PROCEDURES

WHEN TO TEST

Lot Acceptance - Visual Inspection

Product in bulk tankers**.** Check for proper labeling on the truck and that the paperwork to identify the product matches the order. Verify that delivery is from an appropriate location, i.e., HV-R should come from Moreland, LCG-R should come from Pasco. If all paperwork is not in order, confirm, verify, or correct before off-loading.

Dry concentrates in semi-bulk containers, Phos-Bins, bags, etc., and buckets. Make certain that each container is properly labeled with the name and the lot number of the ordered product. Check the paperwork to be sure that it matches the delivery. Verify that delivery is from an appropriate location. If all paperwork is not in order, confirm, verify, or correct before off-loading.

Lot Acceptance - Quality Assurance Testing

Circulate the contents of the tanks thoroughly. Take a one-quart sample from each storage tank when the base is opened in the spring. If plumbing is set up so that all tanks circulate together, then only one sample is needed. Send the samples with the Lot Acceptance form to Wildland Fire Chemical Systems (WFCS) project. For each sample, include the name or number of the tank that it was taken from. Each label should bear the statement “from base storage at opening after recirculation" to aid in identifying the sample.

Take a one-quart sample from each truck/trailer load delivered to the base during the fire season. It is best that the sample be taken via a sampling port, when about half of the concentrate has been transferred to the base tanks from the truck. Send the samples with the Lot Acceptance form to WFCS. Label should include the identification of the tank that the material was pumped into, the shipper number for the delivery, the time and date of the transfer, and the statement “truck delivery sample.”

After final recirculation at base closing, take a one-quart sample from each storage tank. If plumbing is set up so that all tanks circulate together, only one sample is needed. Label with the proper tank designation and “base closing.” Send the samples with the Lot Acceptance form to WFCS.

Quality Control Testing

Sample and test at the base to ensure proper water level adjustment and valve placement during spring setup and installation and when training new employees.

Perform throughout the season to ensure uniform product.

SAMPLE ON RECEIPT

Sampling a Dry Concentrate

Since it is difficult at best to obtain a representative sample from a dry product, an alternate method is used. When a new shipment of bins or bags is received, mark one of the containers with the shipper number, time, and date of receipt. When practical, place the marked container near the mixing operation, so that it can be mixed next. During routine mixing, when the marked container is used, take a sample of the mixed retardant prepared from the powder in that container. Mark the sample with the shipper number, time and date of receipt, and the time and date of mixing. Test and report as described below.

Sampling Wet Concentrate From A Tanker Truck

If transport time is long, (48 hours or more from load to unload), recirculate prior to sampling.

Connect an off-load hose from the valve on the tanker truck to the storage tank. Unless the tanker truck is equipped with an off-load pump, a base pump must be hooked to the truck for efficient transfer. A sample valve installed in the off-load hose will facilitate sampling.

Allow sufficient sample to run through the valve prior to taking a test sample to ensure obtaining the intended sample. The amount of retardant that must flow through the valve will depend on the size of the valve and hose that must be cleared to get fresh material.

The valves on tanker trucks often contain some water from wash down. The first retardant through the valve will already be partially diluted, and if sampled, it will provide incorrectly low values.

If a sample valve has not been installed, the sample must be taken from the end of the transfer hose. This should be done at the end of the transfer rather that at the beginning.

When a tanker arrives with a new shipment of concentrate, two samples should be taken: one for base testing and one to be sent to the WFCS for the Lot Acceptance/Quality Assurance Program.

If any problems are noted with the sample:

Take additional samples of the material, they may be needed by agency and/or suppliers for further testing, and hold for instructions and/or additional testing

Notify appropriate agency personnel of the problem

Notify the supplier of the material.

Sampling Fluid Concentrate from a Tanker Truck

Recirculate the concentrate immediately before sampling.

If the tanker truck has recirculation capability, be sure that the concentrate is recirculated before off-loading.

If the tanker truck does not have recirculation capability, pump the entire load of concentrate into an empty storage tank and recirculate before sampling.

Connect an off-load hose from the tanker truck valve to the storage tank. Unless the truck has an on board off-load pump, a base pump must be hooked into the system for transfer. A sample valve installed in the off-load hose will facilitate sampling.

Allow sufficient sample to run through the valve prior to taking a test sample to ensure a proper sample. The proper amount will depend on the size of the valve and hose that must be cleared to obtain fresh retardant.

The valves on tanker trucks often contain some water from wash down. The first retardant will already be partially diluted and if sampled, will give erroneous values.

During recirculation and subsequent sampling from base storage, the valve will contain residue of the last material which must be removed prior to sampling.

