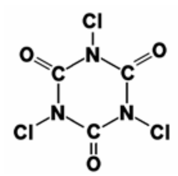
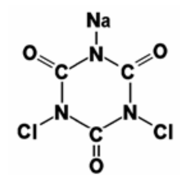
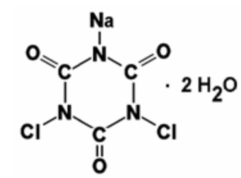
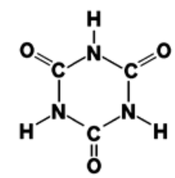
Frequently Asked Questions about OxyChem's ACL® Chlorinated Isocyanurates

Chemical and Physical Properties

Physical and chemical properties of the chlorinated isocyanurates and cyanuric acid

The following chart summarizes some of the properties of these products. For more information contact ACL® Technical Service (877-873-4767).

	ACL® 90	ACL 60	ACL 56	Cyanuric Acid
Chemical Nomenclature	trichloro-*s*-triazinetrione trichloroiso-cyanuric acid	sodium dichloro-*s*-triazinetrione sodium dichloro-isocyanurate	sodium dichloro-*s*-triazinetrione dihydrate sodium dichloroiso-cyanurate dihydrate	*s*-triazine (1H,3H,5H) trione cyanuric acid
CAS Number	87-90-1	2893-78-9	51580-86-0	108-80-5
EPA Registration No.	935-37	935-36	935-38	none
EC Number	201-782-8	220-767-7	---	203-618-0
Chemical Structure				
Formula	$Cl_3(NCO)_3$	$NaCl_2(NCO)_3$	$NaCl_2(NCO)_3 \cdot 2H_2O$	$H_3C_3N_3O_3$
Molecular Weight:	232.4	220.0	256.0	129.1
Color and Physical Form:	white to off-white solid in various granular grades			
Available Chlorine, Theoretical:	91.5	64.5	55.4	none
Minimum:	90	62	55	
Assay, %	>99.0	>97.0	>99.0	>99.4
Cyanuric Acid, %	55.5	58.6	50.4	>99.4
NaCl, %	<0.1	<1.0	<1.0	---
H_2O, %	<0.1	<2.0	---	<0.5
Melting Point, °C (with decomposition)	225	240	loses first water >50°C, second at >95°C, decomposes 240-250°C	sublimes at 350°C
Loose Bulk Density, lb/ft^3 ($1 gm/cc = 62.43 lb/ft^3$) Regular:	66	---	---	50
Granular:	63	55	59	---
Extra Granular:	64	57	59	56
Solubility @ 25°C (gm/100 gm H_2O)	1.2	24	28	0.2
pH, 1% solution @ 25°C	3.0	6.0 – 7.0	6.0	2.8 min.
HMIS Rating Health:	3	3	3	1
Flammability:	0	0	0	0
Reactivity:	2	2	1	0
NFPA Rating Health:	2	2	3	1
Flammability:	0	0	0	0
Reactivity:	2	2	1	0
Other:	OX	OX	OX	

Chemistry of the chlorinated isocyanurates

A detailed review of the chemistry of the chlorinated isocyanurates and a list of properties is available. Contact ACL® Technical Service (877-873-4767) for a copy.

Does cyanuric acid contain cyanide?

Cyanuric acid is not related to cyanide. Despite the similarity in names, cyanuric acid ($C_3N_3O_3H_3$) has NO chemical relationship to cyanide (CN^-). This is obvious from the chemical structure. Cyanuric acid is made by the pyrolysis of urea. Cyanide is not used in or formed as a by-product of the manufacture of cyanuric acid. Furthermore, cyanide is not a degradation product of cyanuric acid or the chlorinated isocyanurates. In fact, cyanide is rapidly destroyed by the available chlorine in the chlorinated isocyanurates. Cyanuric acid does not give a false positive in the standard analytical test for cyanide.

What does "available chlorine" mean?

The term *available chlorine* was established as the basis for comparing the potential bleaching or disinfecting power of chlorine compounds. A number of compounds contain available chlorine, including elemental chlorine (Cl_2), sodium or calcium hypochlorite, the chlorinated isocyanurates and various chloramines.

Available chlorine is a measure of the amount of chlorine in the +1 oxidation state, which is the reactive, oxidized form. In contrast, the chloride ion (Cl^-) is in the -1 oxidation state, which is the inert, reduced state. Gaseous chlorine is defined as containing 100% available chlorine. This is somewhat confusing since only half of the Cl_2 molecule is positive (the Cl_2 molecule can be considered to be one +1 Cl and one -1 Cl).

The available chlorine content of a material is determined by measuring the amount of iodine (I_2) which the material liberates from an acidified iodide solution. The calculated weight of elemental chlorine (Cl_2) required to liberate the same amount of iodine is the *available chlorine* content of the material.

All of chlorines in the chlorinated isocyanurates are in the +1 oxidation state. The available chlorine content of these materials is twice the atomic chlorine content, since each of these chlorines has the oxidizing equivalent of one Cl_2 molecule. For example, the atomic percentage of chlorine in the trichlor molecule is 45.76%; but the theoretical available chlorine content is twice that or 91.53%. This means that one pound of trichlor has the same amount of oxidizing power as 0.9153 pounds of Cl_2.

The concentration of residual chlorine in solution is always expressed in terms of available chlorine. It is clearly advantageous to have a common yardstick for comparing one form, say hypochlorous acid, against another form, say monochloramine. The same also applies to the chlorine compounds used in water treatment such as sodium hypochlorite or calcium hypochlorite. The concept of available chlorine is, to some extent, an artificial one. But it remains the standard for the strengths of chlorinating chemicals as well as for the doses in which they are applied and for the residues which remain in the water.

How does the available chlorine content of different products compare?

In assessing the costs of chlorine from different commercial products, a knowledge of their available chlorine contents is essential. A chart showing the comparison is given on page 4. A metric version is given on page 5.

