A Publication of the
National Wildfire Coordinating Group

Sponsored by
United States
Department of Agriculture

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Department of the Interior
National Association of
State Foresters

Lot Acceptance, Quality Assurance, and Field Quality Control for Fire Retardant Chemicals

NFES 1245 **Sixth Edition—May 2000**

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Sixth Edition
May 2000

Prepared by:
NWCG Fire Equipment Working Team

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WILDLAND FIRE CHEMICAL SYSTEMS
Attn: Program Leader, Wildland Fire Chemical Systems
5775 Highway 10 West
Missoula, MT 59802

This National Wildfire Coordinating Group (NWCG) document provides information needed for cost effective and efficient management of the Fire Retardant Chemical Program.

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Long-Term Fire Retardant Characteristics and Mix Factors[1]

Retardant	Normal Use[2]	Quantity of powder or concentrate per gallon of water	Increase in volume	Quantity of powder or concentrate per gallon of mixed retardant	Mixed retardant per ton of powder or concentrate	Specific weight of mixed retardant	Viscosity of mixed retardant	Specific gravity of treated retardant	Refractometer reading of mixed retardant	Salt Content[2] of mixed retardant
		lb (gal)	*percent*	*lb (gal)*	*gallons*	*lb/gal*	*centipoise*			*percent*
Liquid Concentrate, Unthickened										
Fire-Trol LCA-R[4]	A/B	2.42 (.20)	17.6	2.06 (.17)	972	9.12	<50	.090-1.105	13.0-15.0	7.5 % APP
Fire-Trol LCG-R[5]	A/B	2.57 (.21)	19.3	2.17 (.18)	923	9.13	<50	1.090-1.103	14.0-16.0	7.9 % APP
Fire-Trol 931-R[6]	A/B	2.50 (.21)	20.2	2.08 (.18)	962	9.00	<50	1.075-1.090	11.25-13.75	7.25 % APP
Fire-Trol LCA-F[4]	A/B	2.39 (.20)	18.0	2.02 (.17)	989	9.07	<50	1.090-1.105	13.0-15.0	7.5 % APP
Fire-Trol LCG-F[5]	A/B	2.54 (.21)	19.1	2.14 (.18)	933	9.12	<50	1.090-1.103	14.0-16.0	7.9 % APP
Fluid Concentrate, Gum-thickened										
Phos-Chek HV-R/F[7]	A/B	2.94 (.28)	26.5	2.33 (.22)	860	8.93	1000-1600	1.064-1.076	11.0-13.0	11.3 % AS/MAP
Phos-Chek MV-R[7]	A/B	2.94 (.28)	26.5	2.33 (.22)	860	8.93	450-750	1.090-1.076	11.0-13.0	11.3 % AS/MAP
Phos-Chek LV-R[7]	A/B	2.94 (.28)	26.5	2.33 (.22)	860	8.93	75-225	1.075-1.076	11.0-13.0	11.3 % AS/MAP
Gum-thickened, High Viscosity										
Fire-Trol GTS-R	A/B	1.66	10.0	1.51	1325	9.07	1200-1800	1.087-1.107	15.0-18.25	14.2 % AS
Phos-Chek D75-R/F	A/B	1.20	6.9	1.12	1786	8.91	1000-1600	1.065-1.078	11.25-13.25	11.3 % AS/MAP
Fire-Trol 300-F	A/B	1.77	11.0	1.60	1250	9.12	1200-1800	1.086-1.106	15.0-18.25	14.2 % AS
Gum-thickened, Low Viscosity										
Phos-Chek 259-F	A/H/B/G	1.14	6.3	1.07	1869	8.90	75-250	1.063-1.074	12.25-14.5	10.9 % DAP
Phos-Chek G75-F/W	B/G	1.12	6.7	1.05	1907	8.85	60-250	1.055-1.067	10.25-12.25	11.2% AS/MAP

1 Consult your agency manuals and guidelines for specific product availability.
2 A - Fixed-wing airtanker; H - Fixed-tank helicopter; B- Helicopter bucket; G - Ground engine.
3 MAP - Monoammonium phosphate; DAP - Diammonium phosphate; AS - Ammonium sulfate; APP - Ammonium polyphosphate.
4 The specific weight of concentrate is 12.10 lb/gal for LCA-R and 11.94 lb/gal for LCA-F. Mix ratio is 5:1.
5 The specific weight of concentrate is 12.25 lb/gal for LCG-R and 12.10 lb/gal for LCG-F. Mix ratio is 4.75:1.
6 The specific weight of concentrate is 11.88 lb/gal. Mix ratio is 4.75:1.
7 The specific weight of concentrate is 10.58 lb/gal for HV-R, HV-F, MV-R, and LV-R. Mix ratio is 3.6:1.

SUMMARY

This document provides guidance for airtanker base personnel responsible for the sampling and testing of fire retardant.

The Forest Service Manual requires agency participation in the Lot Acceptance and Quality Assurance Program. Other agencies may have similar requirements or directives.

INTRODUCTION

Several million gallons of retardants are used every year in support of wildland fire suppression. The retardant must be properly formulated and prepared to maximize tactical performance and cost effectiveness.

All of the approved retardants were tested in the laboratory and in the field to determine that their performance met minimum specification requirements. Retardants must be properly mixed and tested in the field to ensure that the critical properties are maintained. The Lot Acceptance and Quality Assurance program was developed to ensure that purchased retardant has the same formulation and exhibits the same critical properties measured in the laboratory.

Quality control testing is necessary to ensure that product variations introduced during mass production, plant packaging, long-haul transportation, and storage do not significantly affect retardant performance. Samples taken to monitor product quality must be representative of the entire batch or load.

Reasons for being concerned about retardant quality include:

An unsafe situation for firefighters is created when an improper mix ratio is used.

Money is wasted when poor quality retardant is delivered to the fire.

The National Bulk and Full Service Retardant Contract requires agencies to sample and test all retardant through the Lot Acceptance and Quality Assurance Program.

Regional Foresters or agency directors have the ultimate responsibility for the quality of all retardants used in their jurisdiction. Through the appropriate regional aviation position, the airtanker base manager ensures that the retardant delivered to the airtanker is within specifications.

Several types of fire suppression chemicals are available but only long-term retardants will be discussed. This guide includes a discussion of the retardant's critical characteristics, specific product information for all long-term fire retardant on the current Forest Service Qualified Products List (QPL), and procedures for measuring retardant properties in the field.

Long-term retardants are available in two forms:

Liquid/Fluid Concentrate: A liquid component which, when added to water forms the mixed retardant.

Powder Product: A dry material which, when blended with water, forms the mixed retardant.

The product information section gives mix ratios and acceptable values for the critical properties of the products discussed in this guide. Although minor variations can be expected, major deviation from the values given for either salt content or viscosity suggest improper mixing or a formulation or product stability problem. Significant variations in operational field mixtures can adversely influence retardant effectiveness in fire control operations.

The methods chosen to determine quality control do not require special skills, are simple and quick to perform, and use a minimum of equipment. The tests are accurate and repeatable when instructions are followed.

RETARDANT CRITICAL PROPERTIES

The retardant characteristics having the greatest effect on fire control effectiveness and accuracy of delivery are retardant salt content, viscosity, and elasticity. The active salt content is, directly related to the ability of the retardant to decrease the rate of spread of the fire. The viscosity and elasticity affect the ability of the retardant to cling to the fuel and penetrate the fuel complex. This, in turn, relates to the amount of retardant salt remaining on the fuel where it is available to slow the fire.

> The use of standard and consistent products allows experienced fire personnel to anticipate the performance of specific retardants and adjust for retardant type when planning retardant applications and related fire control strategy. If the retardant fails to act in the expected manner, that strategy may fail.

