

**Root Cause Analysis Report:
Worker Fatality
PG&E - Kern Power Plant Demolition
Bakersfield, CA**

Business Confidential

Location of Incident: Kern Power Plant, Bakersfield, California
Date of Incident: Tuesday, June 19, 2012, approximately 9:20 a.m.
Type of Incident: Worker fatality; struck by collapsing tank wall

Executive Summary:

On June 19, 2012, a four-person team was in the process of dismantling a large (approximately 40 feet high and 120 feet in diameter) fuel storage tank when a section of the steel wall unexpectedly collapsed and struck the boom lift one of the employees was working from. Due to the position of the boom lift, the force of the impact drove the lift backward until the entire unit overturned causing the basket the employee was riding in to strike the ground. Co-workers immediately suspended their activities and rushed to aid the injured employee. Emergency services (via 911) were summonsed and the employee was transported by ambulance to a local hospital. Tragically the employee's injuries were too severe and he did not survive.

Investigation Methodology:

Cleveland Wrecking Company (CWC) utilized the "Why Tree" methodology for conducting this investigation. The Why Tree approach is a logic-based model for evaluating an undesired event (in this case, a worker fatality) to determine the underlying root cause(s) leading to the event.

The investigation team was led by HS&E managers from the URS Infrastructure and Environmental (IE) Division and included representatives from CWC operations management and the URS IE Legal Department.

Information included in this report was obtained from on-site evaluation of the accident scene; from interviews of CWC employees who either witnessed the incident or who had first-hand knowledge of the events leading to and immediately following the incident; and from project documents including the site health and safety plan, employee training records, daily tailgate meeting notes, and equipment inspection records.

The Incident Timeline is provided in Figure 1. The "Why Tree Analysis" Diagram is provided in Figure 2. The Program Enhancement plan is provided in Appendix A.

Background Information:

In March 2012, Pacific Gas and Electric (PG&E) contracted CWC to dismantle the Kern Power Plant (KPP) located at 2104 Coffee Road in Bakersfield, CA. The facility includes four boilers

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with associated control rooms and smoke stacks, four above ground, heavy fuel storage tanks with associated piping and equipment, administrative building, hazardous waste storage building and other smaller tanks and support structures. The plant ceased operation in the mid-1980s and the site has been idle ever since.

Due to the age of the facility, a number of structures (including the boilers and above ground tanks) contained asbestos insulation. In accordance with State of California regulations, the asbestos insulation needed to be removed prior to the initiation to the demolition of these structures. Because CWC does not normally conduct asbestos abatement work, a specialty sub-contractor was retained by CWC to perform this work. The abatement activities on the four above ground tanks were completed in mid-June. Demolition activities on the four tanks began the week of June 18, 2012.

Incident Review:

The team assigned to demolish Tank 1 consisted of [REDACTED] SUPE (field superintendent), [REDACTED] WORKER1 and [REDACTED] WORKER2, (torch men/laborers) and [REDACTED] WORKER3 (heavy equipment operator). This same team had worked together on a previous CWC project where numerous fuel tanks of similar dimensions to the four at the Kern facility were dismantled.

At the time [REDACTED] SUPE'S crew started to work on the four fuel tanks, other workers were completing the task of emptying the fuel drain lines that were present on either side of the tanks. Once the fuel lines were empty and cleaned, the lines could be disassembled.

On June 18, the crew cut "doors" in the side of the four tanks to provide access for the laborers and equipment. Prior to cutting the doors, [REDACTED] SUPE, [REDACTED] WORKER2 and [REDACTED] WORKER1 discussed the size of the opening and where the door should be cut. The factors bearing on this decision included the location of fuel lines and the terrain surrounding the tanks. The door to Tank 1 was the cut between the fuel lines and on the side where the pieces of the tank could be easily processed and removed from the site. After the door was cut, the floating lid on the interior of the tank was demolished and taken outside of the tank with the excavator.

On June 19, 2012, [REDACTED] SUPE led a safety tailgate meeting to discuss the work that would be completed that day, including the demolition of Tank 1. During the meeting, the entire CWC crew discussed the days' work assignments, JSA's and PPE requirements for their respective tasks. After the meeting, [REDACTED] SUPE'S crew went to Tank 1 and again reviewed the specific steps for dismantling the tank.

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SUPE and his crew had previously determined that the torch men would cut the tank walls from boom lifts positioned inside the tank. This decision was driven by the surface conditions surrounding the tank. The ground outside the tank is uneven and sandy. And with a tank height of 40 feet, the crew was concerned about the difficulties of maneuvering their boom lifts to allow them access to the upper portions of the tank. In addition, other obstacles such as the existing fuel lines would impede efficient work from the outside.

Working from the inside of the tank eliminated these problems. The tank floor was flat, stable, and free of obstructions. With a tank diameter of 120 feet, the crew concluded they had ample room to maneuver the lifts without compromising worker safety. The same approach had been successfully used by this same crew to demolish tanks of similar size over the past 10 years.

As had been the practice on similar jobs, the plan was to cut the top half of the tank in 20' x 20' sections and then use a Link Belt 700 excavator (operated by WORKER3) to fold the cut section in to the interior of the tank.