Chlorine Conversion Chart (English)

1 lb. of the following equals	ACL® 90 Trichlor	ACL 60 Dichlor	ACL 56 Dichlor Dihydrate	$Ca(OCl)_2$ Calcium Hypochlorite	LiOCl Lithium Hypochlorite	NaOCl 12% Bleach	NaOCl 5% Bleach
Gaseous Chlorine (100% Avail Cl_2)	1.1 lbs.	1.6 lbs.	1.8 lbs.	1.5 lbs.	2.9 lbs.	8.3 lbs. (1 gal.)	20 lbs. (2.4 gal.)
ACL 90 Trichlor (90% Avail Cl_2)		1.5 lbs.	1.6 lbs.	1.4 lbs.	2.6 lbs.	7.5 lbs. (0.9 gal.)	18 lbs. (2.2 gal.)
ACL 60 Dichlor (62.5% Avail Cl_2)	0.7 lbs.		1.1 lbs.	1 lb.	1.8 lbs.	5.2 lbs. (0.6 gal.)	12.5 lbs. (1.4 gal.)
ACL 56 Dichlor Dihydrate (55.5% Avail Cl_2)	0.6 lbs.	0.9 lbs		0.8 lbs.	1.6 lbs.	4.6 lbs. (0.5 gal.)	11.1 lbs. (1.2 gal.)
$Ca(OCl)_2$ Calcium Hypochlorite (65% Avail Cl_2)	0.7 lbs.	1.1 lb.	1.2 lbs.		1.9 lbs.	5.4 lbs. (0.6 gal.)	13 lbs. (1.5 gal.)
LiOCl Lithium Hypochlorite (35% Avail Cl_2)	0.4 lbs.	0.6 lbs.	0.6 lbs.	0.5 lbs.		2.9 lbs. (0.33 gal.)	7 lbs. (0.8 gal.)
12.6% NaOCl Sodium Hypochlorite (12% Avail Cl_2)	0.1 lbs.	0.2 lbs.	0.2 lbs.	0.2 lbs.	0.3 lbs.		2.4 lbs. (0.3 gal.)
5.25% NaOCl Bleach (5% Avail Cl_2)	0.06 lbs.	0.08 lbs.	0.09 lbs.	0.08 lbs.	0.14 lbs.	0.42 lbs. (0.05 gal.)	
1 Gallon of Sodium Hypochlorite (12%) equals	1.34 lbs.	1.92 lbs.	2.17 lbs.	1.85 lbs.	3.44 lbs.		2.4 gal. (24.1 lbs.)

Chlorine Conversion Chart (Metric)

1 kg. of the following equals	ACL® 90 Trichlor	ACL 60 Dichlor	ACL 56 Dichlor Dihydrate	$Ca(OCl)_2$ Calcium Hypochlorite	LiOCl Lithium Hypochlorite	NaOCl 12% Bleach	NaOCl 5% Bleach
Gaseous Chlorine (100% Avail Cl_2)	1.1 kg.	1.6 kg.	1.8 kg.	1.5 kg.	2.9 kg.	8.0 kg. (6.9 L.)	20 kg. (16.6 L.)
ACL 90 Trichlor (90% Avail Cl_2)		1.5 kg.	1.6 kg.	1.4 kg.	2.6 kg.	7.2 kg. (6.2 L.)	18 kg. (15.0 L.)
ACL 60 Dichlor (62.5% Avail Cl_2)	0.7 kg.		1.1 kg.	1 kg.	1.8 kg.	5.0 kg. (4.3 L.)	12.5 kg. (10.4 L.)
ACL 56 Dichlor Dihydrate (55.5% Avail Cl_2)	0.6 kg.	0.9 kg.		0.8 kg.	1.6 kg.	4.4 kg. (3.8 L.)	11.1 kg. (9.2 L.)
$Ca(OCl)_2$ Calcium Hypochlorite (65% Avail Cl_2)	0.7 kg.	1.1 kg.	1.2 kg.		1.9 kg.	5.2 kg. (4.5 L.)	13 kg. (10.8 L.)
LiOCl Lithium Hypochlorite (35% Avail Cl_2)	0.4 kg.	0.6 kg.	0.6 kg.	0.5 kg.		2.8 kg. (2.4 L.)	7 kg. (5.8 L.)
12.6% NaOCl Sodium Hypochlorite (12% Avail Cl_2)	0.1 kg.	0.2 kg.	0.2 kg.	0.2 kg.	0.3 kg.		2.4 kg. (2.0 L.)
5.25% NaOCl Bleach (5% Avail Cl_2)	0.06 kg.	0.08 kg.	0.09 kg.	0.08 kg.	0.14 kg.	0.40 kg. (0.35 L.)	
1 Liter of Sodium Hypochlorite (12%) equals	0.16 kg.	0.23 kg.	0.26 kg.	0.22 kg.	0.41 kg.		2.4 L. (2.89 kg.)

Are the chlorinated isocyanurates or cyanuric acid dusts explosive?

Dusts of cyanuric acid or the chlorinated isocyanurates are not explosive.

What trace elements are present in the ACL® products?

Representative samples of all product grades have been analyzed by ICAP in recent years. The following elements were not detected in any of the samples: Ag, As, B, Be, Cd, Co, Cr, Cu, Hg, Mn, Mo, Ni, P, Pb, Sb, Se, Si, Sn and V. The elements Al, Fe, K, S and Zn were found occasionally at about the detection limit. Ti was found at low levels in ACL 56 and 60 but not in ACL 90. The following table summarizes the typical results, in ppm by weight, for the remaining elements determined.

Element	ACL 90	ACL 60	ACL 56
Ba	< 0.12	0.56	0.13
Ca	1.2	10.0	4.0
Mg	1.4	1.7	0.9
Na	75	---	---

What trace organics are present in the ACL® products?

The following halogenated compounds are not detected (detection limit = 3.3 ppm): chlorinated or brominated methanes, chlorinated ethanes, chlorinated ethylenes, chlorinated propanes, chlorinated propenes, chlorinated benzenes and toluenes, bromobenzene, chlorinated butadiene, and total THMs. The following non-halogenated organics were also not detected (detection limit = 3.3 ppm): benzene and alkylbenzenes, methyl t-butyl ether, methyl ethyl ketone, naphthalene, and carbon disulfide.