Active Salt Content

The amount of active fire retarding chemical present (salt content) is directly related to the ability of the retardant to decrease the rate of spread of a fire. The active fire-retarding chemical (salt) is the component of the retardant formulation that is directly responsible for retarding combustion. The retardant retains effectiveness after the water it originally contained has evaporated.

All salts are not equally effective when applied to fuels on an equal weight basis. However, the retardant manufacturers have produced fire retardant formulations with similar combustion retarding effectiveness by adjusting both the mix ratio and the amount of salt in the concentrate or dry product.

Because the effectiveness of the mixed retardant solution is dependent on its concentration of active salt, it is important to maintain the salt content within prescribed limits. Several indirect methods for determining the salt content are suitable for field use. Each depends on appropriate conversion tables to obtain salt content from the measured property: refractometer reading, specific weight, or density.

Refractometer

The hand-held refractometer, shown in figure 1, is a simple field instrument, used with a conversion table, to determine the salt content of mixed retardant. The refractometer is a moderately priced instrument with these advantages:

- Tests can be performed quickly during loading operations.
- Temperature corrections are not needed in most cases.

Hand-held refractometers use arbitrary scales, which may differ between manufacturers. The acceptable values given in the tables were developed for a specific instrument. Other refractometers may be equally suitable but unless they use the same scale, the readings will not relate to the values provided.

Figure 1–Hand refractometer

Specific Weight

The specific weight of a retardant is the weight of one gallon of the mixed retardant, expressed in pounds. Although specific weight is a less accurate indication of salt content than the other measurements, the specific weight can be an indicator of whether or not the retardant is properly mixed. Entrapped air must be removed to obtain accurate specific weights. A mud balance, shown in figure 2, can be used to determine the specific weight.

Figure 2–Mud balance

Hand-Held Density Meter

Another method to determine salt content of a retardant is to use a hand-held density meter and tables that relate density to salt content. Although density meters are relatively expensive and fairly delicate, with care it is possible to use them in the field. The density meter measures the actual density of the solution including incorporated air. To obtain densities suitable for use with salt content tables, the sample must be allowed to sit until the trapped air has escaped. A hand-held density meter is shown in figure 3.

Viscosity and Elasticity

The viscosity and elasticity have a major impact on the characteristics of a retardant drop. The viscosity of the retardant solution is easily measured, however, the performance of a particular retardant is dependent on properties, more difficult to measure, other than viscosity. The retardant with the highest

Figure 3–Hand-Held density meter

viscosity does not necessarily have the best drop characteristics and performance. Also, not all high-viscosity products have the same performance. The viscosity of a specific retardant formulation serves as an indicator of retardant elasticity.

Retardant elasticity determines the ability of the retardant mass to remain intact (resist breakup) during aerial delivery. The elasticity also affects the extent to which the retardant clings to fuels or flows off the fuels onto the ground.

Too little elasticity, as in the case of water-like or unthickened retardants, provides little resistance to breakup. This results in a mist-like condition with most of the retardant in small droplets that evaporate faster and are blown off-target by wind. Also, lower volumes of retardant are spread over a given area.

Retarding effectiveness is related to the amount of fuel surface covered with retardant. Viscosity and elasticity affect how the fire retardant

will spread over the fuel surface building a retardant coating and how much will run or drip off, and come into contact with ladder fuels or the ground.

Retardant viscosity can be measured by a Marsh funnel or Brookfield viscometer. The most accurate measurements are obtained if hydration of the thickener is complete and most of the entrapped air is released. This can take up to one hour, depending on mixing and recirculation time and on the specific hardware.

Retardant concentration and temperature, time since mixing or recirculation, and product age can affect the viscosity. Retardant viscosity increases as temperature decreases. Conversely, as the temperature of a retardant solution increases, the viscosity decreases. This effect should not be overlooked. A viscosity that is low at 90 °F can be several hundred centipoise higher at 70 °F.

The viscosity (and elasticity) of unthickened and slightly thickened retardants is not generally a concern.

Marsh Funnel

The viscosity of a gum-thickened retardant can be related to the time required for a fixed quantity of fluid to flow through a small hole of specific diameter and length. Variations in diameter, length, and volume of the orifice will cause variations in flow-through time. This explains the different values obtained for the viscosity when different funnels are used. Viscosity measured by the Marsh funnel shown in figure 4 is generally within 200 centipoise of laboratory values for most thickened products.

Brookfield Viscometer

Viscosity values during laboratory or field evaluations are usually determined using a Brookfield viscometer (Model LVF) shown in figure 5. The Brookfield viscometer is not used during routine base operations because of the cost of the instrument and its delicacy.

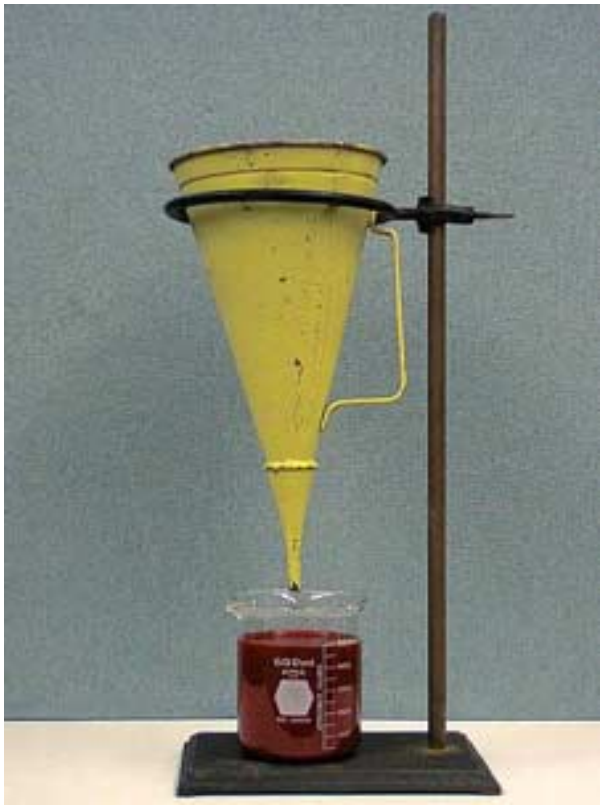

Figure 4–Marsh funnel

Figure 5–Brookfield viscometer

IMPROPERLY MIXED RETARDANT

When mixed retardant does not have the correct salt content or viscosity, tanker base personnel should contact the Fire Chemicals Project Leader at either San Dimas Technology and Development Center (SDTDC) or Wildland Fire Chemical Systems (WFCS) at Missoula Technology and Development Center.

An improperly mixed product can cause many problems. If the mixed retardant does not contain enough water, the mixed retardant:

- ✓ Will contain excessive salt and cost more per gallon than necessary.
- ✓ Will be too viscous to flow readily in loading operations and on fuel.
- ✓ May develop crystals or precipitate during storage, especially as temperatures fluctuate.
- ✓ May exhibit abnormal drop characteristics.
- ✓ May cause excessive corrosion.

If the retardant contains too much water, the retardant may:

- ✓ Not effectively retard the fire because of inadequate salt content.
- ✓ Have greater evaporation and wind drift during aerial delivery.
- ✓ Separate easily in storage.
- ✓ Be more susceptible to viscosity loss due to inadequate concentrations of stabilizers.
- ✓ Be more corrosive due to inadequate levels of corrosion inhibitors.

A gum-thickened retardant held in storage for long periods of time may show some loss of viscosity due to deterioration. Sudden loss of viscosity, of any freshly mixed or stored product, is cause for concern and may be a result of contamination.

When the viscosity decreases due to product deterioration, separation of the mixed product is a potential problem. Store such retardant in a separate tank and use as soon as feasible.

