Environmentally Safe and Affordable Solution for FPCON B Security Requirement

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Abstract *— Temporary implementation of Force Protection Condition Bravo (FPCON B) required to set an overwatch on each Department of Defense (DoD) installation gate across the country. Currently, the overwatch consists on an police cruiser with an idling engine that adversely affects environment, energetic resources, and economical budget across the DoD installations. At the same time, it presents a health concern to cruiser occupant. This paper proposes four courses of action (COAs) for a specific installation; three of these propose solutions to reduce environmental, energetical, economical, and health risks impacts, while the fourth is the cost of doing nothing. Although this report considers one DoD installation, COAs are applicable to any DoD dependency under same situation. It was found that, although current practice does not harm cruiser occupant, three COAs reduced the environmental footprint, energy use and costs over 5 times, and the break-even point is reached at around 2.5 to 5 years.*

Key Terms *— Environment, FPCON, engine idling, police cruiser*.

INTRODUCTION

On May 8th, 2015, by the order of the Commander of the United States Northern Command (US NORCOM), the Force Protection Condition (FPCON) was temporarily risen from Alpha to Bravo, impacting security measures at all installations in the continental United States [1]. Although the Security Forces Squadron (SFS) designs their own security strategy within FPCON B guidelines for each installation, and this implementation is said to be temporary, among other strategies, installations opted to assemble an overwatch per gate, consisting of having a guard inside a police cruiser, with the engine idling, facing traffic flow at a prudent distance from the gate. This overwatch provides a secondary intervention measure after the main guard house with the smallest reaction time. As of May 2022, this temporary requirement still continues, with no signs of being eliminated any time soon.

Real world situations, ranging from domestic protests against government installations to the real risk of war due to the Russian invasion of Ukraine, forecasts that FPCON B measures will remain for a very long time. This forecast makes SFS reframe the current situation and consider better solutions for the gate overwatch, other than having a vehicle idling for long periods of time.

LITERATURE REVIEW

None of the top car producers and sellers in the US recommends idling a car engine for long periods of time. In fact, almost all do not recommend idling the engine longer than 10 seconds. Hyundai and Mazda are the most permissive brands that recommends to not idle your engine more than 5 minutes. All manufacturers claim idling waste energy shorten engine life, constitutes an unnecessary environmental pollution and it is no longer needed to improve performance like in carbureted cars [2].

A study conducted in Hong Kong measured toxic fume levels inside a car cabin during running and idling conditions. The sample consisted of 51 randomly selected private own vehicles ranging from 0 to 18 years and up to 120,000 miles. Over 80% were more than 10 years old and over 56,000 miles and average maintenance. In their research, they detected CO in 35% of the vehicles during driving and 40% of the vehicles during engine idling. The mean CO concentrations either running or idling (1.7 ppmv) did not overpass the Occupational Safety and Health Administration

(OSHA) recommended levels. In the same investigation they found a mean CO_2, of (3096 ppmv) with almost 16% above OSHA recommended level of 5000 ppmv [3].

Comparing these contamination levels with other energy sources considered cleaner requires taking a look into electrical power production contamination. In 2007, a study from NREL calculated these emission factors in terms of contaminants per unit of electrical energy, in this case kw-h (kilowatt-hour). This study measured not only the National average, but also narrowed it down per state. For Ohio for instance, his study shows Nitrous Oxide levels of 0.00188 grams per kw-h, Carbon monoxide of 0.000289 grams and for Carbon dioxide of about 0.998 grams per kw-h. More up to date figures were pulled from the Department of Energy (DoE) of the United States. A wild guess estimate (WAG) with a simple calculation might show same energy produced from an idling engine for 8 hours period may produce 33% of CO and 64% of CO_2 using electric at a constant 250w load [4].

So, reducing idling time alleviates harmful fumes for vehicle occupants while fighting environmental pollution. Idling Reduction Technologies (IRTs) have been developed to reduce idling times on government-owned vehicles (GOVs). GOVs required to idle for long periods of time are ambulances, fire trucks and police cruisers, especially those holding police dogs in its cabin. This study shows IRTs along with implementation economic impact and simple payback periods. Economic implementation costs range from $300 to $30,000 with paybacks from 1.15 to 17.2 years depending on the IRT selected. IRT solutions that are commercially available are Battery APU (Auxiliary Power Units), Diesel Combustion Engine APU, Electrified Parking Space and Managed Engine Stop/Start System. All these alternatives are environmentally safer than idling for extended periods of time [5].

METHODOLOGY

The information required to support this paper is a result of Qualitative and Quantitative methods from a wide range of reputable sources. This paper relied heavily on quantitative figures. Some information was obtained interviewing related personnel such as police cruiser users, supervisors, and technicians. Information gathered was used to quantify amounts used later for calculations in this report.

