California Environmental Protection Agency

Air Resources Board

DRAFT - TEST PLAN FOR CONTROL TECHNOLOGY DEMONSTRATION STUDY ON ABOVEGROUND STORAGE TANKS

Stationary Source Testing Branch
Monitoring and Laboratory Division

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Draft - Test Plan for Control Technology Demonstration Study on Aboveground Storage Tanks

I. Introduction

Aboveground Storage Tanks (ASTs) are used to store gasoline throughout California. These tanks are typically used in agriculture, construction, maintenance and emergency response operations. Local Air Pollution Control Districts usually set permit conditions for ASTs within their jurisdiction, to control emissions and prevent groundwater contamination. Emissions from ASTs vary depending on their type, size and configuration. A significant amount of emissions from ASTs is caused due to evaporation. These losses are known as standing storage (evaporative) loss or breathing loss. Heating of the tank by the sun causes fuel to volatilize and vent to the atmosphere. These evaporative losses increase with higher temperatures. Evaporative losses from ASTs are a significant source of hydrocarbons that contribute to the formation of ozone throughout the state. However, control technology exists that can limit evaporative losses from ASTs.

California Air Resources Board (ARB) is developing a control measure to reduce evaporative emissions from ASTs. The purpose of this study is to evaluate potential emission reductions from ASTs when retrofitted with some simple control technologies. ARB intends to evaluate control technologies such as pressure relief valves, reflecting paint, canopies, insulation, and carbon canisters.

The Engineering Development and Testing Section (EDTS) staff will be conducting this study in two parts. First, a small-scale study will be done in-house on two 50 gallon ASTs. The measurements from this study will also be used to determine the correlation between measured emissions and calculated emissions. Emissions will be calculated using the AP-42 approach for ASTs approved and published by U.S. EPA (Environmental Protection Agency). Second, a field study will be done on commonly used ASTs at a fuel distribution facility in Fresno County.

II. Plan Overview

As mentioned above, the control technology demonstration study on ASTs will be performed in two parts:

- 50 Gallon Tank Study
- AST Field Study

50 Gallon Tank Study

This study will be conducted on two identical (50-gallon) tanks.

- Control Tank: This will be an openly vented (no pressure relief valve) fuel storage tank. The tank will be half filled with gasoline of known RVP (Reid Vapor Pressure). A carbon canister will be attached to the tank to collect and measure the evaporative (standing loss) emissions.
  The tank will also be configured with thermocouples to measure fuel surface temperature and ambient temperature.

- Test Tank: This will be a closed (with a pressure relief valve) fuel storage tank. The tank will be half filled with gasoline of same RVP as used for the control tank. Thermocouples will be used to measure fuel surface temperature and ambient temperature. A carbon canister will be attached to the tank to collect and measure the emissions. This tank will be retrofitted with various control technologies as listed below:

    - Pressure Relief Valve (P/V Valve)
    - Reflecting White Paint
    - Canopy
    - Polyurethane Foam Insulation
    - Carbon Canister

The sequence of testing AST with different control levels is shown in Appendix A as Figure 1. The two carbon canisters used to collect emissions from each tank, will be weighed daily. At the end of each day, the carbon canisters will be replaced with a fresh canister that has been purged with nitrogen or dry air. The test period for each control level will be five consecutive days. Both tanks will be filled with fresh gasoline before testing each level of control technology.

AP-42 Correlation Study: Data obtained from the above study will also be used to determine the correlation between measured emissions and calculated emissions. As mentioned before, AP-42 approach will be used to theoretically calculate emissions from these fuel storage tanks using ambient temperature and fuel surface temperature data. Carbon canisters used to collect emissions will determine the experimentally measured emissions.

AST Field Study

This study will be conducted on common ASTs located in a fuel distribution facility in Fresno County. Two identical sets of common sizes (350, 550 and 1000 gallon) ASTs will be used. For each size category, there will be a control tank and a test tank.

- Control Tank: This will be an open (no pressure relief valve) fuel storage tank. The tank will be half filled with gasoline of known RVP (Reid Vapor Pressure). Thermocouples will be used to measure fuel surface temperature and ambient temperature. Using the temperature data, AP-42 methodology will be used to calculate the emissions.

