

2016 CRT Glass Responsible Management

Maximizing Reuse
Minimizing Life Cycle Impacts

Irresponsible Management of CRT Glass

CRT Problem:

Coerced Recycling leads to “Sham” Responsibility

CRT glass is: silica engineered to serve the purpose of being a picture tube. An engineered blend incompatible for any other current glass product.

The engineered blend of CRT silica is laden with toxics

Silica is abundant globally

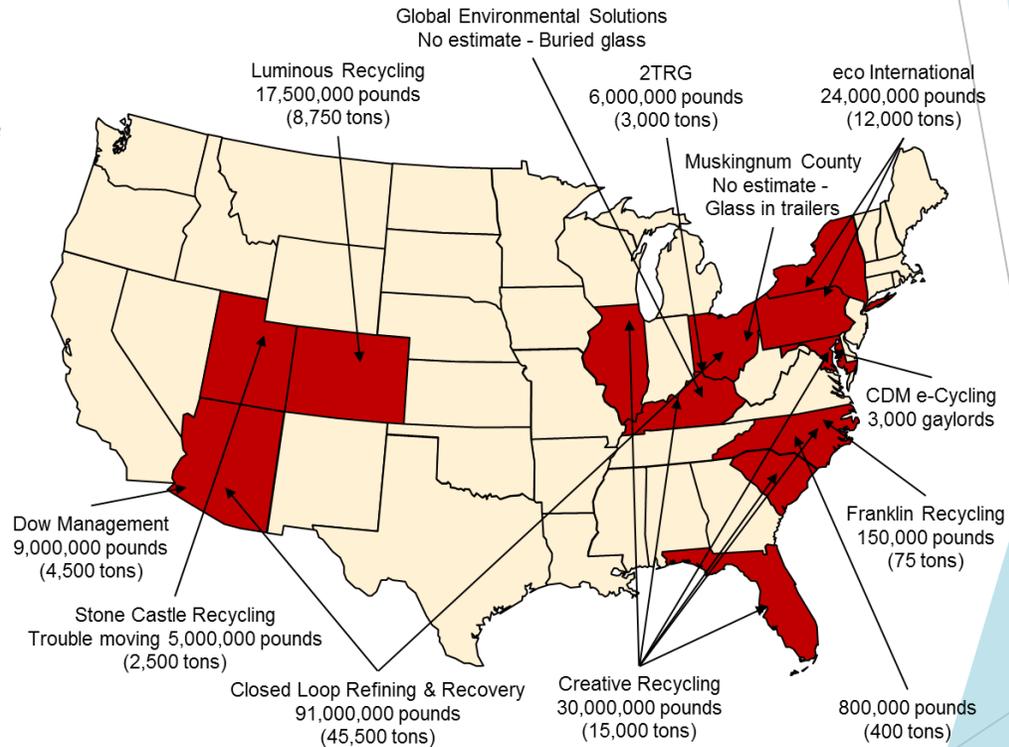
Recycling toxic-free glass is facing significant challenges

EPR, R2 and e-stewards forcing recycling

Recycling CRT glass creates new toxic exposure opportunities

Responsible parties need choice to manage their own risks

At least 12 recyclers across the U.S. have been reported to have **stockpiled, abandoned or buried** CRT glass.



CRT glass quantities at these sites total **at least 183,450,000 pounds (91,725 tons)**.

CRT Recycling Issues

- ▶ CRT manufacturing not viable
- ▶ EPA approved ceramic glazing as legitimate use for CRT glass
- ▶ EPA is clear that Toxic Along for the Ride (TAR) is not allowed. 40 CFR 260.43
- ▶ CRT panel prior late 1980s likely contains 25,000 ppm lead, and contains Arsenic and Antimony
- ▶ Lead smelters want sulfides, not oxides, remain uninterested in large quantities and will not accept panel glass
- ▶ Dilution of the toxics in glass into other products not the solution. 40 CFR 268.3
- ▶ TCLP is wrong criteria for determining consumer product safety. MADL, NOEL, etc testing more appropriate on finished goods
- ▶ Videocon shutdown led CA to allow RCRA landfill as one option.
- ▶ Legal analysis says: OEMs do not escape the chain of custody and can be liable under "arranger" per CERCLA
- ▶ Recyclers and States are unable to indemnify brand reputation of Responsible Parties

An Evaluation of Glass to Various Outlets

- ▶ Considered
 - ▶ Inputs
 - ▶ Outputs
 - ▶ Processing impacts
 - ▶ Climate Change impacts
 - ▶ Closure Long Term Care
 - ▶ End Products
 - ▶ Legacy
- ▶ Performance rating

Performance Rating

Performance is given in percentage with exception of Climate Change impact which is given in Tons. For all options, at least 40.11% is considered recycled through disassembly and recovery, including the CRT metal parts and 4.5% is considered non-recoverable and landfilled.