SUPE marked the initial four cut locations, spaced approximately 20 feet apart, with orange spray paint on the exterior base of the tank walls. These marks identified locations where the two torch men (WORKER2 and WORKER1), working from S-60 Genie boom lifts, would make cuts.

When the torch men were set up to cut the first piece, they alerted SUPE, who was stationed on the ground outside of the tank. SUPE then directed the torch men where to line up their cuts. Once they were aligned to SUPE'S satisfaction, the torch men commenced cutting.

As the torch men cut the tank walls, they would leave "stickers" on both the horizontal and vertical cuts. A sticker is a short (2"-3" long) uncut section of wall which keeps the cut wall section in place until it is ready to push in by the excavator operator.

SUPE frequently entered and exited the tank while the cuts were made to verify the cuts were made in the proper locations, monitor the position of the boom lifts, assist the torch cutters with their equipment (such as moving hoses), and coordinate communication with the excavator operator working outside the tank.

Once the section was cut and with the "stickers" intact, the torch men would signal to SUPE that the cuts had been completed. At this time, the torch men would move their boom lift back and to the center of the tank. SUPE would look outside the tank to determine whether the area was clear. SUPE would then contact the excavator operator by radio and direct him to make the push. As directed, the operator would extend the boom of the excavator and tap the cut

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section of wall, breaking the "stickers". Once pushed, the weight and momentum of the cut section would allow the steel to fold squarely into the tank. The operator would then flatten the cut section of steel against the intact portion of the wall, thus reducing the height of the tank wall by roughly half.

Following each cut, SUPE returned to the exterior of the tank and, using the orange paint as his guide, confirmed the desired location for the next cut. Due to the respirators worn by the torch men, SUPE used hand signals rather than a radio to communicate where the next cut would be made. In order for the torch men to see his signals, they needed to raise their baskets above the rim of the tank to gain line of sight with SUPE.

Once the first section was down, the crew, under SUPE'S direction and using the same process described above, took down wall sections 2 and 3.

After the third section was down, SUPE noticed that WORKER1'S lift was located approximately 25-30 feet from the tank wall. SUPE wanted the boom lift carriage approximately 45 feet from the tank wall. Lifts with 60' booms (rather than standard 40' booms) had been obtained for this project to allow for greater distances between the tank walls and the lift carriages. In addition, SUPE noticed that WORKER1 had his boom extended perpendicular to the carriage (which happened to position the carriage wheels parallel to the tank wall). Instead, SUPE wanted the boom extended over the length of the carriage to afford greater stability when extended (which would also change the wheel alignment to be perpendicular to the tank wall). SUPE communicated his concern to WORKER1 and directed him to reposition the lift.

At the time that SUPE was instructing WORKER1 to reposition his lift, he received a telephone call that required him to go to the front gate. Prior to leaving, SUPE gave each torch cutter a bottle of water and told them to rest (conditions at the time were hot and dry and SUPE was concerned about heat stress). As he left, he told the torch cutter: "I'll be right back." The torch men nodded as SUPE turned toward the front gate, which was about 500 yards from the tank. As he left, SUPE assumed the torch men would suspend their activities until he returned because: (1) This crew had worked together for over 10 years and their practice had been to wait for SUPE'S direction before starting new tasks; (2) it would take a few minutes for the torch men to drink their water; (3) WORKER1 would need a few minutes to reposition his lift; (4) SUPE thought he would return from the front gate before they had finished their water.

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For reasons not known, WORKER1 repositioned his lift and began his next cut above the tank door (note: unlike the previous sections, the location of this cut had not been identified by orange spray paint). Upon finishing his cut, WORKER1 raised his bucket above the rim of the tank and motioned to the excavator operator. Using hand signals, WORKER1 indicates to the operator that he was ready for the newly cut section to be pushed into the tank. The operator then extended the excavator boom and taps the freshly cut section.

Unlike the 3 previous wall sections, this section did not fold squarely into the tank. Instead, because approximately 2/3 of this section extended above the doorway (and therefore was not supported), the bottom, unsupported corner of this section dipped downward, causing the upper corner to tip toward the un-cut wall. The top corner of the cut section then hung up momentarily on the un-cut wall, causing it to bend in toward the interior of the tank. The newly cut wall section continued its downward descent, pulling the corner of the un-cut section down with it. The weight and momentum of the sagging steel drove the un-cut wall further into the tank interior. The collapsing steel struck the boom of WORKER1'S lift and pushed the entire unit backward. Because the carriage was aligned parallel to the wall, the wheels were not positioned to allow the carriage to roll backward. As a result, the force of the sagging steel drove the boom lift upward until it passed its center of gravity. At this point, the entire lift overturned and the basket, along with WORKER1, fell to the ground. Because the entire lift overturned, the fall protection gear worn by WORKER1 could not prevent his devastating injuries.

On his way back from the gate, SUPE heard the crash of the lift overturning. Other crew members, including WORKER4, WORKER1'S step brother, rushed to the scene and tended to WORKER1. Work was immediately suspended and emergency services (911) were called. WORKER1 was transported to the hospital by ambulance. Tragically, WORKER1 passed away as short time later.

