COMPILATION OF A HANDBOOK FOR THE CAL POLY TRACTOR PULL TEAM

by

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ACKNOWLEDGEMENTS

First of all I would like to thank the Cal Poly Tractor Pull Team for all of the fun over the past four years. It is an experience I will never forget.

I want to thank Dr. Mark Zohns and Gary Weisenberger not only for their assistance with the creation of this senior project and handbook, but also for their understanding and experience they bring to the BioResource and Agricultural Engineering Department. It would not have been the same without you.

I also want to thank the tractor pull team members and friends who helped me with this project. Needless to say, it was an undertaking.

Last but not least, I want to thank my family for putting up with me for all this time. Without your constant support and constant nagging to get back to doing homework, none of this would have been possible.

ABSTRACT

This senior project discusses the compilation of a handbook for the Cal Poly Tractor Pull Team. The handbook was written to aid new team members and students in getting acquainted to the history of the motorsport, what is expected of a team member, standard operating procedures of equipment, and event operations.

Results were obtained from a quiz administered to various persons. Responses showed ease of locating information as well as areas of potential improvement.

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TABLE OF CONTENTS

LIST OF FIGURES

INTRODUCTION

Background

Tractor pulling is a motorsport that challenges a competitor to pull a weight transfer machine (also known as a sled) as far as possible down a straight dirt track. The exact origins of tractor pulling are unknown, but it most likely started as many other motorsports did; one person bet that his tractor was better than someone else's. Eventually the competition escalated to the point where custom tractors were built for the purpose of tractor pulling, and the sport was born. Today, pulling competitions are held worldwide and by a variety of machines ranging from stock tractors to fully custom machines.

Figure 1. Tractor pulling a weight transfer machine (sled).

The California Polytechnic State University (Cal Poly) Tractor Pull Team owns two pulling tractors and actively competes in events throughout California and Nevada as a member of the Pacific Tractor Pullers Association (PTPA). The team is comprised entirely of students and is responsible for the maintenance, modification, transportation, operation, and driving in competition of its two modified pull tractors. The team is advised by BioResource and Agricultural Engineering (BRAE) faculty members Dr. Mark Zohns and Gary Weisenberger, who offer their experience and expertise to aid the team. The tractor pulling team is designed to allow students the experience of motorsport competition as well as act as an educational tool to support concepts and material taught in BRAE classes at Cal Poly.

Justification

As the Cal Poly Tractor Pull Team is responsible for the maintenance, modification, transportation, and operation of the two modified pull tractors, it is important that all members are informed of the maintenance and operational procedures associated with the tractors. Currently, students must be taught in a one-on-one fashion by faculty advisors and experienced members of the team as to how to properly carry-out the aforementioned procedures. This task is tedious, slow, and information can vary causing some members to be ill-informed. There is also the issue of how competition events are operated, what competitors need to do, rules regarding safety concerns, technical specifications a vehicle needs to meet, and appropriate behavior at events. Currently everything is taught to members as situations present themselves.

There exists a need for a tractor pull handbook that compiles all of this information and archives it for students to reference. Such a handbook would address all of the aforementioned concerns and issues, as well as present a consistent learning medium through which all members and students will have access to the same information so as to avoid the inconsistencies that occur through one-on-one teaching, and to preserve this information for future members.

LITERATURE REVIEW

A search was initiated to find sources pertaining to the construction of a handbook and guidelines for proper and efficient formatting.

Dr. Philip Hodgson's internet posting through the internet site UserFocus centered around how to construct an effective handbook or manual and formatting concerns. Dr. Hodgson recommends for the general layout of an effective handbook, that it should include a one page quick start guide to help acquaint the user with the purpose of the handbook. For a handbook concerning a machine or product, all functions of the machine or product should be explained in their purpose and function, rather than describing how to use them. This is to help the end-user in understanding how a machine or product works rather than simply how to operate it (Hodgson, 2013).

Dr. Hodgson claims that a good handbook or manual avoids a textbook feel and makes purposeful and effective use of color so as to make it more appealing to the user and more likely to be read. A good handbook strikes a balance between being heavy and detailed and small and flimsy. Organizational formatting is also a concern; a user should be able to quickly find information. Color-coded tabs are recommended for detailed handbooks, as well as breaking down the information hierarchically into sections based on chronology of use and frequency of use. A glossary of technical terms is recommended. Unnecessary cross-referencing to other parts of the handbook should be avoided (Hodgson, 2013).

Dr. Hodgson's recommends making use of visual stepping stones in procedures by clearly showing individual numbered steps. Procedures should mimic the timing and sequencing of actual operations, avoid lengthy paragraphs and technical jargon, and assume that the user has no prior experience or knowledge of the procedure, so as to make the procedure as easy to follow and duplicate results as possible. The article also comments on page design with recommendations for a 12 point san-serif font, high text-to-background contrast for easy reading, and avoiding changing font styles (Hodgson, 2013).

This handbook will contain standard operating procedures (SOPs) regarding routine maintenance of the modified pulling tractors. This section was investigated, and found that the Environmental Protection Agency (EPA) has published guidelines for the preparation of standard operating procedures. The EPA defines an SOP as "A set of written instructions that document a routine or a repetitive activity followed by an organization…" and is integral in maintaining quality of product, service, or procedure. Some characteristics of a good SOP, as defined by the EPA, are listed here (EPA, 2007):

- Should be concise, step-by-step, easy to read format
- Information presented should not be overly complicated
- Avoid speaking in the second person, using the term "you"
- Checklists are good for presenting information
- Should be written so that a person with limited experience but possessing basic knowledge can successfully reproduce the procedure unsupervised

Various handbooks in print were examined and compared to analyze how each was strong and weak in its layout and design. *The Sketchnote Handbook* by Mike Rohde is a minimalistic design with lots of space between lines of text, different fonts and font sizes, variations in text color, and stylized bullet points (Rohde, 2013). This particular handbook uses these characteristics to its advantage considering its content. Headings to each section are of a larger font than the body of the text and colored differently to standout and allow the reader to quickly and easily keep track

of what page he or she is on. Bullet points are stylized giving them emphasis over other content on the page. Although the formatting of the handbook is attempting to stray away from a monotonous black on white textbook-feel, it can be distracting as the reader's attention is being pulled in many directions.

A project design handbook was also analyzed (Caldwell, 2002). This handbook employs colorful, easy to understand graphics, definitions separated and boxed from surrounding text for quick definition look-up, and headings placed over colored backgrounds to make them standout from the text for easy navigation. This formatting system is setup to allow a reader to quickly find information within the text and graphics are designed to provide clarification to topics covered. However, this formatting style also uses large blocks of text which may make some readers shy away from reading and focus more on the graphics.

A section from a gypsum construction manual was also inspected (USG, 2009). This handbook section concerned methods of framing within a building. On the plus side, this handbook was rich with detail and easy to comprehend graphics and diagrams. Headings are moved far left, bolded, and of a larger font than the body of text. This enhances navigation and location of information. However like the project design handbook, the text is in large blocks, which at times can be unappealing. The author of this handbook though did a good job of breaking up these blocks of text and adding appropriate subheading to aid a reader in finding pertinent information quickly. The formatting of this work appears to be striking a balance between level of detail and user-friendliness.

One issue with handbooks is readability. The x-height of a font is the relative size of a typeface based on the height of the letter "x" taken as the height of all lowercase letters compared to the height of uppercase letters. Uppercase is referring to a tall letter, like "h". The lesser the difference between a lowercase letter and an uppercase letter, generally the easier the text is to read. The x-height of a typeface is independent of the point size, or font size.

Agriculture	Agriculture	Agriculture
Eucrosia 11 pt.	Helvetica Neue 11 pt.	Ambrosia 11 pt.

Figure 1. X-Height Comparison

All three fonts are the same point size (11 point). However, the Helvetica Neue is the easiest to read as it has a large x-height. This makes the text appear larger and more legible than the other fonts. Also noted in this source is how italics and underlining can be a distraction to the reader. Italics and underlining are recommended to be used sparingly (RGD Ontario, 2010).

PROCEDURES AND METHODS

Design Procedure

The scope of the handbook was set at the introductory level so it could easily be understood by new team members who may or may not have experience with tractor pulling and/or mechanical devices. It was decided that a section of the handbook should be dedicated to detailing how mechanical devices and machines such as the weight transfer sled, the centrifugal clutch, and the hydraulic winch system on the gooseneck trailer operated. Due to battery problems experienced by the tractor pull team, a section on battery maintenance was also included.

Formatting of the handbook was kept simplistic. Procedures were designed to clearly state the tools and materials required, as well as communicate the step by step process in an easy to understand format. Individual steps were clearly marked for easy reference and figures were added to reinforce the text and actions required. Procedures were designed to mimic real-world actions in chronological order so users can duplicate the desired actions and results.

Content Selection. Given the scope of the project being an introductory handbook, the content selected reflected as such. Primary emphasis was given to tasks and information that would be most beneficial to a new team member, including how certain mechanical devices operated, safety guidelines and concerns, event operations, and checklists for items commonly taken to competition events. This emphasis centered around what a new team member would most likely encounter and have questions about. Advanced maintenance procedures were not included due to depth of technical knowledge required, lack of a hands-on experience through reading a procedure, and varying conditions due to mechanical wear and changing situations. The more advanced procedures were decided to best be learned through one-on-one instruction.

Handbook Topics. The following content was selected for the Cal Poly Tractor Pull Handbook:

- Responsibilities of a tractor pull member
- History of tractor pulling on the West Coast
- History of Mustang Fever
- History of Poly Thunder
- History of the Sleds
- Modified tractor technical specifications
- Battery maintenance
- Centrifugal clutch operation
- Weight transfer sled operation
- Hydraulic winch operation
- Mustang Fever Start-up and shut-down procedures
- Poly Thunder Start-up, Shut-down, and fuel line draining procedures
- Loading and unloading tractors from gooseneck trailers
- What to do before leaving for an event
- What to take to an event, what to do on arrival
- The basics of competition
- Vehicle classes

- What to do after a pull
- Official NTPA rules for event procedures, operations, and class requirements
- Sample driver's log
- Sample maintenance log

Construction Procedure

The handbook was constructed with Microsoft's word-processing program, Microsoft Word.

History Sections. Information regarding the history of the tractor pull team was obtained through the Cal Poly Tractor Pull Team's website. The information was confirmed with tractor pull advisors Dr. Mark Zohns and Gary Weisenberger. Graphics were also obtained from the same website. History of the sport was obtained through interviews with Gary Weisenberger.

