STANDARD OPERATING PROCEDURE

EFFECTIVE DATE: _____

SOP 10.03 APPLICATION EQUIPMENT CALIBRATION, VERIFICATION, MAINTENANCE AND EQUIPMENT USE LOG

APPROVAL: _____ DATE: _____

1.0 PURPOSE AND SCOPE

1.1 This Standard Operating Procedure (SOP) provides a description of Turner Ag Research's method to insure the proper function, use, maintenance, and documentation of application equipment used to test pesticide chemicals in a test system, if the sponsor does not provide other instructions in the study protocols, notebooks, or electronic data collection system.

2.1 GENERAL INFORMATION

2.2 The principal field investigator (PFI) or designate is responsible to ensure that, where appropriate, this SOP is followed. This SOP covers the following application equipment. Tractor mounted and backpack boom sprayers, granular applicators, chemigation, wiper applicators, spot applications and hooded sprayer applications.

2.2 If the sponsor does not provide their own forms for recording application methods and data, the application methods and calibration/verification may be recorded on facility worksheets. Procedures not covered in this SOP can be used to calibrate application equipment as long as the procedure meets the calibration/verification requirements of this SOP and is documented on worksheets. The Trial Notes form can be used to document miscellaneous comments.

2.3 Balances used to weigh granular or dry powder formulation of test substances and adjuvants must be verified prior to weighing test substances to ensure accuracy. Test substances should be weighed immediately before application, but no longer than 72 hours prior to application.

2.4 Balance verification readings must be recorded on the BALANCE LOG.

2.5 SAFETY. It is the responsibility of the PFI to ensure that assigned trials are conducted in accordance with company, Country/ Province, state and federal safety regulations as applicable. As a part of this safety responsibility, applicators and handlers must wear the minimal personal protective equipment specified in the SDS or product label when applying test substances and maintenance pesticide products.

2.6 EXCESS SPRAY SOLUTION DISPOSAL. PFI will ensure that mix sizes result in

minimal excess spray solution. Excess spray solution and rinses will be disposed of in accordance with local regulations. Excess spray solution will be disposed of at a safe distance from the plot areas to prevent possible contamination of the plots.

3.0 CALIBRATION AND VERIFICATION

3.1 Calibration of the application equipment should occur within one calendar day prior to application of a test substance(s) to ensure the correct amount of test substance(s) is applied to the target.

3.2 When required by the protocol, verification of the application equipment is needed before using it the day after calibration. Verification is normally one output and one speed check within +/- *5%* of the calibration value.

3.3 Equipment used to apply test substance must be used within the manufacturer's recommended guidelines, i.e., effective spray swath, boom height, pressure, speed, output, gauge settings, or other specific instructions/recommendations. For broadcast applications, an effective spray swath is normally the number of nozzles multiplied by the nozzle spacing (6 nozzles x 20 inch spacing= 120 inches/ 12 inches per foot= 10-foot effective spray swath). For single pass applications, the effective spray swath should be the same width as or larger than the plot width.

3.4 Where a study protocol indicates an application output range (e.g., 10-30 GPA 15- 46 liters per hectare [LPH]), applicator output must be within this specified application range. Where a study protocol indicates a specific application output (i.e., 3 GPA or *5* LPH), applicator output must be within +/- 5% of the specified output.

3.5 Prior to applying test chemical in a regulatory study, application equipment output calibration must be performed and recorded a minimum of three (3) times at the same settings. The same size spray solution container with the same fittings used for calibration should be used for the actual test substance application.

3.6 If the output of an individual nozzle or outlet is not within +/- 5% of the average, repair or replace it and conduct additional calibration catch runs until you have three runs within specification.

3.7 Application equipment speed calibration is recorded a minimum of three (3) times for mechanical operation such as a tractor with set RPM and gears. For backpack type sprays a target pass time can be calculated. The applicator should practice on the same terrain as the field plot until they are confident that the application can be completed uniformly and within +/- 5% of the target pass time.

3.8 If an application equipment speed run is not within +/- 5% of the mean, additional application equipment speed calibration runs are required until you have three runs within specifications for mechanical applications. At least one verification practice time for backpack sprayers should be recorded and within +/- 5% of the calculated target pass time.

4.0 THE EQUIPMENT USE LOG

4.1 The Equipment Use Log will be used to record the calibration, verification, routine maintenance, non-routine repair and cleaning of field equipment used in regulatory trials. Entries must indicate if the SOP was followed for the activity recorded by placing a checkmark in the "SOP" column.

5.0 EQUIPMENT IDENTIFICATION

5.1 Application equipment used in regulatory studies must have permanent, unique identification (ID), even though the user may have only one piece of that kind of equipment. The manufacturer's serial number will serve this purpose or, alternatively, the PFI may give the sprayer an ID, which must be indelibly marked (engraved, painted, etc.) on any component of the equipment which is not subject to frequent routine replacement. The ID should be referred to in measurements, calibrations, service records and logs. For assistance when assigning a unique new equipment ID, consult the current list of GLP equipment.

5.2 Application equipment descriptions and unique identification will be recorded on the appropriate forms at the time of use.

6.0 ROUTINE EQUIPMENT MAINTENANCE

6.1 Routine maintenance includes modifications to equipment done to keep the equipment in working order. For a pesticide applicator, this includes, but is not limited to, inspections, cleaning, washing, rinsing, nozzle and screen replacement, pressure adjustments, configuration changes, gauge setting changes and lubrication. For associated equipment (soil sampler, shakers, soil sieves, buckets, shovels, etc.), these include washing with soap solution, thorough rinsing with clean water, and drying.

