Chemonite®.ACZA

A Diverse Industrial Wood Preservative

by

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ABSTRACT: Chemonite® is a registered trademark of Arch Wood Protection for the wood preservative first developed and known as ACA, then later reformulated and changed to its present form, ACZA. This ammonia based waterborne preservative has features which are attractive to consider in any selection process involving treatment of Douglas-fir round or sawn material along with any other refractory softwood species of wood common to the Western United States and Canada.

The information presented is intended to describe the various specific attributes of ACZA which set it apart from other waterborne wood treating preservatives available to design architects, engineers, professional building contractors and others having a particular interest in well-established structural integrity and service performance of treated wood products. It will bring additional attributes relative to the treatment process and key differences noted from other waterborne systems, then finally, the treated product attributes which provide the diversity to allow Chemonite®.ACZA to stand alone for many Industrial treated wood product applications.

The paper references provide documents and studies available to support the choice of Chemonite®.ACZA, including the environmental and safety aspects of chemical fixation and leach resistance, improved processing techniques available through Best Management Practices (BMP's), protection from Formosan termites, carpenter ants and woodpecker attack as well as from other biological organisms. Supporting information concerning corrosion, climb-ability and conductivity are also provided along with the most recent updates in AWPA UCS Standards.

Key words: Wood Preservative, ACA, ACZA, American Wood Protection Association, Canadian Standards Association, Canadian Wood Preservation Association, Ammoniacal, Best Management Practices, Carpenter Ant, Chemonite, Climb-ability, Coastal Douglas-fir, Conductivity, Corrosion, Fixation, Formosan Termite, Industrial Wood Preservatives, Leachability, Nail-withdrawal, Refractory species, Pressure Treatment, Sterilization, Use Category System, Utility Pole, Woodpecker.

INTRODUCTION

The purpose of this presentation is to acquaint those in the commercial, industrial and heavy construction industries with the preservative known as Ammoniacal Copper Zinc Arsenate (ACZA or Chemonite®) and characteristics of the wood treated with this waterborne preservative. The bulk of the information provided is relative to Coastal Douglas-fir, a thick-heartwood specie known to be difficult to treat with other waterborne or oil-type preservative systems. Chemonite® was specifically formulated to attain penetration into the Western refractory softwood species of woods providing a waterborne treatment capable of consistently meeting the requirements then specified in the American Wood-Preservers' Association C-Standards, the Canadian Standards Association and many Building Codes as well.

The original formulation of Chemonite®.ACZA was known as ACA (Ammoniacal Copper Arsenate), developed and patented in the 1920's at the University of California, then first used commercially in 1934. This preservative system experienced nearly 50 years of effective treating before a change in formulation was introduced in 1983 by J .H. Baxter & Co., the previous owner of the registered trademark preservative. The new formulation replaced half of the arsenic pentoxide with zinc oxide and the resulting preservative was recognized for environmental advantages over the previous formulation. Chemonite ®II, now known as Chemonite®.ACZA, became a registered pesticide with the U.S. EPA and PMRA in Canada which continues to be successfully used for pressure treating beams, timbers, poles, piling, lumber, plywood, glue laminated timbers and other engineered wood products (17).

Chemonite®.ACZA is a blend of active ingredients in a 2:1:1 ratio of copper oxide, zinc oxide and arsenic pent-oxide, respectively. Historically the copper and zinc are supplied in a dry powder while the arsenic pent-oxide is liquid arsenic acid. These high quality raw materials are dissolved in aqua ammonia with the addition of ammonium bicarbonate to dissolve or "burn" the metals to metallic oxides in a reduction reaction. The resulting preservative provides exceptionally consistent penetration, significantly reduced surface residue, reduced corrosion properties, enhanced product appearance and improved leach resistance after fixation of the chemical takes place in the wood (23).

