Final Report on the 2004 – 2006 Oklahoma Department of Transportation Sprayer Equipment Assessment & Calibration Workshops

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Developed Under Work Activities #4 and #8 of Joint Project 2156 Between
the Oklahoma State University and the Oklahoma Department of Transportation

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1.0 Introduction

This report documents the findings of herbicide sprayer calibration workshops conducted as a part of the 2004-2006 Joint Project 2156: ROADSIDE VEGETATION MANAGEMENT TRAINING, CONSULTATION & DEVELOPMENT OF LEARNING RESOURCES. This Joint Project was between the Oklahoma State University (OSU) and the Oklahoma Department of Transportation (ODOT).

Early on in this Joint Project, two project initiatives were identified as very closely related training and assessment issues. These were Work Activity #4: *Conduct Workshops on Equipment Trouble Shooting and Calibration of Spray Equipment* and Work Activity #8: the *Assessment of the Status of Each ODOT Field Division's Herbicide Application Equipment/Preparation of an ODOT Herbicide Equipment Inventory Report*. Seeing an opportunity to improve productivity and efficiency, in January of 2005 OSU RVM personnel requested and were granted permission to combine these two activities into one assessment & training effort.

The objectives of the combined Initiatives #4 and #8 on Joint Project 2156 became: 1.) review each ODOT Herbicide spray crew's application equipment, 2.) report on the condition of that equipment, 3.) make recommendations concerning improving the performance of the equipment and 4.) train each crew on the proper sprayer calibration procedures and use of speed adjustment charts.

In 2004 – 2006, OSU RVM personnel visited each ODOT division. This Final Report was generated to document the individual and overall findings on the status and condition of equipment. We assessed, inventoried and calibrated a total of 82 ODOT roadside spray rigs. We discussed and reported on the design and function of each spray rig component to the respective spray crew to which the unit was assigned. A detailed discussion of the individual findings is covered in Sections 2.0 – 9.0 of this report. A state-wide summary of the findings is covered in Section 10. A "report card" (Appendix A.) was generated and sent back to the field unit within 2 weeks of the calibration workshop. A total of 269 ODOT herbicide applicators received "hands on" calibration training on their respective spray rigs. This included training on proper sprayer calibration procedures and use of speed adjustment charts (Appendices B. and C.).

In previous Joint Project spray-equipment-inventories the respondents (ODOT herbicide applicators) merely filled out survey sheets to describe the number but most importantly the condition of pieces of equipment. In this Joint Project, OSU RVM personnel were able to physically access all available ODOT spray rigs. This had not occurred during previous equipment inventories. Over the years the most important outcome of the original herbicide equipment inventory surveys was to allow ODOT insight into what equipment needed to be replaced or brought back to operational status. With this in mind, we feel that the most important outcome of our physical access to the equipment on this Joint Project has been the ability to facilitate an immediate assessment of the condition of herbicide application equipment such that ODOT maintenance divisions were able to respond to suggestions on a timely basis.

In 2005, ODOT herbicide applicators treated 98,556 acres (*2005 Annual Oklahoma Department of Transportation Herbicide Program Report*) of highway easement. Most of those acres were treated utilizing large capacity, truck mounted roadside sprayers. These sprayers consist of large spray tanks and necessary components that are "skid" mounted in the back of ODOT trucks. Due to the physics involved in proper sprayer operation, several basic components are required on properly functioning spray rigs. These being:

1) a tank to hold the herbicide solution (herbicide and carrier).
2) a pump generating pressure to move the herbicide and carrier through a piping system.
3) a delivery system consisting of those parts installed past the pumping system to include pressure regulators and spray nozzles that deposit the herbicide/carrier on targeted weeds.
4) a digital speedometer capable of readouts in tenths of a mile.

Currently, ODOT spray trucks are using either Boombuster nozzles or solid stream tip systems and most spray rigs use centrifugal pumps for pressure generation. Motors powering the pumps are either hydraulic or auxiliary gasoline (gas) engines. At this point it is important to note that OSU Roadside Vegetation Management (RVM) personnel are professionals and proficient in assessing the status of the sprayer components. However, our expertise is limited in the area of truck hydraulic system mechanics or gasoline engine mechanics.

If all of the required sprayer components are in place and functioning properly, these sprayers can be calibrated to deliver accurate rates of herbicides. Deliver of accurate herbicide rates is critical to achieving effective weed control. To make an accurate roadside herbicide application, applicators must know how many gallons per acre (GPA) they need to deliver from the sprayer (indicated on the herbicide label), what the effective spray pattern width (SW) is and how many gallons per minute (GPM) the sprayer delivery system is putting out. Knowing these parameters allow applicators to determine what speed the truck operator must maintain to deliver an accurate and desired rate (Appendix C.).

Comments from ODOT applicators attending this training were very positive and OSU RVM recommendations were made in a sincere effort to allow applicators to operate their spray rigs in a confident, knowledgeable and accurate fashion. Most spray rigs had small individual problems that could be fixed by the field crews. Major issues were addressed in reports to respective division maintenance engineers.

We would like to thank the divisions for their participation in this training and assessment endeavor. Without their cooperation, the scope of this report would have been dramatically limited. We encourage suggestions as to how this report can be made more informative and useful. As always we welcome and encourage input from all levels & branches within ODOT.

2.0 Assessment of the Division One Spray Equipment and Calibration Workshops

Table 1. Div. 1 Herbicide Sprayer Assessment/Calibration Workshop.

Division Field Unit	Sprayer Power Source	Herbicide Delivery System	Workshop Attendance	Workshop Date
Adair Co.	NA*	NA	4	6/8/2006
Checotah Interstate	Hydraulic	Solid Stream Head – 9 nozzle	2	6/6/2006
Cherokee Co.	Hydraulic	Solid Stream Head – 9 nozzle	6	6/8/2006
Haskell Co.	Hydraulic	Boombuster Head-437R, 375R, 260-11R	2	6/7/2006
McIntosh Co.	Hydraulic	Solid Stream Head – 9 nozzle	2	6/6/2006
Muskogee Co.	Auxiliary Gas Motor	Solid Stream Head – 9 nozzle	10	6/6/2006
Okmulgee Co.	Auxiliary Gas Motor	Injector System w/ Boombuster Head-437R, 375R, 260-11R	4	6/6/2006
Sallisaw Interstate/ Sequoyah Co. (shared unit)	Auxiliary Gas Motor	Solid Stream Head – 9 nozzle	4	6/7/2006
Wagoner Co.	Auxiliary Gas Motor	Boombuster Head-437R, 375R, 260-11R	4	6/8/2006

* - NA, Not available for assessment

2.1 Comments and Recommendations from OSU Personnel to Division 1

1. Several Division One spray trucks were either missing a working Calc-An-Acre (to digitally monitor their sprayer speed) or the installed Calc-An-Acre was nonfunctional. Without this key component of a spray rig, accurate herbicide application is almost impossible (see *Roadside Vegetation Management Guidelines*, 3rd Ed., Ch.11.6).This inadequacy should be corrected before the next spray season. Failure to rectify this situation can have undesirable consequences

(see *Roadside Vegetation Management Guidelines*, 3rd Ed., Ch.11, p. 11-14). We recommend that new Calc-An-Acre units be purchased for each spray truck utilizing older units and old units (if present) be replaced. On these trucks, ODOT should use the stock cable/sensor/magnet installation which can be installed on all vehicles. Modifications to help secure the magnets onto the truck driveshaft include:

a.) Replace the stock magnet with a longer, wider, larger surface area magnet (available from sources such as Radio Shack) that can be attached by a combination of three methods including an adhesive (Epoxy cement or JB Weld), sheet metal screws through the magnet into the driveshaft and plastic "zip ties" or stainless steel hose clamps.

b.) Make sure that the hose clamp ends do not risk impacting the mounted sensor. Insufficient sensor/magnet (or mounting hardware) clearance can led to destruction of both the magnet and sensor. Calc-An-Acres can be purchased for approximately $275/unit from Wylie Sprayers in Oklahoma City (405-946-4896).

2. Division One spray truck are using either Estes spray heads with banks of VeeJet tips and solid stream tips or have upgraded to banks of Boombuster tips. Spray trucks using either Boombuster style tips or the Estes spray head use electric solenoid valves or electric ball valves to control which tip is used during herbicide applications.

The Boombuster style tips are made of stainless steel with nylon diffusers that actually create the pattern. The steel tips should last forever; however, the nylon diffusers have a life expectancy of 4-5 years of use before needing replacement. Some ODOT spray trucks have nylon diffusers that showed various signs of aging and cracking (many cracks must be seen with a magnifying glass). We recommend that all ODOT spray rigs that have tips with cracked diffusers, carry a new, spare replacement tip on board. Boombuster tip diffusers don't give any warning when they will ultimately break other than showing signs of cracking. A spray tip diffuser that cracks in the middle of a tank load will shut down the application until a new tip is installed. If a replacement tip is on board this repair would only be a minor inconvenience. Tips with cracked diffusers should be returned back to the manufacturer (Evergreen Products, P.O. Box 598, Griffin, GA 30442 (478-982-5593)) for refurbishing at approximately half the cost of a new tip. New tips can be ordered from Wylie Sprayers in Oklahoma City (405-946-4896).

Spray trucks using older Estes spray heads with VeeJet tips also use electric valves to control which banks of tips make the herbicide application. The Estes spray heads are functional but they are more complex and have more moving parts that can fail or break. Consequently more maintenance is required and more repair parts are required to be available for repairs in the field. Parts that showed failure most often with the Estes spray head are brass swing joints necessary to set the spray tip position on the head. It is our recommendation that county units keep in stock spare swing joint parts and extra tips for repairs. These repair parts can be ordered from Wylie Sprayers of Oklahoma, Oklahoma City, OK 73128, 405-946-4896.

