U.S. DEPARTMENT OF ENERGY
CARLSBAD FIELD OFFICE

BASIS OF KNOWLEDGE FOR EVALUATING OXIDIZING CHEMICALS IN TRU WASTE

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U.S. DEPARTMENT OF ENERGY
CARLSBAD FIELD OFFICE

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December 2018

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CHANGE HISTORY SUMMARY

Revision Number	Date Issued	Description of Changes
0	July 2017	Initial issue.
1	December 2018	Streamlined report to be less general and focus criteria to more accurately apply to specific types and sources of waste. Revised throughout to be consistent with removal of chapter 4 and attachment 1. Provided an exemption for LANL RNS and UNS waste with treatment plans approved before BoK rev. 0 was issued. Removed note regarding use of BoK for TRU waste remaining in WIPP Waste Handling Building and Waste Control Specialists. Removed Chapter 4 “Basis of Knowledge Test Methods” and renumbered remainder of the document. Changed title to section 4.1 to “Evaluation and Review” and directs TRU waste sites to options in section 2 for waste containing oxidizing chemicals that fail to meet a BoK criterion. Changed the title to section 4.4 to “pH Adjustment of Oxidizing Acids, Bases and Solutions;” revised language for pH adjustment; added bullet for elimination of potential incompatibilities between 74 reactivity groups; and removed bullet on LANL-CO formal testing. Listed examples of polyols in section 4.5 and introduced polysaccharides as a subcategory of polyols. Removed historical testing discussion on rags and wipes from section 4.5.2. Changed the title of section 4.5.3 to “Ion Exchange Resins” and removed examples of glycerin and organic solvents from this section. Reorganized subsections in section 4.6 and included “Inorganic Sludges with Oxidizing Chemicals not Mixed with Sorbents” and “Oxidizing Chemicals Solidified in a Cement or Grout Matrix” in this section. Inserted Floor-Dry sorbent into Table 4-4. Added an example of a calculation for mixtures of organic and inorganic sorbing materials with oxidizing chemicals.

Revision Number	Date Issued	Description of Changes
		Revised section 4.10 to allow 30 wt. % oxidizing chemical regardless of matrix inorganic or organic composition (excluding organic liquids). Deleted section 5.12.1. Added new section 4.11 “Oxidizing Chemicals in Waste Retrieved from Earthen Disposal Pits.” Added references in section 7.0 Records pointing to the section 2.0 options that would generate the document and deleted paragraph regarding BoK Review Board’s documented decision. Inserted WIPP Certified Programs’ before AK records to distinguish between CBFO records. Replaced Attachment 1 Form 3589-1 with a description of RNS and UNS treatment and a list of drums treated at LANL that are exempt from BoK requirements. Revision 1 involves extensive rewriting of the document; therefore, no change bars are present.

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ACRONYMS AND ABBREVIATIONS

AK	Acceptable Knowledge
AKE	Acceptable Knowledge Expert
BoK	Basis of Knowledge
°C	degrees Celsius
CBFO	Carlsbad Field Office
CFR	Code of Federal Regulations
DOE	U.S. Department of Energy
DQO	Data Quality Objective
DSA	Documented Safety Analysis
EOPS	engineered organic polymer sorbent
EPA	U.S. Environmental Protection Agency
LANL	Los Alamos National Laboratory
LANL-CO	LANL-Carlsbad Operations
$NaNO_3$	sodium nitrate
NTP	National TRU Program
RNS	remediated nitrate salt
SBAA	Safety Basis Approval Authority
SDS	Safety Data Sheet
SPM	Site Project Manager
TRU	transuranic
UNS	unremediated nitrate salt
WAC	Waste Acceptance Criteria
WIPP	Waste Isolation Pilot Plant
WM-STA	Waste Management Senior Technical Advisor
wt. %	weight percent

Units of Measurement

Å	angstrom
cm^3	cubic centimeter
g	gram
g/cm^3	grams per cubic centimeter
J/g	joules per gram
mL	milliliter
mL/g	milliliter per gram
mm	millimeter

NOTE: The latest revision of DOE/WIPP-17-3589 is available within WIPPnet at http://bellview/cbfo/cbfo_docs.html **and outside of WIPPnet at** https://sftp.wipp.energy.gov/human.aspx?r=265069120&Arg12=filelist&Arg06=255414084 **with approved username and password. To obtain username and password, contact Kerry Watson or Cecil Thomas at (575) 234-7301.**

EXECUTIVE SUMMARY

The February 14, 2014, airborne radiation release in Room 7 of the Waste Isolation Pilot Plant (WIPP) underground disposal unit 7 was caused by an exothermic chemical reaction of nitrate oxidizing chemicals and organic materials in a single 55-gallon container. That event exposed hazards not previously evaluated in the WIPP safety basis. A new WIPP Documented Safety Analysis (DSA), Revision 5b, was developed that addressed potential hazards related to the airborne radiation release and evaluated and addressed new fire hazard scenarios. The revised hazards analysis within the DSA specifically included potential chemical exothermic reactions in waste containers and propagating fires. Compliance with WIPP Waste Acceptance Criteria (WAC) was credited as initial conditions to the hazards analysis, and Chapter 18 was added making the WIPP WAC compliance program a safety management program within the DSA. The WIPP DSA, Revision 5b, Chapter 18, and the WIPP WAC required the use of this document when performing the enhanced Acceptable Knowledge (AK) process on transuranic (TRU) waste determined to contain oxidizing chemicals.

The WIPP WAC was revised to address the conditions and requirements of DSA Revision 6. The use of this Basis of Knowledge (BoK) by WIPP Certified Programs is specified in the WIPP WAC, Appendix H, Enhanced Acceptable Knowledge.

This document establishes criteria that must be used by the WIPP Certified Programs to evaluate TRU waste containing one or more oxidizing chemicals to determine acceptability at the WIPP as-is, with respect to the oxidizing chemicals, and to identify when additional evaluation or treatment is required. This BoK also includes options and requirements to be used by TRU waste sites when further evaluation, testing, and/or treatment are required. The U.S. Department of Energy (DOE) Carlsbad Field Office (CBFO) will review requests, plans, and technical justifications and provide written decisions prior to implementation by the TRU waste sites.

1.0 PURPOSE

This Basis of Knowledge (BoK) provides criteria to be used in conjunction with acceptable knowledge (AK) procedures of the WIPP Certified Programs for evaluating transuranic (TRU) waste (hereafter referred to as TRU waste or waste) with one or more oxidizing chemicals to determine acceptability at the Waste Isolation Pilot Plant (WIPP) as-is, identify when additional evaluation or treatment is required, and evaluate waste for acceptability post-treatment. This BoK also includes options and requirements to be used by TRU waste sites when further evaluation, testing, and/or treatment are required.

2.0 APPLICATION AND SCOPE

WIPP Certified Programs' AK personnel performing the enhanced AK process shall evaluate TRU waste that contains one or more oxidizing chemicals using the criteria contained in this BoK. The application of these criteria is not dependent on a TRU waste site's determination that the waste does or does not exhibit the hazardous waste characteristics of ignitability or reactivity due to oxidizer properties. WIPP Certified Programs shall submit BoK evaluations to Site.Documents@wipp.ws for CBFO Waste Management Senior Technical Advisor (WM-STA) review until notified by the CBFO Manager that continued review by the WM-STA is no longer required.

The TRU wastes at Los Alamos National Laboratory (LANL) that were treated with KMI zeolite to remove the oxidizer properties of the oxidizing chemicals contained in each waste type are categorically excluded from the requirement to evaluate the oxidizing chemicals using the criteria contained in this BoK. These wastes post KMI zeolite treatment populations were packaged into a total of 274 55-gallon drums. The CBFO reviewed LANL test data, treatment plans and procedures concurrent with the development of Revision 0 of this BoK and agreed that the planned and implemented processes would result in the successful treatment of the oxidizing properties of the oxidizing chemicals contained in the wastes. The list of 55-gallon drums by container identification number, material treated, waste volume treated, bounding salt waste and KMI zeolite weight percent, and weight percent oxidizing chemical in the treated waste form is included in Attachment I Table I-2. All other LANL TRU wastes with one or more oxidizing chemicals are subject to evaluation using the criteria contained in this BoK.

These criteria are based on bounding conditions developed in part to account for the potential drying of the waste from environmental conditions it can be subjected to inside the transportation packaging and after emplacement in the desiccating salt environment of the WIPP disposal units. Accounting for changes in the waste that can occur due to environmental conditions that can exist during active waste management minimizes the possibility of a radioactive particulate airborne release in the Category 2 nuclear facility until the waste is isolated from the WIPP underground ventilation air flow. If a TRU waste site's waste is outside the criteria established in this BoK, the TRU waste site has the options of:

a) requesting the DOE CBFO WM-STA evaluate information provided by the TRU waste site or Acceptable Knowledge Expert (AKE) that the unlisted oxidizing chemical is bounded by at least one of the listed oxidizing chemicals; or

b) requesting a sorbent equivalency evaluation by the CBFO WM-STA to determine if the unlisted sorbent is compositionally equivalent to a tested sorbent; or

c) performing tests using a method approved by the CBFO Manager and proposing a treatment method when necessary; or

d) performing tests using the modified U.S. Environmental Protection Agency (EPA) method 1040 as specified in section 6.0 of this document, and treating with an acceptable inorganic sorbent; or

e) treating the waste with an acceptable inorganic sorbent as described in section 5.0 when an unlisted sorbent is not compositionally equivalent; or

f) treating waste with oxidizing chemical that was previously sorbed with organic sorbent using zeolites as specified in section 5.0; or

g) treating as specified in section 5.0, with zeolites or other inorganic sorbent when listed oxidizing chemical concentrations in engineered organic polymer sorbent (EOPS) or inorganic sorbent cannot be bounded or when an oxidizing chemical listed in Table 4-1 is the sole component of the waste; or

h) providing a technical justification to the CBFO WM-STA that each container with the current waste form is sufficiently characterized to enable compliant shipment and receipt at the WIPP with respect to the oxidizing chemicals in the waste, and justification that the waste would not develop an unacceptable risk of a release until isolated from the WIPP underground ventilation air flow.

Based on the merits of the technical justification, the CBFO Manager may determine that the waste is acceptable as-is, compliant with WIPP program and facility requirements with respect to the oxidizing chemical in the waste, and presents no additional hazard to the facility that has not been considered and mitigated in the WIPP DSA.

3.0 DEFINITIONS

Organic Materials – Carbon-containing compounds, which include not only hydrocarbons but also compounds with a number of other elements, including hydrogen (most compounds contain at least one carbon-hydrogen bond), nitrogen, oxygen, halogens, phosphorus, silicon, and sulfur. Organic materials are not limited to compounds produced by living organisms, but include human-made substances such as plastics and polymers. Carbon-containing compounds that are simple salts, such as carbonates, oxides, and carbides, are inorganic materials.

