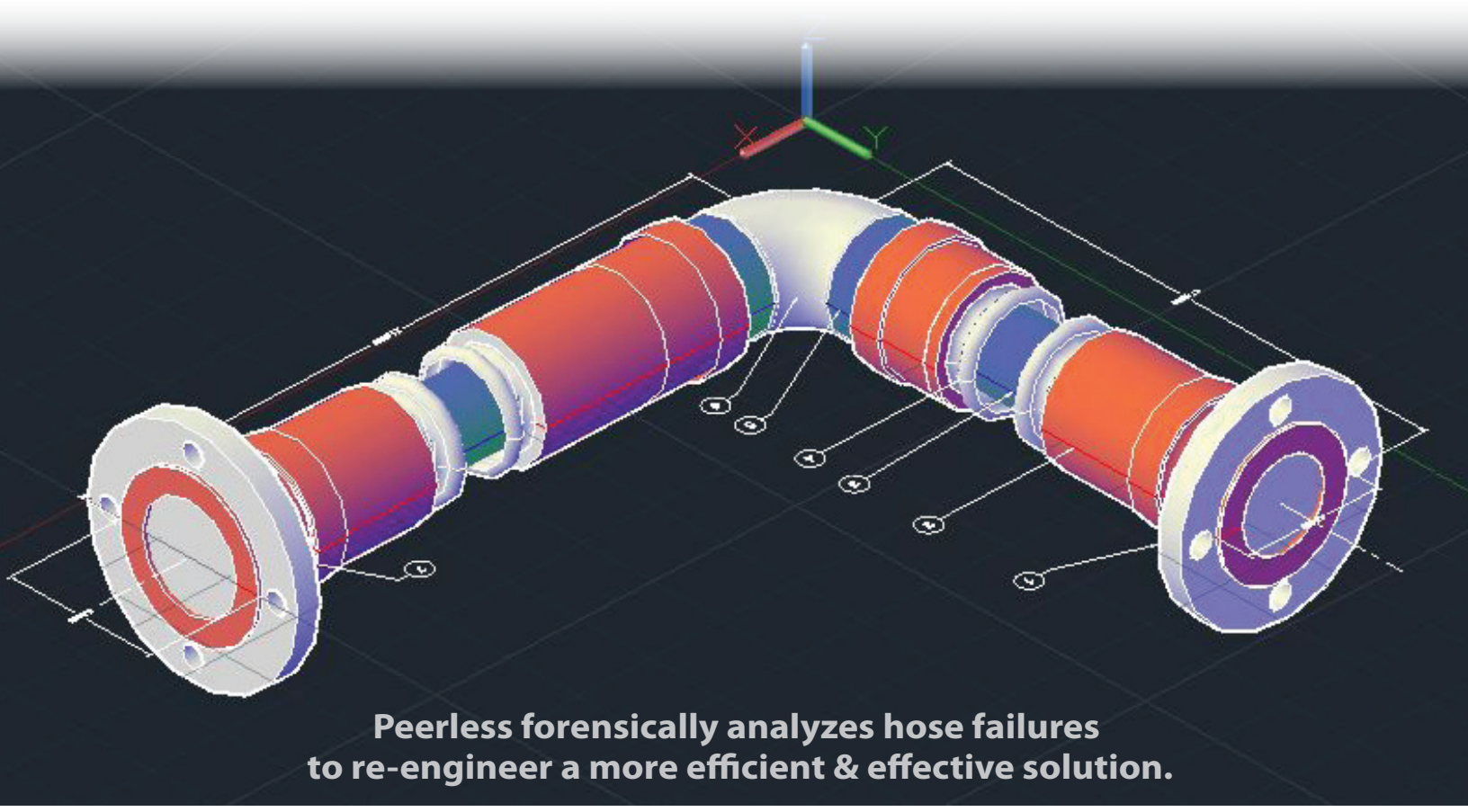
# WORKING SMARTER, NOT HARDER

## ADDRESSING FAILURE MODES TO BUILD A BETTER HOSE



**Peerless forensically analyzes hose failures to re-engineer a more efficient & effective solution.**

PEERLESS
SINCE 1914

www.Peerless-Inc.com

79 Perry St., Buffalo, NY

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## INTRODUCTION

A dogleg hose is a hose assembly that has an angled fitting (either a 90° or 45° elbow) installed at some intermediate point between the ends of the hose, specifically not at either end.