- Test Tank: This will be a closed (with a pressure relief valve) fuel storage tank. The tank will be half filled with gasoline of same RVP as used for the control tank. Thermocouples will be used to measure fuel surface temperature and ambient temperature. Emissions will be calculated using AP-42 methodology. This tank will be retrofitted with various control technologies as listed below:

    - Pressure Relief Valve (P/V Valve)
    - Reflective White Paint
    - Canopy
    - Polyurethane Foam Insulation
    - Carbon Canister

  ASTs will be retrofitted with the above listed controls incrementally. The detail sequence of testing the ASTs with different control levels is shown in Appendix A as Figure 2. The test period for each control level will be five consecutive days. Approximately, two to five days will be needed after each test period to prepare the tanks for the next test. Both tanks will be filled with fresh gasoline before testing each level of control technology. All three size ranges of ASTs will be tested in the field simultaneously.

  Volumetric Measurement of ASTs: At the conclusion of testing, when the test tanks have been retrofitted with all the above control technologies, they will be left undisturbed for two to three months. Volumetric measurements will be made using a sight tube on the control and test tanks for all AST sizes. In this method, a sight tube is used to measure the drop in liquid level over a given period of time. This will be a real time measurement of emissions from ASTs with and without controls.

III. Test Procedure

ARB staff proposes to conduct the 50-gallon tank study using test procedure described in Appendix A. Test procedure for AST field study is in preparation.

IV. Cost of Control Technologies

Material cost information for all the different control technologies that will be used for this study is provided in Appendix A as Table 1. The installation costs for each control technology are currently being evaluated.

V. Timeline

ARB staff started the 50-gallon tank study on March 30th, 2005. A detailed timeline for the 50-gallon tank study is given in Appendix A as Table 2. The staff intends to begin the AST field study on May 2nd, 2005. A detailed timeline for the AST field study for each size category is given in Appendix A as Table 3 and Table 4.

VI. Contacts

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APPENDIX A

Figure 1

50 Gallon Tank Study

Sequence of Testing ASTs with Different Control Levels

Two identical 50-gallon ASTs half filled with gasoline of known RVP:

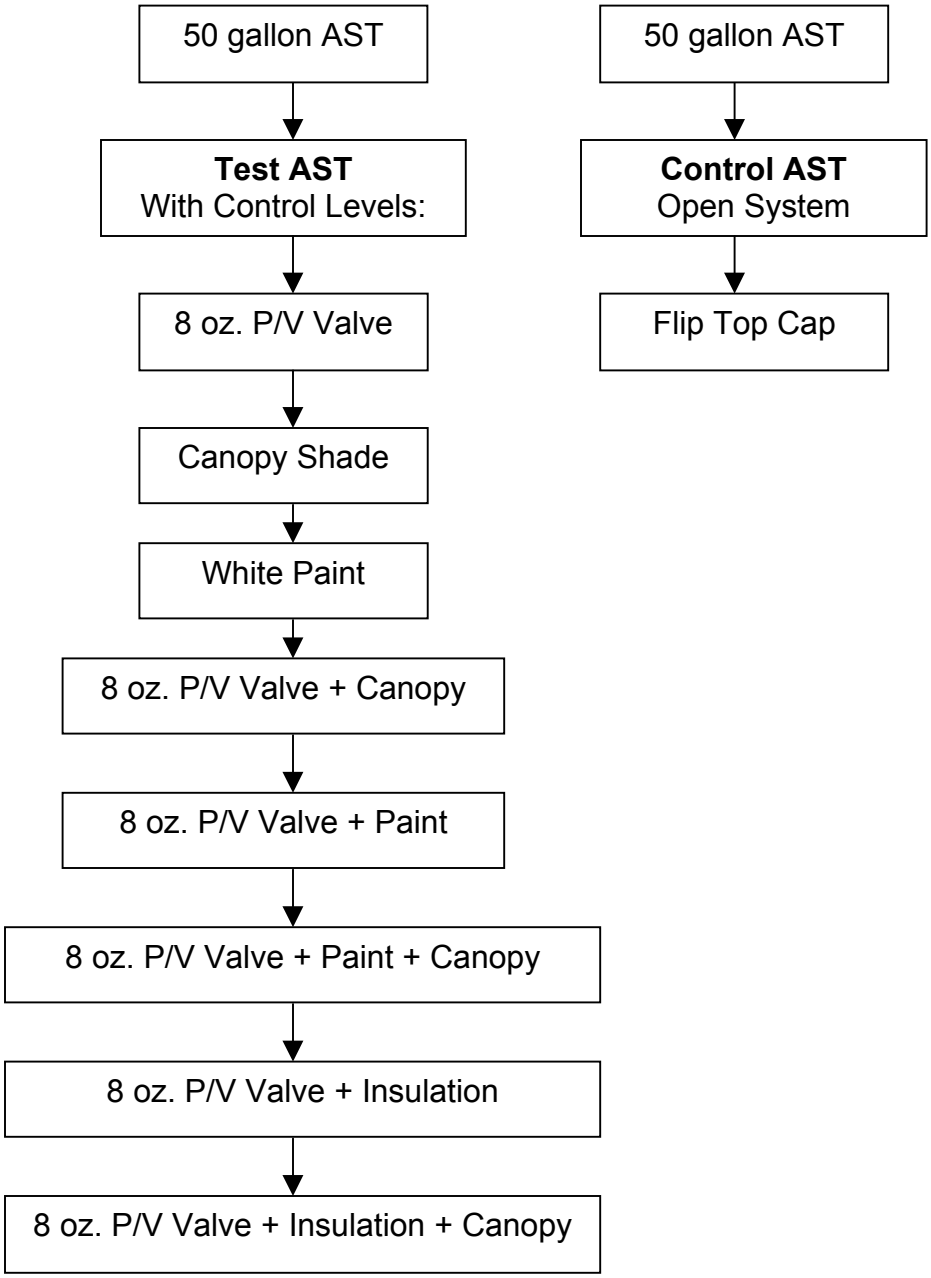
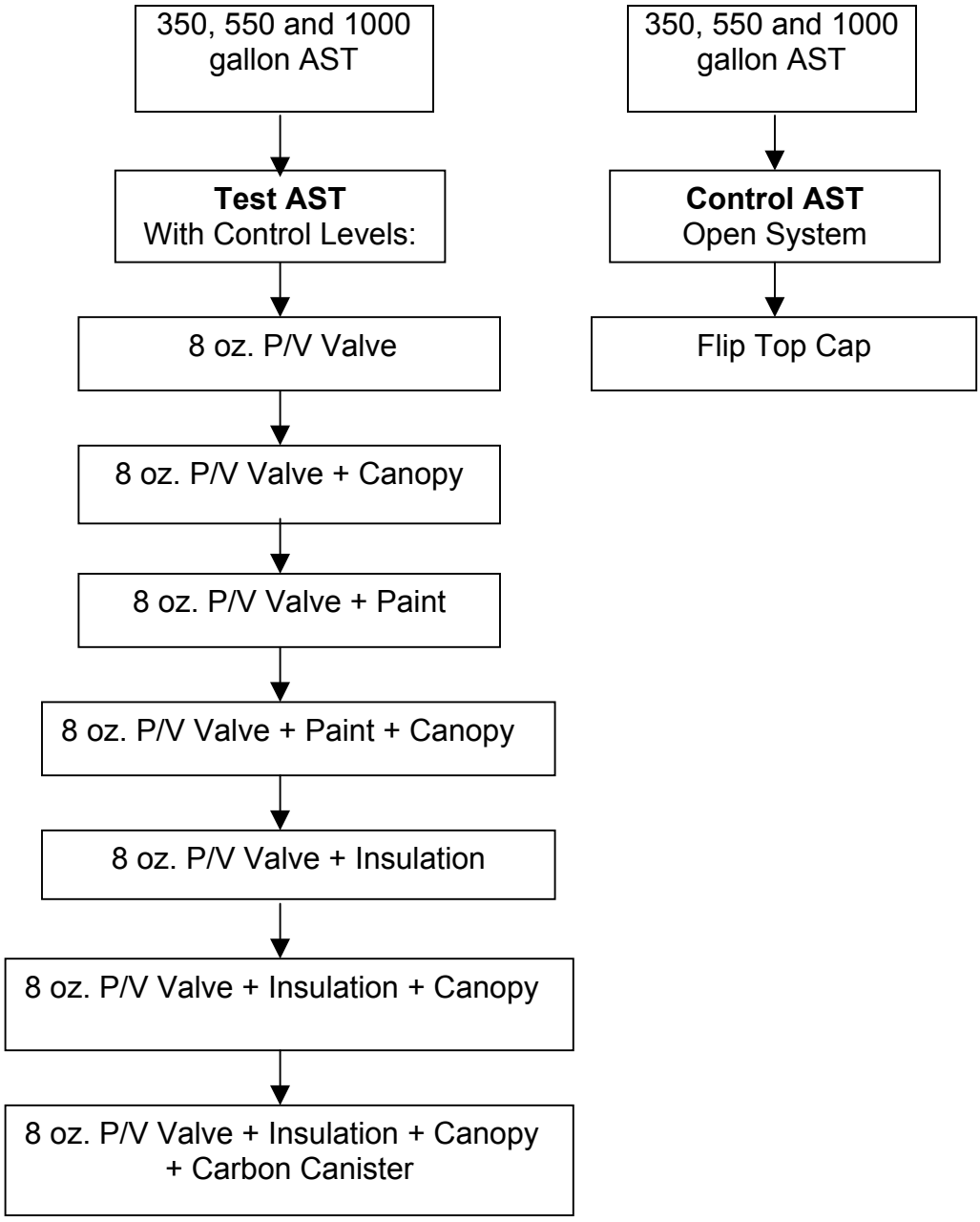


