Vault Roof Replacement Program
This presentation on ComEd’s Vault Roof Inspection and Replacement Program is intended to share the program purpose, process, and provide photos showing field conditions associated with different roof grades.

ComEd has no history in utilizing engineered wood shoring systems in vaults that are part of the program.

The Program regards the use of shoring as a suitable temporary reinforcement but does not presently view it as a permanent solution or substitute when a roof has been graded as needing replacement.
"Vaults" vs. "Manholes"

- Vaults are concrete box structures located in the public way, usually under sidewalks, that house electrical equipment, including transformers, switchgears, bus, and cables.

- Vaults *can be* rooms inside buildings at or below grade.

- A common distinction at ComEd is manholes contain only cable and joints; “vault” indicates the presence of equipment and accessories.
  
  - Additionally:
    
    - ComEd vaults are typically vented at the roof elevation to provide cooling for the transformers and are usually built with sump pumps and lighting. The roof includes large openings containing lift out panels, which are used to provide access for transformer removal and installation.

    - The top of a vault roof is typically surface grade of the public way. A manhole's roof structure is typically below grade; covered typically by 2-3 feet of soil / road bed / pavement. Access to the manhole is provided through 1 or more vented rectangular or circular steel covers.
Sidewalk Vaults

- Within the public way, manholes and conduit (multi-conduit duct package) typically travel in the road right of way with branches to customers traveling laterally into a customer vault where transformation to secondary voltage occurs. When the transformer vaults are external to the customer’s building and have no personnel access to the building, they are typically ComEd-owned and inherently below the sidewalk. For this reason, vaults in the public way are commonly referred to as sidewalk vaults.

- Vaults vary in size from 7’ to 15’ wide and 15’ to 50’ long and 9’ to 15’ deep

- Vaults are typically constructed at the same time as the building and may not meet modern load ratings
• Under the Chicago Municipal Code vaulted spaces in the public way are regulated by 10-28-575
  – This code requires that these vaults be inspected by a licensed engineer
  – In the City of Chicago these vaulted spaces are required to be inspected **annually** if they are within the Central Business District (CBD, bounded by Halsted St. to Lake Michigan and North Ave. to Roosevelt Rd.). 432 vaults presently meet this criteria.
  – Vaults Outside the CBD they are required to be inspected **every 3 years**. 215 vaults presently meet this criteria.
Inspections, Designs and Construction

- **Inspection scope** bid annually – all vaults due for inspection as a package
  - Inspection period within Q2
    - The engineering contractor provides the inspection reports which consists of a general report summarizing all vaults inspected including ranking and recommendations, an individual report for each vault, and photos for each vault
    - Scope includes the structural evaluation as well as documenting any electrical, environmental, or operational issues needing attention
    - Vaults subject to a structural inspection will be giving a rating from 1 to 5: 1 being the worst and 5 the best. Vaults with a grade of 1 are fundamentally the program scope. (description of numerical grades and example photos follow in appendix)

- **Engineering design** bid per vault
  - Engineering prioritized in Q3 and Q4
    - Design submitted to OUC (Office of Underground Conflict) and Deep Excavation
    - Responsible for all permits

- **Construction scope** bid per vault
  - Bidders are qualified electrical contractors that also do this type of civil work
  - Construction is field-executed pending permit
    - Rubber live equipment, shoring, roof demolition, new rebar, concrete, lighting, sump pump
    - Estimated 16 roofs replaced per year
• Obtain list of newly rated vaults from Vault Roof Inspection for succession year scope
• Work with engineering and CDOT to prioritize vaults to meet budget
• Meet with CDOT to confirm annual scope selection
• Issue vault(s) to EOC for walkdown and detailed design
• Obtain IFC drawings for COC bid (4 bidders)
• Award Vault to COC through bid process
Vault Inspection Findings

Thermal Scanning:
- First step is to complete scan
- Scan provides infrared imaging of any electrical issues
- Identify any hot spots on equipment and cables
Electrical Issues:
- Leaking cables
- Bulging joints
- Primary and secondary cables that have to relocated
- Transformer issues
- Corrosion issues
Environmental Hazards:
• Debris and garbage
• Asbestos wrapped cables and pipe
• PCB’s
• Biological hazards
Vault Inspection Structural Findings

Structural Findings (issues):

- Exposed / Failing Rebar
- Spalling / Falling Concrete
- Excessive water damage
Roof Design Criteria

- New vault roofs are designed to be rated for heavy vehicular truck traffic; H-20 heavy duty AASHTO load.