Rating Definitions

Climate change: Tons of CO2e emissions from full truck load transportation and high temperature processing.

Recovered: Raw material reuse.

Beneficial use*: Offsets the use of another raw material such as:

- silica for flux;
- silica for lowering melting temperature;
- glass as substitute for gravel; or
- glass as substitute for landfill cover soil

Long term storage*: Storage until market conditions change, such as slag and lead-concentrated silica.

Unknown: Information on down stream is incomplete and unknown

*Note: silica fluxing agent is reported as beneficial use and is reported under long term storage as slag.

Typical CRT TV set	
Steel	15.00%
Plastic	13.00%
Yokes(copper)	3.00%
Wiring (copper)	2.00%
Circuit boards (copper)	7.00%
Other (aluminum)	2.00%
Silica	43.50%
Lead	3.40%
Other heavy metal/contaminants	11.10%
	100%

Carbon @ 161.8 grams/ton-mile

Carbon melting factor: 0.23 tons/ton melted glass

References: EPA Waste Reduction Model (WARM) and references contained therein - <https://www.epa.gov/warm/waste-reduction-model-warm-material-descriptions-and-data-sources>;

Environmental Defense Fund Green Freight Handbook and references contained therein: -

<http://business.edf.org/projects/green-freight-handbook/>

Summary of Performance

	Glass to Glass	Glass to Lead	Glass to Zinc or Copper	Glass to Ceramic Glaze	Glass to Ceramic Paste	Glass to ADC	Glass to Retrievable Cell	Glass to RCRA Subtitle C Landfill
Carbon Tons/container*	11.33	11.73	11.73	9.37	9.37	1.33	1.33	1.18

Whole CRT TV

Landfill	4.50%	4.50%	4.50%	4.50%	4.50%	4.50%	4.50%	59.89%
Recovered	95.50%	43.36%	40.11%	43.36%	40.11%	43.36%	40.11%	40.11%
Beneficial Use		41.54%	41.54%	17.20%	41.54%	52.14%	38.39%	
Long term storage		52.14%	55.39%				17.00%	
Unknown				34.94%	53.96%			

Glass Portion Only (58% of TV)

Landfill	4.50%							100%
Recovered	95.50%	5.60%		5.60%				
Beneficial Use**		71.63%	71.63%	29.65%	71.63%	100%	66.19%	
Long term storage**		89.90%	95.50%				29.31%	
Unknown				60.25%	93.03%			

*Carbon tons/container reflect only truck transportation as measured from the U.S. population center (approximately located near Plato, Missouri); no carbon emissions for subsequent barge transportation for overseas shipments are included.

**Silica fluxing agent is reported as beneficial use AND is reported in long term storage as slag.

Conclusion

- ▶ Goals
 - ▶ Maximize recovery and reduce life cycle costs of all environs
 - ▶ Minimize current and future risk
 - ▶ Include climate change impact as key criteria
 - ▶ No Toxics Along for the Ride
 - ▶ Minimize stockpiling occurring due to inadequate capacity
- ▶ EPR regulations need to allow actual Responsible management options when Recycling is shown to cause more harm and create unacceptable risk to the responsible parties
 - ▶ In addition to glass-to-glass and smelters
 - ▶ Allow RCRA subtitle C when is shown as lowest exposure risk to public
 - ▶ Alternative Daily Cover
 - ▶ Retrievable cell

Glass to Glass

- ▶ Description: CRT is taken apart and metals separated. Funnel and panel glass are both washed clean of coatings using a fluoride-based acid solution. Clean glass streams are shipped overseas to a CRT furnace for melting into new CRT panels and funnels.
- ▶ Top concerns:
 - ▶ Use of toxic fluoride based acids. Acid fume scrubber necessary to protect immediate vicinity. Generates wastewater that must be treated. Hazardous residuals
 - ▶ Reliability of the CRT factory
 - ▶ Climate change impact due to long distance and high temperature glass-melting process
 - ▶ What is end of life solution for new CRTs in developing nations
- ▶ Closure Care: Similar to manufacturing plant. If chlorinated solvents used then potential long term remediation.
- ▶ Performance:
 - ▶ Climate change: 11.33 CO2 Tons
 - ▶ Landfill: 4.5%
 - ▶ Recovered: 95.5%
 - ▶ Beneficial use: %
 - ▶ Long term storage: %
 - ▶ Unknown: %