A properly mixed, gum-thickened retardant that loses its viscosity may still be an effective retardant, but will have drop characteristics similar to an unthickened or water-like retardant.

LOT ACCEPTANCE AND QUALITY ASSURANCE

The Forest Service uses the Lot Acceptance and Quality Assurance Program to ensure that the retardant manufacturers and the agency airtanker bases maintain a high standard of retardant quality.

All agencies purchasing retardant under the terms of the National Retardant Contract are required to participate in the Lot Acceptance and Quality Assurance Program. Participation is described below.

Visual Inspection

Retardant is delivered to each base as a bulk shipment or in individual containers, such as Phos-Bins, semi-bulk bags, or pails. A visual inspection must be performed on each delivery to the base (usually a truckload) and will consist of observations regarding adequacy of labeling and marking, presence of proper paperwork, and condition of containers. In general, bulk shipments cannot be visually inspected.

Quality Assurance Sampling And Testing

Quality assurance sampling and testing must be performed, throughout the fire season, as

part of airtanker base operations. The times to collect, test, and submit samples are described below:

Base opening—as soon as the base is opened and stored material has been thoroughly recirculated.

New shipment—as each shipment is received at the airtanker base. The liquid/fluid concentrate can be tested in concentrate form but the dry powder must be mixed prior to testing.

Base closing—following the final recirculation of the stored retardant prior to the seasonal closing of the base.

Troubleshooting—whenever base personnel observe unusual retardant characteristics.

Each sample should be analyzed at the base and a portion of the sample retained. A portion of the same sample must be sent to WFCS along with the results of the visual inspection and the base analysis.

QUALITY CONTROL TESTING

Retardant testing should be part of the routine operation of each base to ensure acceptable retardant quality. The retardant should be sampled and tested frequently during mixing operations to allow adjustments to equipment settings that maintain retardant quality. These samples do not need to be sent to WFCS unless problems are encountered.

Mixing

The most common quality control problem is an improper mixing ratio which results in inadequate salt content, viscosity, or stability. The basic corrective action is to adjust the amount of water or retardant concentrate in the mixed retardant. If the salt content is below acceptable, more concentrate or dry powder must be added to mix. If the salt content exceeds acceptable, more water is needed in the mix.

Retardant testing is a part of all mixing operations. The type of retardant and the mixing system will influence the frequency of sampling.

For a product such as a liquid concentrate that does not require storage of the mixed retardant, samples should be tested often enough to ensure proper adjustment of equipment and maintain product quality. Early in the season or when new personnel are working, several refractometer readings need to be taken during each loading operation. Once equipment is adjusted and personnel are trained, a sample should be taken during loading of each airtanker. Test each sample and record the results in the base quality control log.

When mixing dry powder retardant using an eductor or any continuous-mix operation, testing should be frequent enough to ensure proper adjustment of equipment. Recirculation may be necessary to attain a uniform sample. Once equipment is adjusted and personnel are trained, a sample should be taken during loading of each airtanker. Test each sample and record the results in the base quality control log.

A batch mixer should be checked at the beginning of each season to ensure that the water-level indicator is accurate. Once equipment is adjusted and personnel are trained, a sample should be taken during loading of each airtanker. Samples of retardant from each mixed batch should be tested and the results recorded in the base quality control log. Samples are most easily taken from a batch mixer by installing a small valve in the mix tank at a level even with the midpoint of the retardant solution.

Recirculation and Storage

Retardant in storage at a base should be sampled at least once a week during the fire season. Generally testing should be performed after thorough recirculation. If problems (such as a change in salt content, loss of viscosity, or significant stratification in the tanks) are found, consult the regional or agency retardant specialist for specific instructions. Additional samples may need to be taken to assist in determining the cause of the problem.

SAMPLE COLLECTION

Although the reason for sampling (lot acceptance, routine quality control, or suspected problem) will affect the manner in which a sample is taken, there are general guidelines that will usually apply.

Samples should be collected from a sampling valve into a clean, dry container. Flush the sample valve (by allowing approximately one gallon of retardant to flow from the valve into a waste container) prior to filling the sample container. Samples of mixed retardant can be collected from a valve on a batch mixer or transfer hose, at the pump, or from the end of a loading hose.

Thoroughly circulate the contents of each tank before sampling. If base plumbing is set up so that all tanks circulate together, then one sample will represent all retardant in base storage. Samples can be taken from a valve on the storage tank or, during the final few minutes of recirculation, from a valve on the pump or recirculation hose.

Liquid Concentrate

If there is reasonable assurance that delivered liquid concentrate (LC) is consistent throughout each truck/trailer load, LC can be sampled as delivered from the truck transfer hose, preferably midway through the transfer process.

If concentrate must be transferred to base storage prior to sampling, the tank should be as empty and clean as possible. Otherwise the contents of the tank, and any samples taken from it, are a combination of both stored LC and newly delivered LC**. In this situation the test results do not reflect the quality of a single lot.**

Fluid Concentrate

Fluid concentrate separates quickly. They should be recirculated prior to transfer from the tanker to base storage. Sampling can best be accomplished through a sampling valve on the transfer hose, midway through the transfer process.

In the event that the tanker does not have recirculation capability, transfer the entire contents of the truck to a single clean, empty tank and recirculate thoroughly prior to sampling. Sample through a valve on the recirculation hose or pump. **Under no circumstances should the truckload be split between tanks at the base.**

Dry Product

It is difficult to collect a sample, representative of the entire contents, from a container of dry powder. It is better to mix one bag or bin from a delivery and take a sample for testing from the resulting mixed retardant. The retardant must be mixed in a clean tank, otherwise samples will represent a combination of previously and newly mixed retardant. Obtaining a representative sample is easily accomplished with a batch mixer, but less easily with an eductor.

When dry powder is received in bulk, the only feasible sampling location is the storage tank of mixed retardant. Samples should be collected frequently enough to ensure proper retardant quality, approximately every ten to fifteen airtanker loads.

LABELING AND RECORD KEEPING

Each sample must be labeled immediately. If circumstances allow, complete a formal label immediately. In other cases, provide enough information to allow formal labeling at the end of the operational period.

Each label should include at least the following information:

- ✓ Time and date sampled
- ✓ Time and date mixed
- ✓ Identification of the tank containing the retardant
- ✓ Shipper number for the delivery
- ✓ Time and date of transfer

Keep a base quality control log containing the results of all retardant tests. If the sample is for the Lot Acceptance Program, send the sample with the lot acceptance information to NWST. The log should include the following information for each sample:

- ✓ Retardant name
- ✓ Shipper or waybill number
- ✓ Batch identification
- ✓ Mixing and sampling dates and times
- ✓ Tank identification, for storage samples
- ✓ Airtanker number, for load samples
- ✓ Name of person doing the testing
- ✓ Refractometer reading and corresponding salt content
- ✓ Marsh funnel time and corresponding viscosity
- ✓ Solution temperature

Additional information such as sampling locations, date or time tank was last recirculated or new product added, and the reason for testing (routine quality control, troubleshooting, etc.) may be helpful.

As the samples are taken and tested for the Lot Acceptance Program, place a quality assurance sample label on the container and record the appropriate information. A copy of the information should be retained for the base log.

Fill in the sample labels and log entries carefully and completely. Write or print legibly using a pen with waterproof ink since the label or form may come in contact with moisture. Examples of record keeping forms can be found in the Appendix.

FIRE-TROL LCA-R

Fire-Trol LCA-R is composed primarily of liquid ammonium polyphosphate (Arcadian Poly-N 11-37-0). Although attapulgite clay is added to the concentrate to suspend the color and enhance visibility, when diluted for use it is essentially an unthickened product. Fire-Trol LCA-R contains a corrosion inhibitor, and iron oxide provides the color. Mixing is accomplished through simple proportioning of the retardant concentrate and water. The resulting mixed retardant is usually pumped directly into aircraft without intermediate storage.

