed a new time reference for the Reson iCPU that will improve both the accuracy and the precision (reduces jitter to about 2 milliseconds) of the ping timestamps. We have no means for doing a similar thing to the DVLNav host. Because footprint size increases with altitude, the artifacts from time lag errors worsen the bathymetry map as altitude increases.
History:
August 2010: attitude had to be adjusted to 23 msec earlier than it was logged.
Update: applied time lags during AT18-12_Nooner11
J2-604: -0.833sec J2-605&606: +0.178sec (sign as passed to 'mb7kpreprocess')

Cross lines are recommended. Side-by-side swath overlap of at least 10% is recommended (per Dave Caress, MB-system author). A patch test is strongly recommended.

Survey Time:
You now have all the information required to estimate how long a survey will take: swath width in combination with overlap determines line spacing and therefore how many lines are required; forward speed is given; add some extra time for turns, for *Medea* to catch up to *Jason*, etc.

Notes:

Part 2: Pre-survey Checklist (for use by *Jason* personnel)

Hardware setup

o Survey design from science has been transferred to Jason navigator.
o Turn on Reson iCPU and login. *Don't blank password as it disables Microsoft Sharing.*
username reson
password reppe
o Masterclock time reference is synced to the van NTP server (198.17.154.208).
This is used by s7kControlCenter and keeps ping timestamps to within ~2msec of GPS. Confirm 1PPS is seen by s7kControlCenter. Confirm NMEA strings are seen by the I/O module (QC button).
o WindowsXP is synced to the van NTP server (198.17.154.208).
check in Control Panel/Administrative Tools/Event Viewer for recent sync events
o Serial feed from Octans gyro is seen by the s7kControlCenter I/O module.
Use the I/O module QC button to look at the VRU input, which should show NMEA strings @10Hz.
o Destination folder for raw data files created.
D:\<cruise_name>\<loweringID>
If offload time is tight, apply Microsoft sharing to this cruise directory and transfer to seadata4. If it's not, use scp/sftp to transfer directly to seadata3. MS sharing requires the system have a password, as above.
o Press start on the 7K Control Center, bring up the GUI
default xml setup file is 400kHz, equidistant. *Use this unless the chief scientist wants otherwise.*
o Check the BITE status, make sure all lights are green.
Errors will be indicated if Jason is still on deck.
o Jason external timer/trigger module setup invoked to sync DVL and Seabat.
Currently set by a Docklight script at the engineer's station.

7K Control Center Settings

Baseline setup: a preset configuration can be loaded from
C:\Documents_and_Settings\Operator   *example: J2_generic_setup_s7k.cfg*

General setup guidance copied from Reson FAQs

- Set the power to FULL
- Set the range scale so that the sea floor is at the widest point of the sonar wedge
- Set the pulse length to Minimum
- Set the gain to 15-20dB

gates tab
o Adaptive gating *Proven to work well during AT18-12. If more human control is desired use* Absolute Gating by depth: mindepth 1.0m, maxdepth=*same as range in main tab.* <u>*Do not use* No Gates.</u>

ocean tab

- ○ absorption 60
- ○ spreading 27
- ○ sound speed
  from sound velocity probe, confirm traffic in I/O Module tab/QC button

main tab

- ○ range 150 *profile at wedge bottom*
- ○ pulse length 60us
- ○ max rate 5.0
- ○ transmit power 220
- ○ gain 20 *adjust for strong clean profile*

trigger tab

○ input active *main: max rate apparently must be set before triggering is enabled*

I/O tab

○ Confirm sound velocity is on UDP port and slider is reset by incoming measurement.
○ Confirm that NMEA/ZDA messages are received from the Masterclock time reference.
○ Confirm that NMEA messages are coming into ZDU input from Octans.

data recording tab

From Reson FAQs

- 7000 – Sonar Setting
- 7004 – Beam Geometry
- 7006 – Bathymetric Data
- 7007 – Side Scan Data
- 7008 – Beam Formed Data and Snippets
- 7018 – Beam Formed Data only
- 7028 – Snippets Only
- 7051 – 7k System Event Messages.

