ELECTRIC POWER RESEARCH INSTITUTE

Reference Document: Information Regarding Procurement Specifications for Nuclear Power Plant Bulk Chemicals

For Information Only

1022558

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Technical Update, February 2011

EPRI Project Manager
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Electric Power Research Institute (EPRI)

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ACKNOWLEDGMENTS

The following organization prepared this report:

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This report describes research sponsored by EPRI.

EPRI wishes to thank Larry Miller of Dominion Energy for his leadership in the development of this reference document.

Additional thanks go to the members of the utility committee that provided their utility specifications and participated in the review of the document.

Ron Sieber, AEP

Allison Bassett, APS

Bill Pierson, APS

Joe Santi, APS

Mark Mantell, British Energy

Eduardo Marcelo, CNAT

Fred Mis, Constellation

Mark Alley, Duke Energy

Dewey Rochester, Duke Energy

Gary Coker, Entergy

Keith Fruzzetti, EPRI

Rick Reid, EPRI

Nestor van Eeden, ESKOM

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Frank Puzzoli, OPG

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W.J. Waites, Southern Company

Stephen Citzler, STP

Debby Bodine, TVA

Joan Neubauer, Xcel Energy

Charles Nash, Xcel Energy

This publication is a corporate document that should be cited in the literature in the following manner:

Reference Document: Information Regarding Procurement Specifications for Nuclear Power Plant Bulk Chemicals: For Information Only. EPRI, Palo Alto, CA: 2011. 1022558.

PRODUCT DESCRIPTION

This technical update provides information on the procurement specifications of bulk chemicals and resins commonly used in nuclear power plants. Nuclear power plant chemical specifications are often more stringent than those for other industrial applications and may also include special requirements unique to nuclear power plant use. The intent of this technical update is to document, for reference purposes only, the specifications of bulk chemicals used by nuclear power plants.

Background

The idea for this document came about after hurricane Katrina devastated a number of bulk chemical supply facilities located in the south-eastern/central United States, disrupting the supply of frequently used bulk chemicals. A scramble to borrow chemicals from other utilities and find alternate suppliers on short notice resulted in receiving chemicals that, while suitable for the intended use, did not meet procurement specifications without alteration. The information included in this document could facilitate the exchange of chemicals between utilities and provide examples of purchase requirements from multiple users. It is hoped that "nuclear utility grade" chemicals will improve industry availability of the chemical products contained within this reference document.

Objectives

To provide chemistry staff and chemical procurement personnel at nuclear power plants with information useful for the procurement of nuclear grade chemicals and resins.

Approach

The goal of this project was to document information related to the procurement specifications of chemicals and resins commonly used in the nuclear industry. Utility participants contributed their utility bulk chemical specifications. The project team used the information collected to create example specifications for 51 chemicals and resins. An international committee of chemistry experts reviewed the technical update to ensure applicability to the international nuclear power community.

Results and Findings

This technical report contains example specification information for 51 chemicals and resins commonly used in the nuclear industry. These example specifications were developed based on the specifications provided by several utility participants. They include the material to be furnished, the intended uses, limits on impurities, physical properties and other relevant information such as possible packaging, storage, and testing options.

EPRI Perspective

The Electric Power Research Institute (EPRI) is the unique mechanism for collaborative nuclear industry research and development. This technical update is the result of a collaborative effort of a committee of utility chemistry experts and EPRI to provide the nuclear power industry with useful technical information related to nuclear power plant water chemistry controls. Such collaboration will promote improved nuclear power plant operations.

Keywords
Water chemistry
Bulk chemicals
Resins
Specifications

CONTENTS

1 FORWARD

The idea for this document came about after hurricane Katrina devastated a number of bulk chemical supplier facilities located in the south-eastern/central United States, disrupting the supply of frequently used bulk chemicals. A scramble to borrow chemicals from other utilities and find alternate suppliers on short notice, resulted in receiving chemicals that, while suitable for the intended use, did not meet the procurement specifications without alteration.

This document is intended only as a reference document providing examples of many of the purchase specifications for bulk chemicals, including gases and resins, commonly used at nuclear power stations. The specifications contained within are not binding in any way upon any station/utility. Since the majority of nuclear utilities use the same chemicals for the same/similar purpose, and many utilities control system chemistry to common specifications, it seemed logical to develop this reference document on information regarding procurement for nuclear power plant bulk chemicals based on input from multiple utilities.

The intent of this technical update is to document, for reference purposes only, the specifications of bulk chemicals used by nuclear power plants. This information could facilitate the exchange of chemicals between utilities and provide examples of purchase requirements from multiple users. It is hoped that “nuclear utility grade” chemicals will improve industry availability of the chemical products contained within this reference document.

Due to the large assortment of bulk chemicals in use, it is realized that this document is incomplete. Additional chemicals could be added and/or specifications revised in future revisions to make this document more complete. Proprietary chemical formulations and chemical products that require a license to distribute (many biocides) are not included.

CAUTION: Use of any bulk chemical can be hazardous. While use precautions/warnings are not included in this specification, it is expected that the buyer and/or user will be familiar with the information contained in the Material Safety Data Sheets prior to purchase/use, and that appropriate precautions will be followed.

2 GENERAL INFORMATION

2.1 Scope

2.1.1 This document is presented as a reference document that provides information regarding the purchase of bulk chemicals, including gases and resins, commonly used at nuclear power stations. The specifications contained within are not binding upon any station/utility, but are offered only as an example for convenience. Proprietary chemicals procured via a licensed water treatment vendor are not included in these specifications. (Some biocides require a license to distribute/apply. Most water treatment vendors have these licenses.)

2.1.2 This specification document contains chemicals that can be classified as Safety Related, Augmented Quality, or Non-Safety Related. Procurement Engineering should determine the appropriate functional classification for each chemical. Specifications for chemicals typically used in safety related applications, such as boric acid in a PWR reactor coolant system, will be noted by chemical name followed by the words Safety Related. See Appendix 4 for guidance used in the determination of safety related chemicals.

2.2 Definitions

2.2.1 Bidder – A company submitting a proposal to fulfill the requirements of this specification.

2.2.2 CAS No. – CAS registry numbers are unique numerical identifiers for chemicals and alloys. Chemical Abstracts Service, a division of the American Chemical Society assigns these identifiers to every chemical that has been described in the literature. The intention is to simplify database searches as chemicals often have many names.

2.2.3 Certificate of Analysis (COA) – Analysis results demonstrating that the product meets specification for all chemical parameters. Unless otherwise specified, analysis shall be performed on samples obtained from each lot/batch to be delivered.

2.2.4 Certificate of Conformance (COC) - Documentation stating that the product meets all requirements within the specification. This includes chemical purity, product form, packaging, and labeling requirements.

2.2.5 Purchaser – Purchase representative(s)

2.2.6 Safety Related – In accordance with ANSI/AISC standard N690-06, Safety Related is the classification that applies to structures, systems, and components used in a nuclear power plant that are relied upon during or following design basis events to ensure:

1) The integrity of the reactor coolant system pressure boundary;

2) The capability to shut down the reactor and maintain it in a safe shutdown condition; or

3) The capability to prevent or mitigate the consequences of accidents that could result in potential offsite exposure comparable to the guideline exposures of 10CFR100.

(See Appendix 4 for additional information).

2.2.7 Seller/Manufacturer/Vendor – The successful bidder for the chemical(s) covered in these specifications (i.e. the company to whom a purchase order has been awarded). The Seller may also be the manufacturer, or may be a third party that brokers products of one or more manufacturers.

2.3 Codes and Standards

2.3.1 Codes and Standards, if applicable, are included in individual specifications.

2.4 To Be Furnished by the Seller

2.4.1 The Seller shall supply materials meeting the specifications along with a signed copy of the COA. If applicable, a statement acknowledging the COC parameters shall also be included with the COA.

2.4.2 Material Safety Data Sheets shall be furnished for each product, but are not necessary for each shipment, or as agreed to by the Purchaser.

2.4.3 Some materials require a minimum shelf life. Where shelf life is not specified, the Seller shall include information related to storage conditions for maximum shelf life and expected shelf life under typical conditions.

2.4.4 The seller shall ensure that bulk chemical deliveries are made by personnel trained in safety precautions specific for handling the delivered chemical(s), and that delivery personnel abide by station safety procedures, including the use of required personnel protective equipment, as specified in station and/or vendor procedures, whichever is more conservative.

2.4.5 Bulk chemicals shall be protected from freezing and/or prolonged exposure to excessive heat that could result in chemical decomposition, polymerization, etc., loss of physical characteristics important to the chemical application, container bulging and/or leakage

2.5 To Be Furnished by the Purchaser

2.5.1 Updated copy of specification(s) (upon revision/request)

2.5.2 Specify container for chemical product

2.5.3 Procedure/process for resolving quality issues (i.e. specification non-compliance)

3
EXAMPLE PROCUREMENT SPECIFICATIONS

The following chemical information is a compilation of bulk chemical specifications provided by multiple utility participants and the example specifications provided for any bulk chemical may be a confluence of specifications which have been adapted to represent an “example” set of specifications for that bulk chemical. Individual utilities may not use all of the specifications and values listed for certain chemicals. Some utilities may use specification values that are lower or greater than those listed in this document or may not analyze for or evaluate for all listed parameters. These parameters and values should be used as examples for reference and are not meant to be requirements or standards.

1 Ammonium Hydroxide

CAS No. 1336-21-6 Formula: NH_4OH

1.0 General

Ammonium hydroxide is also known as ammonia, aqueous and aqua ammonia.

Material to be Furnished: 28% - 30% ammonium hydroxide solution

Intended Use: Ammonium hydroxide solution is typically used to adjust pH in secondary/primary systems

2.0 Specifications

Certificate of Analysis:

2.1 Chemical Composition — Weight Percent

Chemical Composition	Weight Percent
Ammonia (NH_3) content	28-31

2.2 Impurities — Weight Percent

Impurities	Weight Percent	
Carbon Dioxide (CO_2), max.	0.002	(20 ppm)
Chloride (Cl^-), max.	0.00005	(0.5 ppm)**
Fluoride (F^-), max.	0.0002	(0.5 ppm)**
Sulfate (SO_4^-), max.	0.0001	(1 ppm)
Copper (Cu), max.	0.0002	(2 ppm)
Iron (Fe), max.	0.00003	(0.3 ppm)
Lead (Pb), max.	0.00001	(0.1 ppm)**
Sodium (Na), max.	0.0001	(1 ppm)**
Phosphate (PO_4), max.	0.0002	(2 ppm)
Arsenic (As), max.	0.0005	(5 ppm)**

2.3 Physical Properties

- Specific gravity: 0.806-0.91 at 15.6°/15.6° (60°F/60°F)
- Appearance: Colorless and free from suspended matter or sediment
- Color, by APHA max. 10.0 units
- Residue after ignition, max. 0.002 (wt%) (20 ppm)
- Substances reducing permanganate Pass A.C.S. test.

2.4 Special Requirements

The water used to dilute the ammonium hydroxide shall be deionized.

2.5 Codes and Standards

N/A

**Note for the Reader:

As an illustration of potential differences between this "example" set of specifications and the specifications by any particular utility, at least one utility noted that their specifications for Chloride (Cl^-), Lead (Pb), and Sodium (Na) are as follows:

Impurities	Weight Percent	
Chloride (Cl^-), max.	0.0001	(1 ppm)
Lead (Pb), max.	0.00005	(0.5 ppm)
Sodium (Na), max.	0.00033	(3.3 ppm)

At least one utility has indicated that Arsenic (As) and Fluoride (F^-) is not included in the Certificate of Analysis for this chemical.

This does not identify all differences between this "example" set of specifications and the specifications used within the industry. It is only meant to highlight the fact, through an illustration case in point, that:

a) Individual utilities may not use all of the specifications and values listed for certain chemicals, and

b) Some utilities may use specification values that are lower or greater than those listed in this document or may not analyze for or evaluate for all listed parameters.

2 5-amino-1-pentanol (5-AP)

CAS No: 2508-29-4

1.0 General

Material to be Furnished: 5-amino-1-pentanol (5-AP) 50% solution

Intended Use: Used to control pH in PWR secondary systems

2.0 Specification

Certificate of Analysis:

2.1 <u>Chemical Composition</u> — <u>Weight Percent</u>

Chemical Composition	Weight Percent
Assay (5-amino-1-pentanol)	49-51%
Deionized water	balance

2.2 <u>Impurities</u>

Chloride (Cl^-), max.	0.0002	(2 ppm)
Sulfate (SO_4^-), max.	0.0002	(2 ppm)
Fluoride (F^-), max.	0.0001	(1 ppm)
Sodium (Na), max.	0.0001	(1 ppm)
Iron (Fe), max.	0.0001	(1 ppm)
Copper (Cu), max.	0.0001	(1 ppm)
Lead, (Pb), max.	0.0002	(2 ppm)

2.3 <u>Physical Properties</u> — <u>Limit</u>

- Color (APHA units), max. 25
- Clear and free of visible solids or particulate matter

2.4 <u>Special Requirements</u>

The water used to dilute neat 5-AP to a 50 percent solution shall be deionized. 5-AP shall be supplied with a nitrogen cap to prevent reaction with atmospheric oxygen that can lead to discoloration.

2.5 <u>Codes and Standards</u>

N/A

3 Sodium Tetraborate (Decahydrate) - Safety Related

CAS No. 1303-96-4 Formula: $Na_2B_4O_7 \cdot 10\ H_2O$

1.0 General

Also known as Borax

Material to be Furnished: Sodium Tetraborate in the form of granules, free of dirt and other contaminants. Borax shall be undepleted in the Boron-10 isotope. Some stations specify sodium tetraborate enriched in Boron-10 isotope.

Intended Use: BWR standby liquid control tank and to control sump pH under post accident conditions. Used in PWR ice condensers as neutron poison.

2.0 Specification

Certificate of Analysis:

2.1 Chemical Composition

Chemical Composition	Weight Percent
$Na_2B_4O_7$ 10 H_2O	99.9
Boron-10 (min. max.)	19.75-20.3

2.2 Impurities

Impurities	Weight Percent	
Chloride (Cl^-), max.	0.001	(10 ppm)
Sulfate (SO_4^-), max.	0.005	(50 ppm)
Fluoride (F^-), max.	0.0001	(1 ppm)
Calcium (Ca), max.	0.005	(50 ppm)
Iron (Fe), max.	0.0005	(5 ppm)
Phosphate (PO_4), max.	0.001	(10 ppm)
Heavy metals (as Pb), max.	0.001	(10 ppm)
Water insoluble material, max.	0.005	(50 ppm)

2.3 Physical Properties

2.3.1 Sodium Tetraborate shall be in the form of granules, free of dirt and other foreign material

2.3.2 Requirements when tested with U.S. Standard Sieves:

Sieve Number	Percent Retained (by weight)
8	0.0

2.4 Special Requirements

- If enriched, or alternate boron criteria are required, purchaser shall substitute the percent Boron-10 enrichment for the value noted above under section 2.1.

2.5 Codes and Standards

Safety Related.

4 Sodium Pentaborate - Safety Related

CAS No. 12046-75-2	Formula: $Na_2O\ 5B_2O_3 \cdot 10\ H_2O$
CAS No. 11139-65-4	Formula: $Na_2B_{10}\ O_{16} \cdot 10\ H_2O$

1.0 General

Sodium Pentaborate enriched in Boron-10 content, also known as boric acid sodium salt decahydrate, boron sodium oxide.

Material to be Furnished: Sodium Pentaborate (boron-10 enriched) in the form of granules, free of dirt and other contaminants. The Boron-10 concentration must be greater than or equal to 45 atom percent.

Intended Use: BWR standby liquid control tank as a neutron poison.

