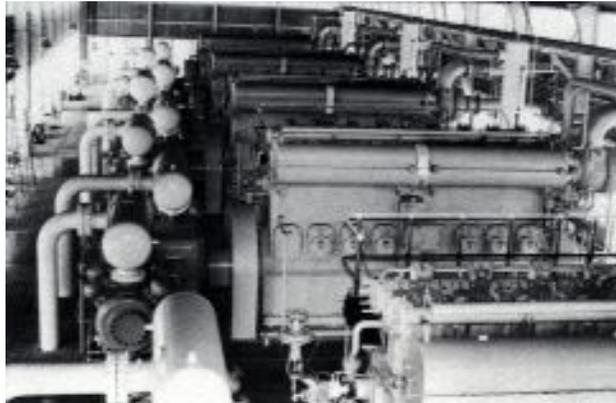


High Ohmic Value, Resistor Spark Plugs Suppress RFI

It is the age of the micro-processor, and "high-tech" is having a heyday. Computers hum in quiet efficiency while industry enjoys the instant transmission of data that is increasing the productivity of virtually every operation. Unfortunately, there is an invisible feature of spark-ignited engines that can interfere with the operation of computers. It's called RFI (Radio Frequency Interference), and it can be disruptive and, in some cases, even dangerous.

Items which could be adversely affected by unsuppressed RFI: 1) Solid-state, electronic magnetos; 2) Engine instrumentation, such as pyrometers and other safety shutdown electronics; 3) Electronic governors; 4) Engine remote start-stop controls, i.e., microwave controlled engines; and 5) Engine diagnostic equipment such as engine analyzers and oscilloscopes.

This "electrical noise," as it is often called, can come from a variety of sources, but Stitt Spark Plug Co., specialists in industrial spark plugs for over 70 years, has concentrated its efforts on eliminating the RFI caused by the spark firing across the gap of a plug in a continuous-duty gas engine. This has led to



These Cooper-Bessemer LS-8SG engine-compressor sets in a booster compressor station were outfitted with Stitt's U137 high temperature, gas-tight, center insulator bore seal spark plugs to effectively suppress RFI. The U137 plugs have a nominal impedance of 10,000 Ohms.

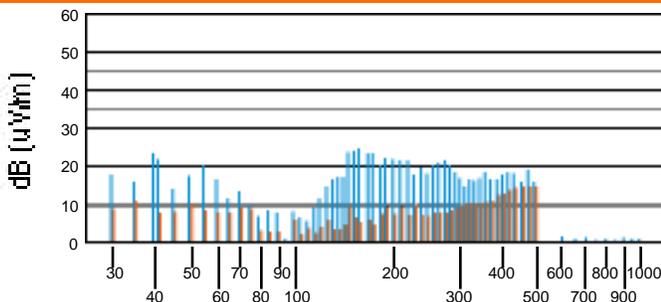
the development and manufacture of a new product that not only solves this specific problem, but also has general application to the industry as a whole. A recent example of such collaboration is Stitt's development of a high temperature, gas-tight, center insulator bore seal spark plug that suppresses the disruptive effects of RFI. Additionally, these plugs are said to remain Ohmic-value stable throughout the long-term elevated thermal loading of the continuous-duty gas engine. And this modification does

not affect the life span of the spark plugs, according to Stitt engineers.

Testing of RFI suppression by Stitt was accomplished at the request of a major interstate gas pipeline. A resistor modification of the 137BSP spark plug was developed to achieve the elimination of 1/4 MegOhm carbon composite resistors. These 1/4 MegOhm resistors, supplemental to the rest of the ignition system, had been found to be essential to the suppression of the RFI radiated by the "ignition noise" generated during the continuous-duty operation of the LS-8SG Cooper-Bessemer gas engines at their compressor stations.

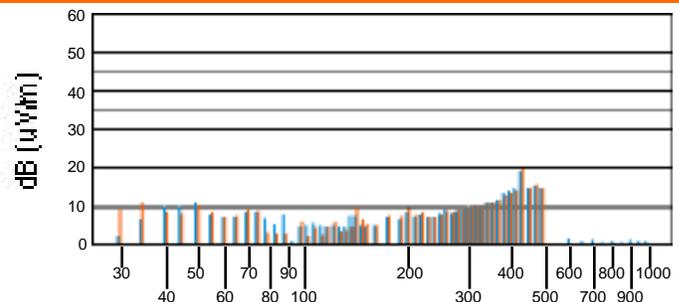
Stitt's findings in this development project were that with a nominal impedance of 10,000 Ohms, the company's high-temperature, resistor center seal suppressed RFI to the same observed levels achieved by the use of the 1/4 MegOhm resistors. Of importance also to the engine operator, the longevity of spark plug performance was not diminished by the resistor modification, according to customer reports to Stitt engineers.

