

**U.S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE
SPECIFICATION FOR
WATER ENHANCERS FOR WILDLAND
FIREFIGHTING
September 2018
Amended May 6, 2021**

1. SCOPE AND CLASSIFICATION.

- 1.1.** Scope. The water enhancers described in this specification are for use in wildland and wildland-urban interface fire management. They may be applied from ground or aerial application equipment, directly to the fire area to slow or stop combustion, and for exposure protection.
- Water enhancers are fire suppressants. They are not fire retardants. They depend on the water that they contain to be effective and when that water has evaporated, they are no longer effective.
- Water enhancers contain thickeners which improve aerial application, minimize drift, and aid in adherence to fuels.
- Water enhancers are the concentrated product (wet or dry) as purchased. The concentrate is added to water to create an enhanced water mixture. Each water enhancer is qualified for use at a specific concentration or concentration range.
- 1.1.1.** Product Types Covered By This Specification. All additives for fighting fires in Class A fuels, except Class A Foams and wetting agents, are covered by this specification.
- 1.2.** Classification. The submitter shall specify the classifications of the wildland fire chemical product, according to the following sections, for which qualification is sought. These classifications determine the specific tests to be performed and performance required.
- 1.2.1.** Form of Concentrate. Each concentrate shall be classified as wet or dry.
- 1.2.1.1.** Wet Concentrate: A wet component which is mixed with water to prepare the enhanced water mixture.
- 1.2.1.2.** Dry Concentrate: A dry component which is mixed with water to prepare the enhanced water mixture.
- 1.2.2.** Water Enhancers may be uncolored or colored.
- 1.2.2.1.** Uncolored products shall be one component, i.e., enhanced water mixtures shall be prepared by blending a single wet or dry concentrate/component with water.

- 1.2.2.2.** Colored products may be:
- a.** one component (concentrate plus color), added to water, or
 - b.** two component product, prepared by adding a qualified colorant to water and then blending a qualified uncolored water enhancer concentrate with the colored water.
- 1.2.3.** Storability.
- 1.2.3.1.** Concentrates shall be classified and evaluated as storable products.
- 1.2.3.2.** Mixed products shall be classified and evaluated as not storable.
- 1.2.4.** Application Methods. Each mixed product shall be classified based on the listed application methods.
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| HF | Helicopters having a fixed tank, either internal or external in direct contact with the helicopter. |
| FW/Multi-Engine | Fixed-wing (all delivery systems) – land-based, multi engine aircraft having a tank and delivery system for aerial application of wildland fire chemicals. |
| FW/Single-Engine | Fixed-wing (all delivery systems) - land-based, single-engine (SEAT) aircraft having a tank and delivery system for aerial application of wildland fire chemicals. |
| HB/G | Helicopters having a bucket suspended below the helicopter such that no chemical is likely to contact the helicopter during normal fire operations and all ground-based application equipment, such as wildland engines, portable pumps, and other such devices. |

2. APPLICABLE DOCUMENTS.

- 2.1.** Order of Precedence. In the event of conflict between the text of this document and the references cited herein, the text of this document takes precedence.
Nothing in this document, however, shall supersede applicable laws and regulations unless a specific exemption has been obtained.
- 2.2.** United States Government Documents. The specifications, standards, and handbooks referenced form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents in effect on the date of the invitation for bids or request for proposals shall apply.
- 2.2.1.** Code of Federal Regulations (CFR). The text of the Codes of Federal Regulation are available at <https://www.govinfo.gov/help/cfr>
- 2.2.2.** U.S. Department of Agriculture, Forest Service, National Technology and Development Program (NTDP-Missoula).
 Manufacturer Submission Procedures for Qualification Testing of Water Enhancer Products. Available at www.fs.fed.us/rm/fire/wfcs/submit.htm
 Standard Test Methods for the Evaluation of Wildland Fire Chemical Products, version in effect on the date of submission for evaluation. Available at www.fs.fed.us/rm/fire/wfcs/tests/index.htm
 USDA Forest Service Manual (FSM) 5160, Section 5162 – Fire Management Chemicals. Available at <http://www.fs.fed.us/im/directives>
- 2.2.2.1** Paper copies of the submission documents can be obtained from the Program Leader or Project Leader, Wildland Fire Chemical Systems (WFCS), 5785 Highway 10 West, Missoula, MT, 59808, if web access is not available.

- 2.2.3. U.S. Department of Agriculture and U.S. Department of Interior.
Interagency Standards for Fire and Fire Aviation Operation. Department of Agriculture, Forest Service, and Department of the Interior Agencies: Bureau of Land Management, National Park Service, and U.S. Fish and Wildlife Service. Available at <https://www.nifc.gov/PUBLICATIONS/redbook/2017/Chapter13.pdf>
- 2.2.4. U.S. Environmental Protection Agency (EPA), Office of Chemical Safety and Pollution Prevention (OCSP).
EPA documents can be obtained from the web site at <https://www.epa.gov/aboutepa/about-office-chemical-safety-and-pollution-prevention-ocspp>
By mail from U.S. Environmental Protection Agency, National Service Center for Environmental Publications (NSCEP), P.O. Box 42419, Cincinnati, OH 45242.
- 2.2.5. United States Department of Health and Human Services.
National Toxicology Program: Report on Carcinogens is available at <https://ntp.niehs.nih.gov/>
- 2.2.6. International Agency for Research on Cancer (IARC).
IARC Monographs of Carcinogens are available at <https://monographs.iarc.fr/>
- 2.2.7. Federal Standards.
Federal Standards can be obtained from <https://www.gsa.gov/acquisition/purchasing-programs/requisition-programs/gsa-global-supply/supply-standards/index-of-federal-specifications-standards-and-commercial-item-descriptions>
- 2.2.8. Military Specifications.
Military Specification can be obtained from <http://www.dsp.dla.mil/>
- 2.2.9. Freedom of Information Act (FOIA).
The Forest Service FOIA information can be found at <http://www.fs.fed.us/im/foia/>
- 2.3. Other Publications. The following publications of the issue in effect on the date of the specification acceptance form a part of this specification.
- 2.3.1. American Society for Testing and Material (ASTM).
Copies of ASTM publications can be obtained on the web at <http://astm.org> or
By mail from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.
- 2.3.2. National Association of Corrosion Engineers International (NACE).
Copies of NACE publications can be obtained at <https://nace.org/home.aspx>
By mail from NACE International, 1440 South Creek Drive, Houston, TX 77084.
- 2.3.3. Society of Automotive Engineers, Inc. (SAE).
Copies of SAE publication can be obtained on the web at <http://sae.org> or
By mail from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

3. **REQUIREMENTS.**

- 3.1 Wildland Fire Chemical Product Qualification Testing. Testing for wildland fire chemical products shall be performed and all products shall be qualified by the Government prior to use (Forest Service Manual (FSM) 5100, Chapter 5160, Section 5162).
Testing shall include a laboratory evaluation and may include a field evaluation during firefighting operations.