If a sample is taken during recirculation, be sure that sufficient retardant has been pumped through the system to ensure obtaining a sample of the fresh retardant.

When a tanker arrives with a new shipment of concentrate, two samples should be taken: one for base testing and one to be sent to WFCS for the Lot Acceptance/Quality Assurance Program.

If any problems are noted with the sample:

Take additional samples of the material, they may be needed by agency and/or suppliers for further testing, and hold for instructions and/or additional testing

Notify appropriate agency personnel of the problem.

Notify the supplier of the material.

SAMPLE DURING MIXING

Sampling Not-Storable and Immediate-Use Retardant - In-line Blending

Take samples from a small valve installed on the discharge side of the loading pump or just behind the loading valve.

If you must sample from the end of the hose, collect samples immediately after loading an airtanker to ensure complete removal of old slurry from hose.

Collect samples often enough during mixing operations to make sure that the mixed product meets the requirements for the specific retardant, at least one sample from each airtanker load (base quality control).

If significant deterioration is discovered in stored concentrate or in mixed retardant stored in aircraft for long periods of time:

Collect a sample of bad material and hold for instructions and/or additional testing

Notify SDTDC or WFCS.

Sampling Storable Retardant - Eductor Mixing

Recirculate the retardant in the tank after a major mixing operation. Then, collect a sample from a recirculation line or pump.

During mixing operations, collect samples often enough to ensure that the mixed product meets the requirements for the specific retardant.

Use fresh samples taken from the valve or line after the product has been pumped or circulated. Do not use mixed retardant that has been sitting in hoses, pumps, or valves.

If a sample is collected from the end of the hose, be sure that sufficient retardant has been pumped through the hose to ensure a fresh sample, i.e., immediately after filling an airtanker).

If significant deterioration of stored material is discovered:

Collect a sample of the unsatisfactory material and hold for instructions and/or additional testing

Notify SDTDC or WFCS.

Sampling Storable Retardant - Batch Mixing

When the dry powder contained in a marked bin or bag is used to make a batch of retardant, take a sample from the sampling port on the batch mixer as the retardant is being transferred to a storage tank.

Allow sufficient retardant to flow through the hose to ensure a fresh sample.

If significant deterioration of mixed material is discovered:

Collect a sample of the unsatisfactory material and hold for instructions and/or additional testing

Notify SDTDC or WFCS.

SAMPLING RETARDANT IN STORAGE

Concentrate or Mixed Retardant

Recirculate tanks every three days and take a sample at least every seven days.

Recirculate the concentrate in the storage tanks prior to sampling.

The valve on a storage tank will contain residue of the last material through it, which may differ from the material currently in the tank. Allow sufficient sample to run through the valve prior to taking a test sample to ensure a proper sample. The proper amount will depend on the size of the valve and hose that must be cleared to get fresh material.

If a sample is collected during recirculation, be certain that sufficient retardant has been pumped through the system to provide a fresh sample.

If any problems are noted with the sample:

Collect additional samples of the material (they may be needed by the agency and/or suppliers for further testing) and hold for instructions and/or additional testing

Notify appropriate agency personnel of the problem.

Notify the supplier of the material.

SAMPLE PREPARATION

Dilute - Dilution of Concentrates

Liquid and fluid concentrates must be diluted prior to testing to determine salt content. A method for diluting a small sample of concentrate is described below. Proper proportions for several mix ratios are given.

1. Using a clean 100 cubic centimeter hypodermic syringe (without the needle), aspirate room temperature water (about 80 °F) into the syringe being certain to expel any visible air bubbles. Refer to table 2 for the proper volume of water to be aspirated.

   NOTE: A smaller syringe can be used, but more than one filling may be necessary to obtain the proper volume of water.

Table 2. - Liquid concentrate dilution.

Mix Ratio	Volume	
	Water	Liquid concentrate
4:1	80 ml	20 ml
4.25:1	85	20
4.5:1	90	20
4.75:1	95	20
5:1	100	20

2. Eject the measured water into a clean, dry sample bottle.

3. Aspirate the proper volume of concentrate into the syringe. Wipe the outside of the syringe with a tissue to remove any concentrate from the surface.

4. Eject the measured concentrate into the water in the sample bottle.

5. Cap and shake to mix thoroughly.

6. Test the diluted sample, by following the instructions in the appropriate procedure.

Blend - Preparation of Fluid Concentrates

Fluid concentrates must be diluted to the proper salt content and then sheared to develop the viscosity prior to testing.