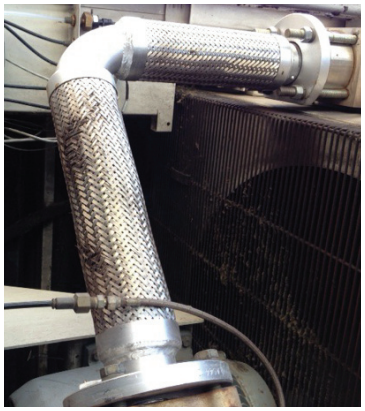
The hose assemblies described in this case study are used to transfer 400+°F compressed air from the compressor discharge to an aftercooler inlet at a flow rate of 700+ cubic feet per minute (CFM).

NOTE: *The dogleg hoses that failed in these applications were provided by the original equipment manufacturer (OEM).*

## THE SITUATION

**7/2/2013** A Peerless customer experienced failure with OEM-furnished dogleg hoses on their compressed air application. When the system engineers became aware of the hose failures, it was recommended by a fellow engineer that they contact Peerless for a hose failure analysis to determine the cause of the problem and solutions for prevent future hose failure.

Peerless met with the engineers to evaluate the application and situation. See Appendix A for more details and excerpts from Peerless' correspondence with the client.



Peerless obtained one of the failed hoses, which was then submitted to Hose Master for rigorous failure analysis. At this time, the hose in question was reported to have failed after a only few months in service.

The customer specifically requested that failure modes be identified and a design developed that would mitigate the risk of these failure modes occurring in the future.

## INSPECTION & ANALYSIS

**7/29/2013** Hose Master issued RMA 8481(Appendix B) and provided photos in a failure analysis report (Appendix C). These photos show the condition of the hose as received and damage to the corrugated tube upon closer inspection.

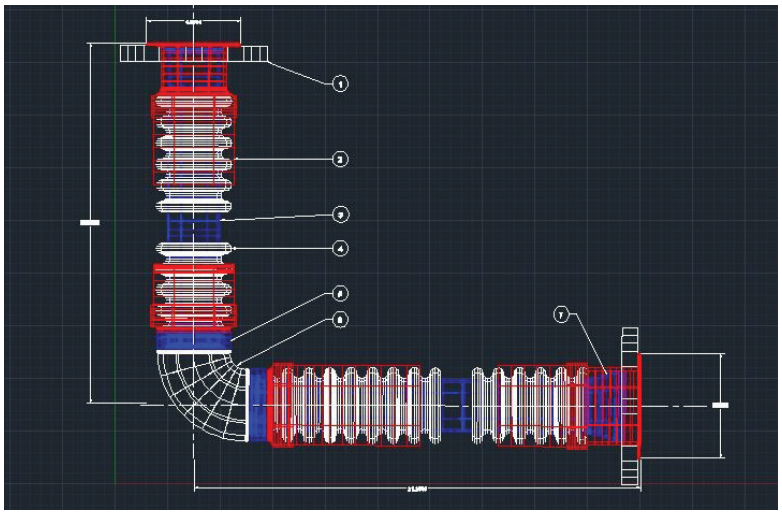
The report revealed that the hose assembly failed due to wear originating from the exterior of the assembly. In addition, it was noted that this assembly was subject to extremely high velocities and subsequent vibration.

Peerless, with the help of Hose Master, applied the findings of this report to the design of an improved dogleg hose assembly.

## THE SOLUTION

**8/13/2013** Hose Master recommended furnishing a hose assembly with double braid, heavier wall thickness and a liner installed internally that would smooth the flow. At high velocities this smoother flow results in less vibration.

Peerless took Hose Master's recommendations and generated engineered drawings, which were sent to the custom for approval prior to construction. These drawings serve the dual purpose of aiding in repeatability for follow-on hoses in similar applications throughout customer facilities nationwide.