The AWPA Standard P5.3-03 for Waterborne Preservatives defines both generic formulations for Chemonite (2); however, in 1999 the Canadian Institute of Treated Wood and Pest Management Regulatory Authority (PMRA) of Canada approved the use of ACZA in Canada (7) replacing ACA, and as a result, the AWPA P-4 Subcommittee having jurisdiction over the P5 Standard identified for removal without prejudice due to lack of use, the preservative ACA from the 2003 Book of Standards. At the same time, the transition into the Use Category System was initiated and is now complete with ACZA presented as a single, stand-alone preservative listed in the 2010 American Wood Protection Association Book of Standards as P22-10(3).

PROPERTIES OF CHEMONITE®.ACZA

There are some definitive differences in the Chemonite treating process which separate it from other waterborne preservative systems. Some of these factors significantly influence the service performance of the treated product and should be taken into consideration when selecting and specifying a preservative for treatment of Coastal Douglas fir or other thin-sapwood refractory species (5).

Sterilization

ACZA has the ability to withstand elevated temperatures during processing and allows for treatment of green or wood seasoned before treatment. Steam conditioning of Douglas-fir poles or piling prior to treatment at allowable temperatures up to 240° F(120°C) for up to 8 hours as per ANSI 05.1 and AWPA T1-10 Section D (Table D2. Processing Limitations, Steam Conditioning for poles) and in Section E Round Timber Piles, which can be very effective in eliminating incipient decay. Preservative temperatures during the Chemonite pressure cycle normally reach 150°F (65°C), the maximum allowed by AWPA.

The resulting temperature combination provides sterilization during treatment, even in large cross sectional dimension Douglas-fir materials. In addition, a Best Management Practice (BMP) for ACZA includes the use of an aqua-ammonia steaming cycle following the after-press vacuum which increases solution recovery and reduces preservative drips. This cycle subjects the treated material to ammonia vapor in the retort heated to 190° - 200°F (88°- 94°C), thereby reducing surface deposits while improving fixation of chemical in the wood material with increased ammonia off-gassing taking place inside the treatment cylinder thereby lowering vapor loss to air.

Fixation of chemical

The recent concern for potential exposure to arsenic from treated wood has raised many questions about the safety of arsenical containing preservative treated wood. Chemical fixation and leaching are terms in the wood-treating industry related to this concern. Fixation is defined in the AWPA Book of Standards Glossary as "A physical or chemical process whereby a wood preservative system is rendered leach resistant in both water and soil applications, such that the active ingredient(s) maintain fungal/insecticidal efficacy."

Although it is not stated, the reference to maintaining efficacy of protection can only be possible when the active ingredient(s) are not leached from the wood in significant quantity over the exposure time. The associated term "leaching" is defined as "The migration from wood of preservative components into surrounding environment by the movement of water" (1).

Fixation is a property of waterborne treating chemicals that has been studied and evaluated with various levels of understanding. Many earlier studies define specific mechanisms involved in making the once water soluble chemicals become attached to the wood substance or complex with other components, thereby being insoluble in water during service exposure (23). The ACZA preservative system has some chemical fixation traits that differ from the processes associated with acid-based formulations such as CCA (chromate copper arsenate). Lebow and Morrell (14) found that during the fixation of ACZA, as ammonia levels decreased by off-gassing, precipitation of zinc arsenate occurred first. The reaction among these components may be the basis for improved arsenic fixation reported in ACZA, and zinc is normally the most leach resistant component detected in the evaluations. Copper is thought to be more directly involved with bonding reactions with the wood, which may occur at a slower rate.