Maintenance Section. The maintenance section of the handbook was constructed from information gathered from online sources, interviews with Dr. Mark Zohns, Gary Weisenberger, and experienced tractor pull members. Graphics for this section were found online. For the section about the operation of the centrifugal clutch, graphics were created with Dassault Systemes' three dimensional software program Solidworks for ease of showing its operation and components.

The hydraulic schematics for the gooseneck trailer winch were created with Autodesk's computer aided drafting software AutoCAD.

Standard Operating Procedures. Information regarding standard operating procedures was obtained through experienced members of the tractor pull team. The individuals interviewed had been with the team for a few years and were experienced in the operation of the modified pull tractors and gooseneck trailers.

Competition Events. The competition events section of the handbook was compiled via information pulled from the 2013 edition of the National Tractor Pullers Association rule book. This information was used to lay out a summarization of competition rules, as well as various track official positions and safety concerns.

The subsections pertaining to what to take to a pull, before leaving for a pull, and after the pull were compiled after interviews with Dr. Mark Zohns, Gary Weisenberger, and experienced tractor pull members.

NTPA Rules and Regulations. Content for the NTPA rules and regulations was taken from the 2013 edition of the NTPA rule book as well as a reformatted version from Dr. Mark Zohns for clarity of graphics.

Sample Driver's and Maintenance Log. The sample driver's and maintenance logs included in the handbook were taken from existing documentation used by the tractor pull team.

Testing Procedure

Testing of the handbook was performed via a nine question testing and evaluation quiz that asked participants to locate information within the handbook to answer the questions. The purpose of the testing was to evaluate the ease of which information could be located as well as have each participant select at a random a section of the materials and comment on its readability, quality of information, graphics, and formatting. The quiz in located in Appendix B.

RESULTS

The responses to the quiz showed each participant was able to locate the requested information. Although the participants were not timed for the duration of the test, all participants finished in roughly the same amount of time. The responses can be seen in Appendix C.

The responses for Question 9 which instructed the participant to randomly choose a section and comment on it results in no two participants selecting the same section. Comments left on this question all pointed to the graphics being helpful and clear and the instructions or text being easy to follow.

DISCUSSION

One of the responses received was missing part of the requested information for the question. It is possible that the participant was unable to locate the requested information. However it is more likely that the participant either misread the question or did not read the entire question and respond. Question 8 on this particular participant's response sheet showed the participant misreading the question and listing everything required to be checked on the trailer before leaving on a trip instead of just two examples as requested. The other participant responses all demonstrated adequate understanding of the questions and material.

A difficult aspect of this project was determining how to layout all of the information and material in a logical and understandable way that can be quickly referenced by users. The layout of this handbook was focused on creating a transition from background information to maintenance basics, then flowing into standard operating procedures and finally what to do at an event. Simplified, the layout flows from the history, to how to do things, to what to do and when. This format seemed the most logical for this material.

RECOMMENDATIONS

As this project was the creation of a handbook for a motorsport team, the information within the handbook will need to be updated and revised as the nature of the sport and team change. For this handbook to be most useful, the updates and revisions should occur as the sport and team evolve.

Further enhancements to this version of the handbook could include section tabs or tags printed onto every page designated what section the user is currently looking at. This would increase navigability of the handbook and provide and easier and quicker method of locating information.

Testing of a similar project should include a question regarding ease of finding information and ask participants to rate their difficulty on a numeric scale so more quantifiable results can be gathered. This question should also be followed by a comment section on how this can be improved.

As a continuation of this project, the next step to take would be to compile a complete maintenance and operations manual for both modified pull tractors. Such a manual would include standard operating procedures for all maintenance that is done to the tractors. This would be a step towards documenting and preserving said procedures for future team members so as to ensure proper maintenance is performed. This manual would extend its scope to all equipment utilized by the tractor pull team including, but not limited to, the gooseneck trailers, mobile weather station, and data acquisition system.

A continuation of this project should also select pertinent standard operating procedures for each piece of equipment used and laminate and store each procedure with the equipment for easy access to users. Such actions would make available important information regarding safety concerns and proper procedures to avoid personal injury and damage.

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APPENDICES

APPENDIX A

HOW PROJECT MEETS REQUIREMENTS FOR THE ASM MAJOR

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ASM Project Requirements

The ASM senior project must include a problem solving experience that incorporates the application of technology and the organizational skills of business and management, and quantitative, analytical problem solving.

Application of Agricultural Technology. This project contains aspects of power transmission, data acquisition systems, and hydraulic systems.

Application of Business and/or Management Skills. This project concerns machinery management.

Capstone Project Experience

The ASM senior project must incorporate knowledge and skills acquired in earlier coursework (Major, Support and/or GE courses). This project incorporates knowledge/skills from these key courses:

- BRAE 129 Lab Skills/Safety
- BRAE 133 Engineering Graphics
- BRAE 142 Machinery Management
- BRAE 151 AutoCAD
- BRAE 152 Solidworks
- BRAE 301 Hydraulic/Mechanical Power Systems
- BRAE 321 Agricultural Safety
- BRAE 418/419 Agricultural Systems Management
- ENGL 148 Technical Writing

ASM Approach

Agricultural Systems Management involves the development of solutions to technological, business or management problems associated with agricultural or related industries. A systems approach, interdisciplinary experience, and agricultural training in specialized areas are common features of this type of problem solving.

Systems Approach. The project involves various mechanical, oil-hydraulic, electrical, and communication systems.

Interdisciplinary Features. This project involves aspects of mechanical systems and agricultural safety.

Agricultural Training. This project contains material intended to be used as an educational tool to teach students the basics of various systems (mechanical, hydraulic, electrical), as well as machinery management.

APPENDIX B

HANDBOOK TESTING AND EVALUATION QUIZ

APPENDIX C

TESTING AND EVALUATION RESPONSES

APPENDIX D

CAL POLY TRACTOR PULL HANDBOOK

CAL POLY TRACTOR PULL HANDBOOK

Written by Jake Wilcox

Spring 2013

TABLE OF CONTENTS

LIST OF FIGURES

ACKNOWLEDGEMENTS

I would like to thank Dr. Mark Zohns and Gary Weisenberger not only for their assistance and contributions to this handbook, but also to the team. This team would not be nearly as educational or fun without their wisdom and experience.

I also want to thank the various tractor pull members who helped me compile information for this handbook. Their hands-on experience with the tractors and club operations helped to make this handbook possible.

I also would like to thank the tractor pull sponsors. Without their support the tractor pull team as we know it would not exist.

Last but not least, I want to thank all of the tractor pull members. Their hard work and commitment to the team, from putting on the Open House Pull to taking the tractors to competition, is what keeps this club going.

INTRODUCTION

As a member of the Cal Poly Tractor Pulling Team, you have the unique opportunity to participate in the motorsport of tractor pulling. Cal Poly is the only college in California, perhaps even the United States to have a tractor pulling team.

The Cal Poly Tractor Pulling Team is proud to be a team comprised solely of students. Cal Poly Tractor Pull members are responsible for the maintenance, transportation, and driving in competition of its two modified tractors. This means that as a member of the team, you have the opportunity to drive one or both of the modified pull tractors in competition as well as perform the routine maintenance required to keep both tractors running.

This handbook was written to aid members of the team, new and experienced, in how tractor pulling events operate, how to properly maintain the modified pull tractors and gooseneck trailers, and act as an educational tool to further concepts discussed in classes.

Prior to the writing of this handbook, the Cal Poly Tractor Pull Team had no written guide to introduce new students to the tractor pulling team and to the sport. Educating new students on the ins and outs of the sport and the team was slow, and usually was done on a one-on-one basis as situations presented themselves. This handbook is designed to introduce new members to the basics so everyone is “in the know”, as well as clarify important safety and operation issues.

This handbook by no means replaces hands-on instruction from experienced members or faculty advisors. This compilation of information is intended to act only as a reference source and educational tool. Always consult a faculty advisor if you are unsure of how to properly perform maintenance, inspections, loading/unloading of tractors, or rules and regulations of events.

The Cal Poly Tractor Pulling Team is a unique opportunity, get involved and take advantage of it.

Happy pulling!

RESPONSIBILITIES OF A TRACTOR PULL MEMBER

As a member of the Cal Poly Tractor Pull Team, you are representing the BioResource and Agricultural Engineering Department as well as Cal Poly University. While you are a member on the team, all university codes of conduct apply. This means all members of the Tractor Pull Team will exhibit professional behavior whenever the team and tractors are being displayed at an event or pulling in competition. Anything less than professional behavior and conduct will not be tolerated. Remember, whether you are wearing a tractor pull shirt, jacket, or just at an event, you are representing Cal Poly and the Tractor Pull Team.

While at a competition event, there are rules and regulations all competitors must adhere by. Be sure to carefully read the summation of rules and regulations located in Appendix A. Most importantly, while at an event the consumption of alcohol is strictly prohibited. Doing so while at an event, or arriving in a state of inebriation is not only dangerous in the pits, but can disqualify the entire team for that event and possibly future events.

As a Tractor Pull Team member, you will also have the opportunity to work on the tractors. It is the responsibility of every member who works on the tractors to update the maintenance logs every time work is performed. Whether it is a simple oil change, valve or clutch adjustment, the logs must be filled out to ensure the documentation is up to date. At the end of every pull, the driver of each tractor must also fill out the pulling log to document when, where, and how the tractor performed. This is important for later pulls when determining how to setup the tractor.

Do not perform maintenance or attempt to start either of the modified pull tractors if you are not sure how to do so. Always tell a tractor pull advisor whenever maintenance is to be performed and ask for help or guidance if you are unsure of anything. Communication is the key to preventing damage and personal injury.

THE HISTORY OF TRACTOR PULLING ON THE WEST COAST

Tractor pulling started just as many other motorsports did; with a bet. Tractor pulling began when a farmer bet another farmer his team of horses could pull a heavier load. A wood skid was employed and loaded with bags of seeds until the team of horses could no longer pull. As agriculture mechanized, horses in the field were replaced with tractors, and naturally, farmers used their new tractors in the pulling competitions.

In 1968, a man named Richard "Billy" Watkins drew plans for a weight transfer machine. Although the plans called for a machine that would drastically change the sport, the weight transfer machine was never built.

In 1972, Cal Poly started a tractor pulling club. The club built a steel sled that used people as weights. As the sled progressed down the track, people on the sides of the track would jump onto the sled creating more resistance for the tractor. This sled worked well until competitors started building-up their tractors.

In 1973, Cal Poly built the first weight transfer machine on the West Coast. This caused a drastic change in tractor pulling due to how the sled creates resistance. Go to the Maintenance and Know How section of this handbook for the specifics on how it works. As the sport grew in popularity, more vehicles classes were added and vehicles became more powerful. The sled had to be modified many times to adapt to the new competition environment. Eventually, the sled had to be replaced. The sled was never dismantled; it resides on the "BRAE ramp" behind building 8A.