Which 7k messages do I have to select if I only want Bathy data?
There are 2 bathymetry records, a corrected record (7006) and a raw record 7027. Refer to the document for details.

○ recording 1012 1013 1016 7000 7004 7006 7027 (7007)

We may replace recording of record 7006 *with record* 7027 *as* 7027 *provides uncertainty information. For now, record both.*

7007 *collects data for backscatter. Record unless science requests otherwise. As of this writing, MB-system does not recognize record 7007 for its backscatter processing.*
IMPORTANT: *upon start of recording a dialog will ask if record type* 7018 *should be recorded. NO! (answer "continue without"). Recording 7018 will slow down the system enough to jeopardize the survey, and will chew up vast amounts of disk space.*

1012, 1013, and 1016 accept the Octans FOG data streams. Added prior to dive 606.

○ Outfile path set to *D:\<cruiseid>\<divenum>*

Lowering:_______ Date:________________ Person:________

Additional Setup Tasks

o Scientist who has read the **survey logging guidelines** section is set to keep event log.
o Jason altimeter is **off** *(interference on similar frequency bands).*
o Medea forward looking sonar is **off** *No history to date that Jason FLS interferes.*
o Confirm Reson 7125 ping rate matches setting of external triggering
o Recording control to **"record"**. Time at which recording was started: _____________
o Check data file growth, path and name of first file: ____________________________
o Patch test completed, on level ground if possible.
See patch test procedure section later in document.

Post-survey Checklist

o Survey completed at time ________________________

o Watchstanders have turned in event notes file to the *Jason* Data Processor

o Survey events log saved in eventlogger, ASCII version with raw .s7k files.

o s7kCenter configuration saved in J2s7k::C:\Documents and Settings\Operator
save each survey's configuration, e.g., J2-xxx_yyyy_mm_dd_hhmm-hhmm.cfg

o Data files copied from Reson iCPU (J2s7k) to data processing station.
  - o Copied to WHOI archive media
  - o Copied to science data package media

o Dive navigation processed to yield .ppl file
o Navigation and Reson .s7k files processed to yield bathymetry grid and sample map
o Changes in checklist/procedures/etc reported back to shore (dsl-sea, Scotty).
o Description of data and post-processing added to cruise Data Package Summary.
o Nascent data product: create additional .s7k format file that includes navigation from .ppl file using DSL-developed *pplTo7k.py.* Add description to Nascent section of the cruise Data Package Summary. *Tabled, precluded by direct recording of Octans FOG.*

Lowering:_______ Date:________________ Person:________

Part 2: Patch Test Procedure

*A "patch test" is a routine using the vehicle that creates a dataset from which roll, heading, and pitch biases may be gleaned during post-processing. The steps don't take a long time and it's important that the snippets be processed properly. So, log patch test events with **seconds resolution**.*

Perform over convenient ground at survey altitude.

1. Full spin (360°) of vehicle.
2. Full spin in the opposite direction.
3. Two minutes on a straight line, pilot's discretion, most level ground.
4. Turn 180°, two minutes back to starting location.

Patch test notes here (add to survey notes later):

Part 3: Survey Logging Guidelines (for use by event loggers from science party)

The ability of someone to piece together a survey after the cruise will depend largely on accurately logged events. Following a simple template makes a big difference.

Log times and an event description. See later for an event log example.
Notable events include:
- Start time and end time of survey lines. *to the minute is sufficient.*
- Heading, length, vehicle speed, altitude
- Navigation events: loss of DVL bottom lock, loss of LBL/USBL.
- Patch test times. *to the second is very desireable.*

Example survey event log file:

Enter these events into the Jason event logger. ***Also*** *type or copy/paste them into a text editor on the event log machine. Give this ASCII file to the Jason Data Processor so that it will accompany the raw bathymetry files.*

Date: 1/1/2020 All times GMT
Dive: J2-2000
Cruise: AT28-35
Logger: Jane Doe

Abbreviations:
heading=h, meters=m, altitude=alt, length=l, X=eastings position, Y=northings position

Survey design: patch test, 9 lines SW<->NE, l=510m, track spacing 150m, alt 60m, two cross lines.

