George Gillespie

10454 Fairway Ridge Road, Charlotte, North Carolina, 28277 | 704 451 9807 | ggillesp333@gmail.com

January 5, 2015

The Honorable Nikki R. Haley
Office of the Governor
1205 Pendleton Street,
Columbia, South Carolina 29201

Dear Governor Haley,

This is a proposal to produce JOBS and expand Aviation and Aerospace in South Carolina. I am an unpaid Aviation Consultant to Duke Engine Company of New Zealand and have been given the task of finding a Majority Partner to fund a new US Corporation with Duke Engine Company of New Zealand as Minority Partner and bring the Duke Aircraft Engine from Concept form to production and stamped with MADE IN THE USA with World Wide Distribution rights. Any fee that I earn will be negotiated with the Majority Partner.

Duke Engine Company New Zealand is a Design Company and not a manufacturing company. Over the last 12 years they have designed, patented and tested a very unique four stroke engine that is small, light weight, one third less parts with a high power density, vibration free and with a spark plug ignition, can use auto fuel (91 to 98 octane), Aviation Gasoline 100LL, Kerosene, Jet fuel, Diesel fuel, Biofuel, Liquefied petroleum, CNG and Hydrogen.

Mahle Powertrain LLC, formerly of Cosworth Engines of Racing fame in the UK are considered experts by most engine manufacturers have been involved with testing the Engine as the concept evolved. Mr. Hugh Blaxill, General Manager of Mahle in the USA has written several supporting letters, (enclosed).

South Carolina has a strong Aerospace Community and with numerous Government and Aviation facilities will have many qualified Veterans returning seeking jobs. These jobs will create engineering and precision assembly that can employ even the disabled.

When you consider that major changes are taking place in the General Aviation Market, OEM producers like Cessna, Piper, Beech, Cirrus and others have priced their single engine aircraft out of reach of the majority of General aviation Pilots. This has opened the door to the EAA Experimental Home Built market, add to that the LSA Light Sport Aircraft coming to the US from other countries and the US, they account for more new single engine aircraft than the OEM market combined and with less restrictions from the FAA.

The rapid advance in the Government procurement of UAV Drones for Military use will require more new and advanced engines. Currently this market is just hardly scratching the surface.

The Aircraft Industry has been painfully slow to make changes in the flat air cooled light aircraft engines from Continental, Lycoming and Franklin and others, designed in the 30's, 40's and 50's. They all burn only gasoline, costly enough in the USA, but in Europe, very costly if you can find it. In Africa it is very difficult to find, but jet fuel is available World Wide at reasonable prices.

Conservationist in the US have convinced the Government to eliminate the use of Aviation Gas 100LL because of the lead content. There is a major search for a replacement fuel. The Chinese have purchased the Continental Engine Company because they have developed an Aero Diesel Engine, currently being used in the popular Cessna 172 and Skylane Models, able to burn jet fuel. Unfortunately the Aero Diesel weighs and costs almost twice as much as the engine it replaces. A major factor in aircraft design is weight and cost.

The Duke Engine has all of the features needed at this stage and timing. It is the Worlds only Patented viable Economical, Small, light Weight, Axial, Four Stroke, vibration free, Liquid Cooled, Spark Ignited, Multi Fuel Engine with High Power Density that can be adapted to the current EAA, LSA, UAV light Helicopter and when certified OEM markets.

The timing is right. This N.Z. Company would like to have this product MADE IN THE USA. South Carolina would be the right destination. I humbly ask your help to find the suitable Partner to invest their time and money or if as a manufacturer help us put together several Companies that will develop the Duke Engine USA from Designs from Duke N.Z. to a Commercially Successful Aviation Engine.

I am available to meet with anyone willing to discuss this project. Much more information and a business plan is available

This is the opportunity to be the first with a Market changing new engine with technical and commercial advantages.

Sincerely,

George Gillespie

MAHLE

Powertrain

November 06, 2012

MAHLE Powertrain LLC
41000 Vincenti Court
Novi, MI 48375-1921
Phone 248-471-5000
Fax 248-471-3680
www.mahle-powertrain.com

Duke Engines Ltd
PO Box 879
Shortland Street, Unit 5
Auckland
New Zealand 1015

Duke Engine V3i

Dear Ralf

Following the completion of our test program on the Duke engine, I would like to summarise our current view of the prospects for commercialisation and future Duke/Mahle cooperation.

