Converting an Ice-Storage Plant from Ammonia to Traditional Refrigerant

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CAMPUSENERGY2017

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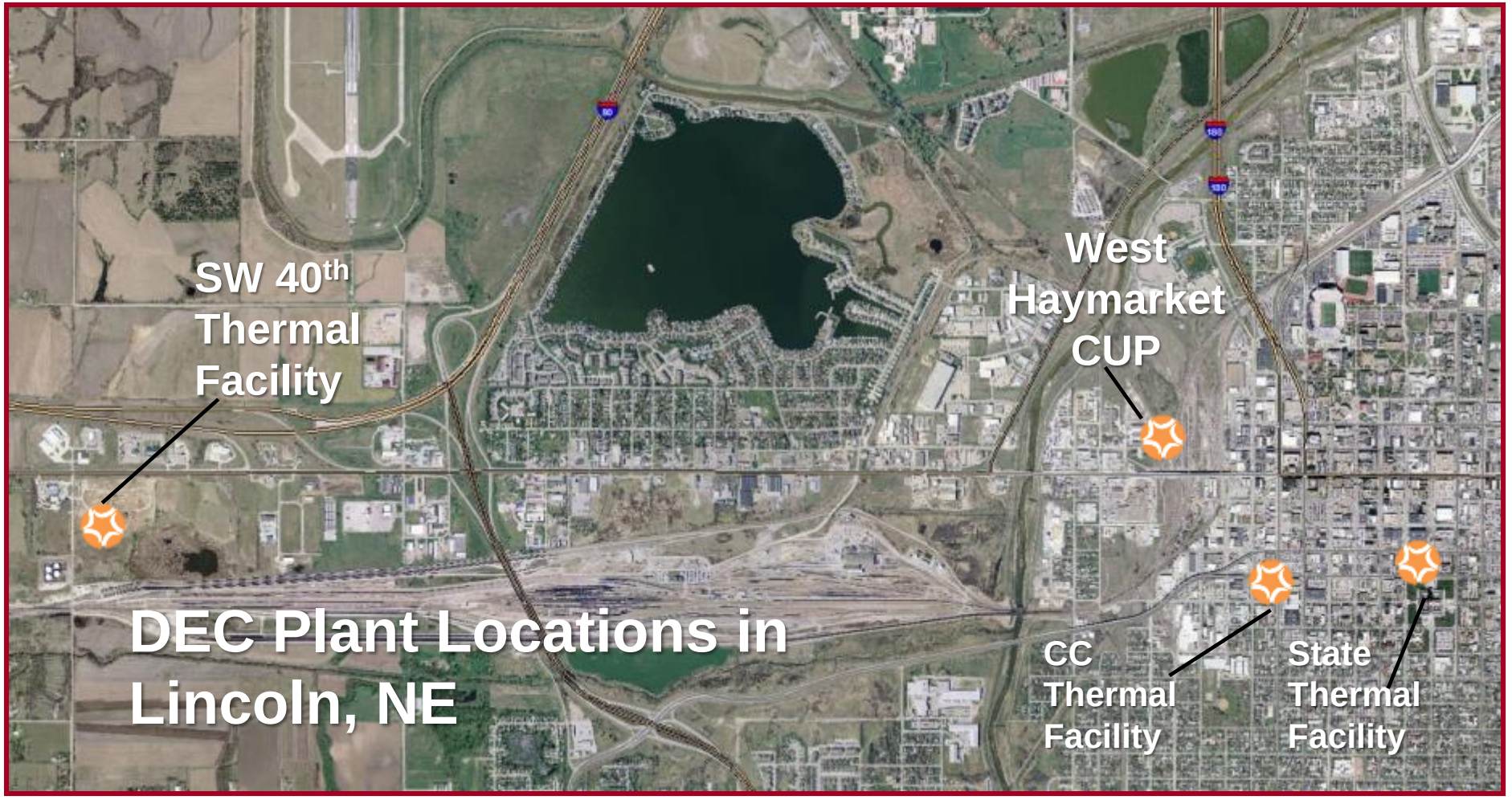
DEC ENERGY

FARRIS ENGINEERING

Agenda

- Background
- Evaluation
- Scope
- Modifying the Ice Tanks
- Construction
- Energy Use
- Lessons Learned

Background


SW 40th Thermal Facility
West Haymarket CUP
DEC Plant Locations in Lincoln, NE
CC Thermal Facility
State Thermal Facility