Product type: Unthickened, liquid concentrate; demand-mixed.

Application: Fixed-wing airtanker and helicopter bucket.

Use level: 1 gallon of liquid concentrate mixed with 5 gallons of water will produce 5.88 gallons of mixed retardant. Each gallon of mixed retardant contains the equivalent of 2.06 pounds or 0.17 gallons of liquid concentrate.

Yield: 1 ton of liquid concentrate yields 972 gallons of mixed retardant.

Viscosity: <50 centipoise (cP).

Field measurement for the viscosity of the retardant mixed 5:1 is not meaningful; therefore, no data is provided for the mixed retardant.

Salt content: 7.5 percent by weight, P205 equivalent.

Field measurement (refractometer): A reading of 13.95 indicates a proper salt content. **A reading between 13.00 and 15.00 indicates an acceptable salt content.**

Specific weight: 9.12 and 12.10 lb/gal, respectively, for mixed retardant and liquid concentrate.

FIRE-TROL LCG-R

Fire-Trol LCG-R is composed primarily of liquid ammonium polyphosphate (McGregor/ Texas Gulf 11-37-0). Although attapulgite clay is added to the concentrate to suspend the color and enhance visibility, when diluted for use it is essentially an unthickened product. Fire-Trol LCG-R contains a corrosion inhibitor and iron oxide as a colorant. Mixing is accomplished through simple proportioning of the retardant concentrate and water. The resulting mixed retardant is usually pumped directly into aircraft without intermediate storage.

Product type: Unthickened, liquid concentrate; demand-mixed.

Application: Fixed-wing airtanker and helicopter bucket.

Use level: 1 gallon of liquid concentrate mixed with 4.75 gallons of water will produce 5.67 gallons of mixed retardant. Each gallon of mixed retardant contains the equivalent of 2.17 pounds or 0.18 gallons of liquid concentrate.

Yield: 1 ton of liquid concentrate yields 923 gallons of mixed retardant.

Viscosity: <50 centipoise (cP).

Field measurement for the viscosity of the retardant mixed 4.75:1 is not meaningful; therefore, no data is provided for the mixed retardant.

Salt content: 7.9 percent by weight, P205 equivalent.

Field measurement (Refractometer): A reading of 15.0 indicates a proper salt content. **A reading between 14.0 and 16.0 indicates an acceptable salt content.**

Specific weight: 9.13 and 12.25 lb/gal, respectively, for mixed retardant and liquid concentrate.

FIRE-TROL 931-R

Fire-Trol 931-R is composed primarily of liquid ammonium polyphosphate. Although attapulgite clay is added to the concentrate to suspend the color and enhance visibility, when diluted for use it is essentially an unthickened product. Fire-Trol 931-R contains a corrosion inhibitor, and iron oxide provides the color. Mixing is accomplished through simple proportioning of the retardant concentrate and water. The resulting mixed retardant is usually pumped directly into aircraft without intermediate storage.

Product type: Unthickened, liquid concentrate; demand-mixed.

Application: Fixed-wing airtanker and helicopter bucket.

Use level: 1 gallon of liquid concentrate mixed with 4.75 gallons of water will produce 5.71 gallons of mixed retardant. Each gallon of mixed retardant contains the equivalent of 2.08 pounds or 0.175 gallons of liquid concentrate.

Yield: 1 ton of liquid concentrate yields 962 gallons of mixed retardant.

Viscosity: <50 centipoise (cP).

Field measurement for the viscosity of the retardant mixed 4.75:1 is not meaningful; therefore, no data is provided for the mixed retardant.

Salt content: 7.25 percent by weight, P205 equivalent.

Field measurement (refractometer): A reading of 12.5 indicates a proper salt content. **A reading between 11.25 and 13.75 indicates an acceptable salt content.**

Specific weight: 9.00 and 11.88 lb/gal, respectively, for mixed retardant and liquid concentrate.

FIRE-TROL LCM-R

Fire-Trol LCM-R is composed primarily of liquid ammonium polyphosphate (Simplot/ Moses Lake 10-34-0). Although attapulgite clay is added to the concentrate to suspend the color and enhance visibility, when diluted for use it is essentially an unthickened product. Fire-Trol LCM-R contains a corrosion inhibitor, and iron oxide provides the color. Mixing is accomplished through simple proportioning of the retardant concentrate and water. The resulting mixed retardant is usually pumped directly into aircraft without intermediate storage.

Product type: Unthickened, liquid concentrate; demand-mixed.

Application: Fixed-wing airtanker and helicopter bucket.

Use level: 1 gallon of liquid concentrate mixed with 4.25 gallons of water will produce 5.17 gallons of mixed retardant. Each gallon of mixed retardant contains the equivalent of 2.34 pounds or 0.19 gallons of liquid concentrate.

Yield: 1 ton of liquid concentrate yields 854 gallons of mixed retardant.

Viscosity: <50 centipoise (cP).

Field measurement for the viscosity of the retardant mixed 4.25:1 is not meaningful; therefore, no data is provided for the mixed retardant.

Salt content: 7.9 percent by weight, P205 equivalent.

Field measurement (refractometer): A reading of 14.20 indicates a proper salt content. **A reading between 13.25 and 15.25 indicates an acceptable salt content.**

Specific weight: 9.19 and 12.14 lb/gal, respectively, for mixed retardant and liquid concentrate.

FIRE-TROL LCP-R

Fire-Trol LCP-R is composed primarily of liquid ammonium polyphosphate (Simplot/ Pocatello 10-34-0). Although attapulgite clay is added to the concentrate to suspend the color and enhance visibility, when diluted for use it is essentially an unthickened product. Fire-Trol LCP-R contains a corrosion inhibitor and iron oxide as a colorant. Mixing is accomplished through simple proportioning of the retardant concentrate and water. The resulting mixed retardant is usually pumped directly into aircraft without intermediate storage.

Product type:	Unthickened, liquid concentrate; demand-mixed.
Application:	Fixed-wing airtanker and helicopter bucket.
Use level:	1 gallon of liquid concentrate mixed with 4.25 gallons of water will produce 5.15 gallons of mixed retardant. Each gallon of mixed retardant contains the equivalent of 2.34 pounds or 0.19 gallon of liquid concentrate.
Yield:	1 ton of liquid concentrate yields 853 gallons of mixed retardant.
Viscosity:	<50 centipoise (cP). Field measurement for the viscosity of the retardant mixed 4.25:1 is not meaningful; therefore, no data is provided for the mixed retardant.
Salt content:	7.9 percent by weight, P205 equivalent. Field measurement (Refractometer): A reading of 14.5 indicates a proper salt content. **A reading between 13.5 and 15.5 indicates an acceptable salt content.**
Specific weight:	9.22 and 12.08 lb/gal, respectively, for mixed retardant and liquid concentrate.

FIRE-TROL LCA-F

Fire-Trol LCA-F is composed primarily of liquid ammonium polyphosphate (Arcadian Poly-N 11-37-0). Although attapulgite clay is added to the concentrate to suspend the color and enhance visibility, when diluted for use it is essentially an unthickened product. Fire-Trol LCA-F contains a corrosion inhibitor and a fugitive color. Mixing is accomplished through simple proportioning of the retardant concentrate and water. The resulting mixed retardant is usually pumped directly into aircraft without intermediate storage.

