

Of Lawyers and Laxness

by Daryll McKinley

L: Please state your name and address for the record.

D: Jimmy James, 2006 Main Street, Limerick, North Dakota

L: Thank you, Mr. James. Is there any reason that you are unable to give a full, proper testimony here today?

D: No.

L: Are you ill, on any medications, or otherwise hindered to give full and proper testimony today?

D: No.

L: Ok, then, shall we proceed?

D: Sure.

L: Mr. James, what is the name of your business?

D: Shot Peening, Inc.

L: What service does this company provide?

D: We shot peen aerospace and automotive components.

L: Please, for the record, what is shot peen, or shot peening?

D: Shot peening is a metal treatment in which the surface of a metal part is bombarded with small shot.

L: What is the purpose or result of shot peening?

D: It extends the fatigue life of the part.

L: If it is performed properly, correct?

D: Yes.

L: How long has Shot Peening, Inc. been in business?

D: 42 years.

L: That's a long time, congratulations.

D: Thank you.

L: How many employees do you have?

D: 14.

L: How many of these employees perform shot peening?

D: Seven.

L: Do you have a quality department?

D: Yes, I have two inspectors.

L: What type of peening equipment do you have?

D: Three manual booths, two automated booths, and one robotic booth.

L: Ok, I'll ask for an in-depth description of those later today. So, you peen aircraft components?

D: Yes.

L: Do you consider this a critical process?

D: Of course.

L: So you must own and use all of the required tooling and fixtures during this process, correct?

D: Yes.

L: Please tell me the types of tooling and fixtures you use.

D: Almen strips, Almen gages, tracer dye, Almen fixtures, and microscopes.

L: Wow, that sounds complicated. Is there a specification that you use or follow to ensure that you are properly performing the peening?

D: Yes, AMS 2432.

L: Please tell me the title of this specification?

D: I can't recall.

L: Really? I would think you would know it well. Are you sure?

D: Perhaps it will come to me.

L: Let's hope. Will you please tell me how it is that your company failed to properly shot peen an engine turbine disk that failed in-flight, causing the aircraft to crash, and resulting in the death of 180 passengers and seven crew members?

D: Uhhhhh

L: Mr. James, did you understand the question?

D: I believe the turbine disk material was found to be defective.

L: Well, sir, the NTSB thinks otherwise. Their report specifically states that the spindle exhibited inadequate shot peening. And my experts have agreed with that finding.

D: I've read all of those reports.

L: And do you agree with the findings?

D: No, I don't.

L: Of course you don't. Have you brought with you today, as required in your subpoena, all of the inspection reports for the subject type spindle?



- D:** I have them for the last year.
- L:** Is that all? Aren't you supposed to keep inspection records for a longer period of time?
- D:** We don't.
- L:** What does the process specification state?
- D:** I'm not sure.
- L:** Have you brought with you today, as required in your subpoena, all of the artisan certification documents for your employees that perform peening?
- D:** Most of them.
- L:** Why not all of them?
- D:** They must have been misfiled.
- L:** Mr. James, are you involved in the day-to-day operations of your business?
- D:** I'm in the office everyday.
- L:** That's wonderful, sir, but it doesn't answer my question. Again, are you involved in the day-to-day operations of your business?
- D:** Yes, I oversee all of the operations.
- L:** Are you the person who trains the artisans?
- D:** Yes.
- L:** And you trained your inspectors?
- D:** Yes.
- L:** When was your last audit?
- D:** Did you say audit?
- L:** Yes, Mr. James, an audit performed by a customer or a third party to ensure that your processes are being properly performed.
- D:** Oh, so far I've not been able to accommodate an audit.
- L:** I see. Sir, do you think your shot peening process may be out of control?
- D:** No, not at all.
- L:** Have you been lax in your responsibilities to your client and the public?
- D:** Not in my opinion.
- L:** Perhaps we will seek a subpoena to inspect your premises and to assess your shot peening process. You might consider it your first audit.

The above is a segment of a fictitious deposition, which very well could have lasted for a few days. As much as you may hate lawyers (L), he was just doing his job against the deposed (D). Could your shot peen shop or business withstand the scrutiny of the legal system? Especially a lawyer whose job it is to pick the meat off of your bones during a deposition?

I have worked as a consulting forensic engineer performing aviation and automotive accident investigations. The majority of my experience involved litigation and finding fault in either the manufacturer's product or an overhauler's repair. This means that I worked with, corresponded with, and was

deposed by lawyers. In these litigious days in which we live, all aspects of failed components are studied and scrutinized. As much as we may tease and joke about lawyers, it is litigation that helps keep the public safe in many regards.