It is the recommendation of the OSU RVM Program that spray trucks using the Estes solid stream spray head be upgraded to the Boombuster tips as funds become available either at the division level or at the county unit level. The approximate cost of the three tips (437-R, 375-R and 260-11-R) would be $250 ($80.00 per tip). Hydraulic and electrical components from the older Estes heads can be used to articulate and control the Boombuster tips. Several county units indicated they could do all of the refitting "in-house" in their yards fairly easily.

3.0 Assessment of the Division Two Spray Equipment and Calibration Workshops

Table 2. Div. 2 Herbicide Sprayer Assessment/Calibration Workshop.

Division Field Unit	Sprayer Power Source	Herbicide Delivery System	Workshop Attendance	Workshop Date
Atoka Co.	Auxiliary Gas Motor	Solid Stream Head – 9 nozzle	1	4/20/2006
Bryan Co.	Auxiliary Gas Motor	Boombuster Head – 437R, 375R, 260-11R	2	4/20/2006
Choctaw Co.	Auxiliary Gas Motor	Solid Stream Head – 9 nozzle	4	4/19/2006
Latimer Co.	Auxiliary Gas Motor	Solid Stream Head – 9 nozzle	2	4/18/2006
Leflore Co.	Auxiliary Gas Motor	Solid Stream Head – 12 nozzle	1	4/18/2006
Marshall Co.	Hydraulic	Solid Stream Head – 9 nozzle	2	4/20/2006
McCurtain Co.	Auxiliary Gas Motor	Boombuster Head – 437R, 375R, 260-11R	1	4/19/2006
Pittsburg Co.	Auxiliary Gas Motor	Boombuster Head – 437R, 375R, 260-11R	1	4/18/2006
Pushmataha Co.	Auxiliary Gas Motor	Solid Stream Head – 9 nozzle	2	4/19/2006
Talihina Yard	NA*	NA	1	4/18/2006

* - NA, Not available for assessment

3.1 Comments and Recommendations from OSU Personnel to Division 2

1.) Most all of Division Two spray trucks were either missing a working Calc-An-Acre (to digitally monitor their sprayer speed) or the installed Calc-An-Acre was nonfunctional. Without this key component of a spray rig, accurate herbicide application is almost impossible (see *Roadside Vegetation Management Guidelines*, 3rd Ed., Ch.11.6).This inadequacy should be corrected before the next spray season. Failure to rectify this situation can have undesirable

consequences (see *Roadside Vegetation Management Guidelines*, 3rd Ed., Ch.11, p. 11-14). We recommend that new Calc-An-Acre units be purchased for each spray truck and old, non-functional units be replaced. Calc-An-Acres can be purchased for approximately $275/unit from Wylie Sprayers in Oklahoma City (405-946-4896). On these trucks, ODOT should use the stock cable/sensor/magnet installation which can be installed on all vehicles. Modifications to help secure the magnets onto the truck driveshaft include:

a.) Replace the stock magnet with a longer, wider, larger surface area magnet (available from sources such as Radio Shack) that can be attached by a combination of three methods including an adhesive (Epoxy cement or JB Weld), sheet metal screws through the magnet into the driveshaft and plastic "zip ties" or stainless steel hose clamps.

b.) Make sure that the hose clamp ends do not risk impacting the mounted sensor. Insufficient sensor/magnet (or mounting hardware) clearance can led to destruction of both the magnet and sensor.

c.) Pittsburg county avoided magnet/sensor issues by utilizing a Calc-An-Acre option listed in the operator's manual. This option is a radar unit that provides accurate road speed monitoring without being exposed to damage issues affecting the magnet/sensor system.

2.) Several Division Two spray rigs were missing sparger tube in the spray tanks. This tube is a required piece of the spray system and is used to provide tank agitation maintaining suspension of herbicides in the tank. Without the sparger tube, some herbicides can "settle out" to the tank bottom resulting in an initial over application (roadside injury) and/or under application with poor weed control. Missing tank sparger tubes should be replaced.

3.) Many of the Division Two spray rigs did not have an in-line 30 mesh screen filter (strainer) on the suction side of the pump, between the tank and the pump. This filter needs to be in place to keep foreign objects from entering the pump, causing pump damage.

4.) Spray units utilizing VeeJet and solid stream spray heads need to have a 50 mesh screen filter plumbed in on the pressure side of the pump before herbicide/carrier reaches the tips. Boombuster tips usually do not require this filter as small particles passing through the first 30 mess filter can be passed through the Boombuster tips (unless otherwise directed on specific report cards).

5.) Most Division Two herbicide spray rigs are doing dual duty where spray rigs are being used to clean bridges or to wet roads during construction. Some crews are extracting water from creeks, rivers or ponds. In doing this, gravel, sand and small rocks are being pumped into the tank and run through the water pump (this is especially true if in-line filters are missing). This will damage and shorten the life of the centrifugal pump. Damaged pumps can not maintain high enough pressures to properly operate multiple tips and deliver adequate back flow required for tank agitation. If this practice continues, it is imperative that adequate filters/strainers be put in place to protect pumps and tips from damage.

6.) Division Two spray trucks are using either Boombuster style tips (or clusters of Boombuster tips) or combinations of VeeJet tips and solid stream tips mounted in groups on three tip banks. The Boombuster style tips are made of stainless steel with nylon diffusers that actually create the pattern. The steel tips should last forever; however, the nylon diffusers have a life expectancy of

4-5 years of use before needing replacement. Some ODOT spray trucks have nylon diffusers that showed various signs of aging and cracking (many cracks must be seen with a magnifying glass). We recommend that all ODOT spray rigs that have tips with cracked diffusers, carry a new, spare replacement tip on board. Boombuster tip diffusers don't give any warning when they will ultimately break other than showing signs of cracking. A spray tip diffuser that cracks in the middle of a tank load will shut down the application until a new tip is installed. If a replacement tip is on board this repair would only be a minor inconvenience. Tips with cracked diffusers should be returned back to the manufacturer (Evergreen Products, P.O. Box 598, Griffin, GA 30442 (478-982-5593)) for refurbishing at approximately half the cost of a new tip. New tips can be ordered from Wylie Sprayers in Oklahoma City (405-946-4896).

7.) Division Two spray rigs loaded on 5 yard trucks are having some type of hydraulic problem. It is crucial to the spray program (especially if a spray rig uses a hydraulic driven water pump) that the truck hydraulics are functioning properly. In brief, as a tank load of herbicide is mixed and then applied, the spray system pressure drops during the application (this happens over a 30 minute to 1 hour period). This is not desirable because dropping hydraulic pressures will result in decreased spray pressures which will change the applicators targeted herbicide rate per acre. Division Two applicators are aware of this and have been making the necessary attempts at adjustments by increasing hydraulic dial settings (i.e. changing spreader or spinner dial from 7 to 8 or 9) during the application. Changing the dials will bring the pressure back to where it needs to be but it is not a cure for the original problem of the decreasing pressure. In our opinion, based on past experiences with other ODOT field division hydraulic issues (Div. 5 had and corrected this problem); it is likely that the hydraulic system is overheating resulting in decreased hydraulic pressures. Truck hydraulic systems are outside of our area of expertise; however, we recommend that Division Two contact Div. 5 to discuss their corrective measures. Division Eight increased the size of the trucks hydraulic pump to minimize overheating (check with Fred Martin/Div. 8 Shop Super.) and Division Four recirculated the hot hydraulic line through the tank of cool water to cool the hydraulic oil (check with Terry Hogan/Div. 4 Shop Super.). To the best of our knowledge, these attempts cured the overheating problem. We know other field divisions have experienced hydraulic problems but we are not aware of exactly how they fixed them. There are many ways to modify the truck hydraulics to minimize the overheating issue, we would be more than happy to assist Division Two personnel in any way to rectify this issue.

4.0 Assessment of the Division Three Spray Equipment and Calibration Workshops

Table 3. Div. 3 Herbicide Sprayer Assessment/Calibration Workshop.

Division Field Unit	Sprayer Power Source	Herbicide Delivery System	Workshop Attendance	Workshop Date
Coal Co.	Hydraulic	Boombuster – 437R	2	3/31/2005
Garvin Co.	Auxiliary Gas Motor	Boombuster – 437R	3	3/30/2005
Hughes Co.	Hydraulic	Boombuster – 437R	3	3/31/2005
Johnston Co.	Auxiliary Gas Motor	Boombuster – 437R	3	3/31/2005
Lincoln Co.	Auxiliary Gas Motor	Boombuster – 437R	3	4/4/2005
McClain Co.	Auxiliary Gas Motor	Boombuster – 437R	4	3/30/2005
Okfuskee Co.	Auxiliary Gas Motor	Boombuster – 437R	4	4/4/2005
Pontotoc Co.	Auxiliary Gas Motor	Boombuster – 437R	2	3/31/2005
Pottawatomie Co. (Two spray units)	Auxiliary Gas Motor	Boombuster – 437R	5	4/4/2005
Purcell Interstate I-35	Auxiliary Gas Motor	Boombuster – 437R	4	3/30/2005
Seminole Co. (Two spray units)	Auxiliary Gas Motor	Boombuster – 437R	4	3/31/2005
Shawnee Interstate I-40	Auxiliary Gas Motor	Boombuster Head – 437R, 375R, 260-11R, 180-6R	3	4/4/2005

4.1 Comments and Recommendations from OSU Personnel to Division 3

1. The in-line filters are currently plumbed between the pump and the electric solenoid which protects most sprayer components but not all. To fully protect the entire spray system the in-line filters should be plumbed between the tank shut-off and the pump. As most spray rigs are not experiencing major problems from this we are not recommending that the in-line filters be replumbed immediately, but rather as these spray rigs are rebuilt in years ahead.

