NAFLIC

National Association For Leisure Industry Certification

Standards & Related Documents Committee

TECHNICAL BULLETIN — February 2015

S16. Hoerbiger hydraulic cylinder

The attached safety alert has been received from Hoerbiger detailing possible failures in their LE 25 and LE 32 hydraulic locking cylinders. It is known that these cylinders are used in the restraint systems of several ride manufacturers. The cylinders are a closed hydraulic circuit used in several orientations to lock restraints in a set position. It would appear that there are three potential failure modes and the manufacturer describes a test procedure to identify each failure. The ride manufacturer should be contacted for further guidance.

The information contained within is that of the manufacturer and not NAFLIC. When following the advice from the manufacturer, you are reminded of your duties and responsibilities under HSG175 regarding modifications.

HOERBIGER Micro Fluid GmbH · Borsigstraße 11 · 93092 Barbing, Deutschland

Zierer Karusell- und Spezialmaschinenbau
GmbH & Co. KG
z.Hd. Mr. Klaus Gäck
Josef Wallner Str. 5

94469 Deggendorf

Ihr Zeichen, Ihre Nachricht vom	Unser Zeichen, unsere Nachricht vom	Telefon

Date
August 11, 2014

Important safety related information for
Personal Restraint Systems
Models LE 25 and LE 32

Valued Customer:

Our LE units have been in use worldwide since 1995 and your company has relied on these proven HOERBIGER components in the manufacture of your equipment. Over the past 19 years, thousands of these units have been installed in personal restraint systems used in amusement park rides and we are not aware of any personal injury attributable to our components. We are pleased about this and we want this to continue.

Revisions, adaptations and improvements of product lines are common place in industry today. This is particularly true at HOERBIGER. In the process, we always welcome input gained from an open dialog with our customers. Over the past several weeks, we have developed some recommendations which are based on exchanges with our customers as well as internal and external experts. Our collective goal is to preserve rider safety by advising you of some simple measures to apply in three areas.

This purpose of this letter is to set out the topics and the recommended steps.

This is important information and should be shared with your end user customers.

I. Joint head (piston rod)

It is possible that a loose joint head connection could lead to a malfunction in the locking mechanism within the Personal Restraint System during a ride. Vibration

or improper adjustment of the threaded screw assembly can cause the connection between the rod-side joint head and the piston rod end to loosen during normal use. We are aware of only one instance (not involving personal injury) where this connection came loose under load and we have also observed several cases in the field where joint heads were loose.

We therefore recommend that the position of the joint head be checked as part of a daily inspection and the correct position should be reference marked with highly visible paint to facilitate inspection. We have outlined an easy to follow method to apply a paint marking in the enclosed annex. Please share this information with your end user customers.

II. Joint head (base side)

We have observed that some end users are sometimes unscrewing the threaded screw assembly unit out too far. This assembly is located on the cylinder base side. If the screw is unscrewed too far, an insufficient number of screw threads are in contact with the connection point. Please also note that the position of the thread is not intended as an adjustment for the spacing between two points within a personal restraint system. If the screw assembly is out too far the result is an unsecure connection which could lead to a malfunction in the locking mechanism of the Personal Restraint System during a ride.

It is important that you share this information with your end user customers.

III. Particulate within hydraulic cylinder

Regardless of stringently clean manufacturing processes and intensive quality control, hydraulic components have very small quantities of particulate that can materialize in the hydraulic fluid contained within the cylinder. Under certain circumstances, these small particles can cause a valve within the cylinder to not close properly. This could lead to a malfunction in the locking mechanism of the Personal Restraint System during a ride. Although the probability of failure is small the possibility of failure cannot be completely eliminated. For that reason we have developed a test to detect any faults. This information should be shared by you with your end user customers.

Further action to be taken

We have enclosed a separate information sheet for each of these issues. These sheets set out a detailed description of the issue and provide remedial instructions.

Clearly, as a component part supplier we cannot make a complete assessment of all potential risks inherent in the final products you manufacture. We simply do not have the immense amount of necessary information required to assess these risks. Our priority at present is to identify any potential issues, provide technical support and assist in the development of long-term solutions as we learn more. Depending on your application of our products and your own internal risk assessment, you may have an obligation to advise others.