Interviews revealed that police cruisers get gas tanks filled three times a week and run 2000 mi per year. This information was key on determining energy consumption of police cruisers.

Subject Matter Experts (SMEs) indicated factors to account for Energy, Occupational Health and Environmental impacts. Came out that to measure Energy in Therms, and Fumes like CO, CO_2, VOC levels in grams were the indicators to watch the most experts care about.

Police Cruiser technical data was obtained directly from the records available from the US Department of Energy dependencies and are specific for brand, model, and year for the two models considered, which are 2018 Ford F150 and 2018 Dodge Durango. Collected data goes from cruiser efficiency measured in MPG (Miles per gallon), Idling recommendations and Fuel tank size.

Occupational Health concerns were addressed comparing similar cases to private vehicles in Hong Kong [3]. Research provided data about how harmful fumes levels are inside a car cabin under similar conditions.

Each vehicle burn fuel at different rates depending on if are idling or running. Annual mileage was used to calculate fuel usage when the car is in motion. Idling time were assumed to be the same as installation gate hours. Since total fuel use is known, calculated idling fuel was obtained subtracting “running vehicle” fuel use to total fuel used. Likewise, idling time were also used to forecast the amount of electric power required in lieu of fuel for the same benefit. Power loads were

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based on DoD heating, ventilating and air cooling standards.

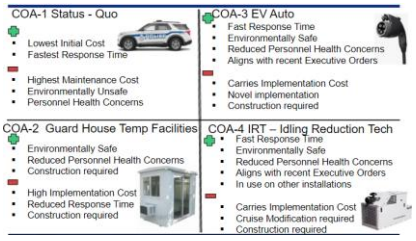
Therefore, this paper presents four COAs (Courses of Action) where COAs 2 to 4 tries to reduce engine idling time by using external power source instead of generating it from the idling engine.

The four COAs are:

- COA #1 – Status Quo – It is customary in the DoD that among recommendations to attend an issue, the alternative of "maintain current situation" is present. Thus, this COA sets the baseline for all other recommendations included in this paper.
- COA #2 – Guard House – This alternative is expected to reduce economic cost and environmental footprint while increases the reaction time. The expectation is the guard to remain in the house until his action is required.
- COA #3 – EV (Electric Vehicle) – This alternative is expected to reduce economic and environmental costs, and keep current reaction time. The expectation is electric power keep guard conformable in the cruiser cabin until his action is required.
- COA #4 – IRTs (Idling Reduction Technologies) – Similar to COA 3, this alternative modifies the police cruiser to accept external electric power to keep cabin conformable and use fuel to power the engine while driving. This alternative also keeps current reaction time.

See Table 1 for details and pros and cons analysis per COA.

Table 1
Proposed COA (Courses of Action)



RESULTS

Occupational Health Impact Results

Installation's Occupational Health office informed that fumes emanation they monitor are carbon monoxide CO and carbon dioxide CO_2. Studies shows that CO and CO_2 measured levels inside a cabin on newer idling car averages of 1.7 ppmv for CO and 3,096 ppmv for CO_2. OSHA established their maximum exposure limit for each fume as 5 ppmv for CO and 5,000 ppmv for CO_2 during an 8-hour period [6].

Energy Impact Results

Fuel and Electricity energy, as many more sources of energy are measured in therms. The U.S. Energy Information Administration (EIA) under the US Department of Energy averaged energy from fuel as 1.25 therms per gallon, which represents 5,655 therms per year per vehicle in this report. In contrast one 1 therm equals 29.3 kw-h representing 790 therms per year per vehicle if they were fully electric. This represents environmental and economic benefits explained in their respective section in this report.

Environmental Results

Fume emanations that the Environmental Office cares the most are CO (carbon monoxide), CO_2 (carbon dioxide), NOx (Oxide Nitrates), and VOCs (Volatile Organic compounds) as these are the most harmful gases to the environment.

Currently, if no action is taken, 2.98 of Mg CO are to be expelled into the environment each year. COA 2, COA 3 and COA 4 represents a huge environmental pollution reduction of 75 to 96 percent, as shown in Figure 1.

Figure 2 shows the carbon dioxide emanations under current conditions COA 1. If no action is taken, 627.8 of Mg CO_2 will continue to hit the environment. COA 2, COA 3 and COA 4 offers a pollution reduction of 97%. Similarly Figure 3 and Figure 4 shows reduction of 97% and 81% respectively for NOx (Nitrogen Oxides) and VOCs (Volatile Organic Compounds).