2. The current in-line filters are equipped with 50 mesh screens which are built primarily for boom-type sprayers which are equipped with small spray tips. ODOT spray systems use large tips and should only require the use of 20 or 30 mesh screens. The larger holes in the 20 to 30 mesh screens will allow our liquid drift control products to pass easier, whereas the 50 mesh screens can filter out liquid drift control products and clog screens. We would recommend replacing all 50 mesh screens with 20 or 30 mesh screens.

3. All division three spray trucks are using Boombuster style tips. The Boombuster style tips are made of stainless steel with nylon diffusers that actually create the pattern. The steel tips should last forever; however, the nylon diffusers have a life expectancy of 4-5 years of use before needing replacement. Many ODOT spray trucks have nylon diffusers that showed various signs of aging and cracking (many cracks must be seen with a magnifying glass). We recommend that all ODOT spray rigs that have tips with cracked diffusers should have a new spare replacement tip on board. Boombuster tip diffusers don't give any warning when they will ultimately break other than showing signs of cracking. A spray tip diffuser that cracks in the middle of a tank load is shut down until a new tip is installed. If a replacement tip is on board this repair would only be a minor inconvenience. Tips with cracked diffusers should be returned back to the manufacturer (Evergreen Products, P.O. Box 598, Griffin, GA 30442 (478-982-5593)) for refurbishing.

5.0 Assessment of the Division Four Spray Equipment and Calibration Workshops

Table 4. Div. 4 Herbicide Sprayer Assessment/Calibration Workshop.

Division Field Unit	Sprayer Power Source	Herbicide Delivery System	Workshop Attendance	Workshop Date
Garfield Co.	Hydraulic	Boombuster – 437R	4	4/29/2004
Grant Co.	Hydraulic	Boombuster – 437R	4	4/27/2004
Guthrie Interstate I-35 South	Hydraulic	Boombuster – 437R	3	5/4/2004
Kay Co.	Hydraulic	Boombuster – 437R	6	4/27/2004
Kingfisher Co.	Hydraulic	Boombuster – 437R	4	5/4/2004
Logan Co	Hydraulic	Boombuster – 437R	5	5/4/2004
Noble Co.	Hydraulic	Boombuster – 437R	7	4/29/2004
Payne Co.	Hydraulic	Boombuster – 437R	3	4/29/2004
Tonkawa Interstate I-35 North	NA*	NA	1	4/27/2004

* - NA, Not available for assessment

5.1 Comments and Recommendations from OSU Personnel to Division 4

1. Many trucks need new pressure gauges which are critical for calibration and monitoring sprayer performance. Each truck needs a minimum of 2 (one in cab and one at tip, since many Div. 4 trucks have two spray tips, each tip needs a pressure gauge mounted at the tip). We recommend using good quality oil-filled pressure gauges that measure 0-60 psi.

2. Several spray rigs do not have in-line strainers. This is a preventative maintenance sprayer component and is well worth installing. We recommend using a screen mesh size of 30 or 30 over 50 (double screened).

3. Division 4 is using a pneumatically-controlled control arm to turn sprayer output on/off. While this has been working fine we heard a few comments of the pneumatic arm bleeding off and accidentally opening the valve. This could be very dangerous and potentially very liable. The pneumatic arms seem to work well but as they get older and begin to fail we strongly recommend that they be replace with in-line electric ball valves. These are available from TeeJet and many other companies. These are 12-volt shutoff valves that could replace the elaborate pneumatic arm shutoffs and would simplify the very critical shutoff control system. The electric ball valves should run around $120 to $160 each and should be plumbed into the output line as close to the spray tip as the system design will allow.

4. It is very important with ODOT's current spray trucks that your personnel be able to accurately (within 1/10 of 1 mile per hour) monitor and change their truck sprayer speeds to maintain constant herbicide rates. Some trucks have had compatibility problems retroactive installation of optional transmission adapters. On all the trucks that cannot get the digital transmission adapter to work, we recommend a return to the original speed cable/sensor/magnet system that came as a stock item with the Calc-An-Acre. The cable/sensor/magnet systems will work on all vehicles and tractors. It is important to mount the magnet to the drive shaft permanently so it won't fall off or get knocked off. We mentioned numerous techniques to your personnel on how to mount the magnets to drive shafts using JB Weld, sheet metal screws, plastic zip ties, or all three at one time. We would recommend purchasing large flat magnets that have more surface area to help facilitate bonding to the drive shaft.

5. When I-35 Tonkawa and Payne Co. crews get their sprayer fixed we will be available to initiate a calibration session with their spray crews. Please contact us and we will work them into our schedule.

6.0 Assessment of the Division Five Spray Equipment and Calibration Workshops

Table 5. Div. 5 Herbicide Sprayer Assessment/Calibration Workshop.

Division Field Unit	Sprayer Power Source	Herbicide Delivery System	Workshop Attendance	Workshop Date
Beckham Co.	Hydraulic	Boombuster – 437R	2	4/28/2005
Blaine Co.	Hydraulic	Boombuster – 437R	3	4/26/2005
Custer Co.	Hydraulic	Boombuster – 437R	6	4/27/2005
Dewey Co.	Hydraulic	Boombuster – 437R	5	4/26/2005
Elk City Interstate I-40	Hydraulic	Boombuster – 437R	3	4/27/2005
Greer Co.	Hydraulic	Boombuster – 437R	3	4/28/2005
Harmon Co.	Hydraulic	Boombuster – 437R	4	4/28/2005
Hydro Interstate I-40	Hydraulic	Boombuster – 437R	3	4/26/2005
Jackson Co.	Hydraulic	Boombuster – 437R	3	4/28/2005
Kiowa Co. (Two spray units)	Hydraulic	Boombuster – 437R	2	4/27/2005
Roger Mills Co.	Hydraulic	Boombuster – 437R	5	4/27/2005
Tillman Co.	Hydraulic	Boombuster – 437R	5	4/28/2005
Washita Co.	Hydraulic	Boombuster – 437R	3	4/27/2005

6.1 Comments and Recommendations from OSU Personnel to Division 5

1. All division five spray trucks are using Boombuster style tips. The Boombuster style tips are made of stainless steel with nylon diffusers that actually create the pattern. The steel tips should last forever; however, the nylon diffusers have a life expectancy of 4-5 years of use before needing replacement. Many ODOT spray trucks have nylon diffusers that showed various signs of aging and cracking (many cracks must be seen with a magnifying glass). We recommend that all ODOT spray rigs that have tips with cracked diffusers should have a new spare replacement tip on board. Boombuster tip diffusers don't give any warning when they will ultimately break other than showing signs of cracking. A spray tip diffuser that cracks in the middle of a tank load is shuts down the application until a new tip is installed. If a replacement tip is on board this repair would only be a minor inconvenience. Tips with cracked diffusers should be returned back to the manufacturer (Evergreen Products, P.O. Box 598, Griffin, GA 30442 (478-982-5593)) for refurbishing at approximately half the cost of a new tip. New tips can be ordered from Wylie Sprayers in Oklahoma City (405-946-4896). Nearly all Division Five spray crews said they currently have replacement tips.

2. Most Division Five spray trucks are currently using Calc-An-Acres to digitally monitor their sprayer speed. We recommend the two trucks that do not currently have Calc-An-Acres install one before their next spray season (Hydro Interstate & Jackson Co.). Many Division Five spray truck Calc-An-Acres are currently installed using the wiring harness that connects directly to the transmission. This installation appears to be working well even though we have had a lot of problem using this wiring harness in other divisions. The transmission wiring harness has advantages over the installation which uses the cable/sensor/magnet. Division Five should continue to use the transmission wiring harness whenever possible but keep in mind we have found some truck transmission will are not compatible with this harness. On these trucks ODOT should use the original stock cable/sensor/magnet installation which can be installed on all vehicles. Calc-An-Acres can be purchased for approximately $275/unit from Wylie Sprayers in Oklahoma City (405-946-4896) as well as the optional transmission wiring harnesses.

3. It was evident after reviewing and calibrating sprayers, and talking with division five spray crews that most of the division five trucks/spray rigs are having some type of hydraulic problem. It is crucial to the spray program that if a spray rig will use a hydraulic driven water pump that the truck hydraulics are running efficiently and effectively. In brief, as a tank load of herbicide is mixed and then applied the spray system pressure drops during the application (this happens over a 30 minute to 1 hour period). This is not desirable because dropping hydraulic pressures will result in decreased spray pressures which will change the applicators targeted herbicide rate per acre. Division Five applicators are aware of this and for years have been making the necessary adjustments by increasing hydraulic dial settings (i.e. changing spreader dial from 7 to 8 or 9) during the application. Changing the dials will bring the pressure back to where it needs to be but it is not a cure for the original problem of the decreasing pressure. In our opinion, based on past experiences with other ODOT field division hydraulic issues, it is likely that the hydraulic system is overheating resulting in decreased hydraulic pressures. Truck hydraulic systems are outside of our area of expertise, however, we can share with Division Five what other field divisions have done to address similar issues in the past. Division Eight increased the size of the trucks hydraulic pump to minimize overheating (check with Fred Martin/Div. 8 Shop Super.) and

Division Four recirculated the hot hydraulic line through the tank of cool water to cool the hydraulic oil (check with Terry Hogan/Div. 4 Shop Super.). To the best of our knowledge both of these attempts cured the overheating problem. I know other field divisions have experienced hydraulic problems but I am not aware of exactly how they fixed them. There is no doubt there are many ways that a person could modify the truck hydraulics to minimize the overheating issue, we would be more than happy to assist Division Five personnel in any way we can to help with this issue.