1. Spark ignition operation on JP8 demonstrated performance levels above our expectations and greater than other comparable conventional 4 stroke port injected engines we have knowledge of. This is a significant achievement for the Duke and MAHLE teams and demonstrates of the engine for operation on heavy fuels.

2. We believe there is more potential, given further development of the current combustion system. It is likely that the engine performance and efficiency would further benefit from the application of direct fuel injection.

3. In our previous letter dated April 16 2012 we stated that it is our view that the Duke engine is viable for development to production with currently no insurmountable roadblocks identified. Development issues noted during this testing have not changed that view.

4. Fundamentally the combined characteristics of high power density and operation on heavy fuel make the Duke engine an excellent fit for the specialist high-value aerospace and military applications.

During the test work I was pleased to see the good team working of the Duke and MAHLE teams. The combined teams worked hard and well to deliver a good conclusion. The contribution of both organizations shows the high potential for future cooperation in both engine development to production and component supply. MAHLE Powertrain LLC is willing to continue its efforts in supporting Duke and future partners.

Best regards

Hugh Blaxill

General Manager
MAHLE Powertrain LLC
41000 Vincenti Court
Novi, MI 48375
USA

MAHLE

Powertrain

April 16, 2012

MAHLE Powertrain LLC
41000 Vincenti Court
Novi, MI 48375-1921
Phone 248-471-5000
Fax 248-471-3880
www.mahle-powertrain.com

Duke Engines Ltd.
PO Box 879
Shortland Street, Unit 5
Auckland, New Zealand 1015

Dear Ralf

Just to follow up on our various communications I would like to confirm the key messages concerning the Duke and MAHLE Powertrain efforts moving forward:

1. MAHLE Powertrain is supporting Duke currently in its work to develop the Duke engine and demonstrate its capability. This includes testing and development activity, access to MAHLE Groups component experts as well as marketing and US regional support. As I have said in the past MAHLE Powertrain is very interested in supporting potential applications of the Duke engine, initially in military applications. We are especially interested in supporting the engineering of the product to take it to market and can also support with the supply of production components.

2. In MAHLE Powertrains experience we expect that the price of a Duke engine in production will be comparable to existing production engine. This is based on the fact that fundamentally the components in the Duke engine are similar in design or process to existing engines. We expect it would be cheaper than some of the more exotic engine designs available today in certain applications.

3. We envisage at this stage a production engineering program to require and investment in the range of US$25M and take approximately 36 months to deliver. These estimates of course depend on application and production volumes which will drive the complexity of any validation program but are based on our experience in the field.

4. We don't see, at this stage, any fundamental road blocks in the design of the engine. Of course there are differences, which lead to some of the advantages of the engine, which require further development. We expect that with the experience of the Duke engineering team, MAHLE Powertrains capability and MAHLE's in depth component design knowledge, the development is readily achievable. Once a suitable engineering program has been completed we would expect the engine to have equivalent durability and reliability to current engines in the designed-for application.

5. MAHLE will be interested in supply components for the engine and is willing to support Duke in establishing a US manufacturing base. The alternatives being considered at this stage could be via MAHLE's manufacturing partners, in house at MAHLE or utilizing MAHLE's production know-how to support the manufacturing at a third partners facility.

I hope that summarizes our discussions to date and look forward to our future work together.

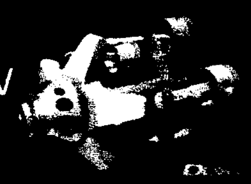
Kind regards,

Hugh Blaxill
MAHLE Powertrain, LLC
General Manager and Head of Engineering Services NAFTA

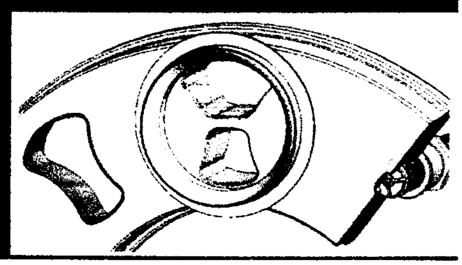
Duke Engines Proprietary and Confidential