Glass to Lead Smelter

- ▶ Description: Glass is substituted with lead bearing raw materials after the sintering (sulfide conversion) process. The silica combines with other impurities (flux process) to form slag. Lead oxide is recovered in ingot form and shipped to refining. Slag (silica with impurities/toxics) is placed in long term storage for future recovery based on commodity market conditions
- ▶ Top Concerns:
 - ▶ Smelters not interested in regulated waste with storage time limits
 - ▶ Smelters not interested in panel glass
 - ▶ Climate change impact due to high temperature process
 - ▶ Long term storage of slag (silica with toxic impurities) or disposal
 - ▶ Sintering produces sulfuric acid but is separate stage of process
 - ▶ Emission filters necessary to protect immediate vicinity.
- ▶ Closure Care: Significant overall, but glass is minor contributor
- ▶ Performance:
 - ▶ Climate change: 11.73 CO2 Tons
 - ▶ Landfill: 4.5%
 - ▶ Recovered: 43.36%
 - ▶ Beneficial use: 42.54%
 - ▶ Long term storage: 52.14%
 - ▶ Unknown: %

Glass to Zinc or Copper Smelter

- ▶ Description: Glass is used as a substitute for silica. Silica is consumed as a flux and removes impurities in the form of slag. Lead and other toxic heavy metals are contained in the slag and placed into long term storage.
- ▶ Top Concerns:
 - ▶ Smelters not interested in regulated waste with storage time limits
 - ▶ Lead not recovered, combined into slag
 - ▶ Smelters not interested in panel glass
 - ▶ Climate change impact due to high temperature process
 - ▶ Long term storage of slag (silica with toxic impurities) or disposal
 - ▶ Sintering produces sulfuric acid but is separate stage of process
 - ▶ Emission filters necessary to protect immediate vicinity.
- ▶ Closure Care: Significant overall, but glass is minor contributor
- ▶ Performance:
 - ▶ Climate change: 11.73 CO2 Tons
 - ▶ Landfill: 4.5%
 - ▶ Recovered: 40.11%
 - ▶ Beneficial use: 41.54%
 - ▶ Long term storage: 55.39%
 - ▶ Unknown: %

Glass to Ceramic Glaze

- ▶ Description: CRT is taken apart in the US and sorted into panel and funnel streams of glass. The coatings are removed using a dry process. Panel glass is may be included as glaze or sent to an aggregate substitution process such as gravel or placed into storage. The glaze processor receives the funnel glass and places into storage for unknown period of time. The glass is eventually crushed and prepared as frit. Information is unclear after this point. It is reported the that the recycler delivers the glass with a recipe for making glaze to unknown customers throughout Europe. USA is a large market for EU ceramics
- ▶ Top Concerns:
 - ▶ Lead content of future products
 - ▶ OSHA lead standard will apply to construction workers cutting tile and in future demolishing tile. No MADL data
 - ▶ No information on downstream customers
 - ▶ Proposition 65 labels
 - ▶ TSCA/CPSC/ROHS/REACH
 - ▶ Climate change impact due to long distance shipping and high temperature processing
 - ▶ Human exposure to panel glass as aggregate in a non-secure application. CERCLA liability risk
 - ▶ Storage time
 - ▶ Proper shipping description when received into foreign country
 - ▶ Processing: Emission filters necessary to protect employees and immediate vicinity.
- ▶ Closure Care: Minor if glass is not accumulated
- ▶ Performance:
 - ▶ Climate change: 9.37 CO2 Tons
 - ▶ Landfill: 4.5%
 - ▶ Recovered: 42.36%
 - ▶ Beneficial use: 17.20%
 - ▶ Long term storage: %
 - ▶ Unknown: 34.94%

