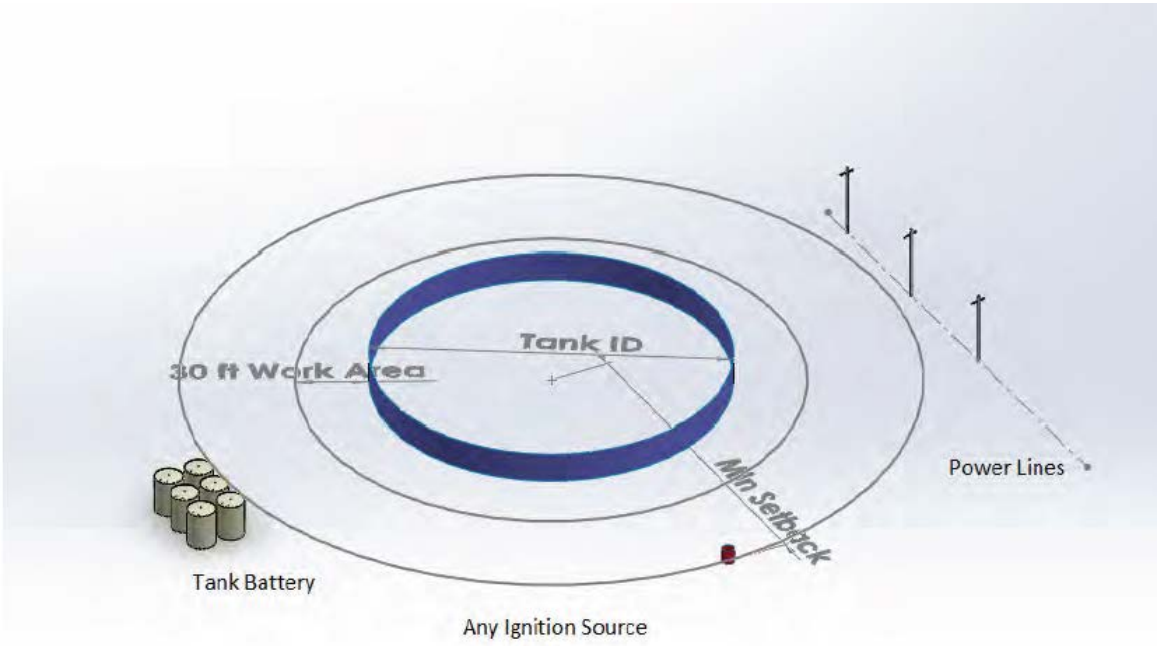
July 2018

C-147 Registration Package for MOGI 9 State 1H Recycling Containment (AST) and Recycling Facility Section 09, T24S, R33E, Lea County



Volume II of II

- *Standards Operating Procedures*
- *Specifications*

Prepared for:
Tap Rock Resources
Golden, CO

Prepared by:

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July 06, 2018

Ms. Oliva Yu
Mr. Brad Billings
NMOCD Artesia
Via E-Mail

RE: Tap Rock Resources MOGI 9 State Com 1H Recycling Containment (AST) and Recycling Facility. Sec. 9, T24S. R33E. Lea County, NM.

Ms. Yu and Mr. Billings:

On behalf of Tap Rock Resources, Hicks Consultants is pleased to submit the attached C-147 registration package for the above-referenced location. Because the files are quite large, this submission composed of two volumes emailed separately. This transmittal letter is identical in both portions.

Volume 1 contains:

- C-147
- Previously-approved variances
- Figures and Site Survey
- Appendix A: Site Specific Information
- Appendix B: Photos
- Appendix C: Well Logs
- Appendix D: Design & Construction Plan
- Appendix E: Operation and Maintenance Plan
- Appendix F: Closure Plan

Volume 2 contains:

- Appendix G: Select Energy/Rockwater Standard Operating Procedures (SOPs)
- Appendix H: Specifications – liner, AST, Mega Blaster Pro (avian protection)

We also wish to provide the following points of clarification to the submission:

1. This submission is a Registration, not a Permit. We have checked the Permit box and labeled it "For OCD Statistics Only", as we have done with other containment registration packages. All variances relating to the design and construction have been previously-approved by OCD, as recently as last year for XTO. Thus, we have also checked the Variance box "For OCD Statistics Only". Because Tap Rock seeks no variance that has not been previously approved, the submission is a Registration in accordance with the Rule.

2. The liner system for the AST is best conceptualized in the drawing entitled "AST Schematic" of Appendix D – Design and Construction in Volume 1. The drawing shows a change to the primary liner as the previously-approved AST systems that uses two (2) 30-mil LLDPE liners (Devon Hackberry). The seconday liner will use a 40-mil HDPE liner rather than a 30-mil LLDPEr liner. Per the attached previously-approved variance, a 40-mil HDPE liner provides equal or better protection than a 30-mil LLDPEr liner.
3. The AST will employ a muscle wall rather than an earthen berm for the walls of the secondary containment.
4. A previously-approved (Devon Hackberry AST) variance request for anchor trenches for vertically-walled tanks is included in this submission.
5. The AST will employ the Mega Blaster Pro (documentation provided) to deter avian species from landing on the treated produced water.
6. The Select Energy/Rockwater SOP for their AST is in Appendix G of the C-147 and the Design/Construction Plan (Appendix D) and the O&M Plan (Appendix E) are abstracted from this SOP. You should read Appendix D and E before you examine the SOP.
7. The AST is located on Tap Rock Resources Mogi 9 State Com #1H production pad. Per the SOPs, the area of the pad that will accommodate the AST will be re-graded, sloped, and a Y-Trench will be excavated to allow for drainage of the AST.
8. Set up of the AST system on the secondary liner will begin on July 14, 2018. We will notify OCD Hobbs 48-hours in advanced of construction.

Please note that the previously-approved variances were written by Ron Frobel, PE. He is the author of several variances that were incorporated into the Part 34 Produced Water Recycle Rule (e.g. 45 mil LLDPE primary liner system, 30-mil LLDPE secondary liner system).

Sincerely,
R.T. Hicks Consultants

Andrew Parker
Project Scientist

Copy: Tap Rock Resources, Josh Matthews (jmathews@taprk.com)
Select Energy/Rockwater Energy Solutions
Ed Martin, State Land Office (surface owner)

Appendix G

Select Energy/Rockwater

Standard Operating Procedures

R.T. Hicks Consultants, Ltd.
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STANDARD OPERATING PROCEDURES

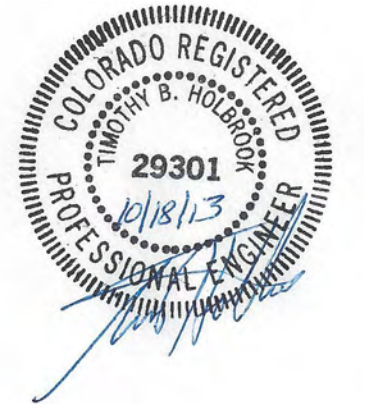
FOR ABOVE GROUND STORAGE TANKS

Rockwater Energy Solutions
Above Ground Storage Tank Division
131 ½ N. 35th Avenue
Greeley, Colorado 80634

CERTIFICATION

This Standard Operating Procedure for Above Ground Storage Tanks (ASTs) was developed based on a draft document provided to Industrial Facilities Engineering, Inc. (IFE) by Rockwater Energy Solutions, and edited for clarity by Industrial Facilities Engineering, Inc. (IFE). IFE observed Rockwater field procedures for erecting portable above ground storage tanks, received verbal input from Rockwater personnel, and documented those field procedures in this SOP. No engineering, safety, mechanical, or structural analysis was completed for this effort, only technical writing. IFE and IFE's personnel do not accept any responsibility for any structural, health, safety, or environmental aspects of the activities described herein.

This document is intended as guidance for installing AST Systems and is subject to review by Rockwater's Health, Safety, and Environmental (HSE), Rockwater legal representatives, and also subject to review by Rockwater's customer's health, safety, and environmental representatives. This document assumes that all Rockwater personnel on customer's sites will be advised of and follow the requirements of customer's HSE programs that apply to construction contractors on customer sites as required by OSHA regulations for process safety management (29 CFR 1910). Any conflicts between the procedures described herein and customer's OSHA requirements should be reported immediately to Rockwater HSE and customer HSE representatives and resolved prior to completing the procedures. IFE recommends reviewing and updating this SOP annually or when conditions warrant.



STANDARD OPERATING PROCEDURES FOR ABOVE GROUND STORAGE TANKS

TABLE OF CONTENTS

Section 1.0 Introduction and Summary

1.1 Introduction and Purpose

Rockwater Energy Solutions, Inc. (and all its affiliated and subsidiary companies, hereinafter collectively referred to as "Rockwater") is committed to providing its employees a safe working environment and avoiding injury to our contractors, customers, and neighbors. As part of our overall commitment to safety, Rockwater seeks to prevent acts or conditions that could result in injury and/or illness to any employee, customer, contractor, neighbor, and/or the environment.

In an effort to prevent potentially harmful acts or conditions, Rockwater has developed this ***Standard Operating Procedure*** (SOP) that focuses on above ground storage tank (AST) systems including planning, set up, operations, and take down. This SOP will discuss steps to be taken to promote a safe process, as well as a list of potential hazards that should be identified and remediated prior to beginning this procedure.

1.2 Background

AST is the industry term for an above ground storage tank. At Rockwater, AST's are used for a variety of field applications within the fluids management operations. AST's can be used in place of traditional tank farms and in-ground water impoundments, and are suitable for fresh water as well as production water. At Rockwater, AST's are available in several standard sizes, ranging from 4,500 barrel (bbl) capacity to 41,000 bbl capacities. Rockwater currently uses two basic styles of AST's. One is referred to as a "pin" tank that uses large diameter steel pins to attach tank plates together. The other type of AST is a "plate" tank. Steel panels of a plate tank are attached using steel plates.

1.3 Intended Use

This SOP will be a part of the training provided to all affected employees when they begin their employment with Rockwater and any time the plan is changed. This SOP will also be reviewed with an employee if his/her responsibilities change under the plan. A written copy of this plan will remain in the regional Safety Office, and will be available for employee review. The Vice-President of Health Safety and Environment, or his agents, may be contacted by any employee if he/she needs additional information about this SOP.

This SOP has been developed to assist affected employees with the operational steps that may be used to complete the task safely. It must be noted, however, that the experience and background of a trained water transfer employee is essential to the success of any project or task.

Nothing contained in this SOP is a substitute for each employee's individual judgment in any given situation. In the event that any employee believes that any task outlined in any SOP cannot be completed safely, then that employee should immediately halt the performance of such task and notify their direct supervisor.

This SOP may also be used to inform customers about Rockwater's typical equipment and procedures for setting up an AST system. This SOP will be reviewed and revised on an ongoing basis to keep pace with best oilfield practices and applicable OSHA regulations.

1.4 Customer Environmental Health and Safety Programs

This SOP recognizes that oil and gas operating companies have developed their own environmental, health, and safety (EHS) programs that contractors who work at customer's sites like Rockwater, must comply with. In addition to this SOP, Rockwater personnel will strictly observe the policies and procedures of each operating company.

1.5 Summary

This SOP is divided into four separate phases, each organized in chronological order. First is the planning phase that includes a customer-Rockwater meeting and close coordination to be sure Rockwater complies with all of customer's

environmental, health, and safety requirements and that the site is ready for the AST setup. This SOP then presents the specific tasks and safety requirements during the second phase - the AST setup phase. The third phase is the AST operation during which periodic checks of the tank are made per customer's requirements. The fourth phase addresses AST takedown during which all materials are removed from the site, and the site returned to customer specified conditions.

Section 2.0 Planning for AST Rig-Up

The planning phase for AST systems includes several important activities that can impact the safety and success of an AST project. Step by step procedures are presented below for each of the following activities during the planning phase of an AST project:

AST order information
Customer meeting
Pre-mobilization on-site meeting
Site soil preparation (by customer)
Notifications
Job Safety Analysis (JSA)
AST material deliveries

2.1 AST Order Information

Rockwater Account Manager will record general AST order information including the customer's site location information, general tank requirements (size, number, liner type, etc), desired schedule, customer's order reference number, and site specific customer contact information. The Account Manager provides this information, along with customer's contractual and safety requirements, to the appropriate personnel.

2.2 Customer Meeting

Prior to finalizing the delivery schedule, a meeting or conference call is held with Rockwater and customer representatives including the customer's purchase agent and the customer's environmental health and safety (EHS) representative. Rockwater is normally represented by the Account Manager, Operations Manager, and Field Operations Supervisor.

This meeting is best done in person, but must at least be covered in a phone call, followed up by a brief email confirming the AST order details, delivery schedule, and noting special conditions, safety requirements, etc.

The following key topics will typically be discussed.

Rockwater site specific staff/roles

Customer roles/responsibilities/contact information including customer's project manager, key on site staff, and EHS staff.

Review AST intended use and customer safety requirements.

Review AST scope of work, what is normally included, what is not.

Permitting for AST (as needed)

Site access and truck route requirements

Time line for AST to be operational

Confirm AST size(s) to be used

AST Layout: Attachment 1 of this SOP presents tank size, setback, and volume per inch data. It also includes an AST Layout Form that can be used during the customer meeting to sketch the location of an AST at a specific customer location. The Sketch should include the position of suction tube, Y trench (if needed), and setbacks to other tanks and existing site equipment. At the end of the meeting, a copy of the sketch should be provided to customer.

NOTE: It is preferable to maintain a 30' clear work area around the perimeter of the tank to provide access for equipment. For all Rockwater ASTs, the minimum footprint should be a circle with a radius of at least 24' greater that the radius of the tank.

Current site conditions, status/schedule for site preparation, and soil preparation requirements

Responsibility for filling the tank, to a minimum of 2 feet deep, immediately after it is set up to protect from wind.

Responsibility for AST inspections during AST operation, any time tank is fully emptied, and the frequency of inspections.

Conditions that could result in standby time charges or additional charges, and what prior customer approvals are required.

Responsibility for the used liner, residual solids left in the tank, and how the site is to be reclaimed.

Begin filling out AST's Pre-Project Evaluation/Checklist in AST Jobsite Workbook (Attachment 4 of this SOP)

Understand customer's OSHA Process Safety Management – Contractor safety and notification requirements for all activities on customer controlled sites.

Note any customer-specific or site-specific, personal protective equipment (PPE) or safety requirements for the AST site.

Notifications: Establish a list of notifications/communications that Rockwater will be responsible for and timing for each. Rockwater standard procedure is to notify owners of buried utilities in the AST site area using state-wide or Canadian Province "one-call" services at least one week in advance of AST setup. Identify any other notifications that Rockwater will need to make (e.g. Truck routes, neighbors, etc). Also identify customer's procedures for notifying the customer if conditions arise that could impact scope, schedule, cost) and get email addresses as needed.

Other Topics

Any additional site preparation to be completed by customer prior to setup
Underground material needs to be taken into account for site preparation.
Other Activities: Discuss AST site activities that will be ongoing during the AST set up. Rockwater personnel will be aware and courteous of simultaneous operations at all times.

Follow Up Email

After customer meeting, the Rockwater Account Manager will prepare a brief email to the customer and Rockwater representatives to confirm the AST order information, schedule, and site specific instructions from the customer, especially for tasks that are not included in the standard AST setup (per AST SOP) and customer specific, safety requirements.

2.3 Pre-Mobilization Onsite Meeting

Rockwater Field Operations Manager will hold a pre-mobilization meeting at the site of the AST project with customer representatives for the purpose of checking the site to confirm it is ready, or soon to be ready, for AST installation. During this meeting, the Field Operations Manager will complete will complete the AST Pre-Project Checklist (included in Attachment 4 of this SOP) and then send it to the Rockwater Account Manager. Based on the information in the checklist and other information, the Account Manager may send a brief follow up email to the customer and Rockwater management, if needed, to update previous site-specific instructions that the Account Manager issued as the follow up to the client meeting.

2.4 Site Soil Preparation

Preparation of the soils on site is required to form a dependable base for the AST. Preparation of the tank pad is the sole responsibility of Rockwater's AST customer (typically an oil and gas operating company). The Rockwater Field Operations Manager will check the status of soil preparation during the pre-project meeting on site. Rockwater personnel will also check the soil preparation using a proof roll test immediately prior to the AST setup.

Rockwater's soil preparation requirements are as follows:

Rockwater recommends a minimum soil compaction of 95% compaction. Soil testing results are normally shared with Rockwater. Due to different regions and environments; this may not always be possible. In order to meet industry standards, site preparation requirements must be deemed satisfactory by a Rockwater representative.

Rockwater recommends soil compaction testing to be conducted via Standard Proctor Test (American Society for Testing and Materials {ASTM} Standard D698) or Modified Proctor Test (ASTM Standard D1557).

Compaction test results must be provided to Rockwater prior to the commencement of AST construction.

A proof roll test may be used if observed and documented by qualified Rockwater personnel. Attachment 3 of this SOP provides guidance on how to perform a proof roll test and how to interpret the results.

Grade AST footprint and 30 ft work area to 0.25 % or 3" ft drop per 100 feet, toward sump location.

Site should be graveled prior to tank installation, utilizing gravel size 2B or smaller. (3/4" road grade preferred, or coarse sand with minimum thickness of 4 inches).

Do not use crushed rock as sharp edges could puncture the tank liner.

After completion of these steps the tank setup can be approved.

2.5 Notifications

Even though the customer or their subcontractor may have already called for utility locates for the soil preparation work, Rockwater Crew Leader must call the local or state underground utility location service again at least one week in advance before construction/digging begins. Rockwater Crew Leader should document the ticket or reference number provided by the one-call service on the Pre-Project Checklist in the AST Jobsite Workbook included in Attachment 4.

The following web site has contacts for all the states and provinces.
http://www.call811.com/state-specific.aspx. The website link below is provided for smart phones:

Call 811 in United States
For Canada
Alberta: 1-800-242-3447
British Columbia: 1-800-474-6886
Ontario: 1-800-400-2255
Quebec: 1-800663-9228
Saskatchewan: 1-866-828-4888

2.6 AST Material Deliveries

Once the delivery route and schedule are established and the pre-project onsite inspection is completed, the AST materials can be delivered. Notifications will be made as agreed to during the customer meeting. Rockwater delivery personnel unload all materials safely and taking care to avoid damage to liners, plates, and all other AST components. They will also stay out of the way of ongoing site activities, and notify Rockwater Crew Leader if site conditions are not suitable for delivery.

Section 3.0 AST Setup

The Crew Leader will fill out the "AST During Project Checklist" during set up of the AST system.

3.1 Job Safety Analysis (JSA)

A job safety analysis must be completed on site prior to beginning work. The JSA will be completed following Rockwater approved procedures. Customer's safety requirements will also be communicated during the JSA. All Rockwater personnel, 3rd party contractors, and customer representatives are expected to participate and sign the JSA forms when the JSA is completed. JSA forms are included in Attachment 2.

3.2 Check Soil Condition

Preparation of the tank pad is solely the responsibility of the customer (oil/gas operating company). However, weather and rain/snow events can change the soil conditions quickly. Therefore, Rockwater will check the soil compaction using field methods prior to setting up the AST using one or more of the following methods, depending upon site conditions immediately before liner and tank layout:

- Perform a proof roll test using the large loader with a bucket full of sand, driving slowly over the tank base area, focusing on the tank wall perimeter. Refer to Ohio Department of Transportation specifications for proof rolling at http://www.dot.state.oh.us/Divisions/ConstructionMgt/OnlineDocs/2009MOP/200 Earthwork/204/204 Subgrade Compaction and Proof Rolling.htm - Proof Rolling (bottom of page 4) for acceptable soil deflections or displacements. This specification is included in Attachment 3.

3.3 Tank Layout

- Check proposed AST site to confirm a 30' clear work area around the perimeter of the tank is possible to provide access for equipment and laydown area for AST materials and erection equipment.
- Check that the minimum distances to existing wells, power lines, etc. are met.
- Regardless of manufacturer, the minimum footprint should be a circle of at least 24' greater than that the radius of the tank.
- Establish final location for the suction tube and stairs.
- For a pin tank, the pad should be graded and sloped 0.25% from high side of location to suction side of tank. This will allow for better drainage of tank.
- For a plate tank, the pad needs to be flat.

3.4 Equipment (Rockwater provided)

All equipment is subject to daily inspection. (Check condition, rigging, oil, water, fuel and cleanliness.) Here is a list of the recommended equipment needed to set a tank. Actual equipment used will vary among regions and specific projects.

- Two 40' extending straight boom man-lifts.
- 16,000 lb capacity extending boom, rough terrain powered industrial truck (Tele-handler or equivalent) as needed.
- Tractor/loader/backhoe unit with minimum one ton lift capacity (Volvo 110 series, or equivalent) and a modified jig for setting walls (as needed).
- 40 ton crane for plate tank setups – large enough to complete the job at hand. In the event that a crane operator is needed, the operating company or Rockwater will contract with a third party for this service.
- Recommended equipment to remove scraps and miscellaneous material on site (trailer, dumpster, etc.)

- Optional excavator with thumb for plate tank setups.

3.5 Hand Tools Recommended

All hand tools are subject to daily inspection.

- Two 13’ ladders
- Four 4 lb. sledgehammers
- 100’ or 200’ tape measure
- 1 case of marking paint – minimum
- Set of wrenches ¼” – 1 ½”
- Set of sockets ¼” – 1 ½”
- Two 36” pry bars
- 8’ rock bar (digging bar)
- Five safety harnesses with retractable tethers (Rockwater owned)
- Five retractable lanyards
- 100’ of 3/8” rope
- Duct tape
- Covered hook bladed knife
- Three 40’ lifting straps (minimum of 5,000 lb capacity)
- Three 20’ 3/8” chains (must have visible certification tags)
- Two rolling head pry bars
- 150’ strap
- Two ½” impact guns
- Ten padded vise grips to pull liners
- Two sets of rigging chains
- Patch tape
- Rubbing alcohol
- Patch roller
- Leather gloves
- Wire brush or wheel with 4” angle grinder
- Generator
- Steel toed rubber boots
- Fire retardant clothing (FRs)

3.6 AST Tank Setup Steps

- There must be a Rockwater company representative on site the day prior to setup in order to approve everything for setup.

Tank Layout

- Determine center of tank and mark with paint, then bury preferred non-abrasive item (tennis ball, sand bag, water bottle, etc.) This will be used to find the center of tank after liners have been placed.
- Measure and double check minimum distance from tank center to existing wells meets the minimum distance
- Measure and paint a line to mark the circumference of tank for panel placement.
- Also mark the circumference of the liner laid out flat to ensure the liner is properly placed.

Suction Pit

- Determine where tank suction is to be placed (the low side of pad).

- For pin tanks, dig 8’ wide x 8’ long x 16” deep sump hole for the suction manifold to set in and taper the edges so there are no sharp corners of the excavation.
- Remove any sharp stones
  - If multiple suction manifolds are required, the sumps should have a minimum of 8’ of separation.

Attention!

In cold weather conditions, the sumps should be dug out as late as possible and should never be left unattended overnight.

Barricade any sump pit with appropriate cones or tape if left open when crew is not present or active in the area.

- When installing a plate tank, the “Y Trench” can be used both for wind stabilization and for draining the tank. The “Plate Tank Y-Trench Guidance Document” can be found in Attachment 5 of this SOP.

Geo Pad and Liner

- All tanks setups will require the use of a Rockwater approved underlayment and liner. Typically one 10 ounce, geo pad is laid out for added protection and one, 30 mil liner will be placed inside the tank.
- In the event that the tank will be holding produced or recycled water, an extra felt liner (geo pad) should be laid out prior to the AST setup.
- Check customer specifications and regulatory permit liner and containment requirements for ASTs that may hold flowback or produced water.
- The crew walks the entire tank base area to and pick up any sharp stones or other sharp debris that could damage the liner.
- Lay out the geo pad prior to the liner. In some cases, the geo pad is “bundled” with the liner and can be rolled out together. After unrolling, pull the geo pad to extend it fully using several crew members spaced along the edge.
- Perform a visual inspection of the liner – repair any defects as necessary.
- Place the liner and align to the center of the tank and painted line for the tank walls. The preferred 30 ft area around tank allows the liner to be laid out flat so that fold back can be uniform.
- Bundling of the liner with the geo pad by the liner supplier is preferred. If the liner is bundled with the geo pad, roll it out across the diameter of the tank, extending outside the painted perimeter wall line. Be sure not to use padded vice grips to move liner unless located at edge of liner. Inspect liner and report any damage or bad seams, punctures due to handling, etc. to the Crew Leader
- Secure liner from wind using sand bags, or if plate tank, use the “Y” trench by filling the trench with water
- Fold the liner toward inside the painted tank edge line to allow stockpiling of sand and placement tank panel walls.

Sand Against Inside Panel

Stockpile sand just inside marked panel perimeter. Place enough sand at spaced locations around the circle to provide for sand approximately 12” deep at tank wall and a 1:1 slope into tank.

