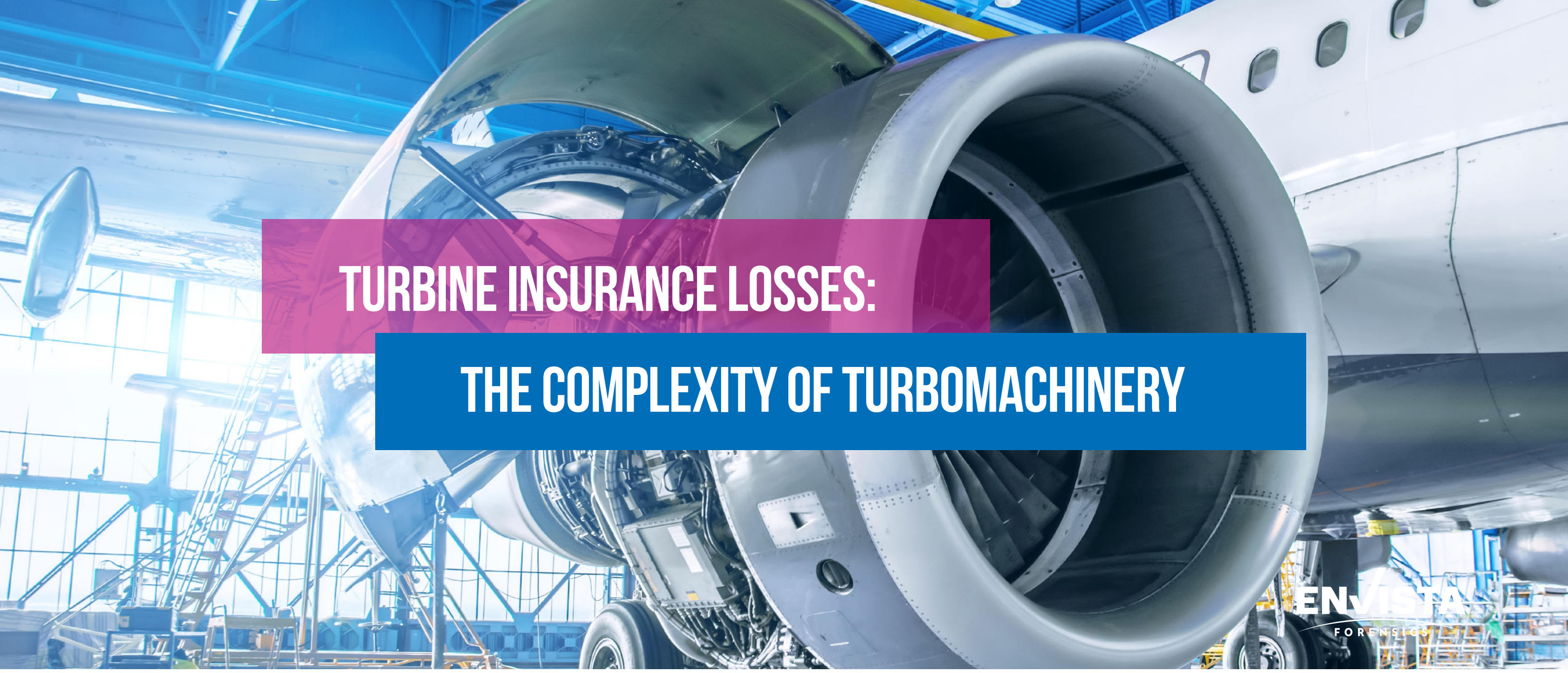

TURBINE INSURANCE LOSSES: THE COMPLEXITY OF TURBOMACHINERY

Author: Tim Leung P.Eng., Project Engineer, Envista Forensics

Turbines are used to generate much of the electricity we use across the globe through steam, gas, wind and water, and to provide thrust for machinery, such as aircrafts. Although turbine losses are relatively infrequent, some of the most significant insurance losses involve turbines. Due to this infrequency and the lack of information available in turbine associated industries on failures, most of the engineers who investigate these losses may have electrical or mechanical knowledge but typically not specific expertise involving how turbines actually operate.

Highlights

- Turbine Applications
- How Turbines Function
- Investigating Turbine Failures
- Case Studies

With various types of turbines in use, the design and application of each system are unique. Therefore, the investigation into a specific turbine failure is better handled by an expert with a wide range of experience and familiarity with the complex, interconnected systems and components of turbomachinery. This paper provides information to assist insurance professionals who become involved in a turbine loss with detailed information on turbines, their operation and their failures.

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Types of Turbines

A turbine is a machine that converts energy from a moving fluid (kinetic energy) to rotational motion (mechanical energy), where it is used to power equipment such as pumps or generators. Turbines can come in many forms and sizes but all operate on this basic principle.

Wind and hydro turbines convert the kinetic energy from wind and water, respectively, into a rotational motion. Due to the geometry of the turbine blades, as the moving fluid passes over them, they begin to rotate. The blades are attached to a shaft and are often coupled to a generator that uses the rotational motion to produce electricity.

Gas turbines are different from wind turbines, as they are a form of internal combustion engine where fuel and air are ignited in the combustion chamber, operating on mechanical energy rather than kinetic. Typically, gas turbines are found in power plants on gas pipelines for driving pumps and are used for propulsion in aircraft.

Steam turbines rotate from pressurized steam. Unlike gas turbines, steam is generated outside of the turbine, usually in a boiler that can be fueled by burning coal or gas, or absorb heat from the decay of radioactive fuel.

