



# Star Sentinel

Powered by Kalogon™

Technical report



***“I now have much less pain because the pressure is constant.”***

Emhe, a StabilAir and Sentinel user

## Introduction

Pressure injuries are a common complication of immobility for wheelchair users. A pressure injury is “localised damage to the skin and/or underlying tissue, resulting from pressure or pressure in combination with shear” [1]. Pressure injuries are sometimes also referred to as decubitus ulcers, pressure ulcers and pressure sores. They can occur due to intense and/or prolonged exposure to sustained tissue deformations. Such deformations can include compression perpendicular to the tissue surface, a shear force parallel to the tissue surface, or a combination of the two. They typically occur at or near bony prominences. The highest pressure points in sitting are typically at the ischial tuberosities [2].

A pressure injury can present as damaged but intact skin, broken skin or as an open wound. They can be painful, costly, and often result in preventable complications for which many individuals are at risk. Consequently, pressure injuries reduced quality of life for wheelchair users and their caregivers, and pose a significant healthcare cost.

In the US, pressure injury care is estimated to cost \$11.6 billion annually (USD from 2000 to 2012), while the cost of individual patient care ranged between \$500 (USD) and \$152,000 (USD) [1]. In the Netherlands, pressure injuries are estimated to cost between \$362 million and \$2.8 billion annually (USD in 2009). In 2011, pressure injury treatment was reported as consuming up to £2.1 billion of the annual National Health Service (NHS) budget in the UK [1].

## Neoprene Vertical Air Cell Cushions (NVACCs)

Specialist wheelchair cushions are “foremost in the prevention and treatment of decubitus ulcers” [3]. This is achieved by redistributing the body’s weight away from the areas most vulnerable to tissue breakdown. The goal of such specialist cushions is to minimise pressure and shear loads over bony prominences to reduce the risk of developing pressure injuries [1].

Neoprene-based vertical air cell cushions (NVACC) have provided pressure redistribution in sitting since the 1970s. NVACCs such as Star are adjustable cushions made from a matrix of vertical air cells interconnected to form one or more compartments/sections. The air level in the cushion is adjusted to ensure maximum immersion of the user while maintaining a safety margin of air to prevent bottoming out. The air flows around the user until the pressure within each compartment/section is equalised. Each cell envelops the user as the cells easily deform and move independently in all directions. NVACCs facilitate immersion and envelopment of the buttocks in the cushion, which in turn can minimize stress concentrations near the ischial tuberosities [4].



Star StabilAir

## Star Sentinel Powered by Kalogon

Sentinel is a small, discreet device that provides air management for single-chamber NVACCs such as Star Standard Air and StabilAir. It aids cushion set-up, removes the need for regular manual air level checks, and alerts users of leaks that may result from any cushion damage.



## Features of Sentinel

### Air Management System (AMS)

Award-winning Sentinel enhances most existing single-chamber NVACCs by controlling and maintaining the pressure set by a clinician. Once the clinician sets the pressure level to individual needs, Sentinel continuously monitors the cushion and automatically adjusts the air level accordingly.

### Ambient Sensing System (ASS)

Sentinel continuously monitors and adjusts the cushion's air pressure in response to the user's posture, user/applied weight fluctuations, and even ambient pressure changes influenced by altitude or weather. For example, figures 3 and 4 below show Sentinel's behaviour in an altitude test in an aircraft. Figure 3 shows that Sentinel vents air to maintain the clinically set level of air as the aircraft ascends. In figure 4, however, Sentinel pumps additional air to compensate for the change in ambient pressure that occurs with a drop in altitude. Sentinel's Ambient Sensing System assists Sentinel in differentiating between this change in external air pressure and a leak to minimise the likelihood of an erroneous leak warning.

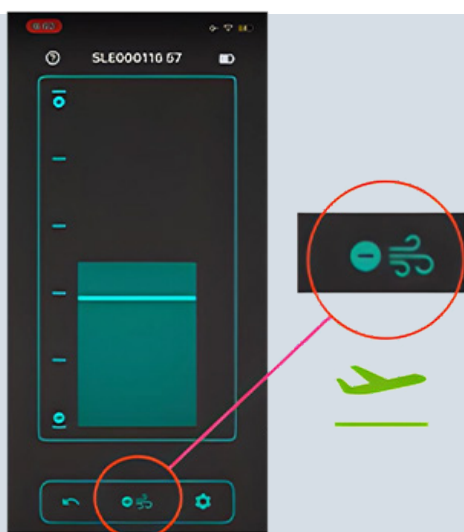


Fig 3. Aircraft Ascending: Cabin pressure decreases, internal cushion pressure increases.

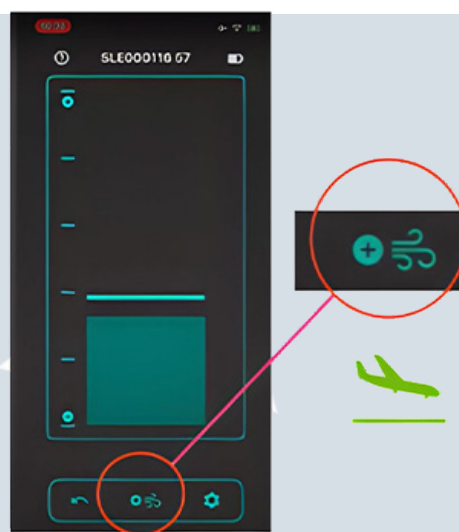


Fig 4. Aircraft Descending: Cabin pressure increases, internal cushion pressure decreases.