Tank Wall Erection

- Ensure all tank parts and pieces are accounted for.
- Crew Leader will complete a visual inspection of each panel as it is prepared to be placed. Fill out Tank Panel Visual Inspection Check Sheet in Attachment 6, place in Jobsite Notebook.
- Stand the first tank panel in place and keep connected to the crane until all the remaining panels have been connected.
- Monitor crane and rigging of first panel closely to ensure it remains stable, especially during wind and while the other panels are attached.
- Begin placing the remaining panels in place with the front-end loader and panel rigging frame

- Personnel secured on man-lift then secure the panels in place with 4 pins each (for pin tanks) or (for plate tanks) with the connecting plates and lug busses, secured with chained cotter pins.
- To protect the liner, distribute sand with shovels to form 1:1 sand bank against the inside bottom of each panel. Be sure the slope is uniform. Alternatively, roll up excess geo pad into minimum 6" diameter cylinders around the inside of the tank ring to help support the liner at the base of the tank wall as the tank is being filled.
- Prior to lifting liner into place against inside panel, place metal covering plates over all panel gaps in plate type tank. For pin tanks, check that sand or rolled up geo pad is evenly placed at base of all walls.
- Prior to covering sump with the geo pad or liner, confirm sump excavation has smooth sides and corners, and that no sharp stones are present.
- When placing the final panel in the circle, attach this final panel only on left or right side but LEAVE OTHER PANEL SIDE OPEN at this time for access and egress points. *(Must have an entry and exit point to the tank at all times.)*

Liner Placement and Securing Top With Clips or Clamps

- After 4 or 5 panels are set, and all liner protection as described above is in place, unfold the liner in sections, toward the base of each panel, making sure the sand or rolled up geo pad will provide padding at the base of the inside of each panel.
- Crew of 2 inside the tank wall unfolds and pulls the liner toward each panel. Working in small liner sections, this inside crew works with a crew of 2 on a man lift located outside and above each tank panel to pull the liner edge up and over the top of each panel. The man lift crew lifts the liner edge using ropes attached (by the inside crew) to padded vice grips that grip the liner. The man lift crew lifts a small liner section to the top of the panel and folds it over the top of the panel, being sure there is enough slack in the liner inside the panel wall.
- Once a section of liner is positioned properly (with liner slack inside the tank) and over the top of each panel wall, the man lift crew secures the top of the liner with clips (pin tanks) or clamps (plate tanks). NOTE: A minimum of 5 clips (pin tanks) or 5 clamps (plate tanks) or more are required at the top of each tank panel to secure the liner. Add additional clips and clamps as needed to secure liner.
- Both inside and man lift crews continue this process, working around the tank, one or two panels at a time, until the entire liner is in place.
- NOTE: The crew must allow sufficient slack in the liner at the wall to allow for liner movement during filling and draining.

Stairs, Fill Tubes, and Suction Tubes

- Install safety stair system, fill tubes, and suction tubes. Ensure that stair system and tubes are appropriately secured to the tank walls according to customer specifications.
- Upon completion of the stair system installation, the stairs should be secured as per the operating company requirements. At a minimum, these requirements should include access chains with "Authorized Personnel Only" (or equivalent) signage at the bottom of the stairs outside the tank, water rescue equipment on the platform at the top of the stairs, and access chains with "Do Not Enter" signage at the top of the stairs that go inside the tank.

Final Steps, Filling, and Inspection

- Close final panel and secure with pins or plates as needed.
- Trim liner and allow approximately 3' of liner to hang over edge of tank.
- Secure liner with sufficient clips or clamps and be sure ratchet straps are applied to all tanks. Place straps to secure the cut edge of liner on outside of tank.

- Inspect all connections and equipment, confirming at least 5 liner clips or clamps (or more as needed) are in place on top of each panel.
- Have a minimum of 8 inches of water put in the high side of the tank to check for leaks and to hold liner in place.
- Fill tank and monitor.
  - If tank remains on site for any period longer than 7 days perform periodic inspections of the tank to ensure everything is in proper working order.
  - Every time a tank is fully emptied and refilled, an inspection must be performed.
  - Visibly inspect all tank panels and stairs for cracking, dents, burrs on the inside of the panels, chipping paint on welds or sharp edges on panels.
  - Look for any cracked or broken valves, damage on pipes and tubes, missing D-Rings, damage to chains or ratchets, and bent clips.
  - Pay close attention to hinge plates for chipping paint and cracking.
  - Water must NEVER go below 24 inches at the LOWEST level in the tank. (Mark this on the liner as a caution).

Crew Leader will complete the Post Project Checklist (included in Attachment 4 of this SOP) and assemble all required jobsite forms into the Jobsite Notebook. Also document crew hours and expenses to Rockwater Field Operations Manager.

Section 4.0 AST Operation

4.1 Inspections and Monitoring

AST Operation Phase includes periodic AST monitoring, leak detection, and identifying potential hazards that may have developed, change in site conditions or if the contents of the tank change from the initial use. Periodic visual inspection of each individual tank panel is also completed. Inspections are recommended whenever the tank is emptied and prior to refilling.

Attachment 4 of this SOP contains a form titled AST Visual Inspection Checklist that is filled out during periodic inspections. The form provides a list of observations that will enable early detection of uneven tank panel settlement, soil settlement, liner damage, insufficient liner slack, or leaks. Any AST issues are quickly reported to the Rockwater Crew Leader.

Attachment 6 to this SOP is a form used to inspect individual tank panels and connections titled Tank Panel Visual Inspection Check Sheet. Each individual tank panel has a unique identifying number that is used on the sheet. Each panel is checked to identify any abnormal wear or damage. Any tank panel issues are quickly reported to the Rockwater Crew Leader.

If the tank is drained, it should be secured from wind impacts and the liner inspected and re-positioned (to provide sufficient slack during filling) prior to refilling. Specifically, it may be necessary to rearrange the liner folds at the walls prior to refilling if the wind has shifted the liner folds when the tank was empty.

If the contents of the tank have changed from the contents originally planned for the tank, report this change to the Rockwater Crew Leader as soon as possible.

CAUTION – If conditions are observed that could indicate an imminent tank failure, clear the area immediately, advise others in the vicinity to do so also and contact the customer to drain the tank, and the Field Operations Supervisor to advise of the situation.

4.2 Initial Leak Detection and Liner Repair

In the event of a leak in the tank due to a hole in the liner, the following steps should be followed.

- If there is a question that it is in fact a leak from the AST, a pH balance test may need to be performed on both the water in the tank and on the ground.
- If the leak is found to be coming from the tank, narrow down from which panel the leak is originating.
- Use a strap or rope to mark the point where the water is coming out of the tank.
- Determine if the water is coming out high or low on the tank.
- Locate the puncture or hole in the liner.
- Empty the tank to the point of damage in liner if necessary.
- Clean area of liner that needs to be repaired.
- Cut out piece of material (patch or tape) to overlay liner.
- Either weld the patch to the injured area in the liner or stick the tape (2 types – dry or underwater) over the leak.
- Make sure puncture is completely covered.
- Monitor as needed.

Section 5.0 AST Breakdown

The AST breakdown follows the reverse order of the setup steps presented in Section 3.0 above. The sump or "Y" trench will be filled in with soils or fill approved by the customer and compacted with a loader to the surrounding grade.

The customer is normally responsible for draining and disposing of all liquids and residual solids that have accumulated in the tank. Rockwater Field Operations Supervisor is responsible for following the customer's requirements for proper off site management or recycling of the liner and geo pad materials, and for returning the site to the customer per the customer's site specific requirements.

Rockwater will complete an AST Visual Inspection Checklist to document the condition of each panel. A completed checklist is then placed into the Jobsite Notebook. If panel or fastener damage is observed, provide a copy of the inspection to Rockwater General Manager.

ATTACHMENTS TO AST SOP

ATTACHMENT 1 - Tank Size, Setback, BBL/inch Data and Layout Form

ATTACHMENT 2 - Job Safety Analysis Form

ATTACHMENT 3 – Proof Roll Testing Guidance

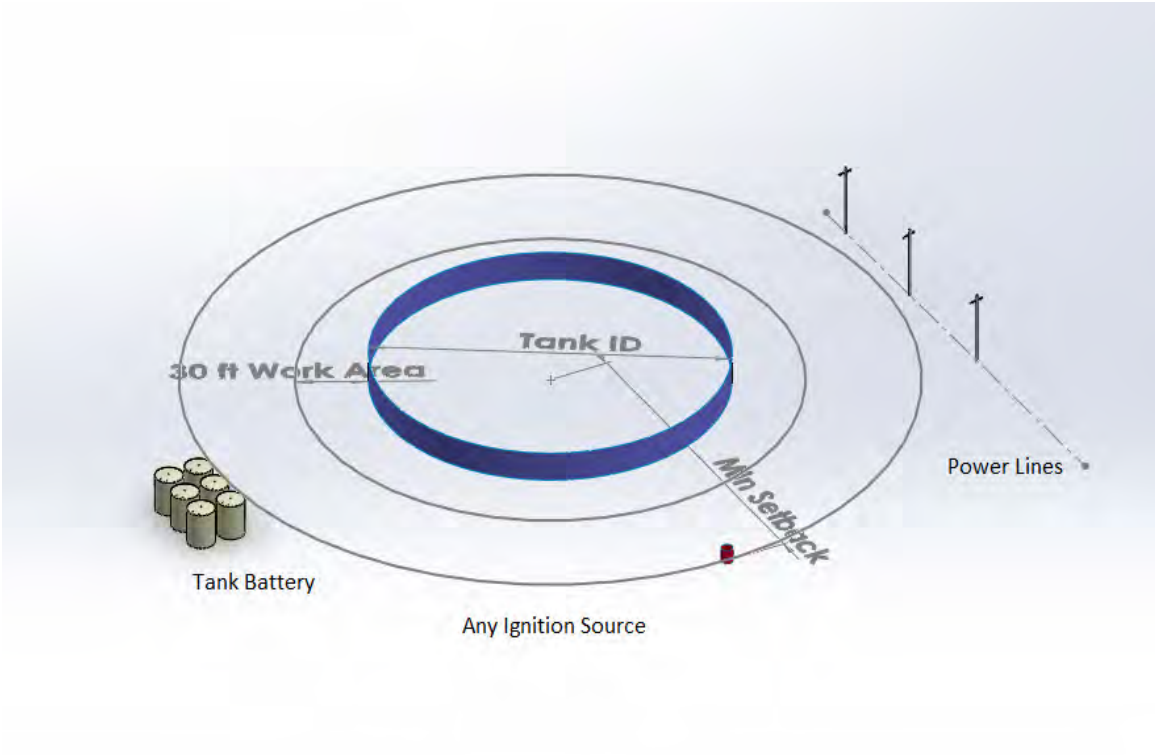
ATTACHMENT 4 - RCK AST Jobsite Workbook Forms

ATTACHMENT 5 –"Y" Trench Guidance

ATTACHMENT 6 - Tank Panel Visual Inspection Check Sheets

ATTACHMENT 1 - Tank Size/Layout Table, Graphic, BBL/Inch, and Layout

Tank	Panels	Inside Dia (ft)	Layout Radius	Minimum Setback from Well to Tank Center (Tank radius + 75 ft + 5 ft)	Capacity (Bbl)	bbl/Inch
PIN 40,000	24	153	76’ 6”	156’ 6”	40,000	279.4
PIN 24,000	20	119.5	59’ 9”	139’ 9”	24,000	166.5
PIN 9,600	12	76.7	38’ 4”	118’ 4”	9,600	68.6
PLATE Atlantis	15	157.5	78’ 9”	158’ 9”	41,000	287.4
PLATE Odyssey	12	126	63’	143’	26,500	185.2
PLATE Poseidon	10	105	52’ 6”	132’ 6”	18,000	128
PLATE Triton	7	73.5	36’ 9”	116’ 9”	9,000	62.9
PLATE Neptune	5	52.5	26’ 3”	106’ 3”	4,500	32.1



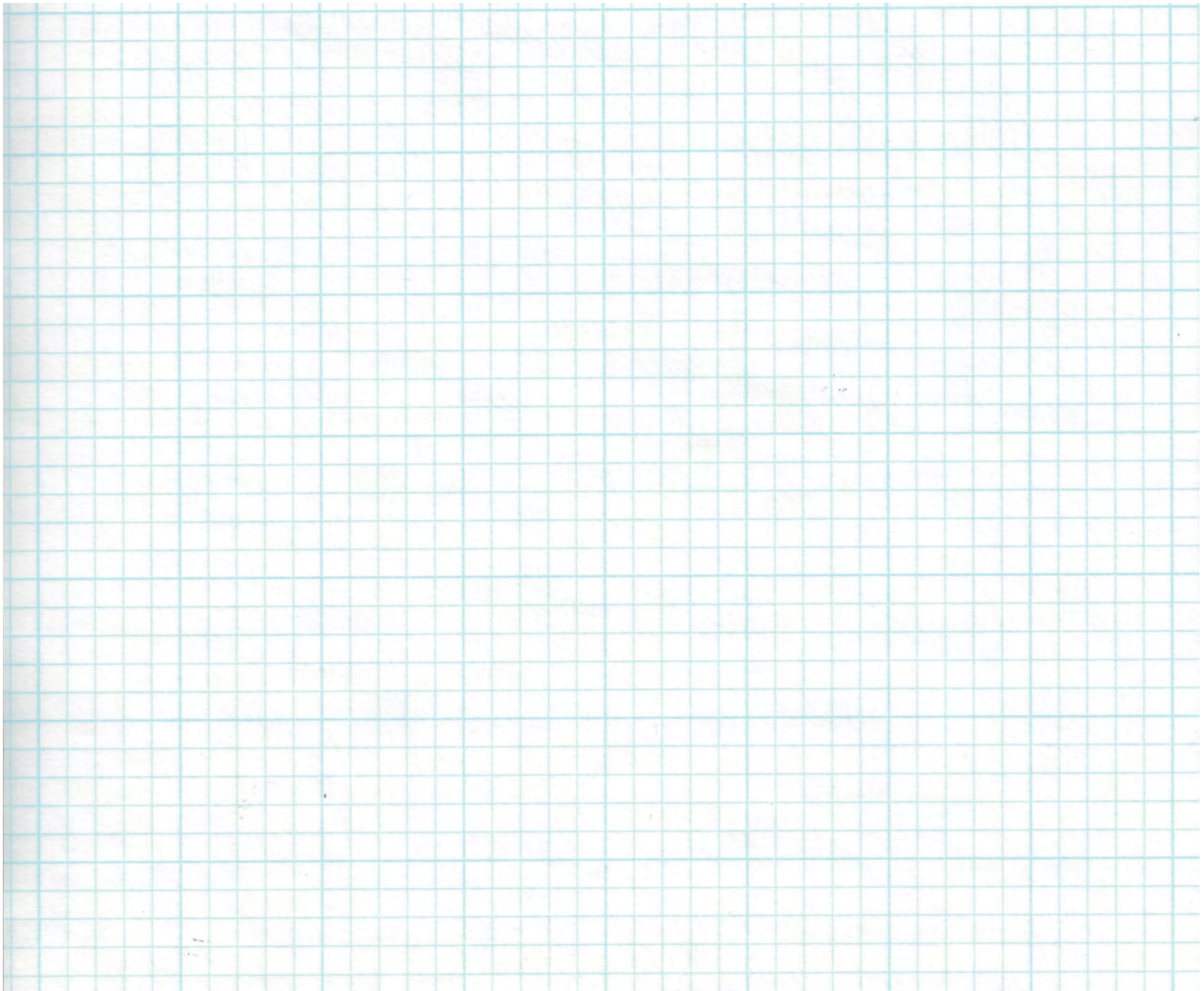
AST LAYOUT FORM

CUSTOMER: _____PAD: _____
LOCATION: _____

TANK FROM: _____FRAC'D DATE: _____ SET DATE: _____
DRECTIONS: _____

ADDITIONAL COMMENTS: _____

PREPARED BY: _____ APPROX. SCALE: _____ NORTH ARROW: ____



ATTACHMENT 2 - Job Safety Analysis Form

TO BE COMPLETED PRIOR TO STARTING JOB
ROCKWATER ENERGY SOLUTIONS JOB SAFETY ANALYSIS

Company: _____
Project #: _____
Project Description: _____

9-1-1 Address: _____
Well #: _____
County/State: _____
Date: _____

Safety Equipment Required To Do This Job											
Hard Hat	☐	4-Gas Monitors	☐	Metacarpal Gloves	☐	Safety Glasses	☐	Lockout/Tagout	☐	Metatarsal	
Fire Extinguisher	☐	Back Support Belt	☐	Confined Space Permit	☐	Work Permit Req'd	☐	Hearing Protection	☐	Boots	☐
Face Shield/Goggles	☐	Safety Harness/Anti-Fall Device	☐	Proper Clothing	☐	Ground Cable	☐	Wheel Chock	☐		

Pre-Job Hazard Assessment											
Lifting	**Y**	**N**	Housing of Tools/Material	☐	☐	Electrical Hazards	☐	☐	Twisting Motion	☐	☐
Manual Lifting (body position)	☐	☐	Secure Footing	☐	☐	Welding/Flame Cutting	☐	☐	Walking	☐	☐
Mechanical Lifting Equipment	☐	☐	**Hazards**			Mechanical equipment	☐	☐	Swinging	☐	☐
Awkward Body Position	☐	☐	Proper tool/matl placement	☐	☐	**Environmental**			Straining	☐	☐
Slip/Trip Potential	☐	☐	Hot/Cold Surface or Material	☐	☐	Pollution (Personal Exposure)	☐	☐	Stretching	☐	☐
Lifting with Other Employees	☐	☐	Inadequate Lighting	☐	☐	**Constant Body Position/Movement**			Reaching	☐	☐
Proper Rigging Practices	☐	☐	Fall Protection/Anchor Points	☐	☐	Climbing	☐	☐	Over Extending	☐	☐
Access/Exit	☐	☐	Pinch Points	☐	☐	Pulling, Pushing	☐	☐	Jumping	☐	☐
Scaffold (Properly Inspected)	☐	☐	Trenching/Excavation	☐	☐	Bending - If 'Y', Identify:	☐	☐	Crawling	☐	☐
Ladder	☐	☐	Hand & Finger Hazards	☐	☐						

Environmental Conditions

Conditions						Temperature		Winds		Mud		Hazwoper		
Day	☐	Drizzle	☐	Ice	☐	32 or less	☐	15 or less	☐	Dried	☐	Reviewed	☐	☐
Night	☐	Humid	☐	Dust	☐	32 to 80	☐	15 to 40	☐	Moderate	☐	MSDS Needed	☐	☐
Clear	☐	Rain	☐	Lighting	☐	80 or More	☐	40 or More	☐	Deep	☐		☐	☐
Fog	☐	Snow	☐	Other	☐									

Sequence of Basic Job Steps	Potential At-Risk Behaviors or Other Hazards	Action Taken to Eliminate or Reduce Potential Hazards

Signatures:

Supervisor: _____ **Crew:** _____

_____

Crew: _____ _____

_____ _____

_____ _____

Must be turned into HSE daily.

ROCKWATER Energy Solutions | **Job Safety Analysis Process Worksheet REV. B** | **"LIVE INCIDENT FREE EVERY DAY"**

Permit To Work #: _____

Permit Approver: _____

Work Team Leader: _____

Work Group / Company: _____

Work Location: _____

Date:_____ Start Time:_____ Planned End Time:_____

Description of Work Activity: _____

_____

Emergency Response Initial Contacts:

Client Representative: _____

1. Radio Channel: _____

2. Phone: _____

WPD Supervisor: _____

1. Radio Channel: _____

2. Phone: _____

Greeley Branch Safety on-call (970) 219-4264 Other Emergencies: 911

Emergency Response Actions:

- Evacuate Area (get to safe zone)
- Notify Operations (and Leads)
- Secure Area
- (Don't allow entry unless it's authorized responders)

Field Staging Areas:

Primary _____

Secondary _____

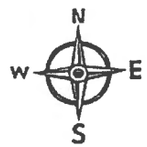
Complete Sign-up Sheet Daily

JSA filled out by whom: _____

By Signing Below I have read, fully understood and have had the opportunity to make suggestions or add aditional hazards. I will follow this process.

Printed Name	Signature	In	Out

Diagram of work location(s) with site muster areas noted **(If multiple locations are applicable, please used 2nd JSA form):**



Current Weather Conditions: _____ Wind Direction: _____

ROCKWATER Energy Solutions

Job Safety Analysis Process Worksheet REV. B

"LIVE INCIDENT FREE EVERY DAY"

Jobs Steps/Procedures	Potential Hazards or Incidents	Safe Procedures/Behaviors	JSA Corrections, Changes, and Notes
List all the steps and tasks associated with doing this job.	List the potential hazards associated with the steps or tasks to do this job.	List the Safeguards/behaviors used to protect all affected individuals from these hazards.	List any changes, corrections, notes, or review comments associated with this JSA and job.

Job Preparation:

- ☐ Get duties assigned.
- ☐ Get Proper Tools and Equipment.
  - ☐ Including PPE
- ☐ Go to Work Location.
  - ☐ Driving
- ☐ Review Plan and Hazard Analysis.
- ☐ Complete JSA.
- ☐ Do job walk around.
- ☐ Prepare Tools and Equipment.

Doing the Job:

#

__.______________________________

__.______________________________

__.______________________________

__.______________________________

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__.______________________________

__.______________________________

__.______________________________

Finishing the Job:

- ☐ If work isn't complete ensure everything is secure.
- ☐ If work is complete make sure everything is correct.
- ☐ Pick up tools and equipment.
- ☐ Housekeeping completed.
- ☐ Complete Paperwork.
- ☐ Leave Work Location.

#

__.______________________________ (×20)

SSE: ______________________________

#

__.______________________________ (×20)

Mentor: ______________________________

Check boxes below that apply for this task

- ☐ Did you get all the material you needed for the job?
- ☐ Did all the hand tools and equipment get inspected?
- ☐ Is this JSA filled out, read by each crew member and signed?
- ☐ Has everyone inspected and wearing all their PPE properly?
- ☐ Does everyone understand that they will give their full attention to this task?
- ☐ Does the crew need hearing protection?
- ☐ Does everyone understand all the instruction(s) and duties given for this task?
- ☐ Has the crew been ask if there are any missing steps, hazards, mitigation on the JSA?
- ☐ Does everyone on the crew understand it is everyone's responsibility to stop activity where a hazard is detected or identified?
- ☐ Have I met greeted and shared JSA's with other contractors in my work vicinity?
- ☐ Are all barriers in place before starting work and left in place if the work is incomplete?
- ☐ Is everyone trained on tools and equipment being used for this task?
- ☐ Does everyone on this crew understand procedures used for this task?
- ☐ Is a hot work permit required?
- ☐ Is a confine space permit required?
- ☐ Did Fire Extinguishers get inspected from truck, pump, air compressor and are set out away from pump/compressor during operation?

Signature of person(s) checking boxes:

Print Name: ______________________________

Signature:

ATTACHMENT 3 – Proof Roll Testing Guidance

204 Subgrade Compaction and Proof Rolling

Importance

Over 25 million dollars of extra work was used to stabilize soft subgrades during the construction seasons of 2000 and 2001. This extra work has been minimized in recent years because of the construction and design criteria created since that time.

This section will help the project construct stable subgrades for pavement construction. Proper subgrade treatment ensures a constructible pavement, enhances pavement performance over its life, and ensures that the pavement design intent is carried through in the construction phase. This section is based on research performed by the Department from the 1960's through today. This section should not be used as the ultimate answer to solve all subgrade problems.

This section is detailed in such a manner so that construction personnel can easily apply information from the field and subsurface investigation to provide reasonable adjustments to the plan subgrade treatment.

Specification and Plan Requirements

Item 204 requires the top 12 inches of the subgrade to be compacted. Item 204 requires the subgrade to be proof rolled. If subgrade stabilization or undercutting is designed for the entire project, then proof rolling is only used to verify the undercut replacement material stability. If special subgrade treatment is provided in the plans at spot locations, proof rolling is specified to identify these areas and then performed afterwards to verify the undercut stability.

Proof rolling deflections and soil conditions that are observed during construction determine if the plan subgrade treatment must be adjusted. Adjustment of subgrade treatment to fit field conditions is essential and is the responsibility of the Project Engineer.

Subgrade Correction Prior to Proof Rolling

The Engineer must observe the effect of heavy equipment operating on the subgrade during rough grading. When rutting and deflection under heavy equipment indicates soft subgrade, the Engineer should authorize the correction. See "Elasticity and Deformation of Soils" in section 203.02 Materials of this manual.

Do not delay the correction until it can be checked by proof rolling. Investigate the extent of the problem by using the "Investigation" section of this Item. Be aware that the condition can be improved by time, drainage, and hauling as detailed in the section "Draining and Hauling" of this item.

If needed, make the correction by excavating and disposing of soft soil, and replacing it with suitable material as detailed in the section "Undercut Depth and Stabilization Determination" of this item.

Drainage and Hauling

Excess water in fine-grained soil is the principal cause of unstable soil conditions. The Engineer has a responsibility to ensure adequate drainage during construction. If the investigation indicates the need for underdrains or the cleaning of the existing underdrain outlets, then the Engineer must order the work as soon as possible.

Some examples of these conditions are as follows:

1. Existing underdrains with clogged outlets on rehabilitation projects.

2. Free water in the subgrade.
3. Saturated soils of moderately high permeability, such as sandy silt and silty clay of low plasticity.
4. Ground water seepage through layers of permeable soil.
5. Water seeping in the test pits.
6. Water seeping from higher elevations in cut locations.
7. Water flowing on the top of the rock or shale in subgrade undercuts.

Note: It is difficult to remove water from hard clay soils with PI's greater than 20 with construction underdrains.

Subgrade stability can be significantly improved by cleaning out the existing underdrain outlets on rehabilitation projects and by adding construction underdrains on new or rehabilitation projects. Once the underdrain systems are in place and functioning, the drainage system can reduce the subgrade soil moisture content from 3 percent over optimum moisture to the optimum moisture content in 6 to 8 weeks. Moisture contents that exceed 3 percent over optimum must be dealt with by other means.

For rehabilitation projects, the Contractor should be instructed to unclog the underdrain outlets immediately. Try to perform this work in the time frame listed above. If the project consists of several phases, instruct the Contractor to perform the outlet cleaning for the entire project at the same time.

For new or rehabilitation projects, subgrade stability can be achieved by constructing the plan or construction underdrains as soon as the water problem is found. On new construction projects a longer period of time can be allowed for the underdrain system to work. Opportune times for this work are at the beginning of construction and before winter shut down.

The plan underdrains should be placed only when they will not be contaminated by further construction. If contamination is a concern then sacrificial or construction underdrains should be used on the project.