The ammoniacal systems use ammonia in water as the carrier to move the active ingredients throughout the cellular structure of the wood. This movement is necessary for the metallic ions to locate attachment or bonding sites in the wood (31). More ions in the matrix (higher chemical retention) make it more difficult to locate an unoccupied site for the ion to fix. Processing methods reducing the immediate loss of ammonia after treatment, such as enclosure or wrapping treated material, or increasing the ammonia available in the wood such as aqua ammonia steaming, have been successful in improving the fixation of the chemical to the wood in ACZA (16). Analytical procedures are now being developed and evaluated that will allow testing material for fixation, with more consistent and meaningful results than previously were available. These analytical tests are based on some of the theories on fixation from earlier studies (10). Fixation periods are directly related to the retention level of waterborne treatments, therefore the higher the retention of chemical in the wood, the longer it takes to fix the chemical to an equivalent level.

Further reports have also shown the actual fixation process for ACZA is not directly related to drying the wood for removal of water. This was previously thought to be a key factor for fixation of all waterborne preservative systems. The ACZA process is more directly related to the off-gassing of ammonia which stabilizes metals in the wood by allowing them to form precipitates, or come out of solution and become insoluble compounds. The preservative retention level continues to affect this process, becoming much more complex when the retention is above 1.0 pcf of active ingredient.

As a general rule, these higher retention materials require longer fixation periods (10, 26), but are not common retention levels for materials used above or in ground contact applications. Copper oxide is more water soluble and has been identified as the last component in many waterborne copper-based preservatives to become fixed, allowing it to be used as an indicator to determine the level of fixation obtained. Methods under development to determine chemical fixation should be of help in defining the specification necessary for material to be considered adequately fixed for shipment. The more "fixed" a chemical becomes, the less potential it has for leaching from wood when exposed to water and/or weathering while in service. This is a critical parameter for the future use of waterborne chemical treatment and encourages the use of BMP's by responsible wood-preserving companies (19).

Leachability

ACZA leaching was studied and compared to the original ACA formulation by Best and Coleman (5). Their results indicated a significant reduction in the leaching of not only arsenic but copper as well, along with reduced leaching of all components at the higher retention levels (1.0 - 2.5 pcf or 16 - 40 kg/m^3). Therefore, even though the fixation period is longer for higher retentions, the resulting fixation may potentially be more stable as indicated by the lower percentage of chemical leached.

Analytical work is continuing to be conducted and reported by Oregon State University on soil samples to determine the amount of copper, arsenic and zinc found in soil around utility poles located in Florida, Virginia, New York and Pennsylvania to include various soil compositions. A multiple sampling grid surrounding the poles was used to provide information at distances and depths in comparison with unaffected control soils and a wood sample included for each pole in the test. These data will assist in determining the potential for leaching from ACZA treated poles. An added portion of this study will evaluate samples from retaining walls and highway guardrail posts and soils in their immediate areas (18, 4).

Safety

The issues of fixation and leachability address environmental exposure concerns of the treated wood product during its intended use, but the human safety element created by exposure to the material must also be considered. This brief summary will approach those factors having the most direct relationship without going into intricate detail associated with the supporting information. It is important to understand the three possible routes of exposure which humans have to any chemical. These include inhalation, ingestion or absorption through the skin. Before any chemical can be a threat to human health or have toxic effects, it must enter the body. Test results at the University of California in Davis by Dr. Peoples (20) show arsenic oxides in treated wood cannot be absorbed through the skin. This eliminates one such avenue for exposure. The inhalation route of entry is confined to inhaling sawdust, surface residue or dust while working with the treated wood because these oxides are also not volatile. This means they do not evaporate into the air at normal ambient temperatures. Eating, using tobacco products or drinking without washing hands prior to performing these activities increases the risk of ingesting sawdust or surface residues from the wood and should be avoided in any circumstances.

Dr. Peoples also showed that bodily fluids could only leach approximately half of the metal oxides entering the body by ingestion. The human body routinely disposes of small amounts of arsenic it absorbs from natural sources such as drinking water, seafood, and red wine. If there were small amounts ingested from treated wood, it would be eliminated from the body in this same way (21). The best protection from any exposure to wood treating chemicals is offered by following personal hygiene and safety precautions. These include using gloves to prevent splinters and contact with surface dust, wearing dust masks and eye protection when machining treated wood, and always washing before eating, drinking or using tobacco products. These are the same precautions recommended for working with untreated wood, and can greatly reduce the potential of chemical exposure from treated wood. Another safety precaution is that treated wood of any kind should not be burned as firewood in a residence or outdoor fire.