In 1996, the old machine was replaced with Gary Weisenberger's Tuff-Drag'n Sled, which is still in use today.

The Agricultural Engineering Department (now BioResource and Agricultural Engineering) started the tractor pull club as a way of getting students involved and as a way to generate money for student scholarships. The original weight transfer machine was leased out to county fairs and events, and the money the sled earned was saved and given back to the students. This tradition remains to this day and is responsible for the majority of the scholarships the BRAE department is able to give to its students.

MUSTANG FEVER

Mustang Fever was built in the department by students Myles Anderson, Russ Angold, and Bobby Pierce in 1999 as part of the senior level mechanical design classes. The entire tractor was designed and built by the trio under the supervision of faculty advisors Dr. Mark Zohns and Gary Weisenberger. The design centered around the two major components of the tractor, the Allison V 1710 twelve cylinder aircraft engine and the Rockwell SQHD differential.

Figure 1. Frame jig.

The Rockwell rear axle was chopped and shortened to accommodate the narrow frame and large rear tires. The axle shafts were shortened and new splines machined into them so planetary gears could be fitted for further gear reduction.

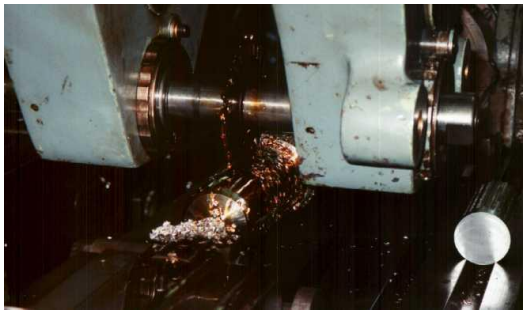

Figure 2. Cutting new splines into axle.

A Fuller 5-speed transmission was mounted into the frame with custom-made mounting plates. The Allison engine was mounted via rectangular tubing utilizing the vertical mounting holes on the engine.

The steering is taken care of with a fully-hydraulic system. The steering wheel is mounted directly to a low-displacement hydraulic motor plumbed to a double acting/double rod cylinder.

Figure 3. Double acting cylinder steering.

The hitch was designed and built to 1999 NTPA regulations.

Figure 4. Hitch assembly.

The exhaust zoomies on Mustang Fever were built by Dr. Mark Zohns. Each cylinder has two exhaust ports with 2 ½" exhaust tube combining into one 3 ½" mandrel-bent exhaust tube. The zoomies became known as the "Zoomies by Zohns." In 2012, the zoomies were replaced with new ones of the same design.

Figure 5. "Zoomies by Zohns."

On March 28, 1999, Mustang Fever rolled out of the shop and made its first pull. Testing included six hooks, one by each of the design and construction members and both advisors.

Figure 6. Mustang Fever ready to pull.

POLY THUNDER

Poly Thunder was originally built as Rocky Mountain Thunder by Albert Wada, a potato farmer from Blackfoot, Idaho. He built and ran the tractor during the 80's until one of the engines was fatally damaged. The tractor sat for ten years before he donated it to the Cal Poly Tractor Pulling Team.

Figure 7. Rocky Mountain Thunder.

In fall of 2002, a group of students went to Blackfoot, Idaho to get Rocky Mountain Thunder. When they returned, it was time to bring the tractor back to life.

First off, the frame had to be straightened and unnecessary parts removed from the frame.

Figure 8. Straightening the frame.

A new mount was made for the transmission and a new transmission input shaft support was created by Dr. Mark Zohns. The front axle was completely remanufactured.

Figure 9. New front axle.

The engines started life as 427 cubic inch Chevrolet V8 marine blocks with a 454 crankshaft, but were bored and stroked to around 519 cubic inches (displacement varies after rebuilds). After Cal Poly obtained the tractor, the engines were sent to Joe Boghosian to be overhauled and brought back to life. They sported 1071 Mooneyham blowers and Mallory Ignition, built to run on methanol.

Figure 10. The freshly rebuilt Chevrolet engines.

After a lot of work, Poly Thunder was finally completed and debuted at the Cal Poly Open House in 2005.

Figure 11. Poly Thunder at Cal Poly Open House, 2005.

THE SLEDS

The first "sled" at Cal Poly was a steel sled that used people as weights. As the sled progressed down the track, more people would jump on. As the sport became more competitive and higher performance tractors were showing up at events, an alternative was needed. Students of the Agricultural Engineering Department designed and built the first weight transfer machine on the West Coast. This sled was based on a semi-trailer frame with a moving weight box driven by the trailer wheels and a skid pan for friction.

A weight transfer machine uses friction to slow and eventually stop a tractor. It is accomplished via a weight box that moves from the rear of the machine to the front, relocating its weight from the wheels to the skidpan. The wheels of the sled move the weight box on the machine, and the rate of movement of the weight box can be adjusted via the onboard transmissions.

Figure 12. The first weight transfer machine.

In 1976, BRAE Department students Ken Ulm and Steve Cooksey designed and built a smaller sled to be pulled by the new mini-modified tractors. In 1978, Mechanized Agricultural graduate Ben Tulloch and Gary Weisenberger designed and built another mid-sized sled to be pulled by four wheel drive trucks. This sled was called "Trucker's Trouble" and was used extensively throughout the West Coast.

When the mini-modified tractors started using superchargers, Gary Weisenberger parked the original mini-sled and built a replacement called "Tuff Drag'n." This sled has been taken to events all over the West Coast, including Hawaii and Tokyo.

Figure 13. Tuff Drag'n mini sled.

In 1997, the Cal Poly Tractor Pull sled became outdated. Gary Weisenberger, other faculty, and students of the BioResource and Agricultural Engineering Department built a new sled to replace

it. The new sled was self-propelled with a Chrysler 440, has four transmissions, and two 2-speed differentials. It also has a pan unloading system which allows tractors a softer start by keeping the skid pan off the ground for a preset distance.

Figure 14. The new sled at its maiden pull at the 1997 Cal Poly Open House.

With the success of the new sled, Gary Weisenberger decided to update the mini-sled with a similar pan unloading system and self-propulsion system. The project was given to Dr. Mark Zohns' senior level mechanical design class. The pan unloading system was given to students Andy Holtz, Mark Hawkins, and Mark Unruh while the steering system was handled by Matt Yore, Matt McClouskey, Rodney Gordon, and Andy Welch. The self-propulsion system consisted of a four cylinder John Deere diesel engine, a variable displacement-pressure compensated hydraulic pump, a geroler motor, and a 3-speed transmission to power the existing differential.

Figure 15. The renovated Tuff-Drag'n mini-sled.

Gary Weisenberger has had a huge hand in tractor pulling on the West Coast, and is the only person in the world who knows how to drive his sled.

Figure 16. Gary Weisenberger.

MODIFIED PULL TRACTOR TECHNICAL SPECIFICATIONS

	Mustang Fever	Poly Thunder
Debut	1999	2004
Frame Style	Wedge	Wedge
Engine Type	Allison V-1710	Chevrolet V8
Displacement	1710 cubic inch	~519 cubic inch
Horsepower	1,325 (2,300 rpm)	1,300 (each)
Induction	Supercharged	Supercharged, 10-71
Ignition	Dual-Mags	Mallory
Clutch	Crower 5 Disc	Crower 5 Disc
Transmission	Fuller 905	Fuller 905-RT
Rearend	Rockwell 3.55:1	Eaton 2-Speed 4.33:1
Planetaries	Rockwell 3.5:1	Rockwell 3.55:1
Drive Tires	30.5L-32	30.5L-32
Steering	Hydraulic	Rack and Pinion
Dry Weight	6,320 lbs	6,350 lbs

MAINTENANCE AND KNOW HOW

This section is designed to introduce tractor pull members with basics of maintenance and how certain mechanisms operate.

Battery Maintenance

Safety:

- Remove all jewelry, wear safety goggles and plastic gloves.
- Do not work near an open flame; no smoking.
- Batteries create hydrogen gas when charging, which is extremely flammable.
- Batteries contain sulfuric acid which eats through cotton clothing, but does not affect polyester or wool.
- Always remove battery negative cable before attempting any electrical work.

Battery Specifications:

- Cold Cranking Amps (CCA): number of amps a battery can deliver at zero degrees Fahrenheit for 30 seconds without the voltage dropping below 7.2 volts.
- Reserve Capacity (RC): number of minutes a fully charged battery will discharge 25 amps at 80 degrees Fahrenheit without the voltage dropping below 10.5 volts.

Maintenance:

Battery should be kept clean. Cable connection needs to be clean and tight. Serviceable batteries should have their fluid levels checked regularly. Check battery fluid levels when the battery is fully charged. If a battery needs water, use only distilled water. It has no minerals and chemicals in it like tap water, which can hurt a battery. Most corrosion on cables is from battery gases condensing on metal parts. To prevent corrosion on cables:

- Apply a small bead of silicon sealer at base of the post and place a felt washer over it.
- Coat washer with high temperature grease or petroleum jelly (Vaseline).
- Coat exposed cable end with grease or petroleum jelly.

State of Charge	Specific Gravity	Voltage - 12V
100%	1.265	12.7
75%	1.225	12.4
50%	1.190	12.2
25%	1.155	12.0
Discharged	1.120	11.90

Centrifugal Clutch

The clutches used in both of the Cal Poly modified pull tractors are 5-disc centrifugal clutches. A centrifugal clutch is preferred because it allows the engine to spin up to a preset revolutions per minute (rpm) before engaging. The clutch will also grab the clutch discs harder as it spins faster.

Figure 17: Typical centrifugal clutch on pulling tractors.

The clutch operates on the principle that an object revolving (spinning) about a point has an acceleration force away from the point of revolution. What does this mean?

Think of a yo-yo on a string. As the yo-yo twirls around your hand, the yo-yo wants to fly off into the air but is held in place by the string. The string is creating an acceleration force toward your hand that is equal to the acceleration force of the yo-yo in some outward direction. So how does this relate to a centrifugal clutch?