Oxidizing Chemical – A chemical that, while alone is not necessarily combustible, readily yields oxygen to cause or enhance the combustion of organic materials.

For the purposes of this BoK, an oxidizing chemical is:

- A chemical identified in this document as an oxidizing chemical; or
- A chemical or chemical mixture identified as hazard class 5.1 or 5.2 in the Hazard class or Division, or Label Codes columns of the Hazardous Materials Table in Title 49 Code of Federal Regulations (CFR) 172.101. However, a chemical with a numeric provision listed in the Special provisions (§172.102) column of the Hazardous Materials Table, that excludes it from the 49 CFR Subchapter C – Hazardous Materials Regulations is not an oxidizing chemical subject to evaluation using this BoK.

NOTE: Safety Data Sheets (SDSs) obtained from chemical manufacturers or distributors may or may not identify that the subject chemical is a 5.1 or 5.2 hazardous material oxidizer. SDSs have not proven to be reliable sources of information. Other sources of information must be used to determine if the chemical in question is or is not an oxidizer.

4.0 CRITERIA FOR EVALUATING TRU WASTE WITH OXIDIZING CHEMICALS

4.1 Evaluation and Review

The WIPP Certified Program's AKEs must evaluate waste containing one or more oxidizing chemicals to the criteria in section 4.0. The certified program shall select an option from section 2.0 paragraph 2 a) through h), when the evaluation determines that the waste fails to meet any of the BoK criteria.

When the TRU waste site resolves the issues with waste that previously failed to meet BoK criteria, using a selected option from section 2.0, the AKE will document actions that made the waste acceptable in an addendum to the original BoK evaluation. Each WIPP Certified Program shall provide BoK evaluations for CBFO Office of the Manager review until such time they are notified by the CBFO Manager that the reviews are no longer required.

4.2 Oxidizing Chemical Verification

The oxidizing chemicals identified in Table 4-1 are bounded by potassium nitrite. Formal testing performed by LANL-Carlsbad Operations (LANL-CO) (hereafter referred to as formal testing) identified the allowed weight percent (wt. %) of oxidizing chemical[1] in EOPS (Table 4-3), inorganic sorbents (Table 4-4), and when remediating previously sorbed oxidizing chemicals (Table 5-1). Waste streams with oxidizing chemicals, whether listed on Table 4-1 or not, must be reevaluated by the AKE to determine if oxidizing chemicals are actually present in the waste. This reevaluation must focus on the process chemistry where the waste originated and what the chemical constituents are in the waste. Actions that could change the oxidizing chemicals during or after the process include: reducing, neutralizing, rinsing, solidifying, drying, calcining, pyrolyzing, and others. If the waste has been repackaged, actions that would have affected the waste chemistry must be identified and evaluated, and additions to the waste must be accounted for. The final description of the waste should be representative of the constituents and overall composition of the waste as it is in its final waste form.

If the AK reevaluation determines that an oxidizing chemical is present in the TRU waste stream and not listed in Table 4-1, the TRU waste site or AKE may implement section 2.0 paragraph 2 a) to provide information to the CBFO Office of the Manger that the oxidizing chemical is bounded by at least one oxidizing chemical listed on Table 4-1. The CBFO Office of the Manager will evaluate the documented position and provide a written decision for the AK record. If the CBFO determines the oxidizing chemical is not bounded by at least

[1] LANL-CO, Results from Preparation and Testing of Sorbents Mixed with Potassium Nitrite, DWT-RPT-003, January 19, 2017, LA-UR-16-27276.

one of the oxidizing chemicals listed in Table 4-1, then the TRU waste site must select from options c), d), or h) from section 2.0.

Table 4-1 – Oxidizing Chemicals Bounded by Formal Testing

Oxidizing Chemicals Bounded by Formal Testing	
Aluminum nitrate nonahydrate	Potassium iodate
Ammonium cerium (IV) nitrate	Potassium nitrate
Ammonium persulfate	Potassium nitrite
Barium nitrate	Potassium periodate
Bismuth (III) nitrate pentahydrate	Potassium permanganate
Cadmium nitrate	Potassium persulfate
Calcium hypochlorite	Praseodymium(III) nitrate hexahydrate
Calcium nitrate tetrahydrate	Rhenium nitrate hexahydrate
Cerium (III) nitrate hexahydrate	Rubidium nitrate
Cesium nitrate	Samarium(III) nitrate hexahydrate
Chromium nitrate nonahydrate	Silver nitrate
Cobalt nitrate hexahydrate	Silver nitrite
Copper nitrate trihydrate	Silver (I) oxide
Erbium (III) nitrate pentahydrate	Silver (II) oxide
Europium (III) nitrate pentahydrate	Sodium bromate
Gadolinium (III) nitrate hexahydrate	Sodium chromate
Indium nitrate tetrahydrate	Sodium dichromate dihydrate
Iron (III) nitrate nonahydrate	Sodium nitrate
Lanthanum (III) nitrate hexahydrate	Sodium nitrite
Lead (II) nitrate	Strontium nitrate
Lead peroxide	Terbium(III) nitrate pentahydrate or hexahydrate
Lithium hypochlorite	Tetrabutylammonium nitrate
Lithium nitrate	Tetrapropylammonium nitrate
Magnesium nitrate*	Thallium(I) nitrate trihydrate
Mercury (II) nitrate monohydrate	Thallium(III) nitrate trihydrate
Neodymium (III) nitrate hexahydrate	Thorium nitrate hexahydrate
Nickel (II) nitrate hexahydrate	Uranyl nitrate hexahydrate
Nitric acid	Yttrium(III) nitrate hexahydrate
Plutonium nitrate pentahydrate	Zinc nitrate hexahydrate
Potassium bromate	Zirconium(IV) nitrate pentahydrate
Potassium chromate	Zirconium oxynitrate
Potassium dichromate	

*Magnesium nitrate is hygroscopic and deliquescent, readily converting to magnesium nitrate hexahydrate when exposed to moisture. Magnesium nitrate hexahydrate is the most stable form of magnesium nitrate salt.[2] Magnesium nitrate hexahydrate is not regulated as a U.S. Department of Transportation (DOT) hazardous material per Special Provision 332 in 49 CFR §172.102. Testing performed by LANL-CO during the oxidizer scoping studies further supports that magnesium nitrate hexahydrate does not enhance the combustion of organic matter.

4.3 Distribution of Oxidizing Chemicals within Waste Components

TRU waste with oxidizing chemicals may consist of a single waste component or multiple waste components. Only the waste components with oxidizing chemicals require evaluation using the criteria in the BoK. Personnel performing the AK characterization must determine

[2] Wheeler, R. C., Frost, G. B., "A Comparative Study of the Dehydration Kinetics of Several Hydrated Salts," Can. J. Chem., **33** (1955), 546-561.

how well the oxidizing chemicals are distributed as well as the concentration of oxidizing chemicals within each waste component that contains oxidizing chemicals.

4.4 pH Adjustment of Oxidizing Acids, Bases, and Solutions

Oxidizing acids and aqueous solutions with oxidizing chemicals in containers and as free liquids separated from the solid portion of the waste generated or treated and repackaged should be pH adjusted prior to sorbing or solidifying. Neutralization to a pH of 6 to 8 is desired as a best business practice. Waste must remain in a safe and compliant state during extended storage periods. When it is known that waste with liquid requiring treatment with sorbent will remain on-site for an extended amount of time after undergoing characterization using real-time-radiography or visual examination, the waste should be treated to a pH > 2 and < 12.5 prior to sorbing. This requirement is to help ensure continued safety of the waste until it is emplaced and isolated from the underground airflow within a WIPP underground waste disposal unit.

pH adjustment of strong acids and bases is necessary for the following reasons:

- The reduction of acid-catalyzed and base-catalyzed chemistry reduces the effectiveness of oxidizing chemicals.
- Strong acids and bases can break down the mineral structure of zeolites and other inorganic sorbents,[3] and the organic "backbone" of some EOPSs, affecting the capacity of the sorbent and possibly rendering the oxidizing chemical treatment ineffective.
- Compatibility of the waste with other waste, packaging materials, and the payload container is substantially increased because potential incompatibilities between 74 reactivity groups are eliminated per the 1980 EPA document EPA-600/2-80-076.
- The potential for hydrogen gas formation from corrosion processes is minimized.

Potentially explosive compounds can form when organic neutralizing or buffering agents are used with oxidizing chemicals. AKEs shall identify and evaluate the use of organic neutralizing or buffering agents with oxidizing acids and bases, and acidic and basic solutions. This evaluation applies prior to sorbing and when the organic neutralizing or buffering agents were ingredients in inorganic sorbents and EOPS products. When either case exists, testing must be performed that demonstrates that the sorbed waste does not pose a hazard when exposed to mechanical impact, spark, friction, and/or heat. Testing results shall be provided to the CBFO Office of the Manager. When testing determines the waste does pose a hazard, the TRU waste site must identify a method of treatment that will eliminate the hazard. Concurrence on the proposed method of treatment must be obtained from the CBFO Manager to assure acceptability at the WIPP following treatment.

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[3] G. Jozefaciuk and G. Bowanko, "Effect of Acid and Alkali Treatments on Surface Areas and Adsorption Energies of Selected Minerals," *Clays and Clay Minerals,* Vol. 50, No. 6, 771-783, 2002.

4.5 Organic Sorbents

Organic sorbents and sorbing materials such as rags, wipes, sorbent pads, and pillows that have been used in TRU waste can be divided into the following groups:

- Polyols (organic molecules containing multiple hydroxyl functional groups, which include synthetic and naturally occurring carbohydrates such as polyvinyl alcohol, rayon, cellulose, starch, glycerin [glycerol], etc.). Cellulose and starch are often referred to as polysaccharides.
- EOPSs, also known as hydrogels and super-absorbing polymers (polyacrylates, polyacrylamides, etc.)
- Condensation polymers such as polyesters
- Hydrocarbons (polypropylene, polystyrene resins, etc.)

Mixtures of polysaccharide materials identified in Table 4-2 and oxidizing chemicals are incompatible, and mixing them can result in adverse reaction consequences. Oxidizing chemicals sorbed into polysaccharide sorbents are not acceptable at the WIPP without treatment (see section 5.0), testing (see section 6.0), or a technical justification supporting compliant shipment and receipt at WIPP (see section 2.0 h)). Waste containing EOPSs (section 4.5.1), and/or hydrocarbon components (section 4.5.1), and/or rags, wipes, sorbent pads, and pillows with polysaccharide (section 4.5.2), and/or condensation polymer (section 5.1) are discussed below.