Product type:	Unthickened, liquid concentrate; demand-mixed.
Application:	Fixed-wing airtanker and helicopter bucket.
Use level:	1 gallon of liquid concentrate mixed with 5 gallons of water will produce 5.90 gallons of mixed retardant. Each gallon of mixed retardant contains the equivalent of 2.02 pounds or 0.17 gallons of liquid concentrate.
Yield:	1 ton of liquid concentrate yields 989 gallons of mixed retardant.
Viscosity:	<50 centipoise (cP). Field measurement for the viscosity of the retardant mixed 5:1 is not meaningful; therefore, no data is provided for the mixed retardant.
Salt content:	7.5 percent by weight, P205 equivalent. Field measurement (refractometer): A reading of 13.95 indicates a proper salt content. **A reading between 13.00 and 15.00 indicates an acceptable salt content.**
Specific weight:	9.07 and 11.94 lb/gal, respectively, for mixed retardant and liquid concentrate.

FIRE-TROL LCG-F

Fire-Trol LCG-F is composed primarily of liquid ammonium polyphosphate (McGregor/ Texas Gulf 11-37-0). Although attapulgite clay is added to the concentrate to suspend the color and enhance visibility, when diluted for use it is essentially an unthickened product. Fire-Trol LCG-F contains a corrosion inhibitor and a fugitive colorant. Mixing is accomplished through simple proportioning of the retardant concentrate and water. The resulting mixed retardant is usually pumped directly into aircraft without intermediate storage.

Product type:	Unthickened, liquid concentrate; demand-mixed.
Application:	Fixed-wing airtanker and helicopter bucket.
Use level:	1 gallon of liquid concentrate mixed with 4.75 gallons of water will produce 5.66 gallons of mixed retardant. Each gallon of mixed retardant contains the equivalent of 2.14 pounds or 0.18 gallons of liquid concentrate.
Yield:	1 ton of liquid concentrate yields 933 gallons of mixed retardant.
Viscosity:	<50 centipoise (cP). Field measurement for the viscosity of the retardant mixed 4.75:1 is not meaningful; therefore, no data is provided for the mixed retardant.
Salt content:	7.9 percent by weight, P205 equivalent. Field measurement (Refractometer): A reading of 15.0 indicates a proper salt content. **A reading between 14.0 and 16.0 indicates an acceptable salt content.**
Specific weight:	9.12 and 12.10 lb/gal, respectively, for mixed retardant and liquid concentrate.

FIRE-TROL LCM-F

Fire-Trol LCM-F is composed primarily of liquid ammonium polyphosphate (Simplot/ Moses Lake 10-34-0). Although attapulgite clay is added to the concentrate to suspend the color and enhance visibility, when diluted for use it is essentially an unthickened product. Fire-Trol LCM-F contains a corrosion inhibitor and a fugitive color. Mixing is accomplished through simple proportioning of the retardant concentrate and water. The resulting mixed retardant is usually pumped directly into aircraft without intermediate storage.

Product type:	Unthickened, liquid concentrate; demand-mixed.
Application:	Fixed-wing airtanker and helicopter bucket.
Use level:	1 gallon of liquid concentrate mixed with 4.25 gallons of water will produce 5.18 gallons of mixed retardant. Each gallon of mixed retardant contains the equivalent of 2.30 pounds or 0.19 gallons of liquid concentrate.
Yield:	1 ton of liquid concentrate yields 869 gallons of mixed retardant.
Viscosity:	<50 centipoise (cP). Field measurement for the viscosity of the retardant mixed 4.25:1 is not meaningful; therefore, no data is provided for the mixed retardant.
Salt content:	7.8 percent by weight, P205 equivalent. Field measurement (refractometer): A reading of 14.20 indicates a proper salt content. **A reading between 13.25 and 15.25 indicates an acceptable salt content.**
Specific weight:	9.13 and 11.92 lb/gal, respectively, for mixed retardant and liquid concentrate.

FIRE-TROL LCP-F

Fire-Trol LCP-F is composed primarily of liquid ammonium polyphosphate (Simplot/ Pocatello 10-34-0). Although attapulgite clay is added to the concentrate to suspend the color and enhance visibility, when diluted for use it is essentially an unthickened product. Fire-Trol LCP-F contains a corrosion inhibitor and a fugitive colorant. Mixing is accomplished through simple proportioning of the retardant concentrate and water. The resulting mixed retardant is usually pumped directly into aircraft without intermediate storage.

Product type:	Unthickened, liquid concentrate; demand-mixed.
Application:	Fixed-wing airtanker and helicopter bucket.
Use level:	1 gallon of liquid concentrate mixed with 4.25 gallons of water will produce 5.14 gallons of mixed retardant. Each gallon of mixed retardant contains the equivalent of 2.31 pounds or 0.19 gallon of liquid concentrate.
Yield:	1 ton of liquid concentrate yields 864 gallons of mixed retardant.
Viscosity:	<50 centipoise (cP). Field measurement for the viscosity of the retardant mixed 4.25:1 is not meaningful; therefore, no data is provided for the mixed retardant.
Salt content:	7.8 percent by weight, P205 equivalent. Field measurement (Refractometer): A reading of 14.5 indicates a proper salt content. **A reading between 13.5 and 15.5 indicates an acceptable salt content.**
Specific weight:	9.20 and 11.93 lb/gal, respectively, for mixed retardant and liquid concentrate.

PHOS-CHEK HV-R AND HV-F (3.1:1)

Phos-Chek HV-R and HV-F are fluid concentrates containing a mixture of monoammonium phosphate and ammonium sulfate as the active fire retardant salts. The formulations are gum-thickened and yield a mixed retardant having a high viscosity for improved drop characteristics from fixed-wing airtankers. HV-R is iron oxide-colored, and HV-F is fugitive colored. Both products also contain corrosion inhibitors and stabilizers.

Product type:	High-viscosity, gum-thickened, fluid concentrate; demand-mixed.
Application:	Fixed-wing airtanker.
Use-level:	1 gallon of fluid concentrate mixed with 3.1 gallons of water will produce 4.06 gallons of mixed retardant. Each gallon of mixed retardant contains the equivalent of 2.58 pounds or 0.25 gallons of fluid concentrate.
Yield:	1 ton of fluid concentrate yields 775 gallons of mixed retardant.
Viscosity:	1200-1800 centipoise (cP). Field measurement (Marsh funnel) **25-36 sec through the large tip**.
Salt content:	11.3 percent by weight active salt: 8.4 percent by weight AS, $(NH_4)_2SO_4$, 1.5 percent by weight DAP, $(NH_4)_2HPO_4$, and 1.5 percent by weight MAP, $(NH_4)H_2PO_4$. Field measurement (refractometer): A reading of 12.0 indicates a proper salt content. **A reading between 11.0 and 13.0 indicates an acceptable salt content.**
Specific weight:	8.93 and 10.47 pounds/gallon, respectively, for mixed retardant and fluid concentrate.

PHOS-CHEK HV-R AND HV-F (3.6:1)

Phos-Chek HV-R and HV-F are fluid concentrates containing a mixture of monoammonium phosphate and ammonium sulfate as the active fire retardant salts. The formulations are gum-thickened and yield a mixed retardant having a high viscosity for improved drop characteristics from fixed-wing airtankers. HV-R is iron oxide-colored, and HV-F is fugitive colored. Both products also contain corrosion inhibitors and stabilizers.