Item 605 in the C&MS details the construction underdrain construction. Construction underdrains are usually placed in the centerline of the roadway. They may also be placed in the ditch line if the water is coming in from a cut section at a higher elevation. The porous backfill is extended to the subgrade elevation. The outlets for the construction underdrain are the same pipe material and backfill as regular underdrains. The underdrains can be outlet to any convenient location such as catch basins, manholes, pipe, or ditches. The project should not be concerned with the contamination in the upper portion of the underdrain backfill. Construction underdrains are sacrificial underdrains that will continue to work throughout the life of the contract, and afterwards even though the upper portion is contaminated.

In Figure 204.A, the subgrade is saturated and the soil acts like a waterbed when the subgrade is Proof Rolled or hauled on. However, once the underdrains are in place and the soil is loaded, as shown in Figure 204.B, then the water has a place to go. As the soil is loaded or hauled on, the water is squeezed out and the subgrade conditions will improve.

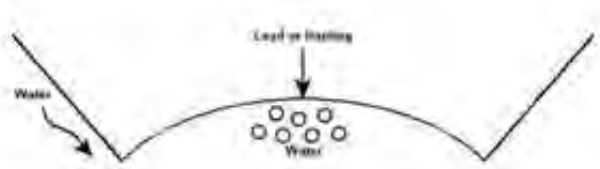


Figure 204.A – Water in the Subgrade without Drainage

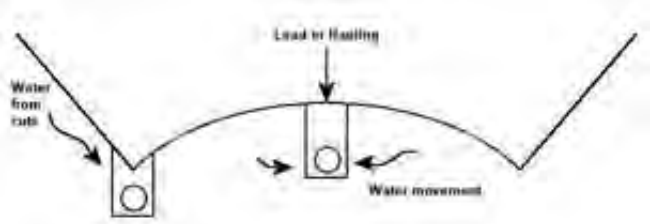


Figure 204.B – Water in the Subgrade with Drainage

By placing the drainage system prior to loading or hauling on the subgrade, the water is given a location to escape the subgrade system. If the drainage system is not in place before hauling or loading, the subgrade will rut or crack, and have a detrimental effect on the subgrade and not improve with loading.

Drainage and hauling can work together to correct soft subgrades under the above given guidelines.

Figure 204.C "Shale and Rock Undercuts" came from Figure 1009-10 in Location & Design Manual – Volume 2, *Drainage Design*. The

specification requirements are detailed in 204.05. Shale and rock are cut 24 inches (610 mm) below the bottom of the pavement. This ensures that the pavement gets uniform support and good drainage. In addition, soft rock or shale can deteriorate due to the accumulation of water under the pavement.

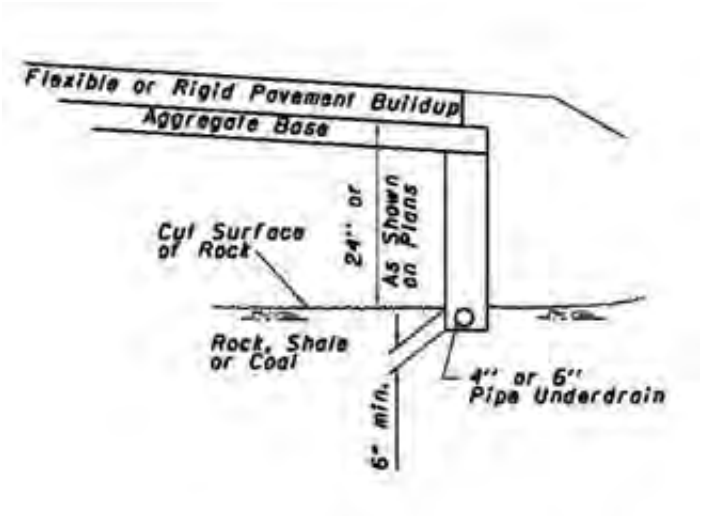


Figure 204.C – Shale and Rock Undercuts

The underdrains in these rock and shale cuts should extend at least 6 inches (150 mm) into the existing rock or shale formation. If the underdrains are too high, the water will accumulate at the rock and soil interface and cause subgrade instability.

Construction or rock underdrains can be placed in the ditches and other strategic locations in cut sections to minimize water coming under the pavement. Water under the pavement without drainage causes the subgrade to act like a waterbed. With drainage, the conditions improve and become more stable.

When to Proof Roll

For areas where subgrade appears to be stable without undercutting, proof roll after the top 12 inches (305 mm) of the subgrade meets the compaction requirements and after the subgrade has been brought to approximate shape within 0.1 to 0.2 feet (30 to 60 mm) required by plan lines.

For areas that are obviously unstable and require undercutting, do not proof roll unnecessarily to demonstrate that subgrade correction is required.

The proof rolling should be done immediately after the subgrade compaction operation, when the moisture content of the subgrade soil is near the optimum moisture content or at the moisture content that achieved compaction. This minimizes the subgrade becoming too wet or too dry for an effective proof rolling evaluation. If the subgrade is too wet, the material will displace and rut. If the subgrade is too dry, a hard surface crust may carry the proof roller over an undesirable soft wet underlying material without rutting or deflection, and the soft subgrade may not be detected.

Proof rolling may be done either before or after pipe underdrains are installed. If done after underdrains are installed, rolling should not be done directly over the underdrains. In C&MS 204.06, proof rolling must be performed at least 1.5 feet (0.5 m) away from the underdrains because of the potential damage to the underdrains.

Proof Rolling

CA-EW-2 “Proof Rolling Documentation Form” is used to document the proof rolling operation. It is imperative that the stations, deflections, weight of the proof roller, and comments are well documented. Digital photographs of subgrade distress are highly recommended.

The primary purposes of proof rolling are to locate soft areas, check the subgrade compaction, to carry out the intent of the design, and to provide uniform support for the pavement structure. Soft subgrade areas that are located will be corrected so that the subgrade density can be maintained throughout the construction. If done correctly, the pavement design intent will be carried through the construction process.

One trip with a proof roller is adequate to achieve satisfactory proof rolling results.

An over loaded proof roller for a soil type may cause satisfactory subgrade to become unstable during proof rolling. Conversely, soft areas will not be found if the proof roller is too light for the soil type.

Selection of Proof Roller Weights and Tire Pressure

In view of the many variations which must be expected in Ohio soil and moisture conditions, the Engineer is given authority to vary the weight and tire pressure of the proof roller to fit the conditions. The weights and tire pressures for the different soils are detailed in C&MS 204.06.

It is imperative that the project chooses the correct load for the type of soil on the project. These loads and tire pressures are soil type sensitive when evaluating the subgrade. For A-3, A-4, A-6, and A-7 soils, use a 35 ton (32 metric ton) roller with a tire pressure of 120 psi (820 kPa). This load and tire pressure is used on most projects because these are the most common soils found in the State of Ohio.

For granular soils, and soil, rock and granular mixtures, use a 50 ton (46 metric ton) roller with 150 psi (1030 kPa) tire pressure.

The goal of proof rolling is to maximize the load to locate soft subgrade. These soft soils could be 3 to 5 feet (1 to 2 m) deep. In rare cases, the soft soil may be deeper than 5 feet (2 m).

Close inspection throughout proof rolling is necessary to observe the rolling effects and to mark soft subgrade locations for correction or investigation. Inadequate stability is indicated by deflection, cracking, or rutting of the surface of the subgrade.

Failure Criteria

The failure criteria is used in this section to determine the locations from which to perform a detailed analysis. This detailed analysis consists of methods discussed later in this section such as rut depth, soil borings and test pits. If the subgrade deflects beyond the failure limits given in this section and the soil borings and test pits determine that the subgrade does not need to be undercut then the subgrade should be considered satisfactory. One additional area to evaluate is the moisture content of the soil. Some soils are more prone to rut at moisture contents greater than 3 percent below the optimum moisture content. In fill locations, the moisture content can be reduced to minimize this problem. If all of the above criteria are met then there is no reason the subgrade should not perform as anticipated. If there is any debate between the Department and the Contractor, especially if a warranty is involved, then further nondestructive or destructive testing can be used to resolve the issue.

The failure criteria for new construction and reconstruction projects are different because of the following reasons:

New construction projects

1. Longer construction time frames allow the subgrade to stabilize.
2. Haul roads to minimize the loading of the subgrade can be established for new construction projects.
3. Drainage and maintenance of these projects are much easier.
4. Even when rutting does appear during proof rolling, the material may be re-graded, hauled on, and re-compacted to meet the specifications.

Rehabilitation projects

1. The soil conditions under pavements are highly variable.
2. Water accumulates under the pavement because of the freeze thaw and wet dry cycles, high existing ditches and underdrain outlet clogging.
3. Construction time frames are limited.
4. Space limits the ability to dry the material in place.
5. Once the pavement is removed, all the drainage is toward the subgrade. This compounds an already poor drainage situation.
6. Alternate haul routes are limited or not available on rehabilitation projects.

The Criteria

In all situations, the maximum allowable rutting or elastic movement of the subgrade is the amount that allows the subgrade soil to maintain the specified density throughout the construction process. For example, if subgrade density can be maintained with 6-inch ruts, then this would be the allowable maximum.

The Contractor must be afforded reasonable use of the subgrade for hauling and for constructing the base material. If subgrade density cannot be maintained through reasonable use of the subgrade, then the allowable proof rolling rutting is too much. If the project conditions allows, areas other than the subgrade should be used as haul roads. For a Contractor ‘to bid’ to haul loaded trucks or scrappers endlessly across the subgrade throughout the life of the project is going above and beyond the reasonability test. At a minimum, the Contractor should be allowed the use of the subgrade to place the base material with vehicles of legal weight.

The following criteria have worked in the vast majority of the projects.

For new construction projects, permanent rutting in excess of 1 inch (25 mm) should be considered failure. In addition, elastic (rebound)

movement or rutting in excess of 1 inch (25 mm) with substantial cracking or substantial lateral movement should be considered failure. Rutting and cracking greater than detailed above is considered “pronounced elasticity.”

Elastic, rebound, or rolling movement is always associated with excess water in the subgrade system.

For reconstruction projects, permanent rutting greater than ½ inch (13 mm) should be considered failure. In addition, elastic (rebound) movement or rutting in excess of ½ inch (13 mm) with substantial cracking or substantial lateral movement should be considered failure. Rutting and cracking greater than detailed above is considered “pronounced elasticity.”

When deflections are greater than these criteria, there is no assurance that overlying pavement construction will not damage the subgrade compaction. Although subgrade density and stability can be maintained during the proof rolling, the repetitive loading, hauling of materials, and base and pavement construction can destroy the subgrade compaction.

See Figures 204.D, 204.E and 204.F.

In Figure 204.D, the soil has been compacted in the top foot of the subgrade and the conditions are good for the top 3 feet (1.0 m). However, there is a soft layer at a lower elevation. The soft layer has no detrimental effect on the subgrade density during the subgrade compaction.

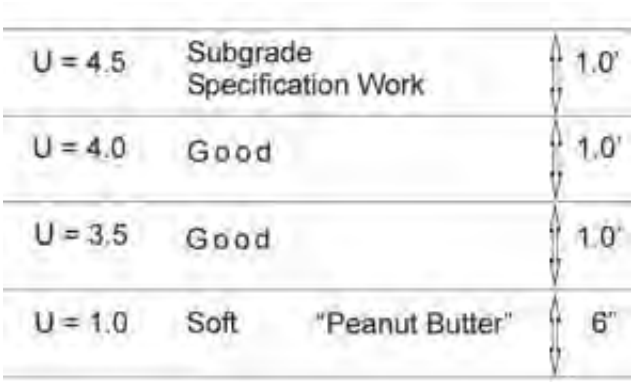


Figure 204.D - Stage 1 Compaction of Subgrade

In Figure 204.E the proof roller deflects because of the soft soils. The subgrade density may or may not be affected by the proof rolling. The loss of subgrade density is proportional to the amount of rutting or elasticity during proof rolling and subsequent construction operations. The severity of the overall subgrade condition can be measured by the amount of the deflection and elasticity on the surface.

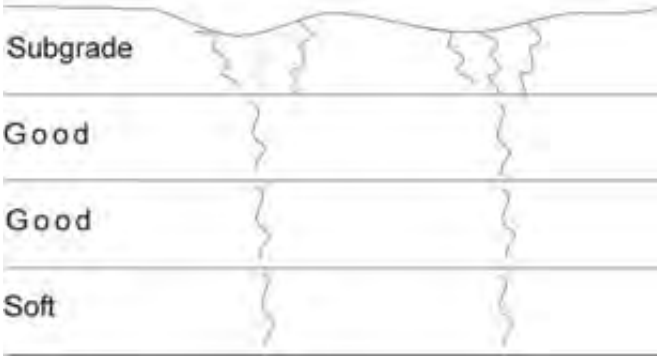


Figure 204.E - Stage 2 Proof Rolling

In Figure 204.F, when the deflections exceed the failure criteria, the proof rolling, repetitive loading, and pavement construction can destroy the top layers of the subgrade.

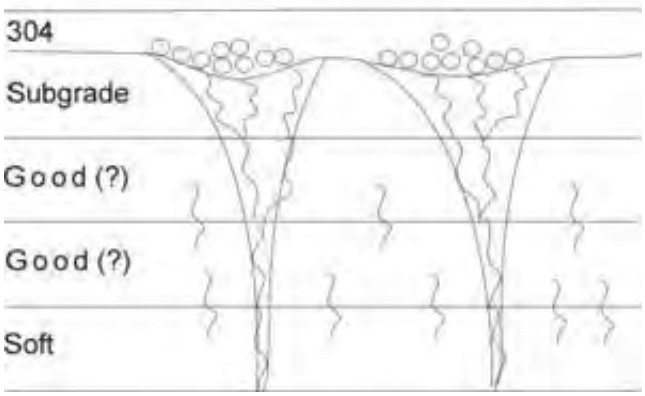


Figure 204.F - Stage 3 Hauling, Grading, and Placing 304

In actual field conditions, this soft layer can be just a few inches thick and at any elevation from the top 1 foot (0.3 m) to as deep as 5 feet (2 m). In addition, it may be an indication of an overall soil condition that is just over optimum for the entire 5-foot (2 m) depth of the subgrade. The field excavation is used to identify the layer or layers causing the surface distress is detailed in the section "Investigation" of this Item. Therefore, it is imperative that these conditions are correctly identified.

As shown in Figure 204.H "Subgrade Treatment Chart" subgrade constructability is suspect at curve locations to the left of the triangles. Further details are given in the section "Undercut Depth and Stabilization Determination" in this Item.

Crusting is a condition when the subgrade surface appears to be dry and there is substantial cracking on the surface with or without rutting. This indicates a need for further investigation and usually indicates soft or wet underlying soil with the top foot or so of the subgrade being very dry.

Variations in the Proof Rolling Results

The project should not be concerned with occasional or nominal deflections in excess of the above failure criteria. If the density is checked and the investigation shows that good soil extends throughout the top 5 feet of the subgrade, then the design intent will be fulfilled and the project can be constructed. All soils will occasionally deflect under these loads.

The pavement design is based on an average CBR. The CBR value was directly correlated to soil density many years ago. By using the average CBR (Density) value, the pavement design accounts for a 30 percent, or one standard deviation variation, in the subgrade strength from the design CBR; 15 percent is expected to exceed this value and 15 percent is expected to be less than this value. Therefore, some variation in the subgrade condition is already accounted for in the pavement design.

Another consideration is the fact that these proof rolling loads and tire pressures are about 10 times the final in-place stresses once the pavement is constructed. The proof rolling tire pressures are between 120 to 150 psi (820 to 1030 kPa) and the stresses once the pavement is constructed are about 8 psi (55 kPa) for a thin asphalt pavement and 4 psi (27 kPa) for a thick concrete pavement. Therefore, these loads are the largest loads that the subgrade will encounter.

If the project can be constructed while maintaining subgrade density, then the subgrade design intent will be fulfilled.

The project should not be concerned with the "Pavement Warranty" issues that Contractors often bring up. If the project follows theses guidelines and properly documents the subgrade work, Central Office can defend the warranty issue.

Once failure is established based on the proof rolling results, then the responsibility for the correction of the failure should be determined.

Responsibility for the Soft or Failed Subgrade

If soft or failed subgrade locations are found, take compaction tests to determine if the specifications are met in the top 12" (300 mm). The Engineer should instruct the Contractor to correct any deficiencies found in these locations.

The Department is responsible when the soft or failed subgrade is encountered in:

1. Cuts.
2. On rehabilitation projects.
3. In shallow fill locations where the soft material is found under the contract fill.
4. When the soft material is found at lower elevations than the project contract work.

Subgrade stability may not be possible by compacting the upper 12 inches (0.3 m) because of conditions at these lower elevations.

It is the Contractor's responsibility to correct all failed or soft locations in fills. If the Contractor built the fill correctly, the proof rolling will do nothing but verify specification work. If the fill fails then the proof rolling will determine the location of the deficient specification work.

If the Contractor fails to maintain the subgrade, then the Engineer should instruct the Contractor to repair the failed areas. See C&MS 203.04.A for the Contractor's responsibility to drain and maintain the subgrade.

Investigation

Investigate the causes of failed locations quickly to expedite the corrective treatment. Three pieces of information are needed to make the most economical subgrade treatment:

1. Rut Depth
2. Soil Boring Information
3. Test Pit Data

At this point the rut depth has already been determined.

Soil Boring Information

For rehabilitation projects or cut sections, the soil borings can be examined to determine an estimated undercut depth or stabilization methods.

Evaluate standard penetration test (SPT) results from soil borings in the failed subgrade locations. The standard penetration test (SPT) is an indicator of the soil consistency or strength, and measures the number of blows per foot (N) required to drive the soil sampler through the soil. The soil data on the boring logs are presented as the number of blows required to drive each 6-inch (150 mm) increment. The first 6 inches (150 mm) of the run is ignored because the sampler may not be seated in the borehole or may be driven through cuttings. For example, standard penetration data shown as 1/2/3 has an N value of 5 blows per foot.

When investigating the need for undercutting or stabilization in failed locations, look at the borings in those locations in the upper 5 feet (1.5 m) of the subgrade. At each location, pick the lowest N value when multiple N values are taken in the top 5 feet (1.5 m) of subgrade.

Average the N value along the failed locations. This value provides one part of the information needed to determine the undercut depth or stabilization methods.

Test Pits

Once the soil borings have been evaluated, construct test pits by excavating 3 to 5 feet (0.6 to 1.5 meter) into the subgrade using the Contractor's excavation equipment. Excavate at least two test pits that represent the failed area. Use judgment for long areas; usually about two to four test pits per mile is sufficient. Construct the test pits across the width of the subgrade in the failed locations. Pick locations with the highest deflections to evaluate the most severe locations.

Warning: These trenches may collapse on the construction personnel. The Department offers an 8 Hour Construction Safety Class to evaluate the trench collapse risk. In addition, there is a trench safety class offered by the Bureau of Workers Compensation, Division of Safety and Hygiene. These classes are given statewide all year around. (614-466-5563)

An examination of the soil and moisture conditions in these test pits provides valuable information to make the appropriate correction. Once the pits are excavated, the Engineer must examine the trench sidewalls and the bottom of the cut.

Record the test pit information on CA-EW-3, "Subgrade Test Pit Investigation" form shown in Figure 204.G. The soil conditions vary with depth and must be quantified. By examining the sidewalls, the Engineer can determine the soil type, layer thickness, soil condition, and soil strength by using a hand penetrometer.

CA-EW-3 Subgrade Test Pit Investigation

Subgrade Elevation:	Date:
Station:	Evaluation Stations:
Rut Depth:	Tire Pressure:

Unconfined Compressive (ton/SF) From Penetrometer		Soil Layer
U1		Layer Type:
U2		Layer Thickness:
U3		Soil Condition:
Uavg		Comments:
U1		Layer Type:
U2		Layer Thickness:
U3		Soil Condition:
Uavg		Comments:
U1		Layer Type:
U2		Layer Thickness:
U3		Soil Condition:
Uavg		Comments:
U1		Layer Type:
U2		Layer Thickness:
U3		Soil Condition:
Uavg		Comments:
U1		Layer Type:
U2		Layer Thickness:
U3		Soil Condition:
Uavg		Comments:
Soil Type (see section 203.02): Clay, Silt, Sand Gravel, Sandstone, Shale, Rock, Combination		
Soil Condition: Wet, Dry, Organic, Roots, Water seepage, Soup, Jell-O, Hard or Soft Peanut Butter		
Critical Later/ Design layer = U:		
Inspector Signature:		

Figure 204.G – Form CA-EW-3 Subgrade Test Pit Investigation

The Engineer must field classify the soil. See 203.02 Materials, "Identifying Soil and Granular Materials in the Field" for help in the classification.

Added soil conditions are described on the bottom of the test pit form. These conditions are stated in commonly-known consistencies, so that the non-geotechnical reader can relate to the soil conditions. They are listed on the bottom of the form. No explanation is needed for these terms.

Hand Penetrometer Readings

A hand penetrometer can be used to further classify the soil and to estimate its strength. A hand penetrometer can be obtained from a test lab supply company for less than $100. Hand penetrometers can be obtained from the following companies:

Gilson	Model # HM-500	Phone 800-444-1508
ELE	Model # E129-3729	Phone 724-864-3364
Humboldt	Model H-4200	Phone 800-444-7220

The exact instructions come with the hand penetrometer. In summary:

1. Push the hand penetrometer slowly into the soil at right angles.
2. Record the reading when the hand penetrometer penetrates the soil to the ¼-inch groove mark.
3. Record the readings to the nearest 0.25 tons per square foot (tsf).
4. Take at least three different readings in each soil layer.

Use CA-EW-3 “Subgrade Test Pit Investigation” form to record the readings. Average the readings once three readings are taken for the soil layer. Also evaluate the bottom of the test pit; this is extremely valuable information. Once the averages are determined, record the lowest average unconfined reading on the bottom of the form. This would be the most critical soil layer.

Average the unconfined readings (U) of all the test pits in the failed locations. Use this number to further evaluate the undercut depth or stabilization methods.

Consider the following when evaluating the sidewalls of a trench:

1. Different layers of a natural formation or cut are more noticeable than fill materials.
2. High unconfined numbers may be obtained with high deflections or rolling at the surface. This is an indication of soft soil at a lower elevation than 5 feet (2 m) or a subgrade soil that is just too wet.

Undercut Depth and Stabilization Determination

Once the proof rolling rut depth (in inches), soil boring information (N), and unconfined data from the test pits (U) are obtained, use the “Subgrade Treatment Chart” in Figure 204.H to determine the undercut depth requirements. The input values (rut depth, N and U) are on the horizontal axis. The two curves denote the type of project under construction. The left vertical scale shows the undercut depth in feet of granular material. The right vertical scale shows the stabilization depth required in inches of lime or cement.

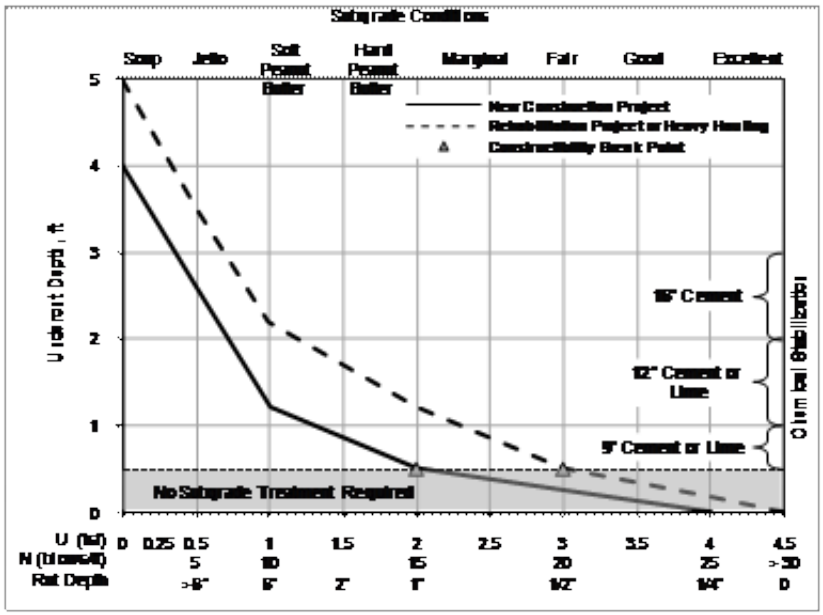


Figure 204.H - Subgrade Treatment Chart

The horizontal dashed line at about ½ foot indicates that treatment is not required for results below this line. The top portion of Figure 204.H details the general subgrade condition.

Figure 204.H takes into account the standard deviation of test results, anticipated truck loading, and type of project under construction.

Use the rut depth, N values, and unconfined strengths (U) from a hand penetrometer to draw a vertical line to the curve for the type of project under construction. At that intersection draw a horizontal line to the left and right. This determines the granular undercut depth or stabilization needs.

The undercut chart gives the required stabilization method to obtain stability when the undercut or stabilization is completed.

It would be rare to see a perfect alignment in the results from all three inputs. In some cases, one or two of these inputs may not be available. In other cases, some judgment is needed to redesign the most economical undercut that will work. In order of hierarchy, use the test pit data, then the N values, and then the rut depth. The rut depth is the least reliable indicator of undercut need because it cannot determine which soil layer is causing the deflection.

There will be cases where the N values and unconfined values are all high but the subgrade is rolling and cracking, and rut depth is greater than allowable. In this case use the rut depth as a guide to redesign the undercut. See the last example in the example section.

There is an example in Figure 204.I.

Given: 5 mile long Rehabilitation Project
Average N value was 12
U= 1.4 tsf
Average Rut Depth was 2-4 inches.

Answer: Use an undercut depth of 2.0 feet (0.6m) or stabilize with 12-16 inches of cement or lime. Since this is a long project, give serious consideration to the stabilization method. It will be more cost effective.