I have also audited peening shops in which the artisans had no idea of the purpose of shot peening and its effect on parts. Develop a saturation curve? Measure the pre-bow on an Almen strip? Inspect for complete coverage? These were foreign thoughts to the artisans. I might as well have been speaking Urdu. It is my hope that with the progress that has been made in the shot peening industry during the last decade, these types of shops will become nonexistent. Unfortunately, the following are real-life examples of component failures due to improper shot peening.

On August 14th, 1968, a S-61L helicopter crashed at Compton, California. All eighteen passengers and three crewmembers were killed and the aircraft was destroyed by impact and fire. The crash occurred when one of the main rotor blades separated from the main rotor. The failure was caused by a single fatigue crack in the spindle that originated in an area of substandard hardness and inadequate shot peening (1).

On December 8th, 2002, during take-off, a Boeing 767 experienced failure of the left engine. An emergency was declared and the aircraft returned to the airport, without further incident. An investigation determined that the Stage 1 high pressure turbine disk had undergone repair work in 1998 to remove nicks and other damage. The repaired area required shot peening to match the original condition of the part. An errant shot peening process produced peened surface extrusion folds (PSEF), a detrimental over-peening effect, which reduced the fatigue life of the part and caused fatigue cracking (2).

On July 4th, 1999, a Fokker 100 experienced severe vibration subsequent to landing and during taxi. Three months later, on October 9th, 1999, the same aircraft suffered another severe vibration, this one occurred throughout the airframe and caused substantial damage. None of the 84 passengers or crew members were injured.

In May of 2001, a similar incident involving another Fokker 100 occurred at Dallas-Ft. Worth International Airport, and an investigation was performed. During previous overhaul work of the landing gear, repair work had been performed to remove scoring from the hub. The technical report stated that comparison of the repaired area and the original surface revealed a "markedly different" intensity in the shot peening of each area. The intensity in the repaired area was lower than that of the original, thereby reducing the fatigue resistance and leading to fatigue cracking of the component (3).

In each of these cases, the failed component was in a critical application in which human life and limb were endangered, and in the S-61L helicopter crash, lives were lost. There are likely other unreported cases. I did not research automotive accidents involving faulty shot peening leading to death or injury, but I would not be surprised if they existed.

Aren't all shot peened components critical? Isn't every shot peen process critical? If you are involved in the shot

Continued on page 8

peening of components, you can bet it's critical and someone is banking on it being done properly. Hopefully, you will be asked questions regarding your shot peened process during an audit, or a pre-audit, instead of at a deposition.

There are many peening shops that have gone to great lengths to get their processes up to the standards imposed by Nadcap, and our hats are off to them. They have achieved certification through Nadcap and have reaped the rewards of increased business and the satisfaction of a job done well and correctly. Through their efforts, and the efforts of manufacturers and vendors of peening equipment, the visibility of the shot peening process and its benefits has increased over the last few decades.

So, if your shop is not up to standards, how do you get there? How do you reach the peak of the Nadcap standard? As they say in football, the best offense is a good defense. I would recommend you begin with an internal audit; collect all of the information, specifications, equipment literature, written procedures, artisan training process, etc., that you have in your shop. All of this data can be used to baseline the current state of your peening procedures. The baseline will indicate areas that are satisfactory and those that are deficient.

The next step would be to contact an unbiased third party to visit your shop for a few days and perform a pre-audit service. The inspector will perform an in-depth examination of your shop, equipment, artisans, and processes (all while wearing a smile!). When finished, you will receive a written report of all findings and a list of recommended actions. The length of this list will depend on the state of your peening process. After a period of time, the inspector will make a follow-up visit to insure compliance and to provide further guidance. At this point, your shop should be prepared for a Nadcap audit, and certification.

Happy peening!

- (1) NTSB Aircraft Accident Report, File 1-0016, Dated August 27th, 1969
- (2) Aviation Safety Network, Boeing 767-219ER ZK-NBC, Dated December 8th, 2002
- (3) Aviation Mechanics Bulletin, September – October 2001, Vol. 49 No. 5



Daryll McKinley has a Bachelor's Degree in Mechanical Engineering, a Master's Degree in Materials Engineering, and he is a Registered Professional Engineer. During his career, he has developed and conducted shot peened artisan training and certification programs for the U.S. Navy, which were later adopted by private industry. During his employment with the Department of

Defense, he conducted shop audits, authored peening process specifications, and wrote equipment specifications.

Mr. McKinley's background includes mechanical design and testing, hardware failure analysis, aircraft accident investigation, materials processing, and corrosion control.

He has experience in the aerospace, automotive, military, and litigation fields. His past employers include the Department of Defense, General Dynamics, and a forensic consulting firm. Mr. McKinley now works as a consulting engineer performing failure analysis, mechanical design and shot peening training.

You may contact Mr. McKinley by phone: 850-449-2528 or email: dwmckinley@hotmail.com.