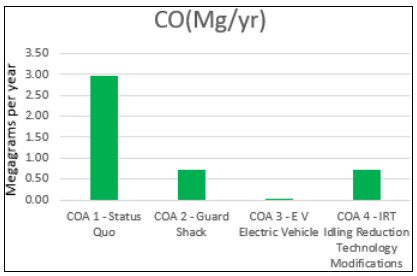


Figure 1
Carbon Monoxide per COA per year

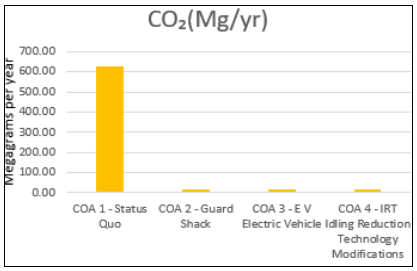


Figure 2
Carbon Dioxide per COA per year

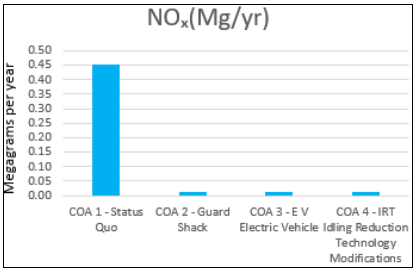


Figure 3
Nitrous Oxide per COA per year

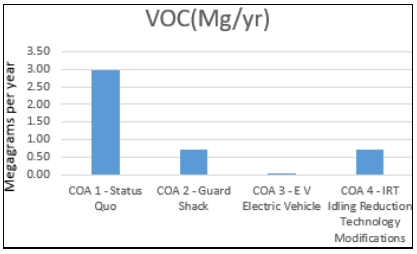


Figure 4
Volatile Organic Compounds per COA per year

Economic Results

Implementation costs for COA 2, 3 and 4 are very similar and depend on electrification. It averages $36,000 per vehicle. COA 1 shows no cost, as it is the cost of doing nothing. Figure 5 shows energy cost to run operations per COA. Note that COAs 2, 3 and 4 cut energy expense in half; about $6500 savings per year.

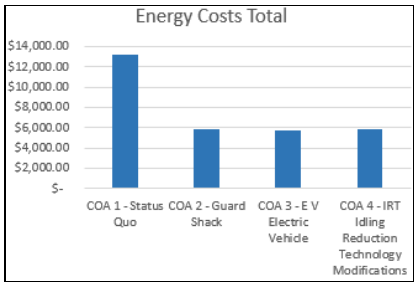


Figure 5
Total Energy Cost per COA per Year

Given the projected implementation costs and savings per year, expected payback periods were calculated as shown on Figure 6. Note that COA 1 never reaches a payback period since it is the status quo. Other COAs reaches payback around 5 years while COA 2 reaches it in half of time.

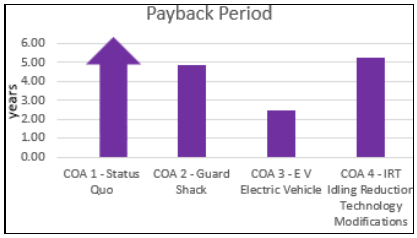


Figure 6
Payback per COA

CONCLUSION

Occupational Health Impact Results

Fume average levels of CO and CO_2 levels inside cars cabin fall under OSHA regulation. Although these are average levels, maximum levels

are not expected to surpass regulatory levels on newer vehicles.

This report concludes that there is no reason believe fume fumes levels affects occupant health if vehicle age and maintenance kept by DoD regulations.

Energy Impact Conclusions

Currently COA 1 fully depends on fuel as the main energy source and each cruiser consuming 5,650 therms per year. For COAs 2 through 4, energy use per year were calculated as 115 therms from fuel aper years and 1400 Therms from Electric, 1515 therms total. COA #3 is the least energy consuming activity needing just 1160 Therms from electric and none from fuel.

To run the overwatch operation on electric requires much less energy if electric energy is used.

Environment Impact

Applying any of the COA benefits the environment. Energy transformation is not 100% effective, since liberates heat and other byproducts. The byproducts we focused on are CO (carbon monoxide), CO_2 (carbon dioxide), NOx (Oxide Nitrates), and VOCs (Volatile Organic compounds).

It was concluded that electrification of the overwatch operation will reduce CO emissions between 75% to 96%, CO_2 to be cut in 97%, NOx 97%, and VOCs to 81%.

Economic Impact

Being COA 1 the Status Quo solution, does not require any implementation cost, but also its the one that wastes the most energy, produces the most polluting fumes and it is the most expensive to run, with operations costing $18,045 every year when combining fuel and maintenance costs.

COA 2 and COA 4 that proposes electrification for an environmental controlled officer space shows around $35,000 as implementation costs. However, the combined maintenance and energy operations is calculated to be reduced by near $8,000 per year. Thus, implementation of either COA will show paybacks in almost 5 years.

COA 3 which calls for complete electrification, although requires a similar implementation cost, it reduces maintenance to $2,900 contributing to a faster payback period of 2.5 years.

In summary, the implementation of any COA shown in this report, other than Status Quo, represents Energetic, Environment and Economic benefits when compared to current operations.

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