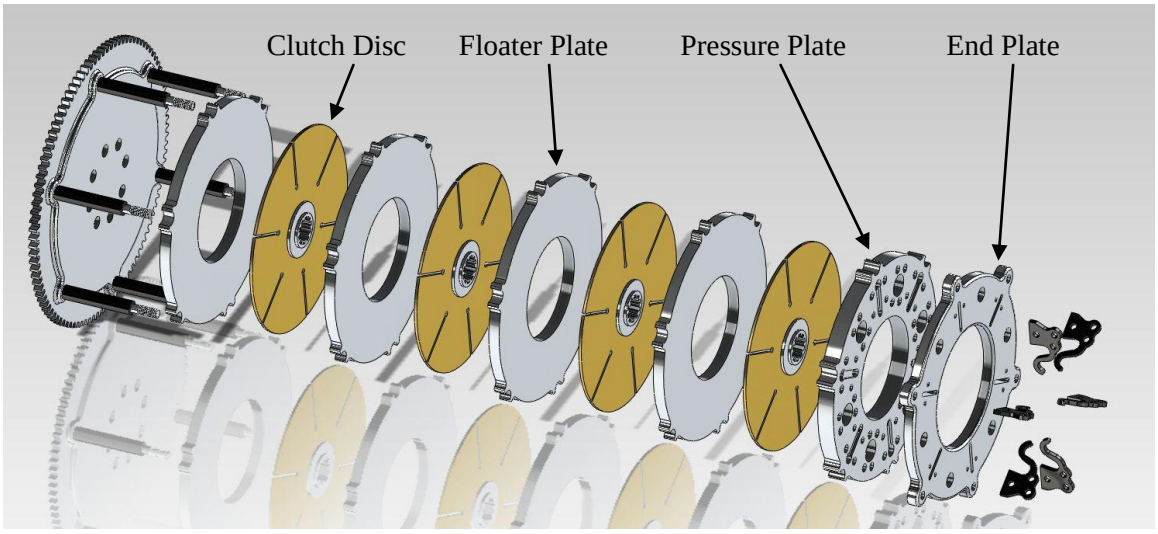

Figure 18. 4-disc centrifugal clutch exploded view.

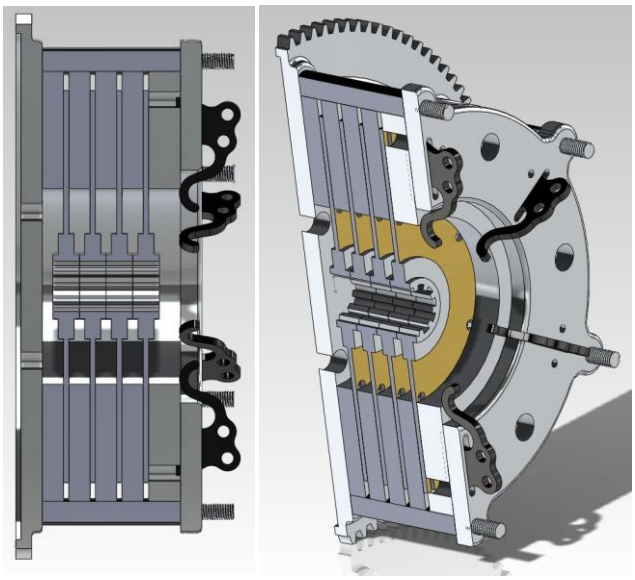

Figure 19. Cross section of a centrifugal clutch.

The black arms depicted in Figure 19 are responsible for making the clutch work. On each arm there are holes drilled for attaching a weight (not depicted). Each one is held in place via a pin or bolt behind the end plate. As the clutch assembly spins up to its preset engagement rpm, those arms will want to rotate outward on that pin. The end of the arm consequently pushes against the pressure plate inside the clutch, engaging the clutch discs. Essentially, each arm is a lever; one side has a weight, the other side contacts the pressure plate.

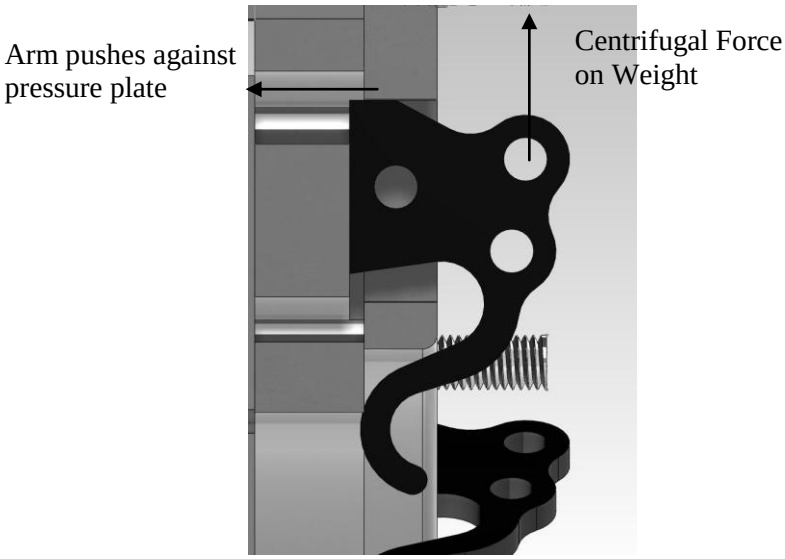

Figure 20. Centrifugal arm.

Weight Transfer Machine (The Sled)

The sleds used today are vastly more intricate and adjustable than the early wood and steel sleds used for pulling. The weight transfer machine at its core is designed to use the rotation of the wheels to move a weight box from the rear of the machine to the front where the skidpan is located. Doing this creates more friction and drag between the skidpan and the ground creating the resistance for the pull tractors.

The weight transfer machine accomplishes this via several transmissions. Gary Weisenberger's big sled has four transmissions resulting in 448 gear combinations. The wheels power the drive shaft which in turn feeds power to a transmission, which outputs power to another transmission, and so forth. The final transmission is connected to a jackshaft with chain sprockets on it, which are connected to the weight box. As the wheels of the sled rotate, they turn the transmissions which turn the jackshaft, which pulls the weight box toward the front of the sled creating more resistance.

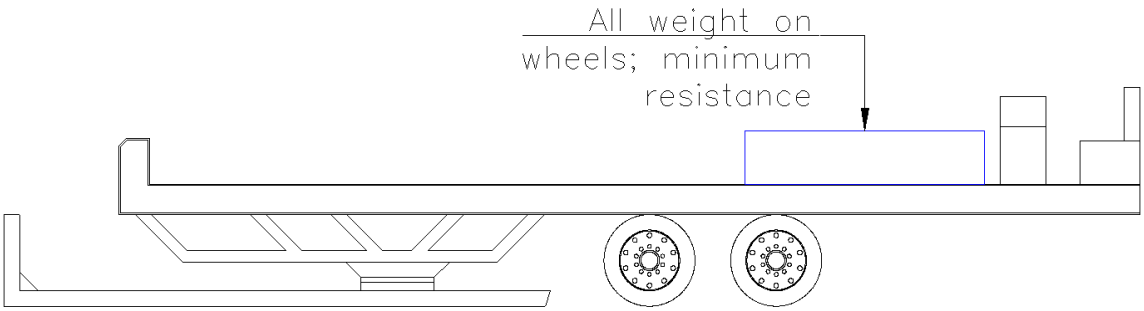

Figure 21. Weight box at rear creates little frictional resistance.

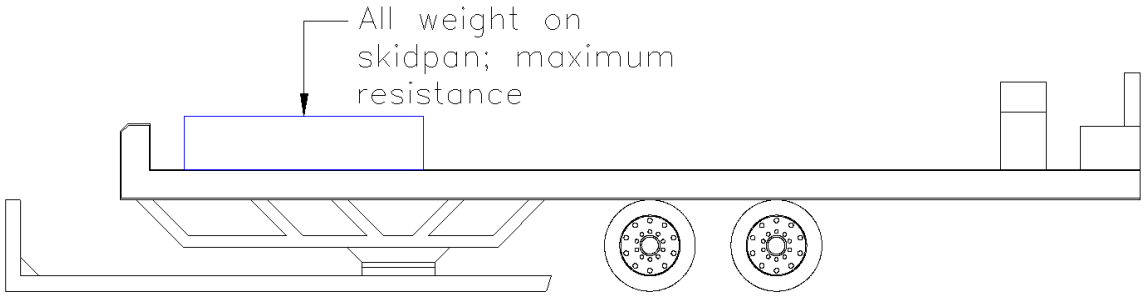

Figure 22. Weight box at front creates lots of frictional resistance.

This design allows pulling vehicles to gain some momentum before the weight box starts pushing down onto the skidpan. The vast number of gear combinations allows the sled operator to dial in the appropriate gear ratio for the given track conditions and pulling environment.

Single Tired Gooseneck Hydraulic Winch

The single-tired gooseneck has an electric over hydraulic winch used for loading the modified pull tractors. The hydraulic system employed consists of a hydraulic pump driven by an electric motor which powers a bi-directional hydraulic pump coupled to the winch drum. The system is controlled via a solenoid operated directional control valve.

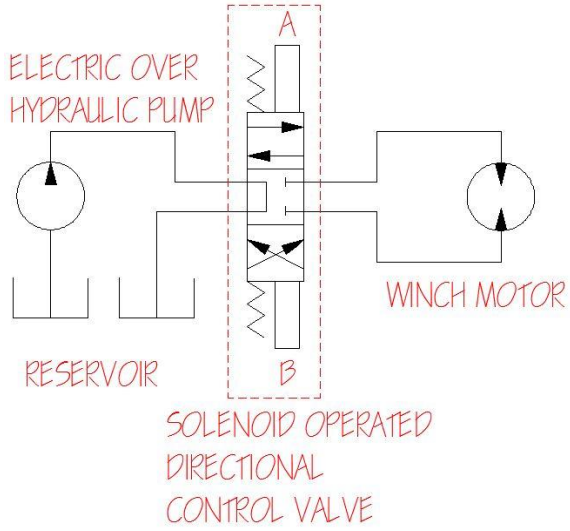

Figure 23. Single tired gooseneck hydraulic schematic.

This hydraulic system is designed for safely loading the tractors onto the trailer. However, this hydraulic system is not safe for unloading the tractors. Referring to the schematic above, it's clear that the hydraulic pump, the directional control valve, and the hydraulic winch motor are all directly plumbed together. When unloading the tractor, hydraulic fluid is free to flow from the motor back to the reservoir essentially causing the winch to free-spin and lose control of the winch motor. If the directional valve is switched to the no-flow position while the winch motor is free-spinning, then the motor will instantly stop resulting damage to the trailer, the winch hydraulic system, the tractor, or will snap the winch cable causing complete loss of control over the tractor.

The remedy for this issue would be to employ a flow control valve into the system so that the winch motor is subject to a restricting flow rate when unloading. However, due to space limitations in the trailer, this type of system would be difficult employ.

To avoid damage and personal injury, whenever the single tired gooseneck is used for moving the tractors, or any piece of equipment, the winch should only be used for loading.