135610 Start bias spin to starboard, alt 40m, h=140
135720 end starboard spin, h=150
135835 start spin to port, alt 43m, h=140
135940 end port spin
140020 Start patch test l=30m, alt 60m, h=180
140225 reverse track, alt=60m, h=000
140350 original track new height, alt=30m, h=180
140605 reverse track, alt=30m, h=000
140805 end patch test
1412 start survey line 1, alt=60m, h=045, l=510m, X=11800,Y=4532, spd 0.3 m/s
1425 lost DVL bottom lock over knife edge feature, X=12005, Y=4737.
1426 regained DVL bottom lock
1453 end line 1
1459 start of line 2, X=xxxxx, Y=yyyyy, h=225, etc

.
.
1852 end line 9, end of main survey, move to start of first crossline
1902 start crossline 1,alt=60m, h=135, X=, Y=
.
.
2015 end crossline 2, end of multibeam measurements.

Other significant events:
Observed in real-time multibeam a ravine feature SE of track line 4 near
X=____, Y=____, time 1420-1422.

Part 4: Example MB-system Post-processing Script

```
# Example script, used to process raw bathymetry (record 7006) from
# Reson Seabat 7125 to a grid. Includes specifics to ROV Jason.
# NDSF/Jason navigation is recorded externally to the Reson files.
# In October 2011 we added recording of Jason's Octans FOG directly
# into the raw Reson files in parallel.
# Typical nav/attitude treatment:
# A dead reckoned history is recorded externally using DVLNav and
# is then post-processed to remove most flyers, merged with a
# georeferenced navigation history. Requires creation of a PPL file
# and merging with bathymetry files using 'mb7kpreprocess'. See
# 'mb7kpreprocess' man page for the PPL format.
# Alternative nav/attitude treatment:
# Navigation post-processing is handled as above, but overwrite of
# directly recorded attitude is avoided by using alternates to
# PPL and 'mb7kpreprocess'. Instead PPL records can be parsed to
# yield two files with 1. Lon, lat only and 2. depth, which would
# then be merged using mbset
#
# New Oct 2011: we now transfer attitude data directly from Jason's
# IMU/VRU (Octans FOG, serial splitter at Prizm rack) to the
# Seabat 7125 iCPU (com4). This imbeds attitude into the raw
# multibeam record with as little lag as we can make it. However,
# a comparison of timeseries between the DVLNav history and the
# directly recorded history shows no appreciable time skew between
# the two.
#
# Summer 2010 the Reson heads were mounted on Jason such that a 180
# degree heading offset was required. Autumn 2011, after the unit
# was sent to Reson for maintenance, this appears to no longer
# apply. If something looks very strange, try adding/removing.
#
# Determination of a time lag might come from the MB-system utility
# mbrolltimelag or from a custom NDSF procedure. Dana has authored a
# Matlab script called "show_wiggles" that has been very useful and
# is housed on the main at-sea post-processing machine, seadata3.
#
# Caution: some lines have been word-wrapped. Fixing required.
# Scott McCue smccue@whoi.edu WHOI/NDSF, from original by D Yoerger.
# Key additions by James Pelowski, Jason at-sea data processor.

# Get basic listing of raw bathymetry files
/bin/ls -1 *.s7k | awk '{print $1" 88"}' > procs7k.mb-1