These systems remove the need for regular manual checks on the cushion’s air level. Continuous maintenance of the cushion’s clinically set air level ensures constant optimal pressure redistribution and user comfort. This can include adjustment for user weight changes over time, e.g., post-rehab, or short-term shifts in load, e.g., the user lifting something. Figure 5 shows Sentinel’s effective average air adjustments in response to applied weight changes compared to a cushion without Sentinel.

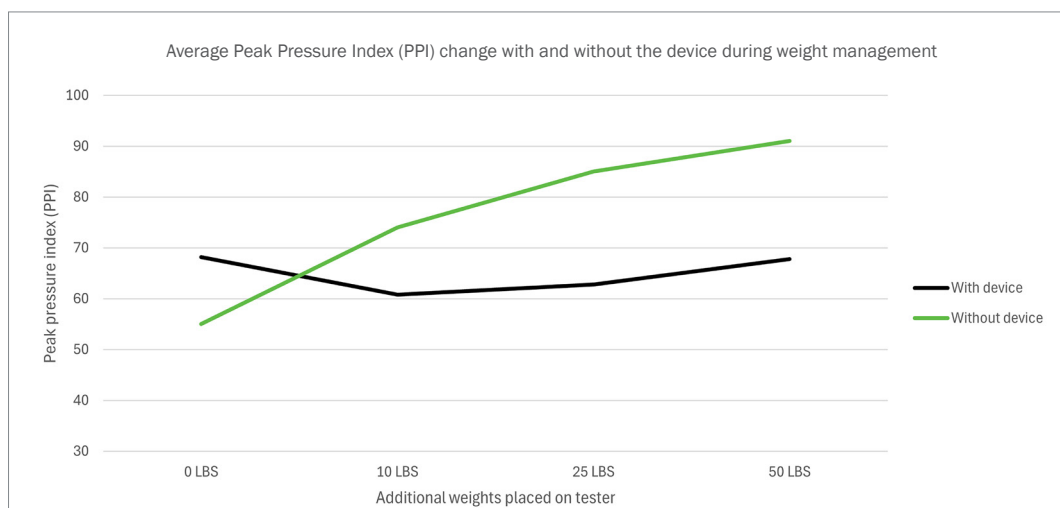


Figure 5: Effect of Sentinel on Peak Pressure Index (PPI) as applied weight rises

## Leak Detection and Management

In addition to monitoring the air level within the cushion, Sentinel also continuously monitors ambient air pressure to effectively differentiate a leak from other possible causes of internal air pressure changes. Sentinel is therefore able to identify air leaks resulting from damage up to 3mm in size. Once a change in air pressure is determined as consistent with a leak, Sentinel alerts the user audibly and visually to check the cushion. Sentinel then actively pumps air into the cushion to maintain optimal pressure within the cushion, thus helping to preserve the cushion’s pressure redistribution function. While leaks are uncommon on Star cushions (representing a claim rate of <0.01%), this functionality offers users additional safety and peace of mind.

Figure 6 and Label table 1 show the interface pressure in a manually adjusted Star cushion. Sentinel was connected to the cushion in the test illustrated below, and a 3mm hole was created intentionally to initiate a leak in the cushion. Figures 6 and 7 and Table 1 show that after 60 minutes of use with Sentinel, the air level was effectively maintained despite damage to the cushion, with no increase in Peak Pressure Index (PPI) or Dispersion Index (DI). When Sentinel was not in use, the pre-damaged cushion lost air pressure within 7 minutes, resulting in a significant increase in PPI and DI, as seen in Figure 8 and Table 1.

## Definitions

**Peak Pressure Index (PPI):** The average pressure within a 10cm<sup>2</sup> area around the ischial tuberosities where the highest pressure values are recorded [5].

**Dispersion Index (DI):** is the sum of pressure over the ischial tuberosity (IT) and Sacral/coccyx region divided by the sum of the total pressure readings for the whole pressure mat [5].

