



2006 CAI / Arnel Danvers Chemical Plant Explosion Analysis

- Key Findings
- E Ink Process Safety Differences

Eink

CAI Danvers Explosion Review & Comparison to E Ink Operations

- In the 3/14 South Hadley Planning Board meeting, a community member referenced an industrial explosion at CAI & Arnel in Danvers in 2006.
- There was a request for E Ink to consider this accident and identify how E Ink operational practices promote safe operation, in contrast to this facility.
- E Ink staff investigated this incident via the US Chemical Safety and Hazard Investigation Board (CSB) report*.
- E Ink’s review found the conditions at the CAI & Arnel plant in 2006 were quite different than conditions at E Ink’s current facility and planned facility expansion:

Safety Category	CAI & Arnel (2006)	E Ink
Chemicals	Heptane, several others	Toluene, Isopar E, several others (not Heptane)
Process & Safety Controls	Insufficient Controls	Sufficient Controls
Flammable Liquid Permits	None	Currently permitted, will request new 70k gallon permit
Federal & MA Chemical Safety Laws	Gaps in laws in 2006 – insufficient safety checks	Strong safety regulations to check safety compliance

2 * Report link: [Microsoft Word - Danvers Report Final.doc \(csb.gov\)](#)

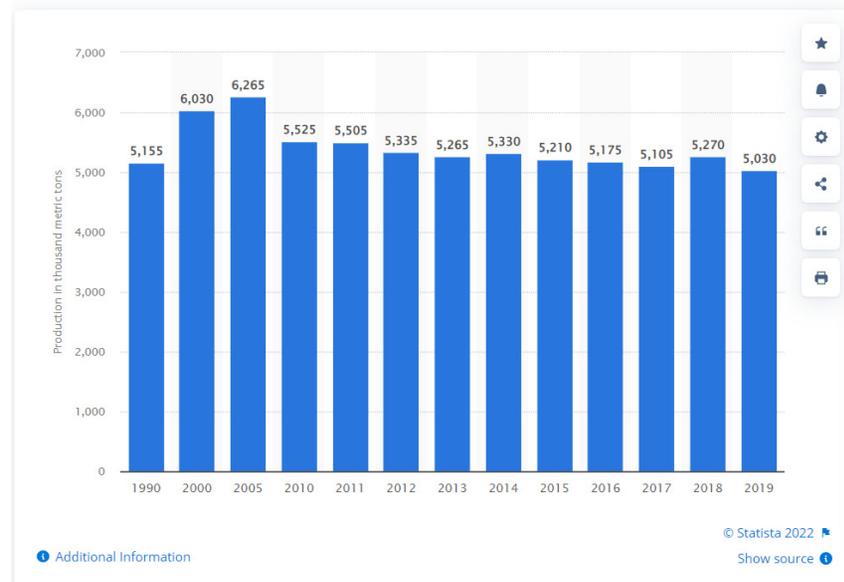
Toluene is a common solvent used widely in the US

- Toluene is a common solvent used in many products
 - Paints, paint thinners
 - Nail polish
 - Rubber, plastics
 - Pharmaceuticals, medicine
 - Lubricants, detergents
- Toluene is so common, you can buy it at Sherman Williams
- E Ink's robust process and safety protocols will enable safe handling of this common solvent

Over 5 million tons of Toluene is produced in the US every year (1990-2019)

[Chemicals & Resources](#) > [Chemical Industry](#)

Toluene production in the United States from 1990 to 2019
(in 1,000 metric tons)



Source: Statistica.com

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2006 CAI & Arnel Danvers Incident

Description:

- “During the early morning hours of November 22, a powerful explosion destroyed the CAI/Arnel ink and paint manufacturing facility in Danvers, Massachusetts. Scores of nearby homes and businesses were damaged, some beyond repair. A number of residents were hospitalized. There were no injuries in the plant, which was unoccupied at the time.” ([CAI / Arnel Chemical Plant Explosion | CSB](#))

The CSB identified 4 key Process & Safety Control findings at CAI & Arnel that contributed to this explosion

- These 4 findings are described in the following pages
- E Ink’s comprehensive Process and Safety Controls are compared to each finding.

2006 CAI & Arnel Danvers Compared to E Ink Operations

CSB Safety & Process Control finding for CAI & Arnel 2006 operation:

1. The steam valve on the mix tank 3 heater was inadvertently left open overnight. High temperature steam continued flowing through the heating jacket and heated the mixture to its boiling temperature.
2. The mix tanks were not equipped with automatic controls to prevent overheating the mixture when the process was unattended.