6.1.1 Record the date of maintenance on the Equipment Use Log

6.1.2 Give a brief description of the maintenance in the column headed "other".

6.1.3 Circle "R" under the "Non-routine or Routine Maintenance" column.

6.1.4 The person completing the form must initial and date the log.

6.2 PRE-CALIBRATION ROUTINE- The spray system is checked for leaks or malfunctions. Spray lines are flushed with water. Nozzle tips and mesh screens are washed with detergent solutions then rinsed thoroughly with water.

6.3 POST- SPRAY ROUTINE- Leftover spray solution sprayed out in an open, unused section of the field. The spray line is flushed with soap solution followed by flushing with clean water. The spray container is washed with detergent solution and triple-rinsed. Nozzles and screens are washed with soap solution and rinsed. Tractor and sprayer are thoroughly hosed down with clean water.

7.1 NON-ROUTINE EQUIPMENT MAINTENANCE

7.2 Non-routine repairs include any repair or part replaced because of failure or malfunction of the equipment.

7.2.1 Record the date of the equipment malfunction/failure or the date the equipment failure was noticed on the Equipment Use Log.

7.2.2 In the column headed "other", record "see NON-ROUTINE MAINTENANCE RECORD".

7.2.3 Circle "N" under the "Non-Routine or Routine Maintenance" column.

7.2.4 The person completing the form must initial and date the record as needed.

7.2.5 If repairs were contracted to an outside vendor, attach an invoice copy to the Non-Routine Maintenance Record.

8.0 MALFUNCTION PROCEDURES

8.1 If a malfunction occurs while actually applying the test substance to the test plot, record the nature of the malfunction on the Trial Notes form and the Equipment Use Log and check the "Non-Routine Repair" box as described for non-routine equipment repairs above.

8.2 If the severity of the malfunction constitutes a deviation from the SOP or study protocol, immediately notify the appropriate Study Director. A study protocol or a SOP deviation must be completed by the PFI and sent immediately to the Study Director for his/her signature and comments.

9.0 EQUIPMENT CLEANING

9.1 All equipment utilized in regulatory studies must be properly cleaned (washing with an appropriate cleaning solution and rinsing with water three times as required) prior to and after use to minimize potential contamination. The decision as to which measures need to be taken will be the responsibility of the PFI or designate, unless specific measures are preferred or prohibited by the study protocol. Cleaning will be documented by checking the "Clean" column on the Equipment Use Log.

10.0 BORROWED OR SINGLE-APPLICATION EQUIPMENT

10.1 Single use application equipment is equipment that is built to apply a test substance(s) to a regulatory trial(s) and then dismantled for other uses. Borrowed equipment is equipment that is not owned by Turner Ag Research. No equipment ID or use log will be kept for borrowed or single use application equipment. The equipment type and description will be documented in the trial data as well as the calibration and cleaning procedures.

10.2 Calibrate the equipment as described in this SOP.

11.0 RECORDS

11.1 Application records (calibration, maintenance, repair and service records) will be maintained. The PFI is responsible for ensuring that the Equipment Use Log is completed correctly. These will be provided to the archivist for archiving by April 30 of the following years as applicable.

11.2 Applicable copies of the application records will be included as part of the field data package submitted to the Sponsor and/or Study Director as required and/or requested.

12.1 BOOM SPRAYERS

12.2 Purpose of Equipment

12.2.1 Boom sprayers are used to apply liquid spray solution containing test substance to regulatory studies plots.

12.3 Description of Equipment

12.3.1 Tractor-mounted boom sprayers may include straight boom, drop nozzle, or other configurations from which test substance is emitted in solution under pressure through hoses and nozzles. The sprayer is mounted on a tractor or similar self-propelled vehicle capable of speeds up to approximately 15 mph. The sprayer is supplied with pressure from either an air compressor, C02 tank or a mechanical pump. Spray boom pressures generally are regulated at approximately 15-60 psi using a pressure regulator. Spray solutions are mixed in spray containers which are carried on the sprayer. The containers typically in use range in size from 0.5 - 10 gallons with some equipment having several hundred gallons capacity. The sprayer is activated by manual, electrical, or pneumatic controlled valves.

12.3.2 Back-pack or other hand-held sprayers generally consist of a 0.25- to 5-gallon spray container pressurized by a compressed air or C02 tank which is carried by the applicator. The spray boom is hand-held. Operating pressure is adjusted with a pressure regulator mounted on the C02 or compressed air tank and the on/off valve is manually operated.

12.4 Calibration

12.4.1 Prior to calibration, test the spray system to check for leaks, cracked, broken or loose nozzles, hoses and fittings. Ensure that switching devices operate properly and that the system {tanks, lines, screens, nozzles) is free of particles or debris. Each spray nozzle will be calibrated within pressure and flow rate recommendations in the manufacturer's specifications.

12.4.2 Adjust the spray boom height for correct spray pattern overlap as described by the manufacturer for the spray nozzle selected. Determine the width of the effective spray swath. For band applications, determine from the protocol whether the application rate is based on only the band sprayed area, or if it is based on the total overall area sprayed.

12.4.3 Determine required application volume in gallons/acre (GPA or liter/hectare [LPH]) from study protocol.

12.4.4 Check nozzles for accurate volumetric output. Total volume output is determined by adding the output of the individual nozzles. Individual nozzle output should be within +/- 5% of the mean nozzle output for the boom.

12.4.5 Determine the target sprayer speed (e.g., mph, ft/sec, sec./100ft, or m/sec, etc.) based upon the total sprayer output, spray width, and the target application volume (GPA or LPH) required in the study protocol. Trial runs will be within +/- 5% of the target speed. A minimum of three measurements will be averaged for a final sprayer calibration speed.

12.4.6 The speed calibration should be done in an area similar to the area to be treated and which has been under the same irrigation and tillage regime as the plot(s) to be treated. Where required, cultivation/incorporation equipment should be attached and set to proper depth to simulate actual application.