Rider safety must remain our highest common priority. Operational rider safety is achieved when all entities in the chain connecting the various component suppliers, ride manufacturer and operator all share this high priority.

We strongly recommend you apply these recommendations in your manufacturing and servicing activities and we request that you please pass this information on to end user customers of the various rides you manufacture.

We are available to personally answer any questions you may have or to provide further technical support. You can reach Mr. David Niemes directly at our factory in Germany at +49 162 2777 287 or via e-mail: david.niemes@hoerbiger.com. We will also be reaching out to you soon.

Sincerely,

HOERBIGER Micro Fluid GmbH

Norbert Gauß
General Manager

ppa. Daniel Schmitt
Head of Business Segment
Compact Motion Technology

Enclosures:
Annex 1: **Paint marking** of the piston rod at joint head
Annex 2: **Inspection** of the threaded screw assembly
Annex 3: **Particulate** within the hydraulic cylinder

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Models LE 25 and LE 32

Annex 1: Paint marking of the piston rod at joint head

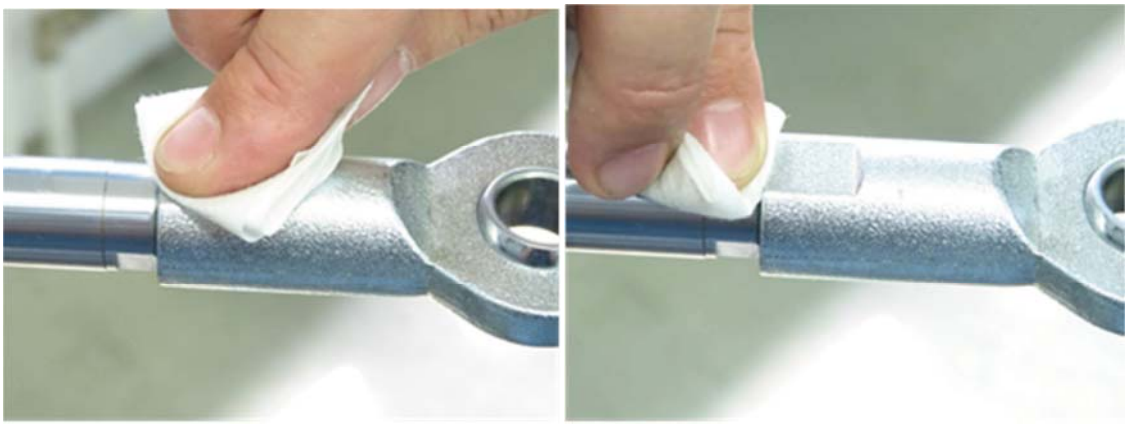
It is possible that a loose joint head connection could lead to a malfunction in the locking mechanism within the Personal Restraint System during a ride. Vibration or improper adjustment of the threaded screw assembly can cause the connection between the rod-side joint head and the piston rod end to loosen during normal use. We are aware of only one instance (not involving personal injury) where this connection came loose under load and we have also observed several cases in the field where joint heads were loose. The simple procedure described below will help reduce risk.

We recommend that the position of each head joint should be checked and the correct position be referenced marked with highly visible paint marking to facilitate a daily inspection. This recommendation should be shared by you with the end user customers.

Step1: Apply paint marking to the joint head

- Use a general purpose parts cleaner and degreaser prior to painting. The area should be free of residue after cleaning. The area to be marked on the joint head and piston rod should also be free of rust. We recommend Loctite® 7063 or DuPont 3608S™ or 3M™ S-151 Cleaner.
- Do not use brake cleaner or a nitro-cellulose combination thinner.
- Be careful not to damage the piston rod itself and keep the cleaning fluid off the section of the piston that moves in and out of the cylinder.

Cleaning Area:



Paint Marking

Use a high quality visible thread locking paint and follow the recommended application instructions. After consultation with you, we will determine the quantity of paint required and we will supply it to you. The paint marking should be one continuous line running from the joint head to the piston rod. The paint should be applied at a point where it will be visible to the operator during daily checking. The markings should also be checked annually, or more frequently, depending on climatic conditions.

Step 2: daily inspection of correct position of joint

The correct position of the joint can be verified by checking to see that the paint marking between joint head and piston rod is undamaged.