Product type:	High-viscosity, gum-thickened, fluid concentrate; demand-mixed.
Application:	Fixed-wing airtanker and helicopter bucket.
Use-level:	1 gallon of fluid concentrate mixed with 3.6 gallons of water will produce 4.55 gallons of mixed retardant. Each gallon of mixed retardant contains the equivalent of 2.33 pounds or 0.22 gallons of fluid concentrate.
Yield:	1 ton of fluid concentrate yields 860 gallons of mixed retardant.
Viscosity:	1200-1800 centipoise (cP). Field measurement (Marsh funnel) **25-36 sec through the large tip**.
Salt content:	11.3 percent by weight active salt: 8.4 percent by weight AS, $(NH_4)_2SO_4$, 1.5 percent by weight DAP, $(NH_4)_2HPO_4$, and 1.5 percent by weight MAP, $(NH_4)H_2PO_4$. Field measurement (refractometer): A reading of 12.0 indicates a proper salt content. **A reading between 11.0 and 13.0 indicates an acceptable salt content.**
Specific weight:	8.93 and 10.58 pounds/gallon, respectively, for mixed retardant and fluid concentrate.

PHOS-CHEK LV-R AND MV-R (3.6:1)

Phos-Chek LV-R and MV-R are fluid concentrates containing a mixture of monoammonium phosphate and ammonium sulfate as the active fire retardant salts. The formulations are gum-thickened and yield mixed retardant having a low (75-225 centipoise) or medium (450-750 centipoise) viscosity for improved drop characteristics from a variety of drop platforms. Both products are iron oxide-colored; they also contain corrosion inhibitors and stabilizers.

Product type:	Low/medium-viscosity, gum-thickened, fluid concentrate; demand-mixed.
Application:	Fixed-wing airtanker and helicopter bucket.
Use-level:	1 gallon of fluid concentrate mixed with 3.6 gallons of water will produce 4.55 gallons of mixed retardant. Each gallon of mixed retardant contains the equivalent of 2.33 pounds or 0.22 gallons of fluid concentrate.
Yield:	1 ton of fluid concentrate yields 860 gallons of mixed retardant.
Viscosity:	75-225 centipoise (cP) for low viscosity and 450-750 centipoise for medium viscosity. Field measurement (Marsh funnel) **44-75 sec through the small tip** for the low viscosity and **18-21 sec through the large tip** for the medium viscosity.
Salt content:	11.3 percent by weight active salt: 8.4 percent by weight AS, $(NH_4)_2SO_4$, 1.5 percent by weight DAP, $(NH_4)_2HPO_4$, and 1.5 percent by weight MAP, $(NH_4)H_2PO_4$. Field measurement (refractometer): A reading of 12.0 indicates a proper salt content. **A reading between 11.0 and 13.0 indicates an acceptable salt content.**
Specific weight:	8.93 and 10.58 pounds/gallon, respectively, for mixed retardant and fluid concentrate.

PHOS-CHEK MV-F (3.7:1)

Phos-Chek MV-F is a fluid concentrate containing a mixture of monoammonium phosphate and ammonium sulfate as the active fire retardant salts. The formulation is gum-thickened and yields mixed retardant having a medium (450-750 centipoise) viscosity for improved drop characteristics from a variety of drop platforms. MV-F is fugitive-colored; it also contains corrosion inhibitors and stabilizers.

Product type:	Medium-viscosity, gum-thickened, fluid concentrate; demand-mixed.
Application:	Fixed-wing airtanker and helicopter bucket.
Use-level:	1 gallon of fluid concentrate mixed with 3.7 gallons of water will produce 4.64 gallons of mixed retardant. Each gallon of mixed retardant contains the equivalent of 2.27 pounds or 0.22 gallons of fluid concentrate.
Yield:	1 ton of fluid concentrate yields 881 gallons of mixed retardant.
Viscosity:	450-750 centipoise (cP) for medium viscosity. Field measurement (Marsh funnel) **18-21 sec through the large tip** for the medium viscosity.
Salt content:	11.0 percent by weight active salt: 8.0 percent by weight AS, $(NH_4)_2SO_4$, 1.5 percent by weight DAP, $(NH_4)_2HPO_4$, and 1.5 percent by weight MAP, $(NH_4)H_2PO_4$. Field measurement (refractometer): A reading of 12.0 indicates a proper salt content. **A reading between 11.0 and 13.0 indicates an acceptable salt content.**
Specific weight:	8.90 and 10.55 pounds/gallon, respectively, for mixed retardant and fluid concentrate.

PHOS-CHEK G75-F AND G75-W

Phos-Chek G75-W and G75-F are mixtures of monoammonium phosphate and ammonium sulfate as the active fire retardant salts. G75-W is uncolored and G75-F contains a fugitive coloring agent. They both contain bactericide and corrosion inhibitors. The formulations are designed for application from the ground or helicopter bucket. Both formulations contain a low concentration of gum-thickener to provide viscosity to improve drop characteristics and adherence to the fuel.

Product type:	Low-viscosity, gum-thickened, dry powder; eductor-mixed.
Application:	Ground, engine and helicopter bucket.
Use level:	1.12 pound of dry retardant mixed with 1 gallon of water will produce 1.07 gallons of mixed retardant. Each gallon of mixed retardant contains the equivalent of 1.05 pounds of powder.
Yield:	1 ton of powder yields 1907 gallons of mixed retardant.
Viscosity:	60-250 centipoise (cP).
	Field measurement (Marsh funnel): **35-52 sec through the small tip.**
Salt content:	11.2 percent by weight active salts: 8.4 percent by weight AS, $(NH_4)_2SO_4$ and 2.8 percent by weight MAP, $NH_4H_2PO_4$.
	Field measurement (refractometer): A reading of 11.25 indicates a proper salt content. **A reading between 10.25 and 12.25 indicates an acceptable salt content.**
Specific weight:	8.85 lb/gal for mixed retardant.

PHOS-CHEK 259-F

Phos-Chek 259-F is a diammonium phosphate-based (DAP) retardant designed for all types of air or ground application. Phos-Chek 259-F contains a fugitive coloring agent and a low concentration of gum thickener to provide viscosity and improve drop characteristics. The product also contains bactericide and corrosion inhibitors. This is the only long-term retardant relatively noncorrosive to magnesium, thus enhancing its application by helicopter.

Product type:	Low-viscosity, gum-thickened, dry powder; batch or eductor-mixed.
Application:	Ground, engine, helicopter with fixed-tank or bucket, and fixed-wing airtanker.
Use level:	1.14 pounds of dry retardant mixed with 1 gallon of water will produce 1.06 gallons of mixed retardant. Each gallon of mixed retardant contains 1.07 pounds of powder.
Yield:	1 ton of powder yields 1869 gallons of mixed retardant.
Viscosity:	75-250 centipoise (cP).
	Field measurement (Marsh funnel) **46-84 sec through the small tip.**
Salt content:	10.9 percent by weight DAP, $(NH_4)_2HPO_4$.
	Field measurement (refractometer): A reading of 13.35 indicates a proper salt content. **A reading between 12.25 and 14.5 indicates an acceptable salt content.**
Specific weight:	8.90 lb/gal of mixed retardant.

FIRE-TROL GTS-R

Fire-Trol GTS-R contains ammonium sulfate as the primary fire retardant salt. It also contains a small amount of ammonium phosphate that acts as both a corrosion inhibitor and a retardant salt. This product also contains bactericide and additional corrosion inhibitors. The iron oxide colored formulation is designed for fixed-wing air application. The formulation contains a relatively high concentration of gum thickener to provide a high viscosity for improved drop characteristics from fixed-wing airtankers. Due to the high viscosity this formulation is not normally used for ground engines or helicopters.