Registered pesticides must be reviewed on a regular basis for re-registration with the U.S. EPA or PMRA in Canada. A requirement of this process includes data submission to confirm the safety of the treated wood. There have been four epidemiological studies on workers at arsenical wood preserving plants and carpenters extensively using treated wood. Even in these high occupational exposures there are no long-term effects from working with the preservatives or arsenical treated wood. ACZA-treated wood is a safe product and does not require any special protective clothing or equipment except the normal safety precautions used with any wood product, treated or not.

The formulation change for Chemonite has made a very significant effect on the safety of ACZA in the environment and for users of the treated product for several reasons. First of all the amount of the more toxic component, arsenic, was reduced in half by replacing it with zinc (a less toxic component). Therefore, the overall toxic level of the preservative system is reduced. Zinc also acts to prevent the uptake of copper by the body if it is ingested, offering an added margin of safety. The addition of zinc to the formulation improves the fixation of arsenic by forming a less Soluble precipitate with zinc. Also, combined with the relatively low loss of copper and zinc from treated wood, this addition of zinc presents the advantage of reducing potential environmental interaction by leaching (26). The scientific evidence available supports ACZA treated wood as a very safe product to the environment and humans who have contact with it.

Other attributes

Corrosion: The recommendation has always been to use hot-dipped galvanized fasteners or hardware when in contact with ACZA treated wood. The basis for this is to have the galvanic coating sacrificed in order to afford protection to the rest of the metal over time. This creates a surface corrosion within the first year or two of service that may cause concern for those not familiar with this process. However, several tests have indicated this initial corrosion rate is not sustained over a long period of time and does not affect the long term strength, service life or performance of the hardware. Actual test data on bolts removed after 38 years of exposure in a Portland General Electric line outside of Portland, Oregon resulted in all but one sample meeting or exceeding the rated breaking strength for the bolt size. The one exception had test results at 98.5% of the rated strength value. Other accelerated and full-size corrosion tests indicate similar results with ACZA being significantly less corrosive than the earlier ACA formulation. These tests also indicate dry or materials having lower ammonia levels are less corrosive to the galvanizing coatings than freshly treated wood, thereby supporting the need to have wood undergo fixation before shipment or use (12, 28, 30).
Note: Arch recommends the use of stainless steel in marine salt water or splash zones with ACZA treated wood as well as in other extremely corrosive conditions. Specific recommendations should be obtained from an informed source for acceptable types of hardware in these exposures.

Conductivity: Electrical conductivity is an appropriate concern when selecting any material as a utility pole to carry electricity. A number of studies have been conducted to evaluate and understand this particular aspect of waterborne treated wood poles. Generally speaking, even untreated wood poles will conduct electrical current when levels of moisture are above the fiber saturation point. Testing of the metal oxides used in ACZA by applying voltage to compressed pellets of the dry powder indicate these components are nonconductive. Further testing has identified water or treating solutions are the more conductive elements in treated wood, therefore any freshly treated wood pole should be considered as "hot" for handling purposes.

Conductivity drops in a similar fashion as treated and untreated wood undergoes drying, therefore the moisture content is the critical factor, not the treatment. There is also evidence of decreasing conductivity over the service life of ACZA poles. Poles dried below fiber saturation do not induce the same level of conductivity measured before drying took place when they are subsequently re-wetted. All test results show ACZA treatment does not create a shock hazard. Because there is no consistent field test method available to accurately predict if a safety hazard exists, it is recommended that under adverse conditions, ACZA or any wet pole, should be approached and handled as if it is electrically hot (13).

