Expectation for aircraft engines

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Environment:
JAL focus on carbon dioxide emissions reduction

- According to the international momentum of SDGs, Japan Airlines (JAL) made target in 2012, “we reduce carbon dioxide emissions per revenue ton-kilometer 23% compared to 2005 until 2020.”

【CO₂ reduction* trend 】

* carbon dioxide emissions per revenue ton-kilometer

2018 80.6%
2020 Target 77.0%
Various efforts are being made in daily operation to reduce CO₂ by flight crews, cabin crews and maintenance staff.

- **Engine water washing**
  - Engine water washing is performed as routine maintenance to clean up dust and sand inside of Engine for fuel saving.
  - FY18 achievement: 18,700 ton

- **Cabin sunshade**
  - During aircraft parking, the window sunshade hold down cabin temperature rise, which reduce APU operation on ground.
  - 800 ton

- **Water weight saving**
  - Fine control of amount of water on board based upon experience and prediction.
  - 7,600 ton
Environment:
Airplane operation for carbon dioxide emissions reduction

Take-off
- De-rate and rapid climb operation
  - Low power at take off, high power at climb, reaching cruise altitude ASAP to enjoy the best fuel saving performance. One of noise reduction flight method.

Decsent
- Drag reduction
  - Keeping safe flight operation, with shallow flap angle, delayed operation of flap and landing gear.

Landing
- Low power reverse operation
  - Reverse operation with idle power as long as aircraft weight and runway condition is met requirement.

Taxiing
- One engine taxi
  - To the spot after landing, taxiing with one engine operation.
Environment: New airplane introduction

- New “fuel efficient” airplane, such as A350 and B787, brings 15~25% CO₂ reduction comparing to old type airplane. So early aircraft renewal is key to reduce CO₂, but the stable finance structure is important as well to go forward.

【Fuel efficient airplane* in JAL】

<table>
<thead>
<tr>
<th>Year</th>
<th>Fuel Efficient Airplane</th>
<th>Other</th>
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<tbody>
<tr>
<td>2016</td>
<td>64%</td>
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<tr>
<td>2017</td>
<td>70%</td>
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<td>2018</td>
<td>76%</td>
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<tr>
<td>2019</td>
<td>79%</td>
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<tr>
<td>2020</td>
<td>80%</td>
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*A350, 787, 777ER, 737-800
Envirionment:
Bio jet fuel introduction

Investment to Bio Jet Fuel Company* in the U.S.A
*Fulcrum Bioenergy Inc.

JAL Bio Jet Fuel Project** in Japan
**sponsored by Green Earth Institute (Japanese Company),
collecting old cloths (cotton)
Thus, JAL is eager to reduce carbon dioxide emissions with many activities, so that JAL expect more fuel efficient aircraft and aircraft engines, that maybe same as other airlines’ expectation.

However, we know that is not easy way for the airline just to choose fuel efficient aircraft engines.

As well as environment, or more than that, airlines’ top priority is “Safety”.

Also, “Maintenance cost reduction” is very important.
How do you feel about Aircraft Engines?
Safety & maintenance cost

- We know “fuel saving” is very challenge, new technology, new design, new material, weight reduction, etc., that possibly become new real threat of “safety” in some cases.

- For example, B787 was big challenge and step to achieve great fuel saving, but the airlines is suffered with “technical issue”, more than previous type of engine, that was not predicted during engine development.

- Also, please note that although the airline have a maintenance program contract with OEM, a lot of engine removals due to technical issue give a big cost impact to both, OEM for maintenance cost and airlines for operational cost.
Safety & maintenance cost

=Example=

- **787/GEnx** HPT Stage 1 Blade cracking issue
- Corrective action is "increased wall thickness".
- JAL needs to remove approx. 30 engines in next 12 months for blade modification. To avoid "AOG*", additional spare or lease engines maybe required. -> operational cost

* AOG : Aircraft On Ground

Ref: GE WTT at Taipei 2019, Do not transfer any copy of picture.
We understand total operation cost is lower than before, but we wonder how long that will be kept in entire life.
Summary

Airline is always “greedy”, wants everything.

We like to save fuel to reduce carbon dioxide emissions, but that shouldn’t be trade off “safety” nor “maintenance cost”.

We expect OEM continuous efforts on,

new technology, new material, new product and repair,

to achieve 3 key factors.
Summary

Safety

Environment

Cost
Thank you very much for your attention !