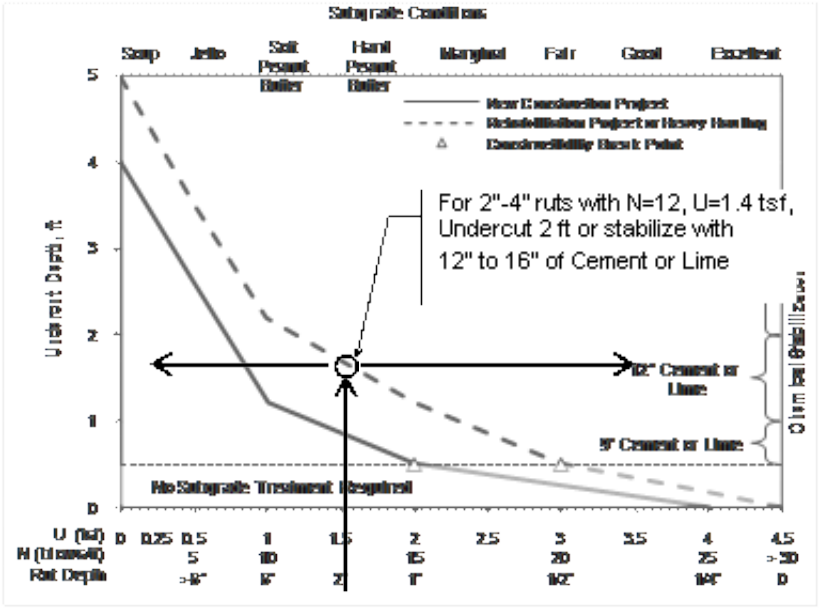


Figure 204.I - Example using the Subgrade Treatment Chart

After making the undercut, this depth may need to be adjusted to meet the actual conditions. See the section, "Implementation during Construction" of this manual.

General Rules

On new construction projects, if all of the soft material can be removed and the bottom of the test pits or cuts are stable, then soil may be used as replacement material. For reconstruction projects, soil is usually not available in large quantities and the bottoms of the cuts are highly variable. Therefore, soil undercuts are less effective solutions on reconstruction projects.

If the bottom of the test pit is unstable, when conditions are highly variable, or for rehabilitation projects then use granular material, rock, geotextile, or lime or cement stabilization, rather than soil.

Undercuts should be used in small locations or in areas where spot locations are identified. Consider cement or lime stabilization for long areas greater than one mile.

Only the most unusual cases require removal to depths greater than 3 feet (1 meter). Seventy five to ninety percent of subgrade problems can be solved with a one-foot treatment of granular material and geotextile or stabilization with lime or cement. Use stabilization methods for projects with long areas to stabilize or when the undercut depth is greater than 1.0 foot.

If a project or section of a project undercut locations are more than 30% of the total area, undercut or stabilize the entire area. If you do not undercut the entire area, these locations will grow and the construction will be inefficient as the construction proceeds. The Department pays a higher cost at a reduced final quality by undercutting a high percentage of the subgrade throughout the project. ODOT would not repair a bridge deck or pavement with this high a percentage of repairs.

Stabilization methods speed construction because of the ability to work immediately after a rain. Estimates indicate that the construction production is increased by at least 50 percent by using stabilization methods.

Examples

The following table shows some example solutions. The types of material refer to 703.16.C and Item 206.

Given	Solution
Rehabilitation Project with Silty A-4a material with N=15 or U=2.0 tsf Rut Depth>1"	1.5 feet of Granular Material Type B, C or D with geotextile or 12 inches of stabilization with cement
Rehabilitation Project with Deep, weak, and wet A-4 with N = 12 or U=1.4 tsf Rut Depth = 2"	2.0 feet of Granular Material Type B, C, or D, with geotextile or 12-16 inches of stabilization with cement
New Construction, Deep, weak & wet A-4, A-6 or A-7-6 combination with N = 10 or U=1.0tsf. Rut Depth = 4"	1.5 feet of Granular Material Type B C or D with geotextile or 12 inches of stabilization with lime or cement. (Check the PI of the soils. Use the stabilization type according to the PI's of the soil.)
New Construction Jell-O like consistency soil with N = 5 or U=0.5 tsf. Rut depth > 6"	2.5 feet of Granular Material Type B, C, or D, with geotextile or 16 inches of stabilization with cement. (Check the PI of the soil.)
Any Project with soup like consistency soil with N = 2 or U=0.25 tsf Rut Depth = Buried equipment	5 feet of Granular Material Type B, C, or D, with geotextile. (May need two layers of geotextile, Use type D Granular Material if available)
Reconstruction Project Sandy, A-4a, A-6a soil, PI < 20, N = 8 or U=1.0 tsf Rut Depth = 6". (Long Project)	Cement Stabilized Subgrade 16" deep at 6%
New construction A-7-6 clay soil, PI > 20 N = 11 or U=1.2 tsf Rut Depth =3". (Long Project)	Lime Stabilized Subgrade 12" deep at 5%
Reconstruction Project A-6a silty clay PI < 20, N=30 and U>4.5 tsf Rut depth > 2" and rolling The key here is the rolling. Probably caused by high moisture content of the soil at a depth. If the subgrade is rolling with one pass of a proof roller then the subgrade condition can rapidly deteriorate during construction.	16" of Cement at 6% or 2.5 foot undercut with Granular Material Type B, C, or D, with two layers of geotextile. Use Type D material if available.

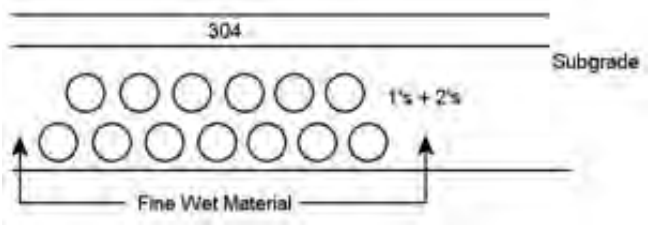
Type of Undercut Materials

Use Granular Material Types B, C, D, E, and F. They are cheaper than 304.

Type B is a well-graded aggregate with the gradations of Items 304, 411, or 617. Type C has a top size of 3 inches and type D has a top size of 8 inches. Both C and D are well-graded materials. The larger top size material will bridge the soft material better that the smaller size material.

Use Granular Material Type E when water levels are high or cannot be drained. The Type E materials are very porous. Always choke the Granular Material Type E with Granular Material Type B or geotextile fabric.

There is a potential for piping of soil into the Granular Material Type E as shown in Figure 204.J. In the upper detail, when the open material is placed on soft fine graded soil, the soil pipes into the open graded material during construction or by loading. In the lower detail, the geotextile fabric blocks the material from entering the open graded material. Geogrids will not work for this application.



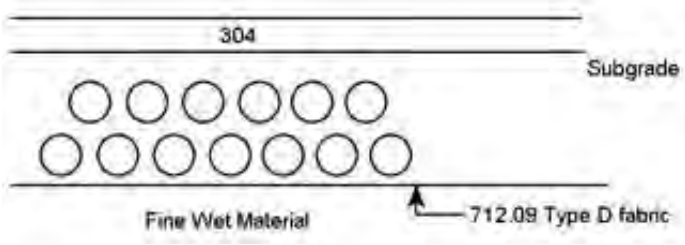


Figure 204.J - Soil Piping in Open Material

Underdrains cannot be placed through Granular Material Types D, E, or F or geotextile fabric. Use Granular Material Type B in the locations of the underdrains. Always drain the undercut to an underdrain, catch basin, or pipe.

Always use 712.09 Geotextile Fabric Type D. The cost is around $1.00 per square yard. In the case of deeper undercuts, multiple layers can be used at a 12-inch vertical spacing if needed.

Cement and Lime Stabilization of the Subgrade

Item 206 Chemically Stabilized Subgrade can be used to treat unstable subgrades. Lime or Cement can be used to stabilize the subgrade.

Lime is used for A-6b (silty/clay) or A-7-6 (clay) soils which have a plasticity index of 20 or greater. Use 5 percent lime by dry weight of the soil assuming a dry weight of 110 pounds per cubic foot.

Cement can be used to treat unstable subgrades consisting of A-3 (fine sand, coarse and fine sand), A-2-4 through 7 (gravels), A-4a (sand silt), A-6a (silt and clay), A-6b (silty clay), or A-7-6 (clay) which have a plasticity index less than 20. Use 6 percent cement by dry weight of the soil assuming a dry weight of 110 pounds per cubic foot.

See Item 206 Chemically Stabilized Subgrade of this manual.

Implementation during Construction

Once they type of stabilization treatment has been chosen, constant monitoring of the construction is required to adjust the treatment to meet the field conditions. Soil conditions always vary; they vary the most on rehabilitation projects or in cuts.

If the undercut option is chosen, the project should monitor the bottom of the cut and evaluate the condition. Take hand penetrometer readings at the bottom of the cuts and compare them to the initial test pit or soil boring information. If the condition changes from the earlier evaluation of the test pits or the soil borings, then adjustments to the undercut depth are required.

In addition, for undercuts that are two feet deep or greater, give consideration to placing multiple layers of geotextile fabric. The need for additional layers of geotextile can be determined by placing about ½ of the undercut depth. Load the undercut with a fully loaded truck. If the area is unstable, then place another layer of geotextile and continue to fill the undercut.

Once the undercut or stabilization is complete, proof roll the area to ensure that the final subgrade meets the rut depth and density requirements as detailed earlier in section “Failure Criteria”.

Constant vigilance is needed in order to make the most economical correction. It is easy to over-excavate unnecessarily and waste money. It is more difficult to make the right economical choice to stabilize the subgrade and to meet the design and construction needs.

Documentation Requirements - 204 Subgrade Compaction and Proof Rolling

1. Materials.
2. Compaction according to S-1015.
3. Lift thickness and roller passes.
4. Equipment used.
5. Type of soils.
6. Verify square yardage.
7. Verify subgrade line and grade.
8. Proof Roll and make corrections.
9. Subgrade Test Pit Investigations.
10. Undercut measurements.
11. Document on CA-EW-1,CA-EW-2,CA-EW-3, CA-EW-8, CA-EW-12 and CA-D-3. Do not duplicate the information on all forms

ATTACHMENT 4 - RCK AST Jobsite Workbook Forms

TAB 3 - Required AST Checklists/Forms

Complete the following checklist/forms and file them in this section of the AST Jobsite Notebook:

- **AST Pre-Project Checklist**
- **AST During-Project Checklist**
- **Tank Panel Visual Inspection Checklist (Attachment 6 of the AST SOP)**
- **AST Post-Project Checklist**
- **AST Visual Inspection Checklist (use for Periodic Monitoring)**

AST Pre-Project Checklist

Customer Company Name_____Pad/Location _____

Customer Field Rep Name/Phone/Email_____

Customer's Soil Preparation Contact Name/Phone/Email_____

Customer's Water Contact Name/Phone/Email_____

Rockwater Job Reference No. _____Rck Field Ops Mngr._____Date of pre-op visit_____

Proposed Start date:_____ Proposed End Date:_____

Approved trucking route obtained?_____ Planned Tank Contents: _____

Site Preparation/Status

Ground is level, proper grade stone is spread evenly: _____
Proper Compaction Test completed on tank pad: Y/N____ Compaction % Std. Proctor _____
Results provided?_____ (attach to this notebook)
Soil Test Data Reviewed by: _____
Proof Roll Test Observed by: _____ Date _____
Estimated Grade % _____
General description/evaluation of tank pad, downstream from tank pad:_____
Who providing lift equipment? Rck Ops_____ or 3rd Party Contr ____, Contr Name _____
Is 3rd party contractor safety program approved by RCK and customer?_____

AST Tank Information

Pin_____ Plate_____
Tank Capacity Needed, Number of Tanks: 4.5K__ 9K __ 10K__ 18K__ 26.5K__ 40K__ 41K__ Custom__

Sump/Stairs/Fill Tubes/Suction Tubes Locations Shown on Sketch Attached dated _____
Netting Required? _____ "Y" Trench Required? _____

Requested Liner Material: _____Liner Thickness: _____
Requested Geo Pad Material: _____Geo Pad Thickness:_____
Will double Geotextile liner be needed under the tank?_____ Double Liner Required? _____
Tank level monitoring system needed?_____
Additional Items needed for water suction or Discharge: (each tank comes with 1-Stair system, 2-Suction tubes, and 2-6" Discharge tubes): _____

Safety

- Utility Notification Ticket Number _____ Date Called In_____By _____
- AST Crews finished customer (contractual) and Rockwater Operations training?_____
- JSA Completed on Rockwater approved form?
- Subcontractors approved per Rockwater subcontractor management program?_____
- Subcontractor employees received required client training?_____
- Required lift and other equipment on site? _____
- Crane or large front end loader lifting capacity_____ Weight of Liner Bundle_____

AST During Project Checklist

Customer Name_____Pad/Location _____Tank ID No. or Stair Number(s)_____

Customer Field Rep Name/Phone/Email_____

Customer's Soil Preparation Contact Name/Phone/Email_____

Customer's Water Contact Name/Phone/Email_____

Rockwater Job Reference No. _____Rck Crew Leader_____ Cell Phone _____

AST Rig-Up Start date:_____ Proposed AST Project End Date:_____

Tank Panel Visual Inspection Checklist completed and attached? _____ Tank Contents: _____

All Panels are compatible (all have the same ID number)_____

AST Pre-Project Form Completed? _____ If not, date completed _____

Date of AST layout sketch, prepared during Pre-Project Site visit that you will be using: _____

Distance from tank center to closest structure:_____ Distance from tank side to nearest structure:_____

Utility locate ticket No. _____ Date called in _____

General description/evaluation of tank pad preparation _____

Tank Panel Visual Inspection Checklist completed and attached? _____ (date)_____

Safety:

Weather conditions onsite during operations:
JSA Completed_____ (time/date) SOP's Followed____ Roped off work area and sump?____
Inspection of hinge and pin system completed during the installation of each panel____
Slings/rigging and lift equipment inspected by _____
Fall protection being used when hanging the liner____ Tag line used during the movement of panels____
BBS Cards completed during this project?____ Hazard Signs Installed____ Cotter Pins in every connection___
All crew and subcontractors within our work area are properly trained and know stop work policy?____

Liner Manufacturer: _____Liner Serial Number: _____

Geo Pad Manufacturer: _____ Geo Pad Serial Number: _____

Job Box on site (Job box ID)_____GEO needed between the panels or under the tank?_____
Patches made on liner? _____ Sketch of location(s) attached? _____
Field tickets signed by customer representative and Rck Ops as needed? _____RCK Branding installed?_____
Customer contact notified that AST ready for water? (Who/Date/time)_____
Water placed into tank to minimum water level (Date/Time) _____

Comments about the overall Rig up Process (Faulty equipment, issues, concerns, improvement areas, etc.):

Completed walk around/visual inspection of the tank/connections and AST Visual Inspection Checklist? ____

AST Post-Project Checklist

Customer Company Name_____Pad/Location _____

Customer Field Rep Name/Phone/Email_____

Customer's Water Contact Name/Phone/Email_____

Rockwater Job Reference No. _____Rck Crew Leader_____ Cell Phone _____

Actual Start date:_____ Actual End Date:_____

Tank ID /Stair Number(s)_____

Were any additional Items requested during the project and provided for water suction or discharge? _____
(each tank comes with 1-Stair system, 2-Suction tubes, 2-6" Discharge tubes).
List any additional items:

Inspection of hinge and pin system completed by (name)_____(Date/Time)_____

Tank Panel Visual Inspection Checklist completed and attached? _____ (date)_____

Were there any damage to the equipment or panels?___ If yes, panel numbers:_____

Jobsite Notebook Documents (check when completed and in Jobsite Notebook):

Completed, dated, signed JSAs: _____Tank Panel Visual Inspection Check Sheet: _____

Pre-Project Checklist: _____During Project Checklist: _____Post Project Checklist: _____

Liner and Geo Pad serial numbers on During Project Checklist? _____

Soil test data in Jobsite Notebook?_____

BBS Cards completed during this project_____

Walk around check for leaks or any abnormal conditions? (Date/Time)_____

Crew Leader (signed)_____(Date/Time)_____

AST Visual Inspection Checklist

Customer Company Name_____Pad/Location _____Date of Inspection_____

Customer Field Rep Name/Phone/Email_____

Customer's Water Contact Name/Phone/Email_____

Rockwater Job Reference No. _____Rck Crew Leader_____ Cell Phone _____

Tank ID /Stair Number(s)_____ Tank Contents: _____

Tank Panel Visual Inspection Checklist completed and attached? _____ (date)_____

- CAUTION – If conditions are observed that could indicate an imminent tank failure, remove yourself and from the area immediately, advise others in the vicinity to do so also, and contact the customer to drain the tank, and the Field Operations Manager to advise of the situation.
-
- **Periodic Inspection Tasks:**
-
- Observe soil at base of all panels all around the tank to find any wet or moist areas that may indicate a leak
-
- Check for any uneven gaps between the panel edges from top of panel to bottom of panel. Uneven gaps between panels should be reported immediately, and noted on a sketch with the panel numbers involved and email or fax to the Field Operations Manager immediately
-
- Check that no panel bottom has sunk below the soil surface at any location. Tank panel settlement should be reported immediately, and noted on a sketch with the panel numbers involved and email or fax to the Field Operations Manager immediately. NOTE: Panel settlement should not be confused with soil pushed up against the panel bottom. If it is not clear from observing, call the Field Operations Manager.
- Check that the soil around the tank panels and within 10 feet of the tank panel is firm and has not been eroded by stormwater or leaking water
-
- Observe a vehicle driving near the perimeter of the tank to see if any soil settlement has occurred, note the location on a sketch
- Check contents of tank, advise Field Operations Manager if different than original order (see AST Pre-Project Checklist)
- Any running water on the ground in the vicinity of the tank is suspect and must be traced to its source using a pH test or other means. Take photographs of any running water if safe to do so.
- Check all liner clip (pin tanks) or clamps (plate tanks) are securing liner
- If tank is at low level check that sufficient liner slack is present against panel wall.
- Check all pins and plates, and cotter pins are in place
- Note any rust or corrosion of panels, stairs, or fill/suction tubes
- Note any damage to fill/suction tubes
- Note any liner visible liner damage, or damage to fill or suction tubes

---

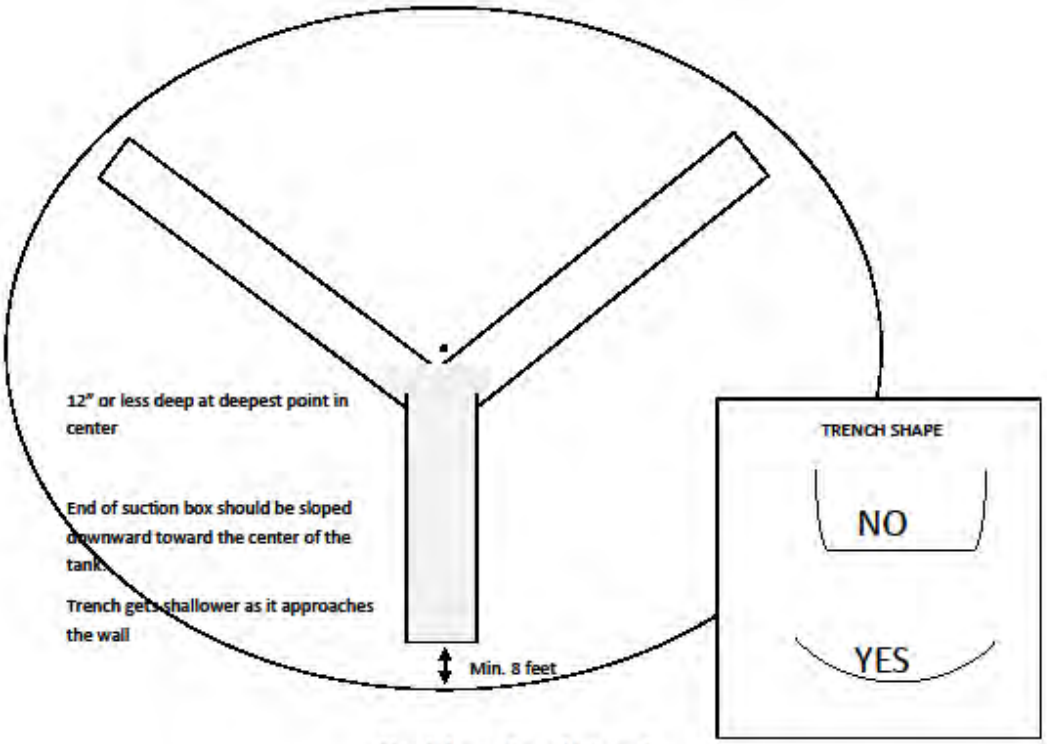
Customer contact notified of to drain tank? (Date/time)_____

Field Operations Manager notified of any issues (name/date/time) _____

Inspection Completed by:

(Printed name)_____(signed) _____ (date)_____

ATTACHMENT 5 – "Y" Trench Guidance Document



Guidelines for a Y-trench

Tank Center should NOT be located in the trench, but behind it and between the branches of the "y".

Depth is NOT to exceed 18 inches—12" depth recommended. (In some states a ground disturbance or pit permit is required if you disturb the ground deeper than that.) If you require more trench to accommodate more water for weighting down the liner, make it wider.

Trench should be deepest in the main channel and slope up to surface level as it approaches its end 3 feet from the line for the tank wall. Done properly—your suction should never float!

Side channels do not need to be as deep but should still slope from wall to center to feed water to suction channel.

The sides of the trenches should be sloped in (not an abrupt dropoff) See example above right.

Suction trench should begin a minimum of 8 feet from where the wall will be located.

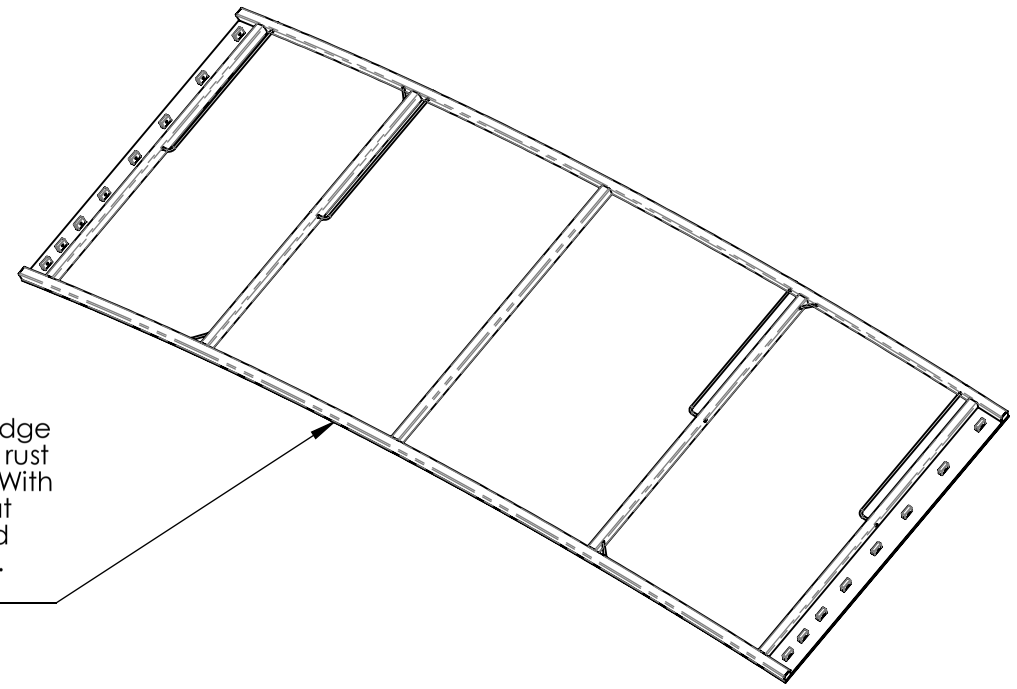
ATTACHMENT 6

Tank Panel Visual Inspection Check Sheets

Poseidon Panel Visual Inspection Check Sheet - Page 1 of 2

Tank Number	Panel No	Location	Date

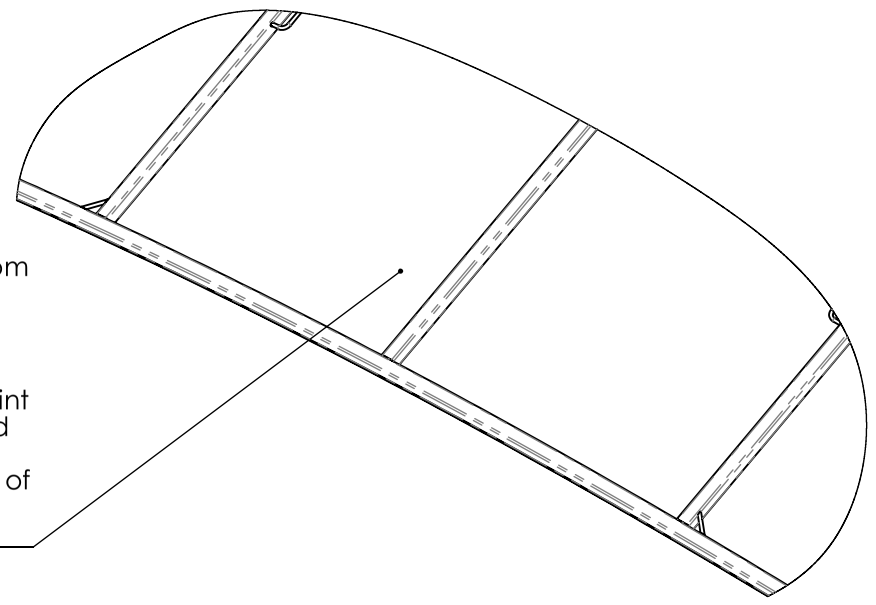
Step 1



Check the bottom edge of the tank panel for rust or damaged paint. With wire brush check that paint is not loose and easy to be removed.

