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"Solutions in Depth"

Intake Tunnel Investigation Report

SeaView Systems' Report on the January 2009 Visual and Profiling Sonar Investigation of the Main Intake Cooling Tunnel accessed from shore.

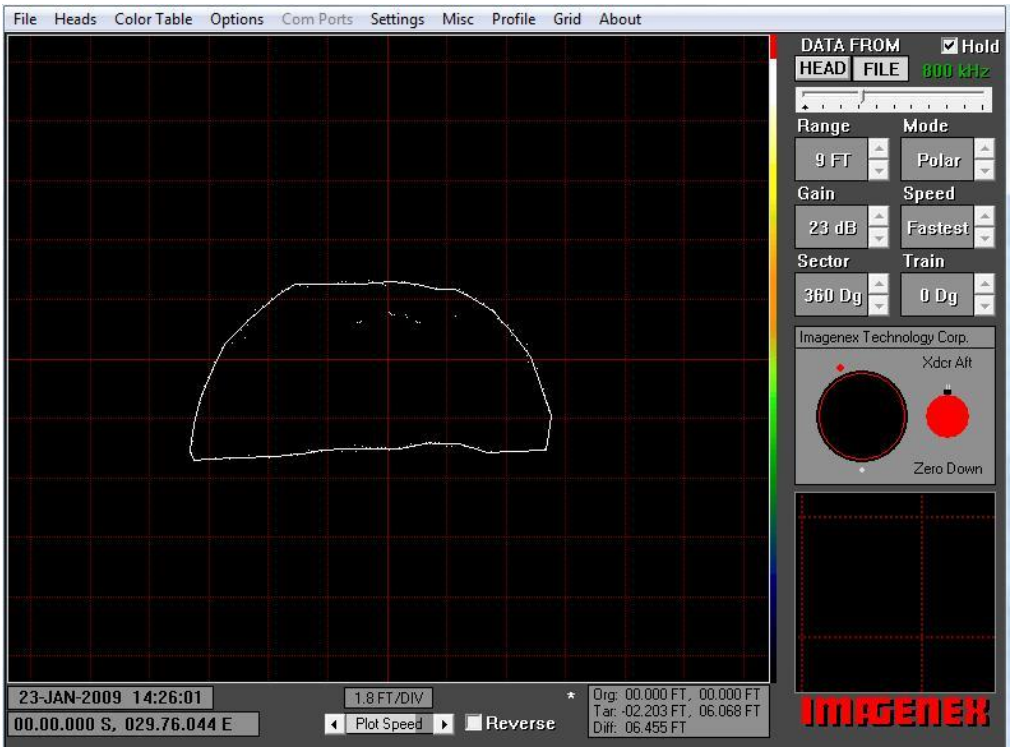

Table of Contents

SEAVIEW SYSTEMS

Investigation Report

1 Project overview

On January 23rd 2009, in response to concerns resulting from a low intake flow condition experienced on/around January 17th, SeaView Systems, Inc., used a ROV (Remotely Operated Vehicle) to perform a visual and profiling sonar investigation of the internal surfaces of the Main Intake Cooling Tunnel, West Branch Tunnel and the shoreside riser.

The ROV accessed the tunnel from the onshore access point in the Surface Water building directly upstream of the traveling screens (screens were secured for the duration of the project). A cursory visual investigation of the inshore vertical uptake riser was performed. A visual and profiling sonar investigation was performed along the entire length of the intake tunnel (3000ft), the branch tunnel leading to the Western crib and a partial investigation of the tunnel leading to the Emergency Service Water building .

1.1 Investigation objectives

- Establish that the tunnel was clear and had not suffered any catastrophic damage that could result in the restriction of flow to the intake tunnel.
- Investigate areas of major concrete spaling, severe cracking in the concrete, offsets of construction joints and/or other points of concern that may be discovered during the investigation of the tunnel.
- Acoustically measure the interior surfaces with a profiling sonar to determine the depth of sedimentation within the pipeline.

1.2 Investigation Method

- Position control trailer and winch for operations inside of the Service Water building.
- Run power, fiber optic and audio communications cables and secure against tripping or damage.
- Prepare computers and digital video recorder for operations. Synchronize clocks.
- Prepare line counter and check for correct operation and calibration.
- Prepare Falcon DR ROV for investigation.
- Perform pre-dive checks.
- Dive ROV and proceed down riser to Main Intake Tunnel.

