International Journal of Research in Engineering and Science (IJRES)
ISSN (Online): 2320-9364, ISSN (Print): 2320-9356
www.ijres.org Volume 14 Issue 4 ǁ April 2026 ǁ PP. 177-183

Vacuum Line in the Munich Olympic Village
A pneumatic waste disposal system from the 1970s

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Abstract
The central pneumatic waste disposal system in Munich's Olympic Village, which has been out of service due to recurring blockages in the pipes, is highly likely to be dismantled in the near future. This paper presents a comprehensive study of this system through literature review, systematic technical analysis, evaluation of documents from the operating company of the Olympic Village (Olympiadorf-Betrieb-Beteiligungsgesellschaft, abbreviated as ODBG) and interviews with residents, combined with an analysis of the system's schematic diagrams. The system was designed and built by the Swedish company Centralsug (now Envac AB) in the early 1970s. Centralsug's products are widely used in large residential complexes and public facilities worldwide. And the company also remained responsible for the system's maintenance and operation in Munich for decades. This paper covers the system's background, working principles of pneumatic transportation, and recurring issues over more than a decade, including frequent blockages, lack of waste sorting facilities, and severe pipe corrosion. After approx. 50 years of operation, ODBG considered that the system was no longer worth renovating. Although the system effectively reduced disruption caused by waste collection and improved hygiene standards when it was introduced as an innovative solution in the 1970s, years of operation have led to blockages, corrosion and maintenance difficulties, rendering it incapable of safe operation. It was permanently decommissioned in 2019. Instead of it, the traditional waste bin solution proposed by ODBG is feasible, but it would disrupt the quiet environment of the "car-free community" and damage the road surface; technical modifications are difficult to implement due to issues such as pipe bends and fire safety concerns. This paper not only analyses the various proposed measures but also puts forward the following recommendation: in the short term, implement the ODBG proposal whilst optimizing waste collection management; from a heritage conservation perspective, retain visible above-ground facilities such as waste chutes and repurpose them as an alternative to complete demolition.

Keywords: *Waste disposal System, Pneumatic System, Olympic Village, Heritage Conservation, Technical Facilities*

Date of Submission: 12-04-2026 Date of Acceptance: 26-04-2026

I. INTRODUCTION

Between 1969 and 1972, accommodation for approx. 12,000 people was built on the Munich Olympic site, along with commercial, office and public facilities such as school and church [2, p2]. It was predictable that a large amount of waste would be produced daily. It was necessary to solve the problem in an efficient facility [25].

During the planning phase, two solutions were compared. The conventional solution was placing waste containers in the basement or courtyard of the residential buildings. An innovative solution was to build a central pneumatic waste disposal system. The disadvantages of the first solution were hygiene problems, dirt, odours and disturbance to residents due to the noise of waste collection vehicles. In addition, the Olympic Village was planned as a "car-free city". The building intendants would have had to transport the waste containers to the central collection stations at great expense. The following prognosis was reached, with the conventional waste disposal solution, ten building intendants and two waste collection lorries would have been busy all day collecting rubbish in the Olympic Village in 1992 [3, p.82].

In contrast, the pneumatic waste disposal system ran automatically, required significantly fewer workers, and reduced waste disposal distance for residents and for building intendants. The amount of space required for waste disposal could be also significantly reduced [6]. A pneumatic waste disposal system from the Swedish company Centralsug AB was built for the Olympic Village as the "optimal solution".

1.1 THE COMPANY CENTRALSUG AB

Centralsug AB, now Envac AB, offers a wide range of waste disposal solutions and specializes in pneumatic systems. The first waste disposal system was developed for a hospital in Sweden in 1961, followed by an installation in a residential area in Sundbyberg near Stockholm in 1965 [26]. Centralsug AB's systems consist of a sealed pneumatic pipe system; the waste is transported through the pipes to a waste collection centre. Using the system almost completely eliminates dirt and odours, and the automatic control system ensures that there is no direct contact with the waste. Today, Envac AB also develops also mobile systems. In new projects across a range of applications – from commercial kitchens, hospitals, city centres, large residential areas to airports – waste separation is also made possible through additional drop-off bins [13].

1.2 THE WASTE DISPOSAL SYSTEM

The key data of the waste disposal system in the Munich Olympic Village is as represented in table 1.

Table 1: Key Data [25].

Property developer	Olympiadorf - Maßnahmeträgergesellschaft GmbH
Architect	Heinle, Wischer u. Partner, Stuttgart
Waste disposal system	Centralsug AB
Buildings	Flat bungalows to high-rise buildings with up to 17 floors, office buildings and shopping areas, sports facilities
Number of apartments	5500
Waste chutes	119
Air valves (for supply air to the transport pipe)	38
Maximum distance to the control centre	1100 m
Total pipe network	5100 m