Inspected By	Pass or Fail	Comment

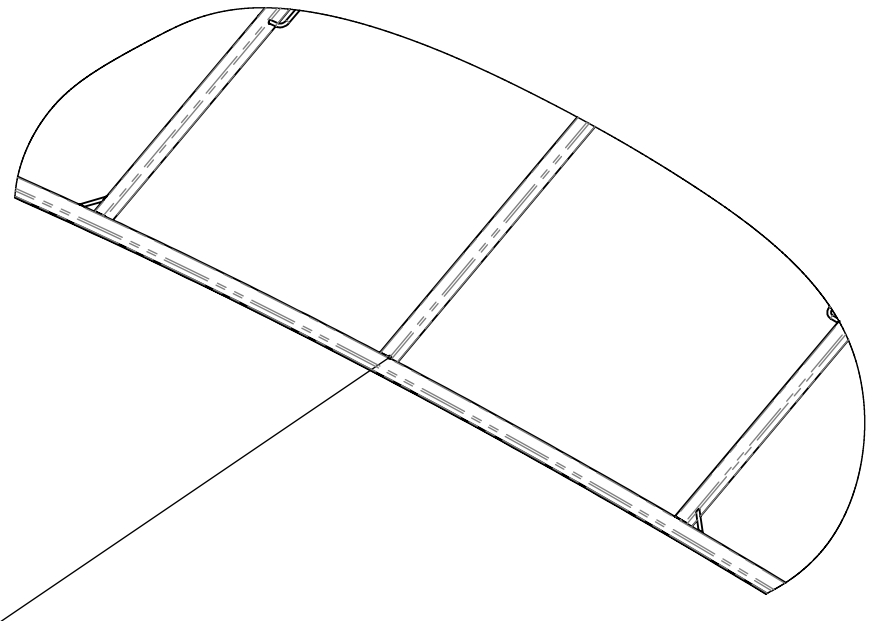
Step 2



Check the lower bottom (both inside and outside) area shown carefully for cracked welds or signs that the metal has yielded. Paint that is missing, cracked or has a crinkle appearance are signs of metal yield.

Inspected By	Pass or Fail	Comment

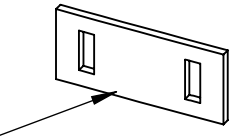
Step 3



Check the outer surface of the tubes near the weld in the lower bottom area shown carefully for signs that the metal has cracked or yielded. Paint that is missing, cracked or has a crinkle appearance are signs of metal yield. Any rust could be a sign of the start of a crack

Inspected By	Pass or Fail	Comment

Step 4



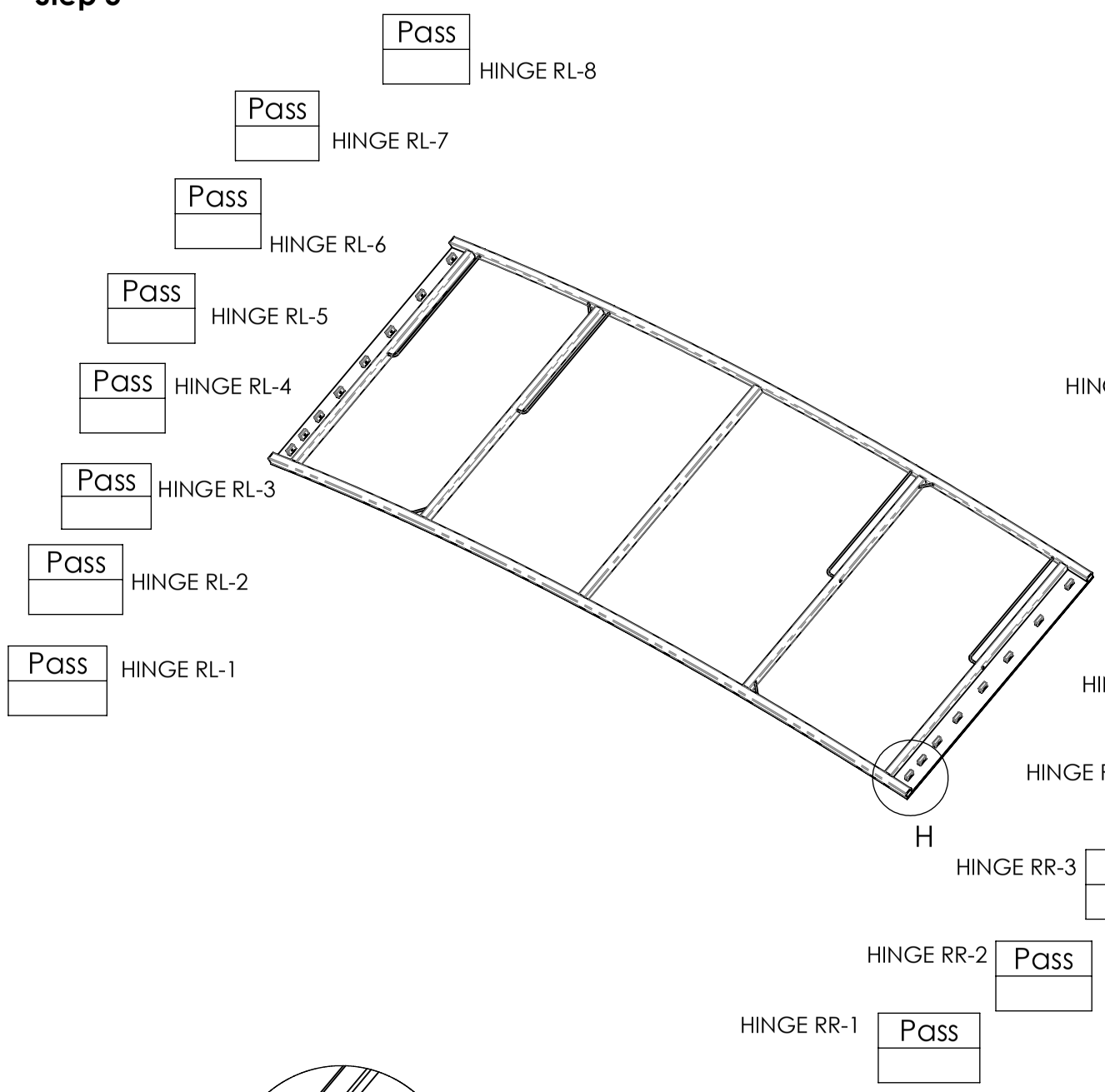
Check connection plates for bends, wear spot, rust. Check that the slots are not deformed.

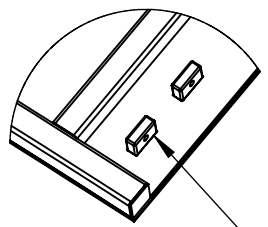
Inspected By	No of Plates that Pass	No of Plates that Fail
Comment		

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
A	As Released	06/27/13	

Poseidon Panel Visual Inspection Check Sheet - Page 2 of 2

Step 5



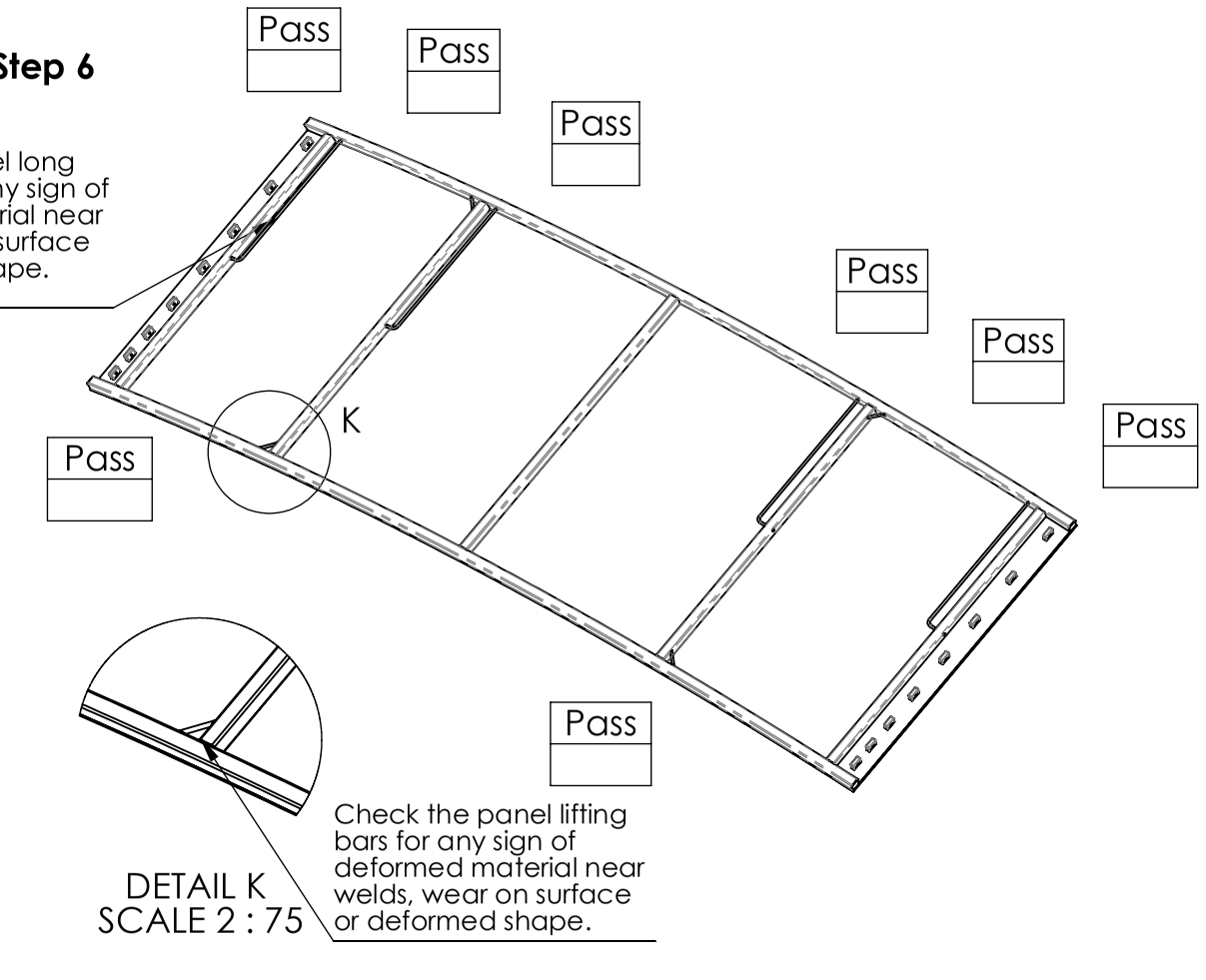


DETAIL H
SCALE 1 : 25

Check the hinge plates for any signs of metal yield near the welds to the repad plate. Initial each box next to hinge.

Step 6

Check the panel long lifting bars for any sign of deformed material near welds, wear on surface or deformed shape.

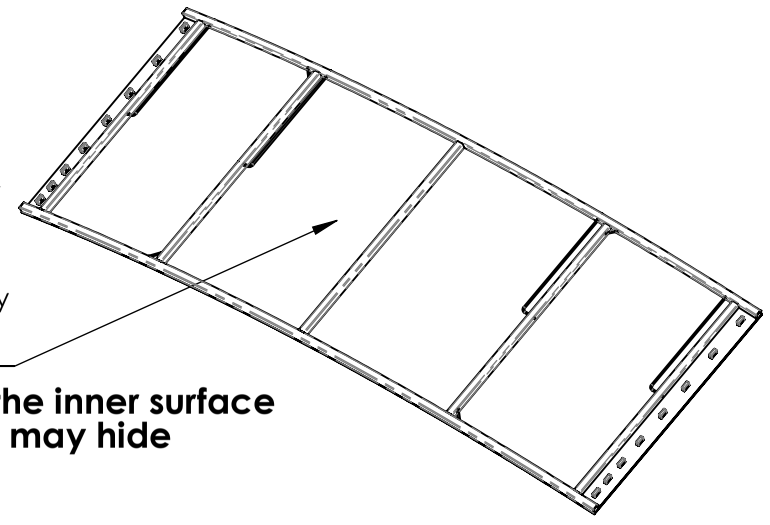


DETAIL K
SCALE 2 : 75

Check the panel lifting bars for any sign of deformed material near welds, wear on surface or deformed shape.

Step 7

Visually inspect all other areas and welds for anything that looks out of place and note on the inspection sheet any repairs or modifications recommended.



Visually inspect the inner surface Foam on outside may hide problems

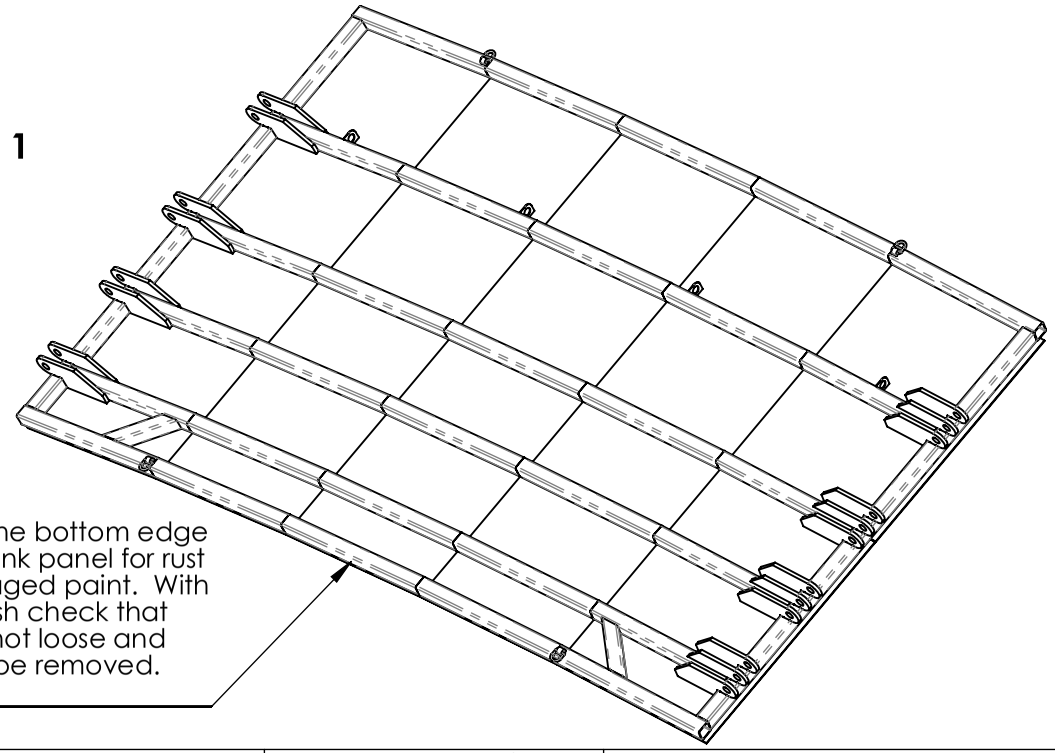
Inspected By	Pass or Fail	Comments

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
A	As Released	06/27/13	

MWS Tank Panel Visual Inspection Check Sheet - Page 1 of 2

Tank Number	Panel No	Location	Date

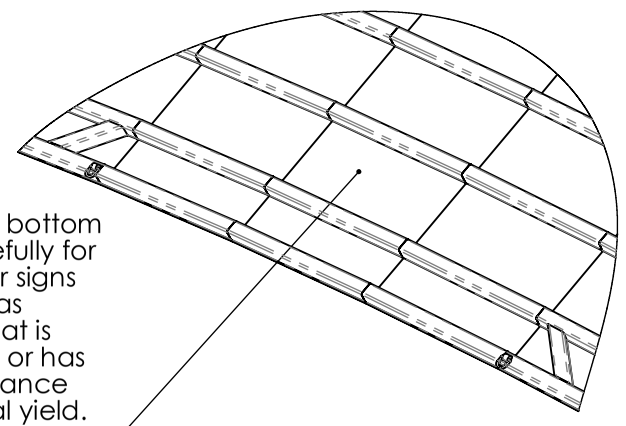
Step 1



Check the bottom edge of the tank panel for rust or damaged paint. With wire brush check that paint is not loose and easy to be removed.

Inspected By	Pass or Fail	Comment

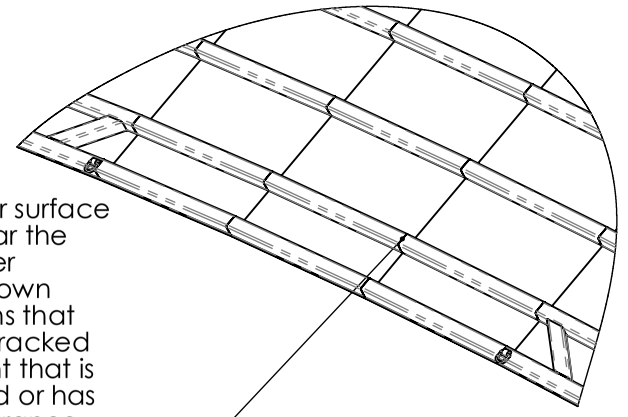
Step 2



Check the lower bottom area shown carefully for cracked welds or signs that the metal has yielded. Paint that is missing, cracked or has a crinkle appearance are signs of metal yield.

Inspected By	Pass or Fail	Comment

Step 3

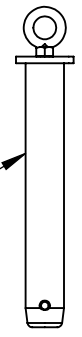


Check the outer surface of the tubes near the weld in the lower bottom area shown carefully for signs that the metal has cracked or yielded. Paint that is missing, cracked or has a crinkle appearance are signs of metal yield. Any rust could be a sign of the start of a crack

Inspected By	Pass or Fail	Comment

Step 4

Check connection pins for bends, wear spot, rust. Check that the top cap weld is not cracked or missing.



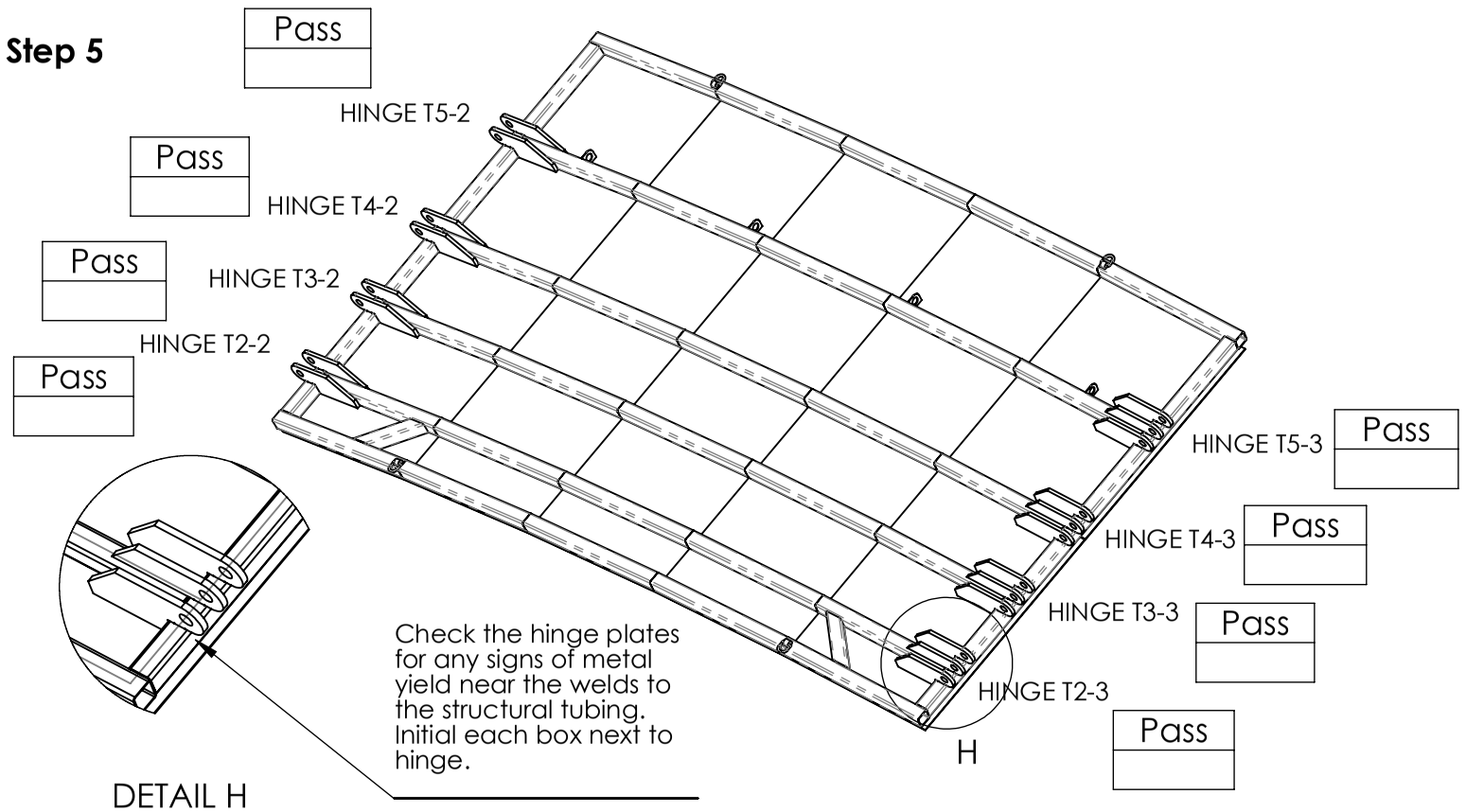
Inspected By	No of Pins that Pass	No of Pins that Fail
Comment		