Woodpecker resistance: There are utility companies in the Eastern U.S. with very favorable reports of decreased woodpecker attacks on ACZA treated poles. Mike Brucato summarized Virginia Electric Power's experience with ACZA following several attempts using various other control methods and published this information in 1994 (6). Several other utilities reported similar results including Kissimmee Utility Authority (FL), North Star Electric (MN), Kentucky Power Co-op Inc., and Hoosier Energy (IN) (9). Chemonite cannot be considered 100% effective in prevention of woodpecker damage, but it has significantly decreased the amount of damage and number of pole replacements reported by the field experience to date.

Additional tests were considered in cooperation with EDM and other utility companies to expand the understanding of this attractive feature of Chemonite® for utility poles. The major issue with such a study is to design the evaluation method of such intermittent and sporadic styles of damage with any scientific measurements and have a level of confidence in what is predicted from them. However the Companies who have localized woodpecker attack over time with many other treated poles speak well of the reduced damage in Chemonite®.ACZA poles used for replacements.

Formosan Termites and Carpenter Ants: Formosan Termites are not as wide spread as native subterranean termites and certainly neither one are any particular threat in Canada or the Northern areas of the United States, but this information may be considered of particular interest to some, particularly for treated material being offered in areas where these organisms are found. The residents in Hawaii and areas of the Southern U.S. with infestations of the Formosan termite fully understand the threat this voracious wood-destroying insect presents and as the areas of attack have spread there has been an increased level of concern. Tamashiro, et.al. report the testing of Chemonite®.ACZA treated boards and timbers provided excellent protection when exposed to this termite (29).

Carpenter ants do not ingest cellulose from wood, but excavation by these insects is extremely damaging to the structural integrity of structures they colonize. Laboratory and field testing has shown that ACZA treated material resists attack by carpenter ants with very high mortality rates (11). This is true for both freshly treated and aged or weathered material and can be a very attractive feature for products such as utility poles from the standpoint of protection from the insect itself and resulting woodpecker attack when these insects are present.

Climb-ability: One aspect of waterborne treated utility poles and Chemonite®.ACZA treatment in particular, is the resistance and opposition by linesmen due to perceived climb-ability. This property can be measured using gaff penetration tests. Past studies by Arizona Public Service and Columbia Research and Testing indicate that all waterborne treated poles have gaff penetration resistance similar to untreated wood of the same species at the same moisture content. Individual test sample variations caused by density and grain pattern of the wood are normally greater than differences attributed to the preservative treatment groups. This makes comparison very difficult but by far, the most notable factor in gaff penetration analyses relates to the ease of penetration into oil-type preservative treated wood due to the lubricating effect of the oil (22). Gaff penetration tests with CCA also identified sharpness of the gaffs to be a continual problem in evaluating the penetration into wood.

These tests also suggested that newly designed gaffs produced some level of improvement. The Buckingham CCA model 9106 and Klein gaffs required less force than the other brands tested to penetrate ACZA treated or untreated control wood (8). Most of the climbing issues relative to gaff penetration are identified as dealing with subjective problems and are difficult to resolve satisfactorily using technical information.

Arch presently has several pole treating facilities using the Emulsified Treatment process identified as "ET" on CCA southern pine treated material. This outer surface (0 - 1 inch zone) emulsified oil has gained acceptance by utility line crews and with recent results of a pole climbing study reveal no difference in the ratings for the ease of climbing 20 year Southern Pine CCA ET treated poles or Oil-Penta treated poles. The effects of the oil remain and these results were printed in an Arch Wood Protection Test Report in May, 2008.
A copy is available by calling 678-627-2000 or contacting www.wolmanizedwoodHD.com/poles on the web.

Although ACZA Douglas-fir and W. Red Cedar poles have not experienced the same level of concern from the line crews as a problem in climbing, and as such, ET treatments were not considered for those species. However, ET treatment has been used successfully in test treatment of Douglas-fir crossties to determine if there may be additional positive influence from the presence of oil in the outer zone of wood in the tie.

