BART Tunnel Ventilation

Marin O'Brien, Matthew McGuire, Colin McGill, Dominic Nguyen, Homza Al-Ariemy | Alejandro Gutierrez| University of California, Merced

Project Description

BART has tunnel ventilation systems in place to assist in emergency fire situations. Our design will be a failsafe to ensure fans are running in supply or exhaust, as confirmed by central. The system must also monitor power output of fan to ensure proper fan operation is occurring.

PVD

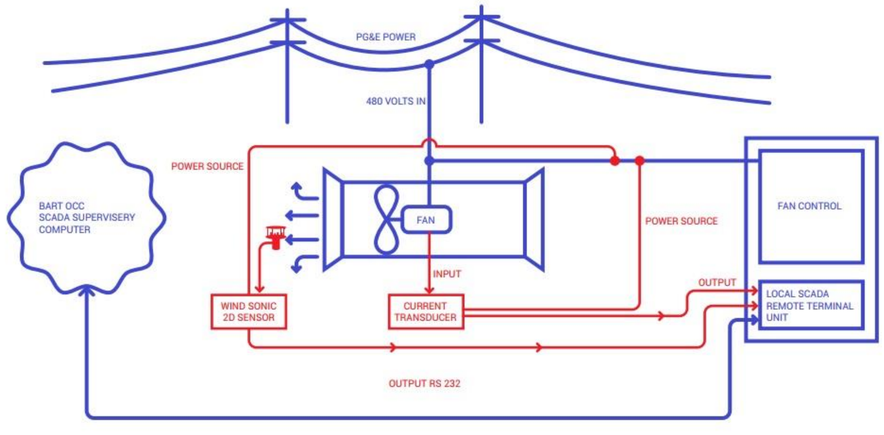
Wind Vane

Sonic Sensor

Ammeter

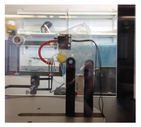
Current Transducer

Proposed Solution

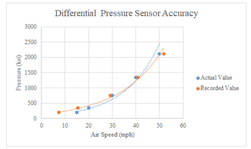


Project Overview

Wind Tunnel: Accuracy Test

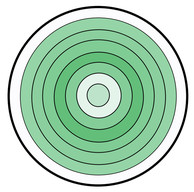


- Used a pressure sensor for small scale tests
- Found reliable data based on speed increases



- The sensor works in both directions
- Proves fundamentals of sonic sensor

Wind Tunnel: Location Test



- Cross sectional view of fan exhaust
- Determine best location for the sonic sensor
- Evaluated
- Heat map on the left reflects shows this data

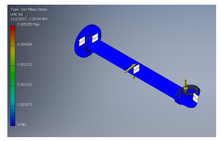
Transducer: Lab Test

Fan Speed Setting	Peak Current (A)
0 (fan off)	0.073
1	0.317
2	0.342
3	0.366

Table 1. Test Fan Current Usage

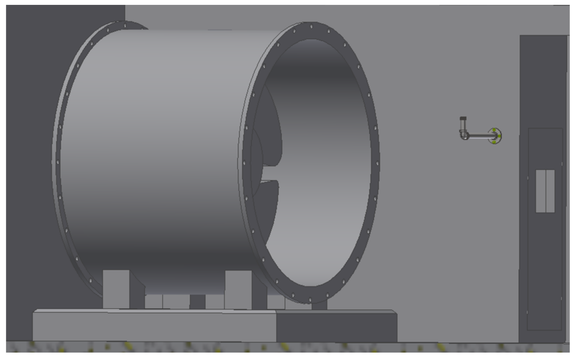
- Measured current to the fan at different power outputs
- Higher fan speeds equate to higher current

Mount: Stress Analysis



- This wall mount is built to hold the sonic sensor
- Stress analysis was performed to verify durability
- It is placed far enough to not interfere with maintenance

Solution Appearance



Economic Analysis

Item	Sub Total/System	Cost/Part
Split Core Transducer	$58.00	
Sonic Sensor	$1100.00	
Sensor		$800.00
Data Logger		$300.00
Mounting Bracket	$95.53	
Stainless Steel Pipe, Coupling, Flange, Elbow		$75.53
Nuts,Bolts, Set Screws		$20
Wiring	$100	
Installation ($110/hr)	$275	2.5 hours
Total	≈ $1627.53	

Item	Cost/Part	Sub Total/System
Cost of Parts	$1,352.53	
160 Fans		$216,404.8
Cost of Installation	$275	
160 Fans		$44,000
Total		≈ $260,414.8

Conclusions and Recommendations

To address BARTs emergency tunnel ventilation fan safety operation procedures Railwaze compiled a comprehensive system that confirms three main features: fan operation direction, wind speed through the ventilation duct, and power supplied to the fan system. The proposed solution incorporates a 2D Wind Sonic Ultrasonic Sensor, a Split Core Current Transducer, a Remote Terminal Unit, a wall mount, and the required cabling. The system proposed by Railwaze allows BART to ensure that each emergency fan is operating in the proper orientation during an emergency situation via data that reflects: whether the fan is operating in supply or demand, if debris or other materials are blocking a fan inlet and reducing maximum fan speed, and finally if a fan is being supplied the proper power required for operation.

While this system has components that are rated to last many years it may be advisable for BART to consider cheaper alternatives for the ultrasonic sensor. Railwaze has determined that having the added benefit of knowing the max and average wind speeds within each ventilation site is a valuable piece of data. If BART determines that the velocity of air within the ducts is not a required data point then it may be advisable to find an alternative solution, though not overly necessary.