- 3.1.1** Additional Testing at the Discretion of the Forest Service.
Additional tests not specified in this document may be required at the discretion of the Forest Service when information provided in the product information or otherwise known to the Forest Service suggests a need.
The submitter shall be informed, before any additional testing is performed, of the specific tests to be performed and the reason for the tests.
- 3.2** Manufacturer Submission Process. The submitter (manufacturer, distributor, or supplier) shall make a request for evaluation to the USDA Forest Service, Branch Chief for Fire Equipment and Chemicals.
- 3.3.** Product Information
- 3.3.1.** Formulation Disclosure Sheet. The submitter shall submit a Formulation Disclosure Sheet (Table 1 of Manufacturer Submission Procedures) including the required information on all ingredients contained in the formulation.
Full disclosure of the types and amounts of each chemical in the product, the Chemical Abstract Services (CAS) number, quality or grade, and manufacturer or source shall be included for each ingredient.
The manufacturing process, manufacturing site, and other related information about each ingredient and for the product shall also be provided.
- 3.3.2.** Mix Ratio Range. The submitter shall specify the use range for which qualification is requested. The evaluation shall be conducted on the concentrate and on the mixed product prepared using the manufacturer's recommended range of mix ratio.
- 3.3.2.1.** Maximum Mix Ratio. The highest concentration of the uncolored product shall be no greater than 3.0 percent weight/weight (for dry concentrates) or volume/volume (for wet concentrates).
- 3.3.3.** Minimum Allowable Viscosity. The viscosity of the mixed product at the lowest mix ratio as described by the submission and disclosure information, shall be at least 200 centipoise (cP) when prepared with room temperature (70 °F), ASTM soft water.
- 3.3.4.** Health and Safety Information. The submitter shall submit the following safety information to the Government for review, prior to shipping the product for testing.
Safety Data Sheet (SDS) for the concentrated product as supplied by the manufacturer.
- SDS for each ingredient of the proposed product from the manufacturer/supplier shown on the formulation disclosure sheet.
 - SDS for the proposed product from the manufacturer/supplier shown on the formulation disclosure sheet.
- Summary of any toxicity or related safety test results conducted by or for the manufacturer prior to submission to the Government
- 3.3.5.** Technical Data Sheets. The submitter shall provide completed Technical Data Sheets (Tables 2 and 3 of Manufacturer Submission Procedures) giving all required information regarding the physical properties and characteristics of the water enhancer.
A description of the field mixing and handling requirements shall be included
- 3.3.6.** Reaction Ingredient Residual. When the submitted product is the result of a chemical reaction, information explaining the reaction process and listing the residual amounts of the reaction ingredients shall be provided.
- 3.3.7.** Other Technical Information. The submitter shall provide information regarding laboratory mixing, field mixing, handling, loading, and any special cleanup procedures that may be of use to laboratory or field personnel.

3.3.8. Patents. Copies of patents covering any aspect of the formulation or its application in wildland fire operations should be included in the submission documentation.

3.4. Chemicals of Concern.

3.4.1. Unacceptable Ingredients. The following ingredients do not comply with Forest Service direction and shall not be accepted:

- Sodium ferrocyanide (Yellow Prussiate of Soda or YPS)
- Dichromate
- Thiourea
- Borate or other boron-containing compounds
- Polychlorinated biphenols (PCB)
- Polybrominated diphenyl ethers (PBDE)
- Nonylphenol ethoxylates (NPE).

3.4.2. Environmental and Health Regulations. A review of environmental regulations as they apply to the formulation and the ingredients of the formulation shall be completed as a part of the overall review. Specifically, the status of each chemical with regard to the regulatory lists shown below shall be determined.

- a. National Toxicology Program's Annual Report on Carcinogens.
- b. International Agency for Research on Cancer (IARC) Monographs for Potential Carcinogens.
- c. 40 CFR 302.4. – CERCLA, List of Hazardous Substances and Reportable Quantities.
- d. 40 CFR 261.33. – Resources Conservation and Recovery Act (RCRA), Acutely Hazardous and Toxic Wastes.
- e. 40 CFR 372. – Superfund Amendment and Reauthorization Act (SARA) Title III, sec 313, Emergency Planning and Community Right to Know (EPCRA), Toxic Release Inventory (TRI).
- f. 40 CFR 372. – Superfund Amendment and Reauthorization Act (SARA) Title III, sec 313, Emergency Planning and Community Right to Know (EPCRA), Toxic Release Inventory (TRI).

3.4.3. Chemical Profile and Risk Assessment. Chemical profiles shall be prepared and a risk assessment shall be performed on all products prior to being placed on the Qualified Products List (QPL).

All chemical profiles and risk assessments shall be performed by the Government or by an approved third party selected by the Government, using accepted methodology.

Based on the information provided in accordance with 3.3, at the discretion of the Government, chemical profiles and/or a risk assessment as described in 3.4.3.1 and 3.4.3.2 may be required before lab-work begins.

3.4.3.1. Chemical Profile. When there is no existing chemical profile or the existing profile is out of date, a new profile shall be developed by the Government or qualified third party selected by the Government, at Government expense.

3.4.3.2. Risk Assessment. A risk assessment shall be performed by the Government or a qualified party selected by the Government, at submitter expense, prior to a product being placed on the Qualified Products List (QPL).

If a risk assessment is required before the laboratory evaluation is performed, based on the information developed in 3.4, the Government shall make a written notification to the submitter of these concerns and include the acceptable remedies and the associated costs.

3.4.3.3. Environmental Consultation with Regulatory Agencies. A new product may be included in an environmental consultation with the regulatory agencies [U.S. Fish and Wildlife Service (FWS) and National Oceanic and Atmospheric Administration – National Marine Fisheries Service (NMFS)]. The extent of the consultation will be based on the similarities and differences to other products from the same supplier.

The composition of a product, the results of laboratory testing required by this specification, applicable chemical profiles, and product risk assessments will be shared with these regulatory agencies to inform them of the characteristics of the product and assist them in making their determination.

The consultation will result in a formal statement of findings from each regulatory agency.

3.5. Performance Requirements.

3.5.1. Determination of Laboratory Mixing Procedures. A suitable set of conditions and methods for preparing laboratory samples of the mixed product shall be determined.

These procedures shall be used to prepare all samples for the laboratory evaluation.

All dilutions shall be prepared with 70° F fresh water unless otherwise specified.

If standard mixing operations are not acceptable/sufficient, the submitter shall provide acceptable mixing equipment, capable of accurately measuring to 0.1%, and procedures. Costs of additional equipment and/or personnel time shall be the responsibility of the submitter.

3.5.2. Health and Safety.

3.5.2.1. Mammalian Toxicity and Irritation Tests. As required by 3.5.2.1.1. and 3.5.2.1.2., the mammalian toxicity and irritation performance of the concentrate and mixed product shall be determined in accordance with 4.1.1.

3.5.2.1.1. Concentrate. The toxicity of the wet or dry concentrate shall meet the requirements in Table 1 when tested in accordance with 4.1.1.

Table 1. Toxicity and irritation requirements for wet or dry concentrate.	
<u>Test</u>	<u>Requirement</u>
Acute oral toxicity	LD ₅₀ > 500 mg/kg.
Acute dermal toxicity	LD ₅₀ > 2000 mg/kg.
Primary eye irritation for single and double washed eyes	Mildly irritating or less. If more irritating, recommend protective gear and safe handling procedures.
Primary dermal irritation	Primary irritation index < 5.0. If more irritating, recommend protective gear and safe handling procedures.

- 3.5.2.1.2. Enhanced Water Mixture (Mixed Product). The toxicity of the mixed product at the highest recommended mix ratio shall meet the requirements in Table 2 when tested in accordance with 4.1.1.