## OUTCOME

**8/26/2013** Peerless and Hose Master's collaborative solution for an enhanced dogleg hose design can be utilized in numerous applications.

For example, a hose at another of the client's plants was failing due to same conditions. It was a more complex design, however, using the same proven process, Peerless was able to design a more effective and reliable hose replacement for this plant as well. That design was approved by customer engineers and Peerless is waiting authorization to begin fabrication.

Completed Dogleg Assembly - Design 1 for Customer's Initial Requirement

## **APPENDIX A -** Excerpts from correspondence between Peerless & customer

**Peerless:** It was a pleasure meeting you today. Please don't hesitate to call for questions or to provide any additional info you may deem useful to our investigation. I do have a couple questions that arose after scrutinizing this hose more carefully. Do you know the volumetric flow rate of the air inside the hose (CFM)? If so what is it?

**Customer:** ***40,000 scfh of Nitrogen, 350 to 400 degrees F, and 150 psig***

**Peerless:** Are there any pictures we can have of the environment this in which this hose is operating?

**Customer:** ***The hose is at a pharmaceutical company, and the rest of the equipment is showing corrosion.***

**Peerless:** There are some distinct design head-scratchers that a couple of our more experienced inside guys and our metal hose assembly fabricator called out. One specifically is that it is a 2-1/2 inch flanged set using 3 inch metal hose with a 2-1/2 inch elbow. The expansion out of the compressor only to be "choked" at the elbow and expand again past the elbow is an odd design to say the least. Also, our fabricator brought up the fact that there are really only two ways (outside of sabotage) that braids will fail. They are arcing and vibration/rubbing on an external object. Are we absolutely sure this hose is well clear of all interferences?

**Customer:** ***Yes***

**Peerless:** There are a lot of questions. Some will be definitively answered by the analysis, but I think some could be answered quite easily prior.

We want to make sure you guys get the right hose for the right application that will be safe and effective and will last as long as that first one you described (or longer).

Please let me know if you have any of these answers or any other pertinent information before I pass as much as I know on to Hose Master.

**Customer:** ***If you look at the bottom picture you will see the braid starting to fail. Let me know what you find out as soon as you can because we don't have a spare.***

## APPENDIX B - RMA 8481 from Hose Master

HOSE MASTER
1233 East 222nd Street • Cleveland, Ohio 44117
(800) 221-2319 • Fax: (216) 481-7557 • www.hosemaster.com
Cleveland • Houston • Atlanta
ISO 9001 Registered Quality System
NAHAD Metal Hose Listed Manufacturer

### *FAILURE ANALYSIS REPORT*

| | |
|---|---|
| **Date: 7/11/13** | **ID/Length: 2.5" x 15" x 26"** |
| **RMA No.: 8481** | **Quantity: 1** |
| **Customer: Peerless Mill Supply Co., Inc.** | **Hose Type: competitor dogleg** |
| **Customer No.: 758** | **Fitting #1: carbon lap joint flange** |
| **Report to: Lisa Ochenduski** | **Fitting #2: carbon flange (custom)** |

| *Customer Supplied Data:* | |
|---|---|
| **Working Pressure: 150 PSI** | **Media: air** |
| **Media Temperature: 400°F** | **Time in Service: 3 months** |
| **External Temperature: ambient** | **Type of Application: compressor** |

**Inspection Results:**
**The assembly is not a Hose Master product.**

**The as-received assembly was in fair condition. (See photograph 1)**

**Braid damage in several locations was found on both sections of the assembly. Indications of wear originating from the exterior were present. This included several sections of braid missing from the affected areas as well as heavy braid wear on the corrugation crests. (See photographs 2 - 4)**

**The assembly was then tested with 40 PSI of nitrogen while underwater. Leaks originating from several corrugation crests within the damaged sections of braid were found. A representative section was removed for microscopic examination.**

**Under magnification, fractures were found within the braid wear on the corrugation crests. (See photographs 5 & 6)**

| **Conclusion:** | **Code:W02 - CL** |
|---|---|
| **The assembly failed due to wear originating from the exterior of the assembly.** | |

***Please Note: The inspected materials will be scrapped after 30 days from the date of this report unless other arrangement is made with Hose Master***

President Authorization:_____Date:_____

Rev.: B, Date: 2/10/2010 aka30 q:/procs/pa

## APPENDIX C - Hose Master Failure Analysis Report




Photo 1 – As-received assembly.