Table 4-2 – Polysaccharide Sorbents that Require Treatment

Sorbent Name	Composition listed in the Safety Data Sheet
Slikwik	100% processed corncobs (cellulose)
sWheat Scoop	100% Wheat (70-89 dry wt. % starch)
Polysaccharide sorbents not otherwise specified	A composition containing cellulose, starches, or sugars.

4.5.1 Engineered Organic Polymer Sorbents with Oxidizing Chemicals

Table 4-3 lists the wt. % of oxidizing chemicals allowed when well mixed in a tested EOPS. An oxidizing chemical can be considered well mixed in the EOPS when at least one of the following criteria is met:

- EOPS was added to the liquid; or
- A known liquid is added in a volume approaching the sorbing capacity of the EOPS for that liquid; or
- Liquid is stirred or mixed with the EOPS

Table 4-3 – Wt. % of Oxidizing Chemicals Allowed in EOPS (Previously Sorbed)

EOPS	Composition listed in the Safety Data Sheet	Wt. % of oxidizing chemicals allowed
Aquasorb	Cross linked copolymer of acrylamide and potassium acrylate	≤ 31
Nochar N910 and A610	Thermoplastic elastomer (Copolymer of styrene, butadiene and possibly acrylates and phthalates)	≤ 30
Nochar N960 and A660	Copolymer of acrylamide	≤ 32
		≤ 40 (metal nitrates only*)
Nochar N965	Mixture containing 60% N910 and 40% N960	≤ 31
Quik-Solid	Sodium polyacrylate (lightly cross-linked)	≤ 33
Universal Polypropylene	Polypropylene	≤ 30
Waste Lock 770	Sodium polyacrylate, crosslinked	≤ 31
Waterworks SP400	Acrylic acrylate resin	≤ 32

***** Excludes silver nitrate ($AgNO_3$) and lithium nitrate ($LiNO_3$)

Waste shall be evaluated to determine if the oxidizing chemical concentration is below the wt. % in Table 4-3. Sum the dry weight of each of the oxidizing chemicals and divide by the cumulative sum of the weights of the sorbents and oxidizing chemicals to yield the concentration of oxidizing chemicals in the waste. If the weights of either the oxidizing chemicals or the sorbents are not known, it may be possible to perform bounding calculations for the oxidizing chemical concentration using information such as solubility of the oxidizing chemical and the EOPS sorbing capacities for their products that are specific to the chemical(s) being sorbed (typically, information such as ionic strength and pH of the solution must be provided). Examples of how bounding calculations can be used are shown in section 4.6.1. When oxidizing chemical concentrations are not known and cannot be bounded, the TRU waste site may select an appropriate option listed in section 2.0 or the mixture can be treated as 100 wt. % oxidizing chemicals.

The addition of more organic sorbent to achieve the allowable oxidizing chemical concentration is not acceptable. When dried to constant mass, EOPSs are fuels, and potassium nitrite (the bounding oxidizer) concentrations above those listed in Table 4-3 accelerated their burn rates when tested. The sorbent scoping studies burn test showed that 40 wt. % potassium nitrate in Nochar N960 burned slower than the 3:7 potassium bromate and cellulose standard. When the TRU waste with oxidizing chemicals contains only metal nitrates (excluding silver nitrate $AgNO_3$ and lithium nitrate $LiNO_3$), 40 wt. % of oxidizing chemical concentration in Nochar N960 or A660 is acceptable.

EOPSs have been used to sorb oxidizing chemical solutions for more than 15 years without a reported self-ignition event. While EOPSs and carbohydrate sorbents are organic compounds, they react with oxidizing chemicals differently. The oxidizing chemical to fuel concentrations that produced non-oxidizer results in burn rate tests were approximately 20 wt. % less for the carbohydrate sorbents than for the EOPSs. Color changes were observed in some EOPSs during sample preparation for burn testing, indicating that some chemical changes were occurring. These potential chemical changes were represented in the samples tested and the burn rates observed for these samples were virtually the same as the burn rates for EOPS samples with no observed color changes.

Oxidizing chemical wastes sorbed in EOPSs not found in Table 4-3 are not acceptable for disposal at WIPP until the following criterion is met:

- The TRU waste site or AKE has provided information to the CBFO WM-STA showing that the sorbent is equivalent to one of the sorbents listed by name in Table 4-3 and requested an equivalency determination from the CBFO. A written response from the CBFO Manager documenting the determination result will be provided to the TRU waste site and the AKE for inclusion in the AK record.

When equivalency is determined, 30 wt. % oxidizing chemical to EOPS will be the approved acceptance criteria. If the CBFO Manager determines the EOPS is not equivalent, TRU waste sites must select an applicable option other than sorbent equivalency listed in section 2.0.

4.5.2 Organic Rags, Wipes, Sorbent Pads, and Pillows

When the TRU waste site or WIPP Certified Program determines that waste rags, wipes, sorbent pads, and pillows contaminated with oxidizing chemicals would yield oxygen readily to cause or enhance the combustion of organic materials, the following criteria shall apply:

- Rags, wipes, sorbent pads, and pillows shall be treated to the criteria contained in section 5.1; or
- The TRU waste site may treat the waste by a method that can be approved by the CBFO Manager.

4.5.3 Ion Exchange Resins

Other organic wastes or materials containing oxidizing chemicals are known to exist at some of the TRU waste sites. Some of these are in the TRU waste inventory and others will enter the TRU waste inventory. An example of organic waste is ion exchange resins (with divinylbenzene and polystyrene back bones) with various nitrate loadings. Ion exchange resins with oxidizing chemicals that are stabilized with Portland cement are not oxidizers when the resins are well mixed in the cement and do not exceed 10 wt. % in the set cement monolith. When the cement monolith is intact based on visual observation, it is acceptable to conclude that the 10 wt. % limit for the ion exchange resins has been met. Ion exchange resins in excess of 10 wt. % tend to fracture the cement due to swelling. [4]

Ion exchange resins that do not meet the criteria above, organic solvents and other miscellaneous organic materials containing oxidizing chemicals are not acceptable at the WIPP without a verifiable basis that can be used to determine the waste will be safe and

[4] G. Veazey and R. Ames, “Cement Waste Form Development for Ion-Exchange Resins at the Rocky Flats Plant,” LA-13226-MS, March 1997, Los Alamos National Laboratory

compliant for receipt and emplacement in the WIPP. A verifiable basis may include the results of testing or other information that can be confirmed. Due to the potential to form mechanical impact, spark, friction, and/or heat sensitive compounds when some oxidizing chemicals and organics are mixed, the CBFO may require additional testing beyond the testing of oxidizing chemicals to determine acceptability.

4.6 Inorganic Materials with Oxidizing Chemicals

4.6.1 Oxidizing Chemicals Sorbed in Inorganic Sorbents

Table 4 provides the maximum concentration of oxidizing chemical acceptable at the WIPP when it is sorbed in a listed inorganic sorbent. An oxidizing chemical can be considered well mixed in the inorganic sorbent when at least one of the following criteria is met:

- Inorganic sorbent is added to the liquid; or
- A known liquid is added in a volume approaching the liquid holding capacity of the inorganic sorbent; or
- Liquid is stirred or mixed with the inorganic sorbent.

Table 4-4 – Inorganic Sorbents, Allowable-Oxidizing Chemical Concentrations, and Liquid Holding Capacities

Sorbent Name	Composition listed in the Safety Data Sheet	Wt. % of Oxidizing Chemicals Allowed	Measured Liquid Holding Capacity (mL/g sorbent)
Absorb-N-Dry	Fuller's Earth 90-100% or Bentonite calcined 90-100% and Quartz <10%	≤ 28	0.683
Aquaset	Sodium montmorillonite	≤ 27	0.263
Aquaset II	Sepiolite	≤ 45	1.44
Aquaset II-G	Sepiolite	≤ 36	1.33
Celite S	Kieselguhr (a diatomaceous earth)	≤ 36	3.07
ChemOil-Away	Volcanic ash ≥98% organic material ≤2%	≤ 13	0.853
Drierite	Calcium sulfate	≤ 29	0.843
Floor-Dry	Kieselguhr (a diatomaceous earth)	≤ 36	3.07
KMI Natural Zeolite (4 to 7 Å pore size	Clinoptilolite	≤ 35	0.51
Oil-Dri	Bentonite 90-100%	≤ 38	1.06
Plaster of Paris	Calcium sulfate hemihydrate	≤ 24	0.931
Portland cement (when used as a dry sorbent)	Portland Cement	≤ 20 *****	0.611
Spill-X-A	Magnesium oxide 60-100% Attapulgite 7-13% Sodium carbonate 5-10%	≤ 33	0.605
Totalsorb**	> 99% expanded Amorphous Alumina Silicate	≤ 36	1.51
Zeolite (10 Å pore size)	Zeolite	≤ 44	1.12
Zeolite (4 Å pore size)	Zeolite	≤ 35	1.15

***** The wt. % of oxidizing chemical allowed for Portland cement does not apply to ion exchange resins with oxidizing chemicals (see section 4.5.3) and wet mixed and set cement (see section 4.6.3).

** CBFO correspondence CBFO:ONTP:JRS:PG:17-0695:UFC 5900.00 dated June 20, 2017. Key words: BoK Approval, LA-MHD04.001, Type 1, WCS.

Waste shall be evaluated to determine if the oxidizing chemical concentration is below the wt. % of oxidizing chemical allowed in Table 4-4. Sum the dry weight of each of the oxidizing chemicals (exclude the weight of the waters of hydration) and divide by the cumulative sum of the weight of the sorbents and oxidizing chemicals (including the weight of the waters of hydration) to yield the concentration of oxidizing chemicals in the waste.

If the weights of either the oxidizing chemicals or the sorbents are known, it may be possible to perform bounding calculations for the oxidizing chemical concentration using the solubility of the oxidizing chemical and the inorganic sorbent liquid holding capacity. Examples of how bounding calculations can be used are shown below.

<u>Example 1</u>

The oxidizing chemical (sodium nitrate [$NaNO_3$]), sorbent name (Aquaset II), and volume of $NaNO_3$ solution sorbed (2 gallons) are known, but the concentration of $NaNO_3$ in the solution and the weight of Aquaset II are unknown.