Glass to Ceramic Paste

- ▶ Description: CRT is taken apart in the US and sorted into panel and funnel streams of glass. The coatings are removed using a dry process. The glass processor receives the funnel and panel glass and places into storage for unknown period of time. The glass is eventually crushed and sized accordingly. Information is unclear after this point. It is reported that the recycler delivers the glass with a recipe for making ceramic paste to unknown customers throughout Europe. USA is a large market for EU ceramics
- ▶ Top Concerns:
 - ▶ Lead being introduced into products that don't require lead nor commonly contain lead
 - ▶ Lead content of future products
 - ▶ OSHA lead standard will apply to construction workers cutting tile and in future demolishing tile
 - ▶ No information on downstream customers
 - ▶ Proposition 65 labels
 - ▶ TSCA/CPSC/ROHS/REACH
 - ▶ Climate change impact due to long distance shipping and high temperature process
 - ▶ Human exposure to lead, arsenic, antimony, and barium
 - ▶ Storage time
 - ▶ Proper shipping description when received into EU
 - ▶ Emission filters necessary to protect employees and immediate vicinity.
- ▶ Closure Care: Minor if glass is not speculatively accumulated
- ▶ Performance:
 - ▶ Climate change: 9.37 CO2 Tons
 - ▶ Landfill: 4.5%
 - ▶ Recovered: 40.11%
 - ▶ Beneficial use: 41.54%
 - ▶ Long term storage: %
 - ▶ Unknown: 53.96%

Glass to Alternative Daily Cover

- ▶ Description: CRTs are taken apart and metals are separated for recycling. Glass is blended with stabilizing compound and tested for compliance with the "Land Ban" treatment standards. Treated glass is beneficially reused by substituting for "dirt" and placed on layers of garbage at rate of at least 6 inches. Density of treated glass (1.5 times typical soil) make it highly effective daily cover. Strict permit and EPA oversight. Low climate change impact due to local availability.
- ▶ Top Concerns
 - ▶ Silica and Heavy metals beneficially reused but not recovered
 - ▶ Emission filters necessary to protect employees.
- ▶ Closure Care: Landfills operate with strict requirements. 30 years of active life and 30 years post-closure care with some providing in-perpetuity financing.
- ▶ Performance:
 - ▶ Climate change: 1.96 CO2 Tons
 - ▶ Landfill: 4.5%
 - ▶ Recovered: 43.36%
 - ▶ Beneficial use: 52.14%
 - ▶ Long term storage: %
 - ▶ Unknown: %

Glass to Retrievable Cell

Panel Glass to Reuse/Funnel Glass to Retrievable Cell

- ▶ Description: CRTs are taken apart and metals are separated for recycling. Glass is sorted into panel and funnel. Panel glass is cleaned. Funnel glass is blended with stabilizing compound and tested for compliance with the "Land Ban" treatment standards. Treated funnel glass is placed into a retrievable cell. Panel glass is beneficially used as substitute for aggregate/gravel for applications within the secure landfill. Treated funnel glass (20% lead) is stored similar to slag and will be retrieved for recovery as market conditions change. Strict permit and EPA oversight. Low climate change impact due to local availability.
- ▶ Top Concerns:
 - ▶ Similar to slag. Time in storage is dependent on the commodity market
 - ▶ Emission filters necessary to protect employees.
- ▶ Closure Care: Landfills operate with strict requirements. 40 years of active life and 30 years of post-closure care with some providing in-perpetuity financing.

Performance:

- ▶ Climate change: 1.96 CO2 Tons
- ▶ Landfill: 4.5%
- ▶ Recovered: 40.11%
- ▶ Beneficial use: 38.39%
- ▶ Long term storage: 17%
- ▶ Unknown: %

Glass to RCRA Subtitle C Landfill

- ▶ Description: CRTs are taken apart and metals are separated for recycling. Glass is blended with stabilizing compound and tested for compliance with the "Land Ban" treatment standards. Treated glass is placed into a secure hazardous waste landfill. Strict permit and EPA oversight. Low climate change impact due to local availability.
- ▶ Top Concerns:
 - ▶ No silica or heavy metals recovery
 - ▶ No beneficial reuse
- ▶ Closure Care: Landfills operate with strict requirements. Minimum 30 years of post-closure care with some in-perpetuity financing.
- ▶ Performance
 - ▶ Climate change: 1.18 CO2 Tons
 - ▶ Landfill: 59.89%
 - ▶ Recovered: 40.11%
 - ▶ Beneficial use: %
 - ▶ Long term storage: %
 - ▶ Unknown: %