12.4.7 Time actual application pass time(s) through the plot and if collected, record on the appropriate worksheet.

12.4.8 A description of the spray equipment along with raw data and calculations for speed and volume determinations must be recorded on a worksheet. On the Equipment Use Log, record the date the spray calibration or verification was performed, the trial(s) the calibration or verification was performed for, and the person performing the calibration or verification procedure.

13.1 GRANULAR TEST SUBSTANCE APPLICATORS

13.2 General

13.2.1 Prior to calibration, read the operator's manual (if applicable) to become familiar with the basic operations and adjustments available. Inspect the applicator unit to ensure the unit (hopper and outlets) is clean and free of dirt, debris, etc. Clean if necessary.

13.2.2 Make all hydraulic and/or electric connections, if necessary. Operate the unit (empty) according to manufacturer's instructions and inspect for proper operation. Make adjustments or repair. All cleaning and/or repairs should be entered in the appropriate logs (Equipment Use Log and/or Non-routine Maintenance Record).

13.3 Blank Granules

13.3.1 Do not use the test substance or blank granules more than twice for calibrating. Do not use granules used for calibration for trial applications. Each time the granules flow through an applicator, a physical change may occur that could cause them to flow differently. Test substance or blank granules used for calibration should not be returned to the original container. Blank granules may

be discarded. Test substance granules may be used for maintenance applications, combined with a non-GLP container of the same product or stored for proper disposal at a later date. If test substance granules were used for calibration, the amount used should be properly recorded on the appropriate Test Substance Use log.

13.3.2 Balances used to weigh granular test substances must be verified prior to weighing test substances to ensure accuracy. Test substances should be weighed immediately before application, but no longer than 72 hours prior to application. The test substance should be stored in an airtight container if not used within 24 hours.

13.3.3 Balance verification readings must be recorded on the Balance Log.

13.2.4 Record calibration or verification on a worksheet including equipment description. Record on the Equipment Use Log the date the calibration/verification was performed, the trial(s) the calibration/verification was applied, and the person performing the calibration/verification procedure.

13.3 Nobel and Gandy -Type Planter-Mounted Applicators

13.3.1 The planter-mounted granular applicator is used to apply granular test substances to test plots. Placement of the test substance using granular mounted applicators is usually "in-Furrow", "T-Banded" or "Banded". Granular applicators can be mounted on a toolbar to apply test substance chemicals "Over-The-Row".

13.3.2 Method 1-Moving Calibration for Ground-Driven Band Applicators:
Select and calibrate/verify applicator speed for application on soil similar to the plot. Individual runs should be within +/- 5% of the mean. Measure a set distance (typically 50-500ft) and set each applicator outlet adjustment for the approximate desired flow rate. Calculate amount of test substance product needed for the measured distance. Unhook flow tubes from the bottom of each applicator outlet, add enough calibration granules to the hopper boxes to cover the openings during calibration and attach the granule collection containers to each applicator outlet. Drive the unit with the applicator(s) engaged through the measured area. Compare the weight of granules collected to the calculated amount. The collected output should be within +/- 5% of the product rate specified in the study protocol. Individual outlet should be within +/- 5% of the mean. Reattach the flow tubes to the bottom of each applicator outlet.

13.3.3 Method 2 - Stationary Calibration for Ground-Driven Banded Applicators:
Determine the number of revolutions the planter drive wheel or granular applicator drive wheel will make in a set distance. Select applicator equipment speed for application. Calculate amount of test substance product needed for the measured distance. Unhook flow tubes from the bottom of each granular applicator outlet; add enough calibration granules to the hopper boxes to cover the outlets during calibration. Set each applicator outlet for the approximate flow rate desired and attach granule collection containers to each outlet. Turn each planter drive wheel or granular applicator drive wheel by hand at the same speed (+/- 5%) it will turn during application. This should be

done for the calculated number of revolutions in the calculated number of seconds to equal the feet per second the unit will be traveling during application. The drive wheel must be turned at an even speed throughout the calculated time period. The calculated number of revolutions must be completed in the calculated time and the drive wheel immediately stopped. Compare the weight of granules collected to the calculated amount. The collected output should be within +/- 5% of the product rate specified in the study protocol. Individual applicator outlet should be within +/- 5% of the mean. Reattach the flow tubes to the bottom of each applicator outlet.

13.3.4 Method 3 - Stationary Calibration Using an Electric Motor to Calibrate Ground-Driven Band Granular Applicators: Determine applicator equipment speed (mph) for application . Application speed should be the speed simulated by the electric motor. Select length of time to run the electric motor for application. This may be determined from the chart supplied by the calibrator motor manufacturer. For a chosen speed, the chart lists the time (seconds) to run the motor and the simulated distance covered. Calculate the amount of product required for the time and speed selected for calibration. Unhook flow tubes from the bottom of each applicator outlet, set each applicator outlet for the approximate desired flow rate, add enough calibration granules to the hopper boxes to cover the openings during calibration and attach granule collection containers to each outlet. Attach electric motor to the planter. Run calibrator motor for the exact length of time selected in Method 2. Compare the weight of granules collected to the calculated amount. The measured output should be within +/- 5% of the product rate specified in the study protocol. Individual applicator outlet output should be within +/- 5% of the mean. Reattach the flow tubes to the bottom of each applicator outlet. Calibrate applicator speed (ft/sec) in the field.
Applicator speed should be the same as determined above. Individual runs should be within +/- 5% of each other.

13.3.5 Method 4- Calibration of Electric-Driven Gandy-Type Band Applicators: Determine amount of test substance needed for plot. Determine amount of product (gram) for each applicator outlet for calibration for the selected speed and time for calibration. Unhook tubes from each applicator outlet, fill the hopper with enough calibration granules to cover the outlet opening during calibration and attach collection containers for each applicator outlet. Operate the unit for the time selected above and collect granules from each outlet. Adjustments to output should be made according to manufacturer's instructions until output collection is within the specified rate. The measured output should be within +/- 5% of the rate specified in the study protocol. Individual applicator outlet should be within +/- 5% of the mean. Calibrate/verify applicator equipment speed in the field on ground similar to the test plot.