1. Use a freshly circulated sample of fluid concentrate.

2. A 10-speed Osterizer blender with six-cup and one-cup containers is used to provide the necessary shear.

3. Fill the blender container using the appropriate volumes of concentrate and water from table 3.

   - When using the one-cup container, a large capacity hypodermic syringe (without the needle) or a 100-mL graduated cylinder can be used to accurately measure the concentrate and water. This will make sufficient retardant for testing with a refractometer or a Brookfield viscometer.

   - When using a six-cup container, a 500-mL or 1000-mL graduated cylinder should be used. This larger volume is needed for testing the viscosity using a Marsh funnel or when preparing a single sample to be subdivided for additional testing.

4. Place the blender knife attachment on the container and position the container on the blender.

5. Blend at the lowest speed for 60 seconds.

6. Remove the blender knife attachment and allow mixed retardant to sit for10 minutes.

7. Test the mixed retardant, following the instructions in the appropriate procedure (refractometer or Brookfield viscometer).

Table 3. - Fluid concentrate dilution.

	One-Cup Container		Six-Cup Container	
Mix Ratio	Water	Concentrate	Water	Concentrate
3.1:1	186 mL	60 mL	1066 mL	344 mL
3.6:1	194	54	1105	307
3.7:1	196	53	1110	300

TEST THE PREPARED SAMPLES - SALT CONTENT

Determining Fire Retardant Salt Content Using a Hand-Held Refractometer

The values given for each product were determined using a Reichert Model 10440 hand-held refractometer. Other refractometers may be suitable but will require calibration for the specific brand and model.

1. If the retardant to be tested is a wet concentrate, dilute to the proper use level before testing to determine salt content. Proper procedures for preparing a mixed retardant from liquid concentrate or fluid concentrate were discussed earlier.

2. Take a freshly agitated sample of the retardant solution to be analyzed. If possible, allow the sample to reach room temperature (approximately 80 °F).

3. Lift the instrument cover plate to expose the prism.

4. Using the dipstick provided, or a plastic stirring rod, place one or two drops of the sample on the face of the prism and close the cover. The retardant should form a thin layer covering nearly the entire prism for best results. Avoid use of an excessive amount of retardant as this can give an inaccurate reading.

5. Point the instrument toward a strong light source. Natural light, outdoors is best.

6. Look through the eyepiece and read the value where the light/dark line intersects the scale. Tilting the refractometer with respect to the light source may sharpen the contrast and improve readability.

7. Clean the prism and cover plate with damp cloth or soft tissue. Dry thoroughly.

8. Refer to the product information sheet to determine whether a reading is acceptable.

> **NOTE:** Although variations in the temperature of the solution do not affect the accuracy of the refractometer, variations in temperature of the refractometer itself may do so. To minimize this problem, store the refractometer between 60 °F and 85 °F. Low temperatures cause greater variation than do high temperatures.

Determining Retardant Salt Content Using a Hand-Held Density Meter

A hand-held density meter is not usually used for field quality control. However, if the test material is pre-treated as appropriate for retardant type, the density can be substituted for specific gravity and used to determine if product is within the acceptable limits.

1. If the retardant to be tested is a wet concentrate, dilute to the proper use level before testing to determine salt content.

2. Pretreat retardant sample as appropriate for the thickener type.

3. Turn density meter on. (Mettle DMA 35; other instruments may be suitable; follow the manufacturer's operating instructions.)

4. Inject the sample slowly into the tubing attached to the bottom of the meter using a hypodermic syringe.

5. Allow the temperature (shown on the meter face) to stabilize.

6. Read the density and temperature directly in windows on the meter face.

7. Flush sample tube with clean water.

8. Use table 4 to convert degrees Celsius to degrees Fahrenheit.

9. Correct density reading for temperature less than 75 °F or greater than 85 °F using the following rule:

   a. For every 5 °F the retardant solution temperature is <u>below</u> 80 °F, <u>subtract</u> 0.001 from the reading.

   b. For every 5 °F the retardant solution is <u>above</u> 80 °F, <u>add</u> 0.001 to the reading.

10. Refer to the appropriate product information page to determine if the readings are within the acceptable range.

> **NOTE:** Freshly mixed retardant samples contain a large number of small air bubbles that will cause inaccurate density readings. Before making corrections to mixed retardant, the sample densities should be verified by retesting after the retardant has been allowed to sit for several hours or overnight.

Table 4. - *Conversion of temperatures from degrees Celsius to degrees Fahrenheit*[1].