7.0 Assessment of the Division Six Spray Equipment and Calibration Workshops

Table 6. Div. 6 Herbicide Sprayer Assessment/Calibration Workshop.

Division Field Unit	Sprayer Power Source	Herbicide Delivery System	Workshop Attendance	Workshop Date
Alfalfa Co.	Hydraulic	Boombuster – 437R	2	4/19/2005
Beaver Co.	Hydraulic	Boombuster – 437R	3	4/21/2005
Cimarron Co.	Hydraulic	Boombuster – 437R	1	4/21/2005
Ellis Co.	Hydraulic	Boombuster – 437R	1	4/20/2005
Harper Co.	Hydraulic	Boombuster – 437R	4	4/20/2005
Major Co.	Hydraulic	Boombuster – 437R	4	4/19/2005
Texas Co.	Hydraulic	Boombuster – 437R	2	4/21/2005
Woods Co.	Hydraulic	Boombuster – 437R	2	4/19/2005
Woodward Co.	Hydraulic	Boombuster – 437R	1	4/20/2005

7.1 Comments and Recommendations from OSU Personnel to Division 6

1. All division six spray trucks are using Boombuster style tips. The Boombuster style tips are made of stainless steel with nylon diffusers that actually create the pattern. The steel tips should last forever; however, the nylon diffusers have a life expectancy of 4-5 years of use before needing replacement. Many ODOT spray trucks have nylon diffusers that showed various signs of aging and cracking (many cracks must be seen with a magnifying glass). We recommend that all ODOT spray rigs that have tips with cracked diffusers should have a new spare replacement tip on board. Boombuster tip diffusers don't give any warning when they will ultimately break other than showing signs of cracking. A spray tip diffuser that cracks in the middle of a tank load is shuts down the application until a new tip is installed. If a replacement tip is on board this repair would only be a minor inconvenience. Tips with cracked diffusers should be returned back to the manufacturer (Evergreen Products, P.O. Box 598, Griffin, GA 30442 (478-982-5593)) for

refurbishing at approximately half the cost of a new tip. New tips can be ordered from Wylie Sprayers in Oklahoma City (405-946-4896).

2. Several division six spray crews said they make applications with a single person on the truck. Whether a crew uses one or two personnel on a spray truck it would be very beneficial to install a spray system pressure gauge up near the cab so that personnel can easily monitor spray system pressures during an application. Currently the only gauge on the trucks is mounted near the tip and is difficult to monitor during the application. We recommend running a 3/8 inch hose w/pressure gauge to the cab and mounting it on the side mirror bracket or inside of cab. We recommend using a 0-60 psi gauge and not the 0-100 gauge. This can be plumbed a number of ways.

3. We recommend that Division Six reinstall the Calc-An-Acre digital speed monitors back on the spray trucks using the stock cable-sensor-magnet that comes with a new unit. The Calc-An-Acres, as we understand it, were used in the past on the single axle trucks but were not removed and reinstalled when these were replaced with the dual axle trucks. We recommend that each spray rig have an operational Calc-An-Acre so that applicators can monitor and maintain as accurate ground speeds as possible. We no longer recommend the use of the electronic wiring harnesses with the Calc-An-Acre (this is where we tied into the truck transmission instead of using the cable-sensor-magnet). Calc-An-Acres can be purchased for approximately $275/unit from Wylie Sprayers in Oklahoma City (405-946-4896).

8.0 Assessment of the Division Seven Spray Equipment and Calibration Workshops

Table 7. Div. 7 Herbicide Sprayer Assessment/Calibration Workshop.

Division Field Unit	Sprayer Power Source	Herbicide Delivery System	Workshop Attendance	Workshop Date
Caddo Co.	Hydraulic	Boombuster – 437R	7	4/11/2006
Carter Co.	Hydraulic	Boombuster – 437R	3	4/13/2006
Comanche Co.	Hydraulic	Boombuster – 437R	5	4/11/2006
Cotton Co.	Hydraulic	Boombuster – 437R	5	4/12/2006
Grady Co.	Hydraulic	Boombuster – 437R	3	4/11/2006
Ardmore Interstate I-35e	Hydraulic	Boombuster – 437R	3	4/13/2006
Jefferson Co.	Hydraulic	Boombuster – 437R	4	4/12/2006
Love Co.	Hydraulic	Boombuster – 437R	5	4/13/2006
Murray Co.	Hydraulic	Boombuster – 437R	5	4/13/2006
Stephens Co.	Hydraulic	Boombuster – 437R	4	4/12/2006

8.1 Comments and Recommendations from OSU Personnel to Division 7

1. All Division Seven spray trucks were either missing a working Calc-An-Acre (to digitally monitor their sprayer speed) or the installed Calc-An-Acre was nonfunctional. Without this key component of a spray rig, accurate herbicide application is almost impossible (see *Roadside Vegetation Management Guidelines*, 3rd Ed., Ch.11.6).This inadequacy should be corrected before the next spray season. Failure to rectify this situation can have undesirable consequences (see *Roadside Vegetation Management Guidelines*, 3rd Ed., Ch.11, p. 11-14). We recommend that new Calc-An-Acre units be purchased for each spray truck and old units (if present) be replaced. On these trucks, ODOT should use the stock cable/sensor/magnet installation which

can be installed on all vehicles. Modifications to help secure the magnets onto the truck driveshaft include:

a.) Replace the stock magnet with a longer, wider, larger surface area magnet (available from sources such as Radio Shack) that can be attached by a combination of three methods including an adhesive (Epoxy cement or JB Weld), sheet metal screws through the magnet into the driveshaft and plastic "zip ties" or stainless steel hose clamps.

b.) Make sure that the hose clamp ends do not risk impacting the mounted sensor. Insufficient sensor/magnet (or mounting hardware) clearance can led to destruction of both the magnet and sensor.

Calc-An-Acres can be purchased for approximately $275/unit from Wylie Sprayers in Oklahoma City (405-946-4896).

2. All division Seven spray trucks are using Boombuster style tips. The Boombuster style tips are made of stainless steel with nylon diffusers that actually create the pattern. The steel tips should last forever; however, the nylon diffusers have a life expectancy of 4-5 years of use before needing replacement. Some ODOT spray trucks have nylon diffusers that showed various signs of aging and cracking (many cracks must be seen with a magnifying glass). We recommend that all ODOT spray rigs that have tips with cracked diffusers, carry a new, spare replacement tip on board. Boombuster tip diffusers don't give any warning when they will ultimately break other than showing signs of cracking. A spray tip diffuser that cracks in the middle of a tank load will shut down the application until a new tip is installed. If a replacement tip is on board this repair would only be a minor inconvenience. Tips with cracked diffusers should be returned back to the manufacturer (Evergreen Products, P.O. Box 598, Griffin, GA 30442 (478-982-5593)) for refurbishing at approximately half the cost of a new tip. New tips can be ordered from Wylie Sprayers in Oklahoma City (405-946-4896).

3. It was evident after reviewing and calibrating sprayers, and talking with division Seven spray crews, that some of the division Seven trucks/spray rigs (usually 5 yard trucks) are having some type of hydraulic problem. It is crucial to the spray program (especially if a spray rig uses a hydraulic driven water pump) that the truck hydraulics are running efficiently and effectively. In brief, as a tank load of herbicide is mixed and then applied, the spray system pressure drops during the application (this happens over a 30 minute to 1 hour period). This is not desirable because dropping hydraulic pressures will result in decreased spray pressures which will change the applicators targeted herbicide rate per acre. Division Seven applicators are aware of this and for years have been making the necessary attempts at adjustments by increasing hydraulic dial settings (i.e. changing spreader or spinner dial from 7 to 8 or 9) during the application. Changing the dials will bring the pressure back to where it needs to be but it is not a cure for the original problem of the decreasing pressure. In our opinion, based on past experiences with other ODOT field division hydraulic issues (Div. 5 had and corrected this problem); it is likely that the hydraulic system is overheating resulting in decreased hydraulic pressures. Truck hydraulic systems are outside of our area of expertise; however, we recommend that Division Seven contact Div. 5 to discuss their corrective measures. Division Eight increased the size of the trucks hydraulic pump to minimize overheating (check with Fred Martin/Div. 8 Shop Super.) and Division Four recirculated the hot hydraulic line through the tank of herbicide/carrier to cool the hydraulic oil (check with Terry Hogan/Div. 4 Shop Super.). To the best of our knowledge, these attempts cured the overheating problem. We know other field divisions have experienced

hydraulic problems but we are not aware of exactly how they fixed them. There are many ways to modify the truck hydraulics to minimize the overheating issue, we would be willing to assist Division Seven personnel in rectifying this issue.

4. Almost all division Seven spray rigs utilized a drop-tip in addition to the 437-R Boombuster tip. Drop tips are useful in that they make sure that the edge of the road shoulder is treated properly. This includes a 1-2 foot edge of the paved road edge. Drop tips have small orifices and need additional screening from particles (rust, sand, ect.) that will clog the tip resulting in a skip or miss in the spray pattern. The drop tip will require a 50 mesh screen right at the tip. Screens in place right before the spray pump (25-30 mesh) do not filter out smaller particle that can (and eventually will) clog the drop tip, keeping them from being effective. To retrofit all units with parts that are uniform, we recommend purchasing and installing the following parts (each truck will need one of each part listed):

TeeJet Part*	**TeeJet Part Number**
Veejet Spray Nozzle	H-U ¼ 20 (50^{o})
Nozzle Body	CP (B) 1321
Nozzle Body Adapter	(B) 4676 ¼
Tip Strainer	5053 (50) mesh

*Teejet parts are available through Wylie Sprayers in Oklahoma City (405-946-4896)

5. Two spray rigs, Jefferson Co. and Love Co., have a very unusual problem. CB radio's were installed and wired so that when the radio mike is keyed, some type of electrical surge is produced through the spreader/spinner control box resulting in an increase in hydraulic pump rpm's and Boombuster tip pressure from 25 psi to greater than 80 psi. This situation should be corrected and the division electrician responsible for this wiring should be informed about the issues regarding this wiring technique. Any attempt to use the radio during a spray operation would result in excessive pressures, over application and the production of fine spray particle susceptible to drift or off-target movement.