13.4 Broadcast Granular Applicators

13.4.1 Purpose of Equipment: Granular broadcast applicators are used to broadcast granular test substances to test plots.

13.4.2 General: The accuracy of the test substance application may be influenced by wind, granular particle size and shape, application rate, ground slope, ground speed and local terrain. Application of granular test substance should be done when the wind velocity is less than 10 miles per hour (mph). Alternately, wind screens that allow accurate placement of granules may be used. For Gandy-type pneumatic applicators, check hoses (clean and tighten connections), boom height, distance between applicator outlets, air-flow (900-1200 cubic feet per minute (cfm), operation of electrical or ground drive units and proper metering wheels.

13.4.3 Method 1- Moving Calibration for Centrifugal (Spinner)-Type Applicators: Calibration course and collection trays should be set as per the diagram following this section. The width of each collection tray used for collection and calibration of test substance should not exceed 10% of the anticipated swath width. The length of the collection tray should be equal to or greater than the width with a minimum length of 1.0 feet. A collection tray measuring 1.5 to 2.9 ft x 1.5 to 2.0 ft is usually adequate. Trays should be placed a minimum of 25% wider than the anticipated effective swath width. All passes should be made in the same direction at a constant ground speed and spinner speed. Prior to making any calibration passes, fill the applicator hopper with a sufficient quantity of test substance or blank granules, if available, to ensure that the outlet holes are completely covered throughout the calibration process and application of the test substance. First make a trial application(s) to determine the effective application swath width. Apply sufficient product (approximately 100 pounds product/acre) so that differences in swath pattern may be determined. The trial applications should be made using a ground speed and a gate opening for the applicator near the settings used for application to the test plot. After the trial application(s), weigh the granules from each collection tray. The effective swath pattern width (ft) is the distance between the points on either side of a single swath where the rate of deposit equals one-half of the effective application. Example: The center collection tray has 20 grams (g) of material. The effective swath width would be the sum of distances in each direction from the center tray to a point where 10 g of material was collected. If the trays that collected 10 g of the material were each 10 ft. from the center, then the effective swath width is 20 ft. A plot of the amount of material collected from each tray will provide the application pattern. The plot may be made using graph paper. An example is provided following this section to assist the applicator in constructing a spread pattern test graph. The applicator may then determine whether the swath pattern is acceptable by comparing to those swath patterns detailed in a diagram following this section. Data collected and graphs made by the PFI to determine effective swath width and to confirm an acceptable distribution pattern of granules need not be submitted as part of the data package. However, these records (appropriately identified, signed and dated) should be maintained with the PFI's copy of the trial data. If necessary, adjustments to the swath pattern may be made by: 1) adjustment of the spinner or gate opening; 2) change of spinner speed; 3) change of travel speed and; 4) general applicator orientation {spinner should be parallel to the application surface).

13.4.4 Calibration Verification: Determine effective swath width as above. Measure a

specified distance to be traveled. Place a measured and recorded amount of test substance or blank material in the hopper. In some instances, the amount of material to be applied to the test area is so small that a uniform application cannot be achieved. In these instances, the applicator may uniformly mix measured and recorded amounts of the test substance and blank material to achieve a uniform application to the plot area. Travel the measured distance at a constant spinner and travel speed while applying the test substance or blank material. The time (seconds) taken to travel the calibration distance should be recorded on the appropriate worksheet form for each application pass. The mean speed of application should be calculated. Each individual time application (seconds) is to be within +/- 5% of those obtained for calibration. If not, re-calibration is required. Measure and record the weight of material left and determine the application rate. The mean output should be calculated. Each individual output measurement should be within +/- 5% of the mean. The measured output for the applicator should be within +/- 5% of the rate specified in the protocol.

13.4.5 Method 2- Stationary Calibration for Gandy-Type (Pneumatic) Applicators and for Centrifugal (Spinner)-Type Applicators: Determine effective swath width and test substance output needed per plot for broadcast application. Select speed (mph) for application and time for calibration. Determine amount of product needed for each applicator outlet for calibration. Fill hopper with calibration granules, operate the unit and collect granules from each individual outlet for the period of time selected. The collected output should be within +/- 5% of the rate specified in the study protocol. If not within +/- 5%, make necessary adjustments according to manufacturer's instructions and recalibrate. Calibrate/verify applicator equipment speed in the field on soil similar to the plot. Applicator speed should be within +/- 5% of the mean. Note: If using an electric motor to calibrate the Gandy-Type Pneumatic Applicator, follow the procedures for "Stationary Calibration Using an Electric Motor to Calibrate for Ground-Driven Band Granular Applicators". The Gandy Type Pneumatic Applicator can be calibrated in a stationary position with the airflow off.

14.0 TREE AND VINE SPRAYERS

14.1 Purpose and Description of Equipment

14.1.1 Sprayers designed to make application of test substances to trees and vines may use an air stream to transport and distribute spray droplets to the target, as in the case of an orchard air-blast sprayer or a backpack mist blower (hand-held air-blast sprayer). These sprayers have fans that create a current of air that passes by spray nozzle(s) and propels the spray material into the tree or vine canopy.

14.1.2 Alternatively, applications may also be made using appropriate pressure through single nozzle "hand gun" type sprayers.

14.1.3 The hand gun applicators or orchard blast applicators may be a PTO driven unit or a self-powered unit pulled behind a tractor. Solo backpack mist blowers are hand-held applicators.

