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Applied Failure Analysis

Reference Guide for a Proper Failure Analysis by CAT Dealer {0374, 1000}

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SMCS - 0374; 1000

Engine

3054 and 3056**3200****3300****3400****3400 All, 3300 All, 3200 All, 3100 All, 3000 All, and D-series All****3500 and G3500 Engines****All 3600 Engines****All C280 Engines****All Marine Propulsion, Marine Auxiliary, and Marine Generator Sets****C-10 All****C-9 and C9 All****C11 All****C12 and C-12 All****C13 and C-13 All****C15 and C-15 All****C16 and C-16 All****C175 Engines****C18 and C-18 Engines****C27 Engines****C32 Engines**

C4.4 Engines

C6.6

C7 All

C7.1

When is an Applied Failure Analysis (AFA) Necessary?

Utilizing the Applied Failure Analysis (AFA) principles is necessary to determine the true root cause of a failure in every repair where a component is prematurely worn out early or in an unusual way, is deformed so that the parts can no longer perform the intended function, or broken. Failure analysis begins with the complaint and component. Facts (product status reports, oil analysis data, and so forth) should be gathered throughout the repair process. Analyzing the failed iron will answer “what happened” and yield questions to determine “how the failure occurred” and “who is responsible”. Gathering background facts such as: interviewing the operator, understanding the failure mode, and using the relevant facts, for example, maintenance records, previous repairs, etc. to define the timeline of events that led to the failure are also important.

In every case, root cause must be determined by the dealer for any unscheduled repair and included in the Work Order Summary.

At minimum, an AFA report should be developed by the dealer (Reference Warranty Bulletin 1.03) under the following circumstances where a claim may be submitted to CAT:

1. A catastrophic failure.
2. An overspeed event.
3. Repeat failures on the same product.
4. Multiple occurrences of the same failure mode for the same customer/application/region.
5. When requested by the customer.
6. When parts are requested to be sent to a Caterpillar Metallurgical Lab for analysis.

The dealer owns the customer relationship and the customer is most concerned with prevention of a repeat failure, which is why the dealer is responsible to determine root causes and confirm if there was a defect in material or workmanship from Caterpillar for all Warranty and Goodwill claims (Reference Warranty Bulletin 1.01). The communication must come from the dealer to create a professional image to the customer and develop trust in the expertise of the dealer. Such communication aids in velocity of quick customer resolution, utilizing local dealer expertise to understand the root cause of failure and quickly work to resolve the customer issue and limit downtime.

8 Steps of Failure Analysis

Caterpillar experience has shown that timely investigation and reporting leads to increased customer satisfaction and settlement of claims. Caterpillar has an established and proven failure analysis process and training that is required per the Marine Service Assessment. That process includes the Eight Steps of Applied Failure Analysis are as follows (Reference AFA I - 26213 ILT & AFA II - 26214 ILT):

1. State the Problem Clearly and Concisely - What is the complaint and component?
2. Organize Fact Gathering - Identify areas that could have led to failure.
3. Observe and Record Facts – Failed component/hardware, pictures, operator interviews, oil samples, ECM downloads, etc.
4. Think Logically with the Facts – Create a timeline of events leading to a determination of what failed first.
5. Identify Most Probable Root Cause - List all probable root causes and eliminate all unlikely root causes based on the facts.
6. Communicate with Responsible Party - Present a logical, organized message, and engage the DSN for more assistance, if necessary.
7. Make Repairs as Directed.
8. Follow-Up with Customer - Ensure that problem was corrected and customer is satisfied.

Note: Making the repair is step #7. Thus the requirement for AFA training for 80% of marine technicians is included in the MSA. It is recognized that the Dealer Technical Communicator cannot be present at every failure, however, the Dealer Technical Communicator needs to be able to investigate the issue and rely on the technician to provide the necessary data and information.

Expectations on Applied Failure Analysis (AFA) Report Contents, Deliverables, and Format.

Through following the AFA process including proper documentation of the facts and possible causes, you will be able to develop the sections of a proper failure analysis report and arrive at root cause of failure. (Reference Intro to AFA Management #33400 AICC). Consider enrolling in the ILT AFA Certified Consulting Analyst course - #45317.