Table 2. Toxicity and irritation requirements for mixed product.	
Test	Requirement
Acute oral toxicity	LD ₅₀ > 5000 mg/kg.
Acute dermal toxicity	LD ₅₀ > 2000 mg/kg.
Primary eye irritation for single and double washed eyes	Mildly irritating or less. If more irritating, recommend protective gear and safe handling procedures.
Primary dermal irritation	Primary irritation index < 5.0.

- 3.5.2.1.3. Report of Mammalian Toxicity and Irritation Test Results. The results of the toxicity testing shall be certified by the testing laboratory and submitted to the Government, in accordance with 4.1.1.1.

- 3.5.2.1.4. Review of Mammalian Toxicity and Irritation Test Results. When the test results for a concentrate indicate that protective gear / safe handling procedures are needed, the manufacturer shall make recommendations to be added to the product label.

In accordance with 4.1.1.2, the results and related recommendations shall be reviewed by the Government.

- 3.5.2.2. Fish Toxicity. The LC₅₀ for rainbow trout exposed to the concentrate shall be greater than 100 mg/L when tested in accordance with 4.1.2.

- 3.5.2.3. Biodegradability. The biodegradability of the concentrate shall be determined in accordance with 4.1.3.

- 3.5.2.4. Open Cup Flash Point and Fire Point. As required by 3.5.2.4.1 and 3.5.2.4.2, the open cup flash point and fire point of the water enhancer concentrate shall be determined in accordance with 4.1.4.

- 3.5.2.4.1. Open Cup Flash Point. When tested in accordance with 4.1.4, the open cup flash point of the concentrate shall not be less than 140 °F (60 °C).

- 3.5.2.4.2. Open Cup Fire Point. When tested in accordance with 4.1.4., the open cup fire point of the concentrate shall not be less than 140 °F (60 °C).

- 3.5.3. Exposure Protection Effectiveness (LIFT). In accordance with 4.2, the enhanced water mixture shall be tested for exposure protection effectiveness using the Lateral Ignition and Flame Spread Test (LIFT) and a performance rating determined.

- 3.5.4. Physical Properties. In accordance with 4.3, the physical properties of the wet concentrate and enhanced water mixtures of the concentrate shall be determined as required in 3.5.4.1 and 3.5.4.2.

These test results shall define the standard characteristics for the submitted product and be used to address quality issues.

- 3.5.4.1. Physical Properties of the Wet Concentrate. The density, viscosity, pH, and fluidity of the wet concentrates shall be determined in accordance with 4.3.

- 3.5.4.1.1. Density of the Wet Concentrate. In accordance with 4.3.1., the density of the wet concentrate shall be determined.

- 3.5.4.1.2.** pH of the Wet Concentrate. The pH of the wet concentrate shall be determined In accordance with 4.3.2.
The pH of the wet concentrate shall be between 4.0 and 10.0.
- 3.5.4.1.3.** Viscosity of the Wet Concentrate. The viscosity of the wet concentrate shall be determined in accordance with 4.3.3.
- 3.5.4.1.4.** Fluidity of the Wet Concentrate. In accordance with 4.3.4, the fluidity of wet concentrate shall be determined as a function of temperature.
The wet concentrate shall remain fluid at 35 °F.
- 3.5.4.2.** Physical Properties of the Enhanced Water Mixtures. In accordance with 4.3, the density, pH, and steady state viscosity of the enhanced water mixtures prepared with 70 °F fresh water over the entire mix ratio range shall be determined.
- 3.5.4.2.1.** Density of the Enhanced Water Mixtures. In accordance with 4.3.1, the density the enhanced water mixtures shall be determined.
The values determined for enhanced water mixtures shall be used as baseline values for stability tests as required in 3.5.6.1.1.1.
- 3.5.4.2.2.** pH of the Enhanced Water Mixtures. In accordance with 4.3.2, the pH of the enhanced water mixtures shall be determined.
- 3.5.4.2.3.** Steady State Viscosity of the Enhanced Water Mixtures. In accordance with 4.3.3.1, the steady state viscosity of the enhanced water mixtures shall be determined.
No viscosity less than 200 centipoise when the mixture is prepared in 70° ASTM soft water shall be acceptable.
These test results shall be used as a baseline value for stability tests as required in 3.5.6.1.1.1.
- 3.5.5.** Corrosion. Wet concentrates and enhanced water mixtures shall meet the requirements as described below when tested for uniform and intergranular corrosion in accordance with 4.4.1. and 4.4.2. The required performance for each application method is summarized in Tables 3 and 3A.
- 3.5.5.1.** Uniform Corrosion.
- 3.5.5.1.1.** Uniform Corrosion of Fresh Wet Concentrate. When tested in accordance with 4.4.1, wet concentrate shall not have corrosion rates exceeding those shown in Table 3.
- 3.5.5.1.2.** Uniform Corrosion of Enhanced Water Mixtures from Fresh Concentrate. When tested in accordance with 4.4.1. enhanced water mixtures, prepared from fresh concentrate shall not have corrosion rates exceeding those shown in Table 3.
- 3.5.5.1.3.** Uniform Corrosion of Enhanced Water Mixtures from Stored Concentrate. When tested in accordance with 4.4.1. enhanced water mixtures, prepared from one-year storage samples of concentrate, shall not have corrosion rates exceeding those shown in Table 3.

Table 3. Maximum Allowable Corrosion Rates (mils-per-year) for Wildland Fire Chemical Products.¹

Temperature: °F	2024-T3 Aluminum				4130 Steel				Yellow Brass	Az31B Magnesium			
	Total		Partial		Total		Partial		Partial	Total		Partial	
	70	120	70	120	70	120	70	120	120	70	120	70	120
.....mils-per-year.....													
Concentrates													
Wet concentrates for fixed-tank helicopters	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Wet concentrates except fixed-tank helicopters	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0				
Mixed Products													
Fixed-tank helicopters ²	2.0	2.0	2.0	2.0	5.0	5.0	5.0	5.0	5.0	4.0	4.0	4.0	4.0
Fixed-wing air tankers ³	2.0	2.0	2.0	2.0	5.0	5.0	5.0	5.0	5.0				
Helicopter bucket and Ground-based application	2.0	2.0	2.0	2.0	5.0	5.0	5.0	5.0	5.0				

¹ All uniform corrosion rates shall be determined by 90-day weight loss tests. All uniform corrosion rates are the maximum allowable average of all replicates.

² Intergranular corrosion tests shall be performed on aluminum and magnesium coupons; no intergranular corrosion is allowed.

³ Intergranular corrosion tests shall be performed on aluminum coupons; no intergranular corrosion is allowed. Intergranular corrosion tests are not required on magnesium.

3.5.5.2. Intergranular Corrosion. When tested in accordance with 4.4.2, coupons of the alloys specified in 3.5.5.2.1 through 3.5.5.2.4 exposed to enhanced water mixtures shall show no evidence of intergranular corrosion as summarized in Table 3A.