What are the mesh sizes for the different grades of the ACL® products?

Product	Sales Specifications - USS Screen Size	Actual Cut	Size in Microns of Actual Cut	% less than 100 microns	% less than 10 microns
ACL 90 XG	1% Max on 12 mesh 95% Min CR on 40 mesh	12-40	425 - 1700	< 0.3	< 0.06
ACL 90 G	2% Max on 14 mesh 95% Min CR on 60 mesh	14-60	250 - 1400	< 0.3	< 0.06
ACL 90 R	1% Max on 20 mesh 40-85% CR on 200 mesh	---	< 850	40 - 80	< 6
ACL 60 XG	2% Max on 10 mesh 2% Max thru 100 mesh	10-60	250 - 2000	< 0.3	< 0.06
ACL 60 G	2% Max on 20 mesh 2% Max thru 100 mesh	20-60	250 - 850	< 0.3	< 0.06
ACL 56 XG	2% Max on 12 mesh 2% Max thru 100 mesh	12-60	250 - 1700	< 0.3	< 0.06
ACL 56 G	2% Max on 20 mesh 2% Max thru 100 mesh	20-60	250 - 850	< 0.3	< 0.06

100 microns = about 150 mesh
10 microns = about 800 mesh (too small for screens)

Regulatory

What are the DOT shipping classifications?

For ACL® 90 or Towerchlor® 90:
- DOT Proper Shipping Name: Trichloroisocyanuric Acid, Dry
- DOT Hazard Class: 5.1
- DOT Identification No.: UN2468
- DOT Packing Group: II
- DOT Hazardous Substance: Not Applicable
- DOT Marine Pollutant: Not Applicable

For ACL 60:
- DOT Proper Shipping Name: Dichloroisocyanuric Acid Salts
- DOT Hazard Class: 5.1
- DOT Identification No.: UN2465
- DOT Packing Group: II
- DOT Hazardous Substance: Not Applicable
- DOT Marine Pollutant: Not Applicable

For ACL 56 or Towerchlor 56:
- DOT Information: Not Regulated

Special Provision 28 in the 49 CFR §172.101 Hazardous Material Table notes that: "The dihydrated sodium salt of dichloroisocyanuric acid is not subject to the requirements of this subchapter." Therefore, these products are not regulated by the DOT and do not require the yellow Oxidizer diamond for shipping.

For Towerbrom® 90M: Same as ACL 90 except:
- DOT Proper Shipping Name: Trichloroisocyanuric Acid, Dry, Mixture

For Towerbrom 60M: Same as ACL 60 except:
- DOT Proper Shipping Name: Dichloroisocyanuric Acid Salts, Mixture

All of OxyChem's ACL Chlorinating Compositions have been tested and do not meet the DOT requirements for *corrosive materials* (49CFR § 173.136).

What are the NFPA oxidizer classifications?

The oxidizer classification of materials is defined in the National Fire Protection Association's (NFPA) publication "NFPA 430, *Code for the Storage of Liquid and Solid Oxidizers*, 2004 Edition". Pages 18-19 of this publication lists some typical oxidizers and their classification. OxyChem's ACL 56 and ACL 90 are Class 1 Oxidizers. ACL 60 is a Class 3 Oxidizer.

The definitions of the NFPA Oxidizer Classes (NFPA 430, 2004 edition, page 5) are given below. These definitions are somewhat different than the older definitions.

- Oxidizer: Any material that readily yields oxygen or other oxidizing gas, or that readily reacts to promote or initiate combustion of combustible materials and can undergo a vigorous self-sustained decomposition due to contamination or heat exposure.
- Class 1: An oxidizer that does not moderately increase the burning rate of combustible materials with which it comes into contact.
- Class 2: An oxidizer that causes a moderate increase in the burning rate of combustible materials with which it comes into contact.
- Class 3: An oxidizer that causes a severe increase in the burning rate of combustible materials with which it comes into contact.

Class 4: An oxidizer that can undergo an explosive reaction due to contamination or exposure to thermal or physical shock and that causes a severe increase in the burning rate of combustible materials with which it comes into contact.

NFPA's web-site is: http://www.nfpa.org.

What are HMIS and NFPA ratings?

HMIS is the acronym for Hazardous Materials Identification System. This system classifies the chemicals you use and color codes the information for easy recognition. This system was developed by the National Paint and Coatings Association in response to the requirement by the Occupational Safety and Health Administration's (OSHA) Hazard Communication Standard that all chemicals in the workplace be labeled to specify hazards. The system utilizes four color bars and a space at the top where the name of the chemical should be written. The hazard classification categories are health (blue), flammability (red), and reactivity (yellow), and the ratings for a given chemical in any category may be 0-minimal hazard, 1-slight hazard, 2-moderate hazard, 3-serious hazard, or 4-severe hazard. Personal Protective Equipment appropriate for the chemical's hazard is recommended as part of the rating system. If chronic health effects are known for a given chemical, the health hazard rating is flagged by the use of an asterisk (*). An explanation of the HMIS rating system can be found at: http://safety.science.tamu.edu/hmis.html.

NFPA is the acronym for National Fire Protection Association. The system rates the health, flammability, reactivity, and other hazards created by short-term exposures to chemicals during a fire or related emergency. It is a system of readily understood markings or signals consistent with the severity of the hazard posed and is intended to give basic information to fire-fighting and emergency personnel to enable them to quickly implement protective measures. An explanation of the NFPA rating system can be found at: http://safety.science.tamu.edu/nfpa.html. Keep in mind that the NFPA ratings were devised to rate the degree of hazard in a fire situation and deal only with acute exposure. This system does not necessarily address the hazards of day-to-day exposure.

What are the HMIS and NFPA ratings for the ACL® and Tower products?