2.0 Specification

Certificate of Analysis:

2.1 Chemical Composition

Chemical Composition	Weight Percent
$Na_2O\ 5B_2O_3\ 10\ H_2O$	99.9
Boron-10 (atom percent)	≥ 45 %

2.2 Impurities

Impurities	Weight Percent	
Chloride (Cl^-), max.	0.0005	(5 ppm)
Sulfate (SO_4^-), max.	0.0002	(2 ppm)
Fluoride (F^-), max.	0.0005	(5 ppm)
Calcium (Ca), max.	0.005	(50 ppm)
Iron (Fe), max.	0.0003	(3 ppm)
Phosphate (PO_4), max.	0.001	(10 ppm)
Heavy metals (as Pb), max.	0.001	(10 ppm)
Water insoluble material, max.	0.005	(50 ppm)

2.3 Physical Properties

2.3.1 Material shall be in the form of granules, free of dirt and other foreign material

2.3.2 Requirements when tested with U.S. Standard Sieves:

Sieve Number	Percent Retained (by weight)
8	0.0

2.4 Special Requirements

N/A

2.5 Codes and Standards

Safety Related.

5 Boric Acid – Safety Related

CAS No.10043-35-3 Formula: H_3BO_3

1.0 General

Also known as ortho-Boric acid; boracic acid; Borofax

Material to be Furnished: Boric acid, undiluted in Boron-10

Intended Use: Typically used in PWR reactor coolant systems as a neutron poison to control reactivity. Boric acid can be used in PWR secondary system coolant to control corrosion.

2.0 Specification

Certificate of Analysis:

2.1 Chemical Composition

Chemical Composition	Weight Percent
Boric acid (H_3BO_3), min.	99.9
Boron-10 (atom percent)	19.65-20.3

2.2 Impurities

Impurities	Weight Percent	
Arsenic (As), max.	0.0002	(2 ppm)
Sodium (Na), max.	0.0005	(5 ppm)*
Chloride (Cl^-), max.	0.00004	(0.4 ppm)
Fluoride (F^-), max.	0.0002	(2 ppm)
Phosphate (PO_4), max.	0.0010	(10 ppm)*
Silica (SiO_2), max.	0.0001	(1 ppm)
Sulfate (SO_4^-), max.	0.0003	(3 ppm)
Calcium (Ca), max.	0.0003	(3 ppm)*
Iron (Fe), max.	0.0002	(2 ppm)
Heavy metals (as Pb), max.	0.0002	(2 ppm)
Water insoluble materials, max.	0.0010	(10 ppm)*

2.3 Physical Properties

2.3.1 Material shall be in the form of granules free of dirt and other foreign material.

2.3.2 Sieve analysis-requirements when tested with U.S. Standard sieves.

Sieve No.	Percent Retained (by weight)
16	10 maximum
50	55-75
100	75 minimum

2.4 Special Requirements

2.4.1 The Boron-10 specification parameter is not applicable to boric acid used in secondary system coolant applications.

2.5 Codes and Standards

Safety Related.

*Note for the Reader:

As an illustration of potential differences between this "example" set of specifications and the specifications by any particular utility, at least one utility noted that their specifications for Sodium (Na), Phosphate (PO_4), Calcium (Ca), and Water Soluble Materials are as follows:

Impurities	Weight Percent	
Sodium, (Na), max.	0.0030	(30 ppm)
Phosphate, (PO_4), max.	0.0030	(30 ppm)
Calcium, (Ca), max.	0.0050	(50 ppm)
Water insoluble materials; max.	0.0050	(50 ppm)

This does not identify all differences between this "example" set of specifications and the specifications used within the industry. It is only meant to highlight the fact, through an illustration case in point, that:

a) Individual utilities may not use all of the specifications and values listed for certain chemicals, and

b) Some utilities may use specification values that are lower or greater than those listed in this document or may not analyze for or evaluate for all listed parameters.

6 Carbohydrazide

CAS No. 147-16-7 Formula: CH_6N_4O

1.0 General

Also known as carbonic dihydrazide and 1,3-diaminourea.

Material to be Furnished: 12% carbohydrazide solution, diluted with deionized water

Intended Use: A low toxicity oxygen scavenger/metal passivator. Carbohydrazide is frequently used in low temperature applications, such as steam generator wet layup, but can be used wherever an oxygen scavenger is needed.

2.0 Specification

Certificate of Analysis:

2.1 Chemical Composition

Chemical Composition	Weight Percent
Carbohydrazide $(N_2H_3)_2CO$	≥ 11 %

2.2 Impurities

Impurities	Weight Percent	
Chloride (Cl^-), max.	0.0001	(1 ppm)
Fluoride (F^-), max.	0.0002	(2 ppm)
Sulfate (SO_4^-), max.	0.0001	(1 ppm)
Copper (Cu), max.	0.0002	(2 ppm)
Iron (Fe), max.	0.0002	(2 ppm)
Lead, (Pb), max.	0.0001	(1 ppm)
Sodium (Na), max.	0.0001	(1 ppm)

2.3 Physical Properties

Color: clear, colorless

2.4 Special Requirements

N/A

2.5 Codes and Standards

N/A

7 Carbon Dioxide Gas

CAS No. 124-38-9 Formula: CO_2

1.0 General

Also known as carbon anhydride

Material to be Furnished: Carbon dioxide gas (CO_2) should appear clear and colorless, with no detectable off-taste or odor. Carbon dioxide shall meet NFPA No.12 specifications, including the CGA G-6.2 specification for water.

Intended Use: Carbon dioxide is added to the electrical generator during periods of non operation. Carbon dioxide may have other applications where a non air atmosphere is desired.

2.0 Specification

Certificate of Analysis:

2.1	<u>Chemical Composition</u>	<u>Volume Percent</u>
	Carbon dioxide, (CO_2), v/v	≥ 99.5
2.2	<u>Impurities (Liquid Phase)</u>	<u>Parts per Million</u>
	Oil Content, ppm. , max.	≤ 10
2.3	<u>Physical Properties (Liquid Phase)</u>	
	Water Content,* ppm, max	20.6
	Dew Point,* max.	-67°F (-55°C)
	Clear, colorless gas	

*Dew Point can be analyzed in lieu of Water Content, or vice-versa

2.4 <u>Special Requirements</u>

N/A

2.5 <u>Codes and Standards</u>

N/A

8 Chromate, Potassium Chromate

CAS No. 7789-00-6 Formula: K_2CrO_4

1.0 General

Also known as chromic acid, dipotassium salt, dipotassium chromate, bipotassium chromate, chromate of potassium, and neutral potassium chromate.

Material to be Furnished: Potassium chromate shall be at least technical grade (granular) suitable for use in a nuclear power plant.

Intended Use: Potassium chromate is used as a multi-metal corrosion inhibitor in auxiliary systems and is added to increase both chromate concentration and pH.

2.0 Specification

Certificate of Analysis:

2.1 Chemical Composition

Chemical Composition	Weight Percent
Potassium Chromate (K_2CrO_4)	≥99.9 %

2.2 Impurities

Impurities	Weight Percent	
Chloride (Cl^-), max.	0.007	(70 ppm)
Fluoride (F^-), max.	0.005	(50 ppm)**
Sulfate (SO_4^-), max.	0.03	(300 ppm)
Sodium (Na), max.	0.02	(200 ppm)

2.3 Physical Properties

Color: Yellowish crystals
Form: Granular

2.4 Special Requirements

Handling Precautions - DANGEROUS! May be fatal if inhaled or absorbed through the skin. Known to be toxic to organs and cause severe burns to tissue. Strong oxidizer. Fire hazard if in contact with non suitable materials. Listed in California as a chemical known to cause cancer.

2.5 Codes and Standards

N/A

**Note for the Reader:

At least one utility has indicated that Fluoride (F^-) is not included in the Certificate of Analysis for this chemical.

This does not identify all differences between this “example” set of specifications and the specifications used within the industry. It is only meant to highlight the fact, through an illustration case in point, that:

a) Individual utilities may not use all of the specifications and values listed for certain chemicals, and

b) Some utilities may use specification values that are lower or greater than those listed in this document or may not analyze for or evaluate for all listed parameters.

9 Chromate, Potassium Dichromate

CAS No. 7778-50-9 Formula: $K_2Cr_2O_7$

1.0 General

Also known as dichromic acid, dipotassium salt, dipotassium dichromate, potassium bichromate

Material to be Furnished: Potassium dichromate shall be at least technical grade (granular) suitable for use as a corrosion inhibitor.

Intended Use: Potassium dichromate is used as a multi-metal corrosion inhibitor in auxiliary systems. Potassium dichromate is typically added to both increase chromate concentration and adjust solution pH to a slightly lower value.

2.0 Specification

Certificate of Analysis:

2.1 Chemical Composition

Chemical Composition	Weight Percent	
Potassium dichromate, ($K_2Cr_2O_7$)	≥99 %	--

2.2 Impurities

Impurities	Weight Percent	
Chloride (Cl^-), max.	0.007	(70 ppm)

2.3 Physical Properties

Color: Reddish-orange crystals
Form: Granular

2.4 Special Requirements

Handling Precautions - DANGEROUS! May be fatal if inhaled or absorbed through the skin. Known to be toxic to organs and cause severe burns to tissue. Strong oxidizer. Fire hazard if in contact with non suitable materials. Listed in California as a chemical known to cause cancer.

2.5 Codes and Standards

N/A

10 Dimethylamine (DMA)

CAS No: 124-40-3 Formula: C_2H_7N

1.0 General

Dimethylamine (DMA) is added for secondary system pH adjustment. DMA is typically supplied as a two-percent solution to keep the flash point approximately 127° Fahrenheit.

Material to be Furnished: 2% Dimethylamine solution, diluted with deionized water

Intended Use: PWR secondary system pH adjuster and solvent

2.0 Specification

Certificate of Analysis:

2.1 Chemical Composition

Chemical Composition	Weight Percent
DMA, %	1.8 – 2.2

2.2 Impurities

Impurities	Weight Percent	
Sodium (Na), max.	0.00005	(0.5 ppm)
Copper (Cu), max.	0.00005	(0.5 ppm)
Iron (Fe), max.	0.00005	(0.5 ppm)
Lead (Pb), max.	0.00001	(0.1 ppm)
Chloride (Cl^-), max.	0.00005	(0.5 ppm)
Fluoride (F^-), max.	0.00005	(0.5 ppm)
Sulfate (SO_4^-), max.	0.00005	(0.5 ppm)

2.3 Physical Properties

Clear with no visible solids

2.4 Special Requirements

N/A

2.5 Codes and Standards

N/A

11 Monoethanolamine (ETA)

CAS No. 141-43-5 Formula: $HOCH_2CH_2NH_2$ or C_2-H_7-N-O

1.0 General

Material to be Furnished: 40%, 80%, 85% Monoethanolamine solution diluted with deionized water

Intended Use: PWR secondary system pH adjustment

2.0 Specification

Certificate of Analysis:

40%, 80%, or 85% ETA shall meet the following specifications:

2.1 Chemical Composition

Chemical Composition	Weight Percent
Monoethanolamine assay	38.5-41.5, 78-82, 83-87
Deionized water	balance

2.2 Impurities

Impurities	Weight Percent	
Chloride (Cl^-), max.	0.00005	(0.5 ppm)*
Fluoride (F^-), max.	0.00005	(0.5 ppm)*
Sulfate (SO_4^-), max.	0.00005	(0.5 ppm)*
Copper (Cu), max.	0.00005	(0.5 ppm)*
Iron (Fe), max.	0.00005	(0.5 ppm)*
Lead, (Pb), max.	0.00005	(0.5 ppm)*
Sodium (Na), max.	0.00005	(0.5 ppm)

2.3 Physical Properties

- Monoethanolamine shall be supplied clear and free of visible solids or particulate matter
- APHA color, max.15 units

2.4 Special Requirements

ETA shall be produced free of ethylene glycol

2.5 Codes and Standards

N/A

*Note for the Reader:

As an illustration of potential differences between this "example" set of specifications and the specifications by any particular utility, at least one utility noted that their specifications for Chloride (Cl-), Fluoride (F-), Sulfate (SO_4^-), Copper, Iron (Fe), and Lead (Pb) are as follows:

Impurities	Weight Percent	
Chloride (Cl^-), max.	0.0001	(1 ppm)
Fluoride (F^-), max.	0.0002	(2 ppm)
Sulfate (SO_4^-), max.	0.0001	(1 ppm)
Copper (Cu), max.	0.0001	(1 ppm)
Iron (Fe), max.	0.0001	(1 ppm)
Lead, (Pb), max.	0.0001	(1 ppm)

At least one utility has indicated that Fluoride (F^-) is not included in the Certificate of Analysis for this chemical.

This does not identify all differences between this "example" set of specifications and the specifications used within the industry. It is only meant to highlight the fact, through an illustration case in point, that:

a) Individual utilities may not use all of the specifications and values listed for certain chemicals, and

b) Some utilities may use specification values that are lower or greater than those listed in this document or may not analyze for or evaluate for all listed parameters.

12 Hydrazine (uncatalyzed)

CAS No. 302-01-2 Formula: $N_2H_4 \cdot H_2O$

1.0 General

Hydrazine is used in applications where the addition of solids is not desired. Reaction rates are significantly lower at ambient temperatures versus typical system operating temperatures.

Material to be Furnished: High purity, uncatalyzed, hydrazine diluted with deionized water to a hydrazine concentration of 35% (55% as hydrazine hydrate).

Intended Use: Added as an oxygen scavenger/reducing agent to PWR secondary water systems during normal operation and during steam generator wet layup. Also added to PWR reactor coolant systems to remove oxygen during startup.

2.0 Specification

Certificate of Analysis:

2.1 Chemical Composition

Chemical Composition	Weight Percent
Hydrazine	34.5-36%

2.2 Impurities

Impurities	Weight Percent	
Chloride (Cl^-), max.	0.0002	(2 ppm)
Fluoride (F^-), max.	0.0002	(2 ppm)*
Sulfate (SO_4^-), max.	0.0002	(2 ppm)
Copper (Cu), max.	0.0002	(2 ppm)*
Iron (Fe), max.	0.0002	(2 ppm)*
Lead, (Pb), max.	0.0001	(1 ppm)
Sodium (Na), max.	0.0001	(1 ppm)*

2.3 Physical Properties

Clear colorless liquid, free of suspended matter
pH of a 1% (3%) solution @ 25°C 10.1-10.7 (9.6-10.2)

2.4 Special Requirements

N/A

2.5 Codes and Standards

N/A

*Note for the Reader:

As an illustration of potential differences between this "example" set of specifications and the specifications by any particular utility, at least one utility noted that their specifications for Iron (Fe) and Sodium (Na) are as follows:

Impurities	Weight Percent	
Iron (Fe), max.	0.0003	(3 ppm)
Sodium (Na), max.	0.0003	(3 ppm)

At least one utility noted that their specifications do not include the Copper (Cu) or Fluoride (F^-).

This does not identify all differences between this "example" set of specifications and the specifications used within the industry. It is only meant to highlight the fact, through an illustration case in point, that:

a) Individual utilities may not use all of the specifications and values listed for certain chemicals, and

b) Some utilities may use specification values that are lower or greater than those listed in this document or may not analyze for or evaluate for all listed parameters.

13 Hydrazine (catalyzed)

CAS No. 302-01-2 Formula: $N_2H_4 \cdot H_2O$ (with 0.2% to 0.6% hydroquinone catalyst)

1.0 General

Catalyzed hydrazine (Amerzine 35%) is typically used in low temperatures applications where addition of a catalyst is needed to improve reaction kinetics.

Material to be Furnished: High purity, hydrazine, catalyzed with hydroquinone, diluted with deionized water to a hydrazine concentration of approximately 35% (55% as hydrazine hydrate).

Intended Use: Added as an oxygen scavenger/reducing agent to PWR secondary water systems during normal operation and during steam generator wet layup. Also added to PWR reactor coolant systems to remove oxygen during startup.

2.0 Specification

Certificate of Analysis:

2.1 Chemical Composition

Chemical Composition	Weight Percent
Hydrazine	34-36
Hydroquinone	0.2-0.6

2.2 Impurities

Impurities	Weight Percent	
Chloride (Cl^-), max.	0.0002	(2 ppm)
Fluoride (F^-), max.	0.0002	(2 ppm)*
Sulfate (SO_4^-), max.	0.0002	(2 ppm)
Copper (Cu), max.	0.0002	(2 ppm)*
Iron (Fe), max.	0.0002	(2 ppm)
Lead, (Pb), max.	0.0001	(1 ppm)*
Sodium (Na), max.	0.0001	(1 ppm)*

2.3 Physical Properties

- Clear colorless – yellow liquid, free of suspended matter
- pH of a 1% (3%) solution @ 25°C 10.1-10.7 (9.6-10.2)

2.4 Special Requirements

Hydroquinone is the only acceptable catalyst. Metal, organometallic, or other organic catalysts are NOT acceptable.