Step 1

Determine the weight in grams of $NaNO_3$ in the solution using $NaNO_3$ solubility of 87.6 g/100 milliliters (mL) in water at 20 ^{0}C and 2 gallons for the volume of solution sorbed.

$$\boldsymbol{NaNO_3\ solubility\ \times vol.sorbed\ =\ wt.of NaNO_3}$$

So

$$\frac{87.6\ g\ NaNO_3}{100\ mL} \times \frac{3785\ mL}{gallon} \times 2\ gallons\ NaNO_3\ solution\ sorbed\ = 6631\ g\ NaNO_3$$

Step 2

Determine the weight in grams of Aquaset II required to sorb 2 gallons of $NaNO_3$ solution using the measured liquid holding capacity of 1.44 milliliters per gram (mL/g) of Aquaset II as listed in Table 4-4.

$$\boldsymbol{\frac{volume\ of\ NaNO_3\ solution\ sorbed}{measured\ liquid\ holding\ capacity\ of\ Aquaset\ II} = weight\ of\ Aquaset\ II}$$

So

$$\frac{2\ gallons\ NaNO_3\ solution\ \times \dfrac{3785\ mL}{gallon}}{\dfrac{1.44\ mL\ NaNO_3\ solution}{g\ Aquaset\ II}} = 5257\ g\ Aquaset\ II$$

Step 3

Calculate the wt. % of $NaNO_3$ in Aquaset II using the weight of $NaNO_3$ from Step 1 and the weight of Aquaset II from Step 2.

$$\frac{\boldsymbol{g\ NaNO_3}}{\boldsymbol{g\ NaNO_3 + \ g\ Aquaset\ II}} \times \mathbf{100} \ = \boldsymbol{wt.\%\ NaNO_3}$$

So

$$\frac{6631\ g\ NaNO_3}{6631\ g\ NaNO_3 + \ 5257\ g\ Aquaset\ II} \times 100 \ = 56\ wt.\%\ NaNO_3$$

Conclusion: The $NaNO_3$ is at a concentration above the ≤ 45 wt. % allowed at the WIPP in Aquaset II and must either be treated with additional Aquaset II to bring the bounded oxidizing chemical salts concentration to meet the oxidizing chemical's allowed concentration identified in Table 4-4 or have tests performed to show $NaNO_3$ at this concentration produces a non-oxidizer result.

Step 4

The TRU waste site has decided to add additional Aquaset II to this waste. Calculate the additional Aquaset II that must be added and mixed to bring the bounded oxidizer salt's concentration to ≤ 45 wt. %. Use the wt. % of oxidizing chemicals allowed value for Aquaset II from Table 4-4, and the weights in grams of Aquaset II and the bounding oxidizer salt.

$$\left(\left(\frac{\mathbf{100}}{\boldsymbol{wt.\%\ oxidizing\ chem.allowed}} - \mathbf{1}\right) \times \boldsymbol{g\ bounding\ oxidizer\ salt}\right) - \boldsymbol{initial\ weight\ of\ sorbent} = \boldsymbol{weight\ of\ additional\ sorbent\ needed}$$

So

$$\left(\left(\frac{100}{45\ wt.\%} - 1\right) \times 6631\ gNaNO_3\right) - 5257 g\ Aquaset\ II = 2848\ g\ Aquaset\ II$$

<u>Example 2</u>

Multiple concentrations of $NaNO_3$ solutions were added to the inorganic sorbent Celite S. The concentration of each individual $NaNO_3$ solution is known, however, the volume of each solution sorbed is not known. The most concentrated solution sorbed was 6 molar $NaNO_3$ so it will be used to bound the $NaNO_3$ solutions sorbed. The solutions were sorbed in 4200 g of Celite S inorganic sorbent.

Step 1

Determine the total volume of the sorbed $NaNO_3$ solutions using the most concentrated (bounding concentration) of 6 molar $NaNO_3$ and the measured holding capacity for Celite S.

$$\boldsymbol{wt. of\ sorbent \times measured\ liquid\ holding\ capacity\ of\ sorbent = volume\ of\ solution}$$

So

$$4200\ g\ Celite\ S \times \frac{3.07\ mL\ solution}{g\ Celite\ S} = 12{,}894\ mL\ total\ volume\ sorbed\ of\ 6\ molar\ NaNO_3$$

Step 2

Determine the weight of $NaNO_3$ solutions sorbed in Celite S using the total volume of 6 molar $NaNO_3$ solution determined in Step 1.

$$\boldsymbol{total\ volume\ of\ 6\ molar\ NaNO_3\ solution\ \text{sorbed} \times concentration\ of NaNO_3\ solution = bounding\ weight\ of\ NaNO_3\ salt\ in\ sorbed\ solutions}$$

So

$$12{,}894\ mL\ total\ volume\ sorbed\ of\ 6\ molar\ NaNO_3 \times \frac{6\ moles\ NaNO_3}{1{,}000\ mL} \times \frac{85\ g\ NaNO_3}{mole} = 6{,}576\ g\ bounded\ weight\ of\ NaNO_3$$

Step 3

Calculate the wt. % of $NaNO_3$ salt sorbed in the known weight of 4200 g of Celite S using the bounded weight of $NaNO_3$ calculated in Step 2.

$$\boldsymbol{\frac{g\ NaNO_3}{g\ NaNO_3 + g\ Celite\ S} \times 100 = wt.\%\ NaNO_3}$$

So

$$\frac{6576\ g\ NaNO_3}{6576\ g\ NaNO_3 + 4200\ g\ \text{Celite S}} \times 100 = 61\ wt.\%\ NaNO_3$$

Conclusion: The sorbed oxidizer is at a concentration above ≤ 36 wt. % allowed at WIPP in Celite S and must either be treated or have tests performed to show $NaNO_3$ at this concentration in Celite S produces a non-oxidizer result.

Step 4

The TRU waste site has decided to add additional Celite S to this waste. Calculate the additional Celite S that must be added and mixed to bring the bounded oxidizer salt's concentration to ≤ 45 wt. %. Use the wt. % of oxidizing chemicals allowed value for Aquaset II from Table 4-4, and the weights in grams of Celite S and the bounding oxidizer salt.

$$\left(\left(\frac{\mathbf{100}}{\boldsymbol{wt.\%\ oxidizing\ chem.allowed}}-\mathbf{1}\right)\times \boldsymbol{g\ bounding\ oxidizer\ salt}\right)-\boldsymbol{initial\ weight\ of\ sorbent} = \boldsymbol{weight\ of\ additional\ sorbent\ needed}$$

So

$$\left(\left(\frac{100}{36\ wt.\%}-1\right)\times 6{,}576\ gNaNO_3\right)-4200\ g\ Celite\ S = 7{,}491\ g\ Celite\ S$$

<u>Example 3</u>

The concentrations of sodium nitrate, potassium nitrate, and calcium nitrate in solution are not known in an evaporator liquid waste stream. The solubility of sodium nitrate is 87.6 g/100 mL of water, the solubility of potassium nitrate is 33.0 g/100 mL of water, and the solubility of calcium nitrate is 129 g/100 mL of water. The process flow sheets identify sodium nitrate and potassium nitrate solutions as the predominant feed solutions sent to the evaporator. A way to bound the concentrations of oxidizer salts in the evaporator liquid waste stream is to identify the salt with the highest solubility between the predominant feed solutions. The liquid has been sorbed in 8 gallons of Aquaset II. The density of Aquaset II (Sepiolite clay) is 2.00 grams per cubic centimeter (g/cm^3).

Step 1

Determine the weight of the Aquaset II using the volume of sorbent used (8 gallons) and the density of the Aquaset II (sepiolite, 2.00 g/cm^3).

$$\boldsymbol{Volume\ of\ sorbent}\ \times\ \boldsymbol{Density\ of\ sorbent} = \boldsymbol{Weight\ of\ sorbent}$$

So

$$8\ gal.of\ Aquaset\ II \times \frac{3785\ cm^3}{1\ gal.}\ \frac{2.00\ g\ Aquaset\ II}{cm^3} = 60{,}560\ g\ Aquaset\ II$$

Step 2

Calculate the volume of solution sorbed from the liquid holding capacity of Aquaset II (1.44 mL/g) using the following equation:

$$\boldsymbol{Sorbent's\ Liquid\ Holding\ Capacity}\ \times\ \boldsymbol{Weight\ of\ sobent} = \boldsymbol{Volume\ of\ solution}$$

So

$$\frac{1.44\ mL}{g\ Aquaset\ II}\times\ 60{,}560\ g\ Aquaset\ II =\ 87{,}206\ mL\ solution$$

Step 3

Calculate the weight of the bounding weight oxidizer salts in the evaporator liquid waste stream.

$$\begin{aligned}&\boldsymbol{Solubility\ of\ the\ bounding\ \ salt} \times \boldsymbol{Volume\ of\ solution}\\&= \boldsymbol{Bounding\ weight\ of\ oxidizer\ salts\ in\ the\ evaporator\ liquid\ waste\ stream}\end{aligned}$$

Of the two most predominant oxidizer salts in the feed solutions, sodium nitrate has the highest solubility (87.6 g/100 mL of water); therefore, it will be the oxidizer salt used for the bounding calculation.

$$\frac{87.6\ g\ NaNO_3}{100\ mL} \times 87{,}206\ mL\ solution = 76{,}392\ g\ of\ NaNO_3$$

Step 4

Calculate the bounding wt. % of oxidizer salts sorbed in 8 gallons of Aquaset II.

$$\frac{\boldsymbol{g\ bounding\ oxidizer\ salt}}{\boldsymbol{g\ bounding\ oxidizer\ salt +\ g\ Aquaset\ II}} \times \mathbf{100}\ = \boldsymbol{bounding\ wt.\%\ of\ oxidizer\ salts}$$

Or

$$\frac{76{,}392\ g\ NaNO_3}{76{,}392\ g\ NaNO_3 +\ 60{,}560\ g\ Aquaset\ II} \times 100\ = 56\ wt.\%\ oxidizer\ salts$$

Conclusion: The sorbed oxidizer salts exceed the ≤ 45 wt. % allowed at WIPP in Aquaset II and must either be treated or have tests performed to show $NaNO_3$ at this concentration in Aquaset II produces a non-oxidizer result.

Step 5

The TRU waste site has decided to add additional Aquaset II to this waste. Calculate the additional Aquaset II that must be added and mixed to bring the bounded oxidizer salt's concentration to ≤ 45 wt. %. Use the wt. % of oxidizing chemicals allowed value for Aquaset II from Table 4-4, and the weights in grams of Aquaset II and the bounding oxidizer salt.

$$\begin{aligned}&\left(\left(\frac{\mathbf{100}}{\boldsymbol{wt.\%\ oxidizing\ chem.allowed}} - \mathbf{1}\right) \times \boldsymbol{g\ bounding\ oxidizer\ salt}\right) - \boldsymbol{initial\ weight\ of\ sorbent}\\&= \boldsymbol{weight\ of\ additional\ sorbent\ needed}\end{aligned}$$

So

$$\left(\left(\frac{100}{45\ wt.\%}-1\right)\times 76{,}392\ gNaNO_3\right)-60{,}560\ g\ Aquaset\ II = 32{,}808\ g\ Aquaset\ II$$

For components of the waste with more than one inorganic sorbent, the maximum allowed concentration of oxidizing chemicals is determined by the lowest maximum concentration of any of the components. For example, for a mixture of Drierite and Zeolite (10 Å pore size), the maximum concentration of oxidizing chemicals allowed is 29 wt. %.