CAI & Arnel	E Ink
<ul style="list-style-type: none">•Unattended processes were left on overnight.•No automated controls to prevent overheating.	<ol style="list-style-type: none">1. E Ink continuously monitors all process operations with heat inputs.2. E Ink currently uses and will continue to use automated process controls, alarms, and safeguards when operating our equipment.3. These systems will include controls to prevent overheating and over pressurization of vessels containing hazardous materials.4. E Ink facility is staffed 24/7/365 to ensure proper response to any process alarms.5. Automated alarm text messaging is in place for key staff.



Automated process control with visual, audio and text message alarm capability

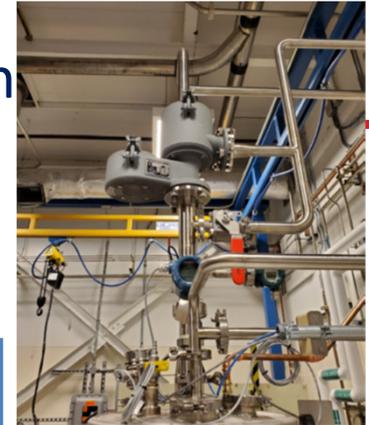
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2006 CAI & Arnel Danvers Compared to E Ink Operation

CSB Safety & Process Control finding for CAI & Arnel 2006 operation:

3. The mix tanks were not designed to be sealed and were not equipped with piping to direct flammable vapor safely out of the building. Flammable vapor flowed unabated out of the top hatch into the production area.

CAI & Arnel	E Ink
<ul style="list-style-type: none"> • Chemical vapor venting into process area. 	<ol style="list-style-type: none"> 1. In areas where hazardous chemicals are present, E Ink will utilize “always on” process ventilation with emergency power backup for this facility. 2. No process ventilation will be released within the building – it will be routed to external pollution control equipment. 3. The ventilation system & process areas will have flammable vapor monitors & alarms to notify E Ink of any hazards & enable corrective action. 4. E Ink has and will continue to use oxygen-monitoring systems to ensure employee safety. 5. E Ink has and will continue to have emergency power backup for critical process systems to enable safe shut down in case of power outage. 6. E Ink’s processes incorporate and will continue to incorporate fail-safe equipment and battery backup for process controls.



Controlled Process Vent



Flammable vapor monitor



Oxygen monitor

2006 CAI & Arnel Danvers Compared to E Ink Operation

CSB Safety & Process Control finding for CAI & Arnel 2006 operation:

- CAI personnel turned off the building ventilation system at night when the building was unoccupied, allowing flammable heptane vapor, alcohol vapor, or a combination of the two to accumulate to a near-ideal explosive concentration that was ignited by an unknown ignition source.

CAI & Arnel	E Ink
<ul style="list-style-type: none"> Facility ventilation turned off at night, allowing flammable heptane vapor to build up. 	<ol style="list-style-type: none"> In areas where hazardous chemicals are present, E Ink will utilize “always on” process ventilation with emergency power backup for this facility. No process ventilation will be released within the building – it is routed to external pollution control equipment. The ventilation system & process areas will have flammable vapor monitors & alarms to notify E Ink of any hazards & enable corrective action. E Ink has and will continue to use oxygen-monitoring systems to ensure employee safety. E Ink has and will continue to have emergency power backup for critical process systems to enable safe shut down in case of power outage. E Ink’s processes incorporate and will continue to incorporate fail-safe equipment and battery backup for process controls.



Controlled Process Vent



Flammable vapor monitor



Oxygen monitor

2206 CAI & Arnel Danvers Explosion

Flammable Liquid Storage findings:

1. CAI and Arnel did not have fire department-issued permits for storing the flammable liquids inside the building or the flammable solids outside, as required by the Massachusetts Board of Fire Prevention Regulations.
 1. E Ink has a flammable liquid storage permit with the South Hadley Fire Department.
 2. E Ink invites the South Hadley Fire Department in to tour the facility for review processes and to remain familiar with the site layout and operation.
 3. E Ink notifies the South Hadley Fire Department when any building modifications are made.
 4. The proposed new facility and tank farm do not change, increase, or modify the oversight burden on the South Hadley Fire Department.