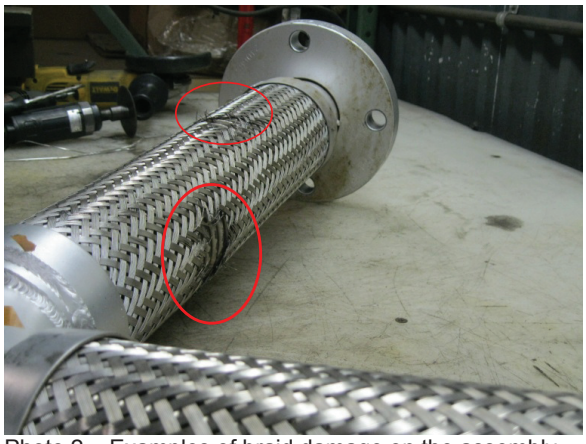


Photo 2 – Examples of braid damage on the assembly.

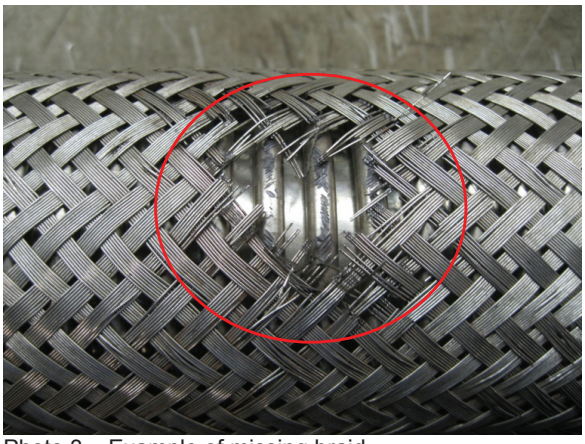


Photo 3 – Example of missing braid.


Photo 4 –Braid wear present on corrugation crests.

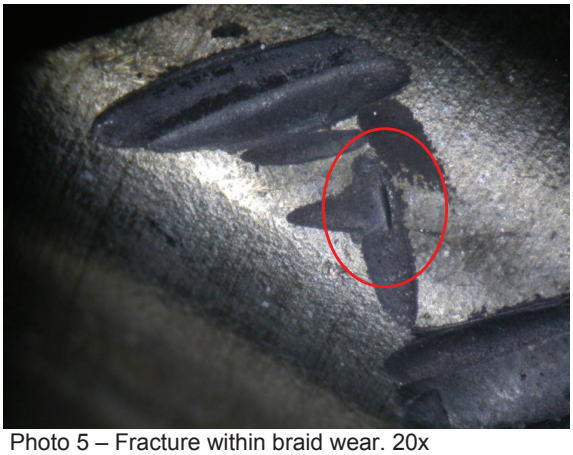


Photo 5 – Fracture within braid wear. 20x

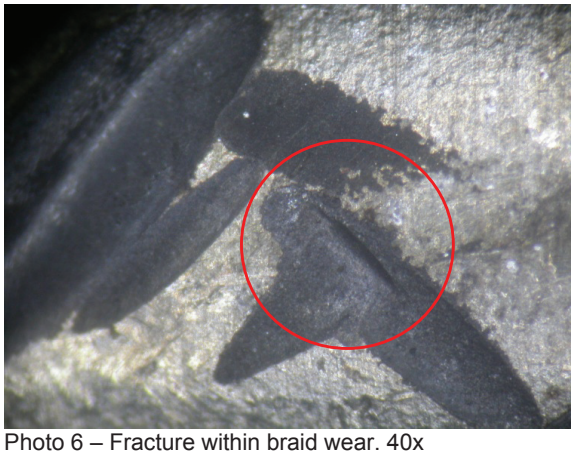


Photo 6 – Fracture within braid wear. 40x

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