STANDARD OPERATING PROCEDURES – MUSTANG FEVER

Operating procedure guidelines:

- These operating procedures are designed to be for reference only.
- They are not a substitute for one-on-one training from an experienced tractor pull member or advisor.
- Do not perform maintenance or attempt to start either of the modified pulling tractors without permission from a tractor pull advisor.
- If you are unsure of how to do the task, do not attempt to do it. Always get help if you are unsure.

Start-Up

Required Tools and Materials:

- 5 gallons of Trick Racing Gas
- 2 people

Step 1: Open the fuel mixture setting 1 click.

Figure 24. Fuel mixture setting, on carburetor (left), from seat (right).

Step 2: Open the fuel valve to the carburetor and close the fuel valve to the intake.

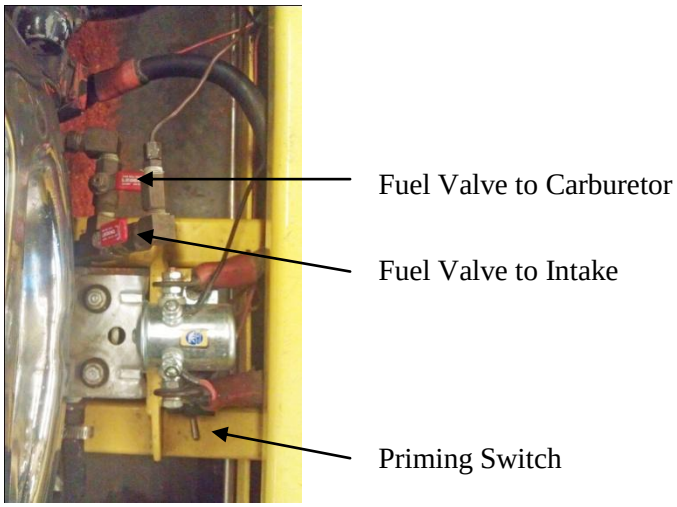

Figure 25. Fuel priming system.

Step 3: Push down on the carburetor vent located on top of the carburetor and turn on the fuel priming pump via the switch located next to the fuel tank.

Figure 26. Carburetor priming vent.

Step 4: Once fuel starts to come out of the carburetor vent, close the vent, turn off the fuel primer pump.

Step 5: Close the fuel valve to the carburetor and open the fuel valve to the intake.

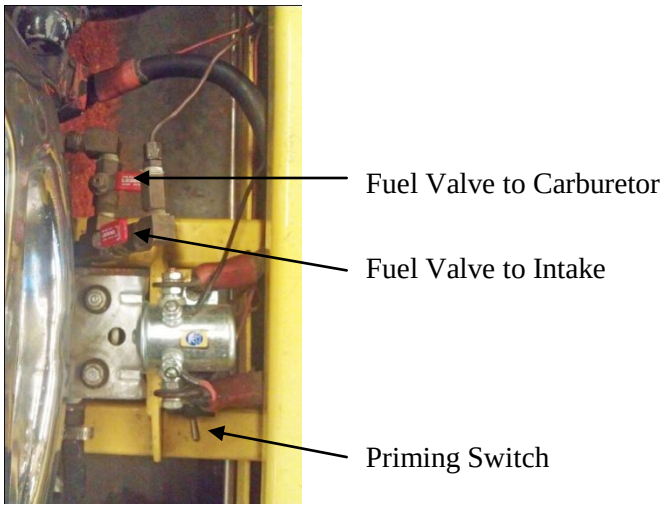

Figure 27. Switch the positions of the fuel valves.

Step 6: Return the fuel mixture setting to the off position.

Step 7: Put the transmission in neutral. Close the neutral lockout “door” over the transmission shifter.

Figure 28. Transmission shifter.

Step 8: Turn on the magnetos.

Figure 29. Magneto switches.

Step 9: While sitting in the seat, use your right hand to hold the “spin” switch until the starter has reached its maximum rpm.

Figure 30. Prime, Spin, and Engage momentary switches.

Step 10: While holding the “spin” switch, use the same hand to flip the “prime” and “engage” switches. Keep your left hand on the fuel mixture setting lever.

Step 11: Once the engine starts to fire, quickly open the fuel mixture setting 1 click, release the “prime”, “spin”, and “engage” switches and apply a small amount of throttle to keep the engine alive. Note: If the engine does not fire, repeat steps 9 and 10 until it fires.

Step 12: Keep a small amount of throttle applied to the engine until it is “firing on all cylinders.” Have an assistant run their hand over the top of each exhaust zoomie to ensure each cylinder is firing correctly.

Figure 31. Throttle lever.

Step 13: If the engine is producing any noise that does not sound normal, or a cylinder is not firing correctly (exhaust gasses will be cool), shut off the engine and notify a tractor pull advisor immediately.

Shut-Down

Required Tools and Materials:

- 1 person in the seat

Step 1: Put the transmission into neutral.

Step 2: Apply throttle to increase the engine rpm to around 1500 rpm.

Step 3: Using your other hand, switch off both of the magneto switches at the same time.

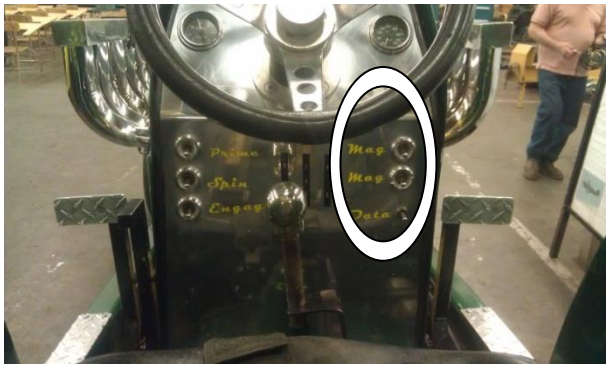

Figure 32. Magneto switches.

Step 4: Turn off the power steering switch.

Figure 33. Power steering switch.

Step 5: Turn off the data collection system.

STANDARD OPERATING PROCEDURES – POLY THUNDER

Operating procedure guidelines:

- These operating procedures are designed to be for reference only.
- They are not a substitute for one-on-one training from an experienced tractor pull member or advisor.
- Do not perform maintenance or attempt to start either of the modified pulling tractors without permission from a tractor pull advisor.
- If you are unsure of how to do the task, do not attempt to do it. Always get help if you are unsure.

Start Up

Required Tools and Materials:

- Squirt bottle with Trick Racing Gas
- Ten Gallons of Velocity Methanol Fuel
- One person in the seat
- One person on the ground

Step 1: Turn on the master power switch located at the rear of the tractor near the left fender.

Figure 34. Main power switch.

Step 2: Make sure the starter is fully engaged by turning the polished silver disk on the front clockwise until it stops.

Figure 35. Rotate starter motor disk clockwise.

Step 3: Turn on the power switch on the dash.

Figure 36. Power switch.

Step 4: Pull out on the two magneto switches to shut them off. Also pull out the two fuel handles to shut off the fuel supply.

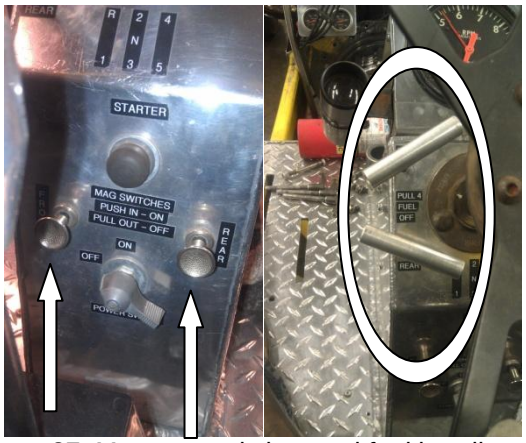

Figure 37. Magneto switches and fuel handles.

Step 5: Press and hold the starter button while watching the oil pressure gauges located at the rear left side of the rear engine.

Figure 38. Oil pressure gauges.

Step 6: As soon as the oil pressure rises, push in the fuel levers. Continue to hold the starter button for an additional 3 seconds.

Step 7: Push and hold the throttle lever to wide-open while another person squirts Trick Racing Gas (about 1 ounce) into the intake horns of each engine. Then release the throttle lever.

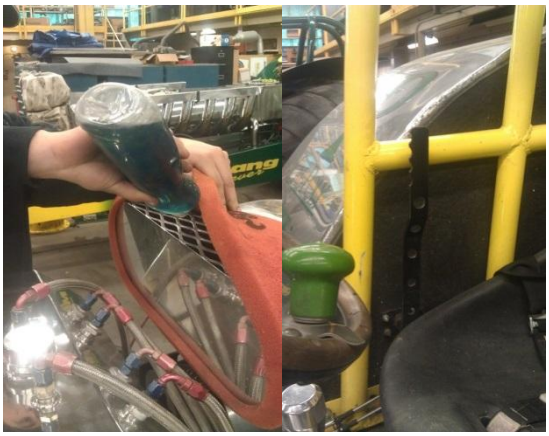

Figure 39. Intake horns and throttle lever.

Step 8: Re-engage the starter motor by turning the polished silver disk on the front of the starter clockwise until it stops.

Step 9: Press and hold the starter motor button. Once the oil pressure rises, push in on the magneto switches to turn them on.

Step 10: Once the engines start, release the starter button. Have another person squirt about an ounce of Trick Racing Gas into each intake horn to help the engines get going.

Step 11: Run your hand approximately 3-4 inches above each exhaust pipe checking for heat to ensure each cylinder is firing.

Shut Down

Required Tools and Materials:

- 1 person in the seat

Step 1: Pull fuel shut-off handles.

Figure 40. Pull fuel shut-off handles.

Step 2: Wait for the engines to "lean-out" – Engine speed will noticeably increase.

Step 3: Switch off the magnetos.

Figure 41. Pull out on the magneto switches to turn them off.

Draining Fuel Lines

Required Tools and Materials:

- Various wrenches
- Fuel catch can
- 2 gallons of Trick Racing Gas
- Fuel screen filters
- Fuel funnel
- Empty fuel can

Step 1: Remove the plastic fuel tank plug from the drain valve. Attach the flexible clear hose and adapter.