2206 CAI & Arnel Danvers Explosion

Flammable Liquid Storage findings:

2. CAI flammable liquids storage inside the building did not conform to OSHA and Massachusetts fire code requirements.
 1. As part of the flammable solvent annual renewal process, E Ink retains a MA Registered Professional Architect/Engineer to review the property/building to determine compliance with the MA State Fire Code and MA State Building Code as well as the Town's Permit and License Restrictions.
 2. E Ink maintains a record of on-site flammable solvents.
 3. This record is shared to the South Hadley Fire Department as part of our annual flammable storage permit process.
 4. The proposed new facility and tank farm do not change, increase, or modify the oversight burden on the South Hadley Fire Department.

A list and explanation of applicable fire codes is contained in the appendix

2006 CAI & Arnel Danvers Explosion

Insufficient 2006 Fire Code findings:

1. “The Massachusetts fire code does not specify a frequency for local fire department inspection of indoor flammable liquids storage areas. More than four years had elapsed since the CAI/Arnel facility storage was inspected by the Danvers fire department.”
 1. Per the updated fire code, the South Hadley Fire Department reviews the annual flammable storage permit and visits E Ink as deemed necessary.
 2. Typically the South Hadley Fire Department is onsite at E Ink for inspection purposes multiple times per year.
2. “The Massachusetts fire code does not require companies that handle flammable and combustible liquids to apply the Flammable and Combustible Liquids Code (NFPA 30), or require organic coatings manufacturers that use flammable and combustible liquids to apply The Standard for the Manufacture of Organic Coatings (NFPA 35).”
 1. National Fire Protection Association’s NFPA 30 – (Flammable and Combustible Liquids Code, 2015 Edition) currently applies to this facility.
 2. E Ink is in compliance with NFPA 30.

2006 CAI & Arnel Danvers Explosion

Insufficient 2006 Fire Code findings:

3. “Massachusetts law does not require re-licensing the land, convening a public hearing to consider the risks to the public, or notifying affected landowners when a licensee increases the quantity of flammable materials above the licensed amount.”
 1. MA state law now requires licensing or permitting for flammable storage.
 2. E Ink is in compliance with the flammable storage permit.
 3. E Ink will request an increased flammable storage license as part of this project.
 1. The South Hadley Fire Chief and Select Board review and approve this type of application.

2006 CAI & Arnel Danvers Incident Appendix

Updated Safety Regulations:

- 527 CMR 1.00 – Massachusetts Comprehensive Fire Safety Code (MCFSC), based on NFPA 1 Fire Code, 2015 Edition with MA amendments which requires the following:
 - The Annual Renewal Process requires the property owner retain a MA Registered Professional Architect/Engineer to review the property/building to determine compliance with the MA State Fire Code and MA State Building Code as well as the Town's Permit and License Restrictions.
 - As per Section 60.8.5 Compliance Requirements (MCFSC) Facilities operating hazardous materials processes as defined by this code shall maintain, for each process in their facility, the following required documents and procedures at their facility for periodic inspection and review by the Head of the Fire Department to remain in compliance with this section. Note: there are (5) five hazard categories which are defined by type of material and scale which require Process Documentation and Analysis.

Additional safety regulations listed on the following pages

2006 CAI & Arnel Danvers Incident Appendix

Current Building and Fire Codes that apply to the new E Ink facility:

- 780 CMR – 9th Edition, Massachusetts State Building Code (MSBC), based on the 2015 International Building Code (IBC) with MA amendments
- 780 CMR 34.00 – Existing Building Code of Massachusetts, based on the 2015 International Existing Building Code (IEBC) with MA amendments
- 527 CMR 1.00 – Massachusetts Comprehensive Fire Safety Code (MCFSC), based on NFPA 1 Fire Code, 2015 Edition with MA amendments
- National Fire Protection Association Standards as referenced in 780 CMR and 527 CMR:
 - o NFPA 30 – Flammable and Combustible Liquids Code, 2015 Edition

2006 CAI & Arnel Danvers Incident Appendix

Current Permits that apply to the new E Ink tank farm:

- 527 CMR 1.00 Table 1.12.8.40 requires a permit to construct aboveground storage tanks (ASTs) containing a fluid other than water exceeding 10,000 gallons. This AST permit is required in addition to the flammable liquid license described above. The process for obtaining this permit is as follows:
 - The AST permit applications are reviewed by the office of the Massachusetts State Fire Marshall.
 - Before submitting the AST permit application, the landowner shall already have obtained the land license and the flammable liquid license (if applicable).

Note: As part of E Ink's tank farm research and outreach, Captain Houle (South Hadley Fire Prevention Officer) and Jake Nummemacher (with the MA State Fire Marshall's Office) met at the site to review the tank farm with Tony Vinciguerra (E Ink's Manager: Environmental, Health and Safety).