- Inspect Main Intake Tunnel.
- Inspect tunnel to West Crib.
- Partially inspect tunnel to Emergency Service Water

1.3 Investigation Tasks

1.3.1 Inshore Vertical Riser

- Perform visual investigation of vertical riser
- Note depth of mussel infestation on riser walls
- Note areas of major concrete spaling, severe cracking in the concrete, offsets of construction joints

1.3.2 Main Intake Tunnel

- Perform visual investigation of crown surfaces of Main Intake Tunnel
- Perform visual investigation of invert surfaces of Main Intake Tunnel
- Note depth of mussel infestation on tunnel walls
- Note areas of major concrete spaling, severe cracking in the concrete, offsets of construction joints
- Measure depth of sedimentation in invert using profiling sonar

1.3.3 Tunnel to West Crib

- Perform visual investigation of crown and invert of branch tunnel
- Note depth of mussel infestation on tunnel walls
- Note areas of major concrete spaling, severe cracking in the concrete, offsets of construction joints
- Measure depth of sedimentation in invert using profiling sonar.

Tunnel

2 Investigation Results

The results of this investigation are described below. SeaView Systems expressly states that we are not qualified to form an engineering opinion of the condition of the pipeline under investigation. Content provided herein are the opinions and observations of laymen.

The investigation results are provided in a number of different formats, both hard copy and electronic. A general written assessment is provided below though a more detailed listing of items observed along with hyperlinks to associated video clips and sonar screenshots is provided on the report hard drive accompanying this report. Hard copy printouts of the investigation logs are provided in the Appendix.

2.1 General Assessment

2.1.1 Inshore Vertical Riser

2.1.1.1 Investigation Notes

- Since only 2 pumps were online the ROV was able to proceed down the vertical riser under its own thruster power.
- Only a cursory investigation was performed as main objective was to ensure that the lakeside end of the intake tunnel was free.
- Visibility was in the order of 6-7 ft maximum

2.1.1.2 Investigation Results

- Mussel infestation appeared to be approximately 1" deep.
- Mussel coverage was approximately 95%.
- No apparent major spalling, cracks, loose concrete or misalignment was observed though mussel coverage prevented view of any small cracks that may have been present.

2.1.2 Main Intake Tunnel

2.1.2.1 Investigation Notes

- Since only 2 pumps were online the ROV was able to proceed down the tunnel under its own thruster power.
- Visibility was in the order of 6-7 ft maximum.

2.1.2.2 Investigation Results

- Live Mussel infestation appeared to be approximately 1/2" deep.
- Mussel coverage was approximately 95%.
- A thicker than average layer of mussels (approximately 1-3" deep) was observed in the crown throughout the length of the tunnel.
- No apparent major spalling, cracks, loose concrete or misalignment was observed though mussel coverage prevented view of any small cracks that may have been present.
- Sedimentation at the base of the inshore riser was up to approximately 34" deep but dropped off to approximately 8" deep within 100ft. of the beginning of the horizontal tunnel.
- Over the length of the main intake tunnel, sedimentation depth gradually built from approximately 9" deep to approximately 14" deep at 2700ft.
- From 2700ft to 2895ft the sedimentation dropped of to near zero.
- From 2950ft to 2970 the sedimentation depth spiked up to approximately 63 ". This corresponded to the area where the West branch joined with the main intake.
- From 2970ft to the East riser at 3000ft, the sedimentation depth dropped off to 2-3".

2.1.3 West Branch Tunnel

2.1.3.1 Investigation Notes

- Visibility was in the order of 6-7 ft maximum

2.1.3.2 Investigation Results

- Mussel infestation appeared to be approximately 1/2" deep
- Mussel coverage was approximately 95%
- No apparent major spalling, cracks, loose concrete or misalignment was observed though mussel coverage prevented view of any small cracks that may have been present
- Working into the West branch tunnel from the main tunnel, the sedimentation was approximately 50" deep before dropping off to approximately 30" deep directly below the West Crib Riser.
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2.1.4 Main Intake Tunnel Sedimentation Volume assessment

- Based on the profiling sonar data recorded, the overall volume of sedimentation laying in the invert of the main intake tunnel is 400 cubic yards.

3 Appendix

3.1 Investigation Log

The investigation logs supplied with this report provide a chronological listing of the investigation project as well as a means to provide a general description of any features observed. Possibly the most useful aspect of the Investigation Log is the use of Hyperlinks. When viewing the Investigation Log as an Excel spreadsheet, the user can click on the corresponding hyperlink to view a short video clip, video still image or a sonar screenshot corresponding to the feature. This provides a very quick method of "mining" into the video record.