9.0 Assessment of the Division Eight Spray Equipment and Calibration Workshops

Table 8. Div. 8 Herbicide Sprayer Assessment/Calibration Workshop.

Division Field Unit	Sprayer Power Source	Herbicide Delivery System	Workshop Attendance	Workshop Date
Craig Co.	Hydraulic	Boombuster Head – 437R, 375R, 260-11R	4	6/15/2006
Creek Co.	Hydraulic	Boombuster Head – 437R, 375R, 260-11R	2	6/14/2006
Delaware Co.	Hydraulic	Boombuster Head – 437R, 375R, 260-11R	3	6/15/2006
Mayes Co.	Hydraulic	Boombuster – 437R	2	6/15/2006
Nowata Co.	Hydraulic	Boombuster Head – 437R, 375R, 260-11R	2	6/13/2006
Osage Co.	Hydraulic	Boombuster Head – 437R, 375R, 260-11R	2	6/14/2006
Ottawa Co	Hydraulic	Boombuster Head – 437R, 375R, 260-11R	4	6/15/2006
Pawnee	Hydraulic	Boombuster Head – 437R, 375R, 260-11R	2	6/14/2006
Rodgers Co.	Hydraulic	Boombuster Head – 437R, 375R, 260-11R	2	6/14/2006
Washington Co.	Hydraulic	Boombuster Head – 437R, 375R, 260-11R	3	6/13/2006

9.1 Comments and Recommendations from OSU Personnel to Division 8

1. All Division Eight spray trucks were either missing a working Calc-An-Acre (to digitally monitor their sprayer speed) or the installed Calc-An-Acre was nonfunctional or disconnected. Without this key component of a spray rig, accurate herbicide application is almost impossible (see *Roadside Vegetation Management Guidelines*, 3rd Ed., Ch.11.6).This inadequacy should be corrected before the next spray season. Failure to rectify this situation can have undesirable consequences (see *Roadside Vegetation Management Guidelines*, 3rd Ed., Ch.11, p. 11-14). We recommend that new Calc-An-Acre units be purchased for each spray truck and old units (if present) be replaced. On these trucks, ODOT should use the stock cable/sensor/magnet installation which can be installed on all vehicles. Modifications to help secure the magnets onto the truck driveshaft include:

a.) Replace the stock magnet with a longer, wider, larger surface area magnet (available from sources such as Radio Shack) that can be attached by a combination of three methods including an adhesive (Epoxy cement or JB Weld), sheet metal screws through the magnet into the driveshaft and plastic "zip ties" or stainless steel hose clamps.

b.) Make sure that the hose clamp ends do not risk impacting the mounted sensor. Insufficient sensor/magnet (or mounting hardware) clearance can led to destruction of both the magnet and sensor. Calc-An-Acres can be purchased for approximately $275/unit from Wylie Sprayers in Oklahoma City (405-946-4896).

2. All Division Eight spray trucks are using banks of Boombuster tips, one 437R, one 375R and one 260-11R. The 260-11R tip treats a 0-11foot pattern. The 375R tip treats a 0-20 foot pattern and the 437R tip treats a 0-29 foot pattern. These tips are to be operated one tip at a time to treat specific widths of roadside easements. They should never be run simultaneously. Spray trucks using Boombuster style tips use electric solenoid valves or electric ball valves to control which tip is used during herbicide applications. Tip spray pressure is maintained at @ 25 psi by inline pressure regulators. If replacement ball valves are needed, they make be ordered from Wylie Sprayers in Oklahoma City (405-946-4896).

Part	Description
Electric Ball Valve	Spray Systems Mod. 344B EC-2, Max. pressure rating 300psi (approximately $185)

If replacement regulators are needed, they can be ordered from Grainger Inc., (918-836-8631), 10707 E. Pine St., Tulsa, OK 74116

Part	Description
Inline Water Pressure Reducing Valve	Watts 1 inch, Series 223 LP10 (adjustment range 10-35psi, maximum pressure supply 300psi) Watts Reg. Co. Approximate cost - $283.80 each.

The Boombuster style tips are made of stainless steel with nylon diffusers that actually create the pattern. The steel tips should last forever; however, the nylon diffusers have a life expectancy of 4-5 years of use before needing replacement. Some ODOT spray trucks have nylon diffusers that showed various signs of aging and cracking (many cracks must be seen with a magnifying glass).

We recommend that all ODOT spray rigs that have tips with cracked diffusers, carry a new, spare replacement tip on board. Boombuster tip diffusers don't give any warning when they will ultimately break other than showing signs of cracking. A spray tip diffuser that cracks in the middle of a tank load will shut down the application until a new tip is installed. If a replacement tip is on board this repair would only be a minor inconvenience. Tips with cracked diffusers should be returned back to the manufacturer (Evergreen Products, P.O. Box 598, Griffin, GA 30442 (478-982-5593)) for refurbishing at approximately half the cost of a new tip. New tips can be ordered from Wylie Sprayers in Oklahoma City (405-946-4896).

3. Most spray rigs were missing a pressure gauge (0-100psi) on the pump output side of the system. The pump pressure gauge is imperative to monitor proper functioning of the centrifugal pump that delivers the spray mixture to the inline regulators controlling spray pressures at the Boombuster tips. Some units were not equipped with tip pressure gauges that are needed to monitor correct tip pressures (range 20-30psi, 25psi preferred). Most of these corrections were made during the training period or were to be made later by individual ODOT units.

4. OSU RVM Program personnel request an opportunity to review any mechanical alterations of current spray rig system designs to determine if any of these modifications will disrupt the proper functioning of ODOT spray rig designs. This includes any permanent removal or detachment of any sprayer component. This can be achieved by a phone consultation with the OSU RVM personnel (405-624-7538). We have encountered situations where important sprayer components were not reattached when trucks were upgraded resulting in nonfunctional sprayers.

10.0 Statewide Summary of Spray Equipment Assessment and Calibration Workshops

Over the course of a three year period (2004-2006), the OSU RVM personnel visited each ODOT division and assessed, inventoried and calibrated a total of 82 ODOT roadside spray rigs. In this same period, 269 ODOT herbicide applicators received "hands on" calibration training on their respective spray rigs.

Equipment assessment followed a protocol established through the utilization of a formal "report card" (Appendix A). Report cards were filled out on site as ODOT spray crews were present during assessment. These crews were instructed to present their copy to the unit supervisor (if they were not present). A written report was sent to each division maintenance engineer within two weeks following the completion of assessment/calibration in their division. Many of the sprayer issues could have been identified earlier if spray crews and their supervisors would review the *Roadside Vegetation Management Guidelines*, 3rd Ed., Ch.10.7, Checklist for Sprayer Problems. It is important to note that many divisions responded quickly to OSU RVM recommendations and these concerns may have already been addressed. However, if in subsequent reassessment of ODOT sprayers, previously identified deficiencies have not been corrected, it may become necessary for ODOT leadership to take a more active, formal role in addressing the issues.

Currently, ODOT sprayers are powered by either hydraulic motors or auxiliary gasoline engine (Table 1 – 8) powering a centrifugal pump (see *Roadside Vegetation Management Guidelines*, 3rd Ed., Ch.10.2.2, p. 4 - 5). Each of these motor types have unique advantages and disadvantages. Of the 82 sprayer units assessed (Table 1-8), 58 (71%) units were hydraulic powered and 24 (29%) were driven by gasoline engines. Both motor types are acceptable as long as each is working properly. It is critical for trucks utilizing hydraulic motors that these systems have adequate cooling capacity and do not over heat. Overheating causes hydraulic system fluctuations resulting in unstable hydraulic motor RPM's. Gasoline motors may have an advantage in hilly terrain due to the motor being independent of the trucks hydraulic system and engine RPM remaining more constant. We speculate that gasoline engines are utilized in Divisions 1, 2 and 3 due to this feature and their hilly to mountainous terrain.

One of the most critical issues identified was the lack of a Calc-An-Acre, digital speedometer or the nonworking order of installed Calc-An-Acre speedometers. Without this key component of a spray rig, accurate herbicide application is almost impossible (see *Roadside Vegetation Management Guidelines*, 3rd Ed., Ch.11.6).This inadequacy should be corrected (by the respective divisions were the deficiency was identified) before the next spray season. Failure to rectify this situation can have undesirable consequences (see *Roadside Vegetation Management Guidelines*, 3rd Ed., Ch.11, p. 11-14).

Most spray units did not have "backup" replacement tips (either Boombuster, Veejet or solid stream) readily available in the event of spray tip failure. Defective tip replacement can be effected in the field by spray crews. On site replacement would negate the need for trips back to the field unit headquarters saving "man hours". This would also help applicators take advantage of herbicide application windows (the most opportune time to make applications under favorable conditions). OSU RVM recommendations are that replacement tips are purchased and carried with spray rigs.

