A Low-Cost Ambulance Idle Reduction System

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Abstract

As per standard ambulance protocol, when the ambient temperature is below a certain threshold, it is necessary to keep the ambulance engine running while outside (i.e. "idling") because of the need to keep the cabin warm using the engine-heated heating system. This tends to be expensive in terms of fuel consumption and operating costs, and can also wear down the engine. A simple, automated system is proposed that constantly monitors the temperature in the patient compartment, and only starts the vehicle engine and heating system temporarily when the temperature falls below a preset threshold. The system costs approximately one-sixth (~$750) compared to currently commercially available systems to install. A preliminary prototype system was installed on the MIT EMS ambulance, and initial data successfully verified key functionality. We estimate that this can reduce the vehicle's idling fuel consumption and engine run time by about 85%.

Background and Motivation

- An ambulance's patient compartment has strict temperature regulations.
  - "The interior of the ambulance patient compartment must be maintained at a minimum temperature of 50°F when the ambulance is prepared for immediate response." (Federal Specification KKK-A-1822F)[1]
  - Recommended storage temperatures of common medicines[2]:

Medicine	Temperature range
Albuterol sulfate	36-77°F (2-25°C)
Epinephrine (EpiPen)	59-86°F (15-30°C)
Naloxone	59-86°F (15-30°C)

- As a result, ambulances are often required idle outside in colder climates to keep the patient compartment warm.
  - "If parked in an unheated area or outside when the exterior temperature is below 45°F, the ambulance shall be kept running…unless prohibited by sign or policy." (MIT EMS SOP)[3]
  - Estimated idling fuel consumption = 1.5 gal/hour[4]

Service	Idle time/vehicle	Cost/vehicle
Collegiate (MIT EMS)	150 h/year	$600/year
Professional services	500-2,500 h/year	$2,000-10,000/year

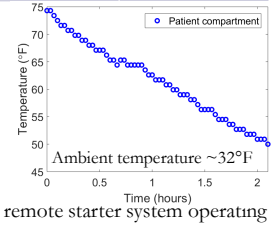
  - Additional 35-50 miles' worth of engine wear and tear per hour[4]
- Goal: implement an automated idle reduction system that
  - Satisfies the temperature requirements described above,
  - Ensures safe operations (e.g. no engine start-up in garage), and
  - Minimizes crew's behavioral change from current practices.

System Design

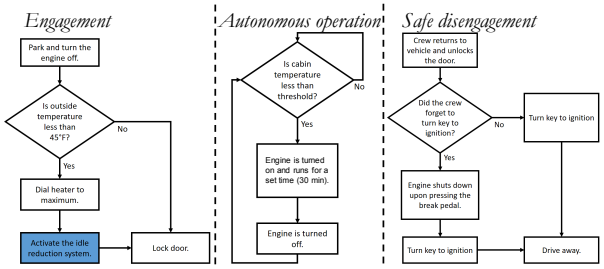
- Existing systems are costly and/or do not satisfy our requirements.

System	Monitors battery?	Monitors temperature?	Cost
Stealth Power[4]	Yes	Yes	$16,000
GRIP[5]	Yes	Yes	$4,800
Havis IdleRight[6]	Yes	No	$1,000

- **Key insight:** Battery management is unnecessary where:
  - Most idle intervals are short (< 30 min), allowing the patient compartment temperature be maintained by thermal inertia; and
  - Temperature management is the only functional requirement.

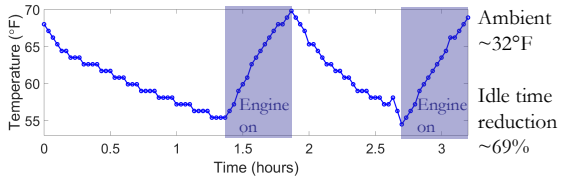


- The simplest embodiment involves a remote starter system operating in cold-start mode, and a modified temperature sensor.
- **Total system cost:** $760 (including labor) in Massachusetts.
- Envisioned operation of the idle reduction system:



Testing and Validation

- A Viper 4706V system was integrated into a Ford E350 (2013) ambulance and tested over January 2018.
- Patient compartment temperature was logged once every 2 minutes using a Lascar EL-USB-TC-LCD.



Discussion and Conclusions

- Estimated efficacy of idle reduction depends on the idling interval.

Idling interval	Percentage of time	Idle reduction
Short (< 30 minutes)	~60% (90 h/year)	~100%
Long (≥ 30 minutes)	~40% (60 h/year)	~60%
	Weighted average	~85%

- The cost saving is ~$500/year, or a payback period of ~1.5 years.
- Performance depends on heater setting, ambient temperature, vehicle thermal mass, and amount of exterior insulation.
- Limitation: System works better with gas engine, not diesel.
  - It is expected gas-engine ambulances will be more common.[7]
- Will there be wear and tear from starting and stopping the engine?
  - Maintenance breakeven point at ~60 s of engine running time.[4]
- Suggested future improvements:
  - Better integration with existing vehicle key fob;
  - Dynamic heater setting and engine run time adjustment;
  - Automated determination of ambulance status; and
  - More thorough study of and response to different ambulance services and their specific requirements.

References

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3. MIT EMS. *Standard Operating Procedures*. 2017.
4. Gaines, L. Idle reduction for emergency and other service vehicles. *Argonne National Laboratory*. 2015; CHO-AC02-06CH11357-1501.
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6. Phillion, D. Personal communication. 2017.
7. Philips, J. Ford to offer gasoline ambulances in 2010. *JEMS*. 2009.

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