Figure 2

AST Field Study

Sequence of Testing ASTs with Different Control Levels

Two identical ASTs for each size, half filled with gasoline of known RVP:



TEST PROCEDURE FOR 50 GALLON TANK STUDY

1. PURPOSE AND APPLICABILITY

This protocol is being developed to continuously measure the fuel surface temperatures and ambient temperatures in two 50 gallon above ground storage tanks (ASTs) in order to develop emission factors for ASTs using various emission control technologies. These emission factors will also be used to correlate actual measured emissions with emissions predicted using calculations from AP-42.

2. PRINCIPLE AND SUMMARY OF TEST PROCEDURE

This protocol provides a means of continuously collecting AST fuel surface temperatures and ambient air temperatures using thermocouples and a Campbell Scientific Data Logger. Actual emissions from the ASTs will be determined gravimetrically by weighing carbon canisters attached to either a 2" tank opening or to a Tedlar bag encapsulating tank vent emission control devices (Pressure/vacuum (P/V) vent valve or similar device).
Two identical tanks are to be used in this study. The first tank will have a two-inch opening that vents directly through a carbon canister and will serve as the control tank providing baseline emissions data. The second tank will have incrementally increasing levels of emission control technology installed on the tank. The effectiveness of each control level over baseline emissions will then be calculated based upon weight measurements of attached carbon canisters.

3. SENSITIVITY, RANGE, AND PRECISION

Temperature Probes. Maximum range of 0 to 150 ^{o}F and accurate to within two degrees Fahrenheit (2 ^{o}F). Note: A radiation shield must be used for ambient measurements.

4. EQUIPMENT

4.1. Two 50-gallon aluminum tanks modified to simulate actual AST's.
4.2. Thermocouples and associated wiring
- 4.2.1. 2 – thermocouples will be attached to cork floats and sit on top of the fuel in each of the tanks to measure fuel surface temperature.
- 4.2.2. 2 – thermocouples will be inserted into the tanks to measure the interior tank head space temperature
- 4.2.3. A single thermocouple will be used to measure ambient air temperature in the proximity of the two tanks.

4.2.4. Thermocouple wire will be used to connect the thermocouples with the data logger

4.3. Campbell Scientific Data Logger

4.4. Carbon canisters

4.4.1. Carbon canister used on the control tank shall be made from a 3" diameter section of PVC pipe and will have a 2" camlock fitting on the inlet to attach to the tank. The exhaust of the carbon canister shall be the fitted with a 2"diameter camlock fitting and topped with a flip top cap.

4.4.2. Carbon canister for the tank employing pressure control technology shall be constructed of a 3" diameter PVC piping and shall have ¼" Swagelock fittings or equivalent for both inlet and exhaust ports.

4.5. Tedlar bag with fitting – A Tedlar bag with an exhaust fitting shall be fabricated to fit over a pressure/vacuum vent valve and sealed to the supporting pipe with the use of duct tape.