14.2 Operation

14.2.1 Proper operation of tree and vine sprayers depends on the type of sprayer, the

crop being sprayed, the size and density of trees or vines, weather conditions and other factors. The manufacturer's manual should be consulted concerning safe and efficient operating procedures. If the application equipment has been custom-manufactured, then operation should be similar to commercially available equipment.

14.3 Calibration

14.3.1 For most applications to vigorously growing vines and fruit or nut trees, it is desirable to apply 67% of the spray material in the upper half of the canopy and 33% of the material in the lower half of the canopy. Consult the manufacturer's manual for proper nozzle selection and arrangement on the sprayer manifold or boom. Select nozzles for air-blast sprayers that provide 67% of nozzle output to the top half of tree or vine (usually top half of manifold) and nozzles that deliver 33% nozzle output to lower half of the tree or vine (usually lower half of manifold). If a single nozzle handgun or mist blowers are used the percent distribution to the tree canopy (upper and lower) does not apply.

14.3.2 For orchard blast sprayers or hand gun applicators, the following calibration methods may be used.

14.4 Method A

14.4.1 Calibrate just like a regular straight boom sprayer described, i.e. discharge measurement for the individual nozzle for a set time and taking the speed at a set distance three times, then calculating the gallons per minute (GPM or liters [LPM]). Individual nozzle output should be within whatever the protocol specifies.

14.4.2 When the nozzles are not on a horizontal boom, calculate the actual swath width based on row spacing or 1/2 row spacing, as appropriate.

14.5 Method B

14.5.1 Determine the appropriate rate of travel for the application. Speeds of 1 - 2 mph or 1.6-3.2 kph are most common. Slower speeds may be used to provide better coverage of large areas and vines, especially when dense foliage is present. Faster speeds may be used for smaller, easier to cover trees and vines or when foliage is not present to impede spray penetration.

14.5.2 Determine speed in mph. Drive the tractor a measured distance over a surface comparable to the orchard or vineyard floor. Use the tractor gear setting and operating RPM that will be used during spraying. Measure and record the time (seconds) required to travel the distance three (3) times and then average the three pass times for a mean time. (Miles per hour (MPH) equals 60 divided by the number of seconds to go 88 ft.)

14.5.3 Determine gallons per acre (GPA or liters per hectare [LPH]) from the protocol.

14.5.4 Determine discharge in gallons per minute (GPM) from the following formula:

$$GPM = \frac{GPA \times MPH \times \text{Row Spacing (ft)}}{495}$$

Note: The Constant (495) is derived from 43,560 ft2/A +88ft.

14.5.5 Example calibration:

1. Determine speed in MPH (2).
2. Determine GPM. For example, for 200 GPA, 2 MPH and tree or vine row spacing of 20 ft.

$$\text{GPM} = \frac{200 \times 2 \times 20}{495} = 16.16 \text{ GPM}$$

3. The spray manifold or boom should be set up with a nozzle combination that will deliver 16.16 GPM. For air-blast sprayers operated using one side of the manifold (for application to a single row of trees or vines), make sure the true swath width is taken into consideration (rows spacing/2).

14.5.6 Discharge rate in LPM can also be determined using comparable equations using LPH, KPH, row spacing in (m) and 10,000 m /hectare

14.5.7 Calibrate/verify sprayer output.

1. Fill the sprayer with water to a known level (preferably full to overflowing) with the engine and pump running at operating RPM.
2. With the tractor stationary, operate the sprayer for a minimum of 15 seconds at the tractor RPM and operating pressure to be used during application. Low GPA's may require longer run time for accuracy.
3. With the engine and pump still running at operating RPM, measure the volume needed to refill the sprayer to the known level.
4. Divide the volume used to refill the tank by the number of seconds the sprayer ran to determine sprayer output.

14.5.8 Total sprayer output in GPM for the initial application will be determined three (3) times and then averaged for total sprayer output.

14.5.9 Record on the appropriate worksheet a description of the spray equipment along with raw data and calculations used to determine applicator speed and total output (GPA). Record in the Equipment Use Log the date the sprayer calibration or verification was performed, the trial(s) the calibration/ verification was performed for and the person performing the calibration or verification procedure

14.6 Back-pack mist blowers

14.6.1 Calibration Method A:

1. Place a known volume of water into the applicator.
2. Measure the amount of time required for the applicator to discharge the water.
3. Repeat Steps I and 2 a minimum of three times to determine the average rate of discharge. (Record this information on a worksheet).
4. After determining the rate of discharge, calculate the application time required per plot to apply the targeted application rate (GPA).
5. Practice and adjust walking speed to meet the desired rate of speed.
6. Repeat Step 5 until three consecutive walking passes are within +/- 5% of

the calculated speed. (Record this information on a worksheet) .

7. Record on the appropriate worksheet a description of the spray equipment along with raw data and calculations used to determine applicator speed and total output (GPA). Record in the Equipment Use Log the date the sprayer calibration or verification was performed, the trial(s) the calibration/ verification was performed for and the person performing the calibration or verification procedure .

14.6.2 Calibration Method B:

1. Place a known excess volume of water into the applicator (start volume)
2. Run the applicator for a pre-set time (i.e. 30 seconds)
3. Disconnect and measure the remaining volume in the applicator (end volume)
4. Calculate the discharge volume.
5. Repeat steps 1 through 4 a minimum of three times to determine coverage rate of discharge.(Record this information in a worksheet)
6. After determining the rate of discharge, calculate the application time required per plot to apply the targeted rate (GPA or LPH)
7. Practice and adjust walking speed to meet the desired rate of speed.
8. Repeat step 7 until three consecutive walking passes are within +/- 5% of calculated speed. (Record this information in a worksheet)
9. Record on the appropriate worksheet a description used to determine applicator speed and total output (GPA or LPH) Record in the Equipment Use Log the date the sprayer calibration or verification was performed, the trial(s) the calibration/ verification was performed for and the person performing the calibration or verification procedure.