2.5 Codes and Standards

N/A

*Note for the Reader:

As an illustration of potential differences between this "example" set of specifications and the specifications by any particular utility, at least one utility noted that their specifications for Iron (Fe) and Sodium (Na) are as follows:

Impurities	Weight Percent	
Iron (Fe), max.	0.0003	(3 ppm)
Sodium (Na), max.	0.0003	(3 ppm)

At least one utility noted that their specifications do not include the Copper (Cu) or Fluoride (F^-).

This does not identify all differences between this "example" set of specifications and the specifications used within the industry. It is only meant to highlight the fact, through an illustration case in point, that:

a) Individual utilities may not use all of the specifications and values listed for certain chemicals, and

b) Some utilities may use specification values that are lower or greater than those listed in this document or may not analyze for or evaluate for all listed parameters.

14 Hydrogen Gas

CAS No. 133-74-0 Formula: H_2

1.0 General

Material to be Furnished: High purity hydrogen gas can be supplied in cylinders or in bulk

Intended Use: To provide hydrogen overpressure in PWR RCS applications, and to provide a hydrogen atmosphere in electric generators.

2.0 Specification

Certificate of Analysis:

2.1 Chemical Composition

Chemical Composition	Volume Percent
Hydrogen, (H_2), v/v	≥99.95

2.2 Impurities

Impurities	Parts per Million (ppm)
Carbon Dioxide, (CO_2), w/w	≤10
Halogens and halides**, w/w	≤ 1
Oxygen, (O_2), w/w	≤ 5
Moisture, (H_2O),* w/w	≤10
Nitrogen, (N_2), w/w	≤ 400
Total impurities, w/w	≤ 500

2.3 Physical Properties

Dew point*, max.	-77°F	(-60.6°C)
Clear, colorless gas		

*Dew Point can be analyzed in lieu of Moisture, or vice-versa

2.4 Special Requirements

N/A

2.5 Codes and Standards

N/A

**Note for the Reader:

As an illustration of potential differences between this “example” set of specifications and the specifications by any particular utility, at least one utility noted that their specifications do not include halogens and halides.

This does not identify all differences between this “example” set of specifications and the specifications used within the industry. It is only meant to highlight the fact, through an illustration case in point, that:

a) Individual utilities may not use all of the specifications and values listed for certain chemicals, and

b) Some utilities may use specification values that are lower or greater than those listed in this document or may not analyze for or evaluate for all listed parameters.

15 Hydrogen Gas (Ultra Pure)

CAS No. 133-74-0 Formula: H_2

1.0 General

Material to be Furnished: High purity hydrogen gas can be supplied in cylinders or in bulk

Intended Use: To supply hydrogen to BWR condensate/feedwater systems. Also, can be used to provide a hydrogen atmosphere in electric generators.

2.0 Specification

Certificate of Analysis:

2.1	Chemical Composition	Volume Percent
	Hydrogen, (H_2), v/v	≥99.995
2.2	Impurities	Parts per Million (ppm)
	Carbon Dioxide, (CO_2), w/w	≤0.5
	Carbon Monoxide, (CO), w/w	≤1.0
	Nitrogen, (N_2), w/w	≤20
	Nitric Oxide, (NO), w/w	≤1
	Oxygen, (O_2), w/w	≤ 2
	Moisture, (H_2O), w/w	≤10
2.3	Physical Properties	
	Dew point*, max.	-77°F (-60.6°C)
	Clear, colorless gas	

*Dew Point can be analyzed in lieu of Moisture, or vice-versa

2.4 Special Requirements

N/A

2.5 Codes and Standards

N/A

16 Hydrogen Peroxide (High Purity)

CAS No. 7722-84-1 Formula: H_2O_2

1.0 General

Material to be Furnished: Hydrogen peroxide (non stabilized H_2O_2), shall be provided as a 30% solution and shall be ACS grade or meet the requirements noted below.

Intended Use: High purity hydrogen peroxide is typically used in PWR reactor coolant systems to establish oxidizing conditions during refueling outages or forced outages where the reactor coolant system will be opened to the atmosphere. High purity hydrogen peroxide can also be used in other RCS applications wherever a strong oxidant is needed. Note that the technical grade hydrogen peroxide (described next) should not be used in RCS environments.

2.0 Specification

Certificate of Analysis:

2.1	Chemical Composition	Weight Percent	
	Assay (H_2O_2), percent	30.0-32%	
	Deionized water	Balance	
2.2	Impurities	Weight Percent	
	Chloride (Cl^-), max.	≤ 0.0003	(3 ppm)
	Sulfate (SO_4^-), max.	≤ 0.0005	(5 ppm)
	Heavy metals (as Pb), max.	≤ 0.0001	(1 ppm)
	Iron (Fe), max.	≤ 0.00005	(0.5 ppm)
2.3	Physical Properties		
	Color (APHA), units, max.	≤ 10	
	Titratable/free acid (meq/g), max.	≤ 0.0006	(0.6 μeq/g)

2.4 Special Requirements

N/A

2.5 Codes and Standards

N/A

17 Hydrogen Peroxide (Technical Grade)

CAS No. 7722-84-1 Formula: H_2O_2

1.0 General

For use where a strong oxidizer is needed. Not for use in the reactor coolant or related systems.

Material to be Furnished: Hydrogen peroxide, technical grade, can be catalyzed and may be supplied in 30%, 35%, or 50% concentrations, meeting the requirements noted below.

Intended Use: Typically used in non-nuclear system applications such as sump neutralizations, or wherever a strong oxidizer is needed.

2.0 Specification

Certificate of Analysis:

2.1 Chemical Composition

Chemical Composition	Weight Percent		
Assay (H_2O_2), percent	30 ± 1	35 ± 1	50 ± 1
Active oxygen content, %w/w	12.7 min.	15 min.	23 min.

2.2 Impurities

No limits specified.

2.3 Physical Properties

No limits specified.

2.4 Special Requirements

N/A

2.5 Codes and Standards

N/A

18 Lithium-7 Hydroxide

CAS No. 1310-65-2 Formula: $^{7}LiOH$

1.0 General

Lithium-7 hydroxide is depleted in the Lithium-6* isotope to minimize the reaction that produces tritium.

Material to be Furnished: Lithium-7 monohydrate, supplied as a dry powder, suitable for use in nuclear station applications.

Intended Use: Lithium-7 hydroxide is typically used to adjust PWR reactor coolant system pH

2.0 Specification

Certificate of Analysis:

2.1 Chemical Composition

Chemical Composition	Weight Percent
Lithium-7 hydroxide ($^{7}LiOH$)	48-58
Water (monohydrate)	42-52
Li-7 (% of elemental Li), min.	99.94*

2.2 Impurities

Impurities	Weight Percent	
Chloride (Cl^-), max.	≤ 0.005	(50 ppm)*
Sulfate (SO_4^-), max.	≤ 0.005	(50 ppm)*
Fluoride (F^-), max.	≤ 0.03	(300 ppm)*
Aluminum (Al), max.	≤ 0.003	(30 ppm)
Calcium (Ca), max.	≤ 0.003	(30 ppm)
Lead, (Pb) max.	≤ 0.001	(10 ppm)
Magnesium (Mg), max.	≤ 0.001	(10 ppm)
Mercury (Hg), max.	≤ 0.00005	(0.5 ppm)
Sodium (Na), max.	≤ 0.01	(100 ppm)
Zinc (Zn), max.	≤ 0.0005	(5 ppm)
Iron (Fe), max.	≤ 0.00005	(0.5 ppm)

2.3 Physical Properties

White granular solid

2.4 Special Requirements

2.4.1 Shipped in polyethylene lined steel drums securely closed to prevent loss or contamination of the contents.

2.5 Codes and Standards

Safety Related.

*Note for the Reader:

As an illustration of potential differences between this "example" set of specifications and the specifications by any particular utility, at least one utility noted that their specifications for Li-7, Chloride (Cl^-), Sulfate (SO_4^-), Fluoride (F^-) are as follows:

Chemical Composition	Weight Percent	
Li-7 (% of elemental Li), min.	99.9	
Impurities	Weight Percent	
Chloride (Cl^-), max.	≤ 0.05	(500 ppm)
Sulfate (SO_4^-), max.	≤ 0.01	(100 ppm)
Fluoride (F^-), max.	≤ 0.05	(500 ppm)

At least one utility with Pressurized Heavy Water Reactor noted that they use LiOH that is not depleted in Lithium-6. Note: Li-6 is a primary source to tritium.

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19 Morpholine

CAS No. 110-91-8 Formula: C_4H_9NO

1.0 General

Morpholine also known as: diethylene oximide, tetrahydro-2H-1,4-oxazine, diethylenimide oxide, and diethylene imidoxide.

Material to be Furnished: Morpholine solution diluted with deionized water to approximately 40 percent, and shall be free of dyes, coloring agents, and suspended matter.

Intended Use: PWR secondary system pH adjustment

2.0 Specification

Certificate of Analysis:

40% Morpholine shall meet the following specifications:

2.1 Chemical Composition

Chemical Composition	Weight Percent
Morpholine assay	39-41
Deionized water	Balance

2.2 Impurities

Impurities	Weight Percent	
Chloride (Cl^-), max.	0.0003	(3 ppm)
Fluoride (F^-), max.	0.0003	(3 ppm)
Sulfate (SO_4^-), max.	0.0003	(3 ppm)
Copper (Cu), max.	0.0002	(2 ppm)
Total Iron (Fe), max.	0.0002	(2 ppm)
Lead, (Pb), max.	0.0005	(5 ppm)
Sodium (Na), max.	0.0003	(3 ppm)

2.3 Physical Properties

Morpholine shall be supplied clear and free of visible solids or particulate matter

2.4 Special Requirements

N/A

2.5 Codes and Standards

N/A

20 Methoxypropylamine (MPA)

CAS No. 5332-73-0 Formula: $CH_3O\ (CH_2)_2\ CH_2\ NH_2$ or $(C_4H_{11}NO)$

1.0 General

Methoxypropylamine also known as: MPA, MOPA, 3-methoxypropylamine, 3-methoxy-1-aminopropane, 3-methoxypropyl-1-amine, 3-aminopropyl methyl ether, CARBO-SORB®.

Material to be Furnished: MPA solution diluted with deionized water to approximately 40 percent, and shall be free of dyes, coloring agents, and suspended matter.

Intended Use: PWR secondary system pH adjustment

2.0 Specification

Certificate of Analysis:

40% MPA shall meet the following specifications:

2.1 Chemical Composition

Chemical Composition	Weight Percent
Methoxypropylamine assay	39-41
Deionized water	Balance

2.2 Impurities

Impurities	Weight Percent	
Chloride (Cl-), max.	0.00005	(0.5 ppm)
Fluoride (F-), max.	0.00005	(0.5 ppm)
Sulfate (SO_4^-), max.	0.00005	(0.5 ppm)
Copper (Cu), max.	0.00005	(0.5 ppm)
Total Iron (Fe), max.	0.00005	(0.5 ppm)
Lead, (Pb), max.	0.000005	(0.05 ppm)
Sodium (Na), max.	0.000015	(0.150 ppm)

2.3 Physical Properties

MPA shall be supplied clear colorless to amber, non-viscous, and free of visible solids or particulate matter

2.4 Special Requirements

N/A

2.5 Codes and Standards

N/A

21 Nitrogen Gas

CAS No. 7727-37-9 Formula: N_2

1.0 General

Spec. C Supplied in cylinders meeting the requirements of the Bureau of Explosives and Rulings of ICC, Specification 3-A

Spec. B Supplied in bulk

Material to be Furnished: Nitrogen gas (N_2) can be supplied in either bulk (Spec. **B**) or cylinders (Spec. **C**) meeting the specifications noted below.

Intended Use: Nitrogen gas can be used in PWR systems where an inert gas atmosphere is desired and/or required.

2.0 Specification

Certificate of Analysis:

2.1	Chemical Composition	Spec.	Volume Percent
	Nitrogen, (N_2), v/v	**C**	≥ 99.9%
	Nitrogen, (N_2), v/v	**B**	≥ 99.995%
2.2	Impurities	Spec.	Parts per Million (ppm)
	Oxygen, (O_2), w/w	**C**	≤ 5
	Moisture, (H_2O), w/w	**C**	≤ 3
		Spec.	Parts per Million (ppm)
	Oxygen, (O_2), w/w	**B**	5
	Carbon Dioxide, (CO_2), w/w	**B**	300
	Carbon Monoxide, (CO), w/w	**B**	10
	Moisture, (H_2O), w/w*	**B**	5.7
2.3	Physical Properties	Spec.	Specification
	Dew Point, max.	**B & C**	-68.9°C (-92°F)
	Clear, colorless gas	**B & C**	

*Dew Point can be analyzed in lieu of moisture, or vice versa

2.4 Special Requirements (Spec. **C**)

2.4.1 Each cylinder shall be marked as follows:
2.4.1.1 Nitrogen Gas, batch number
2.4.1.2 Specification Number
2.4.1.3 Purchase order number
2.4.1.3 Number of cubic feet
2.4.14 Name of Manufacturer

2.4.2 Nitrogen supplied in cylinders shall meet the following requirements:
2.4.2.1 Each batch shall be accompanied with a Certificate of Analysis
2.4.2.2 Cylinders shall be equipped with outlet valve connections conforming to CGA Connection 580, per CGA V-1 (or as otherwise specified)
2.4.2.3 Cylinders shall be thoroughly purged of contaminants before filling to minimize potential for gas contamination
2.4.2.4 Cylinders shall be tested and verified to be leak free
2.4.2.5 Refilled cylinders shall have a new safety disc and washer installed

2.5 Codes and Standards

N/A

22 Oxygen Gas

CAS No. 7782-44-7 Formula: O_2

1.0 General

Oxygen, a common oxidizer, can have a number of applications, and is commonly used in boiling water reactor off gas systems to recombine with hydrogen to form water.

Material to be Furnished: High purity Oxygen gas (O_2), supplied in cylinders.

Intended Use: Oxygen gas can be used in BWR systems to recombine with hydrogen to form water. Oxygen ordered via this specification is not intended for human consumption.

2.0 Specification

Certificate of Analysis:

2.1 Chemical Composition

Chemical Composition	Volume Percent
Oxygen (O_2), v/v	≥ 99.9%

2.2 Impurities

Impurities	Volume Percent	Parts per Million (ppm)
Argon (Ar), v/v	< 1%	--
Halogen content, w/w, max.	--	1.0

2.3 Physical Properties
Gas

2.4 Special Requirements

2.4.1 Each cylinder shall be marked as follows:
2.4.1.1 Oxygen Gas, batch number
2.4.1.2 Specification Number
2.4.1.3 Purchase order number
2.4.1.4 Number of cubic feet
2.4.1.5 Name of Manufacturer

2.4.2 Oxygen supplied in cylinders shall meet the following requirements:
2.4.2.1 Each batch shall be accompanied with a Certificate of Analysis
2.4.2.2 Cylinders shall be equipped with outlet valve connections conforming to CGA Connection 540, per CGA V-1 (or as otherwise specified)
2.4.2.3 Cylinders shall be thoroughly purged of contaminants before filling to minimize potential for gas contamination
2.4.2.4 Cylinders shall be tested and verified to be leak free
2.4.2.5 Refilled cylinders shall have a new safety disc and washer installed

2.5 Codes and Standards
N/A

23 Phosphate, Trisodium (anhydrous)

CAS No. 7601-54-9 Formula: Na_3PO_4

1.0 General

Technical grade trisodium phosphate (TSP) has two applications, and consequently, two grades: one as trisodium phosphate anhydrous and the second as trisodium phosphate crystals. Separate specifications have been developed for each chemical. This specification is for anhydrous TSP.

Material to be Furnished: anhydrous trisodium phosphate in powder or granular form.