°C	°F
4	39
6	43
8	46
10	50
12	54
14	57
16	61
18	64

20	68
22	72
24	75
26	79
28	82
30	86
32	90
34	93
36	97
38	100

1 For values not given in the table, the temperature in °F can be calculated by:
°F = 9/5 x °C + 32.

TEST THE PREPARED SAMPLES - VISCOSITY

Determining Retardant Viscosity Using a Marsh Funnel

1. Be sure the proper tip (0.269 ± 0.002 inch diameter for large tip and 0.187 ± .002 inch diameter for small tip) is in the Marsh funnel.

2. Use fresh samples that have completely hydrated (approximately 30 to 60 minutes after mixing) without excessive air bubbles.

3. Allow the sample to reach room temperature, if possible.

4. Close the funnel tip with a finger and pour retardant through the screen into a clean, dry upright funnel until the fluid level exactly reaches the bottom of the screen.

5. Measure the time in minutes and seconds for exactly one quart (946 mL) of retardant to flow out of the funnel.

6. Refer to the appropriate product information page to determine if the readings are within the acceptable range.

   NOTE: The amount of time elapsed since agitation and the retardant temperature influence viscosity. The viscosity values provided will apply only to retardant at the time and temperature at which the sample is tested.

   The values in the table are for samples at 75 °F to 85 °F. Higher temperatures may give falsely low viscosities; lower temperatures may give falsely high viscosities.

   Remember that Marsh funnel viscosities are estimates of Brookfield viscosity, good to about ± 200 centipoise.

Determining Retardant Viscosity Using a Brookfield Viscometer

While not normally used for base testing, a Brookfield viscometer (Model LVF) can be used to measure viscosity. Its use is common during a field test.

1. Level viscometer by adjusting the tripod feet until bubble level is centered. Tighten clamp to hold in this position.

2. Adjust speed control to 60 rpm. (The 60 should be on the upper surface of the knob.)

3. Attach the spindle guard by the screw on each side of the housing.

4. Attach the correct spindle (number two for viscosities less than 500 centipoise; number four for viscosities greater than 500 centipoise) by screwing it onto the threaded shaft.

   CAUTION: This is a left-handed thread. Tighten finger tight only, holding the shaft to prevent movement of the pointer.

5. Immerse spindle in the liquid to be tested, just to the immersion ring on the spindle.

6. Depress clutch. This procedure relieves wear and tear on the inner workings when measuring thick liquids.

7. Turn motor on, release clutch, and allow to rotate for one minute.

8. Depress clutch to maintain pointer position and turn motor off. If pointer is not in view, turn motor on and off to bring it into view with clutch still depressed.

9. Read dial at pointer position. Clutch can now be released.

10. Calculate viscosity in centipoise by multiplying dial reading by proper factor (five for spindle two; one hundred for spindle four).

11. Run the test three times and report the average viscosity.

TEST THE PREPARED SAMPLES - SPECIFIC WEIGHT

Determining the Specific Weight of a Fire Retardant by Conventional Weight/Volume Measurements

The specific weight of a retardant can be calculated from the weight of an accurately known volume of solution. Conversion to appropriate units of measure may be necessary. If a

container of appropriate known volume is not available, a container can be calibrated by adding a known weight of water to an available container and marking the fluid level.

1. Test the specific weight of a prepared mixed retardant or of a liquid concentrate directly. If the specific weight of a diluted liquid concentrate is to be determined, first prepare a sufficient sample of mixed retardant using the directions in procedure D.

2. Accurately weigh an empty container (1 cup to 1 quart) that has a precisely known volume (such as a kitchen measure) on a small scale, such as a postal or kitchen scale. The capacity of the scale will determine the size of container to use. (There are instructions following this procedure for determining the volume of a container.)

3. Fill the weighed container to the volume mark with retardant to be tested, being sure air bubbles have been allowed to escape.

4. Weigh the filled container.

5. Subtract the weight of the empty container. This gives the weight of the known volume of retardant.

6. Convert ounces to decimal fractions of pounds by dividing the number of ounces by 16; for example:

   2 lb 4 oz = 2.25 lb (2 + 4/16)
   2 lb 8-1/2 oz = 2.53 lb (2 + 8.5/16)

7. Determine the specific weight using table 5 or calculate the specific weight of the retardant by multiplying the weight obtained in step five by the appropriate factor:

Volume weighed	Factor
1 cup	16
2 cups (1 pt)	8
4 cups (1 qt)	4

For example, if one quart (four cups) of retardant weighs 2 lb 3 oz or 2.19 lb, the specific weight is 2.19 x 4 = 8.76 lb/gal.

If one cup of retardant weighs 9 oz or 0.56 lb, the specific weight is 0.56 x 16 = 8.96 lb/gal.