Incident Analysis:

The fatality at the Kern facility is confounding for a number of reasons:

- The crew assigned to the Kern project were some of CWC's most experienced and talented workers; many with 10 or more years with the company.
- Over the past 5 years, the 4-person team involved in the Tank 1 incident had dismantled numerous tanks of similar size without serious incident using similar procedures. CWC management considered this crew to be their "A team" for dismantling elevated structures.

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- SUPE is an experienced field superintendent, fluent in both English and Spanish, and is well respected and liked by his field crews.
- The Tank 1 team reviewed the written JSAs for this assignment during the June 19 tail gate meeting. In addition, the team had physically inspected the tank prior to the initiation of site activities and had discussed their specific steps for cutting the tank.
- WORKER1 was wearing the required personal protective equipment including:
 - Fall protection harness with attached lanyard
 - Disposable coverall, gloves, ear plugs, and safety glasses
 - ½ face respirator with HEPA cartridges
 - Hard hat and work boots
- The Tank 1 team was not under any time pressure to remove the tank. In fact they were assigned the Tank 1 task while waiting for the completion of the asbestos abatement work elsewhere in the facility.

WORKER1 was an excellent employee. He was known as hard worker who was diligent about following health and safety requirements. He was very well liked by other members of the crew and was considered to be a mentor to many.

It is not possible to know why WORKER1 decided to make his next cut without waiting for direction from the Field Superintendent (SUPE). Clearly WORKER1 assumed that this section of wall would fold into the tank like the previous 3 sections. However, crew members interviewed for this investigation expressed surprise that WORKER1 would make a cut near the door because they believed that a cut in this location could jeopardize the structural integrity of that section of the tank wall.

Several crew members mentioned that WORKER1 had “not been himself” during the days leading up to the incident. WORKER1 was normally an outgoing person, very talkative, and enjoyed joking with coworkers. However, prior to the accident, he had apparently become quiet and reserved. This was so unusual that on Monday (June 18) before the incident, SUPE pulled WORKER1 aside to ask if there was something wrong.

WORKER1 apparently indicated that he was OK and was able to continue to work. According to SUPE and other members of the crew, WORKER1

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did not exhibit signs of impairment, he just seemed quite and a bit distracted. Note: the coroner's report did not indicate the presence of illegal or recreational drugs.

Corrective Actions/Program Enhancement:

As previously stated, it not possible to know precisely why **WORKER1** proceeded to cut the tank wall above the door while **SUPE** was away. Regardless, CWC was shocked and greatly saddened by this event and has made a number of changes in our operations to prevent similar incidents from ever happening again. Those changes include the following:

- A Senior Management Steering Committee has been established to provide safety oversight of all CWC operations. The Committee will focus on enhanced CWC Health and Safety management, program enhancement & development, employee training, and program assessments. Corrective actions and recommendations will be documented and assigned to a Responsible Party for resolution.
- Work plans will include diagrams or photos of the structures to be demolished with the sequence of steps that will be employed to accomplish the task. Work plans will be reviewed and approved by the CWC Director of Operations, Project Manager, and Health and Safety Manager. A Registered Professional Engineer will also review plans that involve demolition activities that could impact the stability of the structure.
- Changes to Work Plans will be reviewed and approved by the CWC Director of Operations and the CWC Safety Manager. Changes that may impact the structural integrity of the facility being demolished will also be reviewed and approved by a Registered Professional Engineer.
- Field crews have been instructed to engage only in tasks that have been evaluated and approved by the Superintendent.
- A CWC superintendent will be present for all tank demolition activities. Tank demolition activities will be suspended if the superintendent is call away.
- Crews will not initiate cuts on tank walls until the locations have been approved and identified by the superintendent.
- Field crews have also been instructed to suspend their work activities if they are unsure of the proper procedure for safely completing the task or if they encounter changing conditions that could impact the safety of the crew, client, or members of the public.

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Please refer to Appendix A “Kern Power Plant Demolition Program Enhancement Plan” for additional details.

Attachments:

Figure 1: Event Timeline

Figure 2: PG&E Kern Fatality “Why Tree” Diagram

Appendix A: Kern Power Plant Demolition Program Enhancement Plan

Appendix B: Tank 1 Work Plan

Figure 1
PG&E Kern Power Plant Fatality
Event Timeline

6/19/2012:

0600:

- Daily safety tailgate meeting

0620:

- Crew assignments are made and work begins

0730 – 0846:

- First 3 section of the tank are successfully cut

0850 - 0855: (approximately)

- [REDACTED] SUPE is notified that he needs to meet a contractor at the front gate.
- [REDACTED] SUPE gives the 2 laborers bottles of water and informs his crew that he will return shortly

0855 - 0907:

- [REDACTED] WORKER1 begins to cut unmarked tank wall section above doorway
- [REDACTED] WORKER1 signals to equipment operator [REDACTED] WORKER3 to push in freshly cut wall section

0908:

- Newly cut wall section snags top, left corner (as viewed from outside the tank) of un-cut wall and bend it down into the tank toward the [REDACTED] WORKER1 boom lift.
- Force of collapsing wall drives boom backward causing the carriage to overturn.