Nail-Holding Capacity: A study on incising and preservative treatment effects on nail-holding capacity of Douglas-fir and Hem-fir indicate no significant effects from incising on this wood property. This was also evident when placing the test nails directly into the incision on the face of the board. There was however, a marked improvement in the quality of treatment with both ACZA and CCA waterborne chemicals when the material was incised. Chemonite®.ACZA did obtain greater preservative penetration depth and retention, supporting the use of ammonia-based treatments in refractory species. It was also reported that ACZA treatment appears to significantly improve resistance to nail withdrawal (15).

STEPPING INTO THE FUTURE……Obviously the present interest in both the US and Canada for industrial wood preservatives has given Arch and some of the "old-timers" like ACZA a reason to look closer at what is needed to continue offering treated material with such desirable properties for industrial timber construction. Arch Wood Protection has shown interest by maintaining the registration in Canada for ACZA even though at present there are no treating facilities using this preservative, leaving the option open for future business as the opportunities expand in Canada for treated wood. Arch Wood Protection as of this year offers a 50-year warranty on Douglas fir poles and cross-arms treated with Chemonite®.ACZA.

One approach to ease the plant handling of ACZA is to present the preservative in the form of a liquid, pre-mixed concentrate which then is easily diluted at the plant into the RTU (ready to use) treating solution concentrations for processing material. This has been studied and there are some additional advantages to making a blended concentrate available to treating facilities aside from the safety and environmental concerns of mixing on site, including the ability to utilize recycled copper as a source for metal oxide in the formulation providing yet another "green" factor for environmental sustainability.

Arch has also been recently successful in bringing a proposal to add ACZA preservative-treated Douglas fir crossties into the AWPA U1 Specification C for an assay retention as stipulated in T1Section A in the 0.0 - 0.6 inch (0 - 15mm) zone at 0.40 pcf (6.4 kg/m^3). This change was in response to a request from a shortline railway presently using ACZA material in trestle and bridge construction over water where oil-type preservatives have caused environmental concerns. The ACZA ties are working well, look more like dark brown creosote ties and now, the railway is beginning to use more ACZA Doug-fir ties in regular track maintenance and construction.

Arch has recently proposed updating standards in AWPA for the use of ACZA. The Timber Piling Standard for Northern Marine waters did not include ACZA in the lower retention UCS 5A category as it had never been transposed from the AWPA C-18 Standard. It has now been included into the AWPA UCS format at the CSA retention level 30 kg/m^3 (1.9pcf). The AWPA C-24 Standard retention for sawn timbers used to support residential and commercial buildings which had an ACZA assay of 0.80 pcf or 12.8 kg/m^3 will also be included in the AWPA 2011Book of Standards as a proposal is now in the ballot process to do so.

SUMMARY

There is clearly a wealth of information to support the various attributes of ACZA in both laboratory and field studies. The changes to the chemical formulation and treating process developed over the past decades have only improved the Chemonite®.ACZA treated product performance and expanded its attributes from environmental, health and safety aspects. Chemonite® is a very effective preservative not only in the standard application for protection against decay fungi and insects, but also providing additional qualities to consider in its Formosan termite, carpenter ant, and woodpecker repellent effects. These concerns are critically important for protecting commercial and industrial treated wood products to obtain maximum service life and performance without sacrificing the expected qualities and characteristics. The ability of ACZA to penetrate into the heartwood and provide sterilization during treatment of Douglas -fir and other refractory Western wood species has a definite advantage in the waterborne preservative category.

Environmentally, there is no comparison between wood and any other construction material. Wood is energy efficient, renewable and a sustainable resource offered by nature. When utilized properly with adequate preservative protection from the natural biological modes of deterioration, treated wood provides effective, easy to use and low cost products with a history of long service performance and flexibility to meet the needs for protection in all use category applications and exposures. Combining this natural construction material with the treatability and protection afforded by Chemonite®.ACZA for industrial applications creates a synergy of best alternatives in many ways for architectural designers, engineers, professional building contractors and the owners of products and materials manufactured from preservative treated wood for industrial use.