Product	HMIS Ratings Health	Flammability	Reactivity
ACL 56, Towerchlor® 56	3	0	1
ACL 60, Towerbrom® 60M	3	0	2
ACL 90, ACL 90T, Towerbrom 90M	3	0	2
Cyanuric acid	1	0	0

Product	NFPA Ratings Health	Flammability	Reactivity	NFPA Oxidizer Class
ACL 56, Towerchlor 56	2	0	1	1
ACL 60, Towerbrom 60M	3	0	2	3
ACL 90, ACL 90T, Towerbrom 90M	2	0	2	1
Cyanuric acid	1	0	0	NA

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What warning statements and symbols are required in Europe?

Classification and labeling requirements for chemicals sold into Europe are given in Directives 67/548/EEC (substances) and 1999/45/EC (preparations). Details on these directives can be found at: http://ecb.jrc.it/classification-labelling/. The following Hazard, Risk and Safety phrases must be on the label for the ACL® products when sold into the countries in the European Community:

	ACL 90 Trichloroisocyanuric Acid	ACL 60 Sodium dichloroisocyanurate	ACL 56 Sodium dichloroisocyanurate dihydrate
CAS # EC # / EINECS #	87-90-1 201-782-8	2893-78-9 220-767-7	51580-86-0 Same as ACL 60
Required Hazard Phrases and Symbols	O, Xn, N	O, Xn, N	Xn, N
Required Risk Phrases	R8, R22, R31, R36/37, R50/53	R8, R22, R31, R36/37, R50/53	R22, R31, R36/37, R50/53
Required Safety Phrases	(S2), S8, S26, S41, S60, S61	(S2), S8, S26, S41, S60, S61	(S2), S8, S26, S41, S60, S61

Notes:
- S2 can be omitted when sold for industrial use only.
- Belgium requires the additional safety phrases for all three products:
  S13: Keep away from food, drink and animal feeding stuffs.
  S20/21: When using do not eat, drink or smoke.

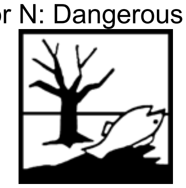
O: Oxidizing
Xn: Harmful
N: Dangerous for the Environment
R8: Contact with combustible material may cause fire.
R22: Harmful if swallowed.
R31: Contact with acids liberates toxic gas.
R36/37: Irritating to eyes and respiratory system.
R50/53: Very toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment.
S2: Keep out of the reach of children.
S8: Keep container dry.
S26: In case of contact with eyes, rinse immediately with plenty of water and seek medical advice.
S41: In case of fire and/or explosion do not breathe fumes.
S60: This material and its container must be disposed of as hazardous waste.
S61: Avoid release to the environment. Refer to special instructions/safety data sheets.

These label symbols are required (printed on orange background) if the product falls into the class listed:

For O: Oxidizing

For Xn: Harmful

For N: Dangerous for the Environment



If a formulation contains a chlorinated isocyanurate, the supplier must determine which phrases are appropriate, based on the directions in Directive 1999/45/EC (Classification, Packaging and Labelling of Dangerous Preparations). This Directive does not provide guidance on the Safety phrases.

The following table summarizes the Hazard and Risk phrases that are required based on just the content of the chlorinated isocyanurate in a formulation. It does not account for the toxicity or other characteristics of other components. If another substance in the preparation has the same phrase, then the appropriate phrase of the mixture must be determined based on the mixing rules given in Directive 1999/45/EC (the Dangerous Preparations Directive). (C = concentration of the chlorinated isocyanurate in the preparation)

Phrase	Annex(1)	ACL® 90	ACL 60	ACL 56
O: R8		C > 39% (2)	C ≥ 50% (3)	NA
Xn: R22	II	C ≥ 10% (4)	C ≥ 10% (5)	C ≥ 10% (5)
R31		C ≥ 10% (4)	C ≥ 10% (5)	C ≥ 10% (5)
Xi: R36/37 (6)	II	C ≥ 10% (4)	C ≥ 10% (5)	C ≥ 10% (5)
N: R50-R53 N: R51-R53 (7) N: R52-R53 (7)	III	C ≥ 25% 2.5 % ≤ C ≤ 25% 0.25% ≤ C ≤ 2.5%	C ≥ 25% 2.5 % ≤ C ≤ 25% 0.25% ≤ C ≤ 2.5%	C ≥ 25% 2.5 % ≤ C ≤ 25% 0.25% ≤ C ≤ 2.5%

Notes
(1) Relevant Annex in Directive 1999/45/EC.
(2) From ADR Regulations - International Carriage of Dangerous Goods by Road (ADR).
(3) Determined using ADR burn tests. Europe specifies a slightly different method (Method A.17 in Annex V of Directive 67/548/EEC, Dangerous Substances Directive) but the results should be similar.
(4) Assumed to be the same as the specific concentration limits for ACL 60 even though the Directive gives higher general limits in Annex II for R22 and R36/37 and no guidance on R31.
(5) Specific concentration limits for ACL 60 and 56.
(6) Xi is superseded by Xn when both are indicated.
(7) R51/53: Toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment. R52/53: Harmful to aquatic organisms, may cause long-term adverse effects in the aquatic environment.

What is the status of these products under the Biocide Product Directive (BPD)?

The Biocide Product Directive is the upcoming set of regulations in Europe for registering pesticides. Once the BPD is in place, pesticide regulations will be harmonized in Europe and a pesticide will only need to be registered once, rather than country by country. Contact ACL® Technical Service (877-873-4767) for a summary of the current status for the chlorinated isocyanurates.

What is the status under California's Proposition 65 regulations?

The chlorinated isocyanurate products <u>are not listed</u> on the California Governor's list(s) of Carcinogens, Reproductive Toxicants, and/or Candidate Carcinogens and, to the best of our knowledge, the ACL® products do not contain any chemicals that are on the list. Therefore, a warning statement for OxyChem's chlorinated isocyanurate products is not necessary.

What is the Kosher status?

Our manufacturing processes do not involve the use of any animal fats, bones or animal by-products. OxyChem has elected not to pursue receiving actual Kosher Certification due to the costs involved. However, the use of OxyChem's chlorinated isocyanurates should not endanger the Kosher-Certified status of any product that includes these materials in its composition.

Health, Environmental and Safety

Are the chlorinated isocyanurates toxic?