Intended Use: Anhydrous trisodium phosphate is typically used in conjunction with caustic in low pressure boiler applications and is also formulated into some auxiliary system corrosion control programs. The phosphate is added to precipitate hardness constituents such as calcium.

2.0 Specification

Certificate of Analysis:

2.1 Chemical Composition — Weight Percent

Chemical Composition	Weight Percent
Trisodium phosphate (Na_3PO_4), min.	97%
Phosphate (P_2O_5), min.	42.0
Alkalinity (Na_2O), % , max.	36-40

2.2 Impurities — Weight Percent

Impurities	Weight Percent
Insolubles (%), max.	< 0.1

2.3 Physical Properties

pH, 1% solution	11.5-12.5
Loss on ignition (%), max.	2.2*
Solubility (gms/kg water 10°C)	≥ 87*
Bulk density (lbs./cuft.), **powder**	≥ 62*
granular	≥ 47*
Screen analysis, (% through US 20), **powder,** min.	100*
(% through US 100), min.	90*
(% through US 20), **granular,** min.	90*
(% through US 100), max.	25 *

2.4 Special Requirements

N/A

2.5 Codes and Standards

N/A

*Note for the Reader:

As an illustration of potential differences between this “example” set of specifications and the specifications by any particular utility, at least one utility noted that they do not include loss of ignition, solubility, bulk density, and screen analysis limits in their specifications for this chemical in order to improve availability of the material.

This does not identify all differences between this “example” set of specifications and the specifications used within the industry. It is only meant to highlight the fact, through an illustration case in point, that:

a) Individual utilities may not use all of the specifications and values listed for certain chemicals, and

b) Some utilities may use specification values that are lower or greater than those listed in this document or may not analyze for or evaluate for all listed parameters.

24 Phosphate, Trisodium (dodecahydrate) – Safety Related

CAS No. 7601-54-9 Formula: $Na_3PO_4 \cdot 10\text{-}12\ H_2O$

1.0 General

Technical grade trisodium phosphate (TSP) has two applications, and consequently, two grades: one as trisodium phosphate anhydrous and the second as trisodium phosphate combined with ten to twelve water molecules. Separate specifications have been developed for each chemical. This specification is for dodecahydrate TSP.

Material to be Furnished: anhydrous trisodium phosphate in crystal form

Intended Use: Dodecahydrate trisodium phosphate is typically used in PWR applications in lieu of sodium hydroxide to adjust containment spray water, under accident conditions, to an alkaline pH range. At some plants, TSP is also used as chemical treatment for primary and secondary component cooling systems.

2.0 Specification

Certificate of Analysis:

2.1 Chemical Composition

Chemical Composition	Weight Percent
Phosphate (P_2O_5), min.	18-20
Alkalinity (Na_2O), %	15.5-20.5

2.2 Impurities

Not specified

2.3 Physical Properties

Physical Properties	Limit/Range
Solubility (gms/kg water 10°C)	≥ 235
or	
Solubility (gms/kg water 25°C)	≥ 300
Bulk density (lbs./ft^3.)	≥54
Screen analysis, (% through US 10), min.	100
(% through US 100), max.	5
(% through US 16), fines, min.	100*
(% through US 20), min.	95*

2.4 Special Requirements

N/A

2.5 Codes and Standards

Safety Related.

*Note for the Reader:

As an illustration of potential differences between this “example” set of specifications and the specifications by any particular utility, at least one utility noted that US 16 and US 20 Screen analysis specifications are not included in the utility’s COA for this material.

This does not identify all differences between this “example” set of specifications and the specifications used within the industry. It is only meant to highlight the fact, through an illustration case in point, that:

a) Individual utilities may not use all of the specifications and values listed for certain chemicals, and

b) Some utilities may use specification values that are lower or greater than those listed in this document or may not analyze for or evaluate for all listed parameters.

25 Phosphate, Monosodium (anhydrous)

CAS No. 755-80-7 Formula: NaH_2PO_4

1.0 General

Technical grade monosodium phosphate (MSP) is typically used in boiler water treatment applications. Also known as monosodium phosphate anhydrous, monobasic sodium phosphate anhydrous, anhydrous sodium biphosphate, sodium dihydrogen phosphate, and MSP

Material to be Furnished: anhydrous monosodium phosphate in powder or granular form

Intended Use: Anhydrous monosodium phosphate is typically used in conjunction with DSP or TSP in low pressure boiler applications.

2.0 Specification

Certificate of Analysis:

2.1 Chemical Composition

Chemical Composition	Weight Percent
Monosodium Phosphate (NaH_2PO_4), min.	98.0
Phosphate (P_2O_5), min.	58.0
Alkalinity (Na_2O), min.	25.4

2.2 Impurities

Impurities	Weight Percent
Insolubles (%), max.	0.05
Pyrophosphate, max	4.0
Moisture (H_2O), max	0.5

2.3 Physical Properties

Color	White
Form	Powder or Granular per order
Screen analysis, (% through US 100), powder, min.	90
(% through US100), granular, max.	20
pH of a 1% solution	4.4 – 5.0

2.4 Special Requirements

N/A

2.5 Codes and Standards

N/A

26 Phosphate, Disodium (anhydrous)

CAS No. 7558-79-4 Formula: Na_2HPO_4

1.0 General

Technical grade disodium phosphate (DSP), also known as phosphoric acid, disodium salt, is typically used in boiler water, and water treatment applications.

Material to be Furnished: anhydrous disodium phosphate in powder or granular form

Intended Use: Anhydrous diodium phosphate is typically used in conjunction with MSP and TSP in low pressure boiler applications.

2.0 Specification

Certificate of Analysis:

2.1 Chemical Composition

Chemical Composition	Weight Percent
Na_2HPO_4 concentration, min	97.0
Phosphate (P_2O_5), min.	48.0

2.2 Impurities

Impurities	Weight Percent
Insolubles (%), max.	0.1
Pyrophosphate, %, max.	2.0
Moisture (H_2O), %, max.	5.0

2.3 Physical Properties

Color	White
Form	Powder or Granular (as per order)
pH of a 1% solution	8.5 – 9.5
Screen analysis, (% through US 100), powder, min.	90
(% through US100), granular, max.	20

2.4 Special Requirements

N/A

2.5 Codes and Standards

N/A

27 Polyacrylic Acid (PAA) (PWR Secondary System Use)

CAS No. 9003-01-4 Formula: $(CH_2CH\ COOH)_n$

1.0 General

This specification is for a high purity polyacrylic acid dispersant.

Material to be Furnished: High purity polyacrylic acid should be supplied as a clear, colorless to pale yellow aqueous solution

Intended Use: Dispersant in PWR secondary water treatment systems.

2.0 Specification

Certificate of Analysis:

2.1 Chemical Composition

Chemical Composition	Weight Percent
Solids content (non-volatile), %, min.-max.	12.6-13.9
Polymer assay	9.6-10.4
Deionized water	balance

2.2 Impurities

Impurities	Weight Percent	Parts Per Million
Free Monomer (as acrylic acid) ppm, max.	0.0499	(499 ppm)
Isopropanol, ppm, max.	0.0999	(999 ppm)
Sodium, (Na), max.	0.0010	(10 ppm)
Chloride (Cl^-), max.	0.0010	(10 ppm)
Fluoride (F^-), max.	0.0010	(10 ppm)
Sulfate (SO_4^-), max.	0.0010	(10 ppm)
Copper (Cu), max.	0.0010	(10 ppm)
Total Iron (Fe), max.	0.0100	(100 ppm)
Lead, (Pb), max.	0.0001	(1 ppm)

2.3 Physical Properties

Physical Properties	Range
pH, neat	8.0-9.0

2.4 Special Requirements

N/A

2.5 Codes and Standards

N/A

28 Polyacrylic Acid (BOP)

CAS No. 9003-01-4, Formula: $(CH_2CH\ COOH)_n$

1.0 General

Polyacrylic acid is also known as PAA, acrylic acid polymer, and 2-propenoic acid homopolymer.

Material to be Furnished: PAA should be supplied as a colorless to pale yellow aqueous solution containing approximately 30 % solids content

Intended Use: PAA is used as a dispersant in balance of plant water treatment systems

2.0 Specification

Certificate of Analysis:

2.1	Chemical Composition	Weight Percent
	Solids content (PAA), %, min.	30
2.2	Impurities	Weight Percent
	Free Monomer (as acrylic acid, %, max.)	0.5
2.3	Physical Properties	Limit/Range
	pH, 1% solution, max.	3.0
2.4	Special Requirements	
	N/A	
2.5	Codes and Standards	
	N/A	

29 Potassium Hydroxide

CAS No. 1310-58-3 Formula: KOH

1.0 General

Potassium hydroxide (KOH) shall be ACS grade or meet the parameter limits noted in section 2.0. Potassium hydroxide is also known as caustic potash and potassium hydrate.

Material to be Furnished: ACS or meeting the parameter limits noted in section 2.0, and shall be supplied in pellet form.

Intended Use: Potassium hydroxide may be used to increase system pH as a substitute for sodium hydroxide, and/or where sodium activation is to be avoided.

2.0 Specification

Certificate of Analysis:

2.1 Chemical Composition — Weight Percent

Chemical Composition	Weight Percent
Assay (KOH), min.	85

2.2 Impurities — Weight Percent

Impurities	Weight Percent	
Potassium Carbonate (K_2CO_3), max.	1.0	(10,000 ppm)
Chloride (Cl^-), max.	0.01	(100 ppm)
Sulfate (SO_4^-), max.	0.002	(20 ppm)
Ammonium Hydroxide (NH_4OH), max.	0.02	(200 ppm)
Iron (Fe), max.	0.001	(10 ppm)
Heavy metals (as Ag), max.	0.001	(10 ppm)
Sodium (Na), max.	0.02	(200 ppm)
Nickel (Ni), max.	0.001	(10 ppm)

2.3 Physical Properties

Color: White
Form: Pellet

2.4 Special Requirements

Handling Precautions – Caustic

2.5 Codes and Standards

N/A

30 Resin, Nuclear Grade, Anion (OH-) Gel

1.0 General

A strongly basic anion exchange type 1 gel resin in the OH- form; comprised of quaternary ammonia exchange groups attached to a polystyrene-divinyl-benzene polymer lattice.

Material to be Furnished: Nuclear grade, spherical bead anion resin regenerated to convert to the hydroxide form, remove ionic and metal contaminants, and rinsed to remove traces of soluble organic compounds and minimize the amounts of ionic and metal contaminants. This resin may be purchased as uniform particle size beads or Gaussian distribution, as specified by purchaser.

Intended Use: For removal of radioactive and/or non-radioactive anionic impurities to produce high quality water. Typically used in system applications where the resin will not be regenerated and/or where resin separation is not needed.

2.0 Specification

Certificate of Analysis:

2.1

Impurities	Specification	Test Method
Sodium (Na), ppm, max.	≤ 30*	See
Iron (Fe), ppm, max.	≤ 40*	Appendix 3
Copper (Cu), ppm, max.	≤ 10	for
Aluminum (Al), ppm, max.	≤ 30*	Possible
Heavy Metals, (Pb, ppm), max.	≤ 10	Test Methods

2.2

Physical Properties	Specification	Test Method
Perfect/Whole Uncracked Beads, % max.	≥ 95	See
Total Wet Volume Capacity, (OH^-) (meq/ml)	≥ 1.1	Appendix 3
Salt Splitting Capacity (meq/l)	≥ 1.2	for
Eqv. % OH^-, min.	≥ 95	Possible
Eqv. % Cl^-, max.	≤ 0.2	Test Methods
Eqv. % $SO_4^=$, max. (1)	≤ 0.2	
Crush Strength, Ave. gm/bead	≥ 350	
Crush Strength, % >200 gm/bead	≥95	
Uniformity Coefficient, max.	≤1.20 (2)	
% Retained on 16 mesh (1200 μm)	≤ 2	
% Through 50 mesh (300 μm)	≤ 0.5	

(1) Only required if manufactured using a sulfate intermediate step

(2) Uniformity Coefficient is applicable only to uniform particle size resin i.e. not Gaussian distribution resin

2.3 Special Requirements

- As per Appendix 2.
- Some plants have storage and climate control specifications such as:
  - Minimum shelf life of 12 months
  - The vendor shall include freeze indicators on shipments made between October 15 and April 30.
  - Shipments from the vendor's warehouse to plants with less than 12 hours drive time do not need climate control due to the short duration of the trips unless specifically requested.
  - Shipments made between October 15 and April 30 with a duration longer than 12 hours and when the projected temperature is below 32°F shall be shipped in climate-controlled trailers unless specifically requested otherwise or temperature extremes are anticipated.

2.4 Codes and Standards

N/A

*Note for the Reader:

As an illustration of potential differences between this "example" set of specifications and the specifications by any particular utility, at least one utility noted that their specifications for Sodium (Na), Iron (Fe), and Aluminum (Al) are as follows:

Impurities	Weight Percent
Sodium (Na), ppm, max.	≤ 50
Iron (Fe), ppm, max.	≤ 50
Aluminum (Al), ppm, max.	≤ 50

This does not identify all differences between this "example" set of specifications and the specifications used within the industry. It is only meant to highlight the fact, through an illustration case in point, that:

a) Individual utilities may not use all of the specifications and values listed for certain chemicals, and

b) Some utilities may use specification values that are lower or greater than those listed in this document or may not analyze for or evaluate for all listed parameters.

31 Resin, Nuclear Grade Cation (H^+) Gel

1.0 General

A strongly acidic cation exchange gel resin in the H+ form; comprised sulfonic acid exchange groups attached to a polystyrene-divinyl-benzene polymer lattice.

Material to be Furnished: Nuclear grade, spherical bead cation resin in the hydrogen form, regenerated to remove traces of ionic and metal contaminants and rinsed to remove soluble organic compounds. May be uniform particle size or Gaussian distribution, as specified by purchaser.

Intended Use: For removal of radioactive and/or non-radioactive cationic impurities and excess lithium to produce high quality water. Typically used in system applications where the resin will not be regenerated and/or where resin separation is not needed.

2.0 Specification

Certificate of Analysis:

2.1

Impurities	Specification	Test Method
Sodium (Na), ppm, max.	≤ 40**	See Appendix 3 for Possible Test Methods
Iron (Fe), ppm, max.	≤ 50	
Copper (Cu), ppm, max.	≤ 10	
Aluminum (Al), ppm, max.	≤ 30**	
Calcium (Ca), ppm, max.	≤ 30**	
Magnesium (Mg), ppm, max.	≤ 30**	
Heavy Metals, (Pb ppm), max.	≤ 10	
Post UV Chloride (Cl^-), ppb, max. [1]	≤ 100	
Post UV Sulfates (SO_4^-), ppb, max	≤ 100	
Water Extractables (TOC), ppm, max	≤ 10	

[1] Documentation shall be provided assuring organic halide solvents are not used in the manufacturing process. If organic halide solvents are used in resin manufacture, the resin should be analyzed for Post UV Chloride, ppb, max. 100.

2.2

Physical Properties	Specification	Test Method
% Cross-Linked	[2]	See Appendix 3 for Possible Test Methods
Whole Uncracked Beads, % max.	≥ 95	
Total Exchange Capacity, (H^+) (meq/ml)	Variable depending on cross-linkage[3]	
% Moisture Holding Capacity	Report	
Eqv. % H^+, min.	≥ 99	
Crush Strength, Ave. gm/bead	≥ 500**	

Crush Strength, % >200 gm/bead	≥ 95
Uniformity Coefficient, max.	≤ 1.20[4]
Harmonic Mean Size, microns	Report
% Retained on 16 mesh (1200 μm)	≤ 2
% Through 40 mesh (420 μm)	≤ 5
% Through 50 mesh (300 μm)	≤ 0.5

(2) As reported by the manufacturer

(3) Specification for exchange capacity varies according to cross-linkage: 8% ≥ 1.8, 10% ≥ 2.0, 12% ≥ 2.2, 16% ≥ 2.4

(4) Uniformity Coefficient is applicable only to uniform particle size resin i.e. not Gaussian distribution resin

2.3 Special Requirements

- As per Appendix 2.
- Some plants have storage and climate control specifications such as:
  - Minimum shelf life of 24 months
  - The vendor shall include freeze indicators on shipments made between October 15 and April 30.
  - Shipments from the vendor's warehouse to plants with less than 12 hours drive time do not need climate control due to the short duration of the trips unless specifically requested.
  - Shipments made between October 15 and April 30 with a duration longer than 12 hours and when the projected temperature is below 32°F shall be shipped in climate-controlled trailers unless specifically requested otherwise.