Most ODOT sprayers are used for herbicide application and other non-herbicide application purposes. Examples of non-herbicide purposes are bridge cleaning and the application of magnesium chloride (MgCl) for ice prevention/removal. Both of these practices

may have detrimental affects on centrifugal pumps. Our recommendation is to exercise caution and avoid induction of abrasive materials such as sand, rocks and possibly magnesium chloride [MgCl] in pumps designed to apply herbicides.

Finally, it is the opinion of OSU RVM personnel that this assessment/calibration effort be continued in subsequent Joint Projects between the Oklahoma State University RVM Program and the Oklahoma Department of Transportation.

APPENDEX A
ODOT Herbicide Sprayer Report Card

ODOT Herbicide Sprayer Report Card

Date: _____ ODOT Div/Unit: _____
Applicator Names:_____
_____

Sprayer Type: _____ Boomless truck sprayer _____ Boomless tractor sprayer
_____ Boom-type tractor sprayer _____ Powered hand-gun sprayer
_____ Small capacity sprayer _____ Rope-wick/Wiper applicator
_____ Shoulder/guard-rail sprayer attachment

Sprayer Part(s)	Good	Bad	Comments or Repair(s) needed:
Tank/lid			
Tank shut-off valve			
In-line Screen -Mesh ( )			
Drift control Injector			
Water pump			
Pump/powered by ____hydraulic ____aux. gasoline			
Hoses/Plumbing			
Agitation system			
Pressure gauge(s) In cab ____ Outside cab ____			
Pressure Regulator(s)			
Nozzle(s) Type:			
Control Arm			
Nozzle shut-off - Solenoid - other			
In-cab switches			
Handgun & hose			
Calc-An-Acre - Cable/magnet -DSA			

Recommended Sprayer Design Changes: (plumbing restrictions, nozzle height, hydraulics, etc..)

White copy – OSU Yellow Copy-County/Int. Unit Pink Copy-Field Div. Hq.

APPENDEX B
Directions on Using the Calibration/Speed Adjustment Charts

Directions on Using the Calibration/Speed Adjustment Charts

Step 1. Select carrier rate to be used for your application. Use either **40, 35, 30, 25,** or **20** gallons of herbicide and water per acre.

Step 2. Select the appropriate calibration/speed chart that matches your selected carrier rate.

Step 3. Load the spray tank at least 1/3 full with clean water and make sure the sprayer and all of its components are working properly. Set system pressure between **20 and 30 psi**.. Make any adjustments to the nozzle tip(s) height and trajectory at this point. Fix all leaks.

Step 4. Collect the discharge out of a single tip or bank of tips for 60 seconds. This will give you **gallons per minute (GPM).** Collect in calibrated buckets or barrels only. It is acceptable to collect the discharge for 30 seconds and multiply by 2, but it is not acceptable to collect for 15 seconds (too much error).

Step 5. With the sprayer running, measure the **effective spray pattern width** in feet.

Step 6. Using the chart selected in Step 2 find your **GPM** down the left side of the chart. Then across the top of the chart find **your effective spray pattern width**. Where these two values intersect within the chart is your correct **vehicle speed (MPH)** that you should travel.

Step 7. Your GPM should remain relatively constant during application as long as you do not have major changes in spray pressure. However, if during application you have a change in effective spray pattern width of more than a foot or two, you should use your selected chart to make a quick adjustment in vehicle speed to compensate for your pattern change. **Simply repeat step 6 with the new effective spray pattern width.** This adjustment only takes a few seconds and helps maintain a constant herbicide rate.

For questions on calibration call: Doug Montgomery or Craig Evans, 405-624-7538

Speed chart for use with BoomBuster 260-11R, 375-R, or solid-stream nozzles and a 20 GPA carrier rate.

GPA 20

	effective spray width (feet)																				
	10	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
GPM	**vehicle speed (MPH)**																				
6.0	14.9	13.5	12.4	11.4	10.6	9.9	9.3	8.7	8.3	7.8	7.4	7.1	6.8	6.5	6.2	5.9	5.7	5.5	5.3	5.1	5.0
6.5		14.6	13.4	12.4	11.5	10.7	10.1	9.5	8.9	8.5	8.0	7.7	7.3	7.0	6.7	6.4	6.2	6.0	5.7	5.5	5.4
7.0			14.4	13.3	12.4	11.6	10.8	10.2	9.6	9.1	8.7	8.3	7.9	7.5	7.2	6.9	6.7	6.4	6.2	6.0	5.8
7.5				14.3	13.3	12.4	11.6	10.9	10.3	9.8	9.3	8.8	8.4	8.1	7.7	7.4	7.1	6.9	6.6	6.4	6.2
8.0					14.1	13.2	12.4	11.6	11.0	10.4	9.9	9.4	9.0	8.6	8.3	7.9	7.6	7.3	7.1	6.8	6.6
8.5						14.0	13.1	12.4	11.7	11.1	10.5	10.0	9.6	9.1	8.8	8.4	8.1	7.8	7.5	7.3	7.0
9.0						14.9	13.9	13.1	12.4	11.7	11.1	10.6	10.1	9.7	9.3	8.9	8.6	8.3	8.0	7.7	7.4
9.5							14.7	13.8	13.1	12.4	11.8	11.2	10.7	10.2	9.8	9.4	9.0	8.7	8.4	8.1	7.8
10.0								14.6	13.8	13.0	12.4	11.8	11.3	10.8	10.3	9.9	9.5	9.2	8.8	8.5	8.3
10.5									14.4	13.7	13.0	12.4	11.8	11.3	10.8	10.4	10.0	9.6	9.3	9.0	8.7
11.0										14.3	13.6	13.0	12.4	11.8	11.3	10.9	10.5	10.1	9.7	9.4	9.1
11.5											14.2	13.6	12.9	12.4	11.9	11.4	10.9	10.5	10.2	9.8	9.5
12.0											14.9	14.1	13.5	12.9	12.4	11.9	11.4	11.0	10.6	10.2	9.9
12.5												14.7	14.1	13.5	12.9	12.4	11.9	11.5	11.0	10.7	10.3
13.0													14.6	14.0	13.4	12.9	12.4	11.9	11.5	11.1	10.7
13.5														14.5	13.9	13.4	12.9	12.4	11.9	11.5	11.1
14.0															14.4	13.9	13.3	12.8	12.4	11.9	11.6
14.5																14.4	13.8	13.3	12.8	12.4	12.0
15.0																14.9	14.3	13.8	13.3	12.8	12.4
15.5																	14.8	14.2	13.7	13.2	12.8
16.0																		14.7	14.1	13.7	13.2
16.5																			14.6	14.1	13.6
17.0																				14.5	14.0
17.5																				14.9	14.4
18.0																					14.9

.GPA carrier rate 25stream nozzle and a -or solid ,R-375 ,R11-260Speed chart for use with BoomBuster

GPA 25

(feet)effective spray width

	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
GPM									**(MPH)vehicle speed**														
6.0	14.9	13.2	11.9	10.8	9.9	9.1	8.5	7.9	7.4	7.0	6.6	6.3	5.9	5.7	5.4	5.2	5.0	4.8	4.6	4.4	4.2	4.1	4.0
6.5		14.3	12.9	11.7	10.7	9.9	9.2	8.6	8.0	7.6	7.2	6.8	6.4	6.1	5.9	5.6	5.4	5.1	5.0	4.8	4.6	4.4	4.3
7.0			13.9	12.6	11.6	10.7	9.9	9.2	8.7	8.2	7.7	7.3	6.9	6.6	6.3	6.0	5.8	5.5	5.3	5.1	5.0	4.8	4.6
7.5			14.9	13.5	12.4	11.4	10.6	9.9	9.3	8.7	8.3	7.8	7.4	7.1	6.8	6.5	6.2	5.9	5.7	5.5	5.3	5.1	5.0
8.0				14.4	13.2	12.2	11.3	10.6	9.9	9.3	8.8	8.3	7.9	7.5	7.2	6.9	6.6	6.3	6.1	5.9	5.7	5.5	5.3
8.5					14.0	12.9	12.0	11.2	10.5	9.9	9.4	8.9	8.4	8.0	7.7	7.3	7.0	6.7	6.5	6.2	6.0	5.8	5.6
9.0					14.9	13.7	12.7	11.9	11.1	10.5	9.9	9.4	8.9	8.5	8.1	7.7	7.4	7.1	6.9	6.6	6.4	6.1	5.9
9.5						14.5	13.4	12.5	11.8	11.1	10.5	9.9	9.4	9.0	8.6	8.2	7.8	7.5	7.2	7.0	6.7	6.5	6.3
10.0							14.1	13.2	12.4	11.6	11.0	10.4	9.9	9.4	9.0	8.6	8.3	7.9	7.6	7.3	7.1	6.8	6.6
10.5							14.9	13.9	13.0	12.2	11.6	10.9	10.4	9.9	9.5	9.0	8.7	8.3	8.0	7.7	7.4	7.2	6.9
11.0								14.5	13.6	12.8	12.1	11.5	10.9	10.4	9.9	9.5	9.1	8.7	8.4	8.1	7.8	7.5	7.3
11.5									14.2	13.4	12.7	12.0	11.4	10.8	10.4	9.9	9.5	9.1	8.8	8.4	8.1	7.9	7.6
12.0									14.9	14.0	13.2	12.5	11.9	11.3	10.8	10.3	9.9	9.5	9.1	8.8	8.5	8.2	7.9
12.5										14.6	13.8	13.0	12.4	11.8	11.3	10.8	10.3	9.9	9.5	9.2	8.8	8.5	8.3
13.0											14.3	13.5	12.9	12.3	11.7	11.2	10.7	10.3	9.9	9.5	9.2	8.9	8.6
13.5											14.9	14.1	13.4	12.7	12.2	11.6	11.1	10.7	10.3	9.9	9.5	9.2	8.9
14.0												14.6	13.9	13.2	12.6	12.1	11.6	11.1	10.7	10.3	9.9	9.6	9.2
14.5													14.4	13.7	13.1	12.5	12.0	11.5	11.0	10.6	10.3	9.9	9.6
15.0													14.9	14.1	13.5	12.9	12.4	11.9	11.4	11.0	10.6	10.2	9.9
15.5														14.6	14.0	13.3	12.8	12.3	11.8	11.4	11.0	10.6	10.2
16.0															14.4	13.8	13.2	12.7	12.2	11.7	11.3	10.9	10.6
16.5															14.9	14.2	13.6	13.1	12.6	12.1	11.7	11.3	10.9
17.0																14.6	14.0	13.5	12.9	12.5	12.0	11.6	11.2
17.5																	14.4	13.9	13.3	12.8	12.4	11.9	11.6
18.0																	14.9	14.3	13.7	13.2	12.7	12.3	11.9
18.5																		14.7	14.1	13.6	13.1	12.6	12.2
19.0																			14.5	13.9	13.4	13.0	12.5
19.5																			14.9	14.3	13.8	13.3	12.9
20.0																				14.7	14.1	13.7	13.2
20.5																					14.5	14.0	13.5
21.0																					14.9	14.3	13.9
21.5																						14.7	14.2