Table 3A. Intergranular Corrosion

Application Method	Alloy	
	Aluminum 2024-T3	Magnesium Az-31-B
Helicopter Fixed-Tank	No detectable IGA	No detectable IGA
Multi-Engine, Fixed-Wing Airtanker	No detectable IGA	Not Applicable
Single-Engine, Fixed-Wing Airtanker	No detectable IGA	Not Applicable
Helicopter Bucket.	Not Applicable	Not Applicable
Ground Based Equipment	Not Applicable	Not Applicable

3.5.5.2.1. Helicopter Fixed Tank. When tested in accordance with 4.4.2., coupons made of 2024-T3 aluminum and Az-31B magnesium shall not exhibit intergranular corrosion following exposure to enhanced water mixtures during uniform corrosion tests.

3.5.5.2.2. Multi-Engine, Fixed-Wing Air Tanker. When tested in accordance with 4.4.2., coupons made of 2024-T3 aluminum shall not exhibit intergranular corrosion following exposure to enhanced water mixtures during uniform corrosion tests.

3.5.5.2.3. Single-engine, Fixed-Wing Air Tanker. When tested in accordance with 4.4.2., coupons made of 2024-T3 aluminum shall not exhibit intergranular corrosion following exposure to enhanced water mixtures during uniform corrosion tests.

3.5.5.2.4. Helicopter Bucket and Ground-Based Application Equipment. There are no intergranular corrosion requirements for helicopter bucket or ground-based application equipment.

3.5.5.3. Effect of Wet Concentrate and Enhanced Water Mixtures on Non-Metallic Materials. When tested in accordance with 4.4.3, the wet concentrates and all enhanced water mixtures shall be tested to determine their effect on the non-metallic materials listed in Table 4 and their ability to meet the requirements of 3.5.5.3.1.

Table 4. Materials To Be Tested To Determine The Effect of Exposure To Wet Concentrate and Enhanced Water Mixtures on Non-Metallic Materials.

<u>Material</u>	<u>Material Specification</u>
- - Shall Be Tested And Performance Provided To User Agencies. - -	
Chloroprene rubber	AMS 3208M
PVC Plastic, Flexible	MIL A-A-55859A
Fiberglass/Epoxy Resin	AMS C-9084
High-Density Polyethylene	ASTM D 4976
Low-Density Polyethylene	ASTM D 4976
Flexible Cross-Linked Polyolefin	AMS DTL-23053/5

3.5.5.3.1

Effect of Exposure to Wet Concentrate and Enhanced Water Mixtures on the Characteristics of Non-Metallic Materials. When tested as required in 4.4.3, the changes in hardness and volume of each of the materials listed in Table 4 shall meet the requirements for acceptable change as shown below.

All results will be reported to user agencies as performance information.

<u>Characteristics</u>	<u>Allowable Change</u>
Hardness	≤ 10-percent decrease
Hardness	≤ 20-percent increase
Volume	≤ 0.5 mL from initial

3.5.6. Product Stability. When tested in accordance with 4.5, concentrates and enhanced water mixtures shall meet all applicable requirements of 3.5.6.1.

3.5.6.1. Outdoor Storage. When tested in accordance with 4.5.1, the concentrates and mixed products shall meet all applicable requirements of 3.5.6.1.1 through 3.5.6.1.3.

3.5.6.1.1. Outdoor Stability of Freshly Prepared Enhanced Water Mixture. In accordance with 4.5.1.1.3.1., the enhanced water mixtures shall be stored outdoors for 14 days.

At the end of the storage period, the stored mixture shall be examined visually and shall have no separation resulting in particles larger than 0.25-inch (0.635-cm) sieve size. Lumps in the concentrate are not disqualifying if they are soft enough or small enough to pass through the sieve.

The stored enhanced water mixture shall be tested as required in 3.5.6.1.1.1.

3.5.6.1.1.1. Physical Properties of Stored Enhanced Water Mixtures. The stored enhanced water mixtures shall be tested to determine the following properties:

- a. Density, in accordance with 4.3.1.
- b. pH, in accordance with 4.3.2., and
- c. Viscosity, in accordance with 4.3.3.1.

These values shall be within the allowable variation, as shown in Table 6, from the original values, determined in 3.5.4.2, for enhanced water mixtures prepared from fresh concentrate.

3.5.6.1.2. Outdoor Stability of Fresh Concentrates. All concentrates shall meet the requirements of either 3.5.6.1.2.1 or 3.5.6.1.2.2.

3.5.6.1.2.1. Dry Concentrates. In accordance with 4.5.1.1.1, dry concentrates shall be stored outdoors for 52 weeks.

The stored concentrate shall have no visual separation such as discoloration or caking.

Lumps in the dry concentrate are not disqualifying if they are soft enough or small enough to pass through a 0.25-inch (0.625-cm) sieve.

The stored concentrate shall be used to prepare enhanced water mixture as required in 3.5.6.1.3.

3.5.6.1.2.2. Wet Concentrates. In accordance with 4.5.1.1.2, wet concentrates shall be stored outdoors for 52 weeks.

There shall be no separation resulting in particles larger than 0.25 inch (0.625 cm) sieve. Lumps in the concentrate are not disqualifying if they are soft enough or small enough to pass through the sieve. The stored concentrate shall be tested to determine the viscosity, density, and pH in accordance with 4.5.1 through 4.5.3.

3.5.6.1.3. Enhanced Water Mixtures from Stored Concentrate. As required by 3.5.6.1., the mixed products shall be prepared from the stored concentrate and fresh water and tested to determine enhanced water mixture stability and corrosion as required by 3.5.6.1.3.1. through 3.5.6.1.3.5.

3.5.6.1.3.1. The Variation of the Physical Properties of enhanced water mixtures from stored concentrate shall not vary from those determined for fresh mixtures to a greater amount than shown in Table 5.

Table 5. Allowable Variation of Physical Properties of Enhanced Water Mixtures Prepared from Fresh Concentrates and Concentrates Stored for 52 weeks.

<u>Property</u>	<u>Allowable Variation</u>
Density	± 1 percent from initial value
pH	Shall be between 4.0 and 10.0
Viscosity	Viscosity greater than 200 centipoise as required by section 3.5.4.2.3.

3.5.6.1.3.2. Stability of Enhanced Water Mixtures from Stored Concentrate. The mixed product as required by 3.5.6.1.3. shall be stored outdoors for 14 days, in accordance with 4.5.1.1.3.1 freshly prepared enhanced water mixtures.

The stored enhanced water mixtures shall be tested as required in 3.5.6.1.1.1.

3.5.6.1.3.3. Uniform Corrosion of Enhanced Water Mixtures Prepared from Stored Concentrate. The mixed product prepared as required by 3.5.6.1.3 shall be tested to determine the uniform and intergranular corrosion. The results shall meet the uniform corrosion requirement of 3.5.5.1.3.

3.5.6.1.3.4. Intergranular Corrosion by Enhanced Water Mixtures Prepared from Stored Concentrate. The enhanced water mixture prepared as required by 3.5.6.1.3. and tested for uniform corrosion as required in 3.5.6.1.3.3. (with acceptable results) shall be tested to determine for intergranular corrosion as specified in 3.5.5.2.

3.5.6.2. Resistance of Wet Concentrates and Mixed Water Enhancers to Microbial Growth. After 14 days in storage in accordance with 4.5.1., wet concentrates and mixed retardant shall show no visible sign of microbial contamination, including growths on the surface or within the fluid, significant discoloration, or other change in appearance.

3.5.7. Color Properties. Enhanced water mixtures shall be evaluated as required in 3.5.7.1 through 3.5.7.3 to determine their color characteristics.