*****NB: For the hyperlinks in the Investigation Logs to function it is most important that the Investigation Log spreadsheet file be left in the same folder as the associated video clips and images named "clips".*****

3.2 Sedimentation Charts

The attached Sedimentation Logs are generated from data collected with the Imagenex 881a profiling sonar. The charts show the depth of sedimentation along the length of the main intake tunnel. They are divided into two sets. The first chart is a single chart showing a general overview of the sedimentation throughout the full 3000ft of tunnel. The second set of charts show the sedimentation depth made at 250ft intervals. Both the overview chart and the 250ft interval charts use the same data set but the overview chart is more compressed in the X axis than the 250ft interval charts.

Distance count in all charts is referenced to elbow at the bottom of the inshore vertical uptake riser.

3.3 Volume Charts

Two charts are provided to illustrate the volume of the sedimentation found in the invert.

3.3.1 Point Volume Chart

This chart shows the volume of sedimentation in a given lineal foot of tunnel.

3.3.2 Aggregate Volume Chart

This chart aggregates the volume of sedimentation found in the invert starting from the elbow at the bottom of the inshore vertical uptake riser. The volume is seen to increase to a total volume of approximately 400 cubic yards at the 3000ft mark.

3.4 Video

The video recorded on this project were recorded with an industrial investigation Digital Video Recorder and has been formatted for playback on a DVD supplied with this report.

3.5 Investigation Vehicle: Seaeye Falcon DR

The investigation was performed using SeaView Systems, Inc.'s Seaeye Falcon DR ROV. This system uses fiber optic technology, SeaView Systems 6000' fiber optic umbilical/spool system and an in-house developed surface power supply system to enable us to perform very long distance tunnel and pipeline penetrations while recording a large amount of video and sonar data.

Seaeye Falcon DR ROV

3.5.1 Video

3.5.1.1 Cameras

On this project, the Falcon DR recorded one channel of color video. The camera used was a very low light color CCD camera mounted on a 180 degree tilt platform.

3.5.1.2 Lighting

Fitted to the ROV were two 75W halogen dimmable lamps and two 150W halogen auxiliary lamps.

3.5.1.3 Video Overlay

Dedicated text was overlaid over each video stream. The following is a brief description of the overlay and how it should be interpreted:

- **Camera Name:** Each of the three cameras is independently labeled Port, Center, or Starboard for easy recognition during playback.

- **Date/Time:** System date and time synchronized with the sonar and line counter record.

- **Pipe Name:** A brief description of the pipeline name for easy recognition during playback.

- **Distance:** Penetration distance in feet from the access manhole. Penetration distance was measured and recorded (both on video and to disk for post processing) throughout the investigation. Distance measurement was achieved by passing the ROV's umbilical through a line distance counter.

On the center camera video the following extra information was recorded:

- **Pitch/Roll:** ROV pitch and roll referenced to horizontal.

- **Heading:** 0-360 degree heading information (often in-accurate as a result of magnetic deviation caused by reinforcing in concrete).

- **Camera Angle:** +/- 90 degree reading of camera angle from horizontal (+ve degrees for above horizontal, -ve degrees below horizontal).

3.5.1.4 Video Recording

The video for all three cameras was recorded independently to a high resolution DVR. Using video viewer software (see file in root directory of external hard drive titled "VIDEO VIEWING PROCEDURES) each of the three video streams may be viewed consecutively on a fast personal computer providing good context to each of the individual streams. Alternatively, once the appropriate CODEC is installed on the viewing PC (performed automatically during ODESSA MSX Viewer installation provided on hard drive), each individual video channel may be viewed using any commercial media viewer (i.e. Microsoft Media Player, etc.).

3.5.2 Other sensors

In addition to the video the Falcon DR ROV system takes a series of other measurements that are used in the processing of the profiling sonar data.

3.5.2.1 Pitch and Roll

Both pitch and roll of the ROV are recorded. This data is used to correct for any misalignment of the sonar within the pipeline as a result of vehicle movement.

3.5.2.2 Penetration Distance

Though not mounted on the ROV itself, an important sensor in the system is the umbilical distance counter. As the ROV proceeds through the pipeline, the umbilical is drawn over a wheel in a line counter assembly that accurately counts the distance traveled (accuracy is typically around 0.1% of distance traveled). This measurement is embedded in the sonar data as a third dimension resulting in the profiling sonar proving a relative three dimensional model of the internal surfaces of the pipeline.