Waste containing inorganic sorbents that are not found in Table 4-4 are not acceptable for disposal at the WIPP until the TRU waste site or AKE has requested an evaluation that the sorbent is equivalent to one of the sorbents listed by name in Table 4-4 and received a written determination from the CBFO Office of the Manager for the AK record. If the CBFO determines that the inorganic sorbent is not equivalent, TRU waste sites must select an applicable option listed in section 2.0. If option 2.0 c) is selected, then data shall be collected using a CBFO approved test plan that demonstrates that the concentration in wt. % of most representative metal oxidizing chemical salt found in the mixture to sorbents produces a non-oxidizer result (see section 6.0).

When there is inadequate information to quantitate the concentration of oxidizing chemical, the waste must be treated as 100 wt. % oxidizing chemical with an inorganic sorbent listed in Table 4-4 using the corresponding allowable oxidizing chemical concentration (or see section 2.0).

NOTE: The CBFO will not grant equivalency for Hydromatrix, Micro-Cel® E, perlite, or vermiculite. These inorganic sorbents are not effective for treating oxidizing chemicals to produce non-oxidizer results, therefore, they must be treated as 100% oxidizing chemical with zeolite or another inorganic sorbent when they contain oxidizing chemicals.

4.6.2 Inorganic Sludges with Oxidizing Chemicals Not Mixed with Sorbents

Inorganic sludges containing oxidizing chemicals that are not mixed with sorbents have been generated from plutonium purification and other processes. As an example, chemical salt sludges resulted from reactions that included neutralization, flocculation, co-precipitation, and evaporation of chemical salts. Inorganic sludges with up to 30 wt. % oxidizing chemical that have not been mixed with sorbent are acceptable at the WIPP, provided liquids are not present in excess of the limit specified in DOE/WIPP-02-3122, Revision 8.0, *Transuranic Waste Acceptance Criteria for the Waste Isolation Pilot Plant.*

4.6.3 Oxidizing Chemicals Solidified in a Cement or Grout Matrix

Oxidizing chemical liquids and particulate containing oxidizing chemicals are sometimes fixed in an inorganic form of cement or grout for disposal. Cement or grout containing oxidizing chemical shall be considered well mixed if the process involved mixing, stirring, or other manipulation of the cement or grout paste and oxidizing chemicals prior to setting. For purposes of this BoK, wastes with oxidizing chemicals, whether listed in Table 4-1 or not, that are cemented or grouted are not considered oxidizers when the following criteria are met.

- No more than 20 volume percent of the set material has external dimensions less than 2 centimeters; and
- No free liquid is present.

Inorganic cements and grouts meeting these criteria prevent the oxidizing chemical they contain from being activated with heat and do not require further treatment.

4.7 Mixtures of Organic and Inorganic Materials with Oxidizing Chemicals

When the waste is a mixture of inorganic sorbent listed on Table 4-4 and organic sorbent listed on Table 4-3, the maximum wt. % of oxidizing chemicals allowed is determined by the lowest concentration allowed of any of the sorbents in the mixture. For example, for a mixture of Drierite and Nochar N910, the maximum concentration of oxidizing chemicals allowed is 29 wt. %.

The wt. % of oxidizing chemicals is calculated by summing the dry weight of each of the oxidizing chemicals and dividing by the cumulative sum of the weights of the sorbents and oxidizing chemicals. If the concentration of oxidizing chemicals in the sorbents exceeds the maximum value listed in Table 4-3 or Table 4-4, the waste can be treated by adding more of the same inorganic sorbent using the weighted average of each of the sorbent components as the maximum concentration of oxidizing chemicals allowed, such that the mixture criterion in the previous paragraph is satisfied.

For Example: If 20 kilograms of Aquaset II waste matrix loaded with sodium nitrate has 2 liters of liquid observed on the top and 2 gallons of Nochar N960 was added to sorb the liquid, then the mixture of Aquaset II and Nochar N960 can be evaluated as follows:

Step 1:

The maximum oxidizing chemical that could be present in the Aquaset II is:

$$20{,}000\ g\ Aquaset\ II \text{ x } \frac{1.44\ mL}{1\ g\ Aquaset\ II} \text{ x } \frac{87.6\ g\ of\ NaNO_3}{100\ mL} = 25{,}299\ g\ of NaNO_3$$

Or

$$\frac{25{,}229\ g\ of\ NaNO_3}{(25{,}229\ g\ of\ NaNO_3 + 20{,}000\ g\ Aquaset\ II)} \text{ x } 100 = 56\ wt.\%\ NaNO_3$$

Step 2:

The mass of 2 gallons of Nochar N960 is:

$$2\ gallons\ Nochar\ N960\ \mathrm{x}\ \frac{0.8\ g}{mL\ Nochar\ N960}\ \mathrm{x}\ \frac{3785\ mL}{1\ gallon} = 6{,}056\ g\ of\ Nochar\ N960$$

With 2 liters of solution:

$$2\ L\ solution\ \mathrm{x}\ \frac{87.6\ g\ NaNO_3}{0.1\ L\ water\ solution} = 1{,}752\ g\ of\ NaNO_3$$

Or

$$\frac{1{,}752\ g\ of\ NaNO_3}{(1{,}752\ g\ of\ NaNO_3 + 6{,}056\ g\ Nochar\ N960)}\ \mathrm{x}\ 100 = 22\ wt.\%\ NaNO_3$$

Step 3

Determine the weighted contributions of each component to the mixture:

There are 20,000 g of Aquaset II matrix to 6,056 g of Nochar N960 so:

$$\frac{20{,}000\ g\ Aquaset\ II}{(20{,}000\ g\ Aquaset\ II + 6{,}056\ g\ Nochar\ N960)}\ \mathrm{x}\ 100 = 77\ wt.\%\ Aquaset\ II$$

And

$$\frac{6{,}056\ g\ Nochar\ N960}{(20{,}000\ g\ Aquaset\ II + 6{,}056\ g\ Nochar\ N960)}\ \mathrm{x}\ 100 = 23\ wt.\%\ Nochar\ N960$$

Step 4

The allowed wt. % $NaNO_3$ concentration in the mixture would be calculated based on the Aquaset II allowed oxidizing chemical concentration of 45 wt. % and the Nochar N960 allowed oxidizing chemical concentration of 40 wt. % for metal nitrates. The new allowed oxidizing chemical concentration is:

$$(45\ wt.\%\ in\ Aquaset\ x\ 0.77\ ) + (40\ wt.\%\ in\ Nochar\ N960\ x\ 0.23) = 44\ wt.\%\ in\ the\ mixture$$

Step 5

Therefore, the additional Aquaset II that must be added to the mixture is:

$$\left(\left(\frac{100}{44\ wt.\%} - 1\right) \times 26{,}981\ gNaNO_3\right) - 20{,}000\ g\ Aquaset\ II = 14{,}339\ g\ Aquaset\ II$$

Sorbents that are not found in Table 4-3 or Table 4-4 are not acceptable for disposal at WIPP until the TRU waste site or AKE has requested an equivalency determination and the CBFO has determined that the sorbent is equivalent to one of the sorbents listed in Table 4-3 or Table 4-4. If the CBFO determines that the EOPS or inorganic sorbent is not equivalent, TRU waste sites must select an applicable option listed in section 2.0.

Waste containing an EOPS sorbent that is not listed on Table 4-3 that also contains an inorganic sorbent that is listed in Table 4-4, may be treated to the wt. % of oxidizing chemical allowed for the inorganic sorbent without requesting an equivalency determination as long as the oxidizing chemical wt. % in the unlisted EOPS is known. When the oxidizing chemical concentration in the mixture is greater than 30 wt. % and the inorganic sorbent's allowable oxidizing chemical concentration is less than 30 wt. %, an equivalency determination is unnecessary as long as the waste is treated with additional inorganic sorbent to meet the allowable oxidizing chemical concentration specified in Table 4-4.

When the CBFO determines the sorbent is equivalent, the CBFO Manager will issue written acceptance criteria for that sorbent and the criteria will be included in a revision to this BoK.

4.8 Oxidizing Chemicals that are the Sole Component of Waste

Oxidizing chemicals that are the sole waste component(s) (e.g., metal nitrate salts with or without free liquid) are not acceptable for disposal at WIPP without treatment (see section 2.0 g)).

4.9 Surfaces Contaminated With Oxidizing Chemicals

Waste components with low porosity and impermeable surfaces that have been exposed to liquid or solid oxidizing chemicals are surface-contaminated only. These types of waste components will not exhibit oxidizing behavior regardless of the distribution of the oxidizing chemicals when there is no observable adhesion of the oxidizing chemical to the surface.

4.10 Oxidizing Chemicals Spilled or Released Into Soils

Soils containing up to 30 wt. % oxidizing chemicals are allowable without treatment provided they are not also contaminated with organics released in bulk liquid form (excludes natural organic matter content of the soil).

4.11 Oxidizing Chemicals in Waste Retrieved From Earthen Disposal Pits

In the case of oxidizing chemicals retrieved from disposal pits where they were likely to have been co-mingled with organic waste. Modified SW-846 Method 1040 and other historic testing indicate that 30 wt. % oxidizing chemical concentration produces a non-oxidizer result in either inorganic or organic matrices. Therefore, the total concentration of oxidizing chemicals in waste retrieved from earthen pits will be ≤ 30 wt. % provided the waste is not also contaminated with liquid organics.

TRU waste sites with burial pits where oxidizing chemical salts were disposed must remove salt crystals other than small visible crystals that are impractical to pick out from the excavated soil/waste mixture. The dissolved salt in the soils plus the remaining visible crystals cannot exceed 30 wt. %.[5] Crystalline oxidizing chemical salts removed from the soil/waste mixture must be treated as oxidizing chemical salts according to the concentrations listed in Table 5-1, if the WIPP is the planned disposal location.

Potentially explosive compounds can form when process waste chemicals are discarded. Organic fuels such as cutting oils, reducing agents such as zero valent metals, and unstable process chemicals such as hydroxylamine nitrate are incompatible with oxidizing chemicals and each other. The BoK does not cover these other incompatibilities. TRU waste sites must ensure that these other incompatibilities are documented, evaluated, and safely managed to ensure that the waste does not pose a hazard when exposed to mechanical impact, spark, friction, and/or heat. BoK evaluations shall not be performed on this waste until after a chemical compatibility evaluation memorandum has been approved by the CBFO indicating that these incompatibilities will be addressed.

5.0 CRITERIA FOR TREATMENT OF WASTE CONTAINING OXIDIZING CHEMICALS

If the waste does not pass the evaluation criteria of section 4.0 and must be treated, the following treatments are acceptable based on formal testing results.