3.5.7.1. Acceptable Colors. Color of the enhanced water mixtures shall be easily identifiable as different from that of long-term retardant.

Water enhancers shall be uncolored or a shade of blue in the color spectrum between 450 and 495 nm. in accordance with 4.6.1.1.

3.5.7.2. Laboratory Evaluation of Fugitive-Colored Enhanced Water Mixtures. As required by 3.5.7.3, all fugitive-colored enhanced water mixtures shall be tested to determine the extent of fading of films applied in accordance with 4.6.1.2. through 4.6.1.4.

All colors used for water enhancers shall be fugitive.

3.5.7.3. Fading of Fugitive-Colored Enhanced Water Mixtures. In accordance with 4.6.1.4., at the end of the exposure period, the enhanced water mixture with fugitive colorant shall be no more colored than a sample of the uncolored product in water, applied and treated in the same manner as the enhanced water mixture in accordance with 4.6.1.3.

- 3.6. Operational Field Evaluation. In accordance with 4.7., after meeting the requirements of 3.1 through 3.5, an analysis shall be performed to determine the need for an operational field evaluation of the water enhancer.

The analysis shall document the rationale for no field test or provide a summary of the issues and performance to be addressed during the field evaluation.

A copy of the analysis shall be provided to the submitter.

Product for the operational field evaluation shall be purchased by the Government or other cooperating agency according to the classification established during qualification testing. All other costs associated with the operational field evaluation shall be the responsibility of the submitter.

The product shall perform satisfactorily under operational conditions during a fire season. An acceptable test should include firefighting operations on a variety of fuel types, slopes, aspects, and exposures.

Operations should include both routine and accelerated burning conditions and multiple ignitions over several months.

4. **TEST PROCEDURES**. Detailed test methods are described in Standard Test Procedures for the Evaluation of Wildland Fire Chemical Products (STP).

- 4.1. Health and Safety.

- 4.1.1. Mammalian Toxicity and Irritation Tests (STP-1.3). As required by 3.5.2.1, mammalian toxicity and irritation testing on wet and dry concentrates and the enhanced water mixture having the highest amount of concentrate, shall be conducted by an independent biological testing laboratory approved by the Government.

All testing shall be conducted in compliance with 40 CFR 160 and 792 Good Laboratory Practice Standards, in accordance with EPA/OCSP Health Effects Test Guidelines, series 870 and shall include:

- a. OCSP 870.1100, Acute Oral Toxicity;
- b. OCSP 870.1200, Acute Dermal Toxicity;
- c. OCSP 870.2400; Primary Eye Irritation;
- d. OCSP 870.2500; Primary Dermal Irritation.

- 4.1.1.1. Report of Test Results. The results of the mammalian toxicity and irritation testing shall be certified by the testing laboratory and submitted directly to the Government as required by 3.5.2.1.3.

- 4.1.1.2. Review of Mammalian Toxicity and Irritation Test Results. When required in accordance with 3.5.2.1.4., the Government shall review the results of the testing and the submitter's recommended protective gear and safe handling procedures to ensure adequate protection for firefighters, workers and the general public who may come into contact with the product.

- 4.1.2. Fish Toxicity (STP-1.5). As required by 3.5.2.2, the toxicity of the concentrate to rainbow trout (*Oncorhynchus mykiss*) shall be determined in accordance with OCSP 850.1075, Ecological Effects Test Guidelines, Fish Acute Toxicity Test, Freshwater and Marine.

Static test conditions in ASTM soft water (described in ASTM E729) at 54 ± 2 °F (12 ± 1 °C) shall be maintained throughout the 96-hour test period.

All fish shall be 60 ± 15 days post hatch.

- 4.1.3.** Biodegradability (STP-1.4). As required by 3.5.2.3, the biodegradability of the wet and dry concentrates shall be determined in accordance with OCSP 835, Section M, Fate, Transport and Transformation Test Guidelines, CO₂ evolution (modified Sturm Test). If biodegradation has not reached 60 percent at 28 days, biodegradation shall be allowed to continue for up to 42 days.
- A commercial inoculum may be used rather than activated sewage sludge.
- 4.1.4.** Open Cup Flash and Fire Point (STP-1.7). As required in 3.5.2.4, the open cup flash point and the fire point of the wet concentrates shall be determined in accordance with ASTM D 92, Standard Test Method for Flash Point and Fire Point by Cleveland Open Cup.
- 4.2.** Exposure Protection Effectiveness Test (STP-2.2). As required by 3.5.3, the concentrate shall be evaluated for exposure protection effectiveness using the vertical LIFT apparatus and general method in ASTM E 1321 Standard Test Method for Determining Material Ignition and Flame Spread Properties as summarized below.
- Enhanced water mixtures (covering the requested evaluation range) shall be prepared from the water enhancer concentrate and applied to a substrate of T1-11 siding or other suitable substrate.
- Treated and untreated substrate, in a vertical orientation, shall be exposed to a radiant panel and the time to ignition determined.
- The time for the treated substrate to ignite shall be compared to the time for untreated substrate to ignite.
- 4.3.** Physical Properties. As required by 3.5.4.1 and 3.5.4.2, the wet concentrate and enhanced water mixtures shall be tested to determine the physical properties.
- 4.3.1.** Density Test (STP-4.3). As required by 3.5.4.1.1 and 3.5.4.2.1, the density of the wet concentrate and enhanced water mixtures shall be determined to the nearest 0.001 g/mL by using fluid displacement or an electronic density meter.
- 4.3.2.** pH Value Test (STP-4.4). As required by 3.5.4.1.2 and 3.5.4.2.2, the pH of the wet concentrate and enhanced water mixture shall be determined with a full range pH meter readable to 0.1 pH unit.
- 4.3.3.** Viscosity (STP-4.5). As required by 3.5.4.1.3, the wet concentrate shall be tested to determine the viscosity at 70 °F.
- A Brookfield Viscometer model LVF, or equivalent, set at 60 rpm shall be used to measure the viscosity.
- 4.3.3.1.** Steady State Viscosity. As required by 3.5.4.2.3, the viscosity of each enhanced water mixture shall be determined in accordance with 4.3.3 at 10 minutes, 1 hour, 24 hours, and daily for 8 days after mixing.
- Viscosity values shall be graphed against time. The viscosity value corresponding to the plateau of the viscosity curve shall be determined as the steady state viscosity.

4.3.4. Concentrate Fluidity Test (STP-4.7). As required by 3.5.4.1.4, the ability of the wet concentrate to flow shall be determined following the general method found in ASTM D-97. A small beaker of the concentrate shall be cooled to the test temperature, as shown below, without being disturbed. Sufficient time shall be allowed for the entire contents of the beaker to reach the test temperature. The process shall be repeated with fresh concentrate cooled to successively lower temperatures until the concentrate does not flow.

40 °F ± 2 °F 35 °F ± 2 °F 5 °F ± 2 °F

4.4. Material Effects. As required by 3.5.5, the effects of wet concentrates and enhanced water mixtures on metallic materials shall be determined in accordance with STP-5.1 and STP 5.2.

4.4.1. Uniform Corrosion (STP-5.1). As required by 3.5.5.1., the wet concentrate and enhanced water mixtures, prepared with fresh water, of all concentrates shall be tested for uniform corrosion as summarized below.

Test coupons of 2024-T3 aluminum, 4130 steel, UNS C27000 yellow brass, and Az31B magnesium shall be engraved with a unique identification number, measured, cleaned, dried, and weighed.