There have been extensive studies, over many years, of the toxicity of the chlorinated isocyanurates and cyanuric acid. This data has been compiled to support product registrations at the U.S. EPA (under FIFRA) and in other countries. The data set supporting the registrations is jointly owned by the Isocyanurate Industry Ad Hoc Committee (IIAHC). Recently, the IIAHC compiled summaries of the toxicity and other data for the HPV program.

A paper by Hammond, et al., is a good review of the toxicity of cyanuric acid and the chlorinated isocyanurates. Contact ACL® Technical Service (877-873-4767) for a copy.

Where can I find the HPV data for the chlorinated isocyanurates?

OxyChem participated in the IIAHC's effort to compile summaries of the toxicity and other data required by EPA's HPV (High Production Volume) program. The Robust Summaries and the comments were posted on the following websites. The cover letters and responses are relatively short documents, but the Robust Summaries are about 130 pages each.
http://www.epa.gov/chemrtk/sdditriz/c14660tc.htm (for sodium dichloro-s-triazinetrione and sodium dichloro-s-triazinetrione dihydrate)
http://www.epa.gov/chemrtk/tricltrz/c14659tc.htm (for trichloro-s-triazinetrione)

Reporting releases

The chlorinated isocyanurates have not been assigned an RQ; however, releases may be reportable. Report any release of these products if it could cause harm to people or the environment, or if the State requires a more stringent reporting threshold. If any spill of these products gets into the ground or surface water or is involved in a fire, toxic gases are released; therefore, the spill should be reported. It is best to report a spill or gas release if there is any uncertainty.

Report to each of:

- National Response Center (NRC); 800-424-8802 (24 hours) [CERCLA]
- Appropriate State Agency [SARA]
- Local Agencies [SARA]

Releases during transportation that require emergency response should also be reported to:

- CHEMTREC; 800-424-9300 (24 hours) [DOT]

How do I dispose of waste chlorinated isocyanurates?

OxyChem's recommended procedure for disposing of waste chlorinated isocyanurates is given on pages 19-20 of our *Detergent, Bleach, Cleaner, and Sanitizer Applications* Handbook. Contact ACL® Technical Service (877-873-4767) for more information.

Environmental fate and biodegradability

The chlorinated isocyanurates are not biodegradable in the normal sense, i.e., decomposition by microorganisms and/or sunlight, and do not exhibit biochemical oxygen demand (BOD) and chemical oxygen demand (COD).

When the chlorinated isocyanurates (TCCA and NaDCC) dissolve in water they hydrolyze according to the following equations:

$$TCCA + 3\,H_2O \rightarrow 3\,HOCl + C_3N_3O_3H_3$$

$$NaDCC + 2\,H_2O \rightarrow 2\,HOCl + Na^+ + C_3N_3O_3H_2^-$$

Hypochlorous acid (HOCl) is quite reactive and oxidizes a variety of organic and inorganic materials in the water. The materials which react with available chlorine are collectively denoted as "demand". The HOCl is reduced to hydrochloric acid (HCl) or its salts during this reaction.

In most applications, the cyanuric acid produced by the hydrolysis reaction will remain intact for some time since it is chemically rather inert. However, in the environment, cyanuric acid will eventually be biodegraded.

Cyanuric acid is found naturally in soil at levels of 1-6 ppm and is readily biodegraded under a wide variety of natural conditions. It is biodegraded by several strains of fungi, including soil fungi. It is biodegraded by some strains of bacteria, including the soil bacteria Hormodendrum masonii. It is biodegraded particularly well in systems of either low or zero dissolved oxygen level such as anaerobic activated sludge and sewage, soils, mud and muddy streams and river water, as well as ordinary aerated activated sludge systems with typically low (1 to 3 ppm) dissolved oxygen levels. Degradation also proceeds in 3.5% sodium chloride solution.

Consequently, there are degradation pathways widely available for breaking down cyanuric acid discharged in domestic effluents. The overall degradation reaction is merely a hydrolysis; CO_2 and ammonia are the initial products. Since no net oxidation occurs during this breakdown, biodegradation of cyanuric acid exerts no primary biological oxygen demand (BOD); however, eventually nitrification of the ammonia released will exert its usual biological oxygen demand.

More information on biodegradability can be found in the HPV Robust Summaries and the section below on BOD.

What is the BOD of the chlorinated isocyanurates and cyanuric acid?

The chlorinated isocyanurates have no BOD. For use on NPDES permits, it may be more proper to use the BOD of cyanuric acid rather than that of TCCA or NaDCC. The BOD of cyanuric acid is also zero.

This conclusion is reinforced by a calculation of the theoretical oxygen demand (ThOD) of trichlor ($C_3N_3O_3Cl_3$). Without nitrification (i.e., without oxidation of any ammonia formed), the ThOD for trichlor is -0.21 mg O_2/mg, that is, the BOD should be less than zero. This is not surprising since trichlor is an oxidizer, therefore, it should not have a BOD.

For cyanuric acid ($C_3H_3N_3O_3$) the calculated ThOD (without nitrification) = 0. Note that the carbon atoms in cyanuric acid are already in the same oxidation state as CO_2. Therefore, it is not degraded by oxidation. Instead, cyanuric acid is slowly hydrolyzed to CO_2 and NH_3, which is not an oxidation reaction and does not require oxygen. A number of literature articles agree that bacteria and other micro-organisms degrade cyanuric acid by hydrolysis, not by oxidation. Therefore, the BOD (without nitrification) is zero.

A zero BOD means that bacteria cannot use cyanuric acid as an energy source, i.e., as food. However, some, but not all, types of bacteria can use cyanuric acid as a nitrogen source. All bacteria which can degrade cyanuric acid have been found to have a particular enzyme which is required for degradation. Only a limited number of bacteria have this enzyme, therefore, many bacteria cannot degrade cyanuric acid. Therefore, the standard “Ready Biodegradation” test indicates that cyanuric acid is not readily biodegraded. However, in the environment, cyanuric acid can be degraded if the right type of bacteria are present. More information on biodegradability can be found in the HPV Robust Summaries.