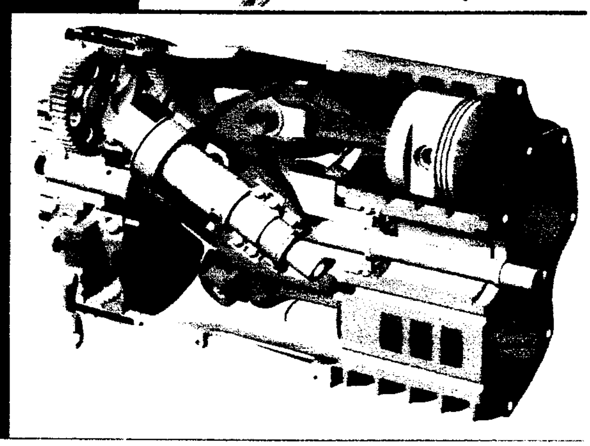
DUKE ENGINES

Duke Engine Technology Overview (Slide 1/x)



- Introduction
  - 5 conventional cylinders arranged axially
  - Cylinder group rotating counter to crankshaft at 20% of crank speed (5 Cyl) causing pistons to reciprocate at 120% of crank speed.
  - Near sinusoidal piston motion using "Z" crank with single inclined journal and nutating body attached to all connecting rods
  - 4-stroke porting and valve function achieved using sliding seals between low-speed rotating cylinder group and monoplane ported surface

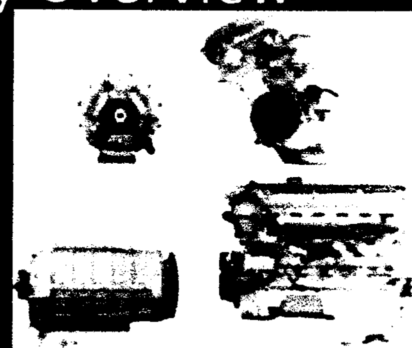




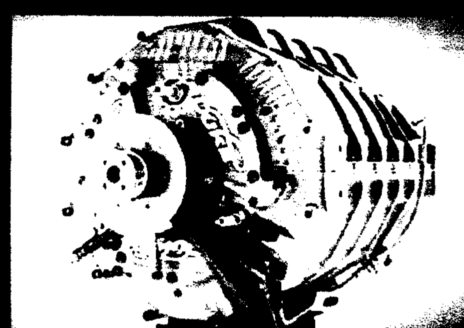
Duke Engines Proprietary and Confidential

Duke Engine Technology Overview

- Key characteristics (1)
  - Near cylindrical shape with large displacement in small external package
  - Low parts count on per cylinder basis
    - 5 Cyl. with 3 injectors, spark plugs and manifold connections.
  - 50%+ weight reduction potential
  - (V3i 3.0l long engine assembly 97kg / 213lb with conventional materials).
  - Up to 50% less size/volume compared to conventional (V3i long engine fits in 89l packing case).
  - Excellent NVH: better than current reference engines.
    - 5 cyl. with 3 firing events per crankshaft rotation, as conventional 6 cyl.
    - Near perfect mechanical balance without additional balance shafts



3.0L Duke compared to BMW M54b30



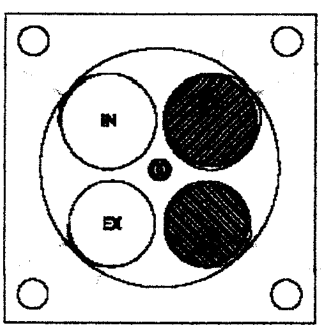
Duke Engines Proprietary and Confidential

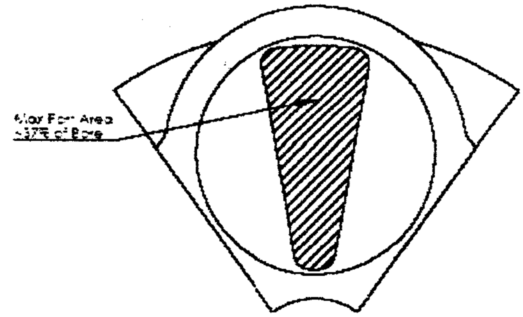
DUKE ENGINES

Duke Engine Technology Overview

- Key characteristics (2)
  - High performance potential 1 - Volumetric efficiency
    - inlet flow area limit 30%+ greater than 4 valve layout (>37% bore area)
    - No valve-train associated speed limit.
    - Sinusoidal piston motion giving lower piston inertial loads
    - V3i 6000 rpm (7200 rpm reciprocating) design speed.