Product type:	High-viscosity, gum-thickened, dry powder; batch mixed.
Application:	Fixed-wing airtanker.
Use-level:	1.66 pounds of dry retardant mixed with 1 gallon of water will produce 1.10 gallons of mixed retardant. Each gallon of mixed retardant contains the equivalent of 1.51 pounds of powder.
Yield:	1 ton of powder yields 1325 gallons of mixed retardant.
Viscosity:	1200-1800 centipoise (cP). Field measurement (Marsh funnel) **32-50 sec through the large tip.**
Salt content:	15.2 percent by weight active salts: 14.2 percent by weight AS, $(NH_4)_2SO_4$ and 1.0 percent by weight DAP, $(NH_4)_2HPO_4$. Field measurement (refractometer): A reading of 16.53 indicates a proper salt content. **A reading between 15.0 and 18.25 indicates an acceptable salt content.**
Specific weight:	9.07 lb/gal of mixed retardant.

FIRE-TROL 300-F

Fire-Trol 300-F is a dry powder product containing ammonium sulfate as the active fire retardant salt. It also contains a small amount of ammonium phosphate that acts as both a corrosion inhibitor and a retardant salt. Other ingredients include additional corrosion and spoilage inhibitors. This fugitive colored formulation is designed for fixed-wing air application. The formulation is gum thickened and yields a mixed retardant having a relatively high viscosity for improved drop characteristics from fixed-wing airtankers. Due to the high viscosity this formulation is not normally used for ground engines or helicopters.

Product type:	High-viscosity, gum-thickened, dry powder; batch mixed.
Application:	Fixed-wing airtanker.
Use-level:	1.77 pounds of dry retardant mixed with 1 gallon of water will produce 1.11 gallons of mixed retardant. Each gallon of mixed retardant contains the equivalent of 1.60 pounds of powder.
Yield:	1 ton of powder yields 1250 gallons of mixed retardant.
Viscosity:	1200-1800 centipoise (cP). Field measurement (Marsh funnel) **32-50 sec through the large tip.**
Salt content:	15.2 percent by weight active salts: 14.2 percent by weight AS, $(NH_4)_2SO_4$ and 1.0 percent by weight DAP, $(NH_4)_2HPO_4$. Field measurement (refractometer): A reading of 16.5 indicates a proper salt content. **A reading between 15.0 and 18.25 indicates an acceptable salt content.**
Specific weight:	9.12 lb/gal of mixed retardant.

PHOS-CHEK D75-R AND D75-F

Phos-Chek D75-R and D75-F are mixtures of monoammonium phosphate and ammonium sulfate as the active fire retardant salts. D75-R contains iron oxide coloring and D75-F contains a fugitive coloring agent. They also contain viscosity stabilizers and corrosion inhibitors. These products contain a relatively high concentration of gum thickener to provide a high viscosity for improved drop characteristics from fixed-wing airtankers. Due to their high viscosity, they are not recommended for application by ground engine or helicopter.

Product type:	High-viscosity, gum-thickened, dry powder; batch or eductor-mixed.
Application:	Fixed-wing airtanker.
Use level:	1.20 pounds of dry retardant mixed with 1 gallon of water will produce 1.07 gallons of mixed retardant. Each gallon of mixed retardant contains the equivalent of 1.12 pounds of powder.
Yield:	1 ton of powder yields 1786 gallons of mixed retardant.
Viscosity:	1000-1600 centipoise (cP).
	Field measurement (Marsh funnel) **24-34 sec through the large tip.**
Salt content:	11.3 percent by weight active salt: 8.5 percent by weight AS, $(NH_4)_2SO_4$ and 2.8 percent by weight MAP, $NH_4H_2PO_4$.
	Field measurement (refractometer): A reading of 12.1 indicates a proper salt content. **A reading between 11.25 and 13.25 indicates an acceptable salt content.**
Specific weight:	8.91 lb/gal of mixed retardant.

P R O C E D U R E S

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, and 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) program. 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 1 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 1–Liquid concentrate dilution.

Mix Ratio	Volume	
	Water (ml)	Liquid Concentrate (ml)
4:1	80	20
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 2.

a. 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.

b. 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 for 10 minutes.

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

Table 2–Fluid concentrate dilution.

Mix Ratio	One-Cup Container		Six-Cup Container	
	Water (ml)	Concentrate (ml)	Water (ml)	Concentrate (ml)
3.1:1	186	60	1066	344
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 pretreated 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 3 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 below 80 °F, subtract 0.001 from the reading.

   b. For every 5 °F the retardant solution is above 80 °F, add 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 3–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 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 4 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.

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

Accurately weigh a clean, dry container.

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

Carefully mark the fluid level.

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

Use a fine-tipped waterproof marker to mark.

Table 4–Conversions from weight of a known volume of retardant to specific weight.

Net Weight of Retardant in 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.

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.

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

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

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

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

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

Use table 5 to convert density (g/ml) to specific weight (lb/gal).

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 5–Conversion from retardant density to specific weight[1]

Density [2] g/ml	Specific weight 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 densities 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 Assurance

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 balls 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 logbook of some type for maintaining the required base quality records and test results.

Appendix I 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 Contracting Officers Representative for further instructions.

FORMS NEEDED TO SUPPORT THE LA/QA TEST PROGRAM

DATA COLLECTION FORMS

The forms in this section are suggested data sheets that contain the required information. They can be photocopied for base use or bases may develop their own forms with spaces for other information that they require.

Send samples with the appropriate form and label to:

By Mail	By UPS or Freight
Wildland Fire Chemical Systems P.O. Box 8089 Missoula, MT 59807	Wildland Fire Chemical Systems 5775 Highway 10 West Missoula, MT 59802

Please include the name and phone number of a contact at the airtanker base on all samples.

CONCENTRATE TEST SUMMARY
(Take a Sample and Complete Form for each Truckload)

Base/Location _____

Retardant Type: _____

Delivery Information:

Date of Delivery _____ Time of Delivery _____

Volume of Delivery: _____ (pounds or gallons; select one)

Shipper Number _____ Shipping Company _____

Manufacturing Site _____

Pumped into Tank Number _____

Field Sample Test Information

Refractometer Reading _____ **pH:** _____

Viscosity: _____ **Density:** _____

Comments: (Date sample sent to WFCS, other identification, etc.)

_____

_____

_____

_____

_____

DRY CONCENTRATE TEST SUMMARY
(Take a Sample and Complete Form for each Truckload)

Base/Location _____

Retardant Type: _____

Delivery Information:

Date of Delivery _____ Time of Delivery _____

Volume of Delivery: _____ (pounds or gallons; select one)

Shipper Number _____ Shipping Company _____

Manufacturing Site _____

Number of Gallons Mixed: _____ (_____ lbs. dry]

Pumped into Tank Number: _____

Field Sample Test Information

Refractometer Reading: _____ **pH:** _____

Viscosity: _____ **Density:** _____

Comments: (Date sample sent to WFCS, other identification, etc.)

_____

_____

_____

_____

RETARDANT MIXING SUMMARY
Sample each Airtanker Load

Base/Location: _____ Retardant Type: _____

Sample Number	Date Loaded	Time Loaded	A/T Number	Refractometer Reading	Viscosity	Fire
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						

Comments:_____

_____

_____

_____

_____

RETARDANT CONCENTRATE SUMMARY
Sample Weekly Following Recirculation

Base/Location: _____ Retardant Type: _____

Tank Identification: _____ Tank Capacity: _____

Sample Date				
Sample Time				
Amount of Concentrate in Tank				
Amount of Concentrate Added to Tank				
Date of Last Recirculation				
Refractometer Reading of Mix				
Viscosity of Mixed Retardant				
Laboratory Analysis:				
Refractometer Reading of Mix				
Density of Concentrate				
Viscosity of Concentrate				

Comments: _____

_____

_____

TESTING EQUIPMENT AND SOURCES

A P P E N D I X T W O

For assistance in locating a source for any required test equipment, contact WFCS.

