



# Explosion of iron hydrogen storage containers – Investigations from 120 years ago revisited



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## ABSTRACT

The explosion of hydrogen gas storage cylinders on May 25, 1894, represents one of the most spectacular failure cases during the late industrialization period in Germany. With respect to modern applications to hydrogen storage as energy carrier, it has several times been referred to as precedent failure case for the whole industrial sector. The detailed investigation reports by Martens have thus gained interest in the last years, but also, because the publications in 1896 about his expertise already provided in September 1894 document one of the first and most comprehensive investigations which can be regarded as a nucleus for modern failure analysis.

After summarizing the newspaper reports in the introduction, the present contribution provides a review of Martens' reports targeted at the development of failure analyses and materials testing procedures as well as potential failure origins.

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## 1. Introduction

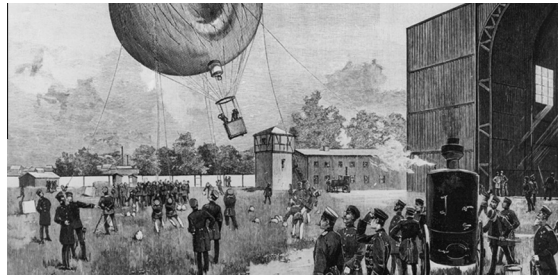
At the end of the 19th century, the airfield Berlin–Tempelhof represented a military area where the pioneers of ballooning and airshipping were performing their trials (Figs. 1–4). While the balloons usually contained hot air, most of the first airship-like flight vehicles were filled with hydrogen for their uplift. Although obviously not the only catastrophe with hydrogen filled airships at that time, the explosion of iron hydrogen storage containers (also referred to as gas bottles or cylinders in this contribution) on the airfield on May 25, 1894, left immense devastation [2–4] which best can be comprehended by the following summarization of newspaper reports [5–7]. The >Nationalzeitung< (National Newspaper) reports [5].

At arrival of the fire brigade, the wooden storage cabin literally totally disappeared from the ground and the violence of the explosion catapulted some of the more than a hundredweight heavy retorts more than 300 steps onto the air strip, while some more flew into the gasometer, into the nacelle and into the barracks. The gasometer which was supposed to contain ca. 700 m<sup>3</sup> gas burnt down, fortunately, without exploding. In the nacelle, an insignificant fire developed which could be extinguished quickly. One of the two cylinders flying into the barracks penetrated a bed which was not occupied due to posting of the occupant, and the second one, after penetrating the roof, lied on a beam, directly above an occupied bed. About 70 out of totally more than 1000 cylinders in the storage exploded. The remaining unexploded gas bottles have been salvaged by the fire brigade out of the burning debris with great cautiousness, due to the hazard of further explosions.

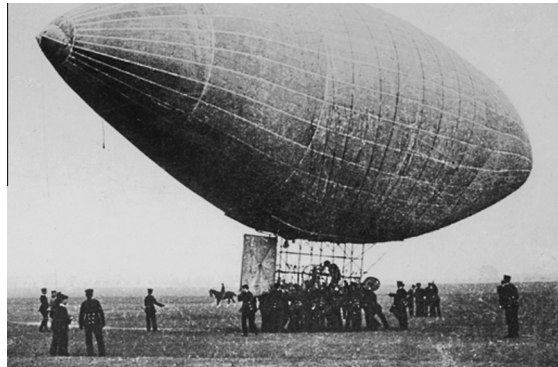
The newspapers reported the incidents and damage quite detailed, like the total destruction of sulfuric acid containers, an iron bottle cutting off a 40 m high chimney and several containers impacting missile-like the officer's mess. It has been

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**Fig. 1.** Illustration of the facilities and of the exercising Royal Airship Department in 1887 [1].



**Fig. 2.** Woelferts' dirigible on the airfield Tempelhof in 1897 [1].



**Fig. 3.** Crash of a motor balloon in 1897 [1].

mentioned explicitly and several times that fortunately nearly nobody was injured [5,6], but the total damage costs amounted to about 100,000 Reich marks [5] which today would be about 2 Mio. €, compared by the buying capacity.

As particularly interesting from the failure analysis perspective have to be regarded the following facts derived from various newspapers:

- The incident happened in two or three explosions starting about 03:45 in the morning [5,6].
- Only about 70 out of 1000 bottles in the storage exploded and only a limited part of the exploded cylinders were totally fractured, while Martens mentioned in his reports that about 400 containers exploded [5].

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