Conventional High Performance 4-Valve





Duke Engine Port

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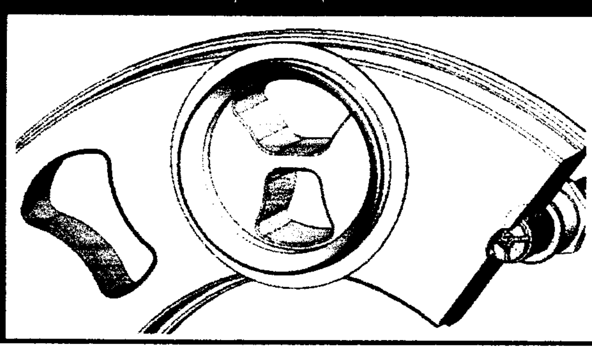
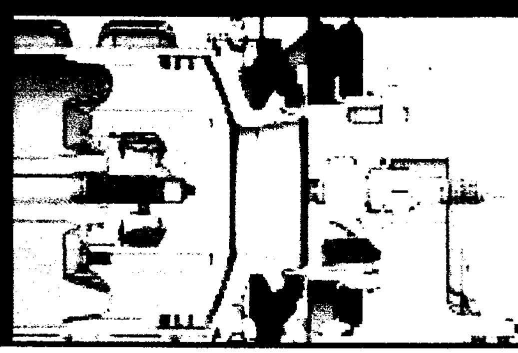
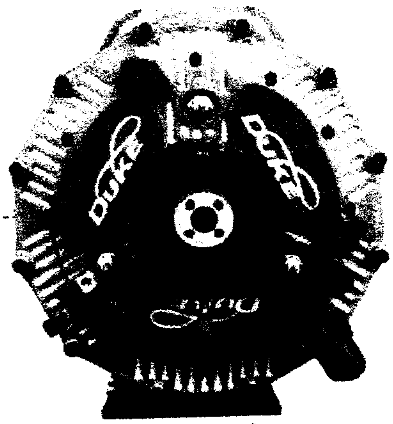
Duke Engine Technology Overview

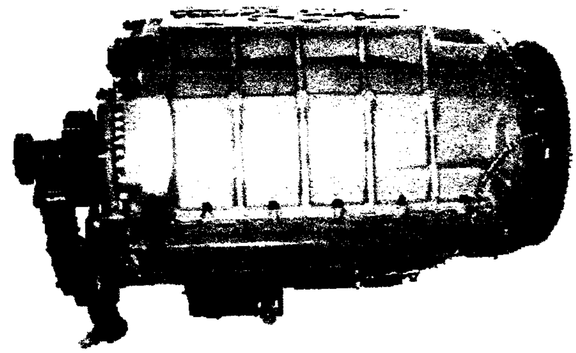
- Key characteristics (3)
  - High performance potential – High torque
  - Detonation resistant - charge not exposed to hot exhaust valves
    - High Compression on low octane fuel - Key to operation of SI cycle on Jet fuel/Kerosene.
    - 12.5:1+ compression ratio on 95 or 91 Octane – full load, MBT spark, lambda 1.
    - 11.9 Bar (172psi) BMEP current status on Gasoline (low compression Jet A1 engine)
    - 10.2 Bar (148psi) BMEP current status on Jet A1
    - 8.9 Bar (128psi) BMEP current status on JP8
  - Pistons reciprocate at 120% of crank speed = 20% increased output torque at given crank speed. (3.0L test status 340 Nm)





for many uses including marine, military, automobile, light aircraft and range extender applications.

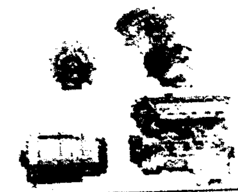




The Duke Engine is already in advanced stages of development. Multicylinder engines are operational and have been tested in Australasia, Europe and in the USA.. The Duke engine's 5 cylinder, 3 litre, 4-stroke internal combustion engine platform with its unique axial arrangement is already in its 3rd generation. During development the Duke has been tested at Mahle Powertrain in the UK & in the USA, and test results are available.

The Duke Engine features many technology breakthroughs. The Duke's unique counter rotation, 3 dimensional, almost vibration free motion and the innovative methodology employed to achieve this, addresses previous limitations that have prevented the commercialisation of axial piston engines to date, especially at higher power and speed.

The Duke offers designers greater freedom. Duke's axial



The Duke Engine delivers huge weight and size savings. In comparisons made to conventional IC engines with similar displacement, the Duke engine was found to be up to 19% lighter and up to 36% smaller.

