Specification for engine borescope inspection report

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Abstract. From the angle of defence engine failure on flight and engine engineering management, combining the experience of borescope inspection for many years, through examples and pictures, this paper describes the specification of borescope inspection report, and further discusses the specification and process of borescope inspection work.

1. Introduction
With the development of modern electronics and optical technology, the borescope inspection equipment is changing with each passing day, and the borescope inspection work gradually develops from the experience type to the electronic and standardized direction of recordable records, remote diagnosis, and traceable defect expansion rules. In the whole engine body condition monitoring, the borescope inspection is the basic work, and it is also an important means of preventing the engine from parking in the air. Behind the attention of the engine engineers, manufacturer's technical support forces and the bureau regulatory agencies, it is an important reference for the engine engineering technology management [1].

In design and manufacturing, it is often said that "drawing" is the "language" of engineering. Similarly, in the communication of information, "borescope inspection report" is the "language" of borescope inspection work. The proper, accurate and comprehensive expression of "language" directly affects the science and rationality of background technology tracking and management. In other words, the quality of the detective report often represents the level of the probe and the quality of the work.

2. The borescope inspection report should contain basic information
With the wide application of computer software technology, basic information in borescope inspection report is usually obtained through computer system. Therefore, the focus of this paper is the requirement and specification of "damage description" module.

Like most of the agents, I was not aware of the problem of the "far - near" level when I was working in borescope inspection. At the site of borescope inspection, the angle and distance can be adjusted at any time, and the workers are immersed in the observation and analysis of the borescope inspection flaw, and they will have a deep impression on the whole picture. If more information is needed, the scope of inspection can be repeated or expanded at any time.

But for engine engineers or technicians who receive and analyze the reports, the borescope inspection report is all the information he has obtained. When taking a close-up photo of a defect, the magnification is often large, but the circumstances surrounding the defect cannot be obtained through the photo. It is well known that even though the stereoscopic method and the laser measurement method have been widely used today, the "comparative law" of the surrounding reference is still an important method to
judge the defects. And just a close-up or size measurement image clearly won't allow the engine engineers, the manufacturers and technicians who follow the analysis to get the full information. The agent must pass through the photo to send a more comprehensive message.

As a result, when the engine engineer reviewing the borescope inspection report, taking the turbine blades of the CFM56-7B engine as an example, usually requires the following pictures [2].

General appearance of the defect on the whole blade, including the site, the length of the leaf and the width of the chord [3]. - Vision

Able to determine the feature images of the defect category, such as ablation, nick, dent, etc. - middle

Features of the defect, such as the measurements of dimensions, etc. Because the larger the magnification, the higher the accuracy of the measurement, the main purpose of this picture is to obtain more accurate measurements. - close shot

Here is a comparison of the two scenarios. In figure 1, which seems to have an accurate size, lacks a "mid-shot" image, and the engineers who follow the analysis can't get enough information through the photos. In particular, there are more defects and more photos, so it is difficult to understand the logical relationship between photos, not enough to make accurate judgment, and even rework. In figure 2, comprehensive information from far and near, can be both master of the overall situation and accurate understanding of details, and can make more accurate judgment.

![Fig. 1. Case 1.](image1)

![Fig. 2. Case 2.](image2)

3. Angle requirement of borescope inspection
When taking pictures, the photographer mainly aims at the aesthetic feeling and the theme of expression, and there is a connection between borescope inspection and taking pictures, but there is a more professional difference [4], which should be the target of "performance characteristic parameters".

Take CFM56-7B engine turbine blade as an example, due to different configuration, the existence of the different division standard, the angle of the photo must respond characteristic parameters, such as: the distance from the root, the defects and the relationship between the cooling holes and so on. This requires workers to be familiar with AMM standards. Only if you are familiar with the standards and consciously adjust your camera angles, you will get some more helpful pictures for the problem.

4. The meaning of "point and surface" in borescope inspection work

In theory, the decision to run an engine can be made only by AMM standards. However, the actual situation is often complicated, such as the condition of the defect critical standard, the preparation of the operation, the revision trend of the manufacturer's standard, the history of CDR, and so on.