Aquatic toxicity

Contact ACL® Technical Service (877-873-4767) for aquatic toxicity data for the Towerbrom® products.

Guidelines for Safe Handling, Storage and Transportation

Transportation of hazardous materials in the U.S. is governed by the Department of Transportation (DOT). Their regulations are given in 49CFR Sections 107 – 397. See section on DOT shipping classifications. In 1995, the Chemical Manufacturers Association Chlorinated Pool Chemicals Panel (CPC Panel) published a handbook titled "Guidelines for Safe Transportation of Calcium Hypochlorite and Chlorinated Isocyanurate Pool Chemicals" (known as the Green Book).

Standards for storage of oxidizers is given in "NFPA 430 Code for the Storage of Liquid and Solid Oxidizers". See section on NFPA. In 1995, the CPC Panel also published a handbook titled "Guidelines for Safe Handling & Storage of Calcium Hypochlorite and Chlorinated Isocyanurate Pool Chemicals" (known as the Blue Book). This handbook summarized the requirements given in NFPA 430.

Both the Blue and Green Books are now out of print, and do not reflect recent changes in NFPA 430. ACL® Technical Service does have some copies available.

A committee of the American Chemistry Council has been working to revise the "bluebook" summarizing the industry's guidelines for safe handling, storage and transportation of dry chlorinated pool chemicals. The new handbook will combine the old Blue and Green Books. However, a final version is not yet available. Contact ACL Technical Service (877-873-4767) for details.

Using Chlorinated Isocyanurates

Recommendations on pool treatment

The most important water quality parameter to maintain in a swimming pool is the free chlorine level. The free chlorine concentration should always be over 1.0 ppm (mg/L) to keep bacteria under control. We normally recommend about 3 – 4 ppm, as this level is required to control both bacteria and algae. The higher level is particularly recommended if a chlorinated isocyanurate, such as one of OxyChem's ACL® products, is being used.

Another important parameter to monitor is the combined chlorine level. This is the difference between the total available chlorine and the free available chlorine. Combined chlorine normally consists of various chloramines. Chloramines are the cause of eye irritation and chlorine odor, not free chlorine. The combined chlorine level should be less than about 0.3 ppm. Higher levels of combined chlorine indicate that the free chlorine level is too low and more sanitizer should be added.

It is good practice to "shock" a pool periodically, say once a week for pools with moderately heavy use, to "burn out" combined chlorine and difficult to control contamination. Shocking involves raising the free chlorine level to 5 – 10 ppm. Of course, the pool should not be used until the free chlorine concentration drops back down below 5 ppm.

It is also important to maintain a good filtration system, so that the water is clear and free of insoluble debris. Chemical treatment of a pool cannot maintain acceptable pool water quality without a good filtration system. The filtration system should run during enough of the day to provide adequate filtration of the entire pool, not just during the time that people are in the pool.

The other important water quality parameters to maintain are pH and total alkalinity. The pH should be kept in the range of 7.2 – 7.6. Lower pHs lead to corrosion of piping and attack on pools walls (plaster, tile grout, etc.) Higher pHs reduce the effectiveness of the chlorine. This is also the pH which is best for the swimmers. Trichlor (ACL 90) is acidic, so over time it can slowly decrease the pH. The pH should be checked routinely and if it drops below 7.2, some soda ash (sodium carbonate) should be added to raise the pH back to the recommended level. The total alkalinity should be maintained in the range of 80 – 125 ppm. Alkalinity (also known as pH buffer) limits how fast the pH changes when acid or caustic are added to the water. Soda ash also adds alkalinity.

If trichlor is used routinely, cyanuric acid will build up to levels exceeding 100 ppm. We have done extensive testing which shows that levels up to over 300 ppm of cyanuric acid are acceptable. As noted above, when trichlor is used, we recommend keeping the free chlorine concentration about 3 – 4 ppm. This helps to compensate for the higher cyanuric acid level. We find that pools stay in great condition if the free chlorine is kept at 3 – 4 ppm, with sparkling clear water, no bacteria and no algae.

At the same time, if the cyanuric acid does go well over 100 ppm, some water should be removed and replaced with fresh water. This is good practice in any case, to limit the buildup of total dissolved solids and difficult to remove contamination. This is difficult to do in areas with water restrictions, but even a relatively small amount of replaced water can make a difference.

Corrosion of copper piping is due to low pH. Keeping the pH in the recommended range will prevent the green/blue copper color in water. Note too that "green hair" (in blonds) is also due to copper in the water, not due to chlorine.

The National Spa & Pool Institute, a swimming pool and spa industry organization, has developed a number of standards for design and use of swimming pools. The NSPI standards are summarized in the table below. See http://www.nspi.org for more information.

Pool Water Parameter	NSPI Recommended Level	NSPI Ideal Level
Free chlorine	1 – 4 ppm	2 – 4 ppm (pools) 3 – 4 ppm (spas)
pH	7.2 – 7.8	7.4 – 7.6
Alkalinity	60 – 180 ppm	80 – 100 ppm (cal-hypo or bleach pools) 100 – 120 ppm (Cl-isocyanurate pools)
Calcium hardness	100 – 1000 ppm	200 – 400 ppm (pools) 150 – 250 ppm (spas)
Cyanuric acid (if used)	10 – 150 ppm	30 – 50 ppm

Commercial pools are normally regulated by the local health department. State or local pool codes normally provide similar limits to those given above. Other good sources of information:
http://www.nspf.org National Swimming Pool Foundation, which conducts pool operator training
http://www.cdc.gov/healthyswimming/ Center for Disease Control and Prevention

OxyChem presented a paper at the National Pool and Spa Institute convention in 1994 which provides data to support the discussion above. A copy is available at http://www.nspf.org/research.html. See also section on cyanuric acid limits.

Spa recommendations

The body of water in a spa is obviously much smaller than that of a swimming pool. Because of this large difference in water volume, the bather contamination load in a spa is several hundred times higher per gallon of water than in a pool. As a consequence, if the spa is not properly managed, the chemistry of the spa water can get out of control very rapidly. For this reason, we suggest the following procedure for using dichlor in your spa. We find this method to be very simple, yet effective.