The Duke Engine has negligible 1st-order or 2nd-order Vibration. The Duke's nutating reciprocator leads to very low angles of con rod articulation resulting in a near sinusoidal reciprocating motion. This combined with the counter-rotating cylinder group and crankshaft in the Duke engine delivers near perfect mechanical balance resulting in a very low vibration engine.

The Duke Engine delivers high thermodynamic efficiency. The absence of hot valves in the favourably shaped combustion chamber allows high compression ratios for efficient operation on low octane fuels. With only 3 exhaust headers for 5 cylinders geometry creates a very compact cylindrical package, allowing for a wide range of design applications, limited space fit, aerodynamic optimization and ease of installation.

there is a low surface area for heat loss prior to any catalytic converter, offering a potential catalyst light-off benifit.

Overview continued –

The Duke Engine offers wide fuel flexibility. The current engine can be run on any suitable spark ignition fuel. Kerosene/Jet A1 operation has been successfully tested. It is expected with further development to be able to operate on all appropriate fuels, including Ethanol/Methanol and blends, Bio ethanol, LPG, CNG, Hydrogen, Kerosene and Diesel.

The Duke Engine is far less complex than traditional IC engines. The Duke engine's lower component count (only 3 sets of injectors and ports for 5 cylinders with no valve train), coupled with potentially lower production costs, make for savings in manufacturing and operation. And the Duke uses existing materials and manufacturing processes in its construction.

Duke Engines is committed to Research & Development, with further advances already underway. The Duke is currently in its 3rd generation running prototype. The engine has been successfully tested at University of Auckland and Mahle UK & USA dynamometers and test facilities, (data available), with systems

The Duke Engine has IP protection. Throughout the development process, Duke Engines has filed patent applications to protect its technology.

Duke Engine Financial Supporters. In addition to the initial founders inputs, Duke Engines has enjoyed support financial and otherwise from New Zealand Trade & Enterprise, TechNZ, Ministry of Science and Innovation and private investors including the Gallagher Group.

Duke Engines - the Future. Duke Engines is now at a third generation of the engine and currently developing the next generation of the technology, including running with kerosene and biofuels and exploring the unique design characteristics of the Duke engine to allow Variable Compression Ratios.

Duke Engines is actively seeking partners right now to join in developing this visionary technology around application specific parameters.

Frequently Asked Questions

WHAT TYPE OF ENGINE IS THE DUKE ENGINE?

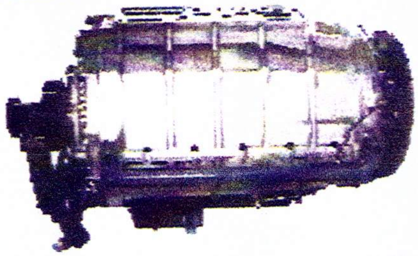
The Duke engine is a four stroke "axial" reciprocating engine. "Axial" because the axis of each cylinder is aligned with the axis of the output/crank shaft. Axial engines are sometimes called 'barrel' and 'Z-crank' engines. The former refers to the cylindrical shape of the Cylinder Group whilst the latter alludes to the shape of the Crankshaft. The Barrel shape is a result of the pistons being spaced evenly around the central Crankshaft and aligned parallel to the Crankshaft axis. The 'Z' in the crank provides the journal surfaces upon which the combustion loads (via conrods and then a swashplate, or the case of the Duke engine a 'Reciprocator') act to provide the driving torque of the engine. The uniqueness of the Duke Engine is the combining of these two motions in a counter-rotating configuration which results in a myriad of mechanical and performance advantages.

WHAT FUEL DOES THE DUKE ENGINE RUN ON?

So far the prototype and developmental engines have run on petrol of various octane levels (91 through 98 octane) and kerosene based Jetfuel without modification and can be readily modified to run on diesel, or indeed any of the alternatives currently proposed as replacements for petroleum-based fuels, such as Bio-Fuels, Hydrogen, LPG, CNG, etc. In fact there are certain features such as the relative coolness of the Combustion Chamber walls during the combustion phase that give the spark ignition Duke Engine advantages for working on low octane fuels, such as kerosene. This feature has some manufacturers very excited as it offers the opportunity for a lightweight, high output engine operating on jetfuel – a fuel typically requiring a heavier, bulkier Diesel engine to be specified.

WHAT ARE THE MAJOR ADVANTAGES OF THE DUKE ENGINE?