Correct position of a paint marking

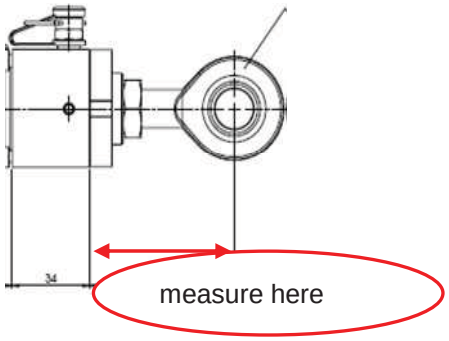
Example of a broken paint mark indicating that the joint thread has moved

All units should be inspected daily during use. If the paint marking is discovered broken or if the joint head is not completely screwed in, the unit should not be used because the Personal Restraint System may fail possibly leading to personal injury or death of a rider.

Annex 2: Inspection of the Threaded Screw Assembly

This information is important for anyone performing service on any personal restraint system using our LE assemblies and should be passed on. We have learned that some end users are sometimes unscrewing the threaded screw assembly out too far. This assembly is located on the cylinder base side and is circled in the picture below. Please note that the position of the thread is not intended as an adjustment for the spacing between two points within a personal restraint system. If this assembly is unscrewed too far there will be insufficient screw threads meeting the fitting to provide a secure connection. The result is an unsecure connection which *could lead to a malfunction of the locking mechanism in the Personal Restraint System during a ride*. This could cause serious injury or death. *Always check that screw thread depth is correct*. The diagram and photo below shows the measuring points to determine the correct screw thread depth.

The following data apply for all LE 32 versions:
(see table below for measurements applicable to the LE 25 versions)
For LE 32 versions the screw thread depth is correct when the rod extends no farther than distance of 64 mm (+/- 1 mm).



The data in the table below applies to the LE 25 versions: *x indicates the version number*

Material Number	Basic size of distance		Measurement Tolerance
850-7001-x	65	mm	+3mm
850-7002-x	65	mm	+3mm
850-7003-x	65	mm	+3mm
850-7004-x	65	mm	+3mm
850-7010-x	65	mm	+3mm
850-7013-x	62,5	mm	+3mm
850-7015-x	65	mm	+3mm
850-7016-x	65	mm	+3mm
850-7018-x	65	mm	+3mm
850-7019-x	65	mm	+3mm
850-7020-x	60,25	mm	+3mm
850-7021-x	60,25	mm	+3mm
850-8002-x	63	mm	+3mm
850-8003-x	63	mm	+3mm
850-8007-x	62,5	mm	+3mm
850-8008-x	65,25	mm	+3mm
850-8009-x	65,25	mm	+3mm

We strongly urge you to immediately check the measurement set out above on all Personal Restraint Systems in your possession and advise your technicians to adjust and maintain the measurements specified when installing the unit into a Personal Restraint System or during routine maintenance.

We recommend that the joint rod heads be secured at the specified dimensions and tightened with a torque wrench. The LE 25 version should be tightened to 80 Nm 10 Nm. The LE 32 version should be tightened to 90 Nm 10 Nm.

The correct measurement must be set and checked when installing or performing maintenance on the Cylinder Accumulator unit. In this way the required minimum screw thread depth engagement (as set out in VDI 2230) is maintained.

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Annex 3: Particulate within the hydraulic cylinder

Regardless of stringently clean manufacturing processes and intensive quality control, hydraulic systems have very small quantities of particulate that can materialize in the hydraulic fluid contained within the cylinder. Under certain circumstances, these small particles can cause a valve within the cylinder to not close properly. This *could lead to a malfunction in the locking mechanism of the Personal Restraint System during a ride.* Although the probability of failure is small the possibility of failure cannot be completely eliminated. For that reason we have developed a test to detect any issues early on. This information should be shared by you with your end user customers.

Either of the two hydraulic cylinder function tests set out below can be applied:

The “Stationary-Test” is a test method performed multiple times on an individual Personal Restraint System to determine functionality.

The “Stream Test” is a test method performed before every ride over the course of a series of 2,100 rides during operations.

Procedure for the “Stationary-Test”

The “Stationary-Test” is an effective method to detect particulate within the hydraulic cylinder. It can also be performed in the field while the Personal Restraint System is mounted on the ride. It should be noted that the test is only effective if the ride’s design mechanics permit sufficient opening force for the retaining clamp to open automatically when the Personal Restraint System is deactivated (in the opening-function). Depending on the design, this can be achieved with the Personal Restraint System alone or with the addition of integrated gas springs or comparable support.