2.4 Codes and Standards

N/A

**Note for the Reader:

As an illustration of potential differences between this "example" set of specifications and the specifications by any particular utility, at least one utility noted that their specifications for Sodium (Na), Aluminum (Al), Calcium (Ca), Magnesium (Mg), and Crush Strength are as follows:

Impurities	Specification
Sodium (Na), ppm, max.	≤ 50
Aluminum (Al), ppm, max.	≤ 50
Calcium (Ca), ppm, max.	≤ 50
Magnesium (Mg), ppm, max.	≤ 50

Physical Property	Specification
Crush Strength, Ave. gm/bead	≥ 350

This does not identify all differences between this "example" set of specifications and the specifications used within the industry. It is only meant to highlight the fact, through an illustration case in point, that:

a) Individual utilities may not use all of the specifications and values listed for certain chemicals, and

b) Some utilities may use specification values that are lower or greater than those listed in this document or may not analyze for or evaluate for all listed parameters.

32 Resin, Nuclear Grade Cation (^{7}Li) Gel

1.0 General

A strongly acidic cation exchange type 1 gel resin in the $^{7}Li^{+}$ form; comprised of sulfonic acid exchange groups cross-linked to a polystyrene-divinyl-benzene polymer lattice.

Material to be Furnished: Nuclear grade, spherical bead cation resin in the lithium form, enriched in the ^{7}Li isotope, and rinsed with deionized water to remove traces of soluble organic compounds and particulate impurities. May be uniform particle size or Gaussian distribution, as specified by purchaser.

Intended Use: For removal of radioactive and/or non-radioactive cationic impurities and excess lithium to produce high quality water. Typically used in reactor coolant system applications to exchange lithium-7 in place of hydrogen ions and cationic impurities. This resin is typically not regenerated.

2.0 Specification

Certificate of Analysis:

2.1

Impurities	Specification	Test Method
Sodium (Na), ppm, max.	≤ 40*	See Appendix 3 for Possible Test Methods
Iron (Fe), ppm, max.	≤ 50	
Copper (Cu), ppm, max.	≤ 10	
Aluminum (Al), ppm, max.	≤ 30*	
Calcium (Ca), ppm, max.	≤ 30*	
Magnesium (Mg), ppm, max.	≤ 30*	
Heavy Metals, (Pb ppm), max.	≤ 10	
Post UV Chloride (Cl^{-}), ppb, max (1)	≤ 100	
Water Extractables (TOC), ppm, max	≤ 10	

(1) Documentation shall be provided assuring organic halide solvents are not used in the manufacturing process. If organic halide solvents are used in resin manufacture, the resin should be analyzed for Post UV Chloride, ppb, max.100.

2.2

Physical Properties	Specification	Test Method
% Cross-Linked	(2)	See Appendix 3 for Possible Test Methods
Whole Uncracked Beads, % max.	≥ 96*	
Total Exchange Capacity, (H^{+}) (meq/ml)	Variable depending on cross-linkage (3)	
% Moisture Holding Capacity	Report	
Eqv. % Li^{+}, min.	≥ 99	

Isotopic composition as Lithium-7, % min.[4]	≥ 99.9
Crush Strength, Ave. gm./bead	≥ 500*
Crush Strength, % >200 gm/bead	≥ 95
Harmonic Mean Size, microns	Report
% Retained on 16 mesh (1200 µm)	≤ 2
% Through 40 mesh (420 µm)	≤ 2
% Through 50 mesh (300 µm)	≤ 0.3

(2) As reported by the manufacturer

(3) Specification for exchange capacity varies according to cross-linkage: 8% ≥ 1.8, 10% ≥ 2.0, 16% ≥ 2.4

(4) The isotopic composition of Lithium-7 is typically performed on the lithium hydroxide used to convert the cation resin to the ^{7}Li form

2.3 Special Requirements

- As per Appendix 2.
- Some plants have storage and climate control specifications such as:
  - Minimum shelf life of 24 months
  - The vendor shall include freeze indicators on shipments made between October 15 and April 30.
  - Shipments from the vendor's warehouse to plants with less than 12 hours drive time do not need climate control due to the short duration of the trips unless specifically requested.
  - Shipments made between October 15 and April 30 with a duration longer than 12 hours and when the projected temperature is below 32°F shall be shipped in climate-controlled trailers unless specifically requested otherwise.

2.4 Codes and Standards

N/A

*Note for the Reader:

As an illustration of potential differences between this "example" set of specifications and the specifications by any particular utility, at least one utility noted that their specifications for Sodium (Na), Aluminum (Al), Calcium (Ca), Magnesium (Mg), Whole Uncracked Beads (%), and Crush Strength as follows:

Impurities	Specification
Sodium (Na), ppm, max.	≤ 50
Aluminum (Al), ppm, max.	≤ 50
Calcium (Ca), ppm, max.	≤ 50
Magnesium (Mg), ppm, max.	≤ 50

Physical Property	Specification
Whole Uncracked Beads, % max.	≥ 95
Crush Strength, Ave. gm./bead	≥ 350

This does not identify all differences between this "example" set of specifications and the specifications used within the industry. It is only meant to highlight the fact, through an illustration case in point, that:

a) Individual utilities may not use all of the specifications and values listed for certain chemicals, and

b) Some utilities may use specification values that are lower or greater than those listed in this document or may not analyze for or evaluate for all listed parameters.

33 Resin, Nuclear Grade (Mixed) Gel

1.0 General

A mixed resin comprised of strongly acidic cation exchange gel resin in the H^+ or $^7Li^+$ form (as specified) and strongly basic Type 1 anion exchange resin in the OH^- form.

Material to be Furnished: Mixed nuclear grade cation and anion resins. The cation component shall be a spherical bead cation resin in the hydrogen or lithium form (as specified), with the lithium enriched in the ^7Li isotope. The anion component shall be a nuclear grade spherical bead anion resin. The cation and anion resins shall be regenerated separately, mixed to approximately equal equivalents of cation and anion exchange capacity, and rinsed to remove traces of soluble organic compounds and particulate impurities. Resin beads may be uniform particle size or Gaussian distribution, as specified by the purchaser.

Intended Use: For removal of radioactive and/or non-radioactive cationic and anionic impurities in reactor coolant systems. This resin is typically not regenerated following use and is not intended to be separated into cation and anion components.

2.0 Specification

Nuclear grade resin mixes shall be comprised of nuclear grade cation resin in the H^+ or $^7Li^+$ form mixed with nuclear grade anion resin in the OH^- form. All resins shall be mixed to provide a stoichiometric cation:anion equivalence, unless otherwise specified, and shall meet the following applicable specifications:

- Anion, OH^- Specification 30
- Cation H^+ Specification 31
- Cation $^7Li^+$ Specification 32

2.1 Special Requirements

As per Appendix 2.

2.2 Codes and Standards

N/A

34 Resin, Condensate Polishing/Demineralizer, Anion (OH^-) Gel

1.0 General

A strongly basic anion exchange type 1 gel resin in the OH^- form; comprised of quaternary ammonia exchange groups attached to a styrene-divinyl-benzene polymer lattice.

Material to be Furnished: Nuclear grade, spherical bead anion resin in the hydroxide form, regenerated to remove ionic and metal contaminants and rinsed to remove traces of soluble organic compounds and particulate impurities. May be uniform particle size or Gaussian distribution, as specified by the purchaser.

Intended Use: For use in condensate polishing vessels and/or demineralizer systems to remove anionic contaminants and produce high quality water. Typically used in system applications where the resin will be regenerated and/or where resin separation is desired.

2.0 Specification

Certificate of Analysis:

2.1

Impurities	Specification	Test Method
Sodium (Na), ppm, max.	≤ 30*	See
Iron (Fe), ppm, max.	≤ 50	Appendix 3
Copper (Cu), ppm, max.	≤ 10	for
Aluminum (Al), ppm, max.	≤ 30*	Possible
Heavy Metals, (Pb ppm), max.	≤ 20	Test Methods
Post UV Chloride (Cl^-), ppb, max. rinse[(1)]	≤ 100	
Post UV Sulfate (SO_4^-), ppb, max. rinse[(1)]	≤ 100	
Water Extractables/TOC (16 hour soak), ppm, max. [(1)]	≤ 30*	

2.2

Physical Properties	Specification	Test Method
Whole Uncracked Beads, % max.	≥ 95	See
Total Wet Volume Capacity, (OH^-) (meq/ml)	≥ 1.1	Appendix 3
Salt Splitting Capacity (meq/l)	≥ 1.2	for
Eqv. % OH^-, min.	≥ 94	Possible
Eqv. % Cl^-, max.	≤ 0.2	Test Methods
Eqv. % $SO_4^=$, max. [(2)]	≤ 0.2	
Crush Strength, Ave. gm./bead	≥ 350	
Crush Strength, % >200 gm/bead	≥95	
Uniformity Coefficient, max.	≤ 1.20[(3)]	
Bead Diameter Volume Mean, microns	540-640	

% Retained on 16 mesh (1200 µm)	≤ 2
% Through 50 mesh (300 µm)	≤ 0.5

(1) Optional, currently no resin manufacturers perform this analysis; if analysis is desired by the utility, a resin distributor or testing laboratory can perform the analysis

(2) Only required if manufactured using a sulfate intermediate step

(3) Only applicable to uniform particle size resin i.e. not Gaussian distribution resin

2.3 Special Requirements

- As per Appendix 2.
- Some plants have storage and climate control specifications such as:
  - Minimum shelf life of 12 months
  - The vendor shall include freeze indicators on shipments made between October 15 and April 30.
  - Shipments from the vendor's warehouse to plants with less than 12 hours drive time do not need climate control due to the short duration of the trips unless specifically requested.
  - Shipments made between October 15 and April 30 with a duration longer than 12 hours and when the projected temperature is below 32°F shall be shipped in climate-controlled trailers unless specifically requested otherwise.

2.4 Codes and Standards

N/A

*Note for the Reader:

As an illustration of potential differences between this "example" set of specifications and the specifications by any particular utility, at least one utility noted that their specifications for Sodium (Na), Aluminum (Al), and water extractables are as follows:

Impurities	Specification
Sodium (Na), ppm, max.	≤ 50
Aluminum (Al), ppm, max.	≤ 50
Water Extractables/TOC (16 hour soak), ppm, max.	≤ 100

This does not identify all differences between this "example" set of specifications and the specifications used within the industry. It is only meant to highlight the fact, through an illustration case in point, that:

a) Individual utilities may not use all of the specifications and values listed for certain chemicals, and

b) Some utilities may use specification values that are lower or greater than those listed in this document or may not analyze for or evaluate for all listed parameters.

35 Resin, Condensate Polishing/Demineralizer Cation (H^+) Gel

1.0 General

A strongly acidic cation exchange gel resin in the H^+ form; comprised of sulfonic acid exchange groups attached to a polystyrene-divinyl-benzene polymer lattice.

Material to be Furnished: High quality, spherical bead cation resin in the hydrogen form, regenerated to remove traces of ionic and metal contaminants and rinsed to remove soluble organic compounds and particulate impurities. May be uniform particle size or Gaussian distribution, as specified by purchaser.

Intended Use: For removal of cationic impurities to produce high quality water. Typically used in system applications where the resin will be regenerated.

2.0 Specification

Certificate of Analysis:

2.1

Impurities	Specification	Test Method
Sodium (Na), ppm, max.	≤ 50	See
Iron (Fe), ppm, max.	≤ 50	Appendix 3
Copper (Cu), ppm, max.	≤ 10	for
Aluminum (Al), ppm, max.	≤ 30*	Possible
Heavy Metals, (Pb ppm), max.	≤ 10	Test Methods
TOC (16 hr. soak) ppm, max.	≤ 10*	
Post UV Chloride (Cl^-), ppm, max.[1]	≤ 100	

[1] Documentation shall be provided assuring organic halide solvents are not used in the manufacturing process. If organic halide solvents are used in resin manufacture, the resin should be analyzed for Post UV Chloride, ppb, max. 100.

2.2

Physical Properties	Specification	Test Method
% Cross-Linked	[1]	See
Whole Uncracked Beads, % max.	≥ 95	Appendix 3
Total Wet Volume Capacity, (H^+) (meq/ml)	Variable depending on cross-linkage[2]	for Possible Test Methods
% Moisture Holding Capacity	Report	
Eqv. % H^+, min.	≥ 99	
Crush Strength, Ave. gm./bead	≥ 500*	
Crush Strength, % >200 gm/bead	≥ 95, or	
Crush Strength, % >300 gm/bead	>85	
Uniformity Coefficient, max.	≤ 1.20[3]	

Harmonic Mean Size, microns	1.2[3]
% Retained on 16 mesh (1200 µm)	≤ 2
% Through 40 mesh (420 µm)	≤ 2.0
% Through 50 mesh (300 µm)	≤ 0.5

[1] As reported by the manufacturer

[2] Specification for exchange capacity varies according to cross-linkage: 8% ≥ 1.8, 10% ≥ 2.0, 12% ≥ 2.2, 16% ≥ 2.4

[3] Applicable only to uniform particle size resin i.e. not Gaussian distribution resin

2.3 Special Requirements

- As per Appendix 2.
- Some plants have storage and climate control specifications such as:
  - Minimum shelf life of 24 months
  - The vendor shall include freeze indicators on shipments made between October 15 and April 30.
  - Shipments from the vendor's warehouse to plants with less than 12 hours drive time do not need climate control due to the short duration of the trips unless specifically requested.
  - Shipments made between October 15 and April 30 with a duration longer than 12 hours and when the projected temperature is below 32°F shall be shipped in climate-controlled trailers unless specifically requested otherwise.

2.4 Codes and Standards

N/A

*Note for the Reader:

As an illustration of potential differences between this "example" set of specifications and the specifications by any particular utility, at least one utility noted that their specifications for Aluminum (Al), TOC, and Crush Strength are as follows:

Impurities	Specification
Aluminum (Al), ppm, max.	≤ 50
TOC (Water extractables), ppm, max	≤ 100

Physical Properties	Specification
Crush Strength, Ave. gm./bead	≥ 350

This does not identify all differences between this "example" set of specifications and the specifications used within the industry. It is only meant to highlight the fact, through an illustration case in point, that:

a) Individual utilities may not use all of the specifications and values listed for certain chemicals, and

b) Some utilities may use specification values that are lower or greater than those listed in this document or may not analyze for or evaluate for all listed parameters.

36 Resin, Anion (OH^-) Macroporous (Macroreticular)

1.0 General

A strongly basic anion exchange macroporous resin in the OH^- form.

Material to be Furnished: Nuclear grade, spherical bead anion resin in the hydroxide form, regenerated to remove ionic and metal contaminants and rinsed to remove traces of soluble organic compounds and particulate impurities.

Intended Use: For use in condensate polishing vessels and/or demineralizer systems to remove anionic contaminants and produce high quality water.

2.0 Specification

Certificate of Analysis:

2.1 Impurities

Impurities	Specification	Test Method
Sodium (Na), ppm, max.	≤ 30	See
Iron (Fe), ppm, max.	≤ 50	Appendix 3
Copper (Cu), ppm, max.	≤ 10	for
Aluminum (Al), ppm, max.	≤ 50	Possible
Heavy Metals (Pb ppm), max.	≤ 10	Test Methods
Rinseable Chloride (Cl^-), ppm max.	≤ 0.1	
Rinseble Sulfate (SO_4^-), ppm, max.	≤ 0.1	

2.2 Physical Properties

Physical Properties	Specification	Test Method
Whole Uncracked Beads, % max.	≥ 95	See
Total Wet Volume Capacity, (OH^-) (meq/ml)	≥ 0.6	Appendix 3
Eqv. % OH^-, min.	≥ 95	for
Eqv. % CO_3^{-2}, max.	≤ 5	Possible
Eqv. % Cl^-, max.	≤ 0.1	Test Methods
Eqv. % SO_4^-, max.[1]	≤ 0.2	
Harmonic Mean Size, microns	Report	
% Retained on 16 mesh (1200 µm)	≤ 5	
% Through 40 mesh (420 µm)	≤ 5	
% Through 50 mesh (300 µm)	≤ 0.5	

[1] Only required if manufactured using a sulfate intermediate step

2.3 Special Requirements
As per Appendix 2

2.4 Codes and Standards
N/A

37 Resin, Cation (H^+) Macroporous (Macroreticular)

1.0 General

A macroporous/macroreticular cation resin in the H^+ form.