Each coupon shall be immersed in the test solution and allowed to remain undisturbed at the required conditions for 90 days.

At the end of the test duration, each coupon shall be cleaned, dried, and weighed, and the corrosion rate calculated.

All corrosion rates for the same product, alloy, immersion condition and temperature shall be averaged.

4.4.2. Intergranular Corrosion (STP-5.2). As required by 3.5.5.2., enhanced water mixtures shall be tested for intergranular corrosion as summarized below.

At least one coupon for each exposure and temperature from the uniform corrosion tests on the specified alloys shall be sliced as shown in Figure 1.

The coupon shall be mounted, polished to 0.3 micron alumina finish, and etched using Keller's reagent for aluminum coupons and Nital reagent for magnesium coupons.

The etched coupons shall be examined microscopically with a magnification of 500X.

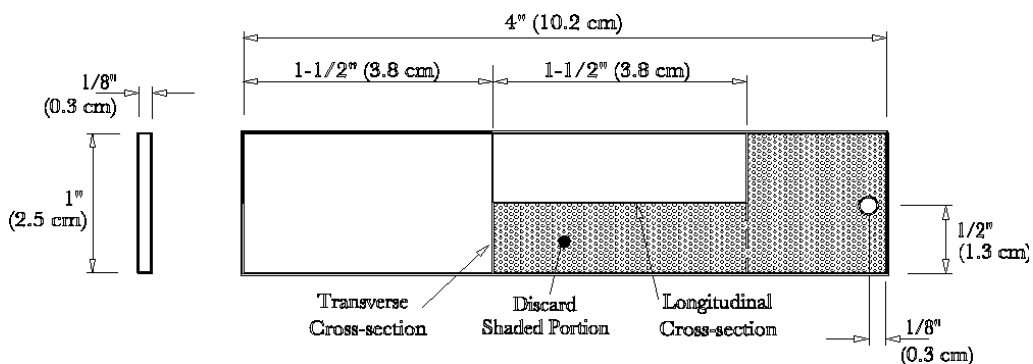


Figure 1. Diagram for cutting and examining coupons for intergranular corrosion.

- 4.4.3.** Effect of Wet Concentrates and Enhanced Water Mixtures on Non-Metallic Materials (STP-5.3). In accordance with 3.5.5.3., the wet concentrate and enhanced water mixtures shall be tested to determine their effect on non-metallic materials as summarized below.
- Prior to exposure of the non-metallic materials, the hardness and volume of each non-metallic sample shall be determined. A hand-held durometer, with the prescribed scale, shall be used to measure the hardness and either fluid displacement or dimensional analysis shall be used to determine the volume.
- The test pieces of each non-metallic material shall be exposed for 20 cycles. Each cycle shall consist of the material being immersed in the fluid at night and on weekends and in the air during the work day.
- At the end of the test period, each test piece shall be rinsed, wiped with a disposable tissue, allowed to air dry, and the hardness and volume of each piece determined on the same day as the exposure ends.
- The change in hardness and volume from the initial value of each shall be calculated. If the result of either exceeds the allowable maximum, the measurements shall be repeated the next day and the calculation of change calculated. No additional measurements shall be allowed.
- 4.5.** Product Stability Test (STP-6). As required by 3.5.6, all concentrates and enhanced water mixtures shall be tested for product stability in accordance with 4.5.1.1.1. through 4.5.1.1.3.
- 4.5.1.** Outdoor Storage Test (STP-6.1). As required by 3.5.6.1, all concentrates and enhanced water mixtures shall be tested to determine storage characteristics in outdoor weather conditions.
- 4.5.1.1.** Concentrates. Each water enhancer concentrate shall be evaluated to determine outdoor stability in accordance with 4.5.1.1.1 or 4.5.1.1.2.
- 4.5.1.1.1.** Dry Concentrates. As required by 3.5.6.1.2.1., each dry concentrate shall be evaluated for outdoor stability.
- To document the initial condition of the product, the fresh concentrate shall be examined visually to determine the general condition of the concentrate, including the fluidity, presence or absence of lumps, the ease of crumbling the lumps, or visually separate layers. The fresh concentrate shall then be stored, shielded from light, in large sample containers outdoors at NDTP-Missoula and NTDP-San Dimas for 52 weeks.
- At the end of the 52 week storage period, the samples shall be examined visually to determine that there are no changes in the general condition, such as fluidity and/or presence of hard lumps, from the original sample.
- As required by 3.5.6.1.3.3., the stored concentrate shall be used to prepare enhanced water mixture in accordance with 4.5.1.1.3.

- 4.5.1.1.2.** Wet Concentrates. As required by 3.5.6.1.2.2., each wet concentrate shall be evaluated for outdoor stability.
The initial condition of the fresh concentrate shall be documented including the presence or absence of crystals or other solids greater than 0.25 inch (0.635 cm).
The fresh concentrate shall then be stored, shielded from light, in a large sample container, outdoors at NTDP-Missoula and NTDP-San Dimas for 52 weeks.
At the end of the 52 week storage period, the sample shall be inspected to determine that there are no changes in the general condition of the concentrate and then evaluated to 3.5.6.1.3.1.
As required by 3.5.6.1.3.3., the stored concentrate shall be circulated and used to prepare enhanced water mixtures in accordance with 4.5.1.1.3.
- 4.5.1.1.3.** Enhanced Water Mixtures from Stored Concentrate. As required by 3.5.6.1.3.3, the mixed product shall be prepared using the method determined in 3.5.1.
As required by 3.5.6.1.3.1. and 3.5.6.1.3.2., the mixed product shall be prepared from stored concentrate and ASTM fresh water and tested to determine the physical properties listed.
Physical properties: density pH, viscosity
As required by 3.5.6.1.3.2 through 3.5.6.1.3.4., the mixed product shall be prepared from stored concentrate and fresh water and tested to determine the outdoor stability and corrosiveness of the enhanced water mixture from stored concentrate.
- 4.5.1.1.3.1.** Outdoor Stability of Enhanced Water Mixtures. As required by 3.5.6.1.1, the freshly prepared enhanced water mixtures from stored concentrate shall be stored, shielded from light, in large sample containers, each containing a large aluminum stability coupon outdoors at NTDP-Missoula and NTDP-San Dimas.
At the end of the storage period, the carboy shall be opened and the stored product mixed for 1 minute at low shear (1800 rpm with 2-bladed propeller-type stirrer).
As required by 3.5.6.1.1.1., the mixed sample shall be tested to determine the physical properties listed.
Physical properties: density, pH, viscosity.
- 4.6.** Color Properties. As required by 3.5.7., the uncolored and fugitive colored enhanced water mixtures shall be tested to determine the color characteristics of the mixed products.
- 4.6.1.** Laboratory Spectral Color Evaluation and Fading of Fugitive-Colored Enhanced Water Mixtures. As required by 3.5.7.1 and 3.5.7.2., the enhanced water mixture shall be tested to determine the spectral color value and fading characteristics of the fugitive-colored mixture in accordance with 4.6.1.1. and 4.6.1.3.
- 4.6.1.1.** Spectral Color Analysis (STP 10.1). As required by 3.5.7.1., the colored enhanced water mixture shall be tested to determine the acceptability to the designated wavelength range.
The testing instrument shall be a HunterLab Spectrophotometer (or equivalent) capable of determining L, a, b, color values or other acceptable color-space values.
- 4.6.1.2.** Preparation of the Test Panels. The fugitive-colored product and the product without color, as a control, shall be used to prepare the test panels.
Four test panels of plate glass shall be treated by applying a 0.064 inch (4 GPC) thick layer of the test product with a Gardner knife or equivalent.
Four control panels shall be treated in the same manner with the uncolored product.