# Merge bathymetry and navigation. This will overwrite the attitude
# written directly into the .s7k from the Octans, which you may not
# want to do. On the other hand, time skew between directly recorded
# Octans and the attitude from DVLNav was measured as so small it
# doesn't matter.
#
mb7kpreprocess -F-1 -I procs7k.mb-1 -W J2-513.ppl

# Trim bathy+nav to survey window
#Survey start:   2010/08/06 01:58:00
#Survey end:     2010/08/06 03:53:00
```

```
mbcopy -F88/88 -I 20100806_025322.mb88 -O
20100806_025322_trimmed.mb88 -E2010/08/06/03/45/00

# Move untrimmed filenames so they don't get into datalist
mv 20100806_025322.mb88 20100806_025322.mb88.save

# Create datalist file in form that MB-system likes
/bin/ls -1 *.mb88 | grep -v "p.mb88" | awk '{print $1" 88"}' >
datalist.mb-1

# An example using alternative navigation merging
# mbset -F-1 -PSONARDEPTHMODE:1 \
# -PSONARDEPTHFILE:../${sonardepth_file} -PSONARDEPTHFORMAT:2 \
# -I datalist.mb-1

# esf files carry ping flagging info. Remove if starting over, keep
# if you did some hand-editing that shouldn't be lost.
# rm *.esf

mbclean -F-1 -Idatalist.mb-1 -Q2 –E120 -B0/1100 –R5

# Here's where that heading offset is imposed, if required.
# Necessary August 2010. Apparently not necessary after a return
# to the factory and after use in Sept 2011.
#mbset -F-1 -I datalist.mb-1 -P HEADINGMODE 2
#mbset -F-1 -I datalist.mb-1 -P HEADINGOFFSET 180
#mbset -F-1 -I datalist.mb-1 P METAHEADINGBIAS 180


# estimate roll bias with mbrollbias or mbeditviz
mbset -F-1 -I datalist.mb-1 -P ROLLBIASMODE 0
#mbset -F-1 -I datalist.mb-1 -P ROLLBIAS -1.4
mbset -F-1 -I datalist.mb-1 P METAROLLBIAS 0.0

# The Reson sonar head is usually mounted aft, slightly starboard of
# center, same altitude as pressure sensor and gyro.
# The Parosound pressure sensor is mounted on the center tray,
# very close the same horizontal plane as the Reson heads, the
# Octans FOG/VRU, and the two DVL units. So, no Z corrections
# are necessary.
# In meters relative to origin. For drawing of origin see
# http://www.whoi.edu/fileserver.do?id=47329&pt=2&p=55415
mbset –F-1 –I datalist.mb-1 –P LEVERMODE 1
mbset –F-1 –I datalist.mb-1 –P SONAROFFSETX -2.85
mbset –F-1 –I datalist.mb-1 –P SONAROFFSETY 0.27
mbset –F-1 –I datalist.mb-1 –P SONAROFFSETZ -0.13
# Renav processing has already translated Octans position. Added
# here for viewer information and in anticipation use of other
# nav info.
#mbset –F-1 –I datalist.mb-1 –P VRUOFFSETX
#mbset –F-1 –I datalist.mb-1 –P VRUOFFSETY
#mbset –F-1 –I datalist.mb-1 –P VRUOFFSETZ

 mbset -F-1 -I datalist.mb-1 P   METAVESSEL "Thomas G
Thompson"