Background

- District Energy Corporation (DEC) is a non-profit corporation and inter-local agency formed by the City of Lincoln and Lancaster County in 1989 for the purposes of
  - constructing
  - financing
  - furnishing
  - operating & maintaining

  thermal energy facilities for providing heating, cooling, and related services to its customers
- Managed by local public power utility Lincoln Electric System
- Originally formed because of a County project to build a then new jail located next to the City/County admin building. New cooling equipment was required for jail as well as an upgraded cooling system for County/City building

Background

City/County Plant was designed to use saline well water as once through heat sink

Water discharged into a naturally occurring saline water way

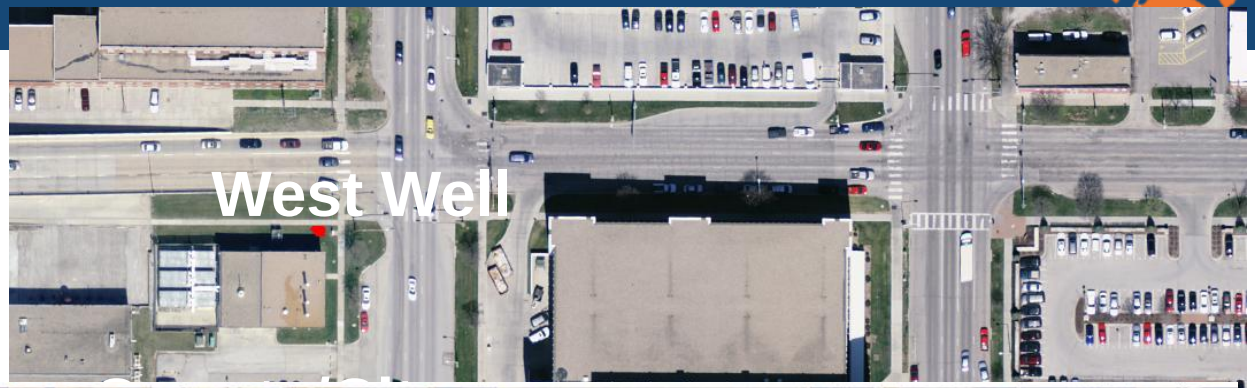
NDEQ issued order to stop discharging west well into storm sewer

- Chloride (salt) content too high to discharge into Salt Creek (800 ppm limit)
- Discharges had to stop by 7/1/2014

Various options were investigated including using East Well but testing indicated gradual increase of chlorides

Required installation of cooling tower, which decreased plant efficiency

Concurrently to the heat sink evaluation, DEC continued its investigation to further mitigate risk related to an ammonia release



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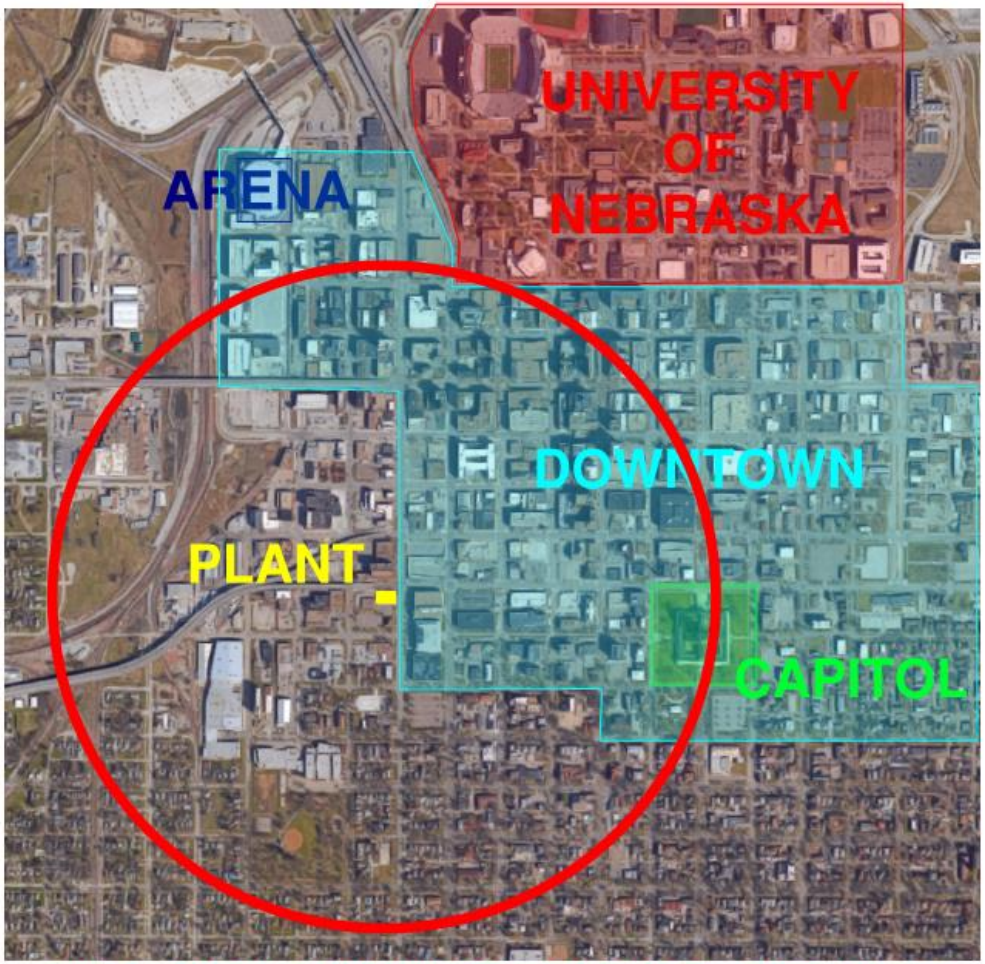
Evaluation