22.0
14.5

.GPA carrier rate 30stream nozzle and a -or solid ,psR ti-437 ,R-375 ,R11-260Speed chart for use with BoomBuster

GPA 30

(feet)effective spray width

	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
GPM	**(MPH)vehicle speed**																						
6.0	12.4	11.0	9.9	9.0	8.3	7.6	7.1	6.6	6.2	5.8	5.5	5.2	5.0	4.7	4.5	4.3	4.1	4.0	3.8	3.7	3.5	3.4	3.3
6.5	13.4	11.9	10.7	9.8	8.9	8.3	7.7	7.2	6.7	6.3	6.0	5.6	5.4	5.1	4.9	4.7	4.5	4.3	4.1	4.0	3.8	3.7	3.6
7.0	14.4	12.8	11.6	10.5	9.6	8.9	8.3	7.7	7.2	6.8	6.4	6.1	5.8	5.5	5.3	5.0	4.8	4.6	4.4	4.3	4.1	4.0	3.9
7.5		13.8	12.4	11.3	10.3	9.5	8.8	8.3	7.7	7.3	6.9	6.5	6.2	5.9	5.6	5.4	5.2	5.0	4.8	4.6	4.4	4.3	4.1
8.0		14.7	13.2	12.0	11.0	10.2	9.4	8.8	8.3	7.8	7.3	6.9	6.6	6.3	6.0	5.7	5.5	5.3	5.1	4.9	4.7	4.6	4.4
8.5			14.0	12.8	11.7	10.8	10.0	9.4	8.8	8.3	7.8	7.4	7.0	6.7	6.4	6.1	5.8	5.6	5.4	5.2	5.0	4.8	4.7
9.0			14.9	13.5	12.4	11.4	10.6	9.9	9.3	8.7	8.3	7.8	7.4	7.1	6.8	6.5	6.2	5.9	5.7	5.5	5.3	5.1	5.0
9.5				14.3	13.1	12.1	11.2	10.5	9.8	9.2	8.7	8.3	7.8	7.5	7.1	6.8	6.5	6.3	6.0	5.8	5.6	5.4	5.2
10.0					13.8	12.7	11.8	11.0	10.3	9.7	9.2	8.7	8.3	7.9	7.5	7.2	6.9	6.6	6.3	6.1	5.9	5.7	5.5
10.5					14.4	13.3	12.4	11.6	10.8	10.2	9.6	9.1	8.7	8.3	7.9	7.5	7.2	6.9	6.7	6.4	6.2	6.0	5.8
11.0						14.0	13.0	12.1	11.3	10.7	10.1	9.6	9.1	8.6	8.3	7.9	7.6	7.3	7.0	6.7	6.5	6.3	6.1
11.5						14.6	13.6	12.7	11.9	11.2	10.5	10.0	9.5	9.0	8.6	8.3	7.9	7.6	7.3	7.0	6.8	6.5	6.3
12.0							14.1	13.2	12.4	11.6	11.0	10.4	9.9	9.4	9.0	8.6	8.3	7.9	7.6	7.3	7.1	6.8	6.6
12.5							14.7	13.8	12.9	12.1	11.5	10.9	10.3	9.8	9.4	9.0	8.6	8.3	7.9	7.6	7.4	7.1	6.9
13.0								14.3	13.4	12.6	11.9	11.3	10.7	10.2	9.8	9.3	8.9	8.6	8.3	7.9	7.7	7.4	7.2
13.5								14.9	13.9	13.1	12.4	11.7	11.1	10.6	10.1	9.7	9.3	8.9	8.6	8.3	8.0	7.7	7.4
14.0									14.4	13.6	12.8	12.2	11.6	11.0	10.5	10.0	9.6	9.2	8.9	8.6	8.3	8.0	7.7
14.5										14.1	13.3	12.6	12.0	11.4	10.9	10.4	10.0	9.6	9.2	8.9	8.5	8.3	8.0
15.0										14.6	13.8	13.0	12.4	11.8	11.3	10.8	10.3	9.9	9.5	9.2	8.8	8.5	8.3
15.5											14.2	13.5	12.8	12.2	11.6	11.1	10.7	10.2	9.8	9.5	9.1	8.8	8.5
16.0											14.7	13.9	13.2	12.6	12.0	11.5	11.0	10.6	10.2	9.8	9.4	9.1	8.8
16.5												14.3	13.6	13.0	12.4	11.8	11.3	10.9	10.5	10.1	9.7	9.4	9.1
17.0												14.8	14.0	13.4	12.8	12.2	11.7	11.2	10.8	10.4	10.0	9.7	9.4
17.5													14.4	13.8	13.1	12.6	12.0	11.6	11.1	10.7	10.3	10.0	9.6
18.0													14.9	14.1	13.5	12.9	12.4	11.9	11.4	11.0	10.6	10.2	9.9
18.5														14.5	13.9	13.3	12.7	12.2	11.7	11.3	10.9	10.5	10.2
19.0														14.9	14.3	13.6	13.1	12.5	12.1	11.6	11.2	10.8	10.5
19.5															14.6	14.0	13.4	12.9	12.4	11.9	11.5	11.1	10.7
20.0																14.3	13.8	13.2	12.7	12.2	11.8	11.4	11.0
20.5																14.7	14.1	13.5	13.0	12.5	12.1	11.7	11.3
21.0																	14.4	13.9	13.3	12.8	12.4	11.9	11.6
21.5																	14.8	14.2	13.6	13.1	12.7	12.2	11.8

22.0																	14.5	14.0	13.4	13.0	12.5	12.1

Speed chart for use with BoomBuster 260-11R, 375-R, or 437-R tips when using a 35 GPA carrier rate.

GPA 35

	effective spray width (feet)																				
	10	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
GPM	**vehicle speed (MPH)**																				
11.0	15.6	14.1	13.0	12.0	11.1	10.4	9.7	9.2	8.6	8.2	7.8	7.4	7.1	6.8	6.5	6.2	6.0	5.8	5.6	5.4	5.2
11.5		14.8	13.6	12.5	11.6	10.8	10.2	9.6	9.0	8.6	8.1	7.7	7.4	7.1	6.8	6.5	6.3	6.0	5.8	5.6	5.4
12.0			14.1	13.1	12.1	11.3	10.6	10.0	9.4	8.9	8.5	8.1	7.7	7.4	7.1	6.8	6.5	6.3	6.1	5.9	5.7
12.5			14.7	13.6	12.6	11.8	11.0	10.4	9.8	9.3	8.8	8.4	8.0	7.7	7.4	7.1	6.8	6.5	6.3	6.1	5.9
13.0				14.1	13.1	12.3	11.5	10.8	10.2	9.7	9.2	8.8	8.4	8.0	7.7	7.4	7.1	6.8	6.6	6.3	6.1
13.5				14.7	13.6	12.7	11.9	11.2	10.6	10.0	9.5	9.1	8.7	8.3	8.0	7.6	7.3	7.1	6.8	6.6	6.4
14.0					14.1	13.2	12.4	11.6	11.0	10.4	9.9	9.4	9.0	8.6	8.3	7.9	7.6	7.3	7.1	6.8	6.6
14.5					14.6	13.7	12.8	12.1	11.4	10.8	10.3	9.8	9.3	8.9	8.5	8.2	7.9	7.6	7.3	7.1	6.8
15.0						14.1	13.3	12.5	11.8	11.2	10.6	10.1	9.6	9.2	8.8	8.5	8.2	7.9	7.6	7.3	7.1
15.5						14.6	13.7	12.9	12.2	11.5	11.0	10.4	10.0	9.5	9.1	8.8	8.4	8.1	7.8	7.6	7.3
16.0							14.1	13.3	12.6	11.9	11.3	10.8	10.3	9.8	9.4	9.1	8.7	8.4	8.1	7.8	7.5
16.5							14.6	13.7	13.0	12.3	11.7	11.1	10.6	10.1	9.7	9.3	9.0	8.6	8.3	8.0	7.8
17.0								14.1	13.4	12.7	12.0	11.4	10.9	10.5	10.0	9.6	9.2	8.9	8.6	8.3	8.0
17.5								14.6	13.8	13.0	12.4	11.8	11.3	10.8	10.3	9.9	9.5	9.2	8.8	8.5	8.3
18.0									14.1	13.4	12.7	12.1	11.6	11.1	10.6	10.2	9.8	9.4	9.1	8.8	8.5
18.5									14.5	13.8	13.1	12.5	11.9	11.4	10.9	10.5	10.1	9.7	9.3	9.0	8.7
19.0									14.9	14.1	13.4	12.8	12.2	11.7	11.2	10.7	10.3	10.0	9.6	9.3	9.0
19.5										14.5	13.8	13.1	12.5	12.0	11.5	11.0	10.6	10.2	9.8	9.5	9.2
20.0										14.9	14.1	13.5	12.9	12.3	11.8	11.3	10.9	10.5	10.1	9.8	9.4
20.5											14.5	13.8	13.2	12.6	12.1	11.6	11.2	10.7	10.4	10.0	9.7
21.0											14.9	14.1	13.5	12.9	12.4	11.9	11.4	11.0	10.6	10.2	9.9
21.5												14.5	13.8	13.2	12.7	12.2	11.7	11.3	10.9	10.5	10.1
22.0												14.8	14.1	13.5	13.0	12.4	12.0	11.5	11.1	10.7	10.4
22.5													14.5	13.8	13.3	12.7	12.2	11.8	11.4	11.0	10.6
23.0													14.8	14.1	13.6	13.0	12.5	12.0	11.6	11.2	10.8
23.5														14.5	13.8	13.3	12.8	12.3	11.9	11.5	11.1
24.0														14.8	14.1	13.6	13.1	12.6	12.1	11.7	11.3
24.5															14.4	13.9	13.3	12.8	12.4	11.9	11.6
25.0															14.7	14.1	13.6	13.1	12.6	12.2	11.8
25.5																14.4	13.9	13.4	12.9	12.4	12.0
26.0																14.7	14.1	13.6	13.1	12.7	12.3
26.5																	14.4	13.9	13.4	12.9	12.5