SUGGESTED PROCEDURE
1. To start-up a freshly filled spa, chemically balance the water. This includes adjusting the alkalinity of the water to 125 ppm (use about 8 ounces of sodium bicarbonate for a 500 gallon spa).
2. Turn on the spa's circulation pump and heater. Measure the disinfectant level. The free available chlorine level should be 3 - 4 ppm. If disinfectant is required, add dichlor to the spa 15 minutes before use. A rounded teaspoon of dichlor supplies about 3 ppm of free chlorine to a 500 gallon spa.
3. Bathers may now use the spa. It is recommended that water temperatures do not exceed 104°F.
4. After bathing, add enough disinfectant to achieve 3 - 4 ppm of free chlorine (about one rounded teaspoon for a 500 gallon spa). Allow the spa's pump to circulate the water for several minutes or until the dichlor is completely dissolved. Place a cover on the spa for dormant period.
5. Repeat steps 2 through 4 for every use of the spa.
6. Superchlorinate the spa water weekly. This is accomplished by raising the free available chlorine level to 8 - 10 ppm. Run the spa's circulation pump until all of the dichlor is dissolved. The spa should not be used for 8 hours.
7. When the spa's water becomes cloudy, drain the spa and add fresh water (this should be done at least every 6 months). Proceed with step 1 of this procedure.

Calcium hypochlorite and chlorinated isos are not compatible

Calcium hypochlorite and chlorinated isocyanurates are incompatible. Mixing of these chemicals may form an explosive mixture. Calcium hypochlorite and chlorinated isocyanurates should not be shipped together and care should be taken to separate these chemicals during storage. It is important that feeding equipment should be adequately cleaned before converting from one product to the other. Cleaning may require an acid soak to adequately clean all surfaces of the feeder. For further information, please contact ACL® Technical Service (877-873-4767).

Cyanuric acid limits in pools

Stabilized chlorine is the sanitizer of choice in the vast majority of home swimming pools because of its effectiveness, ease and economy of use. Chlorine is degraded by the ultraviolet (UV) rays of the sun. On a bright sunny day, an unstabilized pool can use over three times more chlorine than a stabilized pool. The use of cyanuric acid thus provides a tremendous cost savings over the course of a season.

The stabilized chlorine products were introduced in the mid 1960’s. Ever since, suppliers of competitive products have waged anti-stabilized chlorine campaigns. Over the years, they have given a number of alleged reasons for limiting the usage of cyanuric acid (CYA) and the chlorinated isocyanurates in swimming pools. The theme used most frequently is something like: "It’s okay to have CYA levels of 50-100 ppm to prolong the lifetime of free chlorine, but it is not okay to use stabilized chlorine because it will result in high (>100 ppm) CYA concentrations which will lock up the free chlorine and make it ineffective." We feel that, because of the competitive situation, this anti-CYA campaign has distorted the facts.

Over the years, many comprehensive studies on cyanuric acid have been conducted. The purpose of these studies was to insure that pool owners, service people, public health officials and regulatory agencies had factual information on:

1) the toxicity of cyanuric acid and the stabilized chlorine products (trichlor and sodium dichlor); and
2) the effectiveness of free chlorine in pools containing cyanuric acid.

The total cost of the toxicity tests was several million dollars. Details of the toxicity data have now been published in the HPV Summaries. The results show that cyanuric acid is completely safe at use levels.

Over the years, we have also conducted several extensive field trials to demonstrate the effectiveness of stabilized chlorine and to define an appropriate limit for cyanuric acid in pool water. One of the major field trials was conducted by the Public Health Department of Pinellas County, Florida. They monitored and collected data on 1200 pools over a period of eight years (1973-1981). An even more extensive field trial was also conducted in Pinellas County, in 1992. This study collected data on 31 different variables in 486 pools and conducted an broad statistical analysis of the relationship between the variables. A third major field trial was conducted in Albany, New York in 1999.

All of the field trials clearly demonstrate that:
- The most important parameter for controlling bacteria or algae is free chlorine.
- Free chlorine should be above about 1 ppm to control bacteria, regardless of the presence of CYA.
- Free chlorine should be above about 3 ppm to control algae, regardless of the presence of CYA.
- There is no evidence that CYA adversely affects the bacteria counts. Instead, the presence of CYA makes it easier to control bacteria by stabilizing the free chlorine.
- There is no evidence that the presence of CYA leads to higher algae levels.
- The presence of CYA, even well above 100 ppm, does not impact the ability to control bacteria or algae.
- The presence of CYA lowers the ORP reading by about 185 mV at 75 ppm CYA. The change is not proportional to the CYA concentration.
- CYA does not impair the ability to control chlorine feed with ORP.
- CYA does not impair the ability of free chlorine to oxidize organics or nitrogenous compounds.

Much of this work has been published. The results of the 1992 Pinellas County study are available at http://www.nspf.com/research.html. A paper summarizing both the 1992 Pinellas County study and the 1999 Albany, NY study was presented at the 2004 International Pool & Spa Expo (NSPI). Contact ACL® Technical Service (877-873-4767) for copies of the 2004 paper and our CYA position paper.

How long can the ACL® products be stored?

All of the ACL products have excellent stability when they are properly packaged and stored. They can be stored for years without significant decomposition. However, these materials, particularly trichlor, can form enough chlorine-containing gases to cause deterioration of the container. Therefore, the standard shelf-life for packaged product (in bulk bags, plastic drums or pails) is two years. The one exception is for product in cardboard cases where the shelf-life for the case is six months. These guidelines are based on potential deterioration of packaging and not on degradation of product.

For ACL 56 and ACL 60, products stored in containers that are not air-tight may show some drop in available chlorine content over time. These products can pick up atmospheric moisture, thereby reducing the weight fraction of chlorine. However, if the available chlorine content is calculated on a dry basis, the available chlorine content will still be within the product specifications. Products stored in air-tight containers do not absorb ambient moisture and do not show a drop in available chlorine content.