EPA ALTERNATE SENARIO ~910 YDS

Evaluation

- CC TEF Ammonia System Replacement
  - ***Option 1***: Replace existing ammonia system with packaged chillers using conventional refrigerant
  - ***Option 2***: Keep ammonia system and install an ammonia suppression system

Ammonia system installed 1991 and 1997

Evaluation – Option 1

- Replace Ammonia Chillers with R-134a Chillers
  - Advantages
    - Conventional Refrigerant
    - Higher Efficiencies
    - Preserve Ice Capability
    - Compact Footprint (more readily available to expand its cooling capacity)
  - Disadvantages
    - Higher up Front Cost
    - Slightly less Ice Storage

Evaluation – Option 2

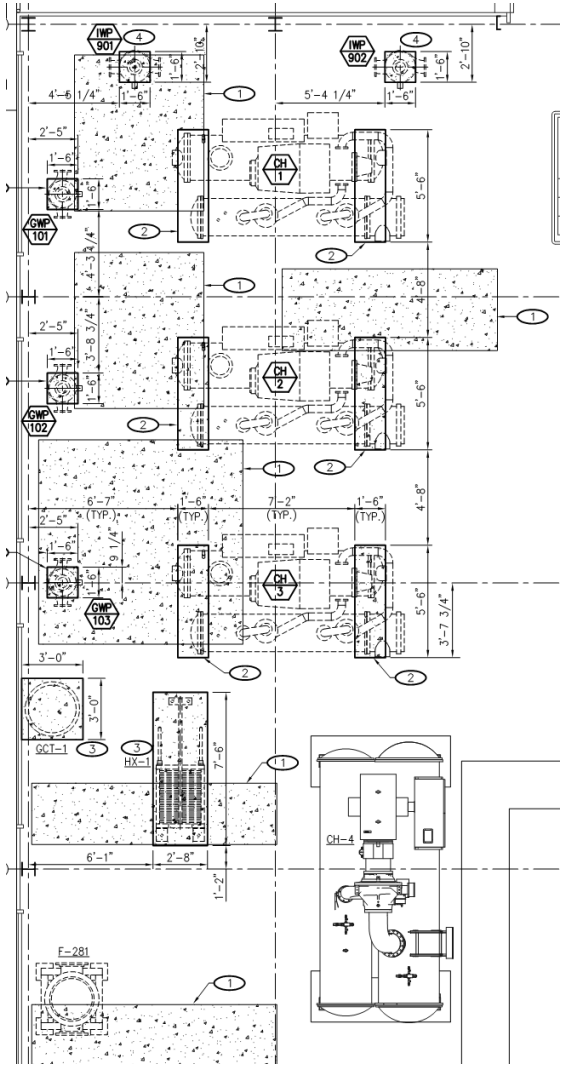
- Ammonia Suppression System
  - Advantages
    - Preserves full ice capability
    - Lower up front cost
  - Disadvantages
    - Equipment near End of Life
    - No Improvement in Efficiency
    - Limited Space in Plant (couldn't readily expand capacity)
    - O&M more difficult; requires system specific knowledge and experience
    - Ammonia/Water mix upon suppression system activation cannot be effectively contained & properly discharged
    - Does Not Eliminate Risk of Ammonia Release & Risk Management Program would need to continue