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
A	As Released	03/06/13	

MWS Tank Panel Visual Inspection Check Sheet - Page 2 of 2

Step 5

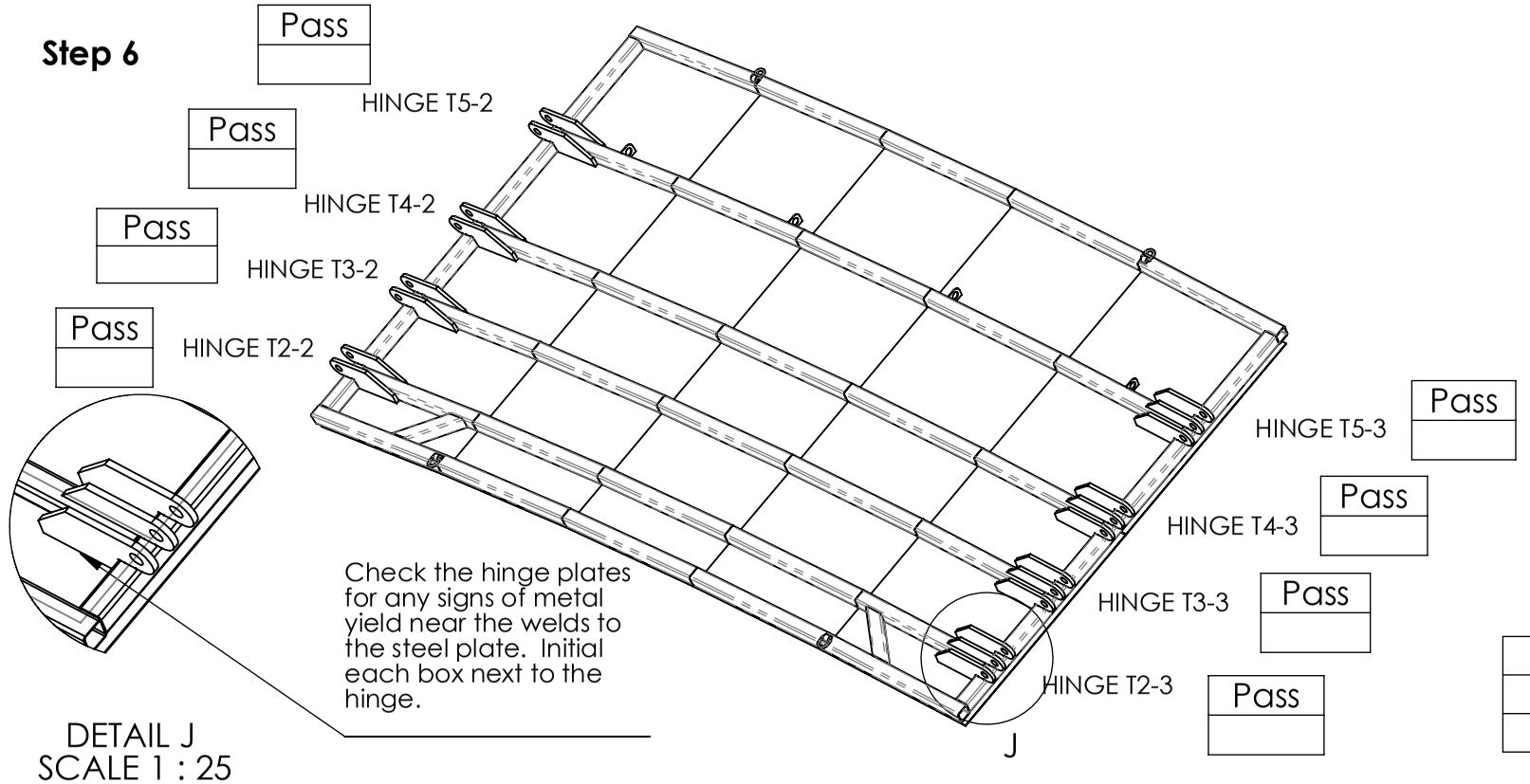
Pass



DETAIL H
SCALE 1 : 25

Step 6

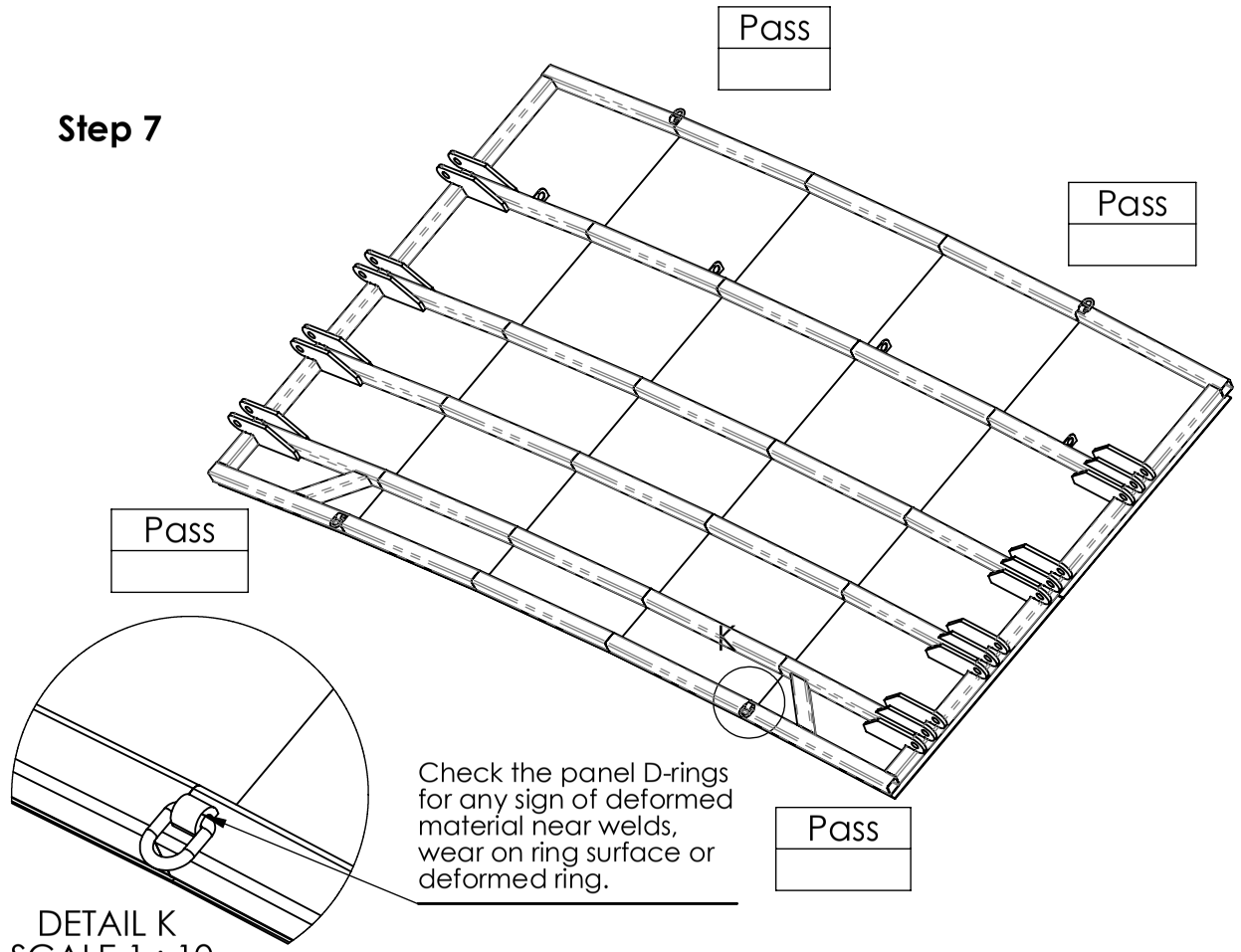
Pass



DETAIL J
SCALE 1 : 25

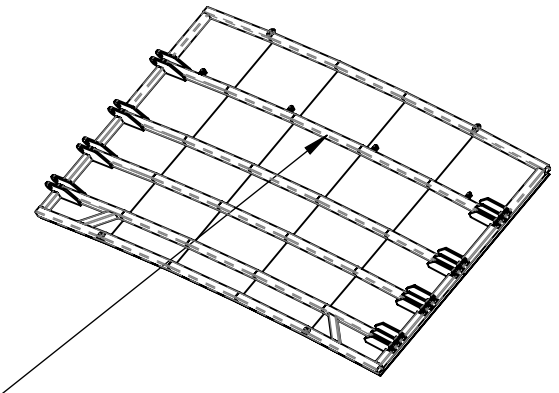
Step 7

Pass



DETAIL K
SCALE 1 : 10

Step 8



Visually inspect all other areas and welds for anything that looks out of place and note on the inspection sheet any repairs or modifications recommended.

Inspected By	Pass or Fail	Comments

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
A	As Released	03/06/13	

Appendix H

Specifications

- **Liner**
- **AST**
- **Avian Deterrent**

R.T. Hicks Consultants, Ltd.
901 Rio Grande Blvd. NW, Suite F-142
Albuquerque, NM 87104

Inland TARP & LINER

4172 North Frontage Rd E Moses Lake, WA 98837
(800) 346-7744 (509) 766-7024 Fax (509) 766-0414
www.inlandtarp.com

TECHNICAL DATA SHEET
Geomembrane 30mil LLDPE

Property	Test Method	Frequency (A)	Unit Metric		Solmax 130-2000
Thickness (min. avg.)	ASTM D 5199	Every roll	mm		0.75
Thickness (min.)	ASTM D 5199	Every roll	mm		0.68
Resin Density	ASTM D 1505	1/Batch	g/cc		<0.926
Melt Index-190/2.16(max)	ASTM D1238	1/Batch	g/10min		1.0
Sheet Density (C)	ASTM D1505	Every 2 rolls	g/cc		<0.939
Carbon Black Content (D)	ASTM D 4218	Every 2 rolls	%		2.0 - 3.0
Carbon Black Dispersion	ASTM D 5596	Every 6 rolls	Category		Cat. 1 / Cat. 2
Oxidative Induction Time (min. avg)	ASTM D3895	1/Batch	min		100
Tensile Properties (min. avg)(B)	ASTM D 6693	Every 2 rolls			
Strength as Break			kN/m		20
Elongation at Break			%		750
2% Modulus (max.)	ASTM D 5323	PerFormulation	kN/m		315
Tear Resistance (min. avg.)	ASTM D 1004	Every 6 rolls	N		70
Puncture Resistance (min. avg.)	ASTM D 4833	Every 6 rolls	N		200
Dimensional Stability	ASTM D 1204	Every 6 rolls	%		+/- 2
Multi-Axial Tensile (min.)	ASTM D 5617	PerFormulation	%		90
Oven Aging-% retained after 90 days	ASTM D 5721	PerFormulation			
STD OIT (min. avg.)	ASTM D 3895		%		35
HP OIT (min. avg.)	ASTM D 5885		%		60
UV Resistance-% retained after 1600 hr	GRI-GM-11	PerFormulation			
HP-OIT (min. avg.)	ASTM D 5885		%		35

Note;

(A) Testing frequency based on standard roll dimensions and one batch is approximately 180,000 lbs (or one railcar).
(B) Machine Direction (MD) and Cross Machine Direction (XMD or TD) average values should be on the basis of 5 specimens each direction.
(C) Correlation table is available for ASTM D792 vs. ASTM D1505. Both methods give the same results.
(D) Correlation table is available for ASTM D1603 vs. ASTM D4218. Both methods give the same results.

*All values are nominal test results, except when specified as minimum of maximum.

Inland TARP & LINER
4172 North Frontage Rd E Moses Lake, WA 98837
(800) 346-7744 (509) 766-7024 Fax (509) 766-0414
www.inlandtarp.com

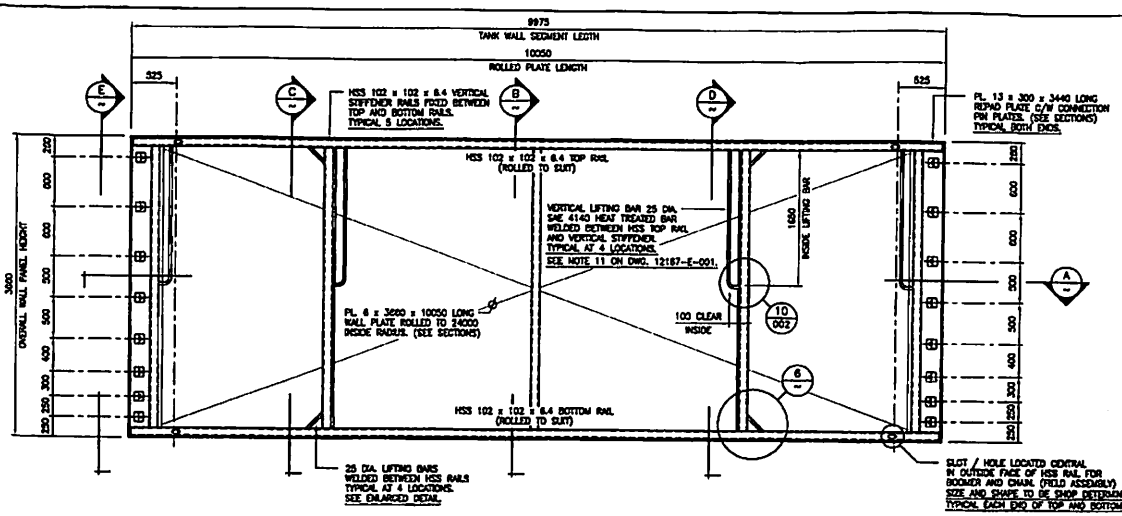
TECHNICAL DATA SHEET
Geomembrane 60mil HDPE

Property	Test Method	Frequency (A)	Unit Metric		Solmax 460ST-7000
Thickness (Nominal +/- 10%) (E)	ASTM D 5994	Every roll	mm		1.50
Asperity Height (min. avg.) (F)	ASTM D 7466	Every Roll	mm		0.38
Resin Density	ASTM D 1505	1/Batch	g/cc		<0.932
Melt Index-190/2.16(max)	ASTM D1238	1/Batch	g/10min		1.0
Sheet Density (C)	ASTM D1505	Every 2 rolls	g/cc		<0.940
Carbon Black Content (D)	ASTM D 4218	Every 2 rolls	%		2.0 – 3.0
Carbon Black Dispersion	ASTM D 5596	Every 6 rolls	Categor y		Cat. 1 / Cat. 2
Oxidative Induction Time (min. avg)	ASTM D3895	1/Batch	min		100
Tensile Properties (min. avg)(B)	ASTM D 6693	Every 2 rolls			
Strength at Yield			kN/m		19
Elongation at Yield			%		12
Strength as Break			kN/m		14
Elongation at Break			%		100
Tear Resistance (min. avg.)	ASTM D 1004	Every 6 rolls	N		159
Puncture Resistance (min. avg.)	ASTM D 4833	Every 6 rolls	N		340
Dimensional Stability	ASTM D 1204	Every 6 Rolls	%		+/-2
Stress Crack Resistance (SP-NCTL)	ASTM D5397	1/Batch	hr		300
Oven Aging-% retained after 90 days	ASTM D 5721	PerFormulation			
HP OIT (min. avg.)	ASTM D 5885		%		80
UV Resistance-% retained after 1600 hr	GRI-GM-11	PerFormulation			
HP-OIT (min. avg.)	ASTM D 5885		%		50

Note;

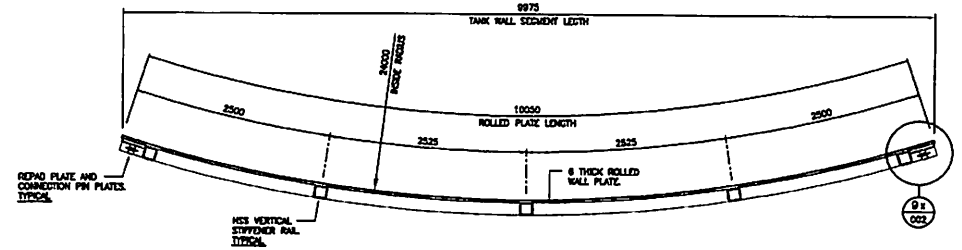
(A) Testing frequency based on standard roll dimensions and one batch is approximately 180,000 lbs (or one railcar).
(B) Machine Direction (MD) and Cross Machine Direction (XMD or TD) average values should be on the basis of 5 specimens each direction.
(C) Correlation table is available for ASTM D792 vs. ASTM D1505. Both methods give the same results.
(D) Correlation table is available for ASTM D1603 vs. ASTM D4218. Both methods give the same results.
(E) The minimum average thickness is +/- 10% of the nominal value.
(F) Of 10 readings; 8 out of 10 must be >7mils (0.18 mm) and lowest individual reading must be >5 mils (0.13 mm) ASTM D 7466 is identical to GRI-GM12.

*All values are nominal test results, except when specified as minimum of maximum.

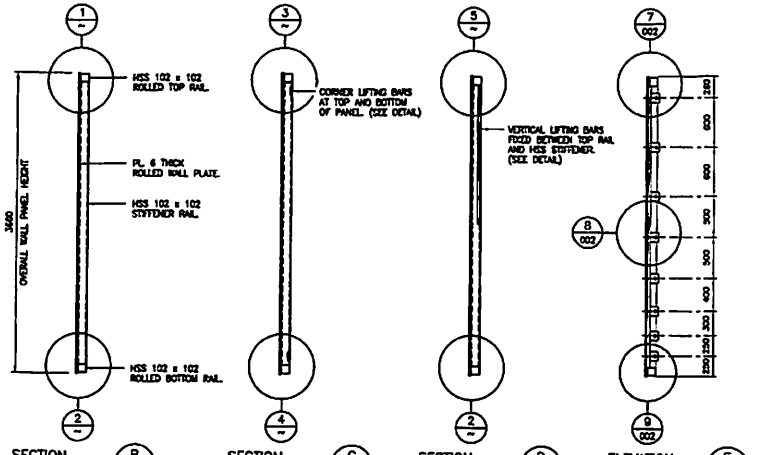


ELEVATION – SHOWING FRAMING TO OUTSIDE FACE OF WALL PANEL
SCALE 1 : 30

(x15 PANELS REQUIRED AS DRAWN)



TYPICAL PLAN SECTION A
SCALE 1 : 30

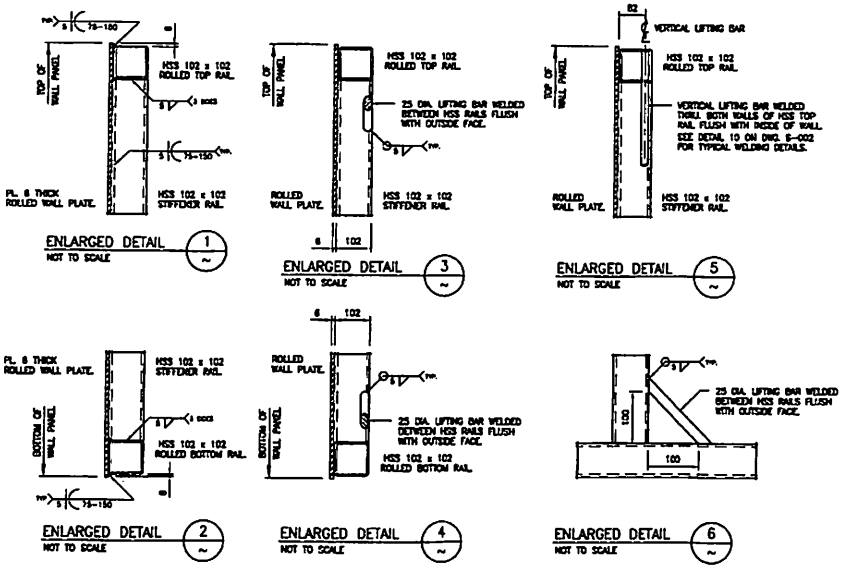


SECTION B SCALE 1 : 30

SECTION C SCALE 1 : 30

SECTION D SCALE 1 : 30

ELEVATION E SCALE 1 : 30



ENLARGED DETAIL 1 NOT TO SCALE

ENLARGED DETAIL 3 NOT TO SCALE

ENLARGED DETAIL 5 NOT TO SCALE

ENLARGED DETAIL 2 NOT TO SCALE

ENLARGED DETAIL 4 NOT TO SCALE

ENLARGED DETAIL 6 NOT TO SCALE

GENERAL NOTES :

1. STRUCTURAL STEEL DESIGN, FABRICATION AND ERECTION SHALL COMPLY WITH THE LATEST EDITION OF :
   - CSA-S16-01 LIMIT STATES DESIGN OF STRUCTURAL STEEL
   - CISC HANDBOOK OF STEEL CONSTRUCTION
   - CSA W59 WELDED STEEL CONSTRUCTION
2. MATERIALS SHALL CONFORM TO THE FOLLOWING GRADES OF CSA G40.21 :
   - HOLLOW STRUCTURAL SECTIONS - 350W
   - W SHAPES - 350W
   - C AND L SHAPES - 300W
   - PLATE AND ALL OTHER SECTIONS - 300W (Fy = 300 MPa / 44 KSI)
3. ALL WELDING SHALL BE IN ACCORDANCE WITH CSA W59-M 'WELDED STEEL CONSTRUCTION (METAL ARC WELDING)'.
4. FRAMING TO BE OF SOLID WELDED CONSTRUCTION (E-4200) COPE FRAMING MEMBERS INTO ONE ANOTHER.

APEGGA PERMIT NO. 2042

DWG. NO.	REFERENCE DRAWINGS	REV	REVISIONS	DATE	BY	CHK'D	APP'D	CLIENT APP'D
12167-S-002	TANK WALL PANEL FRAMING DETAILS	A	ISSUED FOR REVIEW	14.12.10	RP	MH		
12167-E-001	TANK ASSEMBLY LAYOUT PLAN & SECTIONS	0	ISSUED FOR CONSTRUCTION	17.12.10	MH			

FILE : 12167-S-001

ENGINEER AND PERMIT STAMPS

Designed :	Date :	Drawn :	Date :	Checked :	Date :
MH	08.12.10	RP	11.12.10	MH	14.12.10

Client : OPEN RANGE ENERGY CORP

Project : 48m dia. MODULAR WATER TANK

TYPICAL TANK WALL PANEL
FRAMING PLAN, ELEVATION, SECTIONS & DETAILS

Job No.	Scale :	Dwg. No.	
12167	AS NOTED	12167-S-001	0

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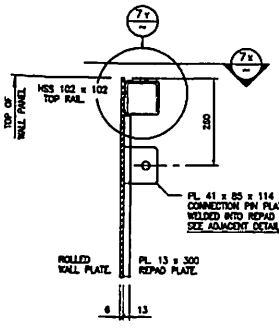
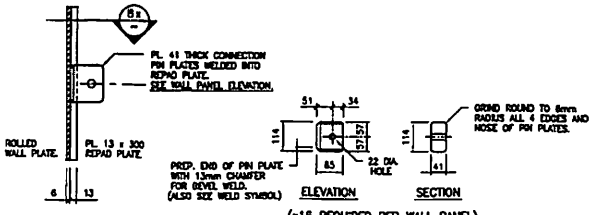
www.beckeng.ab.ca

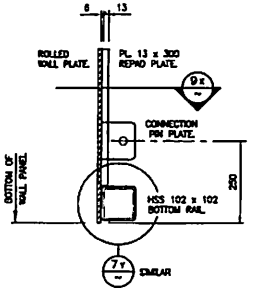


ENLARGED DETAIL 7 / 001
NOT TO SCALE

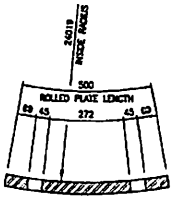


(x16 REQUIRED PER WALL PANEL)

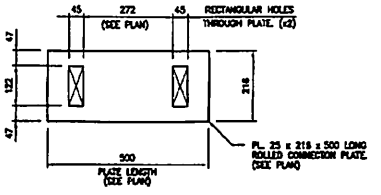
ENLARGED DETAIL 8 / 001
NOT TO SCALE



ENLARGED DETAIL 9 / 001
NOT TO SCALE



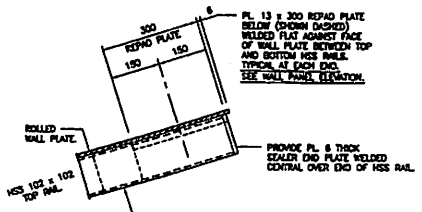
PLAN
(EXAGGERATED SCALE)



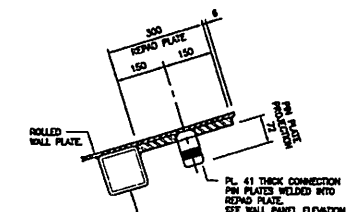
ELEVATION

WALL PANEL CONNECTION PLATES
(x8 REQUIRED PER WALL PANEL)

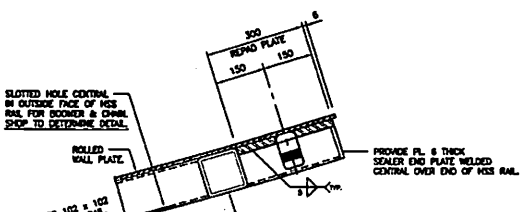
NOTE :
PAINT OUTSIDE FACE OF PLATE FOR IDENTIFICATION PURPOSES ONLY.



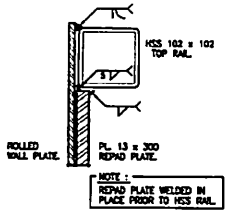
PLAN DETAIL 7x / ~
NOT TO SCALE



PLAN DETAIL 8x / ~
NOT TO SCALE

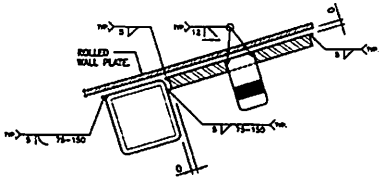


PLAN DETAIL 9x / ~
NOT TO SCALE

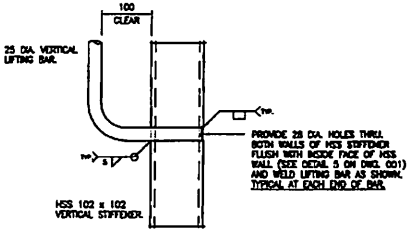


ENLARGED DETAIL 7Y / ~
NOT TO SCALE

EXPLODED TO SHOW WELD DETAILS.



ENLARGED TYPICAL PLAN – EXPLODED TO SHOW WELD DETAILS.
NOT TO SCALE



ENLARGED DETAIL 10 / 001
NOT TO SCALE

APEGGA PERMIT NO. 2042

NOTE :
REFER TO DRAWING 12167-S-001 FOR ALL MATERIAL SPECIFICATIONS AND CONSTRUCTION NOTES.

