AUTHOR: JOHN BRISTOW

55 million revoluti

It is rare that we as modellers consider the amount of testing that is carried out before a new product hits the market, so we were particularly interested when Deluxe Materials offered to tell our readers about the testing they had carried out in conjunction with AMT Turbines to get their new turbine oil approved for use in AMT engines. So let's hear directly from John Bristow, Deluxe Materials owner, with the full story about this interesting test - RCJI.

When we at Deluxe Materials decided to produce an environmentally friendly model turbine oil, we broke new ground by developing a specific lubricant that had so far not been marketed by anyone around the world: Power Model Jet, the new environmentally friendly model turbine oil (you can read about it in the specific article published in issue no.163 of R/C Jet International). One of our long term aims was to gain acceptance by turbine manufacturers so that our oil could be supplied to countries around the world, in the knowledge that it could be safely used in the majority of model turbines.
The advantages were seen as being twofold:
- For modellers - would be easily accessible through their local hobby store wherever they lived.
- Turbine manufacturers would have a purpose made oil that they knew would be available worldwide, it having a consistent formulation, not changing at the whim of a third party blender.

This article focuses on the extensive testing done to gain the confidence and approval of Bennie and Anita van de Goor of AMT Netherlands. It was a pleasure to work with AMT from the start to finish of the project.

A thorough examination of the oil's performance

There were a number of challenges that needed to be addressed to achieve our end goal of having PowerModel Jet oil approved:
- No oil test existed for the evaluation of a specific lubricant, so we developed a new test procedure specifically for model turbine oils.
- We needed the support of an experienced AMT owner and operator and here Geoff White stepped in and kindly lent us a Pegasus HP turbine. To ensure the engine was performing to specification, the Pegasus was sent to AMT and fully serviced, ensuring we had an accurate baseline for testing.
- A critical evaluation of the best place to run the test was needed. Calculations led us to believe that even a test cell designed for high power motorcycles would be unable to cope with the heat from a small turbine.
- We needed to select a test fuel. We decided to use Jet A1 because its quality is consistent, and it is a well-controlled fuel and recommended also by AMT.

The key was working with Geoff and his AMT Pegasus

We visited Geoff on the 10th December 2019 to consult with him and collect the Pegasus turbine so that it could be sent to be prepared for test by AMT.
Geoff liked the idea of introducing such a new oil, as traditional turbine oils were becoming difficult to obtain and he was also aware that they contained harmful organophosphates and as such they are becoming less and less popular.
He reminded me that the oil would need to have manufacturers approvals before he would start using it, as servicing/warranty might otherwise be invalidated.
The Pegasus engine specification states it gives 167 Newtons of thrust whilst consuming approximately 500 grams of kerosene per minute. (Note from AMT: The MAX RPM during the test was higher at 119.000 RPM, not 117,000 as detailed in the manual. This is due to a modification we implemented in turbines delivered post 2005. The fuel consumption would also have been proportionally higher).
The rebuilt Pegasus came back in immaculate condition **(Fig. 1-2)**. Also supplied was a refurbished fuel pump and even a new Li-Po battery, all beautifully packed and presented by AMT.
In **Fig. 3** some parts of the Pegasus photographed prior the test.


Fig. 1


Fig. 2

ons and counting!

Test procedure development

It became evident during discussions with Bennie van de Goor at AMT that a minimum of a 10 hour test would be required to give a full evaluation of high temperature bearing lubrication and deposit control. However, no such test procedure existed in the industry. Bennie had advised that the bearing temperature, typically over 250°C, would evaporate the kerosene within 1-2 minutes during the cool down period. This would be a critical feature of an oil test because no new oil is then being supplied to the bearings.

A new test procedure involving 10 stop/start sequences was needed in order to:

- Assess the ability of the oil captured within the bearing rolling elements to withstand heat.
- Evaluate combustion chamber deposits.