27.0																	14.7	14.1	13.6	13.2	12.7

Speed chart for use with BoomBuster 260-11R, 375-R, or 437-R tips when using a 40 GPA carrier rate.

GPA 40

	effective spray width (feet)																				
	10	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
GPM	**vehicle speed (MPH)**																				
11.0	13.6	12.4	11.3	10.5	9.7	9.1	8.5	8.0	7.6	7.2	6.8	6.5	6.2	5.9	5.7	5.4	5.2	5.0	4.9	4.7	4.5
11.5	14.2	12.9	11.9	10.9	10.2	9.5	8.9	8.4	7.9	7.5	7.1	6.8	6.5	6.2	5.9	5.7	5.5	5.3	5.1	4.9	4.7
12.0	14.9	13.5	12.4	11.4	10.6	9.9	9.3	8.7	8.3	7.8	7.4	7.1	6.8	6.5	6.2	5.9	5.7	5.5	5.3	5.1	5.0
12.5		14.1	12.9	11.9	11.0	10.3	9.7	9.1	8.6	8.1	7.7	7.4	7.0	6.7	6.4	6.2	5.9	5.7	5.5	5.3	5.2
13.0		14.6	13.4	12.4	11.5	10.7	10.1	9.5	8.9	8.5	8.0	7.7	7.3	7.0	6.7	6.4	6.2	6.0	5.7	5.5	5.4
13.5			13.9	12.9	11.9	11.1	10.4	9.8	9.3	8.8	8.4	8.0	7.6	7.3	7.0	6.7	6.4	6.2	6.0	5.8	5.6
14.0			14.4	13.3	12.4	11.6	10.8	10.2	9.6	9.1	8.7	8.3	7.9	7.5	7.2	6.9	6.7	6.4	6.2	6.0	5.8
14.5				13.8	12.8	12.0	11.2	10.6	10.0	9.4	9.0	8.5	8.2	7.8	7.5	7.2	6.9	6.6	6.4	6.2	6.0
15.0				14.3	13.3	12.4	11.6	10.9	10.3	9.8	9.3	8.8	8.4	8.1	7.7	7.4	7.1	6.9	6.6	6.4	6.2
15.5				14.8	13.7	12.8	12.0	11.3	10.7	10.1	9.6	9.1	8.7	8.3	8.0	7.7	7.4	7.1	6.9	6.6	6.4
16.0					14.1	13.2	12.4	11.6	11.0	10.4	9.9	9.4	9.0	8.6	8.3	7.9	7.6	7.3	7.1	6.8	6.6
16.5					14.6	13.6	12.8	12.0	11.3	10.7	10.2	9.7	9.3	8.9	8.5	8.2	7.9	7.6	7.3	7.0	6.8
17.0						14.0	13.1	12.4	11.7	11.1	10.5	10.0	9.6	9.1	8.8	8.4	8.1	7.8	7.5	7.3	7.0
17.5						14.4	13.5	12.7	12.0	11.4	10.8	10.3	9.8	9.4	9.0	8.7	8.3	8.0	7.7	7.5	7.2
18.0						14.9	13.9	13.1	12.4	11.7	11.1	10.6	10.1	9.7	9.3	8.9	8.6	8.3	8.0	7.7	7.4
18.5							14.3	13.5	12.7	12.0	11.4	10.9	10.4	10.0	9.5	9.2	8.8	8.5	8.2	7.9	7.6
19.0							14.7	13.8	13.1	12.4	11.8	11.2	10.7	10.2	9.8	9.4	9.0	8.7	8.4	8.1	7.8
19.5								14.2	13.4	12.7	12.1	11.5	11.0	10.5	10.1	9.7	9.3	8.9	8.6	8.3	8.0
20.0								14.6	13.8	13.0	12.4	11.8	11.3	10.8	10.3	9.9	9.5	9.2	8.8	8.5	8.3
20.5								14.9	14.1	13.4	12.7	12.1	11.5	11.0	10.6	10.1	9.8	9.4	9.1	8.7	8.5
21.0									14.4	13.7	13.0	12.4	11.8	11.3	10.8	10.4	10.0	9.6	9.3	9.0	8.7
21.5									14.8	14.0	13.3	12.7	12.1	11.6	11.1	10.6	10.2	9.9	9.5	9.2	8.9
22.0										14.3	13.6	13.0	12.4	11.8	11.3	10.9	10.5	10.1	9.7	9.4	9.1
22.5										14.7	13.9	13.3	12.7	12.1	11.6	11.1	10.7	10.3	9.9	9.6	9.3
23.0											14.2	13.6	12.9	12.4	11.9	11.4	10.9	10.5	10.2	9.8	9.5
23.5											14.5	13.8	13.2	12.6	12.1	11.6	11.2	10.8	10.4	10.0	9.7
24.0											14.9	14.1	13.5	12.9	12.4	11.9	11.4	11.0	10.6	10.2	9.9
24.5												14.4	13.8	13.2	12.6	12.1	11.7	11.2	10.8	10.5	10.1
25.0												14.7	14.1	13.5	12.9	12.4	11.9	11.5	11.0	10.7	10.3
25.5													14.3	13.7	13.1	12.6	12.1	11.7	11.3	10.9	10.5
26.0													14.6	14.0	13.4	12.9	12.4	11.9	11.5	11.1	10.7
26.5													14.9	14.3	13.7	13.1	12.6	12.1	11.7	11.3	10.9

27.0													14.5	13.9	13.4	12.9	12.4	11.9	11.5	11.1

Appendix C
ODOT Sprayer Calibration & Tank Mix Calculation Worksheet

ODOT Sprayer Calibration & Tank Mix Calculation Worksheet

Date: _____ **Name of Applicator(s):_____**

Spray Width :_____ feet (with the wind) _____ feet (against the wind)

Nozzle Output: _____ gallons per minute **(GPM)** @ _____ p.s.i.

Carrier Rate: _____ gallons per acre **(GPA)**

Ground Speed (refer to calibration charts) : _____ miles per hour **(MPH)**

$$\frac{\textbf{GPM} \times 495}{\textbf{GPA} \times \textbf{SW}} = \frac{\quad \times 495}{\quad \times} = \_\_\_\_\_ = \_\_\_\_\_ \textbf{ MPH}$$

Herbicide/Water Tank Mixture Calculations

Broadcast Applications: ***(Off Center, Boom Buster, Solid Stream, or Boom Type sprayers)***

Tank Load Size: _____ gallons Full _____ Partial _____

Herbicide #1 rate: _____ product per acre (prod/A)

Herbicide #2 rate: _____ product per acre (prod/A)

Drift Control rate: Tank Load Size: _____gal. / 100 gal. = _____ x _____ oz. Product/100 gal. = _____ prod./tank

$$\frac{\text{Tank Load Size: } \_\_\_\_\_ \text{ gallons}}{\text{Carrier Rate: } \_\_\_\_\_ \textbf{GPA}} = \_\_\_\_\_ \textbf{ Acres per Tank}$$

_____ Acres x Herbicide #1 rate: _____ prod/A = _____ product/tank load

_____ Acres x Herbicide #2 rate: _____ prod/A = _____ product/tank load

Spot Treatment Applications: ***(hand-pump, back-pack, or power handgun sprayers)***

Tank Load Size: _____ gallons

Herbicide rate: _____ percent (%) solution (example: 1.0% = 0.01)

Surfactant rate: _____ percent (%) solution (example: 0.25%= 0.0025)

$$\frac{\text{Tank Load Size: } \_\_\_\_\_ \text{ gallons}}{\text{Carrier Rate: } \textbf{100 GPA} \text{ (used for all handgun applications on a } \textbf{spray-to-wet basis}\text{)}} = \_\_\_\_\_ \textbf{ Acres per Tank}$$

_____ gallons/tank load x Herbicide rate: _____ % solution = _____ product/tank load

_____ gallons/tank load x Surfactant rate: _____ % solution = _____ product/tank load