- ADA compliance is incorporated into design of surface panels and grates.

- Where sufficient headroom exists on vault underside, the roof is constructed with a 4" topping slab placed over the structural concrete slab. The 4" topping slab provides future flexibility in the event that paver tiles, granite or special concrete patterns and colors are needed to support city or building renovation. It also will allow repairs to be made to the top surface, while having little impact on the roof structural members.
Vault Engineering Process

Engineering Phase:
- Design submitted to OUC
- Design submitted to Deep Excavation
- Issued for Permit
Scope (Contractor):

1. Dedicate personnel to inspect vaults, identify scope and priority rank
2. Schedule vault work locations in order to maximize efficiencies
3. Coordinate vault work locations schedule dates with CDOT
4. Secure CDOT permits
5. Create, submit and manage SRS
6. Schedule environmental remediation, if needed
7. SRS required for execution, if needed
8. Develop safety plan
9. Execution of roof replacement
10. Manage the metrics to monitor schedule adherence and contractor spend
Construction Phase 1:

- Protect and rubber equipment
- Demo any hangers and fixtures that is supported from the ceiling
- Lower any cable that is in conflict with our work
Construction Phase 2:
• Install shoring and decking
• Support any cables or bus work
Construction Phase 3:

• During the construction process public safety and traffic control is continually being monitored and changed
Vault Construction Process

Construction Phase 4:

- Remove existing grates and liftouts
- Demo concrete roof
- Saw cut the walls to allow for the lowering of the vault roof
Construction Phase 5:

- Frame out new frames for access areas
- Install new frames for access areas
- Install new rebar cages for the new concrete beams
Vault Construction Process

Construction Phase 6:
- Pour, top and restore
- Match any required concrete per CDOT specifications
- Remove any remaining construction debris
GIS-Based Layers for Tracking

Manhole Assessment
2012-2013-2014-2015-2016 Program
GIS-Based Layers for Tracking
## GIS-Based Folders and Files

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The primary function of the inspections is to determine the vault roofs that need to be replaced and determine the general condition of each vault. The rating system that is used for the inspections and is found on each individual report location is as follows:

<table>
<thead>
<tr>
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<th>NEEDS REPLACEMENT</th>
<th>Major deterioration and section loss</th>
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<td>2</td>
<td>POOR CONDITION</td>
<td>Advanced section loss, deterioration, spalling, exposed rebar, and delaminations</td>
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<tr>
<td>3</td>
<td>FAIR CONDITION</td>
<td>Primary structural elements are sound, but have minor section loss, cracking, spalling, and minor exposed rebar</td>
</tr>
<tr>
<td>4</td>
<td>SATISFACTORY CONDITION</td>
<td>Structural elements show some minor deterioration</td>
</tr>
<tr>
<td>5</td>
<td>GOOD</td>
<td>No problems</td>
</tr>
</tbody>
</table>

A general description of each category is found on the report. The 1 and 2 rankings are most important and can be described with more detail as follows:
Rated 1 – Needs Replacement
(CONT.) Rated 1 – Needs Replacement
(CONT.) Rated 1 – Needs Replacement
BE CAREFUL NOT TO CONFUSE ELECTRICAL CONDUIT WITH EXPOSED REBAR. THEY CAN LOOK QUITE SIMILAR.
Rated 2 – Poor Condition
(CONT.) Rated 2 – Poor Condition
Rated 3 – Fair
(CONT.) Rated 3 – Fair
(CONT.) Rated 3 – Fair
Rated 4 – Satisfactory
(CONT.) Rated 4 – Satisfactory
(CONT.) Rated 4 – Satisfactory
Rated 5 – Good
(CONT.) Rated 5 – Good
Other Rated 1 Photos - Vaults with shoring...
Other Rated 1 Photos - Vaults with shoring...
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Other Rated 1 Photos - Vaults with shoring...
Other Rated 1 Photos - Vaults with shoring...
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Vault Types and Ownership / Operating Inspection Cycles