Scope

Units of Tons	Ammonia System	Replacement Studied	Installed	Existing Centrifugal
Chiller Capacity	869	750	1122	500
Ice Build Capacity	530	342	586	na
Firm Capacity	592	500	748	na

Scope

- Primary Scope of Project
  - Remove components of ammonia refrigeration equipment (compressor, receivers, chiller bundle, etc.)
  - Install 3 new packaged rotary screw chillers for use in chilled water or ice production
  - Reuse ice storage tanks-replace ammonia liquid overfeed with glycol



Scope

- Additional Scope
  - Need for an additional cooling tower cell based on load additions noted earlier
  - Updated electrical equipment (deferred from cooling tower project)
  - Building modifications for to improve accessibility and to better accommodate future growth
  - New, secured I/O (comm.) room


New Cooling Tower


New Pump

Construction

Removal of ~ 13,500 pounds of ammonia from site; note fire truck on stand-by

Construction

Removal of ammonia chiller bundle; both views looking Northeast

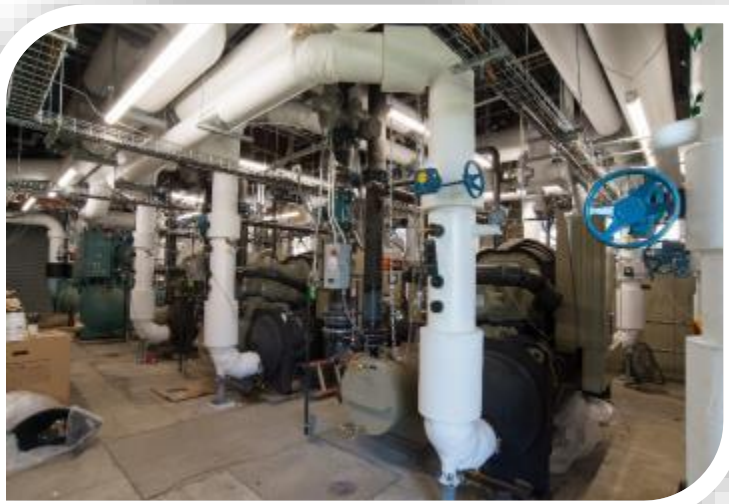
Construction

Construction

Before

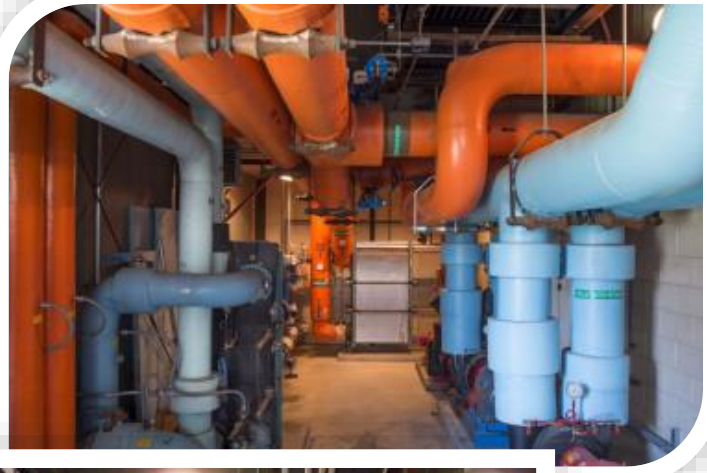
End

During



Construction

