

Senior Design Project Description

Company Name	<i>The Electric Power Research Institute</i>	Date Submitted	<i>04/20/2020</i>
Project Title	<i>Underground Transmission Manhole Vault Inspection System – Phase 2 (EPRI VIS2)</i>	Planned Starting Semester	Fall 2020

Personnel

Typical teams will have 4-6 students, with engineering disciplines assigned based on the anticipated Scope of the Project.

Please provide your estimate of staffing in the below table. The Senior Design Committee will adjust as appropriate based on scope and discipline skills:

Discipline	Number	Discipline	Number
Mechanical	2	Electrical	2
Computer	2	Systems	
Other (Civil)			

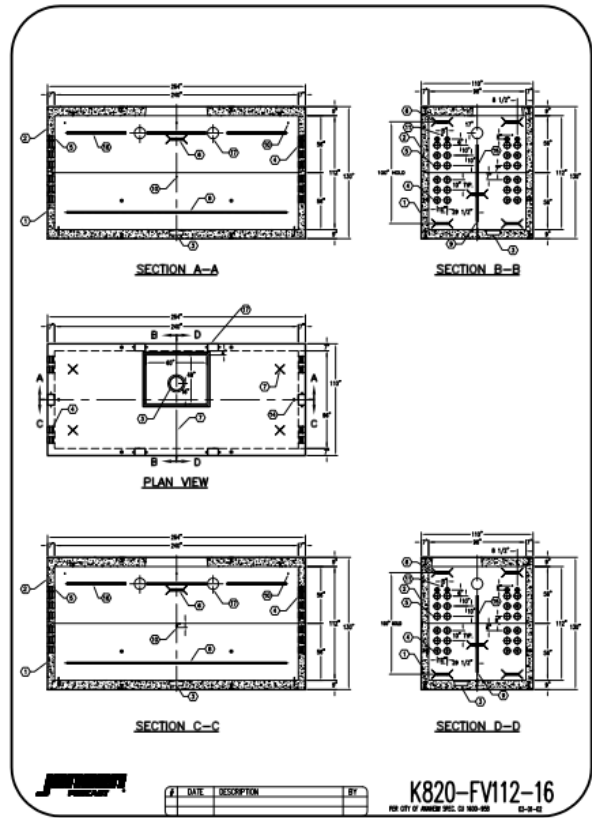
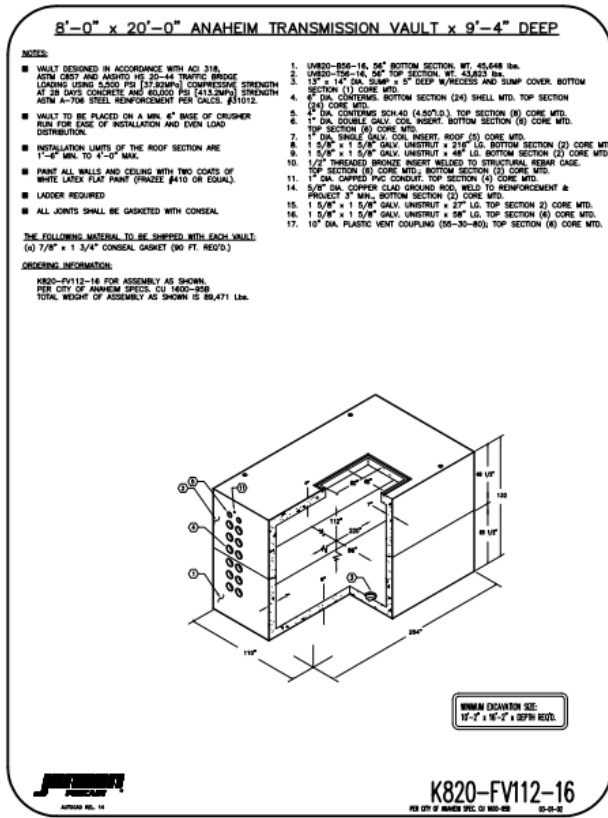
Company and Project Overview:

The Electric Power Research Institute (EPRI) conducts research, development, and demonstration projects for the benefit of the public in the United States and internationally. As an independent, nonprofit organization for public interest energy and environmental research, we focus on electricity generation, delivery, and use in collaboration with the electricity sector, its stakeholders and others to enhance the quality of life by making electric power safe, reliable, affordable, and environmentally responsible. One area of interest for power utilities is underground transmission vaults.

An electrical vault is essentially an underground concrete box that provides access to subterranean electrical utility equipment, such as transformers or switches. Vaults can be difficult to access and the inside of the vault is complicated, hazardous, badly lit, and sometimes full of water or frozen water. Electrical cables and conduits enter and exit the vault through the underground walls and snake through the chamber against the walls, floor, and ceiling before entering and exiting devices.*

*<https://csengineermag.com/article/seeing-what-is-underground/>

This is a typical drawing for a underground transmission vault:



Pictures of Vaults:

Figure 4 Vault Construction



Left: 345 kV XLPE project – Cement vault visible with two chimneys extending up to be level with the future road surface.

Right: 138 kV XLPE project – Bottom half of pre-constructed vault positioned in trench.

(Courtesy of the Public Service Commission of Wisconsin)

Further reference material:

https://www.xcelenergy.com/staticfiles/xcel/Corporate/Corporate%20PDFs/OverheadVsUnderground_Fact_Sheet.pdf

<https://psc.wi.gov/Documents/Brochures/Under%20Ground%20Transmission.pdf>

<http://www.tpud.org/wp-content/uploads/2015/04/Final-Presentation-4-15-2015.pdf>

Project Requirements:

Cost effective and reliable underground transmission cable systems depend on sound engineering practices of design, construction, operations, and maintenance. This project aims to optimize the inspection techniques of underground vaults containing extruded dielectric cables and their accessories to assist utility workers in their inspection routines in an effort to improve overall safety while reducing inspection and outage times.

The Phase I project team worked to design and build a robotic proof of concept prototype (articulating arm) that can stream high quality video and images to the controller from inside a manhole vault. The system is planned to be fastened to the manhole cover entry to provide stability and orientation to the arm. The system design was to be able to view at least 90% of the vault and its contents. A mock manhole vault will be provided for testing at the EPRI Charlotte location. Phase 2 will build on this Phase 1 result and develop designs to waterproof the robotic arm system, reduce overall weight and improve the inspection methods.

Expected Deliverables/Results:

- A precision control system for an improved articulating mechanical arm
- The ability to transmit high quality video and images to the user from the vault in real time
- The system to be water proof
- The inspection must take less than 1 hour to perform
- The system must take no more than 2 or 3 people to operate
- The system must include a sensor suite that monitors acceptable levels of carbon monoxide, natural gas values, and temperature
- A product manual with user instructions
- Extensive testing of Phase 2 build using EPRI supplied vault

Disposition of Deliverables at the End of the Project:

A working prototype is expected to be delivered at the end of the Expo to EPRI

List here any specific skills, requirements, specific courses, knowledge needed or suggested (If none please state none):

- Interest in underground transmission systems. Specifically, extruded dielectric cables found in manhole vaults. Also known as XLPE cables. Reference material can be provided if needed.



UNC CHARLOTTE

The WILLIAM STATES LEE COLLEGE of ENGINEERING

- Control systems – Prerequisite (or taking in Fall 2019) ECGR 4111/ELET 4242/ELET 3242
- CpE pre-requisite (or taking in Fall 2019) ECGR 4090 and an Advanced Embedded course (ECGR 4101 or 5101)
- Mechanical systems