5.1 Treatment with Zeolite

Table 5-1 lists the final wt. % of oxidizing chemicals and zeolites that produces a non-oxidizer result in a homogeneous treated oxidizing chemical and organic sorbent mixture.

Table 5-1 – Final wt. % of Zeolites Required to Treat Previously Sorbed Oxidizing Chemical in Organic Sorbent Mixtures and Rags, Wipes, Pads, and Pillows

Mixture to Remediate	Wt. % of 4 Å to 10 Å zeolite required in a treated homogeneous mixture
Oxidizing chemical in an EOPS	≥ 50
Oxidizing chemical in cellulose (e.g., cheesecloth, cotton rags, wipes, SlikWik®, etc.)	≥ 70
Oxidizing chemical in polyester rags, pads and polyester encased cellulose sorbent pillows	≥ 70

The Table 5-1 final wt. % of zeolites required is a minimum value determined from 3:2 mixtures of the bounding oxidizing chemical to Quik Solid® (the fastest-burning EOPS) and

[5] Kimmitt, R.R., Allowable Nitrate Salt Concentration in ARP Waste, Engineering Design File, EDF-8723, Rev. 2., Idaho Cleanup Project, Idaho Falls, Idaho.

sWheat Scoop® without the addition of powdered cellulose fuel. The 3:2 mixture is the most aggressive burning mixture under the modified SW-846 Method 1040 test. Any other ratio of oxidizer to fuel will produce a slower burn time. The wt. % of 4 Å to 10 Å zeolite required is the minimum wt. % of zeolite that must be achieved in the final previously sorbed waste and zeolite treated homogeneous mixture. The final zeolite concentration of the treated homogeneous mixture is determined from the as-received weight of the zeolite and the weight of the previously sorbed mixture's dry weight.

The zeolite values in Table 5-1 cannot be compared to the zeolite values listed in Table 4-3 as those were derived from bounding oxidizing chemical and organic sorbent mixtures in 10% step-down tests that stopped at the highest oxidizing chemical percentage that achieved a non-oxidizer result. These test samples were also tested without the addition of powdered cellulose fuel. Only the wt. % values for oxidizing chemical and zeolites from Table 5-1 can be used when treating oxidizing chemicals previously sorbed in organic sorbents.

For the purpose of the BoK, the treated mixture is considered well mixed when the zeolite is distributed evenly throughout the waste. It is the responsibility of the TRU waste site to ensure that the treatment process is demonstrated to produce thoroughly blended mixtures. Additionally, it is the responsibility of the TRU waste site to ensure that the selected treatment process is compliant with their safety and regulatory requirements.

5.2 Handling of Zeolite

Zeolites are believed to be compatible with the oxidizing chemicals listed in Table 4-1. However, there are some documented chemical incompatibilities and observed properties of zeolite that should be noted for the TRU waste sites that may be problematic in handling zeolites for treatment of oxidizing chemical wastes.

Strong oxidizers that will attack glass will also attack zeolites. These include oxygen difluoride and other halogenated compounds that may not contain oxygen, such as fluorine, chlorine, and triflouride. Several strong acids have been shown to break down the zeolite structure. Hydrochloric acid (HCl) can dissolve zeolites, while sulfuric acid (H_2SO_4) and hydrofluoric acid (HF) can cause pitting. The degree of dissolution depends on the ratio of Si-to-Al of the particular zeolite variety. Zeolites can also dissolve in strong alkaline hydroxides, such as sodium hydroxide (NaOH), but the hydroxide must be heated.

TRU waste sites handling zeolite should also be aware of its heat of immersion, which results in the zeolite heating upon being mixed with water. This was observed in the holding capacity studies as steam rising from the sample tray when the potassium nitrite solution was slowly added to the zeolite. Heats of immersion of zeolites have been reported as high as 375 J/g (joules per gram).

TRU waste sites treating waste with zeolite are encouraged to perform small-scale tests prior to initiating waste treatment with zeolite to determine if any of these properties need to be accounted for. TRU waste sites should not initiate treatment of oxidizing chemical waste unless the treatment can be performed safely and effectively.

5.3 Treatment of Previously Sorbed Oxidizing Chemicals and Organic Sorbents with Inorganic Sorbents Other Than Zeolites

A TRU waste site may use an inorganic sorbent other than zeolite if test data are developed under the following condition:

- Data are collected using a CBFO approved test plan developed incorporating the criteria in section 6.0 to determine the wt. % of oxidizing chemical allowed for the initial waste mixture blended with the selected inorganic treatment sorbent. This is the wt. % concentration of oxidizing chemical in inorganic sorbent that produces a non-oxidizer result.

Test plans should be submitted to the CBFO Office of the Manager for approval. Approvals will be documented in writing by the CBFO Manager. Data shall be provided to the CBFO after validation by the TRU waste site. Once the data are approved by CBFO, acceptance criteria for that sorbent will be provided in writing and included in a revision to this BoK.

6.0 CRITERIA FOR TESTING WASTE CONTAINING OXIDIZING CHEMICALS

Testing to determine the oxidizing chemical wt. % in sorbent, soil, or other waste that produces a non-oxidizer result shall be developed in accordance with EPA publication SW-846 entitled *Test Methods for Evaluating solid Waste: Physical/Chemical Methods, Chapter One.* The test plan must specify how the waste will be bounded if representative waste sample testing cannot be performed.

If SW-846 Method 1040, *Test Method for Oxidizing Solids,* is to be used, the method modifications specified in section 6.1 must be applied. The modifications made to the SW-846 Method 1040 test were put in place to account for the environmental conditions the waste could experience during shipment in unvented Nuclear Regulatory Commission-certified Type B packages; when received and managed in the WIPP surface storage facilities, and after emplacement in the WIPP underground until the waste is isolated from the underground ventilation air flow. Data Quality Objectives (DQOs) will be established that are no less restrictive than those listed in section 6.2. Additional DQOs may be developed if they will add to the quality of the test results.

It is the responsibility of the TRU waste site to ensure that their testing can be implemented in compliance with site safety and regulatory requirements. The test plan shall be provided to the CBFO for review and approval. Copies of the following types of documents shall be provided to the CBFO Office of the Manager when testing is completed:

- Procurement procedures and records for purchases of quality affecting chemicals and equipment;
- Instrument calibration documents;
- Data validation and verification procedures and reports;
- Sample data sheets; and
- Data report or summary document.

The CBFO Manager will issue written acceptance criteria when the results of testing are accepted. The issued criteria will be incorporated in a revision to this BoK.

Oxidizing chemicals that are likely to ignite or explode during sample preparation are not amenable to testing using the modified SW-846 Method 1040. Alternate test methods and treatments will have to be identified for these oxidizing chemicals. The CBFO will cooperate with the TRU waste sites in seeking an acceptable testing and treatment path for wastes such as these.

6.1 Modified Method 1040 Testing Approach

The SW-846 Method 1040 requires testing representative samples of wastes. Non-radioactive surrogates may be used for testing if a site is unable to conduct burn rate tests on radioactive materials.

Modifications shall be made to the SW-846 Method 1040 to account for the intended use of the analytical results specific to the WIPP or to account for conditions in the laboratory. The SW-846 Method 1040 modifications required or determined acceptable by the CBFO are described below.

- The SW-846 Method 1040 requires drying of a sample at 65 ± 2 degrees Celsius (°C) for 12 hours. The CBFO will approve modifications of the SW-846 Method 1040 to allow samples to be dried at 65 °C with temperature deviations of ± 10 °C. Drying until a constant mass is achieved is required, regardless of total drying time.
- The SW-846 Method 1040 requires the sample to be cut, crushed, or ground so that the particle size of the sample to be tested is no larger than 0.5 mm (passes through a 32-mesh sieve). Materials must be size-reduced as much as possible. If a particle size reduction to no larger than 0.5 mm is not possible, then the difference in size shall be accounted for by developing an alternative reference standard that can be compared to the SW-846 Method 1040 prepared reference standard.
- The SW-846 Method 1040 requires each sample to be evaluated in 1:1 and 4:1 (by weight) waste to cellulose ratios. Since most oxidizing chemicals alone or when mixed with inorganic sorbents are not combustible, the SW-846 Method 1040 specifies the addition of cellulose as the organic fuel for testing. Many of the sorbing materials identified in active TRU waste stream AK records are organic and are readily combustible when dried. Cellulose fuel should not be added to these samples because it will make the sample fuel rich and oxidizer lean. This condition will extend the observed burn times of the samples and it does not accurately represent the actual waste. Remediation samples containing organic sorbents shall be tested in 3:2 oxidizing chemical to organic sorbent portions without the addition of cellulose fuel.
- Per SW-846 Method 1040, the burn rate test is repeated five times for each waste to cellulose ratio mixture. Method 1040 also requires mixing 100 g to 160 g of sample with cellulose to provide enough of the mixture for five tests, and 30 g aliquots are measured from this large batch for each burn test. If these prepared sample

quantities are believed to pose an undue safety risk, each 30 g sample may be prepared individually. DQOs addressing weighing accuracy and mixing times should be developed and implemented for consistency of the samples.

- The SW-846 Method 1040 states that all tests must be conducted under standard test conditions, which include a temperature of 20 ± 5 °C and a relative humidity of 50 ± 10%. If TRU waste sites are conducting testing in a facility that is not temperature- or humidity-controlled, the following modifications may be made to the SW-846 Method 1040: Burn rate testing of a specific sample must be conducted at an initial recorded temperature with no more than ± 5 °C deviation and no more than ± 10% deviation from initial relative humidity at which a 3:7 reference standard was tested. If conditions deviate beyond these ranges, a new reference standard must be tested, and the testing for that sample repeated. DQOs that cover the environmental conditions must be written and monitored during testing to show the environmental conditions are not changing beyond those written in the unmodified SW-846 Method 1040.

- The SW-846 Method 1040 states that the ignition wire should be placed on a ceramic plate before the sample is added on top of the wire in a conical pile. In this configuration, there is a gap between the ceramic plate and the funnel used to form the conical sample pile due to the ignition wire and insulator block attached to the wire. The funnel shall be inverted onto the ceramic plate with no ignition wire present, and the ignition wire shall be carefully pressed or slid into the cone of sample from the top or side to better retain the cone shape without displacing the pile base. For the samples that could not be fully size-reduced per the method, the samples shall be placed on top of the ignition wire ensuring an air gap remains between ceramic plate and the ignition wire.

- The SW-846 Method 1040 states that once the sample pile ignites, the power to the ignition wire is turned off. SW-846 Method 1040 shall be modified to keep the ignition wire energized for 15 seconds, even if ignition occurs sooner, to reduce the subjectivity of when ignition takes place. If the sample ignites within 15 seconds, the ignition shall be turned off. If the sample does not ignite within 15 seconds, the wire shall remain energized until the analyst determines ignition has occurred or for at least 3 minutes, as directed in the unmodified SW-846 Method 1040.