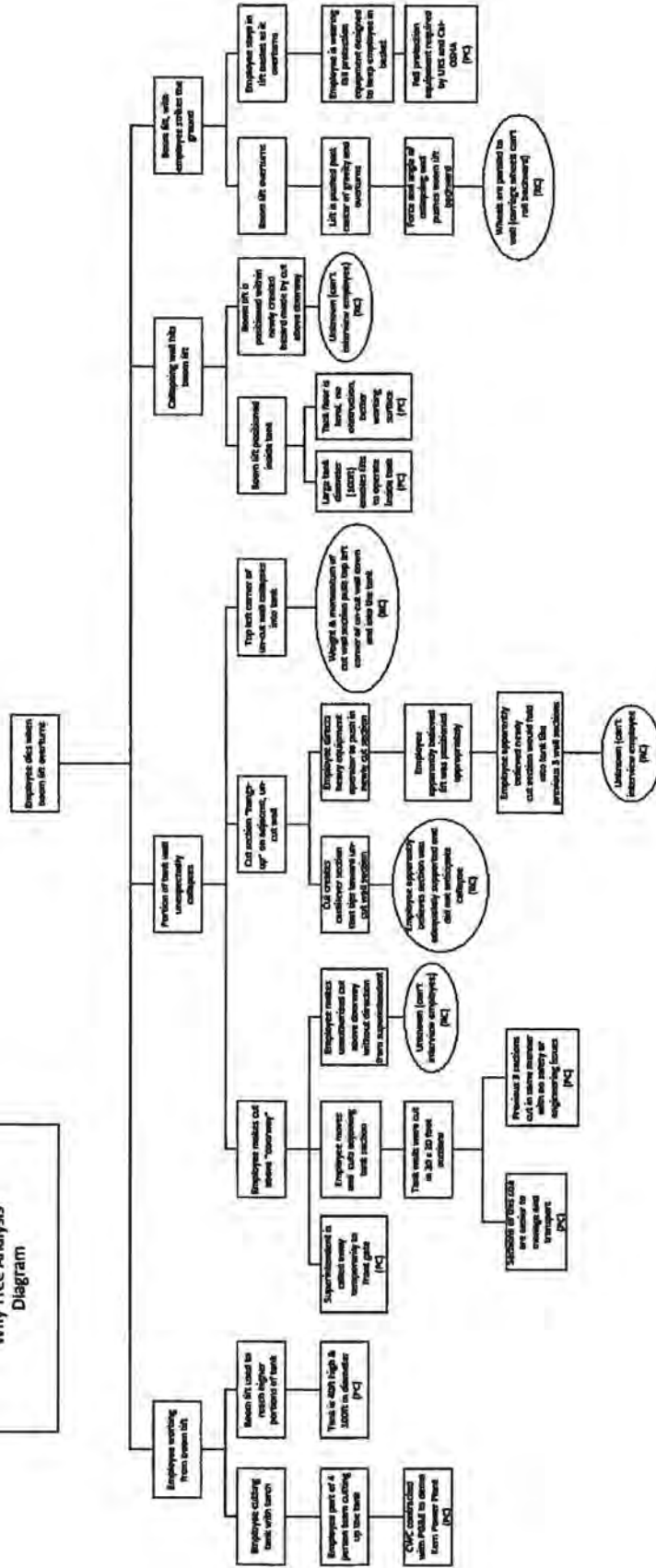
0910 - 0920: (approximately)

- Co-workers come to the aid of [REDACTED] WORKER1
- Emergency services are called
- Site operations are halted

0920 - 0930: (approximately)

- Emergency personnel arrive, tend to [REDACTED] WORKER1, and transport him to hospital

Figure 2
 PG&E Kern Fatality
 Why Tree Analysis
 Diagram



PC - Proper Condition
 RC - Root Cause

APPENDIX A

Kern Power Plant Demolition Program Enhancement Plan

Appendix A
Program Enhancement Plan
PG&E - Kern Power Plant Demolition
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Program Element	Program Enhancement	Responsible Party	Start Date	End Date
Leadership	A Senior Management Steering Committee will provide safety oversight of CWC operations. The Committee will focus on CWC Health and Safety management, program enhancement & development, employee training, and program assessments. Corrective actions and recommendations will be documented and assigned to a Responsible Party for resolution.	[REDACTED]	In progress	Ongoing
	A full time Health and Safety Manager will be assigned to the Kern Project. This person will report to the CWC Director of Operations and work closely the project superintendents. This person will have intimate knowledge of demolition industry and have training in: <ul style="list-style-type: none"> • Hazard recognition • The URS Behavior Based Safety programs with emphasis on 4-Sight. • Emergency procedure. • URS reporting requirements for safety observations, near miss, and incidents. 	[REDACTED]	7/30/12	End of field activities
	Health and safety structure will be reorganized to include a full time HS&E manager.	[REDACTED]	7/25/12	8/17/12
Training	Continue to provide BBS training to all field staff with added focus on the fundamentals of 4-Sight including: <ul style="list-style-type: none"> • Hazard identification and analysis • Change management • Stop work authority • Fitness for duty 	[REDACTED]		Ongoing