- 4.6.1.3.** Light Exposure of the Enhanced Water Mixture. As required by 3.5.7.3., the test and control panels shall be exposed outdoors to natural light at a test facility acceptable to the Government.
All exposures shall be performed in accordance with ASTM G-24 (Standard Recommended Practice for conducting Natural Light Exposures) until 50,000 Langley's are accumulated.
Visual observations and photographic records shall be made after each 10,000 Langley's of exposure.
At the end of the exposure period, the test panels shall be returned to the laboratory for final assessment in accordance with 4.6.1.4.
- 4.6.1.4.** Assessment of Fading. As required by 3.5.7.3., the acceptability of fading of the test panels shall be assessed.
The outer edges of the film shall not be considered during the assessment. This area, the outer edge of the film, approximately 1 in (2.5 cm), shall be removed or masked.
Each panel shall be examined and the appearance of the film shall be compared with the appearance of the control panels.
The appearance of the panels with the test material shall be neutral in color and not significantly different from the appearance of the control material.
- 4.7.** Operational Field Evaluation (STP-12). As required by 3.6, the Government may undertake an analysis to address any concerns arising from the nature of the formulations and/or results of the laboratory evaluation.
The laboratory testing shall be completed prior to conducting an operational field evaluation. When an operational field evaluation is needed, a test plan will be developed. The evaluation will be conducted in accordance with the developed test plan. Detailed test methods are described in Standard Test Procedures for the Evaluation of Wildland Fire Chemical Products.
- 5.** **PREPARATION FOR DELIVERY.**
- 5.1** Submission of Samples for Laboratory Evaluation. When requested, and at no cost to the Government, the submitter shall provide the required amount of concentrate for use in the laboratory evaluation tests.
- 5.2** Packaging and Labeling. Upon completion of documentation submission as required by 3.3.1. through 3.3.8., the product shall be supplied to the laboratory for testing. Labeling shall be legible, clear and permanent.
- 5.2.1** Packaging. The packaging of all wildland fire chemicals submitted for evaluation shall conform to regulations governing the ground and air transport of materials.

The concentrates, in the quantities shown, shall be packaged as specified in Table 6.

Table 6. Test sample quantity and packaging.		
<u>Product Type</u>	<u>Packaging</u>	<u>Quantity</u>
Dry concentrate	5-gallon (18.9 liter) Plastic Pails with <u>Removable</u> Lids	20 pails – Filled, but no more than 50 lbs (22.7 kg) per pail
Wet concentrate	5-gallon (18.9 liter) Plastic Pails with <u>Removable</u> Lids	100 gallons (378 liters). ≤50 lbs (22.7 kg) per pail
Color (as part of a 2-component system)	1-gallon (3.78 liter) Plastic Pails with <u>Removable</u> Lids	3 pails – Filled or each containing 10-15 lbs (4.5-6.8 kg) per pail
Note: Based on specific product information, the Government may specify a different amount of product than shown here.		

5.2.2. Labeling should include the submitting company name, a product name, a manufacturer formulation number (or other unique designation). Other information that will be helpful in identifying the product should be included.

Individual containers of products submitted for evaluation shall be legibly marked in accordance with Federal Standard 123.

Labeling shall comply with Department of Transportation, Occupational Safety and Health Administration, and applicable State and Local requirements and in addition shall include the following:

- a. Manufacturers or submitter's name or trademark.
- b. Product identification including formulation identification codes and production information codes.
- c. Volume of concentrate (weight in the case of a dry concentrate) per container.
- d. Month and year of submission.

Safety Data Sheets (SDS).

- 5.3. Product SDS. An SDS for the product from the submitter of the product, typically the manufacturer, shall accompany the application for qualification and each shipment of product.

The same identification used for marking the Formulation Disclosure sheets and containers should be part of all product SDSs.

- 5.3.2 Ingredient SDS. The SDS from the manufacturer or the supplier of the chemical ingredient, as indicated on the Formulation Disclosure sheet shall be included for every ingredient, as a part of the submission paperwork.

- 5.3.3. Updated/Modified SDS. It is the responsibility of the submitter to send updated SDS's when available.

- 5.4 Additional Quantities. When additional supplies are required, each container shall be marked with the original formulation identification and a secondary name or formulation identification number clearly identifying this as a remake of the original formulation.

This remake shall contain all of the original ingredients from the original sources and no other ingredients.

- 5.4.1 Labeling Additional Quantities. All containers of the remake shall be clearly labeled and identified as a new or additional production using the original formula or recipe.

Example: Product XYZ, original product name and product ID; unique remake code/identifier 123 for the remake – this can be the production code or other identification.

- 5.5 Shipping Submission Sample to Wildland Fire Chemical Systems (WFCS). The laboratory test sample shall be shipped at the submitter's expense to WFCS at the National Technology and Development Program (NTDP) in Missoula, Montana.

The complete address shall be provided as part of the shipping instructions when the product is requested.

An SDS for the product shall accompany the shipment.

If the product is imported, the submitter / supplier shall be responsible for the entire process necessary to deliver the product to the test laboratory.

- 5.5.1. Excess Submission Sample. After the evaluation has been completed, any remaining unused and excess product shall be returned to the submitter at the submitter's expense.

6. GENERAL INFORMATION.

- 6.1. Intended Use. The products covered by this specification are intended for use in wildland firefighting.

The prescribed tests were selected to assess the effectiveness of the products to meet this goal.

The toxicity and environmental tests were selected to minimize hazards to firefighters, members of the general public, and the environment.

- 6.2. Qualification. Products that have been submitted for evaluation as described in this specification and submission procedures and have successfully met the requirements stated herein shall be added to the Forest Service Qualified Products List (QPL).

Specific use designations, based on the requirements for each use or application, shall be included.

- 6.3. Collection Agreement and Test Fees. A Collection Agreement between the

submitter and Wildland Fire Chemical Systems (WFCS), National Technology Development Program (NTDP); USDA Forest Service shall be prepared.

This document describes the roles and responsibilities of the Forest Service, WFCS laboratory personnel, and the submitter.

Specific information in the agreement includes a list of authorized contacts for the Forest Service and for the submitter, as well as an estimate of the cost required for the evaluation.

6.4 Submission of Manufacturer Documentation and Information. All product information described shall be provided to the Government and reviewed by the designated agency representative, as summarized in 3.3 and described in “Manufacturer Submission Procedures for Qualification Testing of Water Enhancer Products,” prior to acceptance of samples for testing.

6.4.1 Paper copies available. Paper copies of the required forms and documents can be obtained from the Program Leader or Project Leader, Wildland Fire Chemical Systems (WFCS), 5785 Highway 10 West, Missoula, MT, 5980, if web access is not available.

6.5 Mixing and Loading Equipment. Suppliers are responsible for providing information relative to the equipment needs associated with the mixing and loading of their product at portable or permanent sites. They are responsible for demonstrating acceptable performance of their systems with their product.