NOTE: A narrow mouth container is preferable to a wide mouth container. If such a container is not available, one can be made from any appropriately sized narrow mouth container.

T-1. Calibrating a Container of Unknown Volume (from 1 cup to 1quart approximate

a. Accurately weigh a clean, dry container.

b. Add sufficient water to the container to increase the weight as shown:

Approximate size container	Weight added (ounces)
1 cup	8
2 cup (1 pt)	16
4 cup (1 qt)	32

c. Carefully mark the fluid level.

d. Empty and dry the container and repeat at least three times.

e. Use a fine-tipped waterproof marker to mark.

Table 5. Conversions from weight of a known volume of retardant to specific weight.

Net Weight of Retardant in the Container		Specific Weight of the Retardant
1 cup container	1 quart container	Pounds/gallon
8 oz	2 lb	8.0
8-1/8 oz	2 lb 1/2 oz	8.13
8-1/4 oz	2 lb 1 oz	8.25
8-3/8 oz	2 lb 1-1/2 oz	8.3
8-1/2 oz	2 lb 2 oz	8.50
8-5/8 oz	2 lb 2-1/2 oz	8.63
8-3/4 oz	2 lb 3 oz	8.75
8-7/8 oz	2 lb 3-1/2 oz	8.83
9 oz	2 lb 4 oz	9.0
9-1/8 oz	2 lb 4-1/2 oz	9.13
9-1/4 oz	2 lb 5 oz	9.25
9-3/8 oz	2 lb 5-1/2 oz	9.33
9-1/2 oz	2 lb 6 oz	9.50
9-5/8 oz	2 lb 6-1/2 oz	9.63
9-3/4 oz	2 lb 7 oz	9.75
9-7/8 oz	2 lb 7-1/2 oz	9.83
10 oz	2 lb 8 oz	10.0

Determining the Specific Weight of a Retardant Using a Hand-held Density Meter

The density of a retardant can be measured using a hand-held density meter. Specific weight can be calculated from the density or it can be looked up directly in the conversion table provided.

1. Determine the specific weight of a prepared mixed retardant or of a wet concentrate directly. If the specific weight of a diluted wet concentrate is to be determined, first prepare sufficient sample of mixed retardant using the directions provided earlier.

2. Turn density meter on. (The Mettler DMA 35 was used for these tests, other instruments may be suitable; follow manufacturer's operating instructions.)

3. Fill the sample tube by slowly injecting retardant from a hypodermic syringe into the right-hand tube in the bottom of the meter.

4. If there are visible air bubbles in the sample tube, slowly inject more retardant until all bubbles are gone.

5. Allow temperature (shown on the meter face) to stabilize.

6. Read density and temperature directly in windows on the meter face.

7. Use table 6 to convert density (g/ml) to specific weight (lb/gal).

8. Flush sample tube with clean water.

NOTE: Freshly mixed or recirculated samples contain large numbers of small air bubbles that will cause inaccurate density readings. To obtain the true density of the retardant solution, it may be necessary to wait overnight for all entrapped air to escape.

Table 6. Conversion from retardant density to specific[1] weight

Density [2]	Specific weight
g/ml	lb/gal
1.010	8.4
1.022	8.5
1.034	8.6
1.046	8.7
1.058	8.8
1.070	8.9
1.082	9.0
1.094	9.1
1.106	9.2
1.118	9.3
1.130	9.4

1.142	9.5
1.154	9.6
1.166	9.7
1.178	9.8
1.190	9.9
1.202	10.0

1 At 80 °F. At lower solution temperatures, the tabulated values will be low; at higher solution temperatures, the tabulated value will be high.

2 For densitites outside the values shown or at temperatures other than 80 °F, the conversion can be made by multiplying the density by the proper constant. The constant depends on the solution temperature:

Temperature °F	Constant
70	8.327
75	8.322
80	8.317

Report The Results Of Testing

Lot Acceptance/Quality

All results of lot acceptance/quality assurance testing should be recorded in the base quality control log. Provide the appropriate information of the lot acceptance form, using water resistant ink. A standard ballpoint pen is fine, most roller ball or felt tip markers are not. Keep a copy of the form at the base and send the original, plus a one-quart sample to WFCS.

Base Quality Control

Each tanker base should have a log book of some type for maintaining the required base quality records and test results.

Appendix II contains sample data forms you may use or develop your own. Be sure that test results are entered. A pocket form for jotting down refractometer readings, a/c number, date, and time may serve as a temporary log.

Problem Solving

Document all pertinent information, such as test results, lot or load number, appearance, and mixing information. Contact your agency specialist and COR for further instructions.