DWG. NO.	REFERENCE DRAWINGS	REV	REVISIONS	DATE	BY	CHK'D	APP'D	CLIENT APP'D
12167-S-001	TANK WALL PANEL FRAMING LAYOUTS	A	ISSUED FOR REVIEW	14.12.10	RP	MH		
		0	ISSUED FOR CONSTRUCTION	17.12.10	MH	MH		

FILE : 12167-S-002

ENGINEER AND PERMIT STAMPS

Designed :	Date :	Drawn :	Date :	Checked :	Date :
MH	08.12.10	RP	11.12.10	MH	14.12.10

Client : OPEN RANGE ENERGY CORP
Project : 48m dia. MODULAR WATER TANK
TYPICAL TANK WALL PANEL FRAMING SECTIONS AND DETAILS

Job No.	Scale :	Dwg. No.	
12167	AS NOTED	12167-S-002	0

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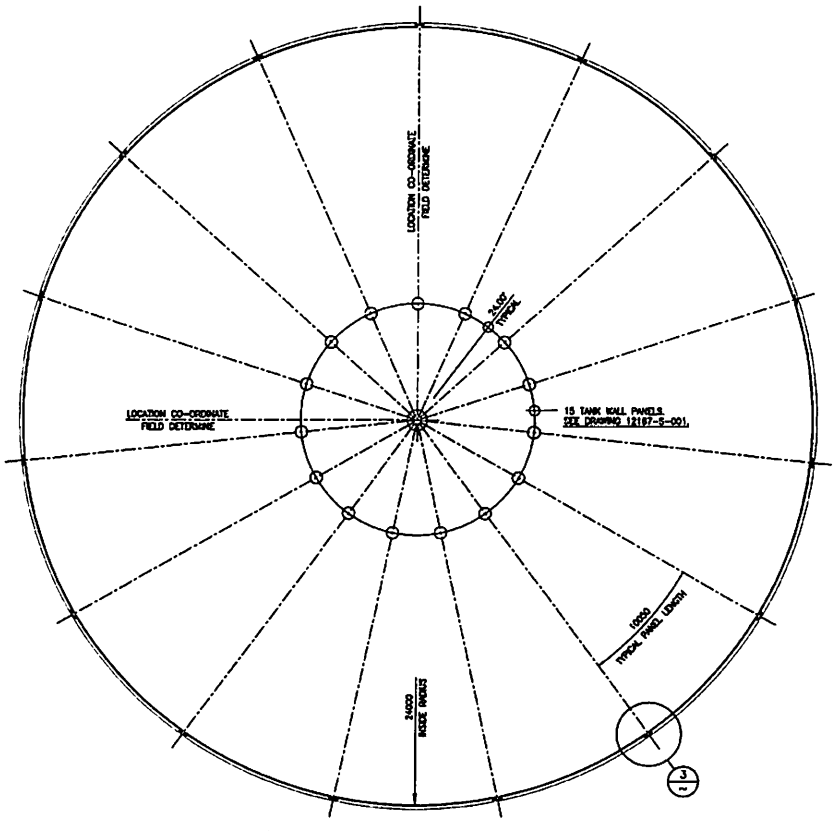
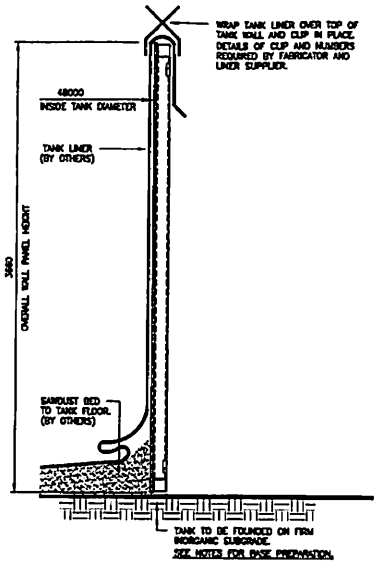
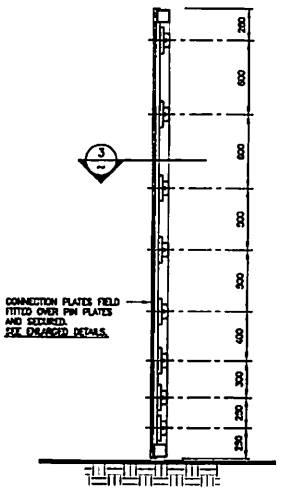
www.beckeng.ab.ca



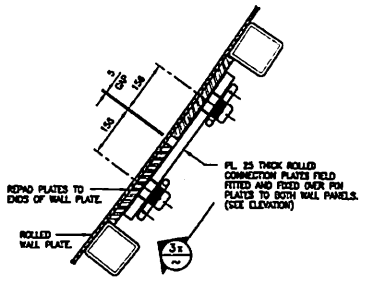
TANK LAYOUT PLAN (A)
SCALE 1 : 75



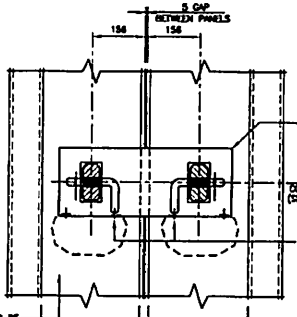
TYPICAL TANK WALL SECTION (1)
SCALE 1 : 20



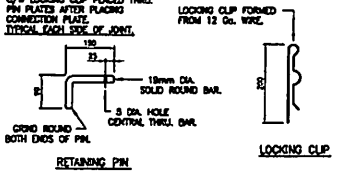
WALL SECTION AT PANEL JOINT (2)
SCALE 1 : 20



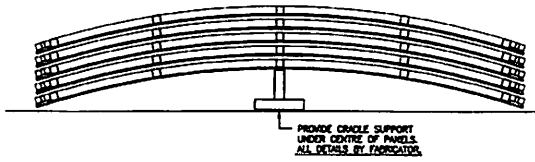
ENLARGED PLAN DETAIL (3)
NOT TO SCALE



ENLARGED ELEVATION (3x)
NOT TO SCALE



SUGGESTED PIN AND CUP DETAILS
SHOP TO CONFIRM ALL DETAILS



TRANSPORT AND STORAGE DETAILS
NOT TO SCALE

APEGGA PERMIT NO. 2042

NOTES :

1. CONTRACTOR SHALL BE FULLY RESPONSIBLE FOR THE STABILITY OF THE STRUCTURE AND FOR THE SAFETY OF ALL PERSONNEL DURING ASSEMBLY AND DISASSEMBLY. ALL WORK SHALL BE IN STRICT ACCORDANCE WITH OCCUPATIONAL HEALTH AND SAFETY REGULATIONS.
2. THE CONTRACTOR SHALL ENSURE ALL THE PANELS ARE ADEQUATELY SUPPORTED OR BRACED UNTIL THE ENTIRE STRUCTURE IS ASSEMBLED.
3. ALL TOPSOIL, ORGANICS, SOFT OR WET SOILS, DEBRIS OR OTHER DELETERIOUS MATERIALS SHALL BE REMOVED FROM THE TANK SITE.
4. THE FINISHED GRADES ALONG THE PERIMETER OF THE TANK SHALL BE LEVEL AND TRUE TO PLANE. THE MAXIMUM ELEVATION DIFFERENCE ACROSS ANY TWO DIAMETRICAL POINTS SHALL BE LESS THAN 230mm.
5. THE MAXIMUM DEVIATION FROM PLANE OVER ANY 3.0 METERS OF CIRCUMFERENCE SHALL BE LESS THAN 5mm AND LESS THAN 12mm OVER ANY 10.0 METERS OF CIRCUMFERENCE.
6. THE AREA SURROUNDING THE TANKS SHALL BE GRADED TO DIRECT SURFACE WATER AWAY FROM THE TANK.
7. THE EDGE OF ANY (DOCUMENTED) SUMP SHALL BE A MINIMUM OF 800mm FROM THE EDGE OF THE TANK WALL.
8. THE PANELS SHALL BE ERECTED PLUMB. THE MAXIMUM OUT-OF-PLUMBNESS OF THE TOP OF THE PANEL RELATIVE TO THE BOTTOM SHALL BE LESS THAN 25mm.
9. THE MAXIMUM DEVIATION FROM THE THEORETICAL RADIUS SHALL BE LESS THAN 50mm AT ANY POINT ALONG THE TANK WALL.
10. THE LINER SHALL BE SECURELY FASTENED TO THE TOP OF EACH PANEL IN ACCORDANCE WITH THE LINER'S MANUFACTURER'S RECOMMENDATIONS. THE LINER SHALL BE INSTALLED WITH SUFFICIENT SLACK AT THE BASE OF THE PANEL TO PREVENT ANY TENSION IN THE LINER.
11. THE VERTICAL LIFTING BAR SHALL ONLY BE USED TO LIFT THE PANELS INTO THE VERTICAL POSITION. THE LIFT RIGGING MUST BE WITHIN 250mm OF THE TOP RAIL PRIOR TO LIFTING THE PANEL.

DWG. NO.	REFERENCE DRAWINGS	REV	REVISIONS	DATE	BY	CHK'D	APP'D	CLIENT APP'D
12167-S-001	TANK WALL PANEL FRAMING LAYOUTS	A	ISSUED FOR REVIEW	14.12.10	RP	MH		
12167-S-002	TANK WALL PANEL FRAMING DETAILS	0	ISSUED FOR CONSTRUCTION	17.12.10	MH	MH		

FILE : 12167-E-001

ENGINEER AND PERMIT STAMPS

Designed :	Date :	Drawn :	Date :	Checked :	Date :
MH	06.12.10	RP	11.12.10	MH	14.12.10

Client : OPEN RANGE ENERGY CORP

Project : 48m dia. MODULAR WATER TANK

TANK INSTALLATION AND ASSEMBLY
LAYOUT PLAN, SECTIONS AND DETAILS

Job No.	Scale :	Dwg. No.	
12167	AS NOTED	12167-E-001	0

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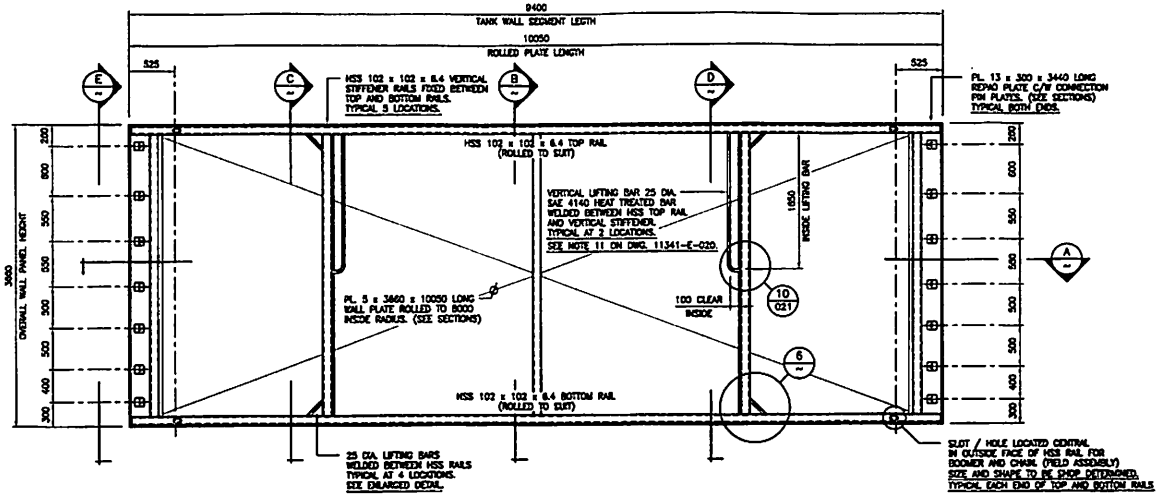
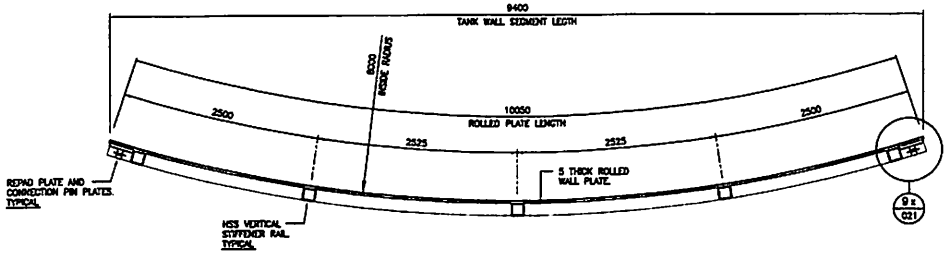
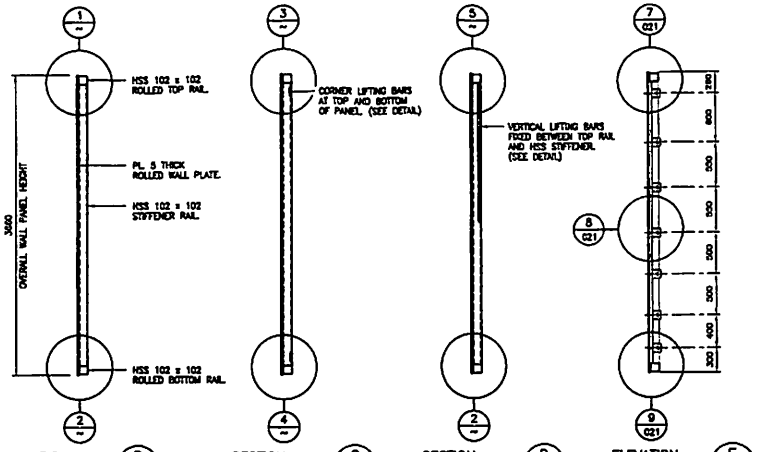


ELEVATION – SHOWING FRAMING TO OUTSIDE FACE OF WALL PANEL
SCALE 1 : 30

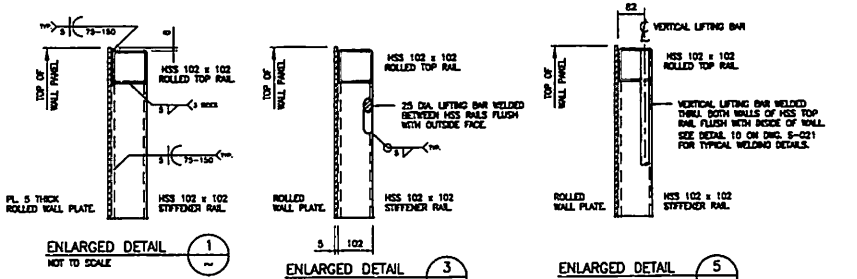
(x5 PANELS REQUIRED AS DRAWN)



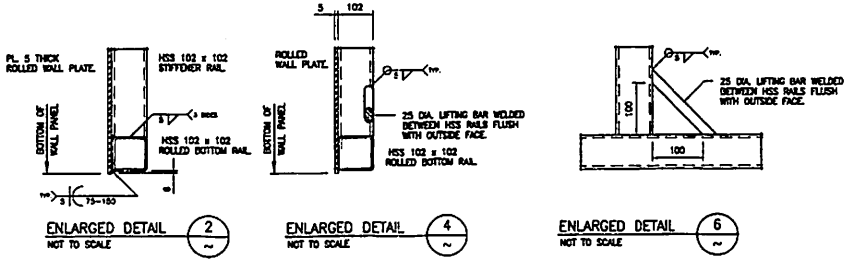
TYPICAL PLAN SECTION A
SCALE 1 : 30



SECTION B SCALE 1 : 30
SECTION C SCALE 1 : 30
SECTION D SCALE 1 : 30
ELEVATION E SCALE 1 : 30



ENLARGED DETAIL 1 NOT TO SCALE
ENLARGED DETAIL 3 NOT TO SCALE
ENLARGED DETAIL 5 NOT TO SCALE



ENLARGED DETAIL 2 NOT TO SCALE
ENLARGED DETAIL 4 NOT TO SCALE
ENLARGED DETAIL 6 NOT TO SCALE

GENERAL NOTES :

1. STRUCTURAL STEEL DESIGN, FABRICATION AND ERECTION SHALL COMPLY WITH THE LATEST EDITION OF :
   - CSA-S16-01 LIMIT STATES DESIGN OF STRUCTURAL STEEL
   - CISC HANDBOOK OF STEEL CONSTRUCTION
   - CSA W59 WELDED STEEL CONSTRUCTION
2. MATERIALS SHALL CONFORM TO THE FOLLOWING GRADES OF CSA G40.21 :
   - HOLLOW STRUCTURAL SECTIONS – 350W
   - W SHAPES – 350W
   - C AND L SHAPES – 300W
   - PLATE AND ALL OTHER SECTIONS – 300W (UNLESS NOTED OTHERWISE)
3. ALL WELDING SHALL BE IN ACCORDANCE WITH CSA W59-M "WELDED STEEL CONSTRUCTION (METAL ARC WELDING)".
4. FRAMING TO BE OF SOLID WELDED CONSTRUCTION (E-4900) COPE FRAMING MEMBERS INTO ONE ANOTHER.

PROFESSIONAL ENGINEER PROVINCE OF ALBERTA
June 2/10

APEGGA PERMIT NO. 2042

DWG. NO.	REFERENCE DRAWINGS	REV	REVISIONS	DATE	BY	CHK'D	APP'D	CLIENT APP'D
11341-S-021	TANK WALL PANEL FRAMING DETAILS	A	ISSUED FOR REVIEW	02.06.10	RP	MH		
11341-E-020	TANK ASSEMBLY LAYOUT PLAN & SECTIONS	0	ISSUED FOR CONSTRUCTION	02.06.10	RP			

FILE : 11341-S-020

ENGINEER AND PERMIT STAMPS

Designed :	Date :	Drawn :	Date :	Checked :	Date :
JH	01.12.09	RP	01.06.010		02-06-10

Client : OPEN RANGE ENERGY CORP
Project : 16m dia. MODULAR WATER TANK
TYPICAL TANK WALL PANEL FRAMING PLAN, ELEVATION, SECTIONS & DETAILS

Job No.	Scale :	Dwg. No.	
11341	AS NOTED	11341-S-020	0

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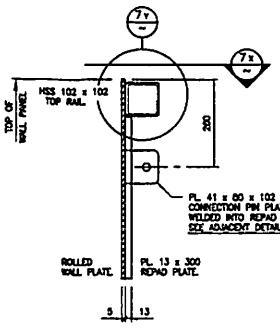
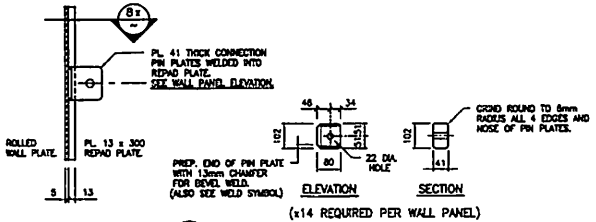
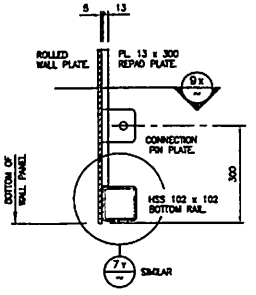


ENLARGED DETAIL 7 (7x) — NOT TO SCALE — 020

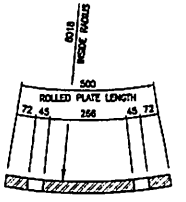


(x14 REQUIRED PER WALL PANEL)

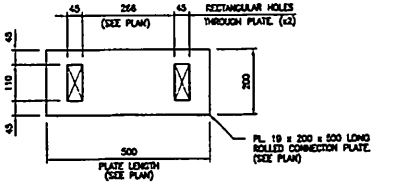
ENLARGED DETAIL 8 (8x) — NOT TO SCALE — 020



ENLARGED DETAIL 9 (9x) — NOT TO SCALE — 020



PLAN
(EXAGGERATED SCALE)

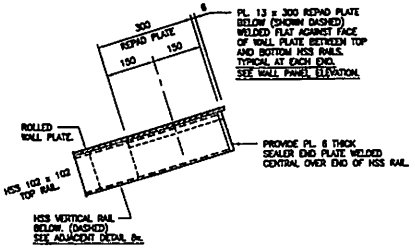


ELEVATION

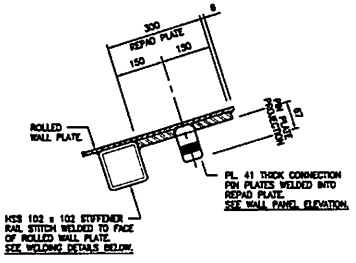
WALL PANEL CONNECTION PLATES

(x7 REQUIRED PER WALL PANEL)

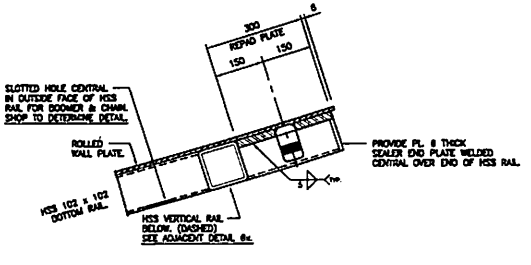
NOTE :
PAINT OUTSIDE FACE OF PLATE FOR IDENTIFICATION PURPOSES ONLY.



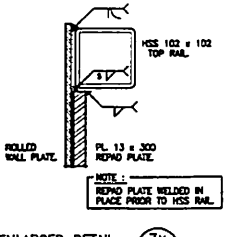
PLAN DETAIL 7x — NOT TO SCALE



PLAN DETAIL 8x — NOT TO SCALE

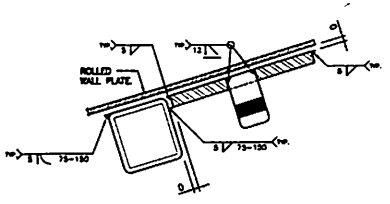


PLAN DETAIL 9x — NOT TO SCALE

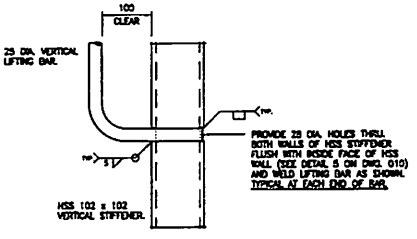


ENLARGED DETAIL 7Y — NOT TO SCALE

EXPLODED TO SHOW WELD DETAILS.



ENLARGED TYPICAL PLAN – EXPLODED TO SHOW WELD DETAILS.
NOT TO SCALE



ENLARGED DETAIL 10 — NOT TO SCALE — 020

APEGGA PERMIT NO. 2042

NOTE :
REFER TO DRAWING 11341-S-020 FOR ALL MATERIAL SPECIFICATIONS AND CONSTRUCTION NOTES.

DWG. NO.	REFERENCE DRAWINGS	REV	REVISIONS	DATE	BY	Chk'D	APP'D	CLIENT APP'D
11341-S-020	TANK WALL PANEL FRAMING LAYOUTS	A	ISSUED FOR REVIEW	02.06.10	RP	MH		
		0	ISSUED FOR CONSTRUCTION	02.06.10	RP			

FILE : 11341-S-021

ENGINEER AND PERMIT STAMPS

Designed :	Date :	Drawn :	Date :	Checked :	Date :
JH	01.12.09	RP	02.06.10		02.06.10

Client : OPEN RANGE ENERGY CORP

Project : 16m dia. MODULAR WATER TANK

TYPICAL TANK WALL PANEL FRAMING SECTIONS AND DETAILS

Job No.	Scale :	Dwg. No.	
11341	AS NOTED	11341-S-021	0

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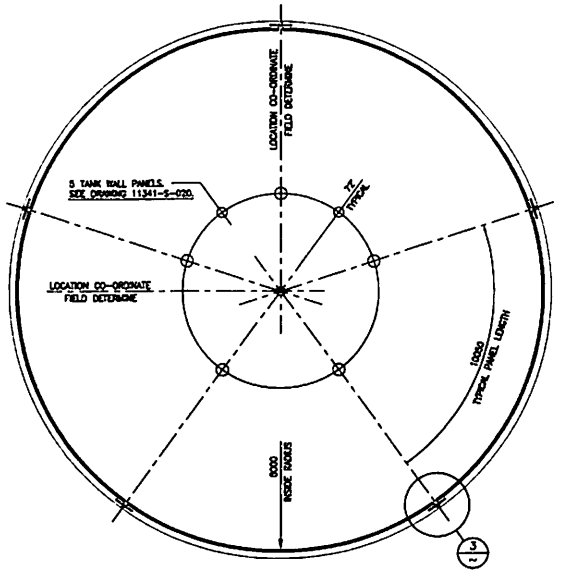
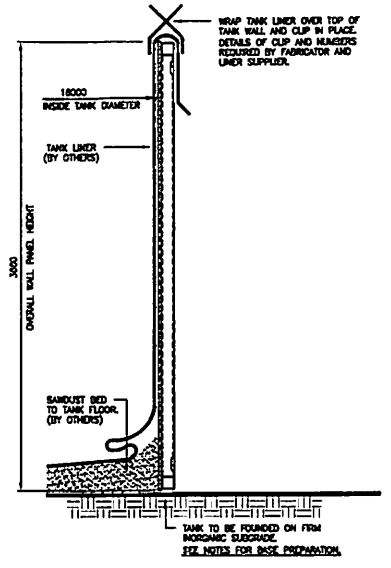
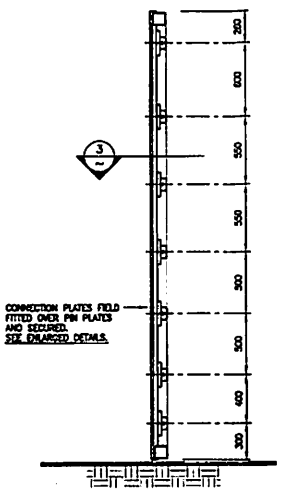


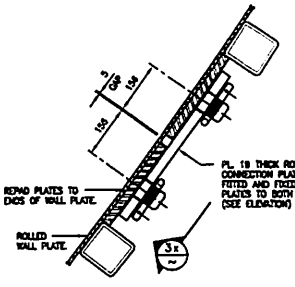
TANK LAYOUT PLAN (A)
SCALE 1 : 75



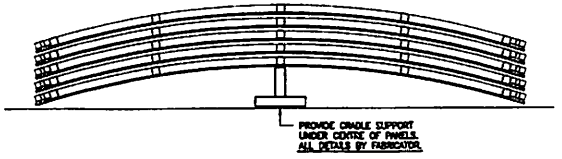
TYPICAL TANK WALL SECTION (1)
SCALE 1 : 20



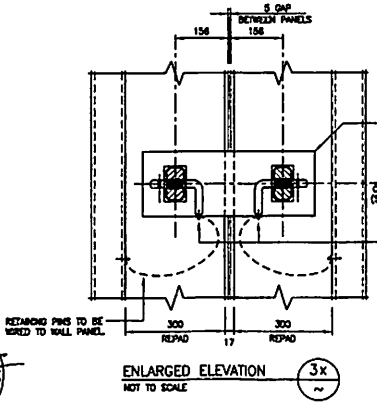
WALL SECTION AT PANEL JOINT (2)
SCALE 1 : 20



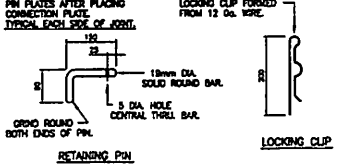
ENLARGED PLAN DETAIL (3)
NOT TO SCALE



TRANSPORT AND STORAGE DETAILS
NOT TO SCALE



ENLARGED ELEVATION (3x)
NOT TO SCALE



SUGGESTED PIN AND CLIP DETAILS
SHOP TO CONFIRM ALL DETAILS

NOTES :

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APEGGA PERMIT NO. 2042

DWG. NO.	REFERENCE DRAWINGS	REV	REVISIONS	DATE	BY	CHK'D	APP'D	CLIENT APP'D
11341-S-020	TANK WALL PANEL FRAMING LAYOUTS	A	ISSUED FOR REVIEW	02.06.10	RP	MH		
11341-S-021	TANK WALL PANEL FRAMING DETAILS	0	ISSUED FOR CONSTRUCTION	02.06.10	RP	MH		

FILE : 11341-E-020

ENGINEER AND PERMIT STAMPS

Designed :	Date :	Drawn :	Date :	Checked :	Date :
JH	01.12.09	RP	01.06.10		02.06.10

Client : OPEN RANGE ENERGY CORP

Project : 16m dia. MODULAR WATER TANK

TANK INSTALLATION AND ASSEMBLY
LAYOUT PLAN, SECTIONS AND DETAILS

Job No.	Scale :	Dwg. No.	
11341	AS NOTED	11341-E-020	0

Beck
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EFFECTIVE WIDE-AREA BIRD CONTROL!

Mega Blaster PRO
sonic bird repeller
covers 30 acres!

- NEMA Rated Case
- Crystal-Clear Digital Sounds

Mega Blaster PRO uses intermittent distress calls to create a "danger zone" that frightens infesting birds away for good.

PREDATOR cries help scare all the birds.

- *Laughing Gull*
- *Ring-Billed Gull*
- *Herring Gull*
- *California Gull*
- *Black-Headed Gull*
- *Glaucous-Winged Gull*
- *Double Crested Cormorant*
- *Marsh Hawk*

Perfect for Landfills, Airfields, Fish Farms, Farm Fields or any multi-acre facility.

Our most powerful system features two high-output amplifiers that drive our specially-designed 20 speaker tower. The intense sound output covers up to 30 acres (12 hectares).

It features solid-state electronics mounted inside a NEMA-type control box, suitable for most any application.