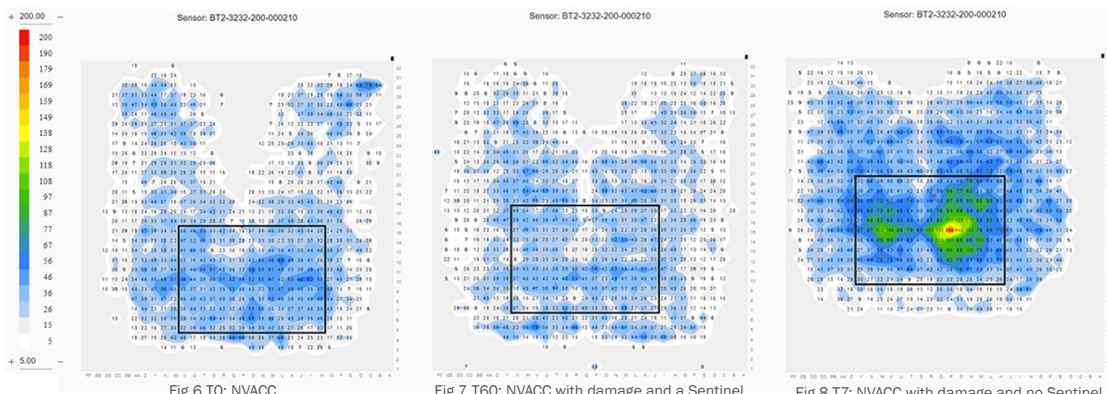


Fig 6 TO: NVACC

Fig 7 T60: NVACC with damage and a Sentinel

Fig 8 T7: NVACC with damage and no Sentinel

	<b>T0: NVACC</b>	<b>T60: NVACC with damage and a Sentinel</b>	<b>T7: NVACC with damage and no Sentinel</b>
Contact Area (in2)	220	243	217
Coefficient of Variance (%)	44	47	58
Peak Pressure Index %	52	45	136
Dispersion Index (%)	34	29	39

In testing with 12 different subjects, Sentinel correctly identified leaks within 1 minute 5 seconds to 12 minutes 48 seconds. Figure 7 demonstrates that Sentinel can maintain the clinically set level of air for at least an hour despite a large leak, thus providing adequate time for the user to transfer onto another suitable support surface.

## Conclusion

Sentinel is a highly effective accessory for neoprene vertical air-cell cushions, enabling continuous maintenance of the cushion’s clinically prescribed air level. Sentinel eliminates the need for manual cushion maintenance and ensures consistent optimal pressure redistribution by automatically adjusting the air level in response to posture, weight changes, and changes to ambient air pressure. With the addition of leak detection and leak compensation, Sentinel offers peace of mind and upgrades Star cushions to one of the most advanced pressure redistribution cushions available today.

## Acknowledgements

Test data produced by Kalogon. Thanks also to Emhe for allowing us to share her story.

## References

- [1] European Pressure Ulcer Advisory Panel, National Pressure Injury Advisory Panel and Pan Pacific Pressure Injury Alliance., Prevention and Treatment of Pressure Ulcers/Injuries: Clinical Practice Guideline. The International Guideline., E. Haesler, Ed., EPUAP/NPIAP/PIIA, 2019.
- [2] K. Hamanami, A. Tokuhiko and H. Inoue, “Finding the optimal setting of inflated air pressure for a multi-cell air cushion for wheelchair patients with spinal cord injury,” Acta Medica Okayama, vol. 58, no. 1, pp. 37-44, 2004.
- [3] O. Shechtman, C. Hanson, D. Garrett and P. Dunn, “Comparing Wheelchair Cushions for Effectiveness of Pressure Relief: A Pilot Study,” Occupational Therapy Journal of Research, vol. 21, no. 1, pp. 29-48, 2014.
- [4] Cohen, L., and Gefen, A. Deep tissue loads in the seated buttocks on an offloading cushion versus air-cell-based and foam cushions: finite element studies. 2017.
- [5] ISO 16840-9: 2015. Technical Report. Clinical Interface Pressure Mapping guidelines for seating. International Standard Organization.



## User story

Emhe is a 75-year-old lady from the Netherlands who was diagnosed with Multiple Sclerosis (MS) in 1982. She also has a long-term joint condition that causes pain and stiffness.

In the past, Emhe experienced pressure injuries, which healed with proper wound care. She lives independently in a personal care home unit with her loyal service dog, Lobke, and receives support from friends, who assist with some daily-living activities.

As a wheelchair user, Emhe has extensive experience with various seat cushions designed to redistribute pressure. She has previously used foam, gel, and vertical air cell cushions, but none provided lasting comfort. These cushions often caused pain, lacked stability, leaked, or failed to maintain proper pressure distribution, requiring frequent repositioning.

Since switching to the **Star StabilAir** cushion and the **Sentinel**, air management device, Emhe has noticed significant improvements. Combined, Emhe reports that these products have addressed her past issues, enhancing her comfort and stability.

“I think it’s a stable cushion that’s comfortable, and I would recommend it to anyone. Sentinel saves a lot of time and effort for healthcare. It provides convenience because Sentinel keeps my cushion at the correct pressure. For users who find it annoying that you have to feel under the buttocks with your hand to set up the correct air pressure in the cushion, it is a godsend. Once adjusted, the cushion will remain at the correct pressure. All in all, highly recommended!”



Star Selimer\_Technical Report\_01\_INT

Etac is a world-leading developer of innovative assistive devices and patient handling equipment. Since 1973, we have been committed to improving quality of life for the individual, family members and caregivers.

For the intended purpose of the products and latest information, please visit [www.etac.com](http://www.etac.com)

Etac

- +46 371 587 330
- [info@etac.se](mailto:info@etac.se)
- [www.etac.com](http://www.etac.com)

**etac**<sup>®</sup>  
Creating Possibilities