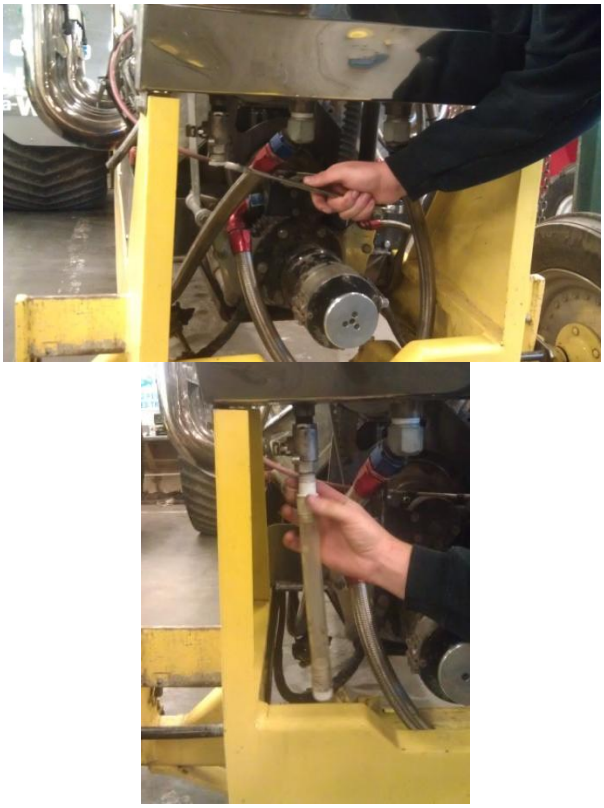

Figure 42. Remove plastic fuel tank plug and attach flexible clear hose.

Step 2: Put a screen filter inside of the funnel and put it on top of the empty fuel can. Direct the flexible clear hose into the funnel and open the fuel tank drain valve. Close the valve once the tank is empty and replace the plastic fuel tank plug onto the drain valve.

Figure 43. Drain fuel through screen into empty fuel can.

Step 3: Using a wrench, disconnect the main fuel supply line just above the starter. Let the line drain into the catch can.

Figure 44. Fuel supply line.

Step 4: Disconnect the fuel lines downstream of the fuel pump. Let these lines drain into the catch can.

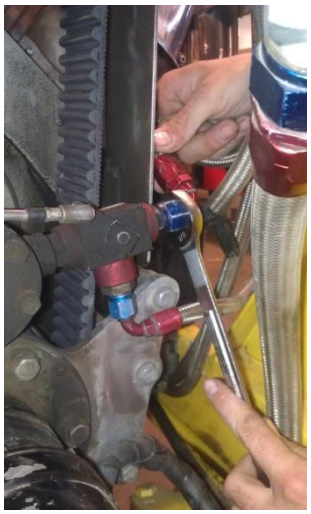

Figure 45. Disconnect downstream fuel lines.

Step 5: Disconnect the fuel return line from the (pill box) and drain into the catch can.

Figure 46. Fuel return line.

Step 6: Repeat steps 3-5 on the rear engine.

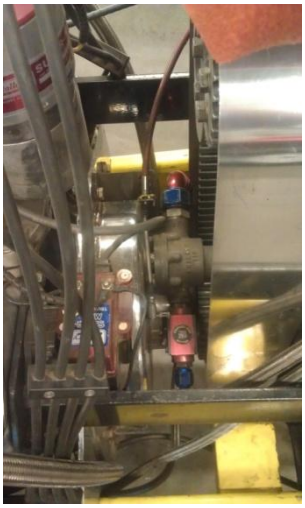

Figure 47. Rear engine fuel pump and lines.

Step 7: Reconnect all fuel lines.

Step 8: Put 1 gallon of Trick Racing Gas into the fuel tank. Start the engines to get the gasoline dispersed through the fuel system.

Figure 48. Put 1 gallon of Trick Racing Gas into the tank.

STANDARD OPERATING PROCEDURES – GOOSENECK TRAILERS

Operating procedure guidelines:

- These operating procedures are designed to be for reference only.
- They are not a substitute for one-on-one training from an experienced tractor pull member or advisor.
- Do not perform maintenance to or modify the gooseneck trailers without permission from a tractor pull advisor.
- If you are unsure of how to do the task, do not attempt to do it. Always get help if you are unsure.

Loading the Modified Pull Tractors

Step 1: Assemble the loading ramps.

- Single tired trailer: Undo the snap rings and open the retaining door to the ramps (located at the rear of the trailer). Line up the center of the ramp with the center of the third board from the edge of the trailer.

Figure 49. Ramps for single tired trailer.

- Dual tired trailer: Refer to *Using the Beavertail Ramps on the Dual Tired Trailer.*
-

Step 2: Position the tractor directly behind and in line with the trailer.

Step 3: Pull out the winch. The dual tired trailer's winch can free-spool by turning the knob on the front side of the winch box so it points upwards. The single tired trailer's winch cannot be free-spooled and has to be run-out via the hand controller.

Figure 50. Winch free-spool knob.

Step 4: Connect the winch hook to the d-ring on the front of the tractor.

Step 5: Have somebody sit in the tractor to operate the brakes in the event of a winch failure.

Step 6: Winch the tractor onto the trailer. Line up the front tires with the centers of the third board from each trailer edge.

Figure 51. Loading Mustang Fever.

Step 7: When the tractor's rear wheels have reached the flat part of the trailer deck, sleeve the rear chains with fire hose then connect the rear chains to the d-ring on the tractor's rear axle. Have the person in the seat apply the brakes before going near the tires.

Step 8: Once the rear chains are attached, winch the tractor forward until the chains are tight. Have the person in the seat re-apply the brakes until the tractor is fully chained down.

Step 9: Attach the front chains. Sleeve each chain with a piece of fire hose before attaching.

Step 10: Tighten all four chains with chain binders. Slip the fire hose over each binder to prevent it from coming undone.

Figure 52. Use fire hose to keep the binder from coming undone.

Unloading the Modified Pull Tractors

Required Tools and Materials:

- One person in the seat
- Multiple people on the ground

Note: The winch on the single tired trailer is NOT to be used for unloading. The hydraulic winch system is not designed for unloading and can cause damage and/or personal injury.

Step 1: Assemble the loading ramps.

Step 2: Have somebody sit in the seat of the tractor and apply the brakes.

Step 3: Remove all of the chains and binders from the tractor. Swing the chains off the trailer and out of the way of the tractor wheels.

Step 4: From a safe spot, push the tractor off of the trailer. A safe spot would be on the ground pushing on the tires.

Step 5: As the tractor starts to roll off the trailer, the person in the tractor should watch and carefully apply the brakes so as to control the speed of the tractor.

Step 6: Only allow the person in the tractor get out once the tractor has stopped and in no danger of rolling away on its own.

Using the Beavertail Ramps on the Dual Tired Trailer

Required Tools and Materials:

- Two people
- Beavertail control box

Step 1: Open the chain box located under the gooseneck at the front of the trailer and get the beavertail control box.

Figure 53. Beavertail control box.

Step 2: Insert the plug into the receptacle behind the driver's side rear wheels.

Figure 54. Beavertail receptacle.

Step 3: Press the unlock button to release the beavertail lock.

Figure 55. Beavertail unlocked.

Step 4: Raise the beavertail to its maximum height.

Step 5: Remove the linch pin holding the ramp retaining bracket and swing the retaining bracket to free the ramp.

Figure 56. Ramp retaining bracket and linch pin.

Step 6: With one person holding the ramps out, lower the beavertail. Line up the middle of each ramp with the middle of the third board from the outside edge of the trailer.

Figure 57. Line up ramps with third board from edge.

Transporting the Modified Pull Tractors With a Forklift

Required Tools and Materials:

- Forklift
- Forklift "boot"
- 6 ft, 6,000 pound sling
- Two people

Step 1: Find and attach the "boot" to the forklift. Use a wrench to tighten the clamping bolts.

Figure 58. Forklift boot attached to forklift.

Step 2: Slip the sling through the d-ring on the front of the tractor with both looped ends free (basket configuration). Use a 6 ft sling so the forklift does not contact the tractor and damage it.

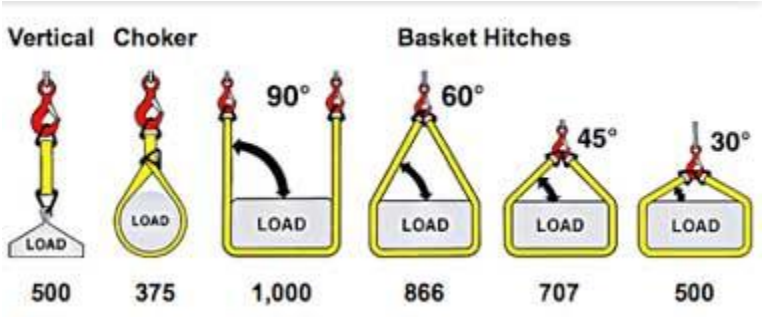

Figure 59. Sling hitch types and capacities with 500 pound sling (treetools.com).

Step 3: Slip the looped ends onto the "boot" on the forklift fork.

Step 4: Have someone sit in the tractor to operate the brakes. Carefully raise the forklift mast to lift the front tractor tires off of the ground.

Step 5: Move the tractor slowly and carefully.

COMPETITION EVENTS

This section is designed to introduce how competition events operate, what people and positions are involved, and what to do at events.

Before Leaving

Before the team leaves Cal Poly for a pulling event, there are a number of things that need to happen. First of all, determine what is necessary to take on the trip. If it will be a multiday, multi-pull trip then battery chargers, generator, and air compressor will be required. Make sure all maintenance work is done on the tractors before they leave Cal Poly (e.g. oil change, valve adjustment, clutch adjustment, etc.).

Pre-Trip Checklist

- Trailer pre-trip inspection
    - Batteries are fully charged
    - Tires inflated to rated psi (rating designated on tire)
    - Axle bearings are lubricated or greased
    - Winch is in working order (no frayed cables)
    - Trailer lights are functioning
    - Chains are securely fastened to deck and in good shape
- Tractor pre-trip inspection
    - Batteries fully charged
    - Fluids are at appropriate levels
    - Tires are inflated to 10 psi (ease of moving)
    - Visual inspection; nothing is broken or loose
    - Poly Thunder: ensure all motor mount bolts are tight and exhaust covers are tied down
    - Mustang Fever: air cleaner is covered, exhaust covers tied down

What to Take

This is a compiled of everything that could possibly be used on a trip. Not everything on this list will be required for every trip.

- Battery chargers
- Generator and gasoline
- Extension cord and splitter
- Clean rags and metal polish
- Ice chest with water and soda
- Toolbox
- Air compressor
- Pop-up tent
- Folding chairs
- Fuel cans and fuel (Trick Racing Gas and Velocity Methanol)
- Fuel filter screens
- Fuel funnel
- Pills for Poly Thunder
- Handheld weather station

- Tow straps
- Gear bag (helmets, gloves, fire suits)
- Flag pole and flag
- Tools and oil for adjusting valves and oil change on Poly Thunder (multi-day trip)
- Mustang Fever and Poly Thunder

Arriving at the Event

When arriving at the competition location, it is important that all tractor pull members get a pit pass as soon as possible. While at the booth, drivers will randomly draw a number to determine their pulling position.