An outline of the sections of an Applied Failure Analysis Report is as follows:

1. Section #1: What is the Problem?
 - a. Customer name, vessel name, serial number, engine hours, dealer work order number.
 - b. Summary of complaint and failure mode.

2. Section #2: State the Facts, Pertinent History, and Observations. (Examples as Applicable)
 - a. Operator interview feedback.
 - b. Timeline of events leading up to failure.
 - c. Determine what failed first.
 - d. ECM downloads / Product Status Report/Application & Installation Guides
 - e. SOS analysis (fuel, oil, coolant, etc.)
 - f. Maintenance records (valve lash, oil change intervals, previous unscheduled repairs, etc.)
 - g. Clear detailed photos of the failed iron.
 - h. Reference SEBF9066- AFA Guidelines for Examining Failed Parts
3. Section #3: Possible Root Causes.
 - a. List of all possible root causes based on the facts.
 - b. List of all unlikely root causes based on the facts.
4. Section #4: Investigation Steps.
 - a. Provide summary of facts gathered that eliminates each possible root cause.
 - b. Provide summary of facts gathered that supports the most likely root causes.
 - c. Determine if more steps and/or pieces of information are needed to confirm the most likely root cause.
 - d. If parts need to be sent to the Metallurgical Lab, define what tests or specific feedback is needed in support of the suspected root cause.
5. Section #5: Summary
 - a. Conclusion of root cause.
 - b. Summary of repair steps taken.
 - c. Recommendation to ensure mitigation of risk of a repeat failure.
 - d. Dealer reference information regarding who completed the report.

Process for Submitting Iron to Caterpillar Metallurgical Lab

- The Caterpillar Metallurgical Lab is an aid to Caterpillar and CAT dealerships to provide specific analysis of failed components that are beyond the capability of the analysis tools of a dealership. As the Caterpillar Metallurgical Lab function relates to the AFA process, the lab is intended to supplement AFA report root cause analysis of the dealer. The timeliness of issue resolution is important and the request for Caterpillar Metallurgical Lab analysis may introduce more delays in issue resolution. The function of the Caterpillar Metallurgical Lab is not to perform a standard failure analysis that would be deemed within the expected capabilities of the dealerships.

Prerequisites for Requesting a Caterpillar Metallurgical Lab Analysis

- DSN Service Request that documents the failure and includes the AFA (written to standard) of the dealer, and any additional information requested via the DSN such as Application & Installation Design & Construction Review Form, Sea Trial data, Engine ECM downloads, SOS results.
- A Caterpillar Metallurgical Lab analysis request by the dealership must include details of the specific parts to be analyzed, areas of focus, and tests and/or failure modes to be considered in the analysis per AFA of the dealer, with the intention to support or refute with what the dealer concluded.
- Based on the information provided, Caterpillar will then make the determination on recalling the parts and initiating the Caterpillar Metallurgical Lab request.

Reference Section

- Warranty Bulletin 1.01 & 1.03
- AFA Guidelines for Examining Failed Parts SEBF9066
- AFA I & II Training (26213 & 26214 ILT) & prerequisites*
- AFA Certified Consulting Course - 45317
- Marine Commissioning Procedure LEBM0025
- Marine Propulsion Checklist LEBM0038 (C7-C32)
- Marine Propulsion Checklist LEBM0039 (3500-C280)
- Sea Trail and Commissioning Tables LEBM0040
- Sea Trial Guide LEBM5081

- Marine Design and Construction Review Form SEHS8716

***Required Prerequisite Courses for AFA I (26213 ILT):**

1. Intro to AFA Management - 33400 AICC
2. Intro to AFA Metallurgy - 33407 AICC
3. Intro to AFA Principles of Fractures - 33403 AICC
4. Intro to AFA Principles of Wear - 33402 AICC
5. Intro to AFA Visual Examination - 33401 AICC

Good and Bad Examples of AFA (Sections)

- Product Evaluation Report - AFA Bad Report (M0074192)
- Failure Analysis Report - AFA Good Report (M0074098)

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