4.6. Various fittings, hoses, adapters and piping

4.7. Calibrated Electronic Scale – Maximum Capacity 25 Kilos, Minimum Accuracy - 0.5 grams.

4.8. 50 gallons of 87 Grade gasoline with a known RVP.

5. PRE-TEST PROCEDURES

5.1. Thermocouples shall be calibrated to work with the data logger used for this study.

5.2. Reid Vapor Pressure (RVP) of the fuel used in this study shall be measured each time new gasoline is introduced into the tanks.

5.3. Both 50 gallon tanks shall be pressurized to 2 PSIG and all fittings shall be leak checked using soap solution.

5.4. Fill each tank with 25 gallons of gasoline through the front top opening and install camlock fitting with attached ball valve and close ball valve.

6. TEST PROCEDURE

6.1. Carbon Canisters

6.1.1. Perform pre-weight check with mass standards.

6.1.2. Weigh empty canister and record weight on form.

6.1.3. Tare the scale and fill the canister with carbon

6.1.4. Record weight of carbon on form.

6.1.5. Place camlock caps on canisters and set aside.

6.2. Control Tank

6.2.1. Install thermocouples in center tank opening.

6.2.2. Install carbon canister on top of ball valve and camlock into place.

6.2.3. Uncap top of carbon canister and install flip top cap.

6.3. Test Tank (Control Technology Tank)
- 6.3.1. Install thermocouples in center tank opening.
- 6.3.2. Install pressure control device on top of ball valve and camlock into place.
- 6.3.3. Place Tedlar bag on top of pressure control device and seal to pipe using duct tape and tie wraps.
- 6.3.4. Attach Tedlar bag to carbon canister.

6.4. Data Logger
- 6.4.1. Turn on data logger and check input from the five separate thermocouples to ensure they are functioning correctly.
- 6.4.2. Record time and open both ball valves on the two tanks.
- 6.4.3. The ambient temperature and those of the two tanks shall be recorded during a daytime test period of at least 6 hours that should capture the peak daytime temperature and approximately one hour beyond the daytime peak temperature.
- 6.4.4. At the end of the test period, the ball valves on the tanks shall be closed and the time recorded.

6.5. Carbon Canisters
- 6.5.1. Carbon canisters are removed from the systems and sealed.
- 6.5.2. Canisters are individually weighed and weight is recorded on form.
- 6.5.3. Weigh a 24” x 24” pan and record weight on form.
- 6.5.4. Tare pan and empty carbon from canisters into the pan and record weight.

6.6. Oven
- 6.6.1. Place pan with used carbon into oven and bake at 140 ^{o}F for four hours.
- 6.6.2. Remove the pan from oven and allow it to cool to room temperature.
- 6.6.3. Weigh pan and record weight. If weight of carbon is within 0.5% of original weight (Step 6.1.3) set it aside for re-use. If weight of carbon is greater than 0.5% of original weight, return to oven and repeat oven cycle until original weight (+/- 0.5%) is obtained.

6.7. Repeat daily test cycle (6.1 – 6.6) for minimum of 5 days.

6.8. New Level of Control Technology
- 6.8.1. Download and save data file from data logger and purge memory.
- 6.8.2. Drain gasoline from both tanks in a safe manner.
- 6.8.3. Install next control technology.
- 6.8.4. Repeat test starting at Step 5.1.