Next, the air pressure in the tires should be adjusted to the desired level. Changing air pressure has an effect on hitch height and should be monitored. Refer to log entries from previous pulls and advice from tractor pull advisors to determine the air pressure required.

After adjusting air pressure, driver and tractor must go to tech inspection for weigh-in and hitch height measurement. A number of tractor pull members will want to assist in this process as suitcase weights will be added or removed to get the tractor and driver as close to the maximum weight limit as possible. Also, the fuel tank must be full before entering tech inspection. After tech inspection, nothing can be added or removed. However, weight distribution can be adjusted by moving the suitcase weights.

The only thing that can be done to the tractors after tech inspection is polishing, so get polishing. The tractors represent Cal Poly and the tractor pull team, so they should be looking as good as possible.

The Competition

Tractor pulling is based on distance, or how far your machine can pull the sled down the track. For each class, the sled is adjusted to provide an appropriate amount of resistance. The first puller in each class, known as the test puller, has options as to whether or not he/she wants to re-pull. Also, if the sled operator decides to adjust the sled gearing, the next puller becomes the test puller. This decision must be made before the initial vehicle leaves the track. For more complete details, refer to the complete NTPA Operations Rules in Appendix A.

It is important that during the event, no one except track officials enter the track area so as to avoid personal injury. If you are working a position on the track, only do so when the pulling vehicle and sled have come to a complete stop.

When at the event, it is important to be professional at all times. Do not consume alcohol, no "horsing around", and maintain good sportsmanship at all times. Also keep track of who is pulling and when our tractors are next in line to pull. The quicker the tractors get onto the track and pull, the better the show will be and the more professional the team looks.

Track Positions

Flagger	The flagger is the person at the end of the track who signals to the driver when it safe to start pulling. He is signaled by the sled driver via red and green lights on the sled. The flagger is the only person allowed to signal to the driver when to pull.

Hookers	The people responsible for hooking or hitching the pulling vehicle to the sled. This is usually done with two people to enhance communication between the driver and hooker to avoid injury and/or damage. One person stands by the vehicle and communicates via hand signals: • How far to back up • Ensure vehicle is in neutral when hooking • When to tighten up
Unhooker	The person who unhooks the pulling vehicle after the vehicle has come to a stop. This can also be accomplished with two people like hooking, one person to communicate, one person to unhook.
Recorder	The person who obtains the distance measurements from the sled operator.

Cal Poly Tractor Pull Members frequently fill these positions at events. If you are not assigned to one of these positions, do not enter the track area. If you are working one of these positions, leave the track area as soon as your task is completed. This is to minimize the chances of being injured.

Vehicle Classes

All pulling vehicles at an event are registered to one or more vehicle classes. Each class has its own restrictions on number of engines, total weight (including driver), protective shielding, type of engine(s), etc. Most of the time, Mustang Fever and Poly Thunder run in the 7,200 pound modified tractor class. Occasionally they will also run in the 8,000 pound modified class. The official NTPA rules for both vehicle classes are located in Appendix B.

Common classes at most events in California include:

- Injected Mini-Modified
- Blown Mini-Modified
- 5800 Modified Tractor
- 7200 Modified Tractor
- 8000 Modified Tractor
- 4WD Super Stock
- 4WD Extreme Diesel
- 4WD Modified
- Pro Stock 9300

After the Pull

After finishing a pull, the driver of each tractor needs to obtain the log book for his/her tractor and fill out a pull sheet which details when and where the pull happened, what gear was used, tire pressure, distance, etc. This information is useful for later pulls when determining how to setup the tractors. A sample driver's log is located in Appendix C.

If either of the tractors are only pulling once, then they should be taken back to the trailer immediately after finishing a pull, unless directed to do otherwise. Mustang Fever requires no immediate attention after a pull and can be loaded up. Poly Thunder runs on methanol which eats at the rubber fittings and attracts moisture that can be damaging to the engines. The fuel lines on Thunder need to be drained and the engines fired on gasoline to protect the fuel system. Refer to *Draining Fuel Lines* in the Poly Thunder Standard Operating Procedures section.

If the tractors are to pull again the next day (multi-day trip) then Poly Thunder needs to have its oil changed and the valves adjusted. This handbook does not cover how to perform oil changes or valve adjustments.

APPENDIX

A. NTPA Event Procedures, Requirements, and Contest Operations
B. 5800 and 7200 Pound Vehicle Class Requirements
C. Sample Driver's Log
D. Sample Maintenance Log

Appendix A: NTPA Event Procedures, Requirements, and Contest Operations

NTPA Event Procedures, Requirements, and Contest Operations

Adapted from the 2013 Rule Book pages. 79 – 88.

1. **Entry Procedure**
   a. Upon arrival, go to PTPA entry site and enter competitors. Competitors will blindly draw a number which decides pulling order in their respective class.
   b. Vehicle must be present on the ground in running order and ready to compete before being allowed to enter.
   c. A vehicle must compete and receive a measureable distance in a class at the event before the vehicle may receive hook points, place points, or purse money. Exception: rainouts.
   d. A vehicle may be entered in more than one class, but only once in each class.
   e. No mixing of classes.
   f. If a competitor breaks on a previous class and cannot make a pull in the next class, the competitor may ask the track official or competition director whether or not to allow the competitor to drop positions.
2. **Withdrawal (scratch)**
   a. A competitor is allowed to scratch (withdrawal) a vehicle prior to the start of the class and be refunded the entry fee, but only if the competitor notifies the entry official.
   b. If a competitor does not officially scratch before the start of the class, the competitor will forfeit the entry fee.
   c. Once a competitor has scratched from the class, that competitor may not re-enter that class for that session.
3. **Vehicle Operations**
   a. Engines may be started and warmed up anytime up to 15 minutes before scheduled pre show ceremonies or starting time of event. After event has started engines may be started anytime.
   b. Pulling vehicles must be operated in a safe manner at all times within the confines of the track, pits, and staging areas. Event officials have the right to disqualify any vehicle considered to be operating in an unsafe manner.
   c. Driver must remain seated while the vehicle is under the green flag and must have complete control of the vehicle at all times.
   d. No riders are allowed on any vehicle being towed or driven. No riders are allowed on any vehicle in pit, track, or adjacent areas, including tow tractors, competing vehicles, tow back, or maintenance vehicles of any kind.
   e. No driving of competition vehicles are allowed in the cold pit area except for loading and unloading.
4. **Clothing/Apparel**
   a. Each member of the competitor's crew must be properly attired when present in the staging or in the competition area. Closed-toed shoes are mandatory. Tank tops or bare torsos are not acceptable in staging or competition area.
5. **Track**
   a. Track area is defined as the area within 35 feet in any direction of the contest course boundaries, including staging area at start end of track and run-of area at finish line of the track.

b. Officially sanctioned contests held outdoors shall be conducted on a 320 foot dirt track, with a safety run-off area that is beyond the finish end of the track and equal to ½ the length of the track (160 feet). The track must be no less than 30 feet in width.
c. Officially sanctioned contests held indoors shall be conducted on a dirt track of no less than 200 feet, with a safety run-off area extending past the end of the track of no less that ½ the length of the track (100 feet). The track must be no less than 30 feet in width.
d. A chalk line will be used to designate the edge of the track with cones or markers placed at the finish line (320 feet).
e. Tracks must be maintained and packed.
f. No ropes, lines, or stakes are allowed within two feet of the edge or end of the track pulling area during competition.

6. Tech Area and Procedures

a. There will be a designated area set up by the pull track officials as a teching area where all vehicles will be teched and officially weighed before they are allowed to compete. Violation of tech procedures may result in disqualification.

7. Weighing Procedures

a. Official weight of a vehicle is defined as: the weight of the vehicle, driver (in vehicle), vehicle with oil, water and fuel, and in a "ready to compete" condition.
b. All competing vehicles in a class must be weighed prior to the start of that class.
c. No vehicle will be allowed past scales if it exceeds class weight restriction.
d. No adding fuel or weights unless reweighted. Note: no fuel may be added after weigh-in even if engine is started and warmed-up, with the exception of a pull-off between two vehicles (all classes).
e. Weighing out to be at the discretion of the track judge or official.
f. A competing vehicle must cross the scales before each class entered and must not weight less than 1,000 lbs below class weight restriction.

8. Drawbar Measurement

a. Drawbars to be measured at time of weight-in. After this time, drawbar may not be altered except for maximum 200 lb. weight moved forward or backward on competing vehicle.
b. Air pressure in tires cannot be adjusted after drawbar is measured.
c. If a competitor moves more than 200 lbs. forward from rear of competing vehicle, that vehicle's drawbar may be re-measured at the discretion of the track official.
d. Drawbars are subject to re-measurement after the pull at the discretion of the track official.

9. Breakage

a. Any competitor who breaks at the event site will receive hook points for all classes entered, but will not receive purse money unless there has been a measureable pull by that vehicle in that respective class.

Contest Operations

1. General Rules

a. Track to be conditioned before start of each event.
b. Any competitor or crew member attempting to sway the decision of any official by talking to official, sled operator, or the promoter, is subject to disqualification from that class.
c. Competitors are not allowed to walk out on the track for any reason while track equipment is preparing track surface or during event. Checking track conditions is at the discretion of the track official.
d. Each licensed competition vehicle will be allowed one, licensed support/utility vehicle to be used at events. Number of seats allowed on support/utility vehicle is not to exceed OEM seating capacity.
e. No two-wheeled motorized vehicles allowed as "pit bikes" or as support vehicles.
f. Maximum number of riders allowed on support vehicles is not to exceed the number of permanently mounted seats on vehicle.
g. When a vehicle is under the green flag, no one is allowed on the track except for track officials.
h. When unscheduled or unsanctioned classes or events are added to those already schedules, the scheduled classes will start on time.
i. Flagment
    i. Pulls shall be operated with two flagmen per track.
    ii. Starting flagmen shall be responsible for readiness of track, pulling vehicle and competitor.
    iii. Second flagmen will be responsible for balance of course.
    iv. The same flagmen shall work for an entire class to assure consistent and equal treatment for all competitors in that class.