Considering everything, we came up with this procedure **(fig. 4)**; the test consists of a large number of "heat soak" cycles followed by a normal ECU controlled shutdown or soaking period. The simple start/stop procedure accelerates the evaluation procedure. It tests bearing lubrication and assesses the ability of the oil captured inside the rolling elements of the bearing to withstand heat. The stop/start sequence increases the severity (compared to running continuously) and allows the test to be completed in a relatively short time. The total test period of 10 hours is just achievable in just 1 day.

At the start and end of the test the turbine starter motor current is measured as a way to assess friction caused by deposits or oil thickening. An intermediate measurement can be made at the mid-way point (5 hours). The performance of the oil is assessed by visual inspection of the bearings and measurement of the current in the starter motor (friction).

The end of test current measurements can also be made at the factory and compared with typical data.

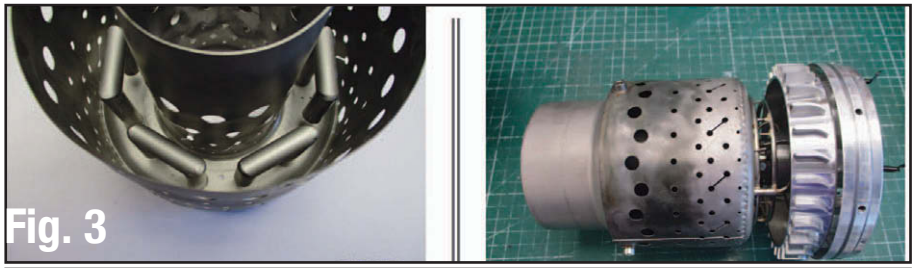


Fig. 3

Test cycle – Model turbine oil evaluation

Sequence	Turbine	Duration/ minutes	elapsed duration/ mins	Measurement criteria
1	Start from cold and run up to 100% of max jet pipe temperature	~32 LITRES FUEL	~50min at max rpm	At cold start measure rpm and current of starter motor. Record all data on control unit : rpm / temperature as normal
2	Engine close down to stopped to allow heat soak under control of ECU.	~10 mins to full cool down to full heat soak and allow re-fuelling of 25 litre fuel reservoir.	10	
3	When ECU allows, repeat sequences 1 & 2 using normal start procedure for total of 10 hours		10 hours with interim starter motor current measurement at 5 hours.	Measure starter motor current and check bearings for noise and roughness at 5hr and 10hrs.
4	Engine returned to AMT for examination			

Fig. 4

Fig. 5

Evaluation of combustion chamber deposits

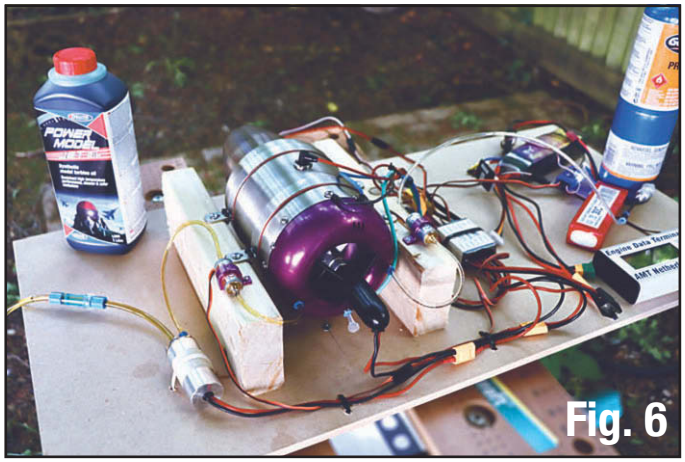
Although not a primary test criterion here, combustion chamber deposits can also be assessed and recorded during this same test e.g. by weight increase of selected combustion chamber components or by visual rating (photography). This method was accepted by Bennie on the 8th of April, so we were now ready to run our test!

Inside or outside?

As said, it quickly became evident that the possibility of running the turbine on a local dynamometer set-up close to the Deluxe Materials HQ was not suitable: it would have contained the sound, but the heat losses from a model turbine were going to far exceed that of a 100hp motorcycle. Hence we decided that a dynamometer install would not cope and opted for testing outside.