Material to be Furnished: High quality spherical bead cation resin in the hydrogen form, regenerated to remove ionic and metal contaminants and rinsed to remove traces of soluble organic compounds and particulate impurities.

Intended Use: For removal of cationic impurities to produce high quality water.

2.0 Specification

Certificate of Analysis:

2.1

Impurities	Specification	Test Method
Sodium (Na), ppm, max.	≤ 40	See
Iron (Fe), ppm, max.	≤ 50	Appendix 3
Copper (Cu), ppm, max.	≤ 10	for
Aluminum (Al), ppm, max.	≤ 40	Possible
Calcium (Ca), ppm, max.	≤ 50	Test Methods
Magnesium (Mg), ppm, max.	≤ 40*	
Heavy Metals, (Pb ppm), max.	≤ 20	
Post UV Chloride (Cl^-), ppb, max.[1]	≤ 100	
Water Extractables, % max.	≤ 0.04	

[1] Documentation shall be provided assuring organic halide solvents are not used in the manufacturing process. If organic halide solvents are used in resin manufacture, the resin should be analyzed for Post UV Chloride, ppb, max. 100.

2.2

Physical Properties	Specification	Test Method
% Cross-Linked	[2]	See
Whole Uncracked Beads, % max.	≥ 95	Appendix 3
Total Wet Volume Capacity, (H^+) (meq/ml)	≥ 1.7	for
Eqv. % H^+, min.	≥ 99.5	Possible
Crush Strength, Ave. gm./bead	≥ 500*	Test Methods
Crush Strength, % >200 gm/bead	≥ 95	
Harmonic Mean Size, microns	Report	
% Retained on 16 mesh (1200 µm)	≤ 3	
% Through 40 mesh (420 µm)	≤ 3	
% Through 50 mesh (300 µm)	≤ 0.5	

[2] As reported by the manufacturer

2.3 Special Requirements

- As per Appendix 2.
- Some plants have storage and climate control specifications such as:
  - Minimum shelf life of 24 months
  - The vendor shall include freeze indicators on shipments made between October 15 and April 30.
  - Shipments from the vendor's warehouse to plants with less than 12 hours drive time do not need climate control due to the short duration of the trips unless specifically requested.
  - Shipments made between October 15 and April 30 with a duration longer than 12 hours and when the projected temperature is below 32°F shall be shipped in climate-controlled trailers unless specifically requested otherwise.

2.4 Codes and Standards

N/A

*Note for the Reader:

As an illustration of potential differences between this "example" set of specifications and the specifications by any particular utility, at least one utility noted that their specifications for Magnesium (Mg) and Crush Strength are as follows:

Impurities	Weight Percent
Magnesium (Mg), ppm, max.	≤ 50

Physical Properties	Specification
Crush Strength, Ave. gm./bead	≥ 350

This does not identify all differences between this "example" set of specifications and the specifications used within the industry. It is only meant to highlight the fact, through an illustration case in point, that:

a) Individual utilities may not use all of the specifications and values listed for certain chemicals, and

b) Some utilities may use specification values that are lower or greater than those listed in this document or may not analyze for or evaluate for all listed parameters.

38 Resin, CP Anion Powdered (OH^-)

1.0 General

A strongly basic anion exchange gel resin in the OH^- form; comprised of quaternary ammonia exchange groups attached to a polystyrene-divinyl-benzene polymer lattice.

Material to be Furnished: Nuclear grade, powdered bead anion resin in the hydroxide form, regenerated to remove ionic and metal contaminants and rinsed to remove traces of soluble organic compounds and particulate impurities.

Intended Use: For use in powdered resin condensate polishing vessels to remove anionic contaminants and produce high quality water.

2.0 Specification

Certificate of Analysis:

2.1

Impurities	Specification	Test Method
Sodium (Na), ppm, max.	≤ 10*	See
Iron (Fe), ppm, max.	≤ 50	Appendix 3
Copper (Cu), ppm, max.	≤ 10	for
Aluminum (Al), ppm, max.	≤ 50	Possible
Carbonate (CO_3^{-2}), ppm, max.	≤ 5	Test Methods
Heavy Metals, (Pb ppm), max.	≤ 10	
Water Extractables, % max.	≤ 0.1	

2.2

Physical Properties	Specification	Test Method
Total Exchange Capacity, (OH-) (meq/ml)	≥ 4.0	See
Eqv. % OH^-, min.	≥ 95	Appendix 3
Eqv. % CO_3^{-2}, max.	≤ 5.0(1)	for
Eqv. % Cl^-, max.	≤ 0.25	Possible
Eqv. % SO_4^-, max.(2)	≤ 0.25	Test Methods
Moisture Content	53-60 wt%	
Whole bead content, % retained on 60 mesh	≤ 6	
V/V	Report test results(3)	

(1) Initial evaluation only, carbonate is expected to increase upon storage

(2) Only required if manufactured using a sulfate intermediate step

(3) Applicable to orders of both anion and cation resins. Utility must specify the cation (H^+ and/or NH_4 form) and cation to anion resin ratios to test.

2.3 Special Requirements

- As per Appendix 2
- The seller shall ensure that the resins are capable of a shelf life of at least 12 months from date of receipt.*

2.4 Codes and Standards

N/A

*Note for the Reader:

As an illustration of potential differences between this "example" set of specifications and the specifications by any particular utility, at least one utility noted that their specifications for Sodium (Na) are as follows:

Impurities	Specification
Sodium (Na), ppm, max.	≤ 35

At least one utility noted that their specification for the shelf life of this resin is 6 months.

This does not identify all differences between this "example" set of specifications and the specifications used within the industry. It is only meant to highlight the fact, through an illustration case in point, that:

a) Individual utilities may not use all of the specifications and values listed for certain chemicals, and

b) Some utilities may use specification values that are lower or greater than those listed in this document or may not analyze for or evaluate for all listed parameters.

39 Resin, CP Cation Powdered (H^+)

1.0 General

A strongly acidic cation exchange gel resin in the H^+ form; comprised of sulfonic acid exchange groups attached to a polystyrene-divinyl-benzene polymer lattice.

Material to be Furnished: Nuclear grade, powdered bead cation resin in the hydrogen form, regenerated to remove ionic and metal contaminants and rinsed to remove soluble organic compounds and particulate impurities.

Intended Use: For use in powdered resin condensate polishing vessels to remove cationic contaminants and produce high quality water.

2.0 Specification

Certificate of Analysis:

2.1

Impurities	Specification	Test Method
Sodium (Na), ppm, max.	≤ 10*	See
Iron (Fe), ppm, max.	≤ 50	Appendix 3
Copper (Cu), ppm, max.	≤ 10	for
Aluminum (Al), ppm, max.	≤ 50	Possible
Heavy Metals, (Pb ppm), max.	≤ 10	Test Methods
Water Extractables, % max.	≤ 0.1	
Total Chlorine (Cl), ppm, max.	(1)	

(1) Documentation shall be provided assuring organic halide solvents are not used in the manufacturing process. If organic halide solvents are used in resin manufacture, the resin should be analyzed for Post UV Chloride (Cl^-), ppb, max. 100.

2.2

Physical Properties	Specification	Test Method
Total Exchange Capacity, (H^+) (meq/ml)	≥ 4.8	See
Eqv. % H^+, min.	≥ 99	Appendix 3
Moisture Content	55-62 wt%	for
Whole bead content, % retained on 60 mesh	≤ 6	Possible
V/V	Report test results[1]	Test Methods

(1) Applicable to orders of both anion and cation resins. Utility must specify the cation (H+ and/or NH_4 form) and cation to anion resin ratios to test.

2.3 Special Requirements

- As per Appendix 2

- The seller shall ensure that the resins are capable of a shelf life of at least 24 months from date of receipt.*

2.4 Codes and Standards

N/A.

*Note for the Reader:

As an illustration of potential differences between this “example” set of specifications and the specifications by any particular utility, at least one utility noted that their specifications for Sodium (Na) are as follows:

Impurities	Specification
Sodium (Na), ppm, max.	≤ 35

At least one utility noted that their specification for the shelf life of this resin is 18 months.

This does not identify all differences between this “example” set of specifications and the specifications used within the industry. It is only meant to highlight the fact, through an illustration case in point, that:

a) Individual utilities may not use all of the specifications and values listed for certain chemicals, and

b) Some utilities may use specification values that are lower or greater than those listed in this document or may not analyze for or evaluate for all listed parameters.

40 Resin, CP Cation Powdered (NH_4^+)

1.0 General

A strongly acidic cation exchange gel resin in the ammonia form; comprised of quaternary ammonia exchange groups attached to a polystyrene-divinyl-benzene polymer lattice.

Material to be Furnished: Nuclear grade, powdered bead cation resin in the ammonia form, regenerated to remove ionic and metal contaminants and rinsed to remove traces of soluble organic compounds and particulate impurities.

Intended Use: For use in powdered resin condensate polishing vessels to replace cationic contaminants with ammonia and to produce high quality water.

2.0 Specification

Certificate of Analysis:

2.1

Impurities	Specification	Test Method
Sodium (Na), ppm, max.	≤ 10	See
Iron (Fe), ppm, max.	≤ 30	Appendix 3
Copper (Cu), ppm, max.	≤ 10	for
Heavy Metals, (Pb ppm), max.	≤ 10	Possible
Water Extractables, % max.	≤ 0.1	Test Methods
Total Chlorine (Cl), ppm, max.	(1)	

(1) Documentation shall be provided assuring organic halide solvents are not used in the manufacturing process. If organic halide solvents are used in resin manufacture, the resin should be analyzed for Post UV Chloride, ppb, max. 100.

2.2

Physical Properties	Specification	Test Method
Total Exchange Capacity, (NH_4^+) (meq/ml)	≥ 4.5	See
Eqv. % NH_4^+, min.	≥ 95	Appendix 3
Whole bead content, % retained on 60 mesh	≤ 6	for
V/V	Report test results[2]	Possible
		Test Methods

(2) Applicable to orders of both anion and cation resins. Utility must specify the cation (H^+ and/or NH_4 form) and cation to anion resin ratios to test.

2.3 Special Requirements

- As per Appendix 2
- The seller shall ensure that the resins are capable of a shelf life of at least 6 months from date of receipt.

2.4 Codes and Standards

N/A

41 Resin, Carbon Material/Fiber (for use in condensate polishing vessels)

1.0 General

A multifunctional purification media combining both adsorptive and filtering capabilities, capable of removing organics, free metals, and chelated metals. The product may contain particles of activated carbon and ion exchange resin affixed to a cellulose base.

Material to be Furnished: Moist powder aggregate, predominantly black in color with white specs.

Intended Use: Primarily used in powdered resin vessel radwaste applications to remove free metals, chelated metals, and organics; and to prevent resin fouling.

2.0 Specification

Certificate of Analysis:

2.1 Impurities

Impurities	Specification	Test Method
Sodium (Na), ppm, max.	≤ 10**	See Appendix 3 for Possible Test Methods
Iron (Fe), ppm, max.	≤ 50	
Copper (Cu), ppm, max.	≤ 10	
Heavy Metals, (Pb ppm), max.	≤ 10	
Chloride (Cl^-), ppm, max.	≤ 50	
Fluoride (F^-), ppm, max.	≤ 50	
Sulfate (SO_4^-), ppm, max.	≤ 50	
Aluminum (Al), ppm, max.	≤ 40	
Total Ash, ppm, max.	≤ 150	
Total Organic Carbon, ppm, max.	≤ 2000 (dry weight)	

2.2 Physical Properties

Physical Properties	Specification	Test Method
Ground black aggregate with white specs.*	NA	NA

* Only applies to carbon material resin

2.3 Special Requirements

Shelf life 2 year from date of shipment**

2.4 Codes and Standards

N/A.

**Note for the Reader:

As an illustration of potential differences between this “example” set of specifications and the specifications by any particular utility, at least one utility noted that their specifications for Sodium (Na) are as follows:

Impurities	Specification
Sodium (Na), ppm, max.	≤ 50

At least one utility noted that their specification for the shelf life of this resin is 1 year from date of manufacture.

This does not identify all differences between this “example” set of specifications and the specifications used within the industry. It is only meant to highlight the fact, through an illustration case in point, that:

a) Individual utilities may not use all of the specifications and values listed for certain chemicals, and

b) Some utilities may use specification values that are lower or greater than those listed in this document or may not analyze for or evaluate for all listed parameters.

42 Sodium Hydroxide (25% to 50% solutions, Safety Related or Non-Safety Related)

CAS No. 1310-73-2, Formula: NaOH

1.0 General

Material to be Furnished: Typically furnished as a 50% solution but can be purchased at lower concentrations such as 25 % or 35% solutions. Sodium hydroxide solutions shall be made from a 50 percent sodium hydroxide solution meeting the specifications noted in 2.0 and diluted with deionized water to the appropriate percent concentration.

Intended Use:

- Non-Safety Related: Sodium hydroxide is typically used to regenerate demineralizer and/or condensate polishing anion resins.
- Safety Related: Sodium hydroxide purchased as Safety Related is intended for use in chemical injection tanks for possible injection into containment spray water to achieve an alkaline pH.

2.0 Specification

Certificate of Analysis:

2.1

Chemical Composition	Weight Percent		Test Method
Assay %, (NaOH) content	49-52	--	ASTM-E291 8-14
Sodium oxide (Na_2O)	38-39.9	--	ASTM-E291 8-14

2.2

Impurities	Weight Percent		Test Method
Aluminum, (Al_2O_3), max.	0.0003	(3 ppm)	
Iron, (Fe), max.	0.0003	(3 ppm)	ASTM E291 41-49
Mercury, (Hg), max.[(1)]	0.00005	(0.5 ppm)*	ASTM E538
Copper, (Cu), max.	0.00002	(0.2 ppm)	
Lead, (Pb), max.	0.0001	(1 ppm)	
Nickel (Ni), max.	0.00006	(0.6 ppm)	
Manganese (Mn), max.	0.00002	(0.2 ppm)	
Calcium (CaO), max.	0.0003	(3 ppm)	
Magnesium (MgO), max.	0.00006	(0.6 ppm)	
Sodium carbonate, (Na_2CO_3), max.	0.05	(500 ppm)	ASTM-E291 15-24
Sodium chloride (NaCl), max.	0.006	(60 ppm)*	ASTM E291 34-40
Sodium chlorate ($NaClO_3$), max.	0.0010	(10 ppm)	
Sodium sulfate (Na_2SO_4), max.	0.0025	(25 ppm)	ASTM E291 50-56
Total Silica	0.0010	(10 ppm)	

2.3 Physical Properties

Appearance: Colorless and Clear with no foreign material

2.4 Special Requirements

(1) Mercury analysis required only if Mercury Cell caustic is purchased

2.5 Codes and Standards

Safety Related (for safety related uses.)

*Note for the Reader:

As an illustration of potential differences between this "example" set of specifications and the specifications by any particular utility, at least one utility noted that their specifications for Mercury (Hg) and Sodium Chloride (NaCl) are as follows:

Impurities	Weight Percent	
Mercury, (Hg), max.	0.0001	(1 ppm)
Sodium chloride (NaCl), max.	0.01	(100 ppm)

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43 Sodium Hypochlorite

CAS No. 7681-52-9, Formula: NaOCl

1.0 General

Material to be Furnished: Sodium hypochlorite should appear as a clear greenish yellow liquid, free of sediment and suspended matter.

Intended Use: Sodium hypochlorite is typically used as a biocide. In applications where color, turbidity, and minimal decomposition are important, filtered sodium hypochlorite should be specified, in all other applications, unfiltered sodium hypochlorite may be used.