**Appendix A
Program Enhancement Plan
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Program Element	Program Enhancement	Responsible Party	Start Date	End Date
Training (Cont.)	This training will be provided to new staff within the first week of employment. Training status of field staff will be reviewed monthly to verify completion.			
	CWC field supervisors and project managers will receive additional training on the fundamentals of project execution, staff communication, and changed conditions management. The training will include the concept of "critical conversations" as related to safety.		8/6/12	8/10/12
	Work plans will be reviewed and approved by the CWC Director of Operations, Project Manager, and Health and Safety Manager. A Registered Professional Engineer will also review plans that involve demolition activities that could impact the stability of the structure.		7/16/12	Ongoing
	The Health and Safety Plan (HSP) will be modified to incorporate the requirements for Safe Work Plans and to provide additional focus on: <ul style="list-style-type: none"> • Roles & responsibilities • Emergency response procedures • Observation, near miss, and incident report procedures • In-field hazard analysis (4-Sight) • Change management procedures • Fitness for duty expectations 		7/16/12	Ongoing

Appendix A
Program Enhancement Plan
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Program Element	Program Enhancement	Responsible Party	Start Date	End Date
Training (Cont.)	The HSP will be incorporated into the Project Management Plan as a stand-alone appendix to enhance compatibility and consistency with the 2 documents.			
	<p>Future projects will have a project kick-off meeting and will be conducted with all project staff prior to the initiation of field activities and will include identification of appropriate Safe Work Plans required. At a minimum, this meeting will include:</p> <ul style="list-style-type: none"> • A brief review of the project work plan • Focused review of the HSP and associated THAs. • Review of employee qualifications and training • General project requirements • PPE requirements • Stop work authority • Change management procedures. • Fitness for duty expectations • Confirmation that employees with English as a second language fully understand the Plan. • Review of Safe Work Plans. 	H&S Manager		
	<p>The daily tail gate safety meeting will include:</p> <ul style="list-style-type: none"> • Review Safe Work Plans that may be performed. • Assignments and anticipated work schedule for the day • Confirmation that employees with English as a second language fully 		7/25/12	Daily

Appendix A
Program Enhancement Plan
PG&E - Kern Power Plant Demolition
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Program Element	Program Enhancement	Responsible Party	Start Date	End Date
Training (Cont.)	<p>understand the topics.</p> <ul style="list-style-type: none"> • Review applicable JSAs • Other issues or hazards that may develop during the work day (bad weather, other contractor activities, fatigue, etc.) <p>THAs will be reviewed again if crew composition changes during the day (ie: if a crew is assigned to a particular task and it is determined later that day that additional workers are needed to complete the tasks, applicable JSAs will be reviewed again to verify all team members understand task hazards and controls).</p>			
Audits	A field audit will be conducted by URS H&S staff within the first two weeks of initiation (or resumption) of significant field activities and each month thereafter. Audit reports will be submitted to the Senior Management Steering Committee.	[REDACTED]	8/12	End of field activities
	H&S manager (to be assigned) will perform weekly audits (or as level of work activities dictate)	[REDACTED]	8/12	Ongoing