Fuel

Fuel was the next issue, and we opted for Jet A1 fuel, as this is a controlled fuel and designed to a known standard. The BP fuel was sourced from a local airport, Blackbushe in Surrey. Practicalities now came into play and we sourced thirteen 25 litre high density containers into which we pumped aviation kerosene pumped straight from the tanker **Fig. 5**.



Testing

By April, Geoff White had built up the test rig **(Fig 6)** and we were ready for testing. **Fig. 7** Here you see Geoff (on the right) and I in June ready to start the test

Fig. 8 shows the total amount of aviation kerosene fuel and oil we had to have on hand. We added 1.35 litres of oil to each 27 litres of kerosene giving a 5% or 20:1 mix.

After a hearty breakfast, Geoff and I started the test at 10.15 am on the 16th May, running all day and finished on schedule at 8:35pm.

My thanks to Geoff for training me to start a gas turbine. Total running time of the test was 10.03hrs (7.78 hours running at the max rpm of 119,000, with 2.25hrs of cool down, generating bearing heat soak).

Duration of the test sequences was defined by the fuel consumption, this being 28.35 litres of fuel-oil mix. The exact running times for each of the 10 sequences was recorded and given in **Table 1**

Table 1 - running details of each sequence

Sequence	1	2	3	4	5	6	7	8	9	10
Start time	10.15	11.07	12.15	1.15	2.15	3.25	4.25	5.25	6.50	7.50
Finish time	10.57	12.00	1.02	2.00	3.10	4.10	5.10	6.10	7.35	8.35
Running Period at max rpm (mins)	42	53	47	45	55	45	45	45	45	45
Cool/soak time (mins)	10	15	13	15	15	15	15	40	25	In storage for inspection by AMT

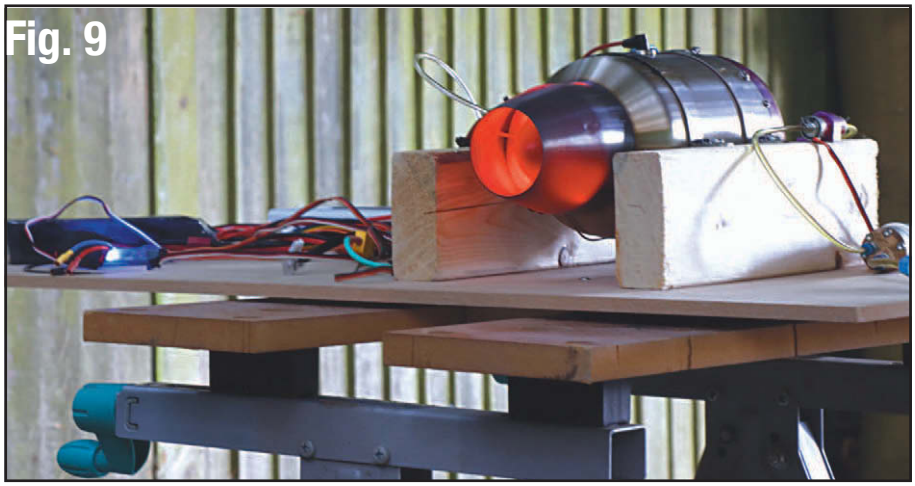


Fig. 9


Fig. 10

Fig. 9-10 show dramatic shot of the Pegasus running at its maximum 119,000 rpm at dusk.

Fig. 11 shows the AMT data recorder.

Throughout the testing, the Pegasus started promptly after each cool down phase, running faultlessly right up to the maximum 119,000 rpm. To make it clear, the 10 hours of running was all completed in a single session, so as well as a test of the oil, it is also testament to the quality of the AMT turbine that this was completed with no issues whatsoever.

We were eventually to consume a total of 283.5 litres of fuel (270 litres of kerosene plus 13.5 litres of Power Model Jet Oil) **Fig. 12**.

We estimated a total of 55.5 million (55.5492 x 106 revs to be precise) revolutions in 10 hours...is that really 5 times what a Le Mans race winner would do in 24 hours?