The generating unit mounts easily to a post or pole using the included hardware. The unit comes pre-recorded in four different configurations for the most common bird infestations.

Choose any or all of the 8 sounds, including predators to give the birds even more of a sense of danger. Customize by choosing volume and silent time between sounds.

CONFIGURATIONS AVAILABLE:

- Agricultural
  # MEGA-AG
- Crow / Raven
  # MEGA-CROW
- Woodpecker
  # MEGA-WP
- Marine / Gull
  # MEGA-MAR

Mega Blaster PRO

Complete system includes the generating unit with two built-in high-output amplifiers, 20-speaker tower with audio cables, 40 watt solar panel, battery clips and all mounting hardware.

BIRD-X

The Bird Control 'X'-Perts

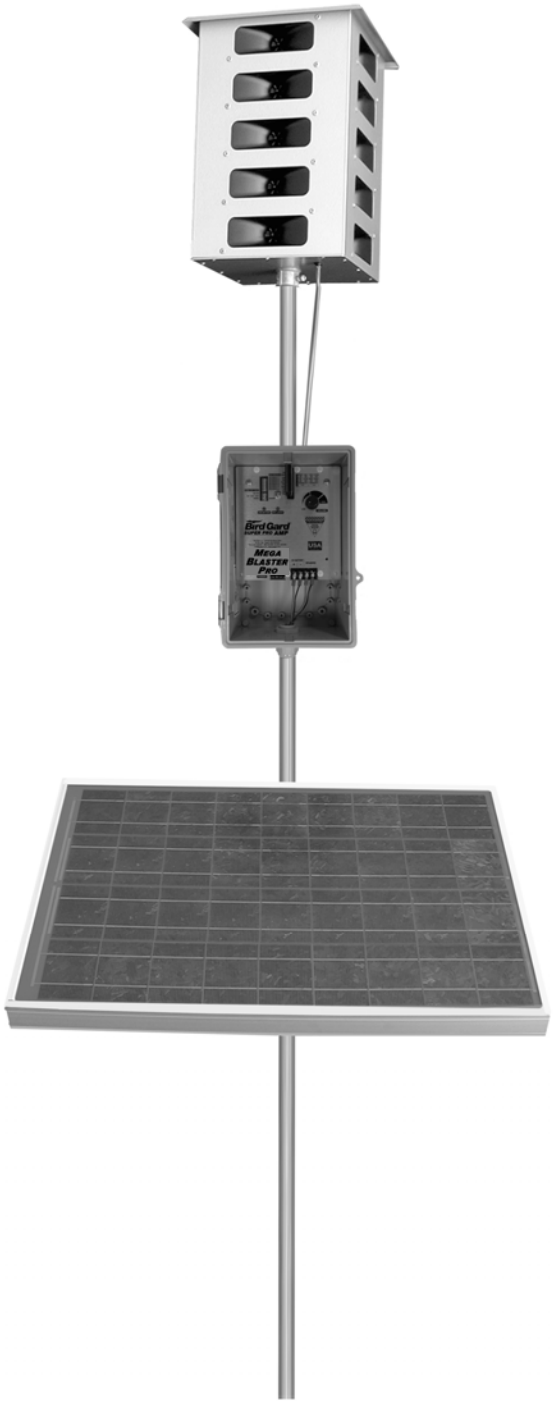
NOTE: This unit is capable of sound output up to 125 decibels. **HEARING PROTECTION IS RECOMMENDED.**

HEARING PROTECTION RECOMMENDED

MEGA BLASTER PRO

BIRD-X

User's Manual



Overview

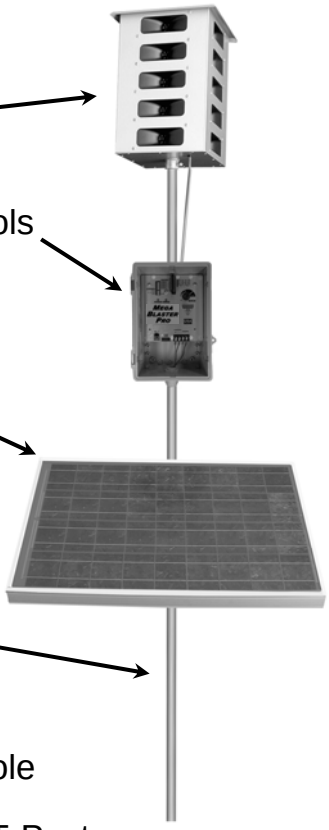
The Bird-X Mega Blaster Pro utilizes the innate power of the natural survival instincts of birds to effectively repel them. Digital recordings of distressed and alarmed birds, along with the sounds made by their natural predators are broadcast through high fidelity weather-resistant speakers over the top of areas. This action triggers a primal fear and flee response. Pest birds soon relocate to where they can feed without feeling threatened.

Your Bird-X Mega Blaster Pro system consists of:

20-Speaker Tower broadcasts the bird sounds

Control Unit produces the bird sounds and contains all operational controls

Solar Panel recharges the 12-volt deep cycle battery



Items needed but <u>not</u> included:

(1) **Mounting Pole** or **Mast** tall enough to raise the 20-Speaker Tower at least 5 feet above the top of the areas, trees or other obstructions

(1) **12-volt Deep Cycle Battery** (RV/Marine) Group 27 or larger wet cell

(1) **T-Post** or similar (Optional) may be needed to support the mounting pole

(1) **Bailing Wire or zip-tie** (Optional) to secure the Mounting Pole to the T-Post

CAUTION: THE MEGA BLASTER PRO IS CAPABLE OF PRODUCING SOUNDS UP TO 125 DECIBELS. PROPER HEARING PROTECTION MUST BE WORN ANYTIME THE UNIT IS TURNED ON.

Bird Control Management Guidelines

An active bird control management program is a key to successfully repelling pest birds. Bird feeding patterns may take several days or weeks to break. Follow all suggestions for maximum effectiveness. Read all instructions prior to installation.

For best results:

- **It is extremely important to fully protect your entire area from birds.** Any areas not fully protected will allow birds to begin feeding at the fringes of the sound coverage. They will soon become bolder and learn the sounds are nothing to fear. This will cause the effectiveness to diminish. Complete Bird-X product coverage forces birds to leave the area entirely.
- Install the Mega Blaster Pro unit at least two weeks before birds are attracted to your area. It is much easier to keep birds away before they have found a food source than it is to repel them once they have developed a feeding pattern.
- Most birds begin feeding from the perimeter of an area. Place Mega Blaster Pro units so the sound protection covers past the edges of the area.
- Birds will often use tall trees for roosting and observation. If birds are in bordering trees it is necessary to position the units so the sound protection covers the trees as well.
- Mount the 20-Speaker Tower at least five feet above trees, areas and structures for maximum coverage. The higher the better. Sound will disperse or reflect off structures or foliage. Mount control unit out of direct sun, if possible.
- When first installed, run Mega Blaster Pro units at FULL volume and on SHORT time off periods. This ensures maximum “bird stress” and creates a hostile environment.
- Watch for changes in bird activity and adjust the location of your Mega Blaster Pro unit if needed.
- **Check the battery and unit settings often to insure continuous bird control. Be certain that the system is not turned down or has a dead battery. Field hands or harvesters may turn down the volume.**
- Changing settings and switches often helps to prevent bird habituation. Periodically change the switch settings of the eight sounds (turning them ON or OFF). NEVER turn OFF the distress calls of the target birds you are trying to repel and always keep at least one predator bird sound turned ON.
- If different bird species enter the protected area and begin causing damage contact us immediately for an updated Sound Recording Card designed to repel the new invading birds.
- Remember that the Mega Blaster Pro system is a management tool, and should be used as part of your overall bird control strategy, sometimes in conjunction with other bird control techniques and devices.

Be aware that under extreme drought or other adverse conditions, birds will disregard all deterrents and risks in order to survive

Materials List

Item	Qty		Notes
Mega Blaster Pro Control Box	1		
Sound Recording Card	1		Pre-installed in control box
20-Speaker Tower	1		
Control Box Mounting U-Bolts	2		1/4” x 1” x 2”
Control Box Brackets	2		
40-Watt Solar Panel	1		
Solar Panel Mounting Bracket	1		
Solar Panel Mounting U-Bolts	2		1/4” x 1-1/8” x 2”
Control Box Connector Cable	1		2 Wire, 4 ft. Long
Battery Box	1		

Assembly

Note: You will find it easier to pre-assemble the following components prior to installation in the field.

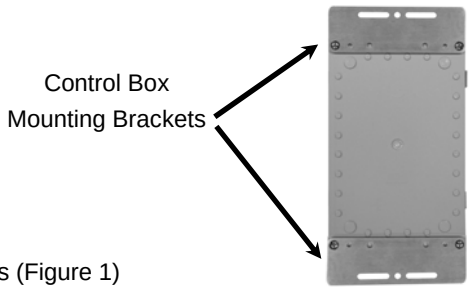


Figure 1

Control Unit

1. Lay the Control Unit face down
2. Attach the two Control Box Mounting Brackets to the back with the included screws (Figure 1)

Solar Panel

3. Install the two Solar Panel Mounting U-Bolts in the Head of the Solar Panel Mounting Bracket (Figure 2)
4. Loosen, but do not remove the Carriage Bolts securing the movable Clamp Plates on the Solar Panel Mount Bracket
5. Lay the solar panel on a flat surface with the glass side down
6. Lay the Mounting Arm across the Solar Panel with the Clamp Plates down. Position the Mounting Arm at an angle so the Clamp Plates slide under the lip of the Solar Panel (Figure 3A)
7. Rotate the Mounting Arm and secure it to the Solar Panel by tightening the Carriage Bolts (Figure 3B)

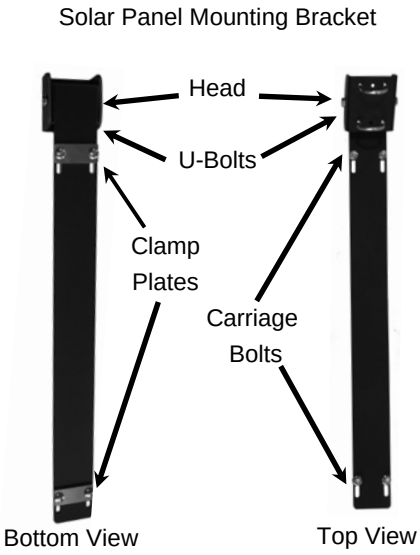


Figure 2

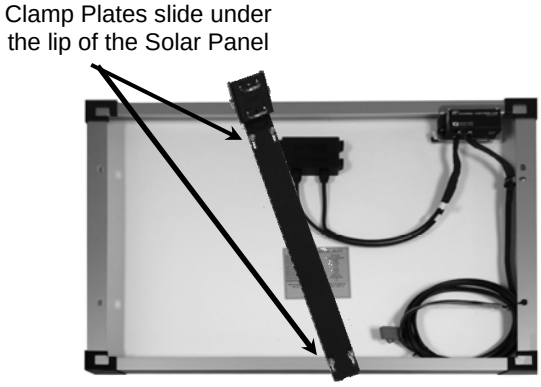


Figure 3A

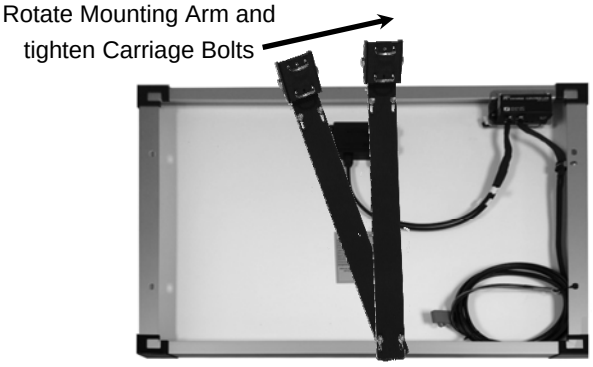


Figure 3B

Placement

Your Mega Blaster Pro will protect an area up to approximately 600 feet in all directions.

Factors to consider when selecting the best location include:

- Birds typically feed from the perimeter of the area and work their way in. Place Mega Blaster Pro units so the sound protection covers all the way to the edges of the area. For larger areas Mega Blaster Pro units should be positioned 400-500 feet inside the area and spaced every 1,200 feet.
- Mount the 20-Speaker Tower at least 5 feet above terrain, areas, trees and other obstacles.
- Placing the Mega Blaster Pro on top of a hill or small rise will give you much better coverage than at the bottom of a valley. The greater the height the further the sounds will travel.
- Wind can blow the sound waves. If the area you need to protect has consistent wind coming from the same direction, position your Mega Blaster Pro more “upwind.”
- Trees surrounding areas provide birds with a safe perch that allows them to fly in, grab food and fly out. It is much more difficult to eliminate bird damage if the birds are able to use the surrounding trees as a staging area for attacks on your areas. Your Mega Blaster Pro unit should be positioned close to any trees bordering your areas. If birds are roosting in the trees at night the TIME OF OPERATION should be set to 24 HOUR.
- Lakes, rivers and wetlands are a favorite resting and hiding place for birds. Your Mega Blaster Pro unit should be placed so the sound thoroughly covers any areas where birds frequent.
- Neighbors, businesses and others may not appreciate hearing the bird sounds. At the limits of the effective range the sounds from your Mega Blaster Pro are at a level people may find annoying. Avoid placing the unit where it becomes a nuisance.

Building a Mounting Pole or Mast

CAUTION: TALL POLES AND MASTS CAN BE HEAVY AND POTENTIALLY DANGEROUS. USE EXTREME CAUTION WHEN CONSTRUCTING OR WORKING AROUND TALL POLES AND MASTS. BIRD-X, INC., ASSUMES NO RESPONSIBILITY FOR DAMAGES OR INJURIES.

Things to consider:

- The 20-Speaker Tower is designed to mount onto a 1 in. (outside diameter) pipe at least 14 in. long. 1 in. conduit works well as it is light, rigid, inexpensive and available in 10 ft. lengths making it ideal for low areas, vineyards and bushes.
- You will want to take down your Mega Blaster Pro unit after harvest and store it in a dry location until the next season.

A suggestion for masts up to 20 feet tall:

1. 3/4 inch Galvanized steel water pipe has a 1 inch outside diameter and is the correct size to fit inside the 20-Speaker Tower. It is often available in 20 ft. lengths from hardware and plumbing supply stores. If these are not available, 10 ft. lengths are common and can be fastened together with a threaded coupler. Assemble the poles on the ground.
2. Slide the 20-Speaker Tower over the pipe and tighten the set screw in the collar at the base.
3. Stand the pole assembly up just inside the drip line of a tree and securely tie the pole to a few heavy branches.
4. Drive a T-Post into the ground at the base of the pole and secure with wire.

For masts taller than 20 feet:

1. Use 20 ft. lengths of galvanized steel water pipe or similar, securely fastened together with threaded reducing couplers.
2. Starting with 3 in. pipe, step the size down with each length of pipe.
3. The last 10 ft. can be 1 in. (O.D.) conduit hose clamped to the final section of galvanized pipe.

A semi-permanent mast support can be made by digging a hole 4 ft. deep and 4 ft. round. In the middle of the hole sink a length of galvanized water pipe large enough that your mast will easily fit inside. Make sure at least 2 ft. of pipe is above ground level. Fill the area around the pipe with packed sand, leaving the last foot filled with concrete to form a cap over the hole. Your mast can be dropped into the galvanized water pipe “receiver” for support. At the end of harvest the mast can be lifted out and positioned on the ground for easy disassembly and storage.

Installation

Note: Foliage, trees, and other obstructions severely reduce the effective range of Mega Blaster Pro units. It is critical that the 20-Speaker Tower is mounted at least 5 feet above all obstructions to achieve the maximum protection.

Mounting Pole or Mast

1. The Mounting Pole or Mast will need to be supported by a T-Post, fence post, tree or other means. The Pole Support should be in place before proceeding.

20-Speaker Tower

2. Lay the 20-Speaker Tower on its side on the ground and cut the zip-tie securing the speaker cables.
3. Slide the 1 in. (outside diameter) Mounting Pole through the Collar at the bottom of the 20-Speaker Tower until it slides over the positioning bolt inside the top of the Tower (Figure 4).
4. Tighten the Set Screw in Collar securely.

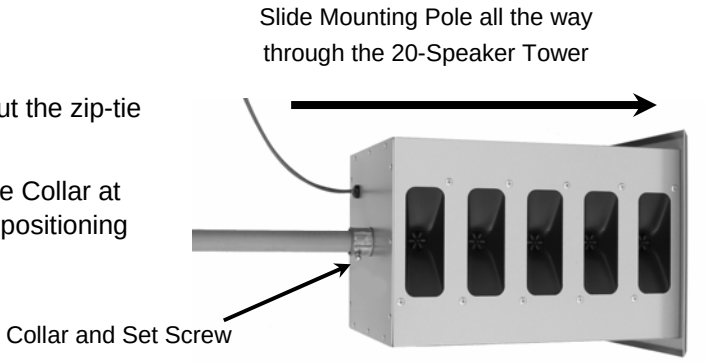


Figure 4

Solar Panel

5. Rest the lower end of the Mounting Pole on the Solar Panel Mounting Bracket approximately three feet from the bottom of the pole with the top of the solar panel facing the 20-Speaker Tower (Figure 5).
6. Lean up the Mounting Pole with the 20-Speaker Tower on top, against the Pole Support and fasten the Mounting Pole to the Pole Support securely with wire or other semi-permanent means.
7. Rotate the solar panel so it receives sunlight.

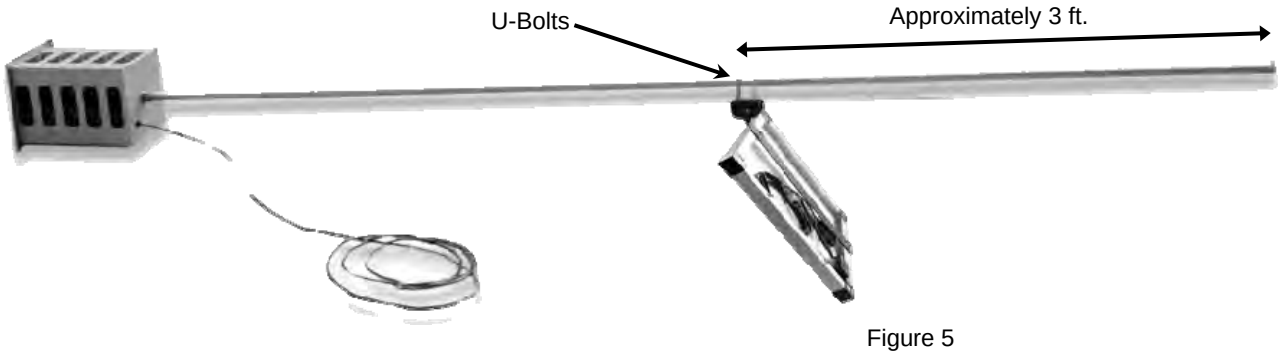


Figure 5

Control Box

8. Attach the Control Box to the Mounting Pole with the U-Bolts.
9. Feed the Speaker Cables through the Cable Strain Relief at the bottom
10. Attach the Speaker Cables from the 20-Speaker Tower to the screws marked “SPEAKER” on the faceplate of the control panel.
11. Locate the Control Box Connector Cable (the grey 2 lead cables) and feed one end through the Cable Strain Relief.
12. Connect the RED wire to the screw marked “+” and the BLACK wire to the screw marked “-” under “12V BATTERY” on the faceplate of the control panel.
13. **MAKE SURE THE POWER SWITCH IS TURNED OFF BEFORE ATTACHING BATTERY.**
14. Connect the other end of the RED wire to the “+” terminal on the 12-volt Deep Cycle battery (not included). Connect the BLACK wire to the “-” terminal on the battery.
15. Hand tighten the Tapered Cinch Nut on the bottom of the Cable Strain Relief to help keep insects and moisture out.

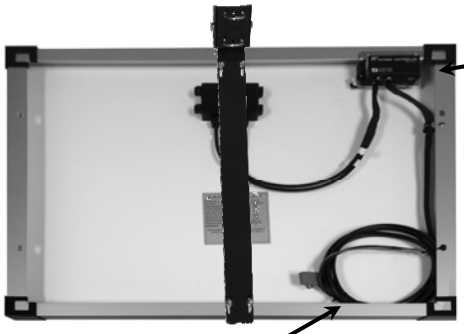
Figure 6

Solar Panel Connections

16. Cut the black zip-ties securing the RED and BLACK wires on the underside of the solar panel. (Figure 7)
17. Connect the RED wire to the “+” terminal on the 12-volt battery and connect the BLACK wire to the “-” terminal on the battery.

NOTE: If you are using a “Sealed Gel” 12-volt battery (instead of a Lead Acid battery) you will need to cut the indicated small BLUE wire on the attached voltage regulator. This prevents Sealed Gel batteries from being overcharged. Failure to cut this wire can result in permanent battery damage. (Figure 8)

Figure 7



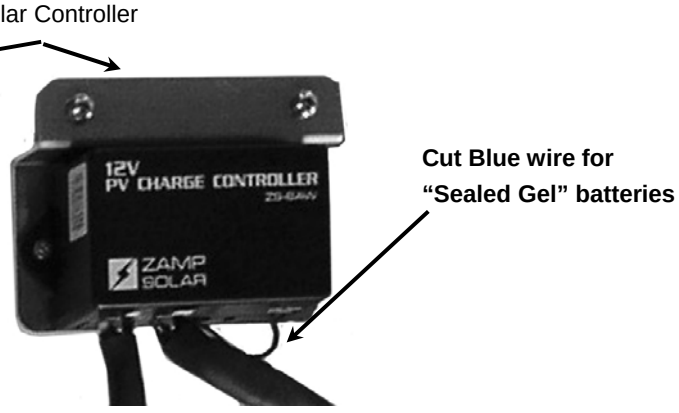


Figure 8

CAUTION: The Mega Blaster Pro is capable of producing sounds up to 125 decibels. Hearing protection must be worn anytime the unit is on!

Settings

Repelling birds requires regular monitoring and active management. Birds are intelligent and highly adaptable so it is important to create and maintain an environment the birds perceive as hostile and dangerous. This is achieved by playing the sounds frequently and at a high volume, otherwise the birds will not be fully repelled and will soon learn to adapt.

Below are the initial settings that should be used when your Mega Blaster Pro is first installed. Please see the "Bird Control Management Guidelines" section for more information.

Recordings

There are eight separate bird sounds contained on the Replaceable Sound Card. The label on the sound card lists each sound with a number corresponding to the eight "RECORDINGS" dip switches to the left of the Sound Card. Initially all RECORDING switches should be turned ON. If the target birds begin returning, periodically change the switch settings for the eight sounds (turning them ON or OFF). ***NOTE:*** **NEVER turn OFF the distress calls of the target birds you are trying to repel and always keep at least one predator bird sound turned ON.**

Mode Settings

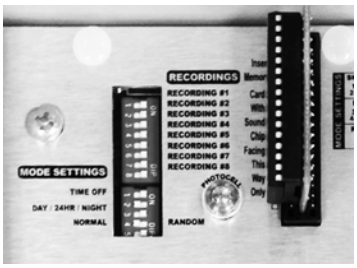
TIME OFF INTERVAL controls the time off periods between each playing of the bird recordings.

Setting	Time Off Duration	Switch #1	Switch #2
SHORT	**17-50 Seconds**	**ON**	**OFF**
MEDIUM	1:00-4:15 Minutes	OFF	ON
LONG	5:00-10:00 Minutes	ON	ON
XLONG	10:00-30:00 Minutes	OFF	OFF

When the Mega Blaster Pro unit is first installed the TIME OFF INTERVAL should be set to SHORT to create the greatest sense of danger and move the birds out of the area the fastest. Once the birds have left the area completely for a week or more you may try increasing the TIME OFF INTERVAL gradually, but you must monitor the birds carefully. Switch back to SHORT at the first sign birds are returning.

TIME OF OPERATION controls when the bird recordings play.

Setting	Switch #3	Switch #4
DAY ONLY	**ON**	**OFF**
24-HOUR	OFF	ON
NIGHT ONLY	ON	ON



Recommended Settings

In most cases birds are only active during the day so the DAY ONLY is recommended. If birds are roosting in bordering trees at night you will need to set the TIME OF OPERATION for 24-HOUR.

RANDOM OPERATION should always be turned **ON**. **VOLUME should be set as high as possible.**

Troubleshooting

Problem	Possible Cause	Solution
No Sound	Volume turned down	Turn volume up
	Dead battery	Charge or replace battery
	Loose battery connection	Verify all battery connections are tight
	All RECORDINGS are turned OFF	Verify all RECORDINGS are switched to ON
	Sound Card not fully seated	Remove sound card and reinstall, making sure it is fully inserted into the socket
	Sound Card is installed backward	Unplug the sound card and reinstall with the label facing to the left
	TIME OF OPERATION set to DAY ONLY without enough light	Change TIME OF OPERATION to 24-HOUR
	Unit was not shut down before the battery was disconnected causing the unit to go into “SAFE MODE”	1. Turn the POWER switch OFF 2. Disconnect the battery 3. Remove the sound card 4. Wait 30 seconds 5. Reinstall sound card 6. Reconnect the battery 7. Turn the POWER switch ON
Was working but stopped	The battery is dead	Connect the battery to a battery charger and see if it will hold a charge. Replace if necessary
	Solar Panel is not getting enough sunlight	Reposition the Solar Panel

Limited Warranty

THIS MEGA BLASTER PRO UNIT IS WARRANTED AGAINST DEFECTS IN MATERIAL AND WORKMANSHIP FOR SIX MONTHS FROM DATE OF PURCHASE (EXTENDED WARRANTY AVAILABLE). BIRD-X WILL REPLACE OR REPAIR, PROVIDED DEFECT OCCURS UNDER NORMAL USE. *RETURNS ACCEPTED ONLY WITH AUTHORIZATION FROM OUR CHICAGO OFFICE.*

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