SW-846 Method 1040 classifies a solid waste into one of four categories of oxidizers based on the shortest mean burning time between the 4:1 and 1:1 oxidizer to cellulose samples. This allows the possibility for a non-oxidizer result to be obtained if any of the five individual burn rates used to calculate the mean burning time are shorter than the mean burning time for the 3:7 potassium bromate to cellulose reference standard. To ensure that the average burn time is in the non-oxidizer category, the following modification shall be made: A non-oxidizer result occurs when either the burn times for all samples and duplicate sample are greater than the 3:7 potassium bromate to cellulose reference standard, or the samples do not burn at all. If the first two aliquots of a sample or duplicate sample do not ignite within 3 minutes, the sample shall be labeled a non-oxidizer, and no further testing shall be required for the remaining aliquots for that sample or duplicate.

6.2 Oxidizing Chemical Testing and Data Quality Objectives

Many factors, such as particle size, reagent moisture content, room temperature, humidity, ventilation, position of the test sample in the hood, and the position of the ignition wire within the test pile can impact the burn rates and method precision. The burn rates for individual burn rate tests performed on each sample and the mean burn rates for each series of burn rate tests shall be recorded on data sheets generated from the execution of a CBFO Manager approved test plan. It is essential that all steps be conducted in a consistent manner under uniform experimental conditions to obtain reliable and reproducible results. Therefore, the test plan shall specify DQOs that define the acceptable level of uncertainty or variation in parameters that can affect the overall method accuracy or precision.

To ensure the environmental conditions are consistent for a set of burn rate measurements performed using the modified SW-846 Method 1040 approach, a DQO for room temperature and humidity shall be specified for the location of the test. All five aliquots for any sample must be tested within a range of 5 °C above or below the room temperature at which the same 3:7 potassium bromate to cellulose reference standard is measured. Relative humidity of the room must remain within a range of 10% above or below the initial relative humidity at which the same 3:7 potassium bromate to cellulose reference standard is measured.

To ensure sample consistency and the proper concentrations of oxidizing chemicals and sorbents in samples, the DQO for weights of oxidizing chemicals, sorbents, and cellulose shall be ± 0.05 g. The DQO to establish dryness of the sample shall be a difference of ± 2 g between the final sample weight and the previous weight measurement. Each test sample batch shall be dried for 12 hours before the first weight measurement. Each test sample batch shall be dried for at least 4 additional hours between subsequent weight measurements. To ensure samples are dried at a consistent temperature, the DQO for drying oven temperature was 65 ± 10 ^{0}C. Finally, to ensure consistency between each burn rate measurement and to gauge the consistency of the procedures, a DQO for the range on the reference standard tests shall be established. For any given series of burn rates, a set of five aliquots of 3:7 potassium bromate to cellulose reference standard must be within a range of ± 60 seconds from the average result obtained, or the reference series shall be invalid and must be repeated. A DQO for thermocouple measurements shall be established to account for error in thermocouple readings so that the temperature of the ignition wire does not exceed 1050 °C or fall below 1000 °C.

7.0 RECORDS

The following documents, under the CBFO records heading, will be generated as necessary when implementing the BoK and shall be processed and maintained as Quality Assurance records in accordance with established CBFO records management procedures.

<u>CBFO records</u>

- TRU waste site (section 2.0 option a)) bounded oxidizing chemical request, WM-STA recommendation memo, Safety Basis Approval Authority (SBAA) concurrence, and CBFO Manager bounded oxidizing chemical approvals with acceptance criteria
- TRU waste site (section 2.0 option b)) sorbent equivalency requests, WM-STA recommendation memo, SBAA concurrence, and CBFO Manager sorbent equivalency approvals with wt. % of oxidizing chemicals allowed
- TRU waste site (section 2.0 option c)) test method approval requests, WM-STA recommendation memo, SBAA concurrence, and CBFO Manager approvals
- TRU waste site test plans (section 2.0 options c) and d)), WM-STA recommendation memo, SBAA concurrence and CBFO Manager approvals
- TRU waste site test data (section 2.0 options c), d) and h)), CBFO review records, WM-STA recommendation memo, SBAA concurrence, and CBFO Manager issued acceptance criteria (when applicable)
- TRU waste site treatment plans (section 2.0 options e), f) and g)), WM-STA recommendation memo, SBAA concurrence and CBFO Manager written approvals
- TRU waste site technical justification submittals (section 2.0 option h)), WM-STA recommendation memo, SBAA concurrence and CBFO Manager written approvals

The WIPP Certified Program AKE and Site Project Manager (SPM) shall be included on electronic and hard copy distribution of CBFO responses to the above listed TRU waste site requests and submittals. The CBFO Assistant Manager for the Office of the National TRU Program (NTP), NTP Compliance Division Director, Office of Quality Assurance Director, CBFO SBAA and CBFO WM-STA shall be included on electronic distribution.

<u>WIPP Certified Programs' AK records</u>

- BoK evaluations

Attachment I: Los Alamos National Laboratory (LANL) KMI Zeolite treatment of TRU Waste Components during the Period of May 18, 2017 through March 14, 2018

Table I-1 shows the waste components in LANL TRU waste that required treatment with KMI zeolite to meet the BoK allowable oxidizing chemical weight percent limits. These waste components included unremediated nitrate salt (UNS), remediated nitrate salt (RNS), WypAll rags, cheesecloth, masslinn cloth, and free liquids such as cloth rinsate solutions and water used during processing that were treated during the period of May 18, 2017 through March 14, 2018. Column two shows the volumes of the waste components treated per treatment batch. These KMI treatment batches were processed using volumetric methods rather than by mass which complicated the process of confirming that the allowable oxidizing chemical weight percent concentrations post treatment were met. Column three shows the bounding mass of nitrate salt that would be present in a batch of processed waste components that were calculated from the density of nitrate salt for RNS waste. The nitrate salt content of WypAll rags and the cheesecloth, and masslinn was calculated from calcium nitrate solubility and the measured mass of the rags being treated. Free liquids were sorbed in KMI zeolite and the nitrate salt mass was calculated using a holding capacity of 1.15 mL/g of zeolite using the bounding solubility of calcium nitrate solution. Column four shows the mass of rags that were used during processing and the fifth column provides the mass of KMI zeolite that was used in each batch. The values reported by Anast et. al., as the weight percent concentrations of nitrate salt and KMI zeolite are listed for each waste component under the Anast et.al. Presentation heading. The values shown below the Bounding Calculation headings were calculated from the masses provided in columns three, four, and five. The last column shows the BoK allowed oxidizing chemical wt. % for remediated cellulose and EOPS, and the allowed concentration of oxidizing chemical in 4 Å zeolite used as a sorbent (unremediated nitrate salt). These KMI treated waste components meet the BoK allowable oxidizing chemical weight percent limits and will not exhibit oxidizing chemical properties.

Table I-1 – UNS and RNS Zeolite Treatment

Waste Component	Waste Component Volume treated per batch	Bounding Mass of Nitrate salt in a batch (g)	Mass of rags (g)	Mass of KMI zeolite (g)[2]	Anast et. al. Presentation		Bounding Calculation		BoK Allowable
					Nitrate Salt (Wt. %)	KMI Zeolite (Wt. %)	Nitrate Salt (Wt. %)	KMI Zeolite (Wt. %)	Oxidizing Chemical (Wt. %)
Remediated Nitrate Salt	0.33 qt.	429		3100	10.6	89.40	12.16	87.84	30
WypAll Rags[1]	2 cups	277	40	3100	8.1	90.7	8.11	91.89	30
(rags) Cheesecloth, Masslinn	2 cups	747	135	3100	18.8	77.9	18.76	81.24	30
Waste Lock 770	1.33 qt.	1107		3100	26.3	73.6	26.31	73.69	50
Free Liquid	0.66 qt.	1043		4131	18.5	81.5	20.16	79.84	30
Unremediated Nitrate Salts[3]	1.33 qt.	1711		3200	34.8	65.2	34.84	65.16	35

[1]Kimberly Clark WypAlls Model L-40.
[2] A 1 gallon bag of KMI zeolite weighs 3100 g.
[3] UNS remediated to allowed wt. % for oxidizing chemical in 4 Å zeolite.

Table I-2 shows the list of 55-gallon drums that were generated from the waste treatment and the weight percent oxidizing chemical for each waste component treated (UNS, RNS, free liquids, cellulosic rags and WypAlls Model L-40).

Table I-2 – List of 55-gallon drums generated from RNS and UNS Treatment

Container ID (Containers = 272)	Wt. % UNS Oxidizing Salt (UNS=84)	Wt. % RNS Oxidizing Salt (RNS = 184)	Bounded Wt. % Oxidizing salt in Free liquids (Free Liquids= 94)	Wt. % Oxidizing Salt in Cellulose (Cellulosic rags = 40)	Wt. % Oxidizing Salt in WypAlls (WypAlls= 66)
LA00000068075	34.8				
LA00000068950	34.8				
LA00000070100		12.2		18.8	
LA00000070101		12.2			
LA00000070103		12.2			
LA00000070104		12.2		18.8	
LA00000070109		12.2	20.2	18.8	8.1
LA00000070114		12.2			
LA00000070115		12.2			
LA00000070116		12.2	20.2	18.8	8.1
LA00000070117		12.2			
LA00000070118		12.2		18.8	8.1
LA00000070120		12.2			
LA00000070122		12.2			
LA00000070125		12.2			
LA00000070126		12.2	20.2	18.8	8.1
LA00000070131		12.2	20.2		8.1
LA00000070145		12.2			
LA00000070146		12.2	20.2		8.1
LA00000070147		12.2		18.8	8.1
LA00000070148		12.2			
LA00000070149		12.2			
LA00000070150		12.2	20.2		8.1
LA00000070151		12.2			
LA00000070152		12.2			
LA00000070153		12.2			
LA00000070154		12.2			
LA00000070156		12.2			
LA00000070157		12.2	20.2	18.8	8.1
LA00000070159		12.2	20.2		
LA00000070160		12.2	20.2		
LA00000070163		12.2	20.2		
LA00000070165	34.8		20.2		