RFI spectrum analysis, comparing high-Ohmic value U827 spark plugs in a cogeneration set with regular 827 plugs (left) and ambient RFI noise levels (right). The U827 plugs reduced RFI to about the same levels as ambient conditions, thus eliminating interference with a nearby computer facility.



Frequency (MHz)

— Engine operating with 827s 01/30/86
— Engine operating with U827s 02/24/86



Frequency (MHz)

— Ambient RFI. Engine not operating 01/30/86.
— Engine operating with U827s 02/24/86

The benchmarked U137 run-times per engine set of sixteen spark plugs were as follows:

ENGINE	INSTALLED	REMOVED	REASON REMOVED	TOTAL OP. HRS.
1	10-3-84	6-12-85		5547
2	5-7-84	6-12-85		9306
3	12-3-84	5-6-85	Overhaul	3227
		6-12-85		846
4	10-24-84	8-22-84	Overhaul	7168
		2-25-85	Rewire Ignition	4270
		6-12-85		3277
5	10-19-83	7-6-84	Overhaul	6169
		6-12-85		7873

Another example of the importance of "electrical noise" suppression is illustrated by Stitt's assistance in virtually eliminating RFI emitted by a cogeneration set ignition system that had caused the suspension of operations at a nearby computer facility. Extensive monitoring undertaken at the computer facility had localized the RFI sources at the secondary wiring, transformer coils, and primary wiring system in the engines operating at a packager's co-gen facility. The initial request to Stitt had been made for recommendations on shielding the ignition system in order to attenuate RFI. However, rather than initiating an expensive shielding of the system, which might have nullified reliability/durability improvements that had already been made on the ignition system, Stitt recommended the use of its 827 spark plugs, modified to the 10,000-15,000 Ohm level, on an engineering trials basis.

These newly modified plugs were installed in February 1986, and no operating problems have been reported since that time. The computer facility has also reported that installation of Stitt U827s has rendered the "electrical noise" of the engines undetectable from the ambient "noise," and their monitoring devices can no longer tell if the packager's engines are "on" or "off." Of equal importance, in addition to virtually eliminating all measurable RFI, these U827 plugs operated 1200 r/min, V-angle, ebulliently-cooled, 4-stroke engines for over 1500 hours, when they were removed as a consequence of scheduled, routine maintenance.

In addition to these high-Ohmic value resistor spark plugs, Stitt has also developed a high temperature, center insulator bore seal with lower resistance values of a nominal 4000-7000 Ohms. These plugs are designed for most

applications where electrical resistance in the secondary side of the ignition circuit is desired for the attenuation of the "electrical noise" (RFI) that can adversely affect the performance of micro-processors or other solid-state, electrical circuitry.

During a research project for the Gas Research Institute, these plugs were operated in a methane-fueled, Chevrolet 7A L displacement, V-8 engine. Packaged as a cogeneration generator set module developing 60 kW at 1800 rpm, and under worst-case lube oil consumption conditions (1 L per 27 hours of operation), Stitt RF407L plugs met the durability objectives of 4000

hours of continuous duty operation.

In further testing to validate the observation that RFI suppression/attenuation can improve engine performance, Seattle Metro and Stitt cooperated to evaluate Stitt's R80 resistor spark plugs (4000-7000 Ohm) in their ebulliently-cooled, sewer gas/digester gas-fueled, 1200 rpm, V-16 turbocharged, VHP Waukesha co-gen engines. In a carefully monitored run of these engines, using the Stitt R80's, the first P9390GSI outfitted with the R80's has reportedly been operating for over 3000 hours, with no spark plug changes, and without any observed misfiring or unscheduled ignition shutdowns. According to Stitt engineers, the RFI suppression contributed to the performance improvement of these engines.

Today, as a result of their research and testing, Stitt engineers believe high-Ohmic value, resistor spark plugs will become very significant in the general design and manufacture of spark plugs. And for this reason, all Stitt spark plugs can be furnished incorporating this electrical resistance while still retaining traditional longevity and performance. In Stitt's high-Ohmic value resistor spark plugs the standard level of resistance is 4000-7000 Ohms. These plugs are designated by an "R" prefix. The higher level of resistance, 10,000 - 15,000 Ohms, is designated by a "U" prefix. *

A cogeneration set at Seattle Metro's West Point sewage treatment facility, in which Stitt 4000-7000 Ohm R80 resistor spark plugs were installed. The first engine outfitted with the plugs has reportedly been operating 3000 hours, with no spark plug changes and without any observed mis-firing or unscheduled ignition shutdowns.