- **Number of Vaults:**
  - Based on CE*GIS data, there are currently ~2,668 vaults; includes customer owned and ComEd Vaults
  - **Vaults located inside buildings or below side walks connected to a building** are owned and maintained by customers (this would include ESSs, CTLs, Spot Network Centers)
  - Customer ownership is indicated within vault maps created by engineering, but is not always indicated within CE*GIS
  - ComEd performs visual inspections on both ComEd and Customer owned vaults and structural inspections on ComEd owned vaults

- **Inspection cycles for Vaults vary based on the vault type:**
  - **Network Centers (NC) – 6 months**
    - Locations fed from multiple primary sources with two or more transformers and connected in parallel on the low voltage side to feed multiple customers
  - **Electric Service Stations (ESS) – 3 year**
    - Locations usually located on customer property to provide service to a large commercial or industrial customer where ComEd usually owns and maintains the primary equipment and the customer maintains the vault and secondary equipment
  - **Community Transformer Locations (CTL) – 1 year**
    - Similar to an ESS except the location serves multiple customers
  - **Transformer Locations (TL) – 3 year**
    - Locations that typically have a single transformer serving single customer load
  - **Key Venues – 3 months**
    - Locations that can have a large number of audience in attendance at one location such as a sporting venue
    - Soldier Field, United Center, Wrigley Field, Guaranteed Rate Field, All State Arena, Navy Pier, McCormick Place, Great America, Arlington Park, Sears Center, Toyota Park, BMO Harris Bank Center, Route 66 Speedway, Hollywood Casino Amphitheatre
Typical Customer Vault in a Building

- Bank of three single phase transformers in a customer owned vault: Structure is owned and maintained by customer and equipment is owned and operated by ComEd
Current Vault Conditions

Current Snapshot of Vault Condition
(647 total as of Feb. 2019)

- The program addresses all vaults that need replacement first followed by ones in poor condition
- Project Management with engineering and CDOT prioritize vaults to meet budget
- ~14-16 per year engineered to be constructed the following year

<table>
<thead>
<tr>
<th>Current Condition</th>
<th>Description</th>
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<td>1. NEEDS REPLACEMENT</td>
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Grading – comment about manholes
Innovative Ways to Shore up Deteriorating Network Vaults

Adjustable Vault Reinforcement®

Patented
Laminated Wood Systems, Inc.

Since 1992, LWS has been a leading supplier of engineered wood structures and steel products for use in the Utility and Telecommunication industry.
Aging Infrastructure
Everything gets old!
Aging Infrastructure

Utilities are faced with deteriorated vaults and manholes.
Options for Remedy

1. Replace Entire Ceiling Section
   - Some Outage
   - Extended Construction Time
   - Cost $100k to $200k
Options for Remedy

2. Complete Change out of Vault and Equipment
   - Cost $400,000 to $500,000 plus per installation
   - Takes weeks to complete with outage
   - Lengthy traffic restrictions
Options for Remedy

3. In-place Vault Replacement System – Build a Vault within a Vault

- Cost $200,000-$500,000 per installation
- One week construction time with line outages
- May limit access and operation of electrical equipment when completed
Options for Remedy

4. Adjustable Vault Reinforcement (AVR®)  
Laminated Wood Systems, Inc.  
Patented System

- Installed cost of standard systems $30k – $60k
- Installation time two days or less
- Systems fits through 30” diameter entrance
- Components installed by two-man crew in vault or manhole
- Can be used as temporary or permanent engineered solution
Two Standard Designs