2.0 Specification

Certificate of Analysis:

2.1 <u>Chemical Composition</u> / <u>Weight Percent</u>

Chemical Composition	Weight Percent	
Available Chlorine (Cl) (w/w%)	11.9-14.8	(143-187 gpl)
NaOCl, (w/w%)	12.5-15.6	
Excess/Free Caustic (NaOH), %**	0.1 - 1.1	

<u>Chemical Property</u>

pH	11.86-13.0*

2.2 <u>Impurities</u>

NA

2.3 <u>Physical Properties</u>**

- Specific Gravity, @ 20°C Report
- Clear greenish yellow liquid, free of sediment and suspended matter

2.4 <u>Special Requirements</u>**

Filtered (through a 0.5 – 1.0 micron filter) sodium hypochlorite should be specified if needed to remove traces of iron, copper, nickel, and/or cobalt.

* Note: Hypochlorite greater than pH 13.0 may decompose at a slightly higher rate than hypochlorite that is within the listed pH range.

** The presence of iron in excess of 1 ppm will result in a brownish tinge and formation of brown sediments. Nickel in concentrations >0.1 ppm will result in formation of a black sediment and catalytic decomposition of bleach (OCl^- to O_2 via reaction $2\ NaOCl \rightarrow O_2 + 2\ NaCl$) at a rate ~0.08% per day. Copper and cobalt will also result in decomposition, although at a slower rate. Iron, calcium, and magnesium will form sediment and result in discoloration, but will not result in solution decomposition. Filtering will effectively remove these contaminants.

*** A small amount of excess caustic retards decomposition due to sunlight.

2.5 Codes and Standards

N/A

44 Sodium Bromide (solution)

CAS No. 7647-15-6, Formula: NaBr + water

1.0 General

Material to be Furnished: Sodium bromide should appear as a clear to slightly yellow liquid, free of sediment and suspended matter.

Intended Use: Sodium bromide is typically used in conjunction with sodium hypochlorite as a biocide

2.0 Specification

Certificate of Analysis:

2.1 Chemical Composition

Chemical Composition	Weight Percent
Sodium Bromide (NaBr)	35 – 46
Total hardness, as $CaCO_3$, ppm, max	20

2.2 Impurities

Not specified

2.3 Physical Properties

Clear greenish yellow liquid, free of sediment and suspended matter

2.4 Special Requirements

N/A

2.5 Codes and Standards

N/A

45 Sulfuric Acid

CAS No. 7664-93-9, Formula: H_2SO_4

1.0 General

Material to be Furnished: Sulfuric acid is available in both a technical grade and a more pure Electrolytic Grade. This specification covers sulfuric acid having either a concentration of approximately 75% (Technical Grade) or 93+% percent (Technical or Electrolytic Grade)

Intended Use: The higher purity Electrolytic Grade Sulfuric acid is typically used to regenerate cation resin. The less expensive technical grade is added to reduce pH e.g. in cooling towers

2.0 Specification

Certificate of Analysis:

2.1 Electrolytic Grade

2.1.1 Chemical Composition — Weight Percent

Chemical Composition	Weight Percent
Assay %, (H_2SO_4) content, min.	93 (66° Be)

2.1.2 Impurities — Weight Percent

Impurities	Weight Percent
Chloride (Cl), max.	0.001 (10 ppm)
Iron (Fe), total, max.	0.004 (40 ppm)*
Lead (Pb), max.	0.0005 (5 ppm)
Sodium (Na), max.	0.001 (10 ppm)

2.1.3 Physical Properties — Limit

Physical Properties	Limit
• Color [1]	Colorless to slightly yellow
• Turbidity	Clear to slightly turbid
• Sediment	Free of sediment

[1] APHA ≤ 40, or light transmission ≥ 90% may be substituted for the colorless and clear specification

2.1.4 Special Requirements

N/A

2.1.5 Codes and Standards

N/A

*Note for the Reader:

As an illustration of potential differences between this "example" set of specifications and the specifications by any particular utility, at least one utility noted that their specifications for Iron (Fe) are as follows:

Impurities	Weight Percent
Iron (Fe), total, max.	0.005 (50 ppm)

This does not identify all differences between this "example" set of specifications and the specifications used within the industry. It is only meant to highlight the fact, through an illustration case in point, that:

a) Individual utilities may not use all of the specifications and values listed for certain chemicals, and

b) Some utilities may use specification values that are lower or greater than those listed in this document or may not analyze for or evaluate for all listed parameters.

2.2 Technical Grade 75% or 93%

2.2.1 Chemical Composition

Chemical Composition	Weight Percent	
Assay %, (H_2SO_4) content, min.	74 - 78%, or	92.5 - 94.5%

2.2.2 Impurities

Impurities	Weight Percent	
Iron, total, max.	0.005	(50 ppm)
Nitrogen Compounds (N), max.	0.002	(20 ppm)
Arsenic (As), max.	0.00002	(0.2 ppm)
Organics, max.	0.01	(100 ppm)

2.2.3 Physical Properties

Physical Properties	Limit
• Specific Gravity ($SG_{60/60F}$)	1.66-1.71 (75%) 183.184 (95%)
• Color [1]	Colorless to slightly yellow
• Turbidity	Clear to slightly turbid
• Sediment	Free of sediment
• Freezing Point	-35°F (-37°C) for 75% -26°F (-32°C) for 93%[2]

[1] APHA ≤ 40, or light transmission ≥ 90% may be substituted for the colorless and clear specification

[2] Various references also provide a value of -21°F (-29°C) for this material.

2.2.4 Special Requirements

N/A

2.2.5 Codes and Standards

N/A

46 TTA (Tolyltriazole)

CAS No. 29385-43-1, Formula: $C_7H_7O_3$

1.0 General

TTA is synonymous with Tolyltriazole, tolutriazole, 5-methylbenzoltriazole, 5-methyl-1,2,3-beenzotriazole, methyl-1H-benzotriazole.

Material to be Furnished: Technical grade product delivered as a white to almost white crystal (solid form), or delivered as a clear red-brown liquid, free of suspended matter.

Intended Use: TTA is typically used as a copper/brass corrosion inhibitor

2.0 Specification

Certificate of Analysis:

2.1 Solid Powder/Crystals

2.1.1 Chemical Composition

Chemical Composition	Weight Percent	
Tolyltriazole, min.	99.0	--

2.1.2 Impurities

Impurities	Weight Percent	
Moisture, max.	0.2	--
Fluoride (F^-), max.	0.1*	(1,000 ppm)
Ash Content, max.	0.1	

* when diluted to a 50±2% by weight solution

2.1.3 Physical Properties

None

2.1.4 Special Requirements

N/A

2.1.5 Codes and Standards

N/A

2.2 Liquid

2.2.1 Chemical Composition — Weight Percent

Chemical Composition	Weight Percent	
TTA, ($Na + C_7H_7O_3$), min.	48-52	--

2.2.2 Impurities — Weight Percent

Impurities	Weight Percent	
Fluoride (F^-), max.	0.1	(1,000 ppm)

2.2.3 Physical Properties

None

2.2.4 Special Requirements

N/A

2.2.5 Codes and Standards

N/A

47 Zinc Acetate (Depleted in ^{64}Zn)

CAS No. 5970-45-6, Formula: $(CH_3COO)_2\ Zn \bullet 2H_2O$

1.0 General

Depleted zinc acetate dihydrate (DZA), also known as zinc diacetate is depleted in Zinc-64 to minimize neutron activation of ^{64}Zn to ^{65}Zn. Zinc is added as an aid to reduce source term and/or minimize the potential for cracking.

Material to be Furnished: Depleted zinc acetate dihydrate should appear as a dry white crystalline or powder and shall meet the specifications noted below.

Intended Use: Zinc acetate is added to PWR reactor coolant systems as a water-soluble carrier for zinc.

2.0 Specification

Certificate of Analysis:

2.1 Chemical Composition

Chemical Composition	Weight Percent	
Zinc Acetate Dihydrate, min.	99.8	--
^{64}Zn isotope, atom percent, max.	1.0	--

2.2 Impurities

Impurities	Weight Percent	
Chloride (Cl^-), max.	0.002	(20 ppm)*
Fluoride (F^-), max.	0.002	(20 ppm)*
Sodium (Na), max.	0.001	(10 ppm)*
Sulfate (SO_4^-), max.	0.005	(50 ppm)
Aluminum (Al), max.	0.005	(50 ppm)*
Calcium (Ca), max.	0.001	(10 ppm)*
Lead (Pb), max.	0.001	(10 ppm)
Magnesium (Mg), max.	0.001	(10 ppm)*
Silicon (Si), max.	0.005	(50 ppm)

2.3 Physical Properties

Not specified

2.4 Special Requirements

N/A

2.5 Codes and Standards

N/A

*Note for the Reader:

As an illustration of potential differences between this “example” set of specifications and the specifications by any particular utility, at least one utility noted that their specifications for Chloride (Cl^-), Fluoride (F^-), Sodium (Na), Aluminum (Al), Calcium (Ca), Magnesium (Mg) are as follows:

Impurities	Weight Percent	
Chloride (Cl^-), max.	0.005	(50 ppm)
Fluoride (F^-), max.	0.005	(50 ppm)
Sodium (Na), max.	0.01	(100 ppm)
Aluminum (Al), max.	0.01	(100 ppm)
Calcium (Ca), max.	0.005	(50 ppm)
Magnesium (Mg), max.	0.005	(50 ppm)

This does not identify all differences between this “example” set of specifications and the specifications used within the industry. It is only meant to highlight the fact, through an illustration case in point, that:

a) Individual utilities may not use all of the specifications and values listed for certain chemicals, and

b) Some utilities may use specification values that are lower or greater than those listed in this document or may not analyze for or evaluate for all listed parameters.

48 Zinc Acetate (Natural)

CAS No. 5970-45-6, Formula: $(CH_3COO)_2$ Zn •$2H_2O$

1.0 General

Natural zinc acetate dihydrate, also known as zinc diacetate contains the normal complement of the ^{64}Zn isotope (~48%) that will activate to ^{65}Zn. Zinc is added as an aid to reduce source term and/or minimize the potential for cracking.

Material to be Furnished: Zinc acetate dihydrate should appear as white crystals or powder.

Intended Use: Natural zinc acetate is added to PWR reactor coolant systems as a water-soluble carrier for zinc.

2.0 Specification

Certificate of Analysis:

2.1 Chemical Composition — Weight Percent

Chemical Composition	Weight Percent	
Zinc Acetate Dihydrate, min.	98	--

2.2 Impurities — Weight Percent

Impurities	Weight Percent	
Chloride (Cl^-), max.	0.005	(50 ppm)
Fluoride (F^-), max.	0.005	(50 ppm)
Sodium (Na), max.	0.01	(100 ppm)
Sulfate (SO_4^-), max.	0.005	(50 ppm)
Aluminum (Al), max.	0.01	(100 ppm)
Calcium (Ca), max.	0.005	(50 ppm)
Lead (Pb), max.	0.001	(10 ppm)
Magnesium (Mg), max.	0.005	(50 ppm)

2.3 Physical Properties

Not specified

2.4 Special Requirements

N/A

2.5 Codes and Standards

N/A

49 Zinc Oxide (Depleted in ^{64}Zn)

CAS No. 1314-13-2, Formula: ZnO

1.0 General

Depleted zinc oxide (DZO) is depleted in the naturally occurring ^{64}Zn isotope. Zinc is added to reduce radiation fields. Maintaining a sufficient zinc concentration in the reactor water will minimize ^{60}Co incorporation in the corrosion layer on the internal surface of the system components and also minimize the potential for cracking.

Material to be Furnished: Depleted zinc oxide is dry zinc oxide sintered into right cylinder pellets with the following dimensions: diameter 10±1 mm, length 10 ±1.5 mm. Zinc oxide pellets are typically used in “passive” skids. Depleted zinc oxide can also be obtained in crystalline or powder form for use in “active” skids.

Intended Use: Depleted zinc oxide is added to BWR reactor coolant as a carrier for zinc

2.0 Specification

Certificate of Analysis:

2.1 Chemical Composition

Chemical Composition	Weight Percent
ZnO, min.	99.8
^{64}Zn isotope, max.	1.0 atom percent, or
	5.0 atomic % as ordered

2.2 Impurities

Impurities	Weight Percent	
Antimony (Sb), max.	0.001	(10 ppm)
Chloride (Cl^-), max.	0.002	(20 ppm)*
Fluoride (F^-), max.	0.002	(20 ppm)*
Sodium (Na), max.	0.001	(10 ppm)*
Sulfate (SO_4^-), max.	0.001	(10 ppm)*
Aluminum (Al), max.	0.005	(50 ppm)*
Calcium (Ca), max.	0.001	(10 ppm)
Cobalt (Co), max.	0.001	(10 ppm)
Lead (Pb), max.	0.001	(10 ppm)
Magnesium (Mg), max.	0.001	(10 ppm)
Silicon (Si), max.	0.005	(50 ppm)

2.3 Physical Properties

Pellet dimensions: diameter 10±1 mm, length 10 ±1.5 mm

2.4 Special Requirements

Depleted in ^{64}Zn isotope

2.5 Codes and Standards

N/A

*Note for the Reader:

As an illustration of potential differences between this "example" set of specifications and the specifications by any particular utility, at least one utility noted that their specifications for Chloride (Cl^-), Fluoride (F^-), Sodium (Na), Sulfate (SO_4^-), Aluminum (Al) are as follows:

Impurities	Weight Percent	
Chloride (Cl^-), max.	0.005	(50 ppm)
Fluoride (F^-), max.	0.005	(50 ppm)
Sodium (Na), max.	0.005	(50 ppm)
Sulfate (SO_4^-), max.	0.005	(50 ppm)
Aluminum (Al), max.	0.01	(100 ppm)

This does not identify all differences between this "example" set of specifications and the specifications used within the industry. It is only meant to highlight the fact, through an illustration case in point, that:

a) Individual utilities may not use all of the specifications and values listed for certain chemicals, and

b) Some utilities may use specification values that are lower or greater than those listed in this document or may not analyze for or evaluate for all listed parameters.

50 Zinc Oxide (Natural)

CAS No. 1314-13-2, Formula: ZnO

1.0 General

Natural zinc oxide contains all the naturally occurring zinc isotopes. Note that natural zinc oxide will become activated in a neutron flux. Zinc is added as an aid to reduce source term and/or minimize the potential for cracking.

Material to be Furnished: Natural zinc oxide is dry zinc oxide sintered into right cylinder pellets with the following dimensions: diameter 10±1 mm, length 10 ±1.5 mm. Zinc oxide pellets are typically used in “passive” skids. Depleted zinc oxide can also be obtained in crystalline or powder form for use in “active” skids.

Intended Use: Natural zinc oxide is added to BWR reactor coolant as a carrier for zinc

2.0 Specification

Certificate of Analysis:

2.1 Chemical Composition — Weight Percent

Chemical Composition	Weight Percent
ZnO, min.	99.8

2.2 Impurities — Weight Percent

Impurities	Weight Percent	
Antimony (Sb), max.	0.001	(10 ppm)
Chloride (Cl^-), max.	0.005	(50 ppm)
Fluoride (F^-), max.	0.005	(50 ppm)
Sodium (Na), max.	0.005	(50 ppm)
Sulfate (SO_4^-), max.	0.005	(50 ppm)
Aluminum (Al), max.	0.01	(100 ppm)
Calcium (Ca), max.	0.001	(10 ppm)
Cobalt (Co), max.	0.001	(10 ppm)
Lead (Pb), max.	0.001	(10 ppm)
Magnesium (Mg), max.	0.001	(10 ppm)
Silicon (Si), max.	0.005	(50 ppm)

2.3 Physical Properties

Pellet dimensions: diameter 10±1 mm, length 10 ±1.5 mm

4
ADDITIONAL INFORMATION (EXAMPLE)

The following is an example of additional information that could be included when purchasing bulk chemicals:

4.1 Testing

4.1.1 Seller Testing

The Seller shall provide chemicals that meet the specifications as detailed in Section B [e.g. Chapter 3 in this Technical Update] “Technical Requirements” of these procurement specifications. It is the seller’s responsibility to ensure that the chemical specifications are satisfied. In the event the specifications are not met, the Seller shall contact the Purchaser to resolve the discrepancy as per Purchaser procedure/process.

