

***Developments in Abrasive Blast Nozzle Technology: Reducing Noise
Exposure While Preserving Nozzle Performance and Usability***

Submitted By:

Matthew Sullivan, *Director of Product*, Oceanit Laboratories, Inc.,
(808) 531-3017, msullivan@oceanit.com

Oceanit Laboratories, Inc.
Honolulu, Hawaii, USA

Additional Presenters:

Dr. Christopher Sullivan, *Director of Acoustics Research & Development*,
Oceanit Laboratories, Inc., (808) 531-3017, csullivan@oceanit.com

PRIMARY TOPIC CATEGORY: Surface Preparation

ABSTRACT:

The U.S. Centers for Disease Control (CDC) estimates that 1 in 3 adults suffer from hearing loss. The U.S. National Institute for Occupational Safety and Health (NIOSH) further provides that 24% of U.S. workers hearing loss is caused by occupational exposure. To prevent hearing loss, the U.S. Occupational Safety and Health Administration (OSHA) recommends that workers not be exposed to sounds at or greater than 85 decibels (dBA) for 8 hours. Abrasive blast nozzles, however, can produce noise levels upward of 115dBA, for which OSHA sets a max safe exposure time of just 15 minutes per day.

Leveraging cutting edge advancements in jet engine technology, new Blast Ninja abrasive nozzle designs can now reduce noise by up to 17dB, an approximate 50x reduction in sound power, when compared with conventional venturi nozzles of the same bore size. Blast Ninja nozzles accomplish this by reducing the nozzle air exit velocity and sound pressure level, while preserving particle velocity to maintain equal abrasive power. The difference in noise exposure enables operators to be safer and more productive, diminishes operator fatigue, and minimizes employer liability. Furthermore, whereas NIOSH estimates a \$100 per dBA of savings when purchasing quieter products, such improvements in acoustical performance can also translate to employer cost savings. The efficacy of Blast Ninja nozzles was evaluated by Oceanit and 3rd party industry partners interested in use or distribution of the nozzles for the industry.

This paper explores the efficacy of such nozzles, and details their performance in different conditions, with different blasting setups, with different abrasives, and on different surfaces.

BACKGROUND:

Abrasive blasting operations used for paint and surface coatings removal are essential for the maintenance of the ships, aircraft, and land vehicles of the United States Armed Forces as well as use industries such as oil & gas, power generation, construction, mining, and infrastructure, among others. Abrasive blasting nozzle design is rudimentary and noise levels produced during abrasive blasting operations in shipyards, maintenance facilities, and factories for removing paint and surface coatings often exceed exposure limits put in place by Occupational Safety and Health Administration (OSHA). Reducing a worker's occupational noise exposure is imperative from a safety and economics perspective.

The U.S. Centers for Disease Control (CDC) estimates that one in three adults suffer from hearing loss and The U.S. National Institute for Occupational Safety and Health (NIOSH) further provides that 24% of U.S. workers' hearing loss is caused by occupational exposure. Exposure to high levels of noise can lead to difficulty communicating and distraction, which can lead to accidents and decreased productivity. Over the past decade, a large number of hearing loss claims have been filed and millions of dollars have been compensated to workers due to Noise Induced Hearing Loss (NIHL).



Figure 1. Abrasive blast operator cleaning a steel surface

To prevent hearing loss OSHA regulates noise exposure above certain levels. OSHA Standard 1910.95 requires hearing protection to be worn by employees based on the noise levels and duration they are exposed to and recommends that workers not be exposed to sounds at or greater than 85 decibels (dBA) for 8 hours. Abrasive blast nozzles, however, can produce noise levels upwards of 115dBA, for which OSHA sets a maximum safe exposure time of just **15 minutes per day**. Exposure of personnel to these levels, even with hearing protection, substantially increases the risk of NIHL. Furthermore, OSHA regulations dictate that improved hearing protection does not constitute a reduction in worker noise exposure and requires the elimination or reduction of the acoustic hazard through engineering controls prior to implementing administrative controls or relying on personal protective hearing protection.

According to OSHA guidance for engineering control of noise in blasting operations at Naval Shipyards (U.S. Department of Labor, OSHA, 2006), common sources of noise include:

- Air discharge from blast nozzle: 112 to 119 dBA
- Supply air inside operator's helmet: 94 to 102 dBA
- Abrasive blasting cabinets: 90 to 101 dBA
- Air compressors: 85 to 88 dBA
- Maximum noise levels up to 145 dBA have been measured at the operator with an empty grit pot

Noise Level dB(A)	Maximum Exposure Time (in an 8-hour working day/shift)
85	8 hours (Wearing hearing protection in the workplace is mandatory)
88	4 hours
91	2 hours
94	1 hour
97	30 minutes
100	15 minutes
103	7.5 minutes
106	3.7 minutes
109	112 seconds
112	56 seconds
115	28 seconds
118	14 seconds
121	7 seconds
124	3 seconds
127	1 second
130 - 140	Less than 1 second
140	NO EXPOSURE (Human pain threshold)
Note: Maximum exposure time halves with every increase of 3dB(A).	

In addition to reducing noise levels, the productivity and efficiency of abrasive blast nozzles are equally if not more important when it comes to the successful adoption of a new nozzle by the surface preparation community. “Productivity” or work output of a nozzle is expressed as area per unit time cleaned by abrasive blasting, while efficiency of a nozzle is quantified by the kinetic energy flux of the airflow and blasting particle stream at the nozzle exit. Both translate directly into how long a blast operator must spend cleaning a surface.

ABRASIVE NOZZLE DESIGN DEVELOPMENT:

Abrasive blast nozzle technology prior to the 1950's focused on straight bore nozzles characterized by a converging entrance, followed by a throat and outlet length which have the same constant cross-section, as shown in Figure 2.



Figure 2. Straight bore nozzle geometry

The next big step in abrasive blasting technology was the venturi nozzle patented in 1955 by G.D. Albert and W.H. Hall. It was developed based on the observation that straight bore nozzles tended to become more efficient as they began to wear. The wear tended to enlarge the outlet, leading to a shape similar to that shown below in Figure 3.



Figure 3. Venturi nozzle geometry

Additional nozzle designs were developed between the introduction of the venturi nozzle and the early 1990's, including the laminar flow nozzle, the double venturi nozzle, and the "Bazooka" nozzle. However, there is no evidence that these nozzle designs had been developed through a scientific optimization process for efficiency, instead being based on observations of existing nozzle performance or trial and.

Seeing this opportunity, the Penn State Gas Dynamics Laboratory designed a new nozzle, dubbed the Penn State Nozzle, using a scientific optimization focusing on efficiency, specifically the doubling of the kinetic energy of the particles leaving the blasting nozzle. Based on computer simulations and experimental testing, the Penn State group claimed to have met their goals of at least doubling the kinetic energy in their patent filing.