The most immediately obvious advantages of the Duke Engine are its size and weight when compared to late model conventional internal combustion engines. Duke purchased two current production 3-litre automobile engines (one European and the other Japanese) for measurement to provide true 'apples with apples' comparisons. The current prototype Duke 3-litre engine is up to 19% lighter than those two engines, despite being far from optimised for minimum weight. For example, the significant weight contributed by the many fasteners in the developmental engines would not be present in a production version. The Duke's size advantage is even more impressive, being as little as one third of the shipping box volume - the crate size that would accommodate the engine - of the 3-litre comparison engines. Similarly, a 'shrink wrap' measurement of the volume of the comparison engines showed the Duke has up to a 36% smaller volume.



WHAT OTHER ADVANTAGES DOES THE DUKE ENGINE POSSESS?

- Valveless porting, reduces the parts count and size of the engine and gives much greater freedom with the design of the combustion chamber shape.
- Internal geometry generating increased power strokes per crank rotation (compared to a conventional 4-stroke engine). Dynamically the current 3-litre version displaces 3.6L for 2 revolutions of the output shaft, making it equivalent to a conventional 3.6 litre engine. A Duke engine can have any odd number of cylinders, with the optimum being 5 for space utilisation, the number of cylinders in turn determining how many power strokes are delivered per crank rotation.

- A greater range of design freedom due to its small cylindrical package size
- Reduced number of combustion 'banks' - the current 5 cylinder engine has only 3 sets of inlet ports, sparkplugs, exhaust ports and associated manifolds, with each cylinder generating a 4 stroke cycle as it passes each of the 3 'banks' - leading to overall weight, volume and parts cost savings.
- An almost perfectly sinusoidal piston motion leads to a near absence of secondary and higher-order unbalanced piston/conrod forces.
- Counter-rotating cylinder groups and crankshart provide cancellation of torque reactions and gyroscopic forces during engine speed flutuations and vehicle maneuvers.
- Power output versatility with the option of utilising high torque/low speed when using the cylinder group as the power take-off point as well as, or instead of the usual crankshaft output.

WHAT IS THE PERFORMANCE OF THE DUKE ENGINE?

Even at the current non-optimised stage in the engine's development, the Duke Engine is delivering superior torque to the comparison engines mentioned above. Specific fuel consumption (a power independent comparison measure of the fuel economy of an engine) has shown a strong downward trend as the design has developed, being already competitive with with modern high end automotive engines operating a similar combustion cycle (gasoline, port injected, spark ignition). More detail

WHAT ENGINEERING CHALLENGES FACE THE DUKE ENGINE?

The design has come a long way since the Duke engine concept was first turned into hardware, yet optimisation of its features has barely begun. Despite this, the Duke engine is favourably comparable to modern conventional designs.

Mechanical and other main characteristics (Seal lubrication, combustion, performance, port timing, port shape, manifold geometry, reciprocating to rotary conversion mechanism etc) are performing satisfactorily at prototype stage, but all will no doubt benefit from concerted R&D effort.

WHY ARE THERE NO COMERCIALLY AVAILABLE AXIAL ENGINES?

Axial engines are challenging to make practicable at typical engine operating speeds. The technical innovations of Duke Engines have been aimed at overcoming these challenges.

WHAT ABOUT SEALS?

The Duke sliding seal arrangement is analogous in function to a ported 2-stroke or Wankel engine port sealing, allowing similar technologies to be applied. The Duke uses sliding metallic seals operating on an oil film. Materials used are those found in production road vehicles. The V3i engine has seals which are of a simple design and operate at modest contact stress and sliding velocities. Oil film calculations conducted support good nominal lubricating film thickness.

All V3i gasoline and Jet A1 testing to date (March 2012) has been completed with a single set of prototype seals which remain in good condition. These seals will be reassembled into an engine for further testing without modification or repair.

Duke challenges in seal development are much less than in a 2-stroke or in the Wankel engine due to lower sliding velocity and a flat monoplane sealing surface (Wankel has 3 seal faces, 1 curved, that meet at a corner, seals). So far, our sliding seal challenges are proving to be modest in reality.

For more Information contact: Ralf Muller ralf@dukeengines.com
Or John Garvey john@dukeengines.com
Duke Engines Limited PO Box 879
Shortland Street - Auckland 1015
T.+64 021 250 4494
www.dukeengines.com