ACL 90 PLUS is very stable and can be stored for years without deterioration. While trichlor does react with atmospheric moisture to slowly form some chlorine-containing gases, the amount of gas formed is insignificant compared to the total chlorine content. In fact, analyses of aged product usually indicates that the available chlorine content is still within specifications and can be readily used.

It is important that certain storage guidelines be practiced in order to recognize and prevent excessive damage to the container. We recommend that containers of ACL 90 PLUS Chlorinated Composition or ACL 90T Chlorinating Tablets be inspected periodically after one year of storage. Of course, it is best to rotate the stock so that the products never stay in storage longer than recommended. If some package deterioration is observed, the product should be used before the package can deteriorate further. If the package is badly deteriorated, the product should be disposed of properly.

The following are recommended guidelines for proper inventory management:
1. Use the FIFO system of inventory management.
2. Periodically visually inspect packages for any sign of deterioration, such as discoloration or distortion.
3. Whenever packages are handled, check for any weakness in the container.
4. If a package starts to deteriorate, use the material before the package degrades further.

Choice of ACL® product in bleach formulations

All the chlorinated isocyanurates produce excellent bleach products when properly formulated. ACL 60 and ACL 56 are excellent choices because they dissolve extremely fast and can readily be formulated in bleaches containing builders, surfactants, strong alkalis and hydrated chemicals.

Formulations containing ACL 60 (anhydrous sodium dichloroisocyanurate) should contain anhydrous components if possible. If the formulation contains hydrated materials, then ACL 56 (sodium dichloroisocyanurate dihydrate) is recommended instead. Formulations which contain both hydrated materials and hygroscopic materials (such as ACL 60) tend to be less stable over time, due to reactions between the hygroscopic components and the hydrated components.

ACL 90 PLUS is often used in I&I bleach formulations or hard surface cleaners, along with an inert ingredient such as sodium sulfate, because of its cost performance. In laundry bleach applications, the possibility exists that undissolved particles may cause spot bleaching or pin-holing because of the low solubility of ACL 90 PLUS. ACL 90 PLUS bleach formulations, therefore, should only be used where high pH levels, high water temperatures and cycle times permit all of the product to dissolve before the fabric is added to the water. ACL 90 PLUS is not recommended for formulated bleaches containing strong alkali, surfactants or hydrated chemicals. These materials may react with ACL 90 PLUS causing decomposition of the triazine ring leading to rapid gas evolution, creating a potential explosion hazard.

All formulations containing chlorinated isocyanurates should be tested to ensure chlorine stability and safety of the product prior to manufacture. See the following section on compatibility. Also refer to our handbook "Detergent, Bleach, Cleaner, and Sanitizer Applications".

What materials or surfactants are compatible with the chlorinated isocyanurates?

The following chemical groups are compatible with chlorinated isocyanurates: aliphatic ketones, aliphatic or aromatic esters, tertiary alcohols, tertiary ethers, aliphatic sulfates, aliphatic nitriles.

The following chemical groups are NOT compatible with chlorinated isocyanurates: strong acids or bases; amines; amides; ammonium salts; primary or secondary alcohols; primary or secondary ethers; other oxidizers including peroxides, perborates, percarbonates; other available chlorine compounds including calcium hypochlorite; phenols; any alkene or acetylene; reducing agents such as sulfides, bisulfites, thiosulfates, nitrites; urea; hydrazines.

Some surfactants which are compatible: the alkyl sulfates (like sodium lauryl sulfate), alkyl sulfonates, amine oxides, polyacrylic acid, aliphatic esters like stearyl stearate. Unfortunately, this list is rather limited. When looking for chelating agents, phophates or polyphosphates are compatible with chlorinated isocyanurates but EDTA is questionable.

Simple compatibility tests can be run by simply mixing equal amounts of a chlorinated isocyanurate and the other material in a small beaker, adding a thermocouple and adding a small amount of water. Most mixtures of solids will not show signs of reaction, even if the two materials are not compatible, but reactions will often occur if a small amount of water is added.

If a formulation passes the simple compatibility test, a storage stability test is recommended. Store the proposed dry mixture in an oven at 40 or 50°C and check the chlorine content over time. This is an accelerated storage test, corresponding to 3-5 times the storage time at 20°C.

Can these products be used for chlorination of human drinking water?

Yes. Registrations for use of the ACL® products in drinking water were approved by the U.S. EPA in July, 2001. The full text of the registered labels for registration numbers 935-40 (ACL 90 Disinfecting Tablets), 935-41 (ACL 60 Disinfecting Granules), 935-59 (ACL 90 Disinfecting Granules), and 935-42 (ACL 56 Disinfecting Granules) can be found at the EPA's website: http://oaspub.epa.gov/pestlabl/ppls.home

OxyChem markets four products for potable water use:

- ACL 90 Disinfecting Tablets in 1" (14 gram) or 3" (200 gram) diameter sizes
- ACL 90 Disinfecting Granules
- ACL 60 Disinfecting Granules
- ACL 56 Disinfecting Granules

OxyChem's brochure "ACL® Disinfecting Compositions for Potable Water" and sales specifications are available on our website. Contact ACL Technical Service (877-873-4767) for more information on package sizes, feeder recommendations, etc.

Are OxyChem's chlorinated isocyanurates NSF certified?

Yes. OxyChem's ACL® Disinfecting products are certified by NSF International under Standard 60 (Drinking Water Treatment Chemicals - Health Effects) for use as drinking water additives. This certification assures that the products are produced to NSF standards of purity. NSF certification is normally a requirement for use in municipal water systems. All NSF certified products are listed on their Internet website at: http://www.nsf.org/certified/PwsChemicals/. No other source of chlorinated isocyanurate is certified by NSF for use in drinking water.

NSF is the most trusted certification in the drinking water industry. NSF certification programs are fully accredited by the American National Standards Institute (ANSI) in the United States and by the Standards Council of Canada (SCC) in Canada. NSF certification is mandated by public health regulators throughout the United States as well as internationally. NSF certification must be maintained by annual audits by NSF, and therefore is not a permanent certification. This insures that products certified by NSF continue to be produced to the same high standards.