USDA Forest Service
Wildland Fire Chemical Systems
5775 Highway 10 West
Missoula, MT 59802
(406)329-4819
(406)329-4859

INSTRUCTIONS FOR MODIFYING THE MARSH FUNNEL

Instructions For Modifying The Marsh Funnel[1]

1. The tubing of the original Marsh funnel tip is too small for determining viscosity of most fire retardant materials. This modification must be made prior to using the funnel for determining the viscosity of fire retardants. Use new, or freshly and expertly sharpened, high-quality twist drills for the operations. Refer to figure 3.

2. Remove the original 1/4-inch outside-diameter brass tip. Drive out with a 1/4-inch punch or similar tool. Take care not to change its inside diameter, its length, or its smoothness. It is used to measure some of the lower viscosity retardants.

3. Enlarge the hole in the plastic funnel with a 13/32-inch drill bit. Leave a smooth surface inside the funnel. Drill slowly to prevent overheating the plastic.

4. Make a new tip from a 2 1/8-inch section of 1/8-inch regular seamless red brass pipe. The dimensions are nominally 0.405-inch outside diameter and 0.269-inch inside diameter. If a smaller inside diameter material is used, drill out with a 17/64-inch drillbit.

5. Enlarge the hole at one end of the tip to 5/16-inch and to a depth of 1/8-inch. Taper the inside of the enlarged end of the tip with a 45 degree reamer. See that the reaming leaves the tip end smooth and does not reduce the overall length of the tip.

6. The flared end of the original tip should now fit neatly into the enlarged end of the larger tip.

7. Install the large tip, machined end up, in the Marsh funnel with a waterproof adhesive; a silicon rubber adhesive works well. If the fit is tight, allow the lower end of the funnel to soften and expand by warming it in hot water (not boiling) for a few minutes.

[1] The Marsh funnel is manufactured by the Baroid Drilling Fluids, P.O. Box 1675, Houston, TX 77251.

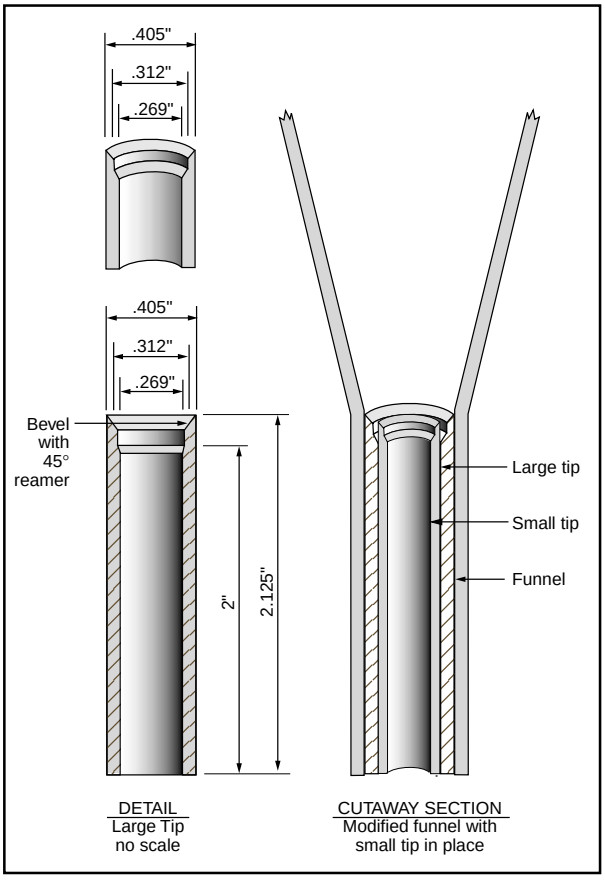

Figure 5—Marsh Funnel modifications for use with fire retardants.

G L O S S A R Y

G L O S S A R Y

The following definitions apply to terms used in this document:

Component - A component is each combination of ingredients packaged by the manufacturer for use in preparation of the product by the user. A component may be a single ingredient, or a combination of ingredients, wet or dry, that is added to water when preparing the mixed retardant. Examples of components, for the purpose of this document, are a liquid concentrate or a gum-thickener if it is added to the mix at the airtanker base.

Corrosion - Result of reaction between a metal and its environment.

Density - The mass of substance per unit of volume, grams per milliliter.

Deterioration - The loss of viscosity over time; specifically, for evaluation purposes, any loss of more than 40 percent of the initial viscosity within one year after preparation of the solution.

Dry Concentrate - A dry concentrate is a dry powder which, when mixed with water, forms the mixed retardant. For the purposes used in this document, a dry concentrate is also a component.

Elasticity - The property of a material enabling it to resist deformation by stretching or pulling apart. Usually used in reference to the cohesiveness or ability of material to hold together during a drop.

Flow Conditioner - Chemicals that, in very small quantities, tend to prevent other powders from caking. Imparts free flowing qualities to powder.

Fugitive Color - A coloring agent which has high visibility when fresh but will gradually (over days and weeks) fade to neutral earth tone with exposure to sunlight.

Ingredient - A single chemical used by the manufacturer in the formulation of the product.

Inhibitor - Any agent which retards a chemical reaction. In retardant applications, usually refers to a viscosity loss inhibitor (bactericide) or corrosion inhibitor.

Iron Oxide Color - A coloring agent which has high initial visibility. The visibility usually remains for greater than one year unless weathered, obscured by vegetation or washed into the soil.

Liquid Concentrate - A retardant concentrate in liquid form which, when diluted with water by simple mixing, forms a mixed retardant.

Long-Term Retardant - A product containing salts which acts as a fire retardant. It contains water which serves primarily to aid in uniform disbursement of the retardant salts over the target area. When the water is completely evaporated, the remaining salts continue to serve as a fire retardant until they are removed.

Lot - Each delivery (usually 20 to 25 tons) of retardant product or components, whether a full or partial truckload, to a mixing base.

Mixed Retardant - A mixture of wet or dry concentrate, and other component(s), mixed with water at the qualified mix ratio.

pH - A measure of the acidity or alkalinity of liquid, on a scale from 0 to 14, with 7 representing neutrality. The lowest numbers are the most acidic and the highest numbers are the most alkaline (basic).

Retardant - A substance that by chemical or physical action reduces or inhibits

flammability of combustibles. Rate-of-speed of flame front is thereby slowed or retarded.

Rheological Properties - All those physical or chemical properties that influence the fluid flow characteristics of a substance. Viscosity and elasticity are principal rheological properties used to characterize retardant behavior.

Short-Term Retardant - A substance that relies on the moisture it contains to reduce or inhibit combustion and is ineffective once its moisture has evaporated. Water and thickened water are short-term retardants.

Specific Weight - Weight, in pounds, of one gallon of substance.

Steady State Viscosity - Viscosity of a retardant 24 hours after initial mixing and that is expected to be maintained for an appreciable time period (week or more).

Thickener - A substance that when added to a liquid acts to increase the viscosity and/or elasticity of that liquid.

Viscosity - The internal resistance of a liquid to flow when a defined force is exerted upon it. The viscosity of retardants is normally measured with a Brookfield viscometer or a Marsh funnel.

Viscosity Reducing Agent - A substance (usually an enzyme) that is added to a gun-thickened retardant to eliminate enough of the viscosity that a hydrometer can be accurately floated in the product.

Wet Concentrate - A type of liquid/fluid concentrate which, when added to water, forms the mixed retardant. For the purposes of this document, a wet concentrate is also a component.

R E F E R E N C E S

R E F E R E N C E S

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Anderson, W.H.; Brown, R.E.; Louis, N.A.; [and others]. Correlation of rheological properties of aerially delivered performance, final report. *Shock-Hydrodynamics contract 26-3198 to INT. On file at USDA Forest Service Intermountain Fire Sciences Laboratory, Intermountain Research Station, Missoula, MT.*

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