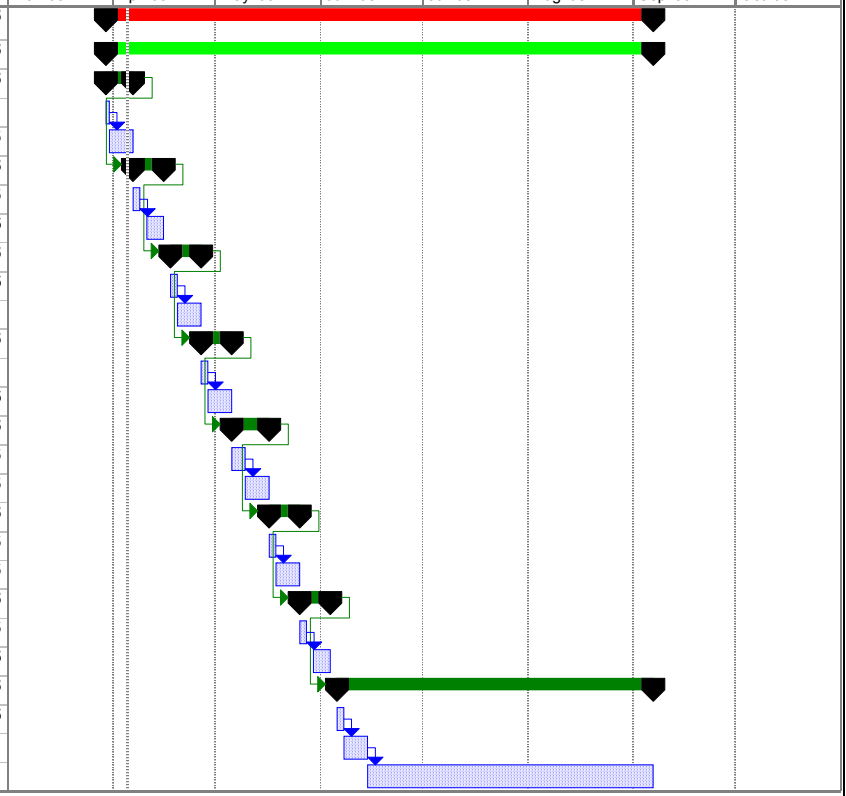
Table 1

Estimated Cost for different Control Technologies to be used on ASTs

Type of Control Technology	Unit Cost
OPW 8 oz. P/V valve, (Distributor – Titan Rubber)	$75.80
Sierra Spray Foam Roofing (Sales Rep. - Gus Hunt)	≅ $5.00 / ft^2
General Coatings Inc. (Sales Rep. – Lee)	Quote pending
Standard White Paint – Owner Applied	$40.00 / gal
Thermo-Insulating Paint - Owner Applied NANSULATE GP™	≅ $0.30 /$ft^2$ with a recommended 3 coat application
Painting – Contracted Out	Labor Cost ≅ $60.00 / hr
Shade Structure – Owner Built Size Dependent Material Costs	$500 - $1,500
Shade Structure – Contracted Out	Labor Cost ≅ $60.00 / hr

Table 2

ID	Task Name	Duration	Start
1	**50 Gallon Tank Study**	**115 days**	**Wed 3/30/05**
2	**Test Sequence for 50 gallons AST**	**115 days**	**Wed 3/30/05**
3	**Tank w/ 8oz. P/V Valve**	**6 days**	**Wed 3/30/05**
4	Configure the tank	1 day	Wed 3/30/05
5	Testing Period	5 days	Thu 3/31/05
6	**Tank w/ Canopy Shade**	**7 days**	**Thu 4/7/05**
7	Configure the tank	2 days	Thu 4/7/05
8	Testing Period	5 days	Mon 4/11/05
9	**Tank w/ White Paint**	**7 days**	**Mon 4/18/05**
10	Configure the tank	2 days	Mon 4/18/05
11	Testing Period	5 days	Wed 4/20/05
12	**Tank w/ P/V Valve + Canopy**	**7 days**	**Wed 4/27/05**
13	Configure the tank	2 days	Wed 4/27/05
14	Testing Period	5 days	Fri 4/29/05
15	**Tank w/ P/V Valve + Paint**	**7 days**	**Fri 5/6/05**
16	Configure the tank	2 days	Fri 5/6/05
17	Testing Period	5 days	Tue 5/10/05
18	**Tank w/ P/V Valve + Paint + Canopy**	**7 days**	**Tue 5/17/05**
19	Configure the tank	2 days	Tue 5/17/05
20	Testing Period	5 days	Thu 5/19/05
21	**Tank w/ P/V Valve + Insulation**	**7 days**	**Thu 5/26/05**
22	Configure the tank	2 days	Thu 5/26/05
23	Testing Period	5 days	Mon 5/30/05
24	**Tank w/ P/V Valve + Insulation + Canopy**	**67 days**	**Mon 6/6/05**
25	Configure the tank	2 days	Mon 6/6/05
26	Testing Period	5 days	Wed 6/8/05
27	Volumetric Measurements	3 mons	Wed 6/15/05