All test methods used to assure compliance with the specifications shall conform to the indicated standards, if provided, unless otherwise stated in the specification or agreed to in writing by the vendor/Seller and the Purchaser. If no test procedure is noted in the specification, the vendor/Seller shall identify the test method source and name on the Certificate of Analysis. Note that the test methods used for analysis are expected to be based on the referenced test method, where provided, and are not expected to be verbatim procedures.

Specification compliance shall be demonstrated by analysis of representative samples obtained from the lot/batch shipped (preferably from the final shipping container, where practical).

4.1.2 Purchaser Testing

The vendor/Seller may be requested to supply the Purchaser with up to a one liter sample representative of the lot/batch from the shipment for independent testing. The Purchaser reserves the right to spot check selected parameters at the discretion of chemistry supervision. Testing will typically include a check for contaminants and/or to verify the chemical delivered matches the chemical product label and COA. The vendor should be notified in the event independent/Purchaser testing indicates one or more tested parameter(s) does/do not meet the Purchaser’s specification. Material may be returned to the vendor, at the vendor expense, if the purchase specifications are not met.

4.2 Packaging and Shipping

4.2.1 It is the Seller’s responsibility to ensure that the chemical products ordered are packaged and shipped IAW Purchaser written agreement and in anticipation of worse than expected transport conditions. The Seller is responsible for ensuring that the chemical products are packaged to prevent physical damage and/or product deterioration during shipping/receiving and long-term storage.

4.2.2 Purchaser shall specify container prior to, or at time of order.

4.3 Quality Assurance

4.3.1 Materials, components, or services required by this specification shall be provided in accordance with the supplier's quality assurance program which has been evaluated by the Purchaser's Quality Assurance Program (or approved equivalent). Subsequent to this approval, the Supplier shall notify the Purchaser(s) of any changes in the approved program.

4.3.2 The Purchaser's quality assurance program bases its approval of the supplier's quality assurance program on the requirements of American National Standards Institute N45.2-1977, Quality Assurance Program Requirements of 10CFR50 Appendix B, Quality Assurance Criteria (U.S. utilities) or equivalent (non U.S. utilities).

4.3.3 If lower tier procurement is required, then Quality Assurance requirements must be invoked on lower tier subcontractors and vendors.

4.4 Labeling

4.4.1 Each container shall be labeled with solvent resistant permanent labels or markings. The labels/markings should be legible, written in English (or appropriate language for non U.S. utilities), and contain the following information (unless otherwise specified):

- Chemical Name
- Safety Related – if designated as safety related in the specification
- Purchase Order No.
- Name of Seller
- Name and address of Manufacturer (if different from seller)
- Lot/Batch No.
- Shelf Life and/or Expiration Date
- "Keep from Freezing"
- Spill/Handling Hazards or NFPA information
- Additional labeling required by law (if applicable)

4.5 Administrative Requirements

4.5.1 Nonconformances to specification requirements, including applicable federal codes or standards invoked by this specification shall not be accepted until approved by the Purchaser's bulk chemical specification program owner and the site chemistry manager or designee. All nonconformances should be documented in a station Condition Report and approved by the Purchaser.

4.6 Specification Clarification

4.6.1 The specification and limit values noted in this specification are intended to be valid to the number of significant figures so noted in the specification. Minor variations between actual analyzed values and the specifications due to rounding of one additional decimal place are not significant.

4.6.2 Technical clarifications may be resolved by the Purchaser's chemistry supervisor/manager or bulk chemical specification owner, without a non conformance or specification addendum. Clarifications judged to be significant should be documented and sent to the bulk chemical specification owner for incorporation during the next specification revision.

4.6.3.1 Specification discrepancies as documented in the station corrective action program are reviewed by the bulk chemical specification owner (subject matter expert) and the plant chemistry manager (or equivalent) for determination of appropriate actions.

4.6.3.2 The purchaser's bulk chemical specification owner is responsible for documenting the specification discrepancies in the station's corrective action program.

A

APPENDIX 1: ESTIMATING A LIMITING BULK CHEMICAL PURITIY SPECIFICATIONS

Any chemical added to a plant system can/will introduce contaminants. The following calculation can be used to estimate the limiting bulk chemical purity specification, based on the impurity limits for the system to which the chemical is added.

$$\text{Spec. (ppm)} = \frac{\text{Max. Impurity (ppb) X \% Soln. X10}}{\text{System Concentration (ppm)}}$$ **Equation A-1**

Where:

Spec.	The bulk chemical solution specification in parts per million
Max. Impurity	The maximum desired diluted/final concentration of the impurity in the system, in parts per billion
% Soln.	The solution strength as supplied by the vendor (e.g. 30%, 50%)
System Conc.	The system concentration of chemical product at the target/control concentration (e.g. 1 ppm)

For example, if the maximum desired feedwater sodium concentration (from ETA) is ≤ 0.01 ppb and the desired feedwater ETA concentration is 3.5 ppm, the specification for an 80% solution would be:

$$\text{ETA Sodium Spec.} = \leq \frac{0.01 \text{ X } 80 \text{ X } 10}{3.5}$$

$= \leq 2.3$ ppm sodium, probably rounded to 2.0 ppm **Equation A-2**

B
APPENDIX 2: ADDITIONAL RESIN SPECIFICATION INFORMATION

General Requirements

1. The seller shall furnish new, unused resins.
2. All test methods shall conform to the indicated ASTM/EPRI Standards, or the test method indicated in the specification[1]. Where "Any Standard Method" is indicated in the specifications, the method shall be stated on the COA. If the vendor prefers to employ a different, equivalent or better method, the purchaser must approve the exception(s) prior to shipping.
3. Unless otherwise specified, the resin shall be packaged in polyethylene-lined fiber drums that have been banded and sealed in a manner to prevent moisture escape, and/or carbon dioxide adsorption. Where requested by the utility, tamper proof seals shall be used. The material shall not be repackaged after leaving the manufacturer, unless approved by the purchaser, for additional testing and/or processing by a purchaser approved third party.
4. During storage, the resin shall be protected from extremes in temperature. Acceptable temperature range for storage greater than two weeks is 37°F- 95°F. During transit, the resin shall be protected from freezing and the time exposed to excessive heat, (>100°F) minimized.
5. Cation and anion resins shall have shelf-lives ≥ 24 months and 18 months respectively, from date of delivery, unless otherwise specified or agreed to by purchaser. Note that if the resin is intended for immediate use (within 60 days), the shelf-life parameter can be waived by the purchaser.
6. All quality control analyses shall be performed on as shipped resin (unless otherwise specified), and sampled in accordance with the appropriate ASTM procedure (D2687 – bead resin, D4456 - powdered resin) or equivalent.
7. Each drum shall be clearly labeled with the following:
    a. Name and address of the resin manufacturer
    b. Resin type (anion, cation, mixed, etc.)
    c. Resin ionic form (H, OH, Li-7, Cl, etc.)
    d. Manufacturer's resin designation
    e. Manufacturer's production batch or lot number
    f. Shelf-life date

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[1] Strict duplication of the ASTM/EPRI test method is not required. Changes implemented to streamline the ASTM/EPRI test methods are acceptable provided the changes do not significantly alter the analyzed result.

g. Purchase order number

8. If specified in the contract, prior to shipment, the vendor shall provide resin samples of each lot in the shipment to a purchaser specified laboratory for analyses to verify adherence to the specifications. The sample package shall contain documentation identifying each sample with the same information as provided in 7 above.
9. A signed Certificate-of-Analysis (COA) for each product shall accompany each shipment, indicating that the product(s) meets the specifications, as approved by the purchaser.

   The Certificate of Analysis shall state the name of the original resin manufacturer, the original manufacturer lot number(s), the original manufacturer product designation, and who applied the functional groups and/or post manufacturing treatment (if different from the original manufacturer).
10. Actual test result data is preferred; however, “Passed” is acceptable if the “Passed” value is more conservative or equal to the specification value for the parameter in question.
11. More information about the use of resins at nuclear power plants can be found in the EPRI Condensate Polishing Guidelines for Pressurized Water Reactor and Boiling Water Reactor Plants – 2004 Revision (EPRI Report 1002889.)

C
APPENDIX 3: POSSIBLE RESIN TESTING METHODS

This Appendix provides an example list of resin testing methods used by Duke Energy.

Table C-1
Example List of Resin Testing Methods by Duke Energy

Parameter	Possible Test Methods(*)	
	ASTM	EPRI*
Sodium	ASTM D4191	Method C, H
Iron	ASTM D1068	Method C
Copper	ASTM D1688	Method C
Aluminum	ASTM D857	--
Calcium	ASTM D511	Method H
Magnesium	ASTM D511	Method H
Heavy Metals (Pb ppm)	Any Standard Method	--
Silica (SiO2),	ASTM D859	--
Silica, Leachable	(6)	--
Total Chlorine	(5)	--
Post UV Chloride		Method D
Rinseable, Chloride		Method D
Sulfate		Method H
Post UV Sulfate		Method D
Rinseable, Sulfate		Method D, E
Carbonate		
Water Extractables, %	ASTM D5627, or (2)	
Organic Extractables (TOC)	ASTM D5042	Method E, D
Rinseable, TOC	Any Standard Method	Method D
TOC, 16 Hr. soak	ASTM D5042	Method E
% Cross-Linked	Any Standard Method	
% Perfect Beads	(4)	Method A (4)
Whole Uncracked beads, %	Any Standard Method	Method A

Table C-1 (continued)
Example List of Resin Testing Methods by Duke Energy

Parameter	Possible Test Methods(*)	
	ASTM	EPRI*
Total Wet Volume Capacity H	ASTM D2187 E	Method I
Total Wet Volume Capacity OH	ASTM D2187 H	Method B
% Moisture Holding Capacity	ASTM D2187 B, or ASTM D4456 B	Method J
Eqv. % H+, Li+	ASTM D2187 G	
Eqv. % OH-	ASTM D2187 I	
Eqv. % Cl-	ASTM D2187 J	
Eqv. % SO4=	ASTM D2187 L	
Eqv. % CO3	ASTM D2187 K	
Crush Strength, Avg. gm./bead	(3)	
Crush Strength, % >200 gm/bead	(3)	
Crush Strength,% >300 gm/bead	(3)	
Kinetics Test, Mohm/min.	(7)	
Uniformity Coefficient, max.	ASTM D2187 D	
Harmonic Mean Size	Any Standard Method	
Bead Dia. Vol. Mean microns		
Particle Size, % Retained-14 mesh		
% Retained On 16 mesh (1200μm)	(1), (8)	

*EPRI Test Methods are available in TR-104422, "Condensate Polishing Guidelines" 1996

(*) Other test methods are acceptable if approved by the utility. Strict duplication of the ASTM/EPRI test method is not required. Changes implemented to streamline the ASTM/EPRI test methods are acceptable provided the changes do not significantly alter the analyzed result.

Notes:

1. Resins shall be sampled IAW ASTM D2687-95, Practice A (Bead) or ASTM D4456-85, Section 19.1 (Powdered)
2. Particle size distribution using a Light-Blockage Automatic Particle Counter shall be used which has been calibrated against ASTM D2187-94, Method D
3. Water Extractables, Duke Test Method 5.1
4. Crush Strength, Duke Test Method 5.2
5. Microscopic Bead Count (% Perfect Beads), Duke Test Method 5.3

6. Total Chlorine in Resin by Oxygen Bomb Combustion, Duke Test Method 5.4
7. Silica Leach Test, Duke Test Method 5.5
8. Kinetics Test, Based on Harries model; Method to be Furnished by Seller
9. Particle Size for powdered resin determined IAW ASTM D4456-85, Method A

D
APPENDIX 4: FUNCTIONAL CLASSIFICATION

From: TR-102260, Supplemental Guidance for the Application of EPRI Report NP-5652 on the Utilization of Commercial Grade Items, Final Report, March 1994

Safety Related Item (SR)

A plant structure, system, component, or part thereof necessary to assure:

1. The integrity of the reactor coolant pressure boundary, or
2. The capability to shut down the reactor and maintain it in a safe shutdown condition, or
3. The capability to prevent or mitigate the consequences of accidents that could result in potential offsite radiation exposures comparable to those in 10CFR100.11 “Determination of Exclusion Area Low Population Zone and Population Center Distance.” (member of the public would not exceed either 25 rem whole body or 300 rem to the thyroid from iodine exposure)

Non Safety Related Item (NS)

An item that does not perform a safety-related function

An engineering evaluation was performed to determine SR Vs. NS chemicals. The following was noted in the evaluation:

Safety Related (SR)

Boric Acid- Used to control reactivity and act as a neutron poison. Boric acid is used for accident mitigation in order to prevent fuel damage. Maintaining the proper boron concentration ensures that the plant may be brought to a subcritical condition from all operating conditions. Boric acid helps to maintain a sufficient shutdown margin.

Sodium Hydroxide – Applicable only to sodium hydroxide used to control reactor coolant system pH under accident conditions and essentially perform the same functions as trisodium phosphate dodecahydrate in iodine retention and is considered a SR chemical in this application. Use of sodium hydroxide for other applications is considered non-safety use and can be purchased as a Non-Safety Related chemical.

Sodium Tetraborate - BWR standby liquid control tank and to control sump pH under post accident conditions. Used in PWR ice condensers as neutron poison.

Trisodium Phosphate Dodecahydrate (TSP) – is a pH adjuster kept is baskets (some nuclear stations) in the containment sumps. During accident conditions, while the safety injection systems are in recirculation mode, the TSP is released to the sump water to increase pH. TSP takes credit for iodine retention in the sump solution to minimize the consequences of a LOCA. TSP is credited with maintaining Iodine formed post accident by failed fuel in solution and non-volatile. See Sodium Hydroxide below.

Non-Safety Related (NS)

Hydrogen Peroxide – Hydrogen peroxide does not affect reactivity, does not support any RCS safety functions, and has no “failure mode” and is considered NS.

Lithium-7 Hydroxide – Although Lithium-7 hydroxide is used in the reactor coolant system (PWRs), and plays a role in managing tritium, it is thought that due to the relatively low dose consequences of tritium, the criteria for determining safety related items is not met.

Resins - resins play an important role in maintaining plant system chemistry parameters; however, they do not support system safety functions. Resins do not perform a safety related function as defined in the Safety Analysis Report (SAR), and should not be purchased as safety related.

Sulfuric Acid – is used primarily to regenerate resins and/or in cooling towers. Sulfuric acid does not support any system safety functions.

Sodium Hydroxide - is used primarily to regenerate resins. Sodium hydroxide is used in non-QA systems and does not support any system safety functions. Note that some stations use sodium hydroxide to control reactor coolant system pH and essentially perform the same functions as trisodium phosphate dodecahydrate in iodine retention (see Safety Related above) and should be considered a SR chemical in that application.

Nitrogen Gas – Although nitrogen can be used in Safety Injection Tanks to supply pressure that allow cooling water to be injected into the RCS in the event of a LOCA, the use of nitrogen is to exclude oxygen, and the quality of nitrogen is incidental to its safety function.

Hydrogen Gas - Hydrogen gas is injected into the RCS to provide a reducing environment and minimize system corrosion but does not support any system safety functions. In the event off-specification hydrogen is added to the RCS, corrosion is time and temperature dependent and an out-of-specification condition would be discovered in normal sampling before significant corrosion would occur.

Potassium Chromate – is a corrosion inhibitor added (at some stations) to the neutron shield tank. The corrosion inhibition function does not support the system safety function and there is no failure that can prevent the system from performing its safety function. Since corrosion is time and temperature dependent, an out-of-specification condition would be discovered during routine sampling before significant corrosion would occur.

Secondary System Amines– (PWRs) are added to steam generators and feedwater to maintain system pH and minimize corrosion. There is no failure of the chemical that can prevent these systems from performing their safety functions. Since corrosion is time and temperature dependent, an out-of-specification condition would be discovered during normal sampling before significant corrosion could occur.

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