Before the test begins, make sure that only one of the Personal Restraint Systems is active and in the locked position. Any other Personal Restraint Systems or mechanical locking mechanisms should not be activated or locked during the test. Make sure that no external force is applied to the Personal Restraint System.

1. Set the individual Personal Restraint System to the opening function.

2. Close the restraint bar and let it go into the lock position with existing force.

3. Now visually check for movement in the locking mechanism. This is done by keeping the restraint bar in place for at least 10 seconds. If the position of the restraint bar changes in any direction or if the cylinder moves more than 2 mm during the 10 second period, the unit may not be in order. It should be exchanged immediately and returned to the manufacturer with a defect description.

Please note that when observing the restraint bar, the mechanical transmission ratio must be taken into account depending on the design specified by the ride manufacturer. The maximum tolerance of the Personal Restraint System at the cylinder is always 2 mm. Please note that the measured tolerance at the restraint bar will vary depending on the transmission ratio between the unit and the restraint bar. For example if the designed transmission rate is 10:1 the maximum measured tolerance will be ten times the 2 mm at the cylinder or 20 mm at the restraint bar. Likewise, if the designed transmission rate is 5:1 the maximum measured tolerance of 2 mm at the cylinder will be five times or 10 mm at the restraint bar.

4. Apply power to the valve and open the restraint bar. End of test cycle. Restraint bar is opened again. Stop applying power to the valve.

5. Start a new test cycle at step 2 (above) beginning with closing the restraint bar.
   Repeat the test cycle (steps 2 to 4) 1,050 times.

Where the second Personal Restraint System is also an LE System, the test cycle should be performed by placing the unit in the opening position starting with step 1.

If an assembly fails during the 1,050 test cycles the affected system should be shut down and exchanged immediately.

Over the years we have also observed that some ride designers, manufacturers and even end users have incorporated a supplemental mechanical locking mechanism to add an additional margin of safety for their riders. This should be considered in your end product risk analysis.

Note:

Where the Personal Restraint System in use is a Type B “Block against extension and comfort adjustment” the electro-magnetic slide valve V2 (at position 8) must be observed to be in operation during the test.

Procedure for “Stream Test”

The following describes a test-procedure performed before every ride over the course of a series of 2,100 rides during operations.

The test is only effective, if the ride’s design mechanics permit sufficient opening force for the retaining clamp to open automatically when the Personal Restraint Systems are deactivated (in the opening-function). Depending on the design, this can be achieved with the Personal Restraint System alone or with the addition of integrated gas springs or comparable support.

Test procedure steps

1. Restraint bars of both Personal Restraint Systems begin in the closed and locked position.

2. The first Personal Restraint System should be deactivated and in the opening position.

3. The function of the second Personal Restraint System is checked for retention by keeping the bar held in place for a minimum period of 10 seconds.

4. If the locked position of the restraint bar changes in any direction or if the cylinder moves more than 2 mm during this 10 second period, the Personal Restraint System may not be in order. The Personal Restraint System should be exchanged immediately and sent to the manufacturer with a description of what happened.

5. This test procedure should then be performed to check the function of the first Personal Restraint System before the next ride. Begin this by deactivating the second system and check that the first Personal Restraint System holds the bar in place without cylinder movement for at least 10 seconds.

   If the test is observed at the restraint bar the mechanical transmission ratio must be taken into account depending on the design specified by the ride manufacturer.
   The maximum tolerance of the Personal Restraint System at the cylinder is always 2 mm. Please note that the maximum tolerance at the restraint bar will depend on the transmission ratio. For example if the designed transmission rate is 10:1 the maximum tolerance will be ten times the 2 mm at the cylinder or 20 mm at the restraint bar. Likewise, if the designed transmission rate is 5:1 the maximum tolerance of 2 mm at the cylinder will be five times or 10 mm at the restraint bar.

Warning: If the cylinder movement is observed to be greater than 2 mm during the above test, the Personal Restraint System should be shut down and exchanged immediately. Cylinder movement during the test indicates there is a potential for system failure which could cause serious injury or death.