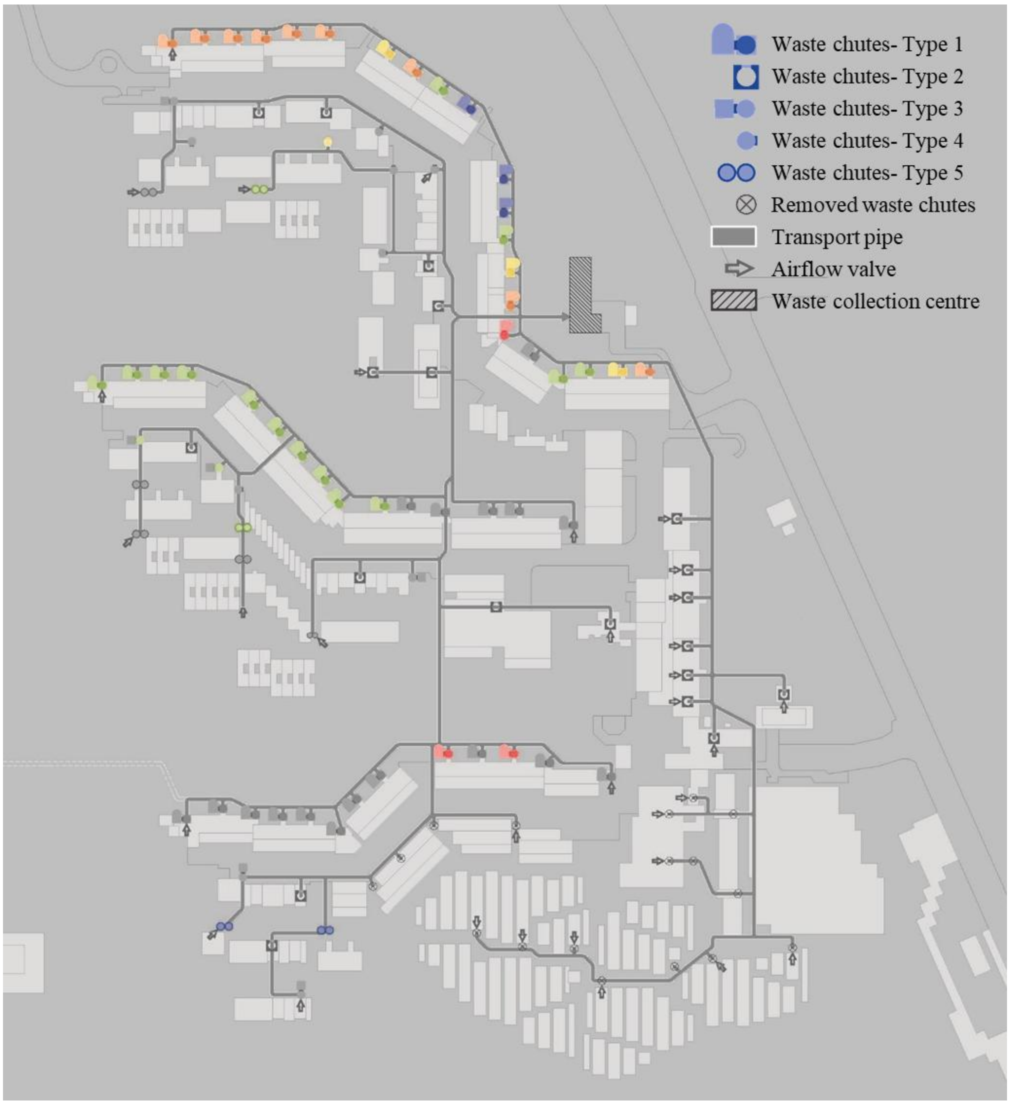

Figure1: site plan of the Olympic Village and the waste chutes (Illustrated by the author)

Residents dispose their waste into one of 119 waste chutes, each of which is assigned to one of the stairwells in the high-rise buildings or to a group of low-rise or single-storey buildings. The waste falls onto the separating disc of the chute valve and is temporarily stored in the chute. All chutes are connected to the waste collection centre by an underground transport pipe system.

An automatic program controls the entire system. At a specific time, the vacuum turbines in the waste collection centre start to operate. When a negative pressure of 250 mbar is generated in the pipes, a transport valve at the other end opens. Air is drawn in and moves towards the waste collection centre. When the air velocity reaches 25 m/s, the disc of the first shaft valve opens, the waste is drawn into the transport pipe and transported to the waste collection centre by the negative pressure. After 15 seconds, the disc closes again and the next shaft valve opens. The process repeated until all shafts have been emptied.

The waste arrives in a collection container and is compressed by a compactor. The containers are then collected for disposal by vehicles from the Munich Waste Management company (AWM). The exhaust air is filtered through dust filters and vented outside via silencers [1, 5].

1 Waste chute
2 Chute valve: The chute valve requires a floor area of at least 2x2 m. A horizontal steel disc functions as the bottom of the chute for most of the time, blocking the fall of the waste. An automatic control system rotates the disc to the side at regular intervals, allowing the waste to pass through. After emptying, the chute disc closes again. [1]
3 Airflow valve: At the end of each pipe section, an airflow valve is installed in a soundproof room. Air is pumped in and carries the waste from all chutes along this section to the waste collection centre. [1]
4 Transport pipe: The steel pipes, with an internal diameter of 500 mm [15], are joined by welding or flanges and are installed horizontally underground [5]. They form an underground network and connect the airflow valves and waste chutes to the waste collection centre.
5 Waste collection containers and compactors: To reduce the volume of waste, it is compressed directly inside the container using a compactor.
6 Containers: When a container is full, it is automatically moved to one side on a rail system. The next empty container is docked onto the compactor
7 Vacuum turbines: The turbines start at a specific time every day; in order to follow the set programme, the shafts are emptied one after the other. Once all the shafts have been emptied, the turbines switch off automatically. [3]
8 Dust filters and sound dampers