As the different types of turbines vary in operation, many turbines have evolved to utilize digital control systems for versatility, increased monitoring and remote control use. Additionally, exotic alloys and sophisticated manufacturing techniques are more often used to push the maximum output of turbines. Despite these advances, turbines have followed the same basic principles since inception and adequate maintenance is a significant factor to the life of a turbine.

Turbine Operation

Turbines are highly specialized, and equipment owners largely rely on the Original Equipment Manufacturers (OEM) who have proprietary knowledge, customized tooling, maintenance and operations procedures. Due to the typically high costs of working with the OEM, some equipment owners elect to utilize third-party components or make minor repairs without the help of the OEM specialists at their own risk, but this is more common in cases with mature or out of warranty units.

Turbine operation can range from continuously running for thousands of hours or starting and stopping multiple times a week. The wide range of “normal” operations puts turbines and their components at risk of cyclical mechanical stresses and thermal cycles, leading to a breakdown in performance and component failures.

Proper assembly, operation and maintenance ensure that turbines will meet their expected service intervals and lifetimes. Keys to prolonging operation are to:

- Maintain the appropriate air and gas mixture
- Control component temperatures
- Supply sufficient lubrication

Investigating Turbine Failures

Turbines are typically operated with plenty of supervisory instruments and sensors because of their level of sophistication, but often take place in redundant setups. The instrumentation and control systems serve to protect the turbine from approaching catastrophic failures, which although rare, do occur.

A single failed component that is let loose in a spinning turbine will quickly damage nearby components, often liberating more debris and causing a chain reaction of destruction. Combustion turbines are also at risk of ingesting foreign objects with the air required for combustion. This can cause similar wreckage throughout the turbine.

Loss investigations often involve the OEM for their specialized knowledge. Analysis necessitates multiple areas of expertise to examine the failed components, which is why hiring an expert who understands the complexity of turbine machinery is critical. Mechanical or material experts with a broad scope of industry experience and specialized knowledge on how these complex machines are designed, maintained, assembled, disassembled, operated and inspected are other resources to help differentiate between loss-related damage and operation-based wear and tear. An expert's ability to scrutinize maintenance contracts, identify work scopes for responsible parties and identify potential subrogation opportunities will assist in reducing the costs associated with a turbine loss. Since it is such a specialized industry, there is a relatively small group of third-party vendors, which can lead to subrogation opportunities.

Case Studies

Power Generating Turbine Failure

A case involving a gas turbine that failed to start, resulting in a loss of operability, prompted the equipment owner to contact the manufacturer of the turbine. The turbine was required to be shipped from Canada to the UK for disassembly and inspection. Turbine losses typically have high business interruption, material and repair labour costs. The insured calculated the interrupted power production at just under $18,000 CAD per day, which accumulated to more than $400,000 CAD in business interruption costs between the initial operational interruption and engine removal. In addition to the business interruption cost, an optimistic repair estimate was provided at $670,000 CAD, or a replacement engine was offered in the neighbourhood of $2,500,000 CAD.

The manufacturer provided the insured with their preliminary opinions on the cause of loss. This included a possible fault in components that had remained at the loss location in Canada. Envista dispatched local experts from the UK and Canada to the manufacturer and loss location, respectively, where our experts were able to inspect the turbine components during disassembly. During the investigation, Envista found that the suggested failure modes were unsubstantiated and we offered our opinion for the turbine failure when we found an improper assembly. Our client later relayed that the insured had performed maintenance on the turbine with their own staff, resulting in the entire claim being denied.

Due to our experts' physical presence at the turbine disassembly and loss location, we did not have to rely solely on second-hand information. We were able to offer our client reports of our findings quickly because of our turbine expertise. Through our investigative efforts and the rapid response time, we presented factual, unbiased reporting that aided our client in processing the claim and closing the file swiftly.

Aircraft Engine Damage

A failure of an aircraft engine can also lead to significant business interruption due to the grounding of an entire airplane. Such event occurred when an aircraft was grounded after finding metal chips in the engine oil. The engine was removed and shipped to the manufacturer in Montreal for disassembly and inspection.

The coverage of the ensuing insurance claim was dependent on the cause of failure. Envista received a preliminary investigation report listing lightning strike, foreign object damage and wear and tear as the possible causes.

Envista's experts inspected the engine components at the client's facility and were able to quickly eliminate foreign object damage. Lightning damage typically affects the bearings of the engine and can leave a damage pattern that looks much different from wear and tear, although those unfamiliar with turbines may find it challenging to distinguish between typical wear and foreign object damage. In this case, no damages were found on any of the removed bearings. A sub-assembly of the engine was sent to its manufacturer, who quickly identified the worn components that produced the metal chips found in the engine oil.

Envista's expertise helped our client disentangle this complicated claim and provided clear investigative data of the cause and source of the metal chips.

Summary

Turbines are highly specialized and, though rare, turbine losses are typically substantial due to the capital equipment replacement cost and business interruption losses. With ever-increasing energy demands, turbine operators are looking to reduce maintenance costs by extending service intervals and upgrading parts that introduce uncommon turbine configurations. This pressure can create unique situations that can lead to equipment breakdowns and increased claims.

The added cost of business interruption adds urgency to process these claims quickly and efficiently. Adequate experience and knowledge will assist with turbine claims and identify potential subrogation opportunities.

Envista has local experts in Canada, U.S., U.K., Singapore, Australia and Mexico who respond quickly with industry-leading expertise to determine the cause of loss, offer remediation and cost consulting to save time and money.