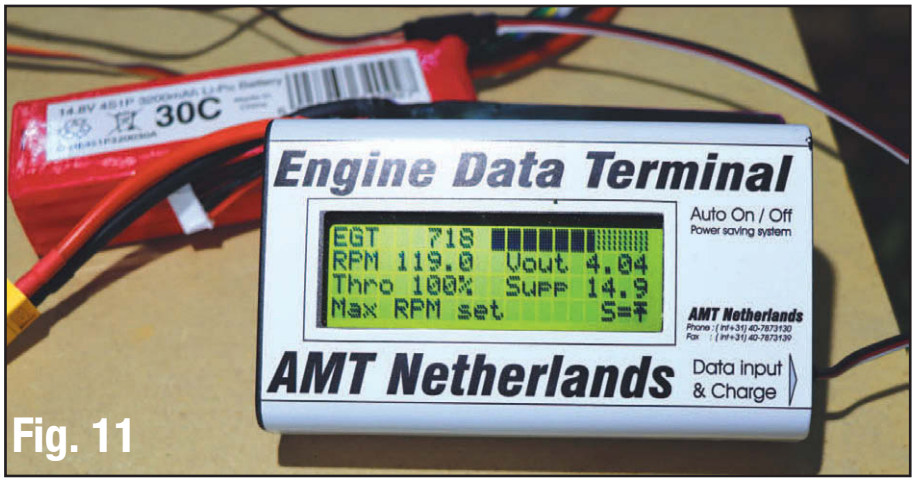


Fig. 11


Fig. 12

Turbine sent away

The same evening the engine was removed from the test stand and sealed ready for shipping back to AMT where it was received on the 2nd of June.

Examination results

On the 19th of June we received a great email from Bennie reporting on the engine inspection with photographs of some of the parts **Fig. 13-14** "We indeed


Fig. 13


Fig. 14

disassembled the Pegasus HP engine with serial number NL2494:

Bearings

Both ball bearings were in good condition after the 10 x 1 hour test cycle.

Carbon build up

The carbon is no more than we expected after a 10 hour run. In my opinion there is no need for additional tests at AMT to prove the quality of the oil
We also received this letter **(Fig 15)** where Bennie kindly now recommends our oil, even in his advertising **(Fig 16)**.