15.1 CHEMIGATION (APPLYING CHEMICALS IN IRRIGATION)

15.2 Purpose of Equipment

15.2.1 Chemigation equipment is used to uniformly apply test substance to test plots via open or closed irrigation systems. Open systems include flood, furrow, border, or basin systems. Closed systems include sprinkler, micro-sprinkler, trickle, and drip systems.

15.3 Description of Equipment

15.3.1 Uniform application of irrigation water is prerequisite to uniform application of test substance. Equipment requirements are dependent upon the type of irrigation system utilized at the test site. Equipment chosen for application of test substance must be described on the appropriate form.

15.4 Open Irrigation Systems

15.4.1 Application of test substance via an open irrigation system requires the use of a gravity flow pesticide dispensing system, also known as a constant head siphon device, using TeeJet 4916 series orifices. Test substance flow rate is determined by the orifice size. This device may be threaded into a 5-gallon or larger container to allow gravity flow of test substance into irrigation water. An example of such device is shown at the end of this section.

Alternatively, other pesticide dispensing systems using orifices or regulating valves may be utilized to uniformly meter concentrated or dilute test substance into irrigation water.

15.5 Closed Irrigation Systems

15.5.1 Closed irrigation systems require that test substance be injected into pressurized irrigation lines. There are several types of injection equipment. The preferred method is a Mazei injector. It is placed inline before the irrigation equipment and the pressure differential created with an inline valve system controls the rate of injection.

15.6 Calibration

15.6.1 Calibration is made to ensure that the correct amount of test substance is applied to the target site. It is recognized that small amounts of undiluted test substance are difficult to apply via chemigation. For ease of application, as well as increased accuracy, test substance may be diluted with a known, and recorded, volume of diluent or may be mixed undiluted.

15.6.2 Determine flow rate for closed or open irrigation system.

1. Determine the amount of test substance to be applied to the treated plot.
2. Determine the time required to irrigate the treated plot.
3. Determine desired flow rate or injection rate by dividing the amount determined in Step 1 by the time determined in Step 2.
4. Example 1: Calibration to apply 3.1 lb *ai*/A of undiluted EPTAM 7E in irrigation. Plot size is 20ft x 100ft= 0.046 acre. Amount of test substance required= 0.046 acre x 3.1 lb *ai*/A= 0.1426lb ai = 77.1 mi.
   Expected time required to irrigate treated plot = 30 minutes. Desired flow rate or injection rate = 77.1 ml / 30 minutes = 2.57 ml / minute.
5. Example 2: Calibration to apply 3.1 lb *ai*/A of diluted EPTAM 7E in irrigation. Plot size is 20ft x 100ft= 0.046 acre. Amount of test substance required= 0.046 acre x 3.1 lb ai/ acre = 0.1426 lb ai = 77.1 ml Test substance is diluted with 3709.9 ml water to produce 3785 ml of solution to be applied. Expected time required to irrigate treated plot= 30 minutes. Desired flow rate or injection rate= 3785 ml/ 30 minutes = 126.2 ml/ minute.

15.6.3 Calibrate flow rate.

1. Open Irrigation Systems. If using a system requiring TeeJet 4916 series orifices, choose the proper size orifice for the desired flow rate or injection rate using the chemical manufacturer's guidelines for gravity flow systems or TeeJet guidelines for pressurized systems. Flow rates are affected by temperature and viscosity of the solution. It may be necessary to change orifices several times before obtaining the desired flow rate. If using other metering devices, follow manufacturer's instructions for adjusting flow rate. Measure and record flow rate three (3) times and take the average for a final volume output.
2. Closed Irrigation Systems. Determine the pressure on the irrigation line before and after the Mazei injector (typically 22 before and 12 after). It may be necessary to change pressure difference to obtain the desired chemigation time. Less differential equals slower injection rate. Also increasing the outflow by increasing the number of drip lines or micro sprinklers can increase the injection flow. The calibration of the flow is

only used to approximate the time to inject the diluted test substance. The entire diluted test substance should be injected and the container rinsed and injected three times to insure 100% of the test substance was delivered to the plot area.

3. Record on the Trial Notes form the length of time required for irrigation of each plot and the length of time application of test substance occurred.

15.5.4 Record on a worksheet form a description of the application equipment along with raw data and calculations used to determine flow rate. Record on the Equipment Use Log the date the calibration or verification was performed, the trial(s) the calibration or verification was performed for, and the person performing the calibration or verification procedure.

16.0 WIPER APPLICATORS

16.1 Description of Equipment

16.1.1 Wiper applicators are devices that physically wipe appropriate concentrations or amounts of spray solution directly onto the target without contacting the crop. They may be either tractor-mounted or hand held units. Wiper applicators generally consist of a hollow plastic holding tube with rope or sponge applicators running on the outside of the tube.

16.1.2 The spray solution, which is contained within the holding tube, flows from the tube into the rope or sponge applicators. Small hand-held units may or may not have a small bottle reservoir with an adjustment valve to allow the appropriate amount of solution to wet the rope wick or sponge applicators. The wiper applicator should allow the solution to flow at sufficient pace to saturate the sponge or rope applicators without excessive dripping.

16.2 Calibration and Application

16.2.1 Carefully check the wicking material to be sure that it is in good condition and clean. Replace the wicking material if it is in poor condition, dirty or contaminated.

16.3 Wiper Applicators With Reservoirs

16.3.1 Calculate the amount of test substance solution required to fill the wiper reservoir and record on a worksheet. Prepare the test substance solution as recorded on the worksheet. Record on a form the total test substance, total adjuvant and total diluent used in the test substance solution. Fill the water reservoir to prime the system. Check the rope wicks or sponges to determine whether the solution is flowing freely through the applicator with minimal dripping.

