**Background**

Legacy engine is a term that is applied to industrial engines that were designed and manufactured before low emission levels were required and before advanced control systems were employed. Typically, they are 20 to 50 years old. Most large legacy engines are mechanically sound and capable of operating reliably for many more decades. Many can perform at present day standards if retrofitted with advanced technology. The challenge comes in designing technology appropriate for a given engine.

**Description**

Large, reciprocating engines provide motive power throughout US Industry. These engines are ruggedly built and typically are capable of continuously generating several thousand horsepower each. They run at relatively low speeds and can continue to operate efficiently more or less indefinitely if properly maintained. These engines must meet a myriad of air quality regulations. These regulations vary widely with locality and application and there are literally hundreds of different requirements that can potentially apply to a given engine.

![Pipeline Compression Engine](source: CTS, Combined Technology Solutions)

The use of these engines is widespread but, by far, the single largest use is in compression stations for the natural gas pipeline system. There are over 17 million installed horse power for gas pipeline compression stations in the US. Exact figures for the amount supplied by legacy engines are difficult to obtain but saying 50% of the installed power is from legacy engines is reasonable.

**Major Natural Gas Pipelines and Compressor Stations**

(Source: US Energy Information Administration)

These engines are sufficiently large and the local requirements are sufficiently unique that each engine must be treated as more-or-less one of a kind. Upgrading each engine is a unique process, often with trial and error approaches. Our proposed research program is quite simple in concept. We proposed to develop the analytical tool packages that can be used to accurately predict the impact of available technologies on a given legacy engine and its emissions. The automotive engine industry has shown this level of analysis is feasible but it is a much different proposition to apply it to hundreds of different engine rather than the design of a new engine that will be reproduced a hundred thousand times. It is planned to seek funding to form an NSF Industry/University Cooperative Research Center and simultaneously seek major funding through the DOE Natural Gas Infrastructure R&D Program initiative.

**Relevance**

The pipeline system map demonstrates the nation-wide impact of this research. The ability to continue to use legacy engines is important for maintaining low cost and reliable delivery of natural gas throughout the country. Through incorporation of advanced technology, these engines can continue to provide this service, can meet current and future emission requirements, and be part of the solution to improve the environment by delivering an environmentally friendly fuel throughout the country.

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Summary: Large legacy engines provide the motive power for much of the natural gas pipeline system and other industrial applications. These engines are capable of meeting today’s and future standards when upgraded with advanced technology. Analytical tools are being developed to enable effective implementation of this technology.

Opportunity: Legacy engines represent a large capital investment. They have the capability to continue to operate for many years to come. They were built prior to today’s strict environmental and efficiency requirements. In order to continue to serve, they need to be upgraded with advanced technology.

Solution: These engines do not have the uniformity of mass produced engines. Sophisticate analytical tools are required to effectively apply the necessary advanced technology on an engine-by-engine basis.

Impact: The natural gas pipeline system provides vital energy that is the lifeblood of our society. Efficient and clean operation of this system is essential for a healthy economy and environment.

Equipment & Expertise: The National Gas Machinery Laboratory is a 10,000 square foot off-campus laboratory devoted to engine and turbocharger performance research. It houses the only large engine turbocharger test facility in the US available for public use.