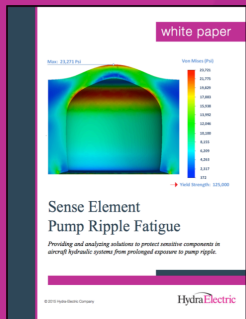



White Paper QuickLook for Aerospace Engineers



Can sensitive components in aircraft hydraulic systems be protected from prolonged exposure to **pressure spikes** and **pump ripple**?



Excerpts from
white paper,
*Sense Element
Pump Ripple
Fatigue*



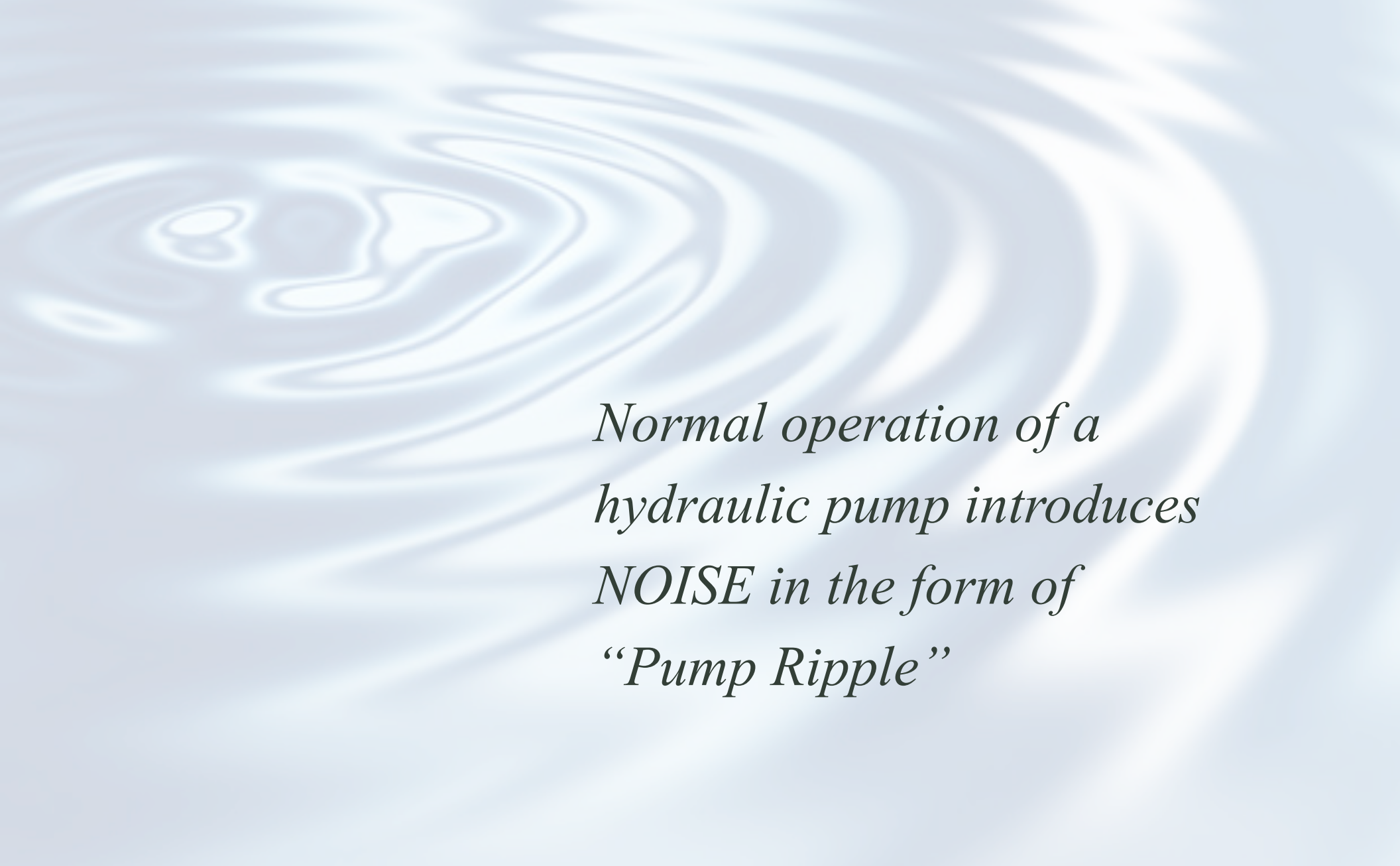
*Aerospace Sensor
technology is plagued by the
balance between sensitivity
and durability*

As devices become more fragile in the pursuit of achieving higher accuracy, they find themselves torn apart in the process

Aircraft hydraulic systems perform numerous critical functions

A PUMP is integral to driving these systems



The background of the slide features a close-up, high-angle view of water ripples. The ripples are concentric and spread out from a central point, creating a series of overlapping, curved lines that catch the light, giving the water a shimmering, textured appearance. The colors range from light blue to white, with the most intense highlights at the peaks of the ripples.