6.6 Definitions. The definitions below may be specific to fire chemical products although most of the terms are in general use. A few of the definitions may not appear in this specification but may be found in related documents such as the “Manufacturers’ Submission Procedures.” They are provided here as a convenience to the reader.

ASTM Soft & Hard Water. Defined in ASTM E729 1996, Standard Guide for Conducting Acute Toxicity Tests on Test Materials with Fishes, Macroinvertebrates and Amphibians.

ASTM E729 1996(2007) Table 1 - Add to high quality water conductivity less than 1 micro-ohm/cm and either total organic carbon (TOC) less than 2 mg/L or chemical oxygen demand (COD) less than 5 mg/L.

Acceptable water can usually be prepared using properly operated deionization, distillation, or reverse osmosis units.

See text of standard for additional information and details.

<u>Salts, mg/L</u>	<u>Very Soft</u>	<u>Soft</u>	<u>Hard</u>	<u>Very Hard</u>
NaHCO ₃	12.0	48.0	192.0	384.0
CaSO ₄ ·2H ₂ O	7.5	30.0	120.0	240.0
MgSO ₄	7.5	30.0	120.0	240.0
KCl	0.5	2.0	8.0	16.0

Biodegradability. A measure of the decomposition of organic matter through the action of microorganisms.

The following three terms are used to describe the extent to which a product is biodegradable.

- Readily Biodegradable. A product which is ≥ 60 -percent biodegraded within 28 days is considered to be readily biodegradable.
- Biodegradable. A product which is not ≥ 60 -percent biodegraded within 28 days but which is ≥ 60 -percent biodegraded by 42 days is considered to be biodegradable.
- Not Biodegradable. A product which is not ≥ 60 -percent biodegraded by 42 days is considered to be not biodegradable.

Class A Fuels. Materials such as vegetation, wood, cloth, paper, rubber, and some plastics in which combustion can occur at or below the surface of the material.

Component. Each combination of ingredients, packaged together by the manufacturer for use in preparation of the mixed product by the user.

Uncolored enhanced water mixtures shall be one-component, prepared by blending a single component, containing all ingredients, with water.

Colored enhanced water mixtures shall be prepared by:

- mixing a single component, including color, with water or
- adding a qualified colorant to water and then adding the uncolored single component to the colored water to prepare the colored enhanced water mixture.

Coupon, Corrosion. A metal test specimen, approximately 1 in x 4 in x 1/8 in (2.5cm x 10.2 cm x 0.3 cm), made of 2024-T3 aluminum, AISI 4130 steel, C27000 yellow brass, or Az31B magnesium for use in uniform corrosion testing.

Coupon, Large Stability. A metal sample, approximately 2 in x 12 in x 1/8 in (5 cm x 30 cm x 0.3 cm), made of mild steel or 2024-T3 aluminum for use in outdoor stability testing.

Density. The mass in grams of 1 milliliter (mL) of product.

Dry Concentrate. A dry, single component which is mixed with water to prepare the mixed product.

Enhanced Water Mixture. A wet or dry water enhancer concentrate, mixed with water at a qualified mix ratio.

The product is not effective once the water it originally contained has evaporated.

Exposure Cycle. Each exposure cycle shall consist of 1 day (8 to 10 hours) and the following night or weekend.

Fire Point. The lowest temperature at which a liquid will ignite and achieve sustained burning when exposed to a test flame.

Fire Retardant. Any substance that by chemical or physical action reduces flammability of fuels or slows their rate of combustion, even after the contained water has evaporated.

Fire Suppressant. Any agent used to extinguish the flaming and glowing phase of combustion by direct application to the burning fuel.

Flash Point. The minimum temperature of a liquid at which it gives off sufficient vapor to form an ignitable mixture with the air above the surface of the liquid under specified environmental conditions.

Forest Service. The term Forest Service as used throughout this document refers to the U.S. Department of Agriculture, Forest Service.

Fresh Water. Water obtained directly from the tap in the WFCS laboratory. This water typically has a hard quality, approximately 130-150 ppm of CaCO₃.

Fugitive Color. A coloring agent which imparts a high degree of visibility to the mixed product when first applied to wildland fuels but will gradually photo degrade over several months.

GPC. A measure of the amount of mixed product applied to wildland fuels to prevent or slow the spread of fire. Gallons of mixed product per 100 square feet.

Hydration. The action of combining a concentrate with water to produce a thickened product.

Ingredient. Each single chemical used by the manufacturer in the formulation of the product. The supplier and quantity of each ingredient shall be specified in the submission paperwork.

Intergranular Corrosion. A corrosive attack on metal at the grain boundary.

LC₅₀. The concentration of product in water that results in the death of 50 percent of the aquatic test specimens within a specified time frame. In this document, LC₅₀ is expressed as milligrams of product per liter of solution.

LD₅₀. The dosage of a product at which 50 percent of the test animals die within a specified time frame. In this document, LD₅₀ expressed as milligrams of the product per kilogram of body weight of the test animal.

Manufacturer. The company or other entity who makes a product.

Miscibility. The ability of concentrate to mix with water under specified conditions.

Mixed Product. The combination of a wet or dry concentrate and water at the qualified mix ratio for use in fire management activities.

Mix Ratio. The proportion of concentrate and water in the mixed product.

The mix ratio can be expressed in several ways:

- Pounds of dry concentrate added to a gallon of water
- Gallons of wet concentrate to be added to a gallon of water
- Volume percentage of concentrate and water – typical for foams and wet concentrate water enhancers

pH. A measure of the acidity or alkalinity of a solution, represented on a numeric scale with 7 representing neutral solutions. Higher numbers represent alkaline solutions and lower numbers represent acidic solutions.

Sample Container, large. A 5.5-gallon (20 liter), low-density polyethylene carboy without spigot. Carboy shall be closed with a size 13.5 rubber stopper secured by a polypropylene screw cap.

Steady State Viscosity. The viscosity after hydration is complete and viscosity is stable.

Temperature. Each temperature included in the specification consists of a Fahrenheit temperature and allowable variation from that temperature and the Celsius equivalents for the temperature and range.

Commonly used temperatures and variations are shown in the first section below and included in the specification requirements and test descriptions by listing a simple Fahrenheit temperature.

Fahrenheit	Celsius
5 °F ± 2 °F	-15 °C ± 1 °C
15 °F ± 5 °F	-9.4 °C ± 2.8 °C
35 °F ± 2 °F	1.7 °C ± 1.1 °C
40 °F ± 5 °F	4.4 °C ± 2.8 °C
70 °F ± 5 °F	21.1 °C ± 2.8 °C
100 °F ± 5 °F	37.8 °C ± 2.8 °C
120 °F ± 5 °F	48.9 °C ± 2.8 °C

Uniform Corrosion. Removal of metal by chemical means over the entire surface.

Viscosity. A measure of the resistance of a liquid to flow, expressed in centipoise (cP).

Water, Deionized. Water treated by distillation, ion exchange, reverse osmosis, or a combination of these methods to remove most salts in conformance to ASTM D-1193 Type IV reagent water.

Water Enhancer Concentrate. A concentrate that is added to water to enhance one or more of the physical characteristics of water such as changing the viscosity or elasticity of the water or improving the ability to cling to smooth or vertical surfaces.

Wet Concentrate. A liquid, single component which is added to water to prepare the mixed product.