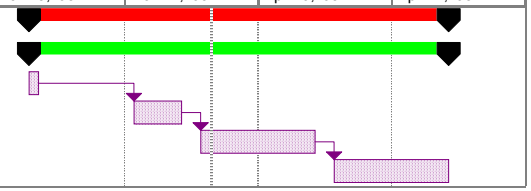


Project: Colored version AST Control T
Date: Tue 4/5/05

Task

Table 3

ID	Task Name	Duration	Start
1	**AST Field Study**	**32 days?**	**Thu 3/17/05**
2	**Test Preparations**	**32 days?**	**Thu 3/17/05**
3	**Site Visit**	1 day?	Thu 3/17/05
4	**Identify Tank Issues**	5 days?	Mon 3/28/05
5	**Tank Repair**	2 wks?	Mon 4/4/05
6	**Site and Test Preparation**	10 days?	Mon 4/18/05

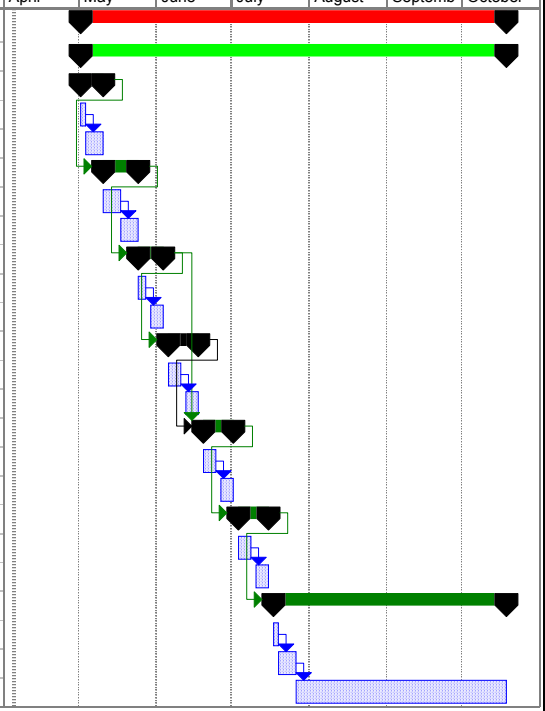


Project: Table 3 Field Study w long term
Date: Tue 4/5/05

Task

Table 4

ID	Task Name	Duration	Start
1	**AST Field Study**	**122 days**	**Mon 5/2/05**
2	**Test Sequence for 350 gallons, 550 gallons and 1000 gallons ASTs**	**122 days**	**Mon 5/2/05**
3	**Tank w/ 8oz. P/V Valve**	**7 days**	**Mon 5/2/05**
4	Configure the tanks	2 days	Mon 5/2/05
5	Testing Period	5 days	Wed 5/4/05
6	**Tank w/ 8oz. P/V Valve + Canopy**	**10 days**	**Wed 5/11/05**
7	Configure the tanks	5 days	Wed 5/11/05
8	Testing Period	5 days	Wed 5/18/05
9	**Tank w/ 8oz. P/V Valve + Paint**	**8 days**	**Wed 5/25/05**
10	Configure the tanks	3 days	Wed 5/25/05
11	Testing Period	5 days	Mon 5/30/05
12	**Tank w/ 8oz. P/V Valve + Paint + Canopy**	**10 days**	**Mon 6/6/05**
13	Configure the tanks	5 days	Mon 6/6/05
14	Testing Period	5 days	Mon 6/13/05
15	**Tank w/ 8oz. P/V Valve + Insulation**	**10 days**	**Mon 6/20/05**
16	Configure the tanks	5 days	Mon 6/20/05
17	Testing Period	5 days	Mon 6/27/05
18	**Tank w/ 8oz. P/V Valve + Insulation + Canopy**	**10 days**	**Mon 7/4/05**
19	Configure the tanks	5 days	Mon 7/4/05
20	Testing Period	5 days	Mon 7/11/05
21	**Tank w/ 8oz. P/V Valve + Insulation + Canopy + Carbon Canister**	**67 days**	**Mon 7/18/05**
22	Configure the tanks	2 days	Mon 7/18/05
23	Testing Period	5 days	Wed 7/20/05
24	Volumetric Measurement of Final Configuration	3 mons	Wed 7/27/05



Project: Table 4 with all sizes Field Stu
Date: Tue 4/5/05

Task