*Normal operation of a
hydraulic pump introduces
NOISE in the form of
“Pump Ripple”*

What's the problem with Pump Ripple?

Hydraulic systems will often include an impeller pump to supply pressure. The pump utilizes centrifugal force to accelerate fluid outward through small veins, generating a **pressure spike**. Sensors located near the impeller pump outlet will be exposed to the full force of the pressure spike and can fatigue over time.

*Pressure spikes
and pump ripple
can severely
damage
conventional
sensing elements*

Typical pressure transducers use delicate sensors such as a piezoresistive silicon (PRT) wafer mounted onto a PCB.

These materials have limited mechanical strength and, to protect components from in-flight hydraulic pressure spikes, often require a SNUBBER.

The Problem with Snubbers

- Do NOT completely protect components
- Add complexity to the design
- Can clog or impact the response of the sensor
- Effects more damaging if the fluid is already being maintained at a high constant pressure

A simple and elegant solution to an otherwise frustrating and costly problem

Hydra-Electric all but eliminates snubber issues by using a special sense element of **stainless steel construction**. This solution is capable of outperforming conventional technology like silicon PRT by withstanding some of the harshest pressure spike and pump ripple environments within aerospace systems.

What this sense element innovation offers

Accurate and linear pressure sensing across temperature and pressure

Superior robust construction that eliminates the need for additional pressure spike attenuation in most applications

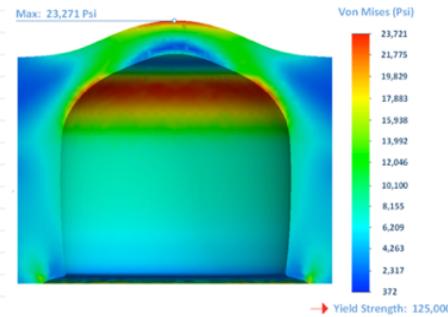
No moving parts that can “lock up” due to rapid pressure fluctuations

Wide range of fluid compatibility due to stainless steel media containment



Fatigue Analysis

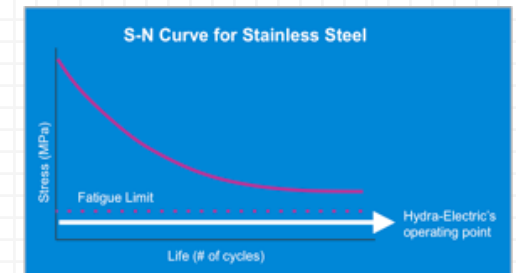
Hydra-Electric conducted finite element stress analysis of the stainless steel sense element to demonstrate **near infinite fatigue life** in a typical high pressure application.



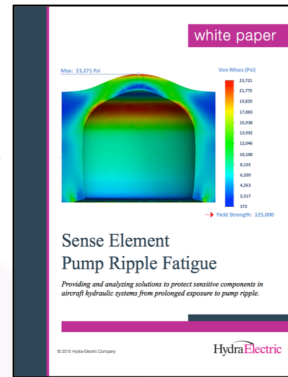
Sense Element
Stress Analysis

Fatigue is the weakening of a material caused by repeatedly applied loads. This cyclic loading can cause progressive structural damage and failure even if it is well below the ultimate strength of the material.

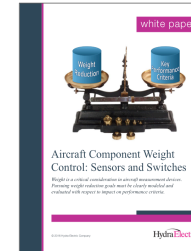
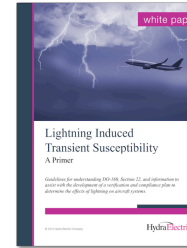
SN Curve for
Stainless Steel



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Steps*

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About Hydra-Electric Company

Hydra-Electric is a provider of breakthrough technology in sensors and switches for the aerospace industry. Its suite of solutions includes pressure, temperature and multi-function sensors; and pressure, temperature and liquid flow switches. Hydra's high performance sensing technology is able to address problems which were previously thought to be unsolvable, including pressure spike damage, pump ripple, high speed impulses, burst diaphragms, broken wire bonds and more.

The company has been an innovator in the industry since 1948 when it introduced the snap action sensing of pressure by means of the negative rate disk spring, a design that remains the standard today for most aerospace pressure switches. Hydra-Electric's products have been used across hundreds of military and commercial applications, including fixed wing and rotary aircraft, missiles, rockets, ships, submarines, tanks and UCAVs.