Container ID (Containers = 272)	Wt. % UNS Oxidizing Salt (UNS=84)	Wt. % RNS Oxidizing Salt (RNS = 184)	Bounded Wt. % Oxidizing salt in Free liquids (Free Liquids= 94)	Wt. % Oxidizing Salt in Cellulose (Cellulosic rags = 40)	Wt. % Oxidizing Salt in WypAlls (WypAlls= 66)
LA00000070168		12.2	20.2		
LA00000070172	34.8				
LA00000070173	34.8		20.2		
LA00000070201		12.2		18.8	8.1
LA00000070205		12.2			
LA00000070206		12.2	20.2		
LA00000070207		12.2			
LA00000070208		12.2			
LA00000070209		12.2			8.1
LA00000070211		12.2			
LA00000070221		12.2	20.2	18.8	8.1
LA00000070223		12.2			
LA00000070232		12.2	20.2		8.1
LA00000070233		12.2			
LA00000070235		12.2	20.2	18.8	8.1
LA00000070237		12.2	20.2	18.8	8.1
LA00000070246		12.2			
LA00000070247		12.2			
LA00000070249		12.2			
LA00000070255		12.2			
LA00000070257		12.2			
LA00000070260		12.2			
LA00000070262		12.2			
LA00000070265		12.2			
LA00000070271		12.2			
LA00000070272		12.2	20.2		
LA00000070274		12.2	20.2	18.8	8.1
LA00000070275		12.2			
LA00000070276		12.2			
LA00000070280		12.2			
LA00000070281		12.2	20.2		8.1
LA00000070285		12.2	20.2		
LA00000070286		12.2			
LA00000070287		12.2	20.2	18.8	
LA00000070288		12.2	20.2		
LA00000070290		12.2			
LA00000070291		12.2	20.2	18.8	8.1
LA00000070292		12.2			

Container ID (Containers = 272)	Wt. % UNS Oxidizing Salt (UNS=84)	Wt. % RNS Oxidizing Salt (RNS = 184)	Bounded Wt. % Oxidizing salt in Free liquids (Free Liquids= 94)	Wt. % Oxidizing Salt in Cellulose (Cellulosic rags = 40)	Wt. % Oxidizing Salt in WypAlls (WypAlls= 66)
LA00000070294		12.2		18.8	8.1
LA00000070295		12.2			
LA00000070296		12.2	20.2		8.1
LA00000070297		12.2			
LA00000070298		12.2	20.2		8.1
LA00000070299		12.2	20.2		
LA00000070578		12.2			
LA00000070580		12.2			
LA00000070581		12.2	20.2	18.8	8.1
LA00000070583		12.2			
LA00000070592		12.2			
LA00000070594		12.2			
LA00000070595		12.2	20.2		8.1
LA00000070599		12.2	20.2	18.8	8.1
LA00000071900		12.2			8.1
LA00000071901		12.2	20.2		
LA00000071902		12.2			
LA00000071903		12.2			
LA00000071904		12.2			
LA00000071905		12.2	20.2	18.8	8.1
LA00000071906		12.2			
LA00000071909		12.2	20.2		8.1
LA00000071911		12.2			
LA00000071914		12.2			
LA00000071915		12.2	20.2		8.1
LA00000071916		12.2	20.2		8.1
LA00000071917		12.2			
LA00000071918	34.8				
LA00000071919	34.8		20.2		
LA00000071928	34.8			18.8	
LA00000071934		12.2			
LA00000071936		12.2			
LA00000071937		12.2	20.2		
LA00000071938		12.2			
LA00000071940		12.2			
LA00000071945		12.2			
LA00000071946		12.2			
LA00000071947		12.2	20.2	18.8	8.1

Container ID (Containers = 272)	Wt. % UNS Oxidizing Salt (UNS=84)	Wt. % RNS Oxidizing Salt (RNS = 184)	Bounded Wt. % Oxidizing salt in Free liquids (Free Liquids= 94)	Wt. % Oxidizing Salt in Cellulose (Cellulosic rags = 40)	Wt. % Oxidizing Salt in WypAlls (WypAlls= 66)
LA00000071948		12.2			
LA00000071951		12.2			
LA00000071955		12.2			
LA00000071956		12.2	20.2	18.8	8.1
LA00000071964		12.2			
LA00000071966		12.2			
LA00000071967		12.2			
LA00000071968		12.2	20.2	18.8	8.1
LA00000071969		12.2			
LA00000071971		12.2	20.2		8.1
LA00000071972		12.2	20.2	18.8	8.1
LA00000071974		12.2			
LA00000071975		12.2			
LA00000071977		12.2			
LA00000071980		12.2			
LA00000071981		12.2			
LA00000071982		12.2			
LA00000071983		12.2	20.2	18.8	8.1
LA00000071985		12.2			
LA00000071986		12.2			
LA00000071990		12.2			8.1
LA00000071993		12.2			
LA00000071994		12.2			
LA00000071995		12.2			
LA00000071996		12.2			
LA00000071997		12.2	20.2		8.1
LA00000072006		12.2			
LA00000072007		12.2	20.2	18.8	8.1
LA00000072013		12.2			
LA00000072014		12.2			
LA00000072015		12.2	20.2		8.1
LA00000072016		12.2			
LA00000072017		12.2			
LA00000072018		12.2	20.2	18.8	
LA00000072022		12.2	20.2	18.8	
LA00000072024		12.2			
LA00000072026		12.2			
LA00000072027		12.2			

Container ID (Containers = 272)	Wt. % UNS Oxidizing Salt (UNS=84)	Wt. % RNS Oxidizing Salt (RNS = 184)	Bounded Wt. % Oxidizing salt in Free liquids (Free Liquids= 94)	Wt. % Oxidizing Salt in Cellulose (Cellulosic rags = 40)	Wt. % Oxidizing Salt in WypAlls (WypAlls= 66)
LA00000072029		12.2			8.1
LA00000072030		12.2			8.1
LA00000072031		12.2			
LA00000072034		12.2			
LA00000072035		12.2			
LA00000072036		12.2		18.8	8.1
LA00000072037		12.2			
LA00000072038		12.2			
LA00000072039		12.2			
LA00000072040		12.2			
LA00000072045		12.2			
LA00000072047		12.2	20.2	18.8	8.1
LA00000072048		12.2			
LA00000072050		12.2			
LA00000072051		12.2			
LA00000072052		12.2			
LA00000072053		12.2	20.2		8.1
LA00000072054		12.2			
LA00000072056		12.2			
LA00000072057		12.2			
LA00000072058		12.2			
LA00000072059		12.2	20.2		8.1
LA00000072060		12.2			
LA00000072061		12.2	20.2		8.1
LA00000072063		12.2			
LA00000072064		12.2			
LA00000072074		12.2			
LA00000072076		12.2	20.2	18.8	8.1
LA00000072077		12.2			8.1
LA00000072079		12.2	20.2		
LA00000072081		12.2			
LA00000072083		12.2	20.2		
LA00000072084		12.2	20.2	18.8	8.1
LA00000072085		12.2			
LA00000072086		12.2			
LA00000072087		12.2			
LA00000072088		12.2		18.8	8.1
LA00000072089		12.2		18.8	

Container ID (Containers = 272)	Wt. % UNS Oxidizing Salt (UNS=84)	Wt. % RNS Oxidizing Salt (RNS = 184)	Bounded Wt. % Oxidizing salt in Free liquids (Free Liquids= 94)	Wt. % Oxidizing Salt in Cellulose (Cellulosic rags = 40)	Wt. % Oxidizing Salt in WypAlls (WypAlls= 66)
LA00000072091		12.2	20.2	18.8	8.1
LA00000072092		12.2	20.2		
LA00000072093		12.2			
LA00000072095		12.2			
LA00000072096		12.2			
LA00000072097		12.2	20.2	18.8	8.1
LA00000072098		12.2			
LA00000072600	34.8				
LA00000072601	34.8				
LA00000072602	34.8		20.2		8.1
LA00000072603	34.8			18.8	
LA00000072605	34.8		20.2		
LA00000072606	34.8		20.2		
LA00000072607	34.8				
LA00000072609	34.8				
LA00000072612	34.8				
LA00000072614	34.8		20.2		
LA00000072615	34.8				8.1
LA00000072616	34.8				
LA00000072618	34.8				
LA00000072619	34.8		20.2		
LA00000072620	34.8				
LA00000072621	34.8		20.2		
LA00000072622	34.8		20.2		
LA00000072625	34.8		20.2		8.1
LA00000072627	34.8		20.2		8.1
LA00000072628	34.8		20.2		
LA00000072645	34.8				
LA00000072674	34.8		20.2		
LA00000072675	34.8				
LA00000072683	34.8		20.2	18.8	8.1
LA00000072684	34.8				
LA00000072685	34.8		20.2		
LA00000072689	34.8		20.2		
LA00000072690	34.8				
LA00000072691	34.8		20.2		
LA00000072693	34.8				
LA00000072694	34.8				

Container ID (Containers = 272)	Wt. % UNS Oxidizing Salt (UNS=84)	Wt. % RNS Oxidizing Salt (RNS = 184)	Bounded Wt. % Oxidizing salt in Free liquids (Free Liquids= 94)	Wt. % Oxidizing Salt in Cellulose (Cellulosic rags = 40)	Wt. % Oxidizing Salt in WypAlls (WypAlls= 66)
LA00000072695	34.8		20.2		
LA00000072697	34.8		20.2		
LA00000072698	34.8				
LA00000072699	34.8				
LA00000072700	34.8				
LA00000072701	34.8		20.2		
LA00000072703	34.8				
LA00000072704	34.8		20.2		8.1
LA00000072705	34.8		20.2		8.1
LA00000072707	34.8				
LA00000072711	34.8				
LA00000072712	34.8				8.1
LA00000072713	34.8				
LA00000072715	34.8				
LA00000072716	34.8		20.2		
LA00000072717	34.8				
LA00000072719	34.8		20.2		
LA00000072721	34.8				
LA00000072722	34.8		20.2		
LA00000072723	34.8				
LA00000072724			20.2	18.8	
LA00000072727	34.8		20.2		8.1
LA00000072728			20.2	18.8	
LA00000072729	34.8		20.2		
LA00000072730	34.8		20.2		8.1
LA00000072731	34.8				
LA00000072732	34.8				
LA00000072733	34.8				
LA00000072734	34.8				
LA00000072735	34.8				
LA00000072739	34.8				
LA00000072742	34.8				
LA00000072743	34.8		20.2		8.1
LA00000072745	34.8				
LA00000072747	34.8				
LA00000072748	34.8				
LA00000072749	34.8				
LA00000072750	34.8				8.1

Container ID (Containers = 272)	Wt. % UNS Oxidizing Salt (UNS=84)	Wt. % RNS Oxidizing Salt (RNS = 184)	Bounded Wt. % Oxidizing salt in Free liquids (Free Liquids= 94)	Wt. % Oxidizing Salt in Cellulose (Cellulosic rags = 40)	Wt. % Oxidizing Salt in WypAlls (WypAlls= 66)
LA00000072753	34.8				
LA00000072757	34.8		20.2		
LA00000072758	34.8				
LA00000072760	34.8				
LA00000072761	34.8				
LA00000072763	34.8				
LA00000072764	34.8		20.2		
LA00000072765	34.8		20.2		
LA00000072770	34.8		20.2		8.1
LA00000072771			20.2		
LA00000072773					8.1