APPENDIX B
Tank #1 Work Plan



628 E. Edna Place
Covina, CA 91723
Phone: 626-967-9799
FAX: 626-967-1479

TANK # 1 WORK PLAN

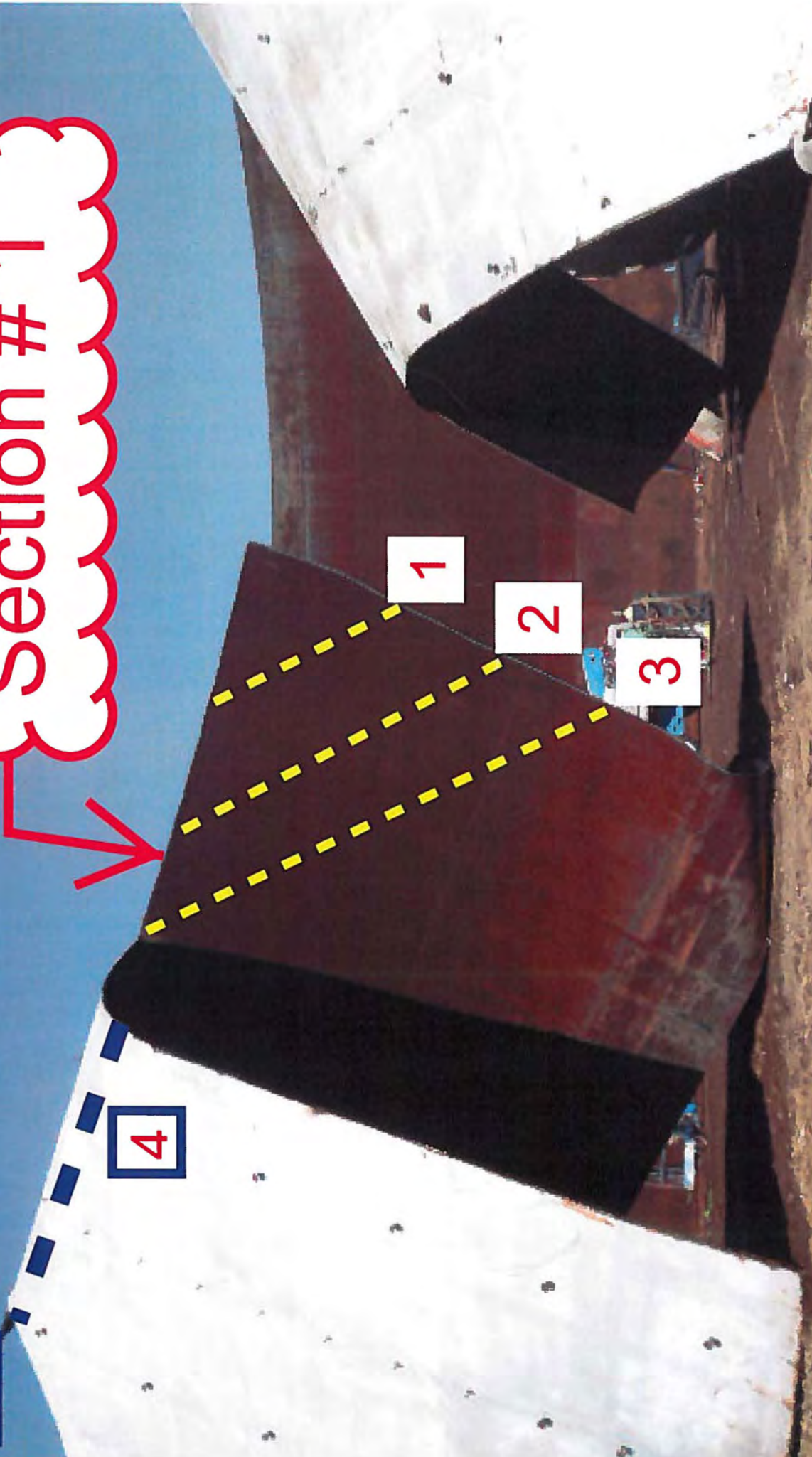
1. Back drag and level tank perimeter areas for boom lift operations using a track loader
2. Torch man will work from a boom lift positioned outside the tank cutting 3 strips of the cantilevered portion of section #1 of the tank finishing with cut #4, felling the section within the tank(see photo #1)
3. A grapple mounted excavator will remove fallen section #1 to a processing area.
4. The excavator will then re-position to the interior of the tank and secure the grapple to the stiffener plate as indicated in photo #6. This will stabilize section #2 while the curvature is removed by torching.
5. Torch man will work from boom lift positioned outside section #2 of the tank and begin torch cutting along cut line 1 down to ring #3 of the tank.
6. Torching will continue laterally along ring #3 as illustrated with line 2 of photo #6 through to the north end of the section.
7. The excavator will relocate to the outside of the tank to support the removal of the remainder of the tank.

Normal tank removal activities will resume working from the outside of the tank as detailed in photo #5 and the tank removal plan enclosed

#1

4

Section # 1



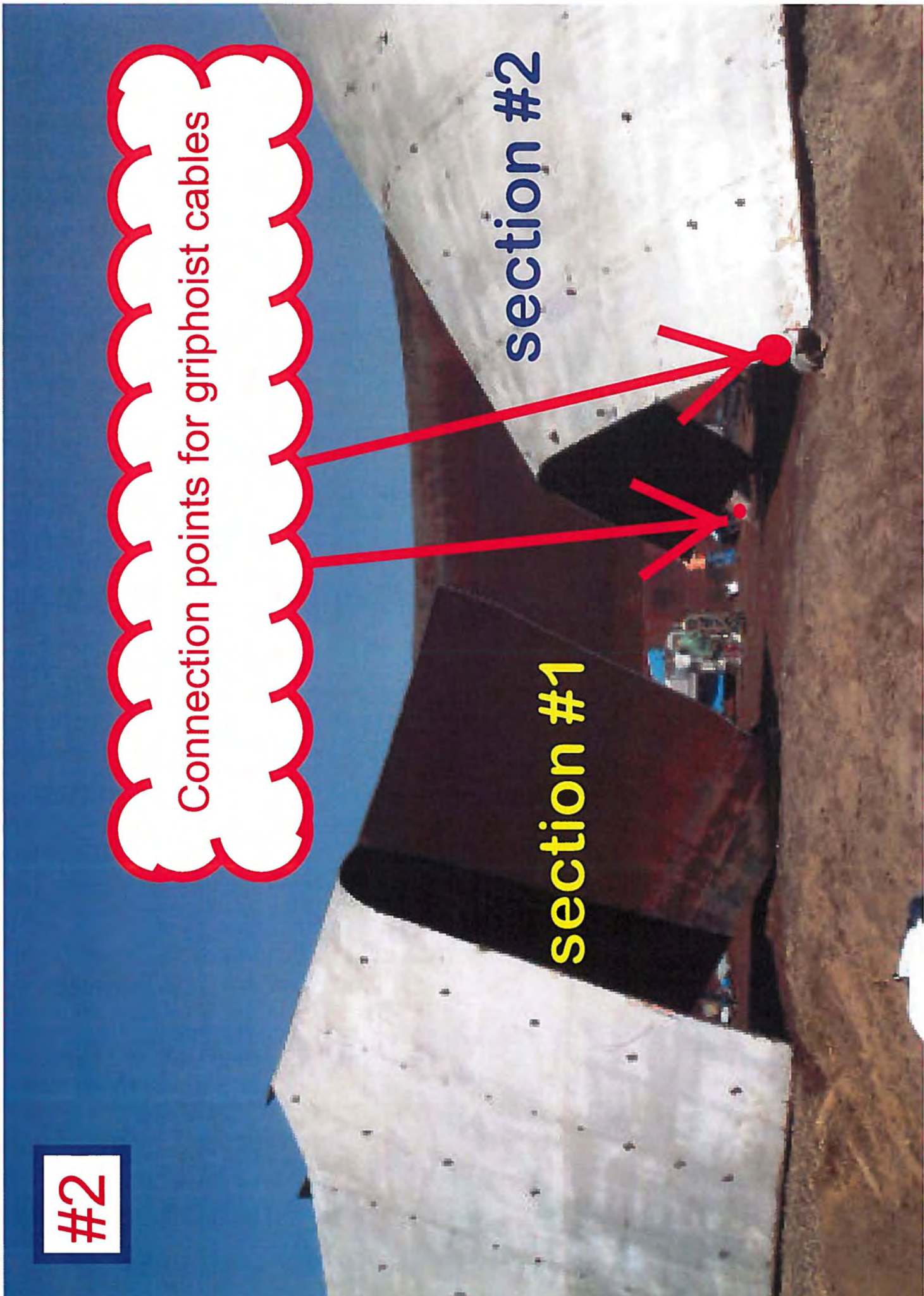
06.19.2012 09:35

#2

Connection points for griphoist cables

section #1

section #2



#3

griphoist cable connection point to failed section @ stiffener plate

section #1

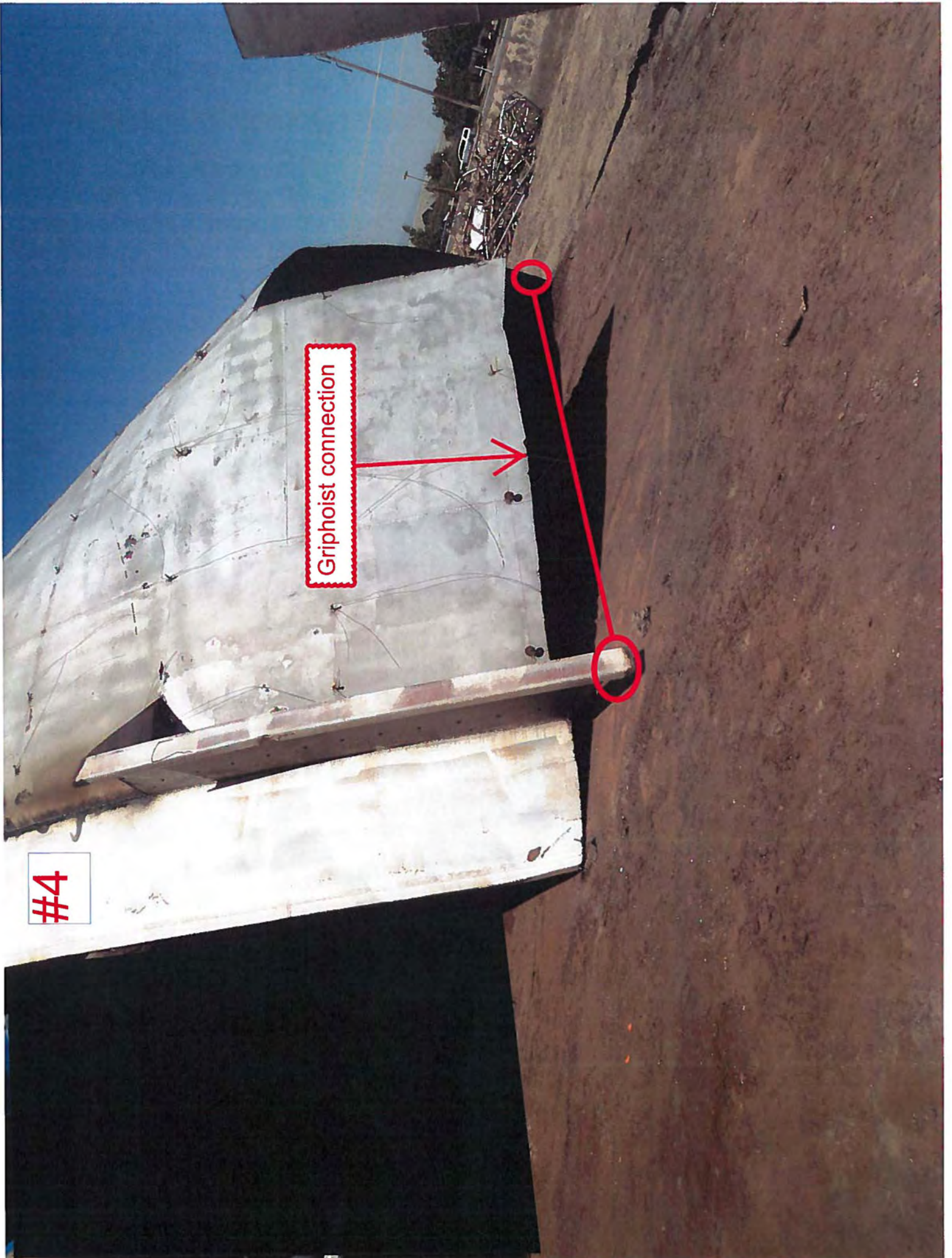
section #2



06.19.2012 09:24

#4

Griphoist connection



#5

< 12'

< 12'

< 12'

< 12'

< 12'

< 12'

< 12'

40'

< 12'

< 12'

< 12'

< 12'

< 12'

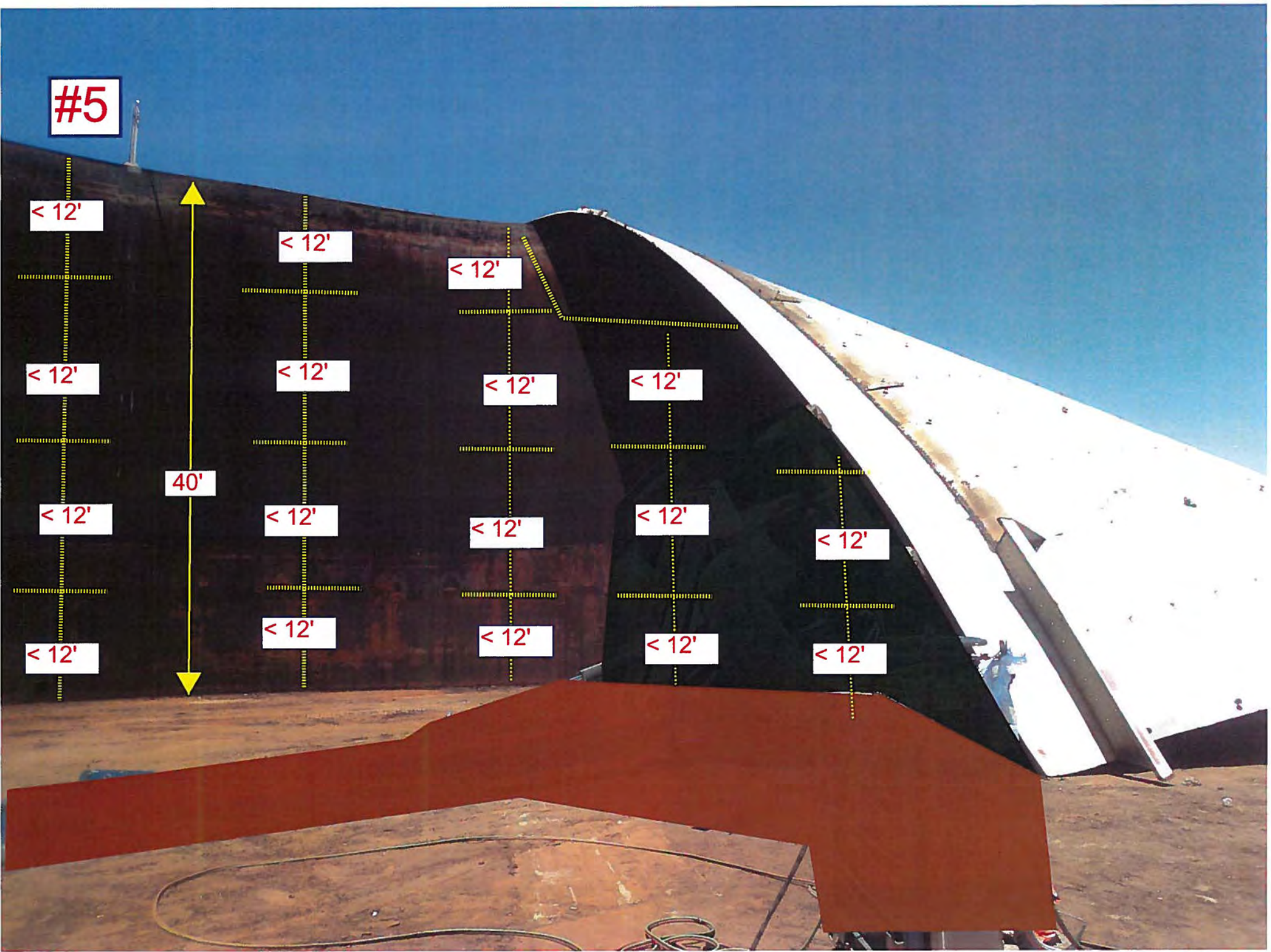
< 12'

< 12'

< 12'

< 12'

< 12'



#6

1

Section # 2

2

Section #1

Connection point for excavator while section #2 is being torched