16.3.2 After the applicator is primed, empty the reservoir and record the amount recovered on the worksheet. Add this solution back to the reservoir as the starting amount for the application.

16.3.3 Drive or walk the wiper applicator through the plot area. After application, empty the reservoir, measure the amount recovered and record on a worksheet. Subtract the amount recovered after application from the starting amount and record the difference as the amount applied.

16.4 Wiper Applicators Without Reservoirs

16.4.1 Calculate the amount of test substance solution required to saturate the wiper applicator and cover the plot area. Record calculations on a worksheet. Prepare the test substance solution as recorded on a worksheet. Record the total substance, total adjuvant and total diluent used to make the test substance solution. Saturate the wiper applicator to prime the system. Check the wicks or sponges to determine whether the solution is flowing freely through the applicator with minimal dripping.

16.4.2 After the applicator is primed/saturated, record the amount of test substance solution remaining and record on a worksheet form as the starting amount for the application.

16.4.3 Walk the wiper applicator through the plot area re-saturating the applicator as needed to ensure adequate coverage.

16.4.4 After application, re-saturate the wiper applicator, measure the amount of test substance solution remaining and record on a worksheet. Subtract the amount of test substance solution remaining after re-saturating after application from the starting amount and record the difference as the amount applied.

16.5 Application Pass Time(s)

16.5.1 The application rate for wick applicators is based on the amount of contact the applicator has with the weed target. Application speed, whether applied by hand or by tractor, has no direct effect on application. However, a slower speed may promote a more even application. For the purpose of calibration, application pass times are not required. The rate applied will be based upon spray solution concentration and total amount of material applied.

16.5.2 Record a description of the equipment along with the raw data and calculations used to determine the concentration of the spray solution applied to the plot on a worksheet. Record on the Equipment Use Log the date the equipment calibration/verification was performed, the trial(s) the calibration/verification was performed for, and the person performing the calibration/verification procedure.

17.0 SPOT APPLICATION

17.1 Purpose of the Equipment

17.1.1 Spot applications are performed to control pests in small localized areas of a field. An applicator will walk or ride a specialized cart through a field looking for pests and then apply varying volumes of spray solution containing a recommended concentration of the test substance to control the pest. To control pests in larger areas of a field, the applicator may calibrate a large commercial sprayer and turn the sprayer on/off as it passes over the pest. Equipment used in spot applications must deliver a specified concentration of test substance to a defined portion of the plot area. The protocol instructions will specify the total area of the spot application (usually 10% of the plot area) and concentration of the spray solution (usually 5% v/v). Volume of spray solution to apply the "spot" area of the plot may vary depending on the application method used.

17.1.2 The spray concentration, volume, and area to be treated specified in the study protocol must be delivered within +/- 5%. These parameters must be met to provide spot application data that will support label recommendations.

17.2 Description of Equipment

17.2.1 Spot application to small localized areas may be applied with single nozzle hand-held sprayers of various types.

17.2.2 A back-pack or side-pack sprayer consisting of a 0.25- to 3-gallon spray container pressurized by a C02 tank which is carried by a person may be used. Operating pressure for the back-pack sprayer is adjusted with a regulator mounted on the C02 tank and the on/off valve is manually operated on the hand-held portion of the boom.

17.2.3 Single nozzle sprayers that are readily available from garden supply stores that use air pressurized by a hand pump may be used. Unless fitted with a pressure regulator, these units do not allow the operator to control the pressure. The on/off valve is manually operated on the hand-held portion of the boom.

17.2.4 An even fan nozzle will generally give a defined uniform spray pattern. However, other nozzles can be used as long as the spray pattern is confined to the defined area of the spot area(s) in the plot.

17.2.5 Spot applications may be made with tractor-mounted sprayers. The applicator will calibrate the sprayer to deliver a volume of spray solution at the specified concentration to the specific area by turning the spray unit on/off as it is driven across the plot.

17.3 Calibration/Application

17.3.1 Hand-Held Units: Carefully check the sprayer to ensure that it is clean and in good working conditions. Be sure the spray lines as well as the spray solution are clean. Replace any worn or broken parts. It is best to test the operation of the sprayer with the calculated amount of water in an area of the same size as the spot area before trying to apply the test substance to ensure the correct amount of solution will be delivered to the target area. Document the sprayer equipment used on the appropriate worksheet form. Document calibration/verification, application, cleaning and any maintenance on the Equipment Use Log.

1. Mark the areas in the plot area to receive the spot application. Record the size and location(s) of the spot application on the Plot Plan. For a protocol that requires application to 10% of the plot area, a 500 ft2 plot requires that 50 ft2 of the plot be identified for the application. The application should try to mimic coverage typical of an actual field application. Spray narrow strips or randomly scattered spots (as long as the areas can be measured and identified for sampling) through the plot rather than treating one large area. For the 10 ft x 50 ft plot, five 2 ft x 5 ft strips or five 1 ft x 10 ft strips applied with an even fan nozzle would provide the required area.
2. Determine the amount of solution to mix for the application. Record the calculations on a worksheet. If the recommended application rate is 13 gal/A (1.3 gallons solution on 10% of an acre) and the spot area is 10% of the plot, a plot size of 10 ft x 50 ft would require that 56 ml be applied in an area totaling 50 square ft.