```

```
mbset -F-1 -I datalist.mb-1 P METAINSTITUTION “WHOI NDSF”
mbset -F-1 -I datalist.mb-1 P METAPLATFORM “ROV Jason”
mbset -F-1 -I datalist.mb-1 P METASONAR “Reson Seabat
7125”
mbset -F-1 -I datalist.mb-1 P METASONARVERSION “7125-FP1”
mbset -F-1 -I datalist.mb-1 P METACRUISEID
“TN252_Delaney10”
mbset -F-1 -I datalist.mb-1 P METACRUISENAME “Enlighten10”
mbset -F-1 -I datalist.mb-1 P METAPI
“Delaney/Kelley”
mbset -F-1 -I datalist.mb-1 P METAPIINSTITUTION “UWashington”
mbset -F-1 -I datalist.mb-1 P METACLIENT “OOI”
mbset -F-1 -I datalist.mb-1 P METASVCORRECTED 0
mbset -F-1 -I datalist.mb-1 P METATIDECORRECTED 0
mbset -F-1 -I datalist.mb-1 P METABATHEDITMANUAL 0
mbset -F-1 -I datalist.mb-1 P METABATHEDITAUTO 1
mbset -F-1 -I datalist.mb-1 P METAPITCHBIAS 0
mbset -F-1 -I datalist.mb-1 P METADRAFT 0

# Apply flags and settings
mbprocess -F-1  -I datalist.mb-1
mbdatalist -F-1 -I datalistp.mb-1 -o –v

# use -G111 so read_gmt works in Matlab
# the -E argument specifies the grid size
# the -A2 argument specifies "topography" convention, z + up
# the -C argment controls the spline interpolation for gaps
#mbgrid -F-1 -I datalistp.mb-1 -E1/1 -U1 -A2 -G111 -N -C5/2
#mv grid.grd J2-512_1x1_test_nopatch.grd
mbgrid -F-1 -I datalistp.mb-1 -E2/2 -U1 -A2 -G111 -N -C5/2 -T0.2 -P2
mv grid.grd J2-513_2x2.grd
mbgrid -F-1 -I datalistp.mb-1 -E1/1 -U1 -A2 -G111 -N -C5/2 -T0.3 -P2
mv grid.grd J2-513_1x1.grd
mbgrid -F-1 -I datalistp.mb-1 -E5/5  -U1 -A2 -G111 -N -C5/2 -T0.1 -
P2
mv grid.grd J2-513_5x5.grd

mbm_grdplot -I./J2-513_2x2.grd -MGDPLOT_DEGREE_FORMAT/ddd.mm.xx -G5
-C10 -A-2.0 -V -S -U -MCWc0.1p -Oout1
sed s/Wc1p/Wc0.1p/ out1.cmd > out2.cmd
chmod 777 out2.cmd
./out2.cmd
mv out1.ps J2-513_p-r+2x2.ps
evince  J2-513_p-r+2x2.ps&

makecpt -Cgebco -T-830/-770/3 > colors.cpt

mbm_grdplot -I./J2-513_5x5.grd -MGDPLOT_DEGREE_FORMAT/ddd.mm.xx -G5
-C colors.cpt -A-2.0 -V -S -U -MCWc0.1p -Oout1
sed s/Wc1p/Wc0.1p/ out1.cmd > out2.cmd
chmod 777 out2.cmd
./out2.cmd
mv out1.ps J2-513_p-r+5x5.ps
evince  J2-513_p-r+5x5.ps&
```

```
mbm_grdplot -I./J2-513_2x2.grd -MGDPLOT_DEGREE_FORMAT/ddd.mm.xx -G1
-C colors.cpt -A-2.0 -V -U -MCWc0.1p -Oout1
sed s/Wc1p/Wc0.1p/ out1.cmd > out2.cmd
chmod 777 out2.cmd
./out2.cmd
mv out1.ps J2-513_G1_2x2.ps
evince  J2-513_G1_2x2.ps&

mbm_grdplot -I./J2-513_5x5.grd -MGDPLOT_DEGREE_FORMAT/ddd.mm.xx -G1
-C colors.cpt -A-2.0 -V -S -U -MCWc0.1p -Oout1
sed s/Wc1p/Wc0.1p/ out1.cmd > out2.cmd
chmod 777 out2.cmd
./out2.cmd
mv out1.ps J2-513_G1_5x5.ps
evince  J2-513_G1_5x5.ps&
```

Reference Material

Reson FAQs:
http://www.reson.com/support/self-help/faq/

MB-system documentation:
http://www.mbari.org/data/mbsystem/html/mbsystem_home.html

MB-system Discussion List archive:
http://listserver.mbari.org/sympa/arc/mbsystem

Backup manuals for Reson and Masterclock equipment on the NDSF Drupal CMS:
http://ndsfdh1.whoi.edu (an account/ password is required)