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Hazard Communication Training Information Sheet

REFER TO MSDS AND PRODUCT LABEL FOR COMPLETE INFORMATION

Product name: Chemonite® ACZA, EPA Registration Number: 62190-34

Hazard Ratings:	Health	Flammability	Physical / Instability	Special hazard
(HMIS)	3	0	0	None

Properties:

Physical State: liquid Color: Dark blue Odor: Ammonia Flammability: Not known to be flammable

Carcinogen, toxic by ingestion, corrosive to eyes, skin and mucous membranes, liver and kidney toxin

Acute Health Hazards:

Inhalation: May be harmful if inhaled. Inhalation of mist or vapor may cause irritation and/or burns

Skin: Can cause severe irritation and/or burns. Prolonged skin exposure may cause permanent damage.

Eye: Can cause severe irritation and/or burns.

Ingestion: Toxic if swallowed. Irritation and/or burns can occur to the entire gastrointestinal tract.

Chronic Health Hazards:

Carcinogenicity: The International Agency for Research on Cancer (IARC) has classified a component or components of this product as a Group 1 substance, Carcinogenic to Humans.

Reproductive and Developmental Toxicity: Not known or reported to cause reproductive or developmental toxicity.

Inhalation: Prolonged or repeated exposure may cause more severe irritation and possibly lung damage, kidney and liver damage, nervous system effects, and perforation of the nasal septum.

Skin Contact: Repeated dermal exposure may cause tissue destruction due to the corrosive nature of this product.

Skin Absorption: Prolonged or repeated exposure, may lead to harmful amounts of material being absorbed through the skin. Chronic (repeated) exposure may cause damage to the liver and kidneys.

Ingestion: Effects similar to those experienced from single exposure.

Eye Contact: Corneal involvement or visual impairment is expected. Prolonged contact may result in permanent damage.

First Aid Procedures:

Inhalation: Move person to fresh air. If person is not breathing, call 911 or an ambulance, then give artificial respiration, preferably mouth-to-mouth if possible.

Skin Contact: Take off contaminated clothing. Rinse skin immediately with plenty of water for 15-20 minutes.

Eye Contact: Hold eye open and rinse slowly and gently with water for 15-20 minutes. Remove contact lenses, if present, after the first 5 minutes, then continue rinsing eye.

Ingestion: Call a poison control center or doctor immediately for treatment advice. Have person sip a glass of water if able to swallow. Do not induce vomiting unless told to do so by a poison control center or doctor. Do not give anything by mouth to an unconscious person.

Personal Protective Equipment (PPE):

Inhalation: Wear a NIOSH approved full-face air purifying respirator with ammonia and inorganic arsenic cartridge and a P100 prefilter if levels above the exposure limits are possible.

Skin Protection: Wear impervious gloves, boots and apron to avoid skin contact. A full impervious suit is recommended if exposure is possible to a large portion of the body.

Eye Protection: Use chemical goggles and a faceshield.

Spill Procedures:

Air Release: Hazardous concentrations in air may be found in local spill area and immediately downwind. Vapors may be suppressed by the use of water fog.

Water Release: This material is soluble in water. Divert water flow around spill if possible. Notify all downstream users

Land Release: Create a dike or trench to contain materials. Absorb spill with inert material (e.g., dry sand, clay, earth or commercial absorbent), then place in a chemical waste container. Avoid runoff into storm sewers and ditches which lead to waterways.

Storage: Store containers in a cool, dry location, away from direct sunlight, sources of intense heat, or where freezing is possible. Maintain good ventilation and store away from zinc metals, copper and copper alloys, and strong reducing agents.