For example, there are some defects on the turbine blade leading edge, only through the turbine blade itself, it is difficult to judge whether the ablation or injuries caused by external things, foreign object wounded after damage cooling gas film, produce stress concentration, and often lead to erosion. The release standard of external injury is different from that of ablation, and the potential impact on safety is different. Borescope inspection workers such as conscious attention to the causes of defects, such as the discovery of turbine blade leading edge after some difficult to define reason of injury, actively expanding the scope of the borescope, check the high pressure compressor air flow, can provide more information to determine damage reason.

Otherwise, the manufacturer or engineer will often issue engineering instructions for a more comprehensive judgment, leading to the delay of judgment and increasing the workload of the production department. If the borescope inspection personnel have the broad field of vision, rich experience and sense of responsibility, and take the initiative to obtain more comprehensive information, which can improve efficiency, at the same time of engine-failure defense, and subsequent repair plan formulation [5].

Take high compressor of CFM56-7B engine as an example, with conventional borescope inspection, only 2, 4, 6, 8 selecting examination stage blade, but the actual work, once found obvious damage, should expand the scope of inspection. Because no matter the FOD, DOD, wind erosion and surge caused damage, at all levels are associated with each other and influence each other, only a comprehensive borescope inspection, to make the right conclusions to ensure safety. The overall inspection conclusion is also the basis for the follow-up of the engine monitoring program and the delivery plan.

Many airlines often have a full borescope inspection on engine before making engine repairs. If workers worked on borescope inspection for the engine on wing, master the principle, process, and finished the analysis of the causes of "by the point and the surface", to provide more detailed information, that such repetitive work often can be avoided or reduced.

The "point and surface" of the borescope inspection work is to analyze the causes and effects of the injury through a more thorough examination of the various levels or units of each other. This will be helpful to the decision making of engine-failure defense, the decision making, the monitoring plan, the repair plan, and even the business insurance claim. Therefore, the "point and face" of the borescope inspection work and the borescope inspection report, is the preventive maintenance concept implementation, not only to the engine-failure defense meaning significant, also is the engine engineering technology management foundation.

5. The description of borescope inspection report

Although with the support of modern electronic optical equipment, the report can be presented in the picture and text, but as a technical report, there are strict requirements on words. For example, "several HPC blades are slightly damaged", which is not rigorous, and the "not exceeding AMM standard" is also described as too vague [6].
At present, the measuring equipment has been widely used, and the words of borescope inspection report should avoid ambiguous words and try to embody the rigor of the technical report in a quantitative and accurate language [7]. In reference to AMM and other manuals, it should be accurate to specific terms, and even quoted in English. Some professional borescope inspection agents have made the borescope inspection report, in this respect to do very well, it is worth learning.

6. Conclusion

China's civil aviation has strict requirements to prevent the engine from being idle, and has also formulated detailed supervision and guidance. Among them, it is required to trace the defect extension in the report. In fact, the modern video probe also provides the basis for this, and in theory, the expansion of the two defects can be almost quantified. From the perspective of engine engineering technology management, it is of great significance to know the expansion speed of the defect and the adjustment of the maintenance plan.

Complete borescope reports, therefore, in addition to the engine basic data information, from the vision to complete defects of close shot show, and "by the point and the surface" state of ontology information, shall also have the extension comparative basis, suggestions and conclusion and monitoring measures, etc.

Of course, it is not possible to require all of the detective reports to have such comprehensive information, and not all engines need such information. Owing to the different engine, owing to the different damage, highlight the main points of emphasis, and this requires a borescope inspection personnel not only have rich experience, and the engine maintenance scheme, engineering technical management process.

In a word, engine borescope inspection is of great significance in the engine-failure defense work, and finally it is to be expressed through the "language" of borescope inspection detective. Expression is rigorous, accurate, pictures "from far to near", "by the point and the surface" defect analysis, a comprehensive and complete borescope inspection reports, reflects the scientific and reasonable borescope inspection process, not only for engine-failure defense, also to include distributed decisions, change prediction, maintenance plan adjustment, fixing arrangement, repairing plan formulation, engine engineering management has an important significance. In addition, some repetitive tasks can be avoided to improve efficiency. To some extent, the specifications of the "borescope inspection report" often reflect the skill level and quality of work.

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