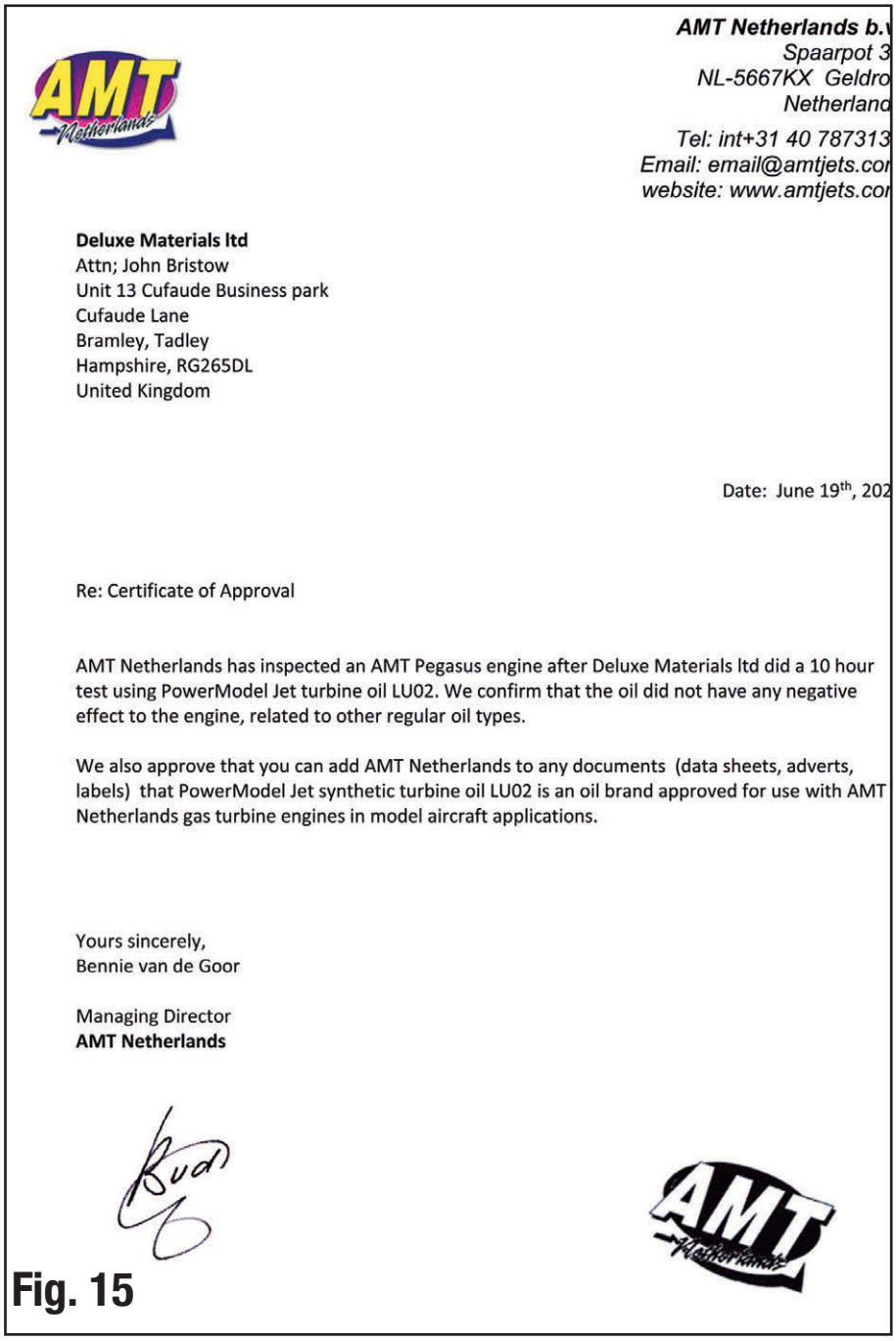
In conclusion

We developed a small turbine engine oil test procedure and completed a 10 hour, 55 million revolution Power Model Jet Oil test successfully.
The Pegasus engine, serial number NL2494, behaved faultlessly for the entire time with no starting issues, loss of rpm etc.
Mission accomplished!

My thanks

It has been a real pleasure and a most satisfying project: particularly rewarding has been working with Bennie and Anita van de Goor at AMT Netherlands, appreciating their highly professional approach at every stage of the project. I would also like to thank Geoff White for his operator/user experience and of course the 7 month loan of his Pegasus turbine: without him the task would have been much more difficult.
I would also like to thank my colleagues, Peter Brett for expertise on running small engines and Hugh Preston for his fuel advice. Without all their help, we would not be where we are today.

John Bristow
proud developer of Power Model Jet oil.



AMT Netherlands b.v
Spaarpot 3
NL-5667KX Geldro
Netherland
Tel: int+31 40 787313
Email: email@amtjets.cor
website: www.amtjets.cor

Deluxe Materials ltd
Attn; John Bristow
Unit 13 Cufaude Business park
Cufaude Lane
Bramley, Tadley
Hampshire, RG265DL
United Kingdom

Date: June 19th, 202

Re: Certificate of Approval

AMT Netherlands has inspected an AMT Pegasus engine after Deluxe Materials ltd did a 10 hour test using PowerModel Jet turbine oil LU02. We confirm that the oil did not have any negative effect to the engine, related to other regular oil types.

We also approve that you can add AMT Netherlands to any documents (data sheets, adverts, labels) that PowerModel Jet synthetic turbine oil LU02 is an oil brand approved for use with AMT Netherlands gas turbine engines in model aircraft applications.

Yours sincerely,
Bennie van de Goor

Managing Director
AMT Netherlands

Fig. 15

Fig. 16