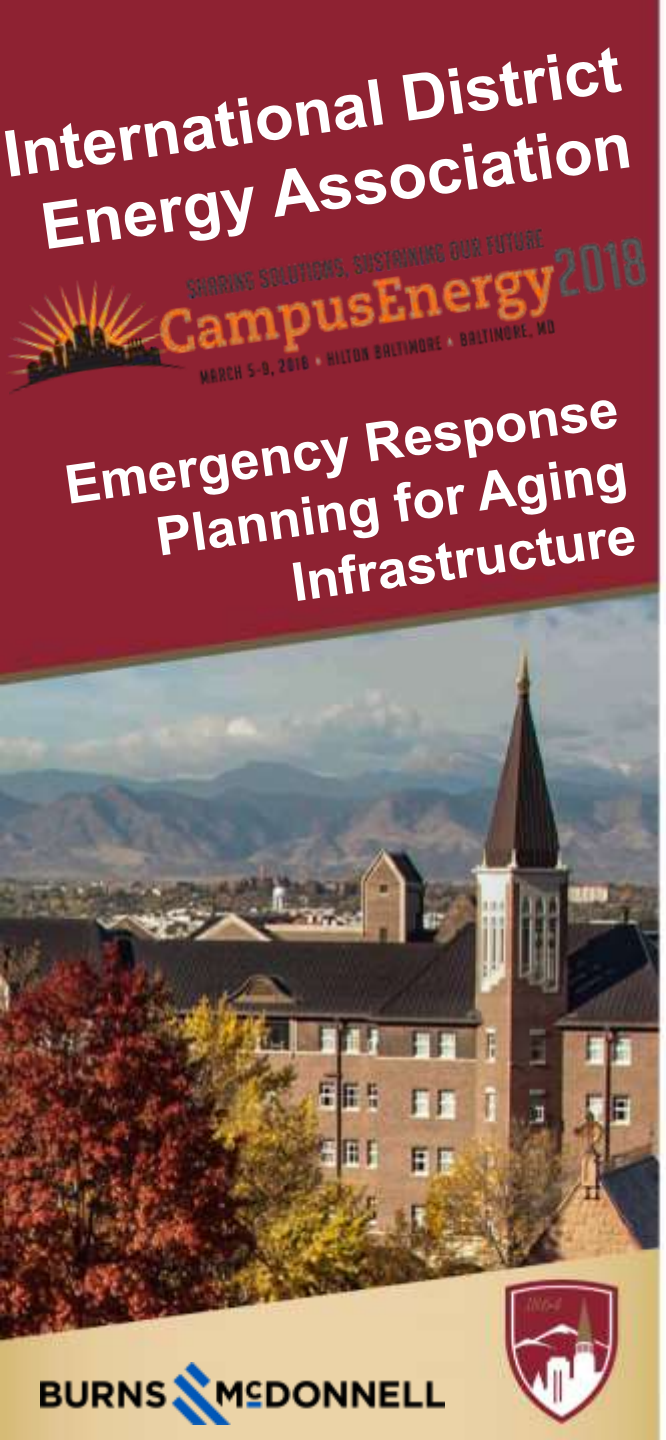
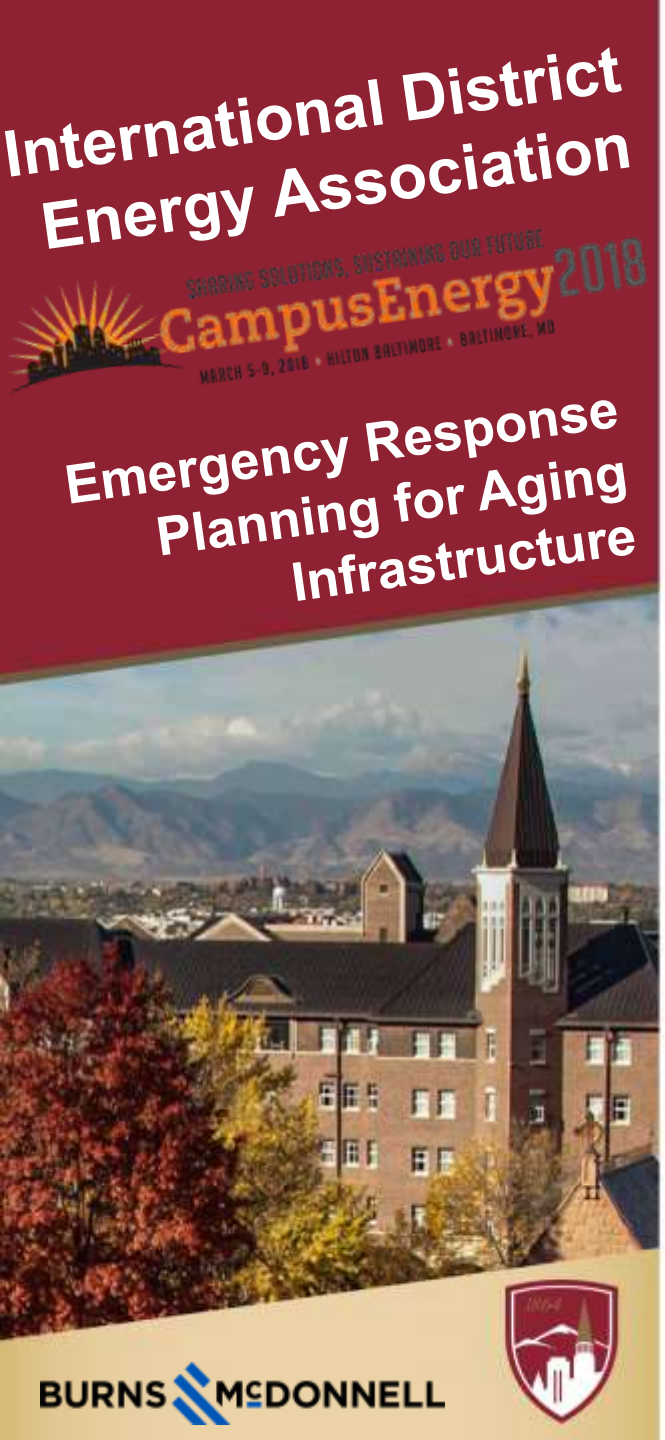


Emergency Response Planning for Aging Infrastructure

March 7, 2018

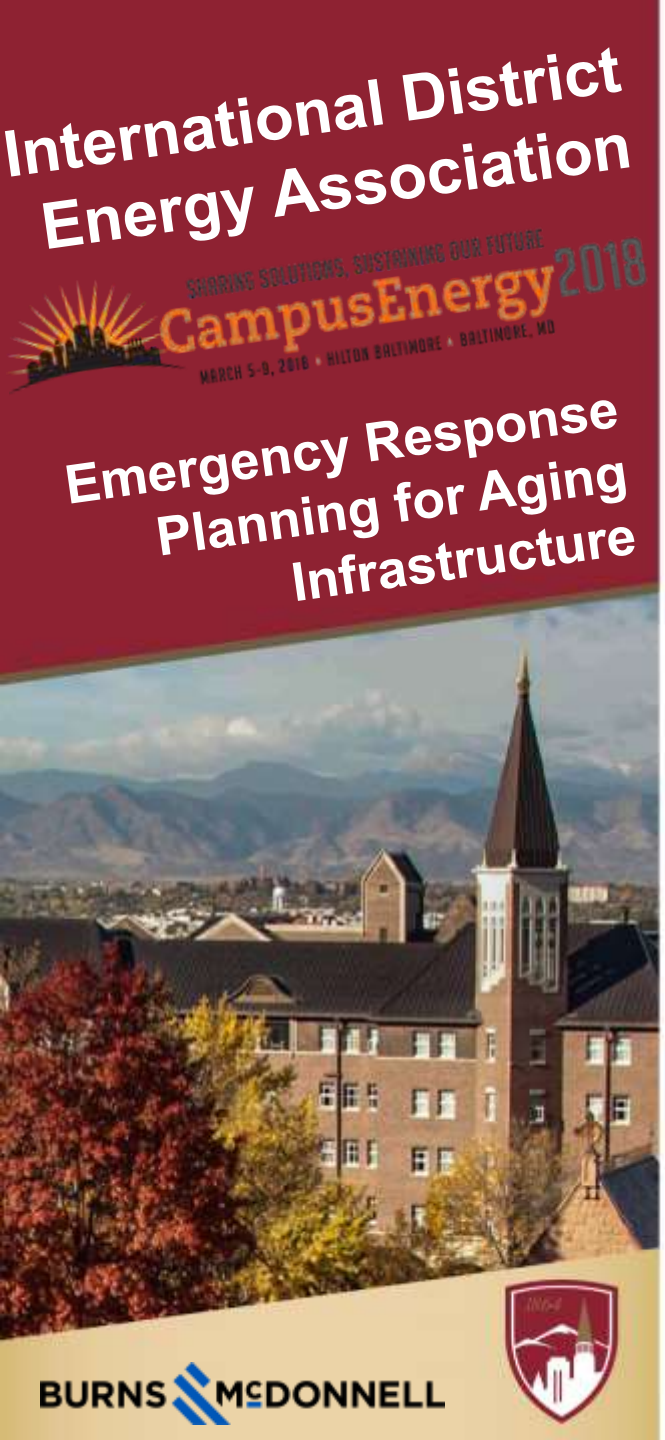
James Rosner, P.E. Associate Vice Chancellor

Jeff Easton, P.E. Project Manager



Agenda

- DU History / Campus Description
- Motivations for Contingency Planning
- Project Goals
- Approach
- Proof of Theory
- Putting into Practice

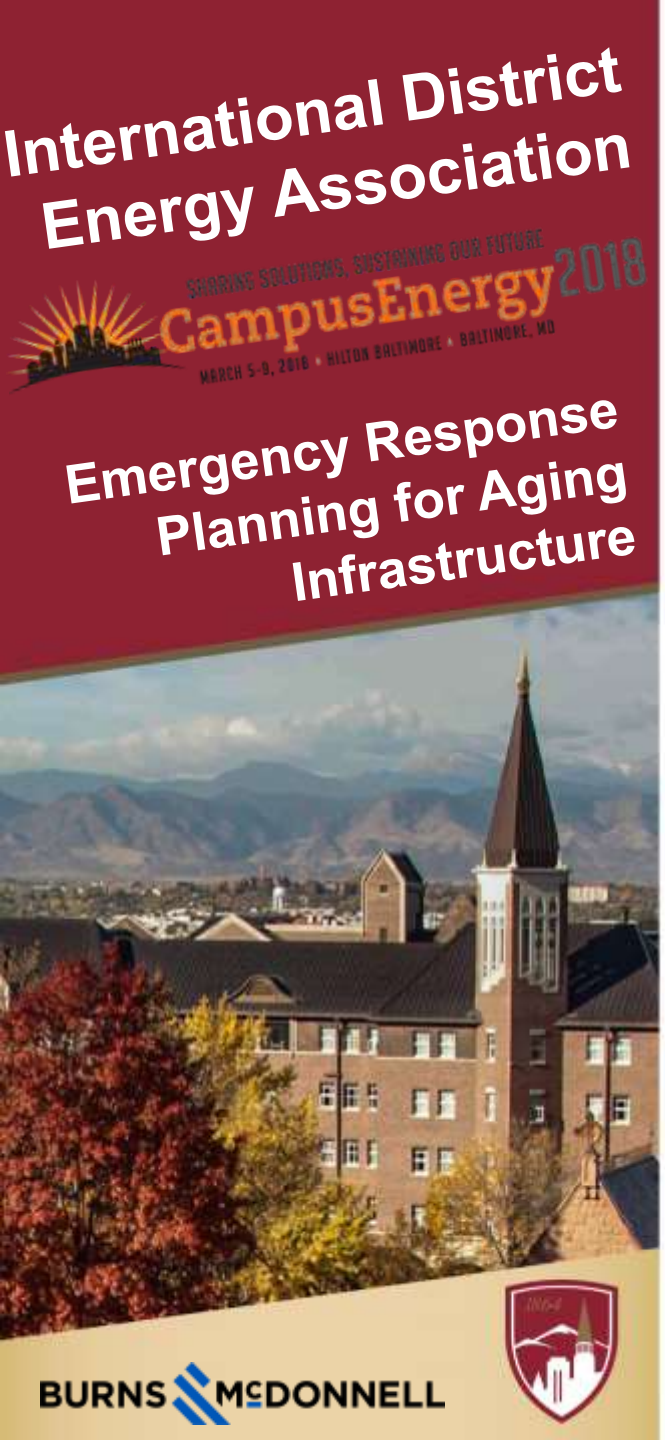


University of Denver (DU)

- Founded in 1864 as Colorado Seminary in then the Colorado Territory
- 3.8 million square feet over 125 acres in the City of Denver
- 11,500 students & 3,800 staff/faculty
- Campus is a working Arboretum
- Great Private University dedicated to the Public Good

University Hall: 1864

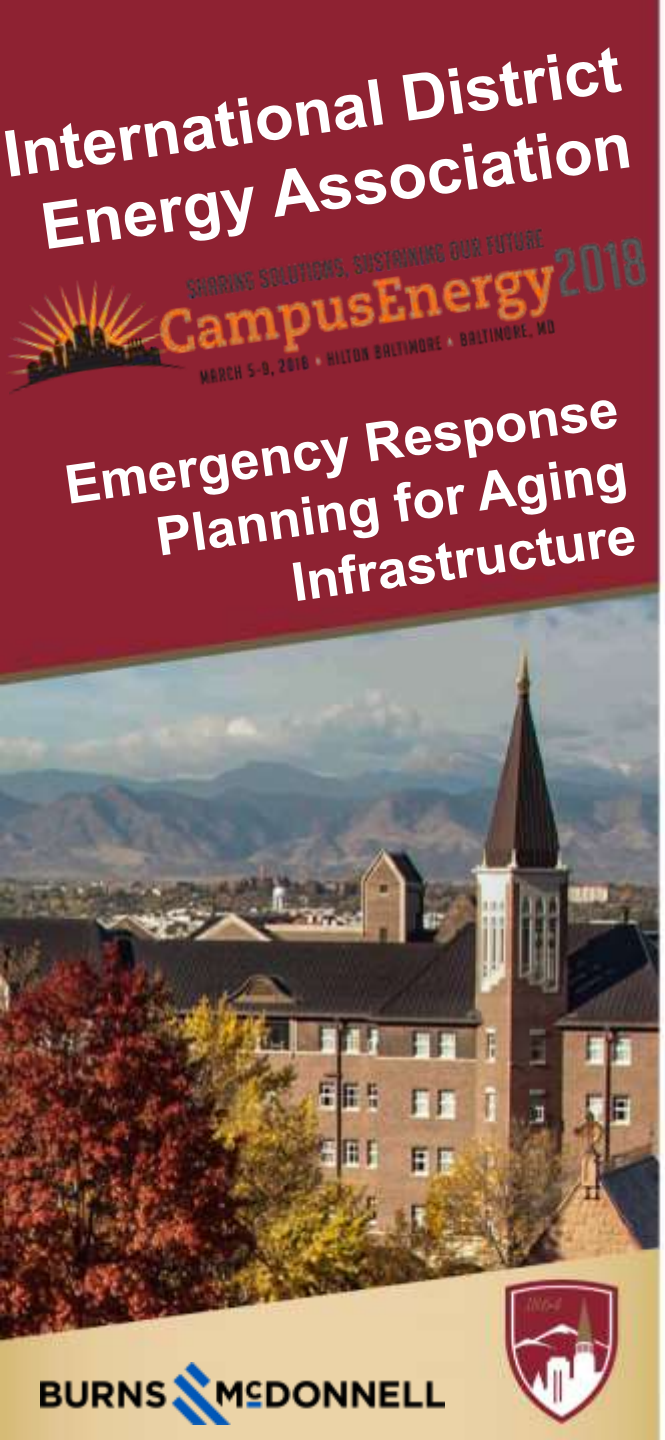
Engineering/Computer Science: 2017



DU Campus Description

- 4 Portfolio Building Categories:
  - Millenium, Legacy, Beneficial, Transition
- 71% buildings < 25 year renovation age
- Improvements despite growing campus since 2006:
  - -18% electrical consumption and -19% MTCDE
  - +6% GSF and +7% FTE
- 18 of 88 Buildings on Central Plant
- Majority on Stand-Alone systems
- Individual Electric Meters

DIVERSE CAMPUS, FLEXIBLE APPROACH



Motivations

- Aging Distribution Infrastructure
- Lack of Building-Level Redundancy
- Major Disaster NOT required

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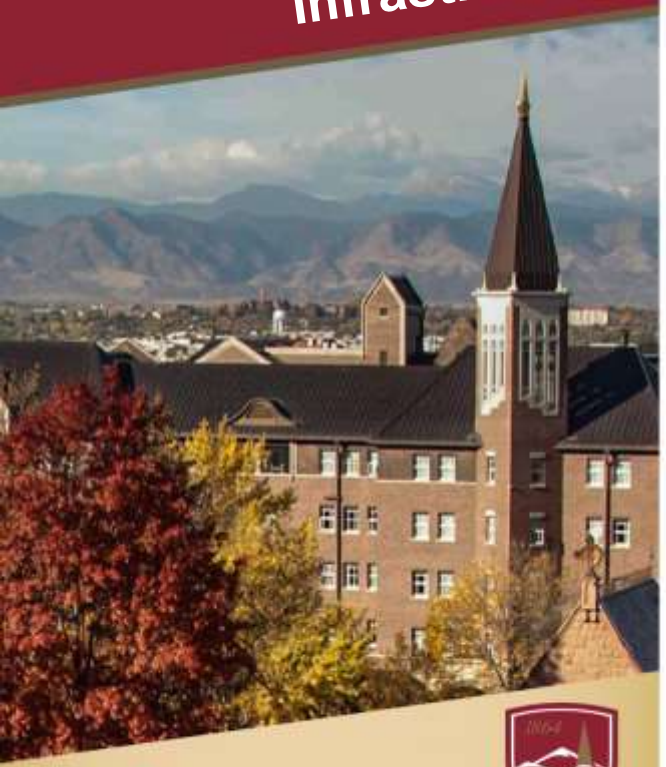
Emergency Response Planning for Aging Infrastructure



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Motivations

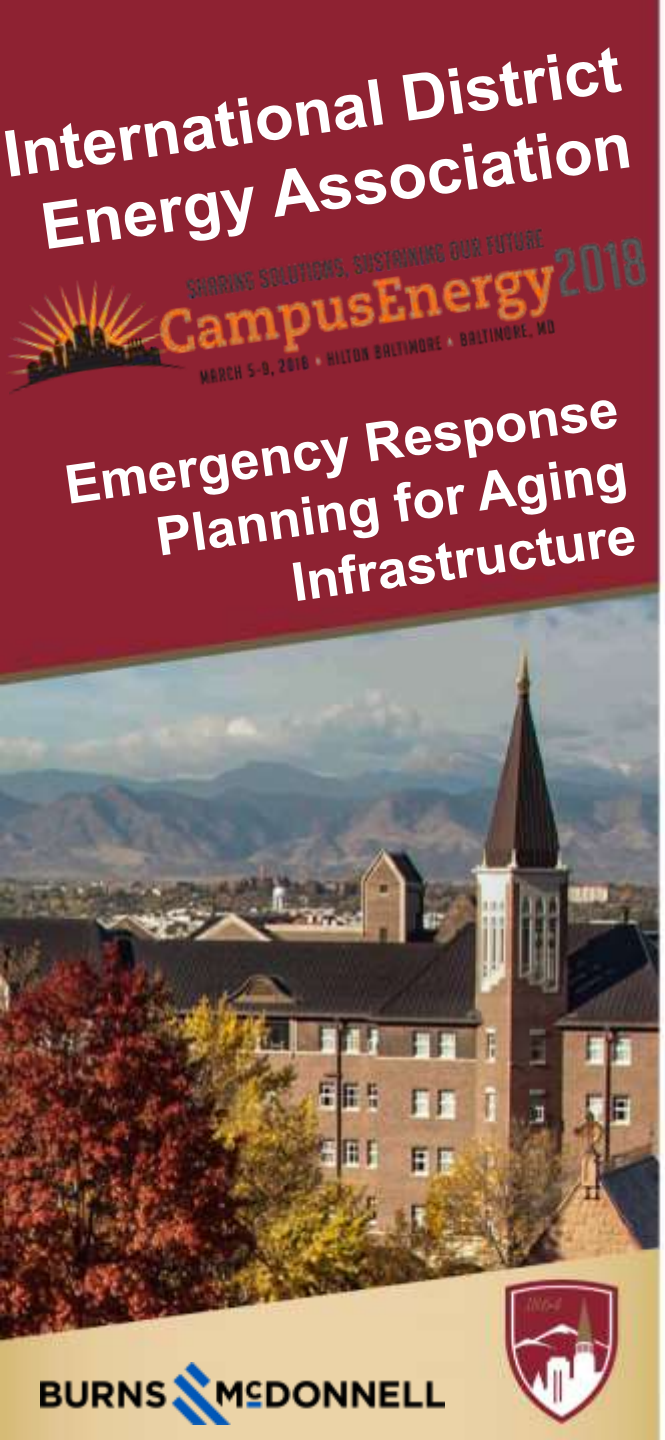
- 3 Failures in 3 Months

3 Building Heating Outage
-Steam Distribution failure

Centennial Towers: 600 bed Dorm
-Electrical Single Phasing

Mary Reed Administration Building
-Steam Distribution failure

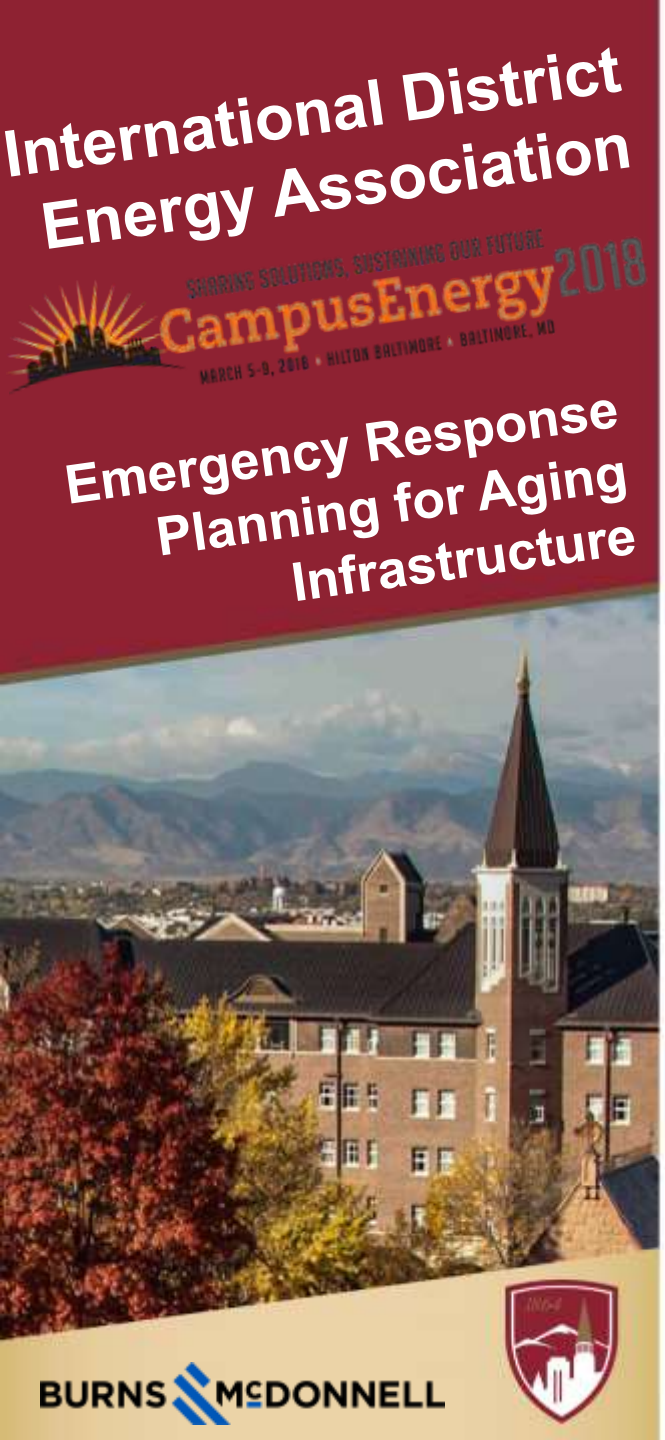
PREDICTABLE REACTION TO DOWNTIME



Project Goals

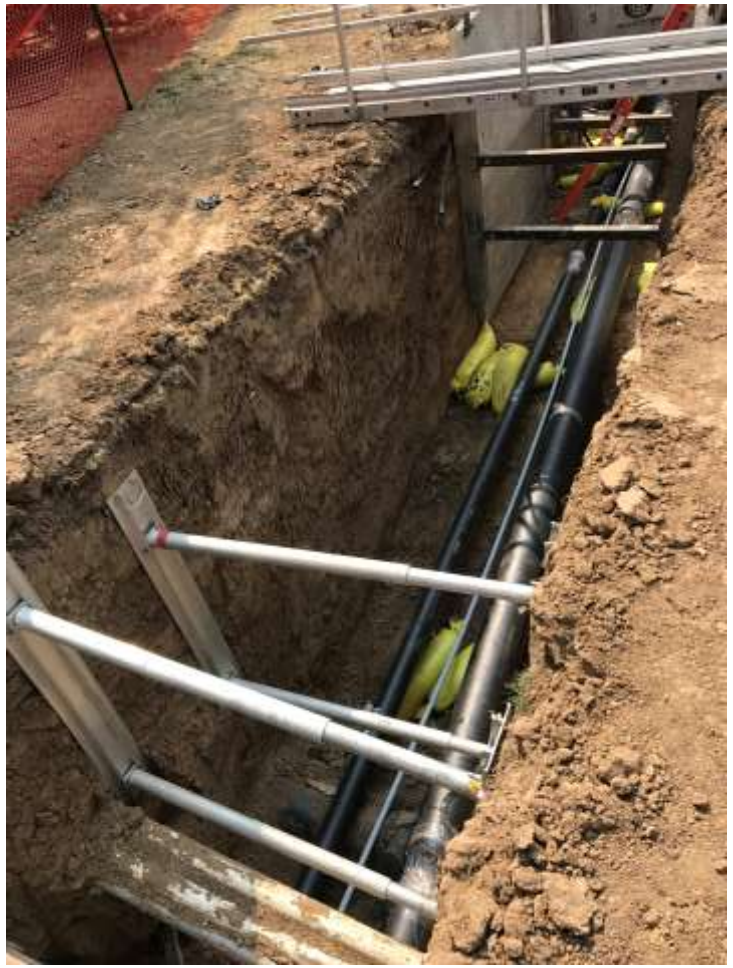
- Cover critical buildings
- Provide QUICK and SIMPLE direction
  - Heat of the Moment!
- Modifiable and Expandable
- Same sheet of music for:
  - DU Emergency Operations Center
  - DU Facilities Management
  - Remediation/Recovery Contractors

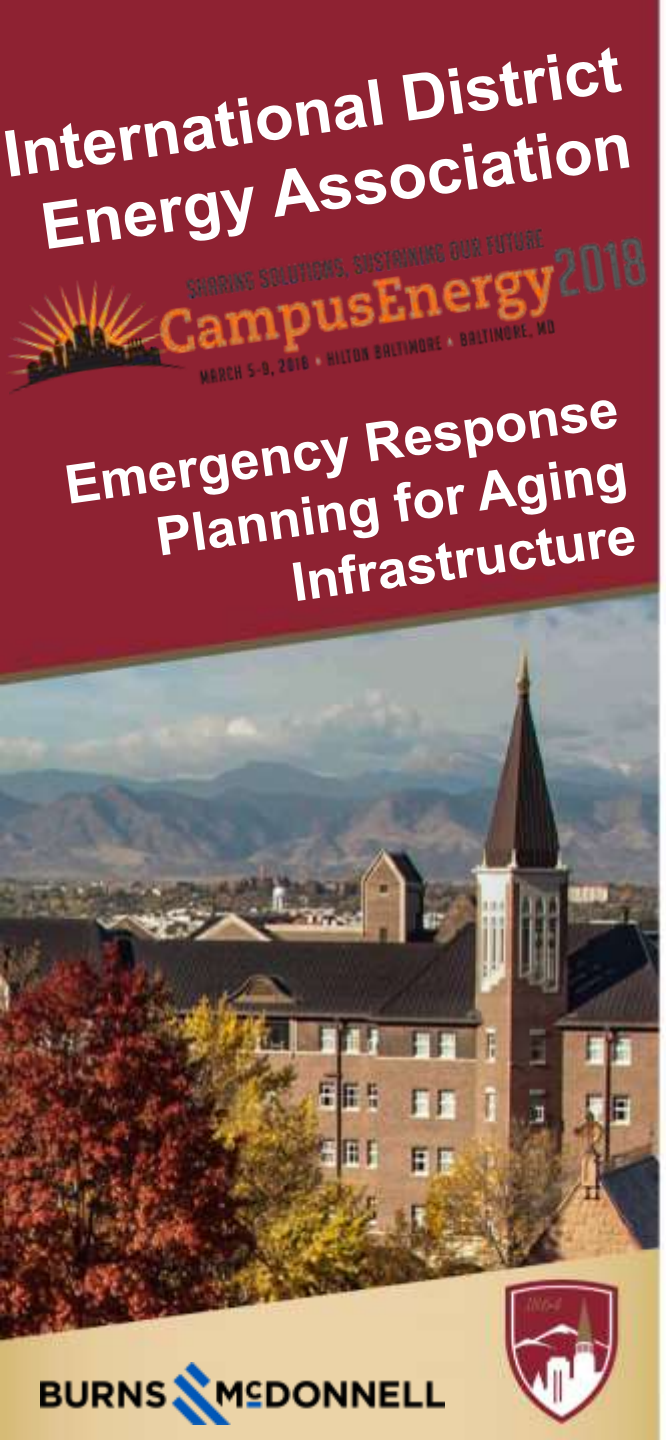
GOAL: MINIMIZE BUILDING DOWNTIME



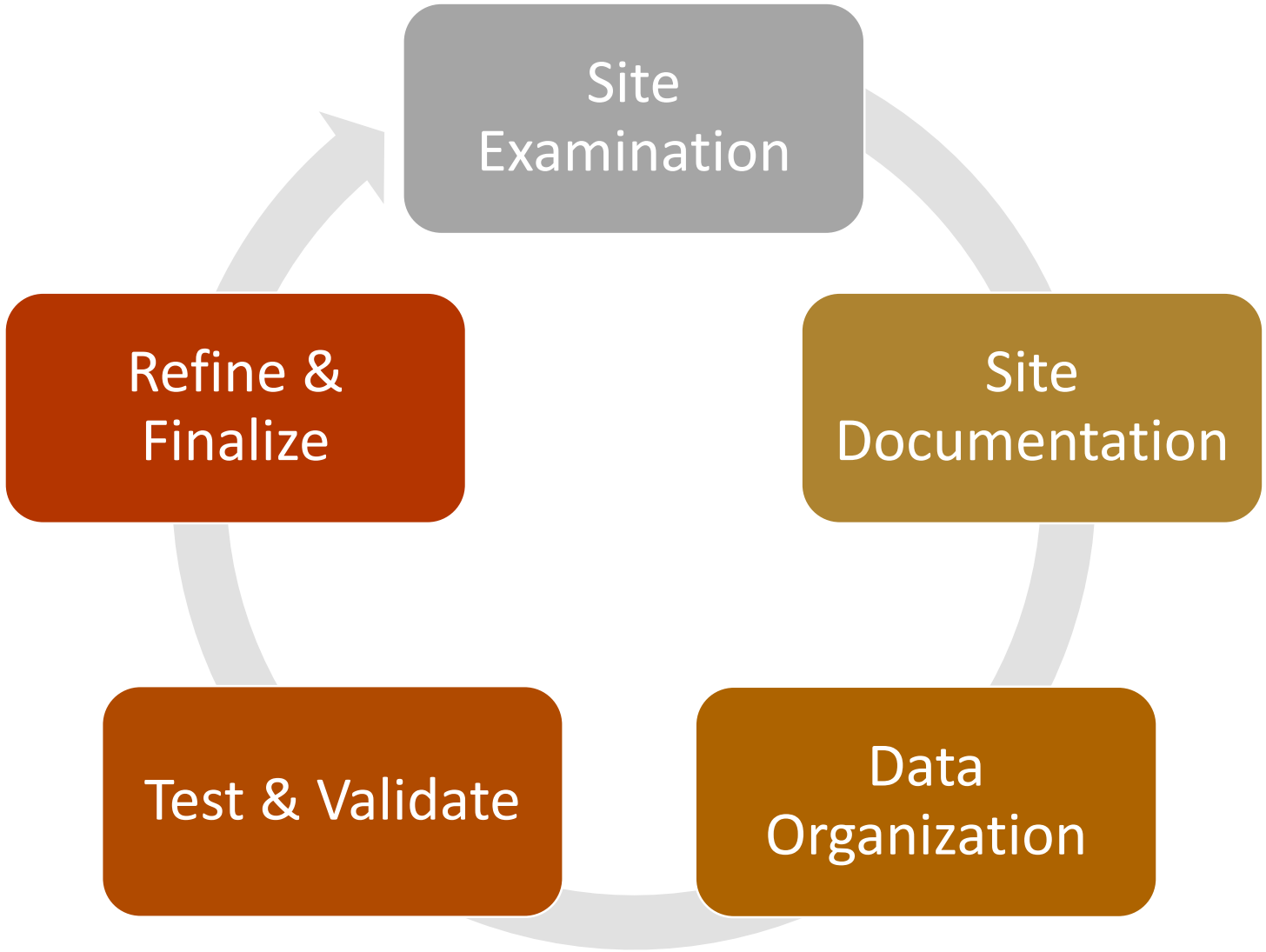
Project Approach

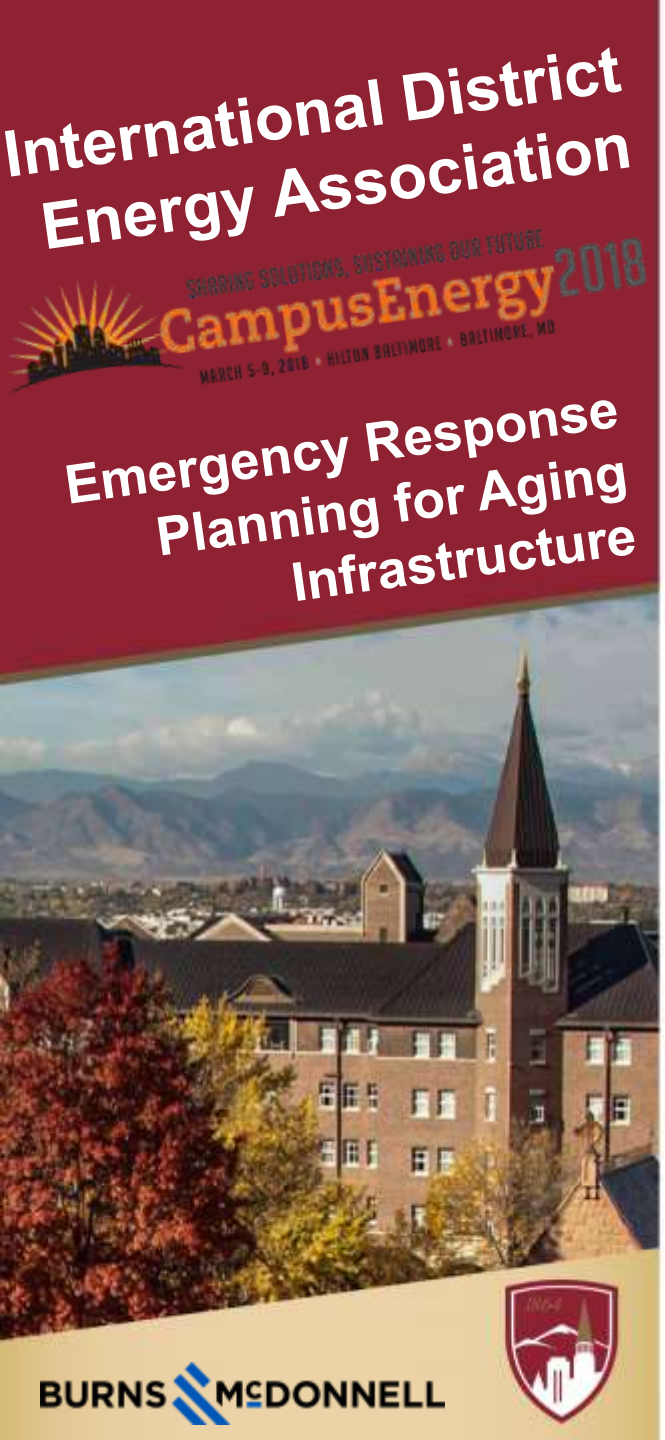
- Variety of Failure Modes:
  - Local Equipment (N)
  - Distribution Line
  - Power Outage
- Various Building Types and Systems
- Military / Fed / Healthcare examples





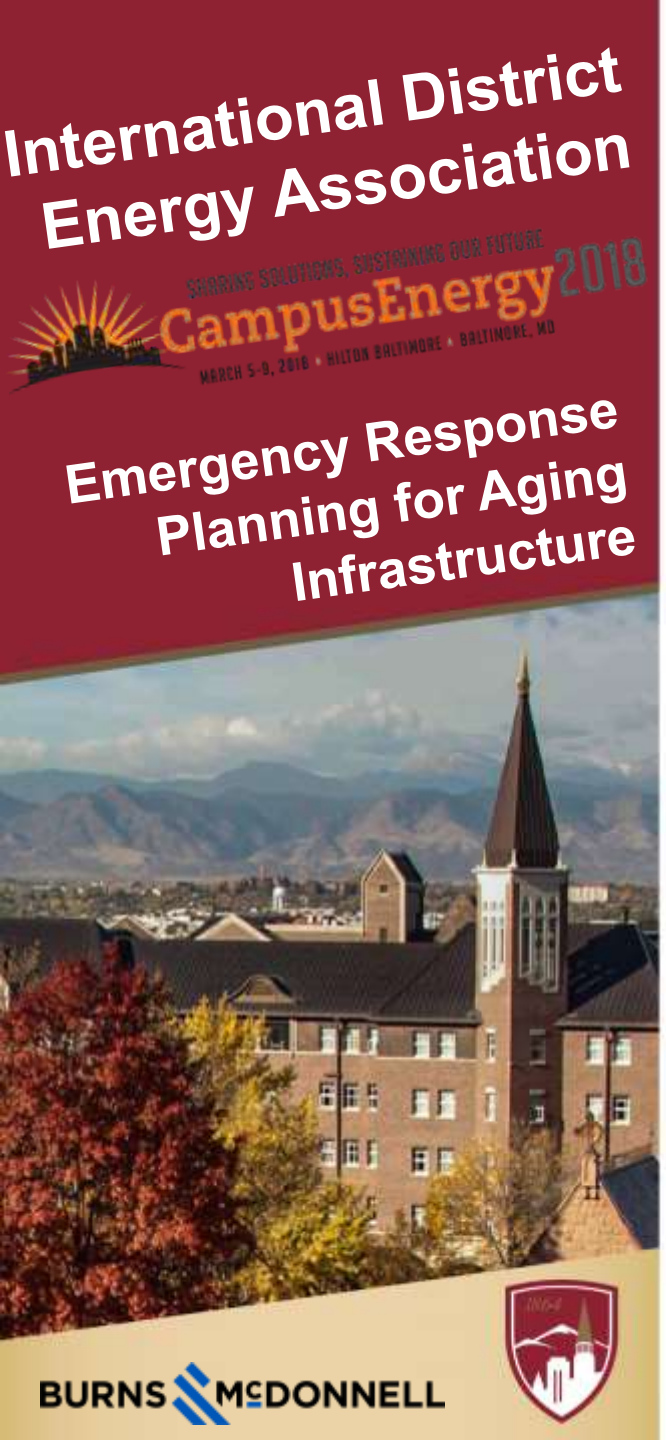
Project Approach





Project Approach

- Building Site Examination
  - Tie Points
  - Rental Equipment Location
  - Hose & Cable
    - Pathways
    - Size/Length
    - Ratings
  - Pumping Restrictions
  - Generator Connections



Project Approach

- Data Organization
  - Database structure
  - Expandable
- Format Considerations
  - Consistent format
  - Small words
- Next Level
  - HTML Interface
  - GIS Integration

	C	AU	AV	AW
1				
2		Electrical Systems		
3	1	45	46	47
4	**Building Name**	**Main Panel Size**	**Building Voltage**	**Transformer Size**
5	Ammi Hyde Building	1600A	208Y/120	300kVA
6	Boettcher West	1600A	480Y/277	300kVA
7	Campus Safety-Parking Servi	800A	480Y/277	750kVA
8	Chamberlin Observatory	-	208Y/120	-
9	Chambers Center	1000A	208Y/120	-
10	Daniels College of Business	2000A	480Y/277	-
11	Driscoll Student Center	600A	480Y/277	-
12	Facilities Service Center	1200A	208Y/120	300kVA
13	Frontier Hall	800A	480Y/277	300kVA
14	IAALS	200A	480Y/277	150kVA
15	Joy Burns Center	1600A	480Y/277	750kVA
16	Knudson Hall	800A	208Y/120	-
17	Mary Reed Building	1200A	208Y/120	500kVA
18	Mass Communications	400A	208Y/120	500kVA
19	Metallurgy	600A	208Y/120	0kVA (N), 300kVA
20	Nagel Hall	2500A	480Y/277	1500kVA
21	Nelson Hall	2500A	480Y/277	2000kVA
22	Olin Hall	1600A	480Y/277	750kVA
23	Physics Building	3000AF/2500AT	208Y/120	1000kVA
24	Ricketson Law Building	3000A	480Y/277	2500kVA
25	Ricks Center	600A	480Y/277	150kVA
26	Ritchie Center	3000A	480Y/277	1500kVA
27	Ruffatto Hall	1200A	480Y/277	-
28	Seeley Mudd Science Buildi	3000A	480Y/277	500kVA
29	Shwayder Art Building	2000A	480Y/277	300kVA
30	Sturm Hall	1600A	480Y/277	750kVA
31	Wesley Hall	600A	240/120	-
32	University Hall	1200A	480Y/277	1500kVA

CLEAR, CONCISE DIRECTION

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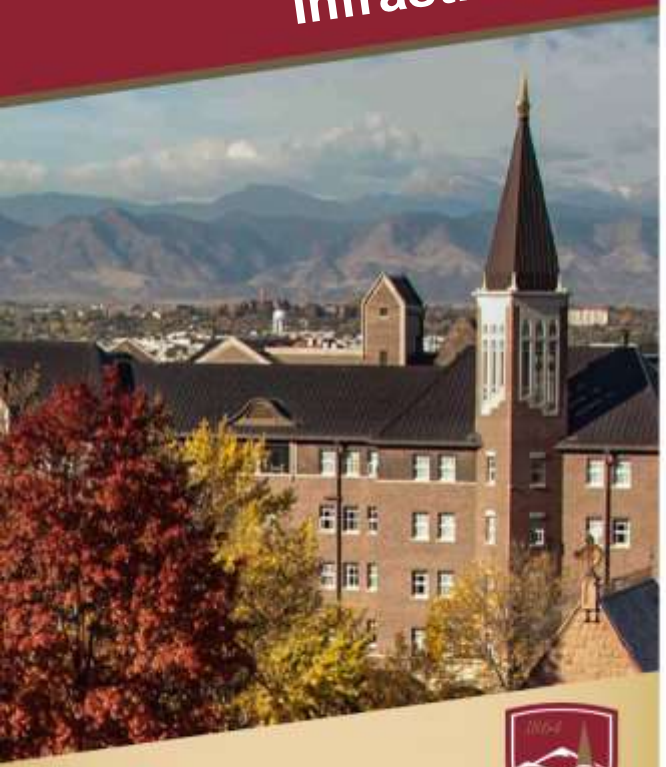
Emergency Response Planning for Aging Infrastructure



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3.0 Chambers Center

Address: 1901 East Asbury Ave. SQFT: 32161

Description: Womens College

uilding served from Sturm chilled water loop?: Yes uilding served from Sturm steam loop?: Yes

Major Equipment:

Cooling:	Building Pumps:	Heating:	Electrical:
Service From Plant	CHW: Bldg Primary (push through) CHW: 150 GPM @ 35 FT ea. Chiller WPD: N/A HW: Bldg Primary (draw through)	Service From Plant	Generator: N/A Main Panel: 1000A

Misc. Notes:	Per dwgs Ex Tan
	LOCAL EQU
	CHILLER
Cooling Equipment	Redundant N+1 CH Pump in place
Heating Equipment	-
Electrical Equipment	-

Rental Electrical Equipment: Loca
near

Aerial View

Rental Electrical Equipment: Locate near	Rental Heating Equipment: Locate near East building doors where temporary connections could be routed through basement stair in building. Basement mechanical room West	Rental Cooling Equipment Not Required
●	▲	◆

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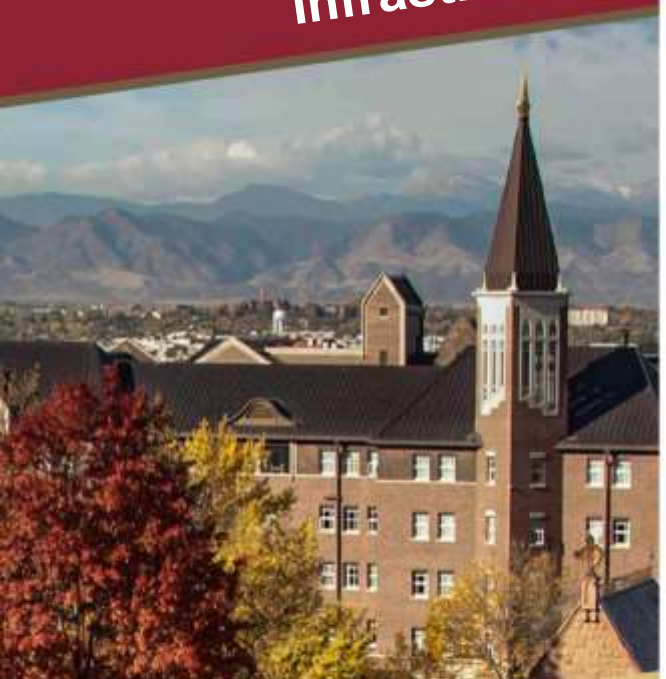

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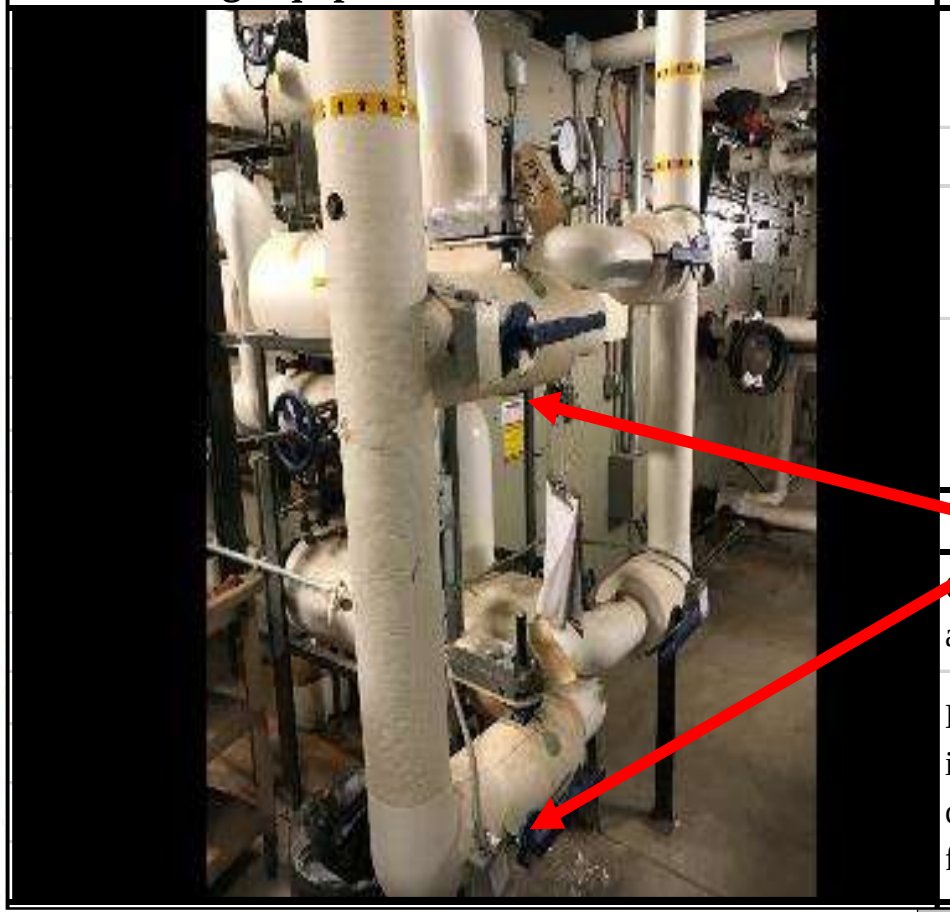
Heating Equipment Connection Reference



Emergency Equipment Identification

- Boiler Requirement: 1200 MBH min required for building
- Gas Pressure Available: DU Investigate lbs
- Pump Required?: Coordinate w/ rental co. existing pump (see front page) can be used with rental blr.
- Connection Requirements: Provide 3" diameter, 50 psig rated hose, 2 x 175' for temporary Sup./Ret. connections

Connection Instructions:

Connection Considerations: Existing isolation valves available. Pipe removal/modifications required.

Description: Use existing redundant HX HWS/R isolation valves for temporary heating equipment connections. Remove pipe spools from valves to HX flanged connections.

Electrical Connection Reference

Emergency Equipment Identification

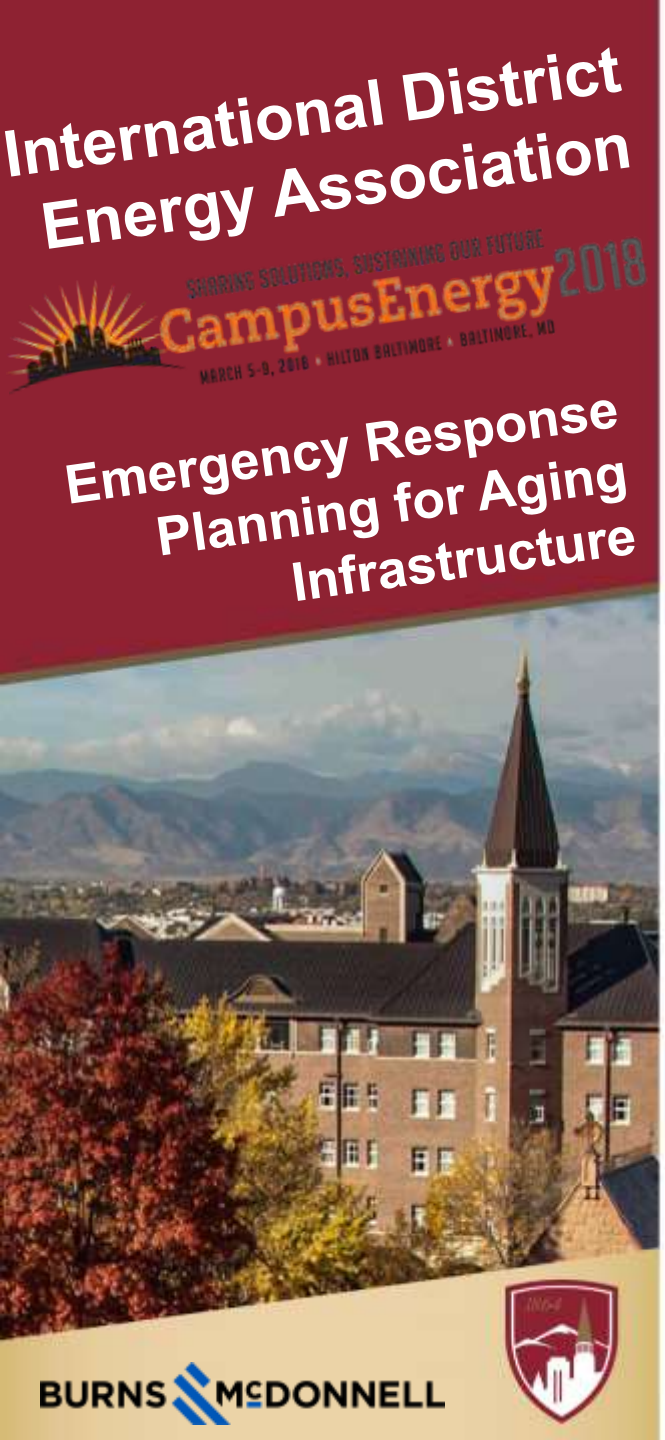
- Electrical
- Min.100 kW Rental Generator required.
- 208V Generator
- 300 kcmil Cable Size. Coordinate with rental company. Provide 100 feet of cable for rental generator connection.

Installation Instructions:

Connection Instructions:

Connection Considerations: Not Rquired

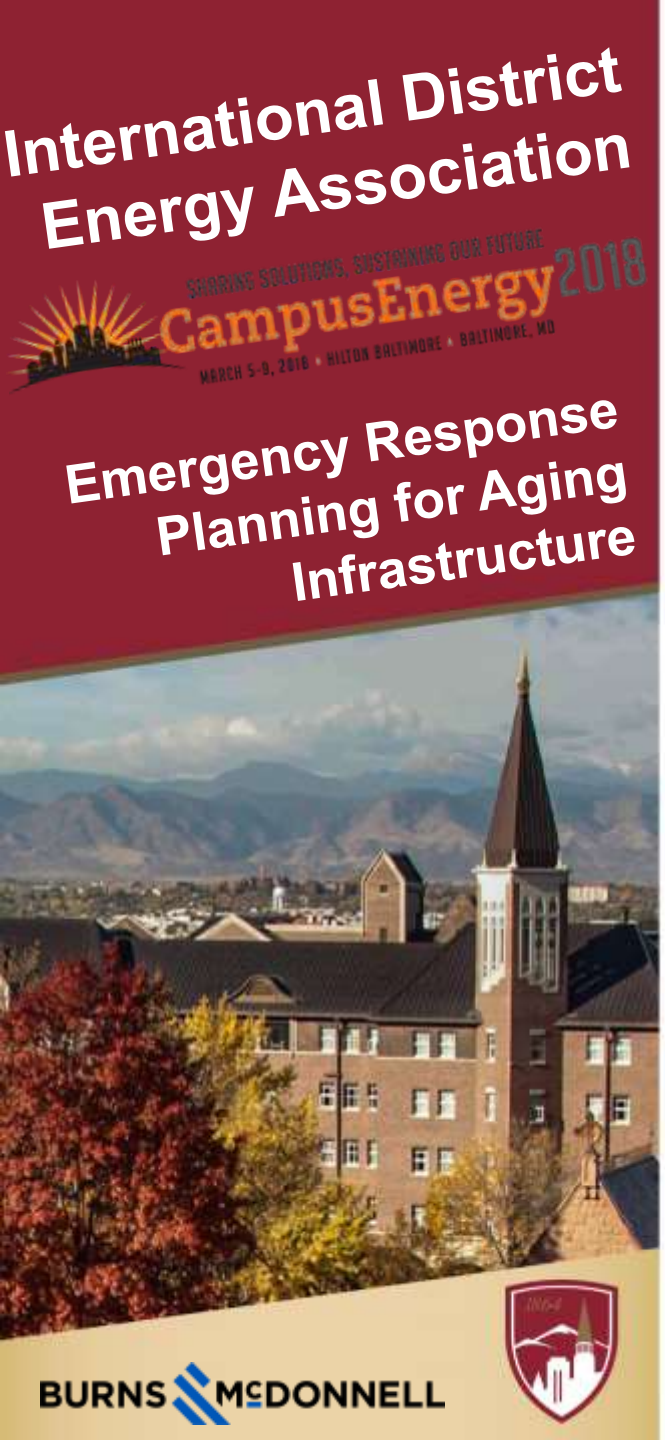
Description: Not Required



Proof of Theory

- DU walked every building and every plan
- GREAT opportunity for any new staff to learn the campus
- Account for time to tweak the plan
- Tutorial for adding new buildings/systems to the plan

TRUST, BUT VERIFY!



Putting into Practice

- Consider additional buildings/systems
- Incorporate into future designs and campus design standards
- Coordinate with Rental Companies
- Train Key Staff
- Meeting/tabletop exercises with providers
- Budget building modifications for connections
  - $50K per year to install valves, disconnects, etc.

EMBRACE THE PLAN

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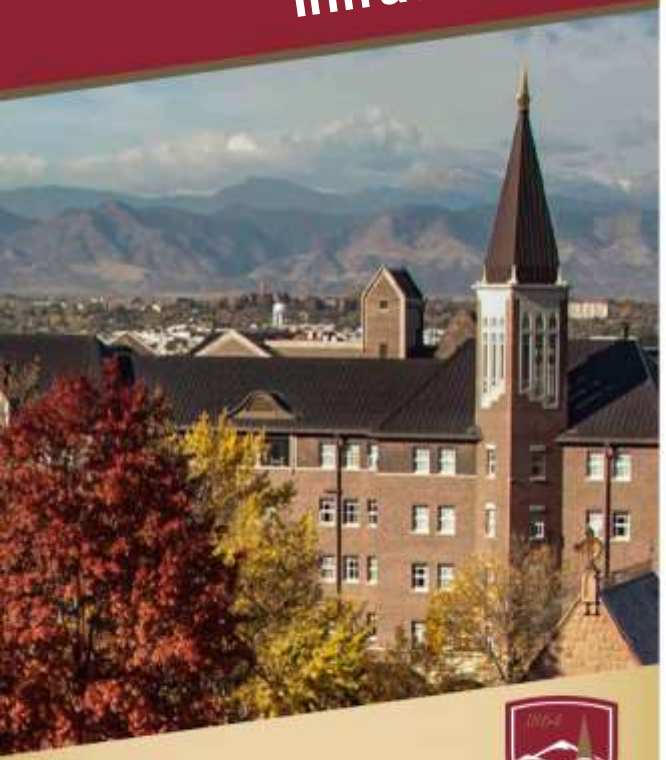

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Questions??