   50 ft2 /43560 ft2 /acre = 0.0011 acre

   1.11 e x 13 gal/acre x 3785 ml gal =56 ml

3. Calculate the amount of test substance needed for the spray solution. Record the calculations on a worksheet. For a 5% solution with an adjuvant at 1%, the spray solution would be 2.8 ml test substance (56 x 0.05) + 0.6 ml adjuvant (56 x 0.01) + 52.6 ml water (56.0- 2.8- 0.6). The total solution = 56.0 ml.
4. Apply the spray solution to the identified plot area(s). Record on a worksheet the amount of solution applied and the total area covered. If the exact amount of solution was mixed and part of the spray solution is left over after spraying the spot area, the remaining solution can be applied to the area already sprayed because a spot application area does not require a uniform application of test substance over the sprayed area. If more solution is mixed than is needed to cover the spot areas, collect and measure the remaining solution so the total amount of test substance applied to the plot can be determined and recorded on a worksheet.
5. Record a description of the equipment and applicator along with the raw data and calculations used to determine the total amount of the spray solution applied to the plot on a worksheet. Record on the Equipment Use Log the date the equipment calibration/verification was performed, the trial(s) the calibration/verification was performed for, and the person performing the calibration/verification procedure.

17.3.2 Tractor-Mounted Sprayer and Hand-Held Sprayers Using Set GPA

Prior to calibration, test the spray system and check for leaks, cracked, broken or loose nozzles, hoses, and fittings. Ensure that switching devices operate properly and that the system (tank, lines, screens, and nozzles) is free of particles or debris. Each spray nozzle will be calibrated within pressure and flow rate recommendations in the manufacturer's specifications. Adjust the spray boom for correct spray pattern overlap as described by the manufacturer for the spray nozzle selected. Determine the width (ft) of the effective spray swath.

1. Mark the areas in the plot area to receive the spot application. Record the size and location(s) of the spot application on the plot map.
2. Determine required application volume in gallons/acre (GPA) from the study protocol.
3. Check nozzles for accurate volumetric output by measuring output three times. Individual nozzle output should be within +/- 5% (+/- 7% for flood jet nozzles) of the mean nozzle output. Total volume output is determined by taking the sum of the individual nozzle output. Each of the three volume output measurements should be within +/- 5% (+/- 7% for flood jet nozzles) of the average of the three measurements.
4. Determine the target sprayer speed (e.g., MPH, ft/sec, sec/100ft) based upon the total sprayer output, spray width, and the target application rate (GPA) required in the study protocol. Two trial runs will be within +/- 5% of the target speed. The mean of the two measurements will be taken as the finale sprayer calibration speed.
   The speed calibration should be done in the field in an area adjacent to or near the plot(s) to be treated and which has been under

the same irrigation and tillage regimes as the plots to be treated.

5. Mix the spray solution as described for the hand-held units.
6. Time application pass(es) through the plot.
7. Record actual pass time(s) on a worksheet form.
8. Apply the spray solution to the identified plot area(s). Spray solution remaining in the tank does not have to be measured because the known output and tractor speed can determine the amount of test substance applied.
9. Record on appropriate worksheet a description of the spray equipment along with raw data and calculations for speed and volume determinations. Record on the Equipment Use Log the date sprayer calibration or verification was performed, the trial(s) the calibration or verification was performed for, and the person performing the calibration or verification procedure.

18.0 HOODED SPRAYER APPLICATORS

18.1 Description of Equipment

18.1.1 Hooded applicators are used to apply non-selective chemicals to vegetation between the rows of susceptible crops. They are usually tractor-mounted half cylinders, U-shaped plastic devices with flexible plastic flaps on the ends with one to three nozzles mounted in the forward, top part of the enclosure. The plastic hood confines the spray droplets to the weeds between the rows.

18.2 Calibration and Application

18.2.1 Check to ensure the hooded applicator is assembled and plumbed according to the manufacturer's instructions. The unit usually comes with TeeJet even flat fan spray tips (e.g. 95015VS). Other even flat fan spray tips can be used to obtain the desired gallons per acre application rate. It is recommended that the lowest pressure with the largest nozzle(s) providing the required gallons per acre be used to reduce crop injury from small particle drift.

18.2.2 Prior to calibration, test the spray system and check for leaks, cracked, broken or loose nozzles, hoses and fittings. Ensure that switching devices are operating properly and that the system (tank, lines, screens and nozzles) is free of particles or debris.

18.2.3 Determine effective spray swath (inside width to the nearest inch at the bottom of the hood).

1. Determine required application volume in gallons/acre (GPA) from the study protocol and calculate nozzle output and application speed.
2. Nozzles should be checked for similar output. Collect and record a volume catch for each nozzle with a hooded applicator or collect and record a total catch for all nozzles for each hooded applicator.
3. Total volume output is determined by taking the sum of the output from individual nozzle for a hooded applicator or a single catch from all nozzles from a hooded applicator. The total volume output for each hooded applicator must be within +/- 5% of the overall mean for all hooded applicators.

4. Determine the target application speed (e.g., MPH, ft/sec, sec/100ft). Trial runs will be within +/- 5% of the target speed. A minimum of three measurements will be averaged for a final sprayer calibration speed.
5. The speed calibration should be done in the field in an area adjacent to or near the plot(s) to be treated and which has been under the same irrigation and tillage regimes as the plots to be treated. Where required, cultivation and/or incorporation equipment should be attached and set to proper depth to simulate actual application.
6. Record applications pass time(s) through the plot.
7. Record a description of the spray equipment along with the raw data and calculations for speed and volume determination on a worksheet or Trial Notes form. On the Equipment Use Log, record the date the sprayer calibration or verification was performed, the trial(s) the calibration or verification was performed for, and the person performing the calibration or verification procedure.
8. The band application rate under the hood is determined by dividing the effective swath by the row width and multiplying the answer by the application rate.

19.0 HISTORY OF CHANGE

REVISION	DATE	DESCRIPTION
SOP 10.01	3/10/16	Fixed general equipment description section and headers.
SOP 10.02	6/11/17	Updated chemigation procedure.
SOP 10.03	3/25/20	Updated borrowed and single use equipment procedure.