Before

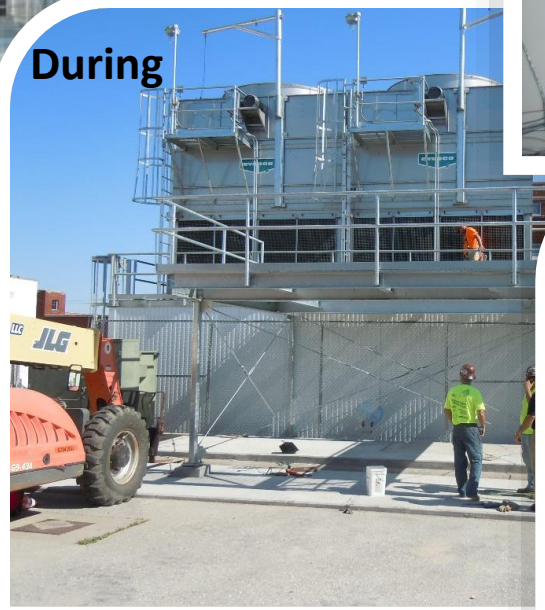


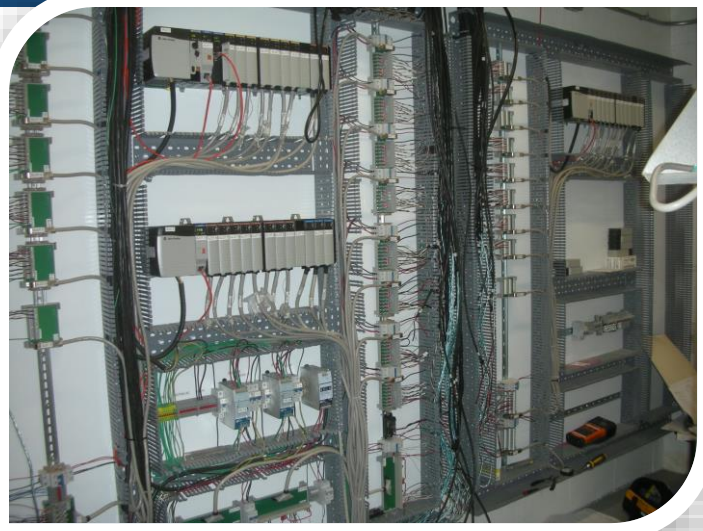
During

End

Construction

Construction

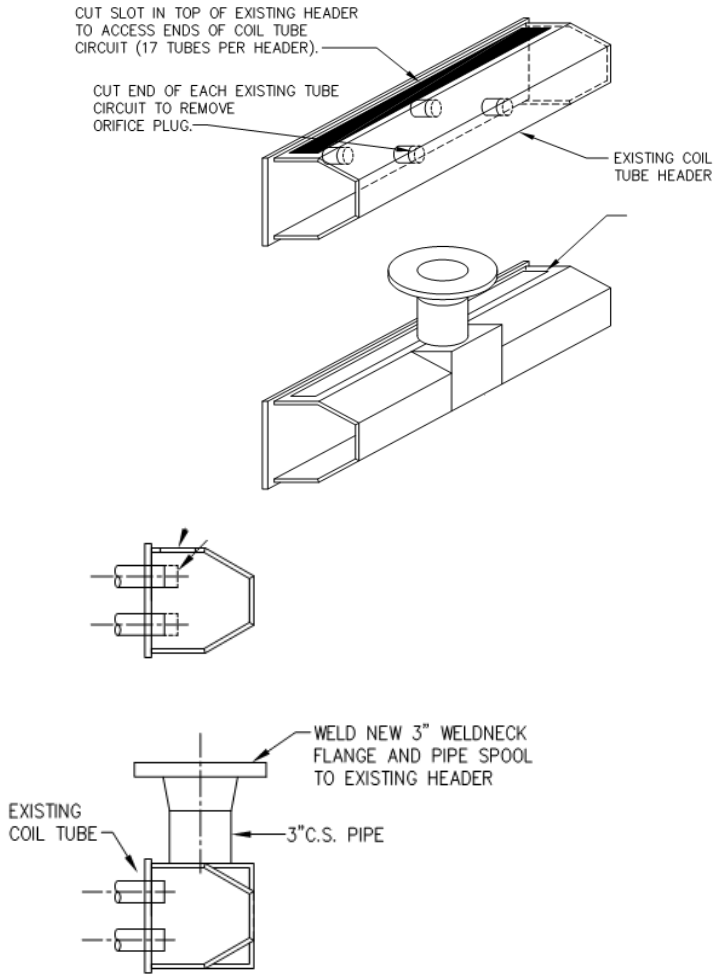




New Comm. Room

Modifying the Ice Tanks

- Using Ammonia
  - Total (3 Tanks) 4,584 ton-hrs or 382,000 lbs ice with a 12.5 hour build time
- Using Glycol
  - 4,240 Ton-Hours ton-hrs reduction of 7.5%
  - Due to less uniform temperature profile for the glycol and uneven ice build.



Energy Use

Year	Electrical Use KWH	Electrical Demand KW	Cooling Degree Days	Equipment
2013	520,500	445.5	949	Wells, NH_3
2014	515,500	713.35	860	Cooling Tower, NH_3
2015	545,000	670.65	883	Cooling Tower, NH_3
2016	618,500	771.00 - 731.1 - 726.8	1146	Cooling Tower, R-134a

- Data for months of June, July, and August only.
- Time of Day Rate implemented at start of 2014.

Lessons Learned

- Ice tanks do not work in reverse flow efficiently
- Weld requirements
- Major component factory testing
- Variable speed chillers have less turn-down in ice mode than advertised
- Scheduling for equipment lead times and installation: tight window for construction prior to operating season

Questions