2. Contest Procedures

a. All pulls must start with a tight chain.
b. Each competitor will be allowed two attempts to make a measureable pull.
    i. An attempt is defined as moving the sled a measureable distance (one inch or more).
    ii. On first attempt, if the competitor lets off on the throttle before going 100 feet, that competitor will get a second attempt, even if pull was greater than 100 feet.
    iii. If no attempt is made to back off throttle, no second attempt will be granted.
    iv. Note: backing-off throttle is intended for driver to make a smooth, safe stop rather than slamming on the brakes before the 100 foot mark.
c. Jerking of the sled to cause slack in the chain is grounds for disqualification.
d. Each competitor has the privilege of and responsibility for spotting the sled for both attempts.
    i. Sled operator must be notified of where competitor wishes the sled to be placed.
    ii. Use of a crew member is recommended to expedite the show.
e. Official pulls must start with sled in gear and from of sled even with starting line.
f. All pulls made during contest will be measured to the nearest inch.
g. Pulling vehicle must remain within boundaries of contest course during a pull.
h. Sled pan must be within boundary lines at start of pull, with chalk line to constitute track boundary.

i. If a vehicle is legal when hooked to the sled and breakage occurs while under the green flag, the pull will be measured.
j. When disqualified in a class less than full, a competitor will receive hook points and place points and purse for last place.
k. If more than one competitor is disqualified in a class less than full, all those disqualified will split the last places, points, and purse evenly.
l. Any vehicle that hooks to the sled and makes a measureable pull shall be considered to have made an official hook even if the sled is reset and the vehicle cannot hook.
m. Only when the original mechanical method of starting fails to work, will tow starting by authorized.
n. Pulling vehicles must be able to drive onto the track and back up to the sled at the starting line, unhook, and drive off the track under their own power, unless breakage occurs while under the green flag. Note: modified minis are exempt from the back-up portion of this rule.
o. It is mandatory that all drivers attend any driver meetings that may be held by the promoter and/or track officials.
p. If the class is restarted, all competitors having pulled previously have the following options:
    i. May hook immediately.
    ii. May drop six positions.
    iii. May drop to last.
q. In the event that the first five vehicles in a class make a full pull, the class will automatically be restarted. Exception: a class may not be restarted for sled setting if more than ½ of class has already hooked.
r. All decisions on re-pulls must be made before vehicle leaves the track. If the track official is not notified of the competitor's intent to re-pull in competitor's original position, then the competitor will automatically be dropped six positions.
s. A competitor will be able to drop six positions if breakage occurs on first attempt and is less than 100 feet. Competitor will have one attempt remaining.
t. If the last vehicle in a class has mechanical problems, it will be allowed six minutes to hook and make an attempt.

3. Test Puller and Options

a. The competitor pulling in first position as determined by draw at time of entry is considered the test puller.
    i. The test puller may take the first pull distance provided the weight transfer is deemed right, OR
    ii. Immediately take a second pull, OR
    iii. Drop and pull in the sixth position, OR
    iv. Drop and pull in last position.
b. Only the test puller on first attempt may be free from disqualification due to running out of bounds or losing ballast. All other reasons for disqualification apply.

c. If sled requires further adjustment, each competitor immediately following each adjustment will be consider the test puller.
d. The sled must be readjusted if the competitor who hooks first fails to reach 75 feet on an indoor track or 125 feet on an outdoor track.

4. Pull-Offs

a. All distances past 300 feet will be measured. Only the top three distances will participate in the pull-off. All vehicles will be red-flagged past 320 feet. If three of more vehicles surpass 320 feet, only competitors past 320 feet will go to the pull-off.
b. All classes will run pull-offs unless the event manager/head official determines there's a valid reason to run a floating finish.
c. A floating finish will be a maximum of 320 feet. If two or more vehicles surpass 320 feet in a floating finish, a pull-off between those vehicles will be held.
d. Competitors will be informed at the driver's meeting.
e. Order of pull will be in the order in which the vehicles in the pull-off made full pulls, unless there has been a sled setting change by the track official.
f. In the pull-off, competitors have two attempts at 100 feet, but do not have the option of dropping six positions. *Exception: the pull-off takes place on a different track, with a different sled, or on a different day. In this case, the first puller will be allowed to take the first distance or drop six positions.*
g. Each competitor will be allowed the same amount of time (three minutes) to get to the sled and make an attempt. For the last vehicle, the six minute mechanical problem rule does not apply.
h. A competitor is required to make an honest attempt to pull, or competitor will receive the same money and points as the top vehicle that did not qualify for the pull-off, unless the competitor cannot come back due to breakage. In this case, the competitor will receive last place points for the pull-off.
i. On a second pull-off, if all drivers who qualified for the second pull-off wish not to hook, then points and purse will be split between the competitors who qualified.

<u>Causes for Disqualification</u>

1. Vehicle will receive only hook points when:
   a. While under the green flag loses safety equipment and failure of safety equipment to function.
2. Vehicle will receive hook and last place points when while under the green flag:
   a. Loses ballast weight.
   b. Goes out of bounds.
   c. Excessive loss of liquid onto the track by pulling vehicle, while hooked to the sled.
      i. Note: Excessive is defined as any steady of intermittent stream discharged onto the track, or a spot equivalent to more than 8 inches in diameter.
3. At indoor pulls, vehicles with excessive exhaust leakage or exhaust extension collapse.
4. Additional grounds for disqualification include:
   a. Unsportsmanlike conduct

   b. Improper language
   c. Conduct detrimental to pulling
   d. Any condition considered unsafe, unfair, or out of order
5. If a member is disqualified during competition for any reason prior to the start of apull, that member cannot be re-instated.
6. Vehicle will receive no points when:
   a. Intoxication: any competitor of any member of his crew under the influence of an intoxicating agent, drug, or having a measureable blood alcohol content during contest activities shall be considered under the influence and will be barred from any further involvement or participation in the event.
   b. Any competitor or crew member found in the staging area, competition area, or the run-off area who is in possession of any intoxicating agent will be barred from any further involvement or participation in the event.
   c. Any competitor or member of a crew who exhibits unprofessional and/or unsportsmanlike conduct including abusive language and/or physical action toward event official, fellow competitor, or spectator and/or deliberate delay of event, will be just cause for a minimum penalty of total disqualification from that event.
   d. Illegal equipment, illegal fuel, and competing without proper personal fire protection.
   e. Unsafe operation of competition vehicle.
   f. Leaving the starting line while under the red flag.
   g. Anyone who knowingly tampers with a vehicle could be permanently suspended.
   h. Head sock/neck skirt must be tucked inside driving suit. Nothing can be exposed while competing under the green flag.
   i. Transporting competition vehicle with drawbar used to tie/secure vehicle to trailer.
   j. Not having five point harness fastened during competition.

Appendix B: 5800 and 7200 Pound Vehicle Class Requirements

I. Modified Tractors

a. Modified tractors are those using any combination of engine(s), transmission(s), and final drives.
b. No portion of the tractor may exceed 14’ forward of the center of the rear tire.

c. 5800 lb class:
   i. Tractor and driver combined weight = 5800 lb.
   ii. Engine limitation: one single automotive, marine, aircraft, or industrial engine.
      1. Engine is limited to one (single) stage of boost (supercharged or turbocharged).

d. 7200 lb class:
   i. Tractor and driver combined weight = 7200 lb.
   ii. Engine limitation:
      1. Three (3) supercharged automotive engines with 8-71 superchargers with overdrive limits listed below, or a single staged turbocharger. No intercooler allowed, with port-fuel injection only.
         a. Wedge heads that accept a stock OEM intake manifold bolt pattern are limited to 70% maximum overdrive.
         b. Big Chief or any wedge head without a stock OEM intake manifold bolt pattern are limited to 50% maximum overdrive.
         c. Hemi Heads are limited to 45% maximum overdrive.
      2. Two (2) supercharged automotive engines with 14-71 superchargers at 70% maximum overdrive, or single staged turbocharger. No intercooler allowed, with port-fuel injection only.
      3. Four (4) naturally aspirated Big Block automotive engines.
      4. Five (5) naturally aspirated Small Block automotive engines.
      5. One (1) Allison engine with twin turbocharger or auxiliary stage, plus one (1) naturally aspirated automotive engine.
      6. One (1) Allison engine with single staged supercharger or turbocharger, injected or carbureted, plus one supercharged automotive engine with 8-71 supercharger limitation.
      7. Two (2) Allison engines on gas, with a maximum of 8.8/1 supercharger ratio, or two (2) Allison engines on alcohol with a maximum of 8.1/1 supercharger ratio. If automotive carburetors are used, an SFI spec 4.2 blower containment device is required.
      8. One (1) industrial or marine engine with limitation of 12 cylinders. Maximum of two (2) stages of boost. Diesel or alcohol allowed.
      9. Two (2) Packards on gas or alcohol with 6.5/1 supercharger ratio. Stock Packard butterfly must be utilized.
      10. Three (3) Ranger aircraft engines with a maximum of 800 cubic inches each, with single stage centrifugal superchargers on alcohol with fuel injection.
      11. One (1) turbine or a combination of turbine engines not exceeding a maximum of 5050 total horsepower.

12. All automotive engines may run a maximum of two (2) valves per cylinder and are limited to one (1) spark plug per cylinder.
13. More engines than allowed may be carried as ballast, but the extra engines must be disabled during the class.

e. 8000 lb Unlimited Class
   i. Tractor and driver combined weight = 8000 lb.
   ii. Engine Limitation:
      1. Any combination of engines is allowed, as long as the General Rules are followed.

f. Chassis
   i. Modified tractors that have the frame bolted to the transmission shall also have the frame bolted to the axle housing to prevent splitting of the tractor. The frame must be of sufficient strength that when the bolts attaching the transmission or rearend are removed, the frame will still support the weight of the tractor in the heaviest class being entered.

g. Driveline/Driveline Shielding
   i. No input or output shaft that attaches to a drive shaft may extend (cantilever) more than 4" beyond a bearing.
   ii. Drive shaft shield bolts must be located at least 1-1/2 bolt diameters from any edge or end. For full-floating drive shaft shields, a minimum of 1" of the shield must be piloted inside its respective holder.
   iii. Drive shaft carrier bearings must be approved by the PTPA technical committee.

Appendix C: Sample Driver's Log

PULL INFO	
LOCATION:	
DATE:	
PROMOTER:	
PRIZE MONEY:	
SLED:	
TRACK CONDITIONS:	
TRACTOR SETUP	
DRIVER NAME:	
DRIVER WEIGHT:	
TRACTOR WEIGHT:	
# FRONT WEIGHTS:	
# REAR WEIGHTS:	
REAR TIRE PRESSURE:	
FRONT TIRE PRESSURE:	
GEAR USED:	
POST PULL INFO	
DISTANCE:	
SLED GEAR:	
PAN DROP (Y/N):	
FRONT TIRE LIFT (Y/N):	
LIFT HEIGHT (IN):	
CLUTCH OPERATION:	
OTHER TRACTOR'S NAME:	
DISTANCE:	
OTHER TRACTOR'S NAME:	
DISTANCE:	
OTHER TRACTOR'S NAME:	
DISTANCE:	
GENERAL COMMENTS	

Appendix D: Sample Maintenance Log

Date	Maintenance	Cost	Additional Comments