AVR® w/ Heavy Decking  AVR® w/ Netting
Additional Options

AVR® w/ Steel Support System

AVR® No-Post System
Adjustable Vault Reinforcement

AVR® w/ Decking

Adjustable Wood & Steel Columns

Adjustable Wood Beams
Adjustable Vault Reinforcement

AVR® w/ Decking

Adjustable Wood & Steel Columns

Adjustable Wood Beams
AVR® w/ Decking

Adjustable Wood & Steel Columns

Adjustable Steel Ledger Angles

Adjustable Wood Beams
Adjustable Wood Decking

Vault Access Area

AVR® w/ Decking

Adjustable Wood Decking

Adjustable Steel Ledger Angles

Adjustable Wood and Steel Columns

Adjustable Wood Beams
Materials

- **Wood members**
  - Treated options in Southern Yellow Pine or Coastal Douglas Fir (CCA or ACZA)
  - Untreated options in Alaskan Yellow or Port Orford Cedar
  - Member sizes can vary based on material/load
    - Posts from 6” x 6 3/4” x As Required
    - Beams from 3” x 15” x 8’-0” or 10’-0” (per individual beam)
    - Heavy Decking from 7 1/4” x 4 3/8” x As Required

- **Steel Members**
  - Hardware contacting wood – Hot dipped Galvanized ASTM A123
  - Hardware contacting concrete – Stainless Steel 316 grade
Design

• Applicable Standards/Specifications
• Design does not consider any remaining strength of existing structure
• All dead (any material producing static load), live (vehicular and/or pedestrian load), and impact loads (live load increase) are considered.
Safety First – AVR must be installed by qualified personnel who have been trained in proper safety practices. It is the responsibility of the utility or contractor to implement proper work and safety methods.
AVR Hardware Kits & Wood Member Bundles
Stainless Steel Ledger Plates are Attached to Vault Walls
Tongue & Groove Ceiling Decking Installed Atop Ledger Plates
Bracket Assemblies are Bolted to Support Columns
Support Columns are Located and Plumbed
Columns are Secured in Place Using Temporary Shoring
Support Beams are Placed Atop Columns & Temporarily Secured
Bracket Plates are Bolted in Place
Remaining Ceiling Decking Members are Installed
Ceiling Decking Members are Secured to Each Other
Support Beams are Raised Securely Against Vault Ceiling
Support Beams are Drilled and Bolted to Adjustable Brackets
Ledger Plates are Secured to Ceiling Decking and Vault Walls
Angle Clips are Used to Secure the Support Beams to the Decking
Angle Clips Secure the Column to the Vault Floor
Filler Blocks are Cut to Fit Tightly Between Column & Beams
Temporary Shoring is Removed – Installation Complete
Field Example 1
Customer Supplied Drawings
Field Example 1

LWS Design Drawing
Field Example 1
Project Photos – “Before”
Field Example 1

Project Photos – “After” AVR Heavy Decking Installation
Field Example 2
Customer Supplied Drawings
Field Example 2
LWS Design Drawings

LANS-0001.08A1 Adjustable Vault Reinforcement
w/ Heavy Decking
Field Example 2
LWS Design Drawings

5/8"x6" Stainless Steel Wedge Anchor [3 1/2" min. embedment] - [2] per angle

4'-0" Hex Head Screws

Vault Access (field cut as required)

AVR-04-B 3'-3" Angle
AVR-04-A 4'-6" Angle
AVR-04-BB 2'-0" Angle

24'-10 7/8" 2'-0" 4'-10 3/4"
Field Example 2
Project Photos – “Before”
Field Example 2
Project Photos – “After” AVR Heavy Decking Installation
Field Example 2
Project Photos – “After” AVR Heavy Decking Installation
Field Example 3
Customer Supplied Drawings

[Diagram with measurements and notes]
Field Example 3
LWS Design Drawing
Field Example 3

Project Photos – “Before”
Field Example 3
Project Photos – “After” AVR Heavy Decking Installation
Field Example 4

Project Photos – “Before”
Field Example 4

Project Photos – “After” AVR Heavy Decking Installation
Field Example 5

Project Photos – “After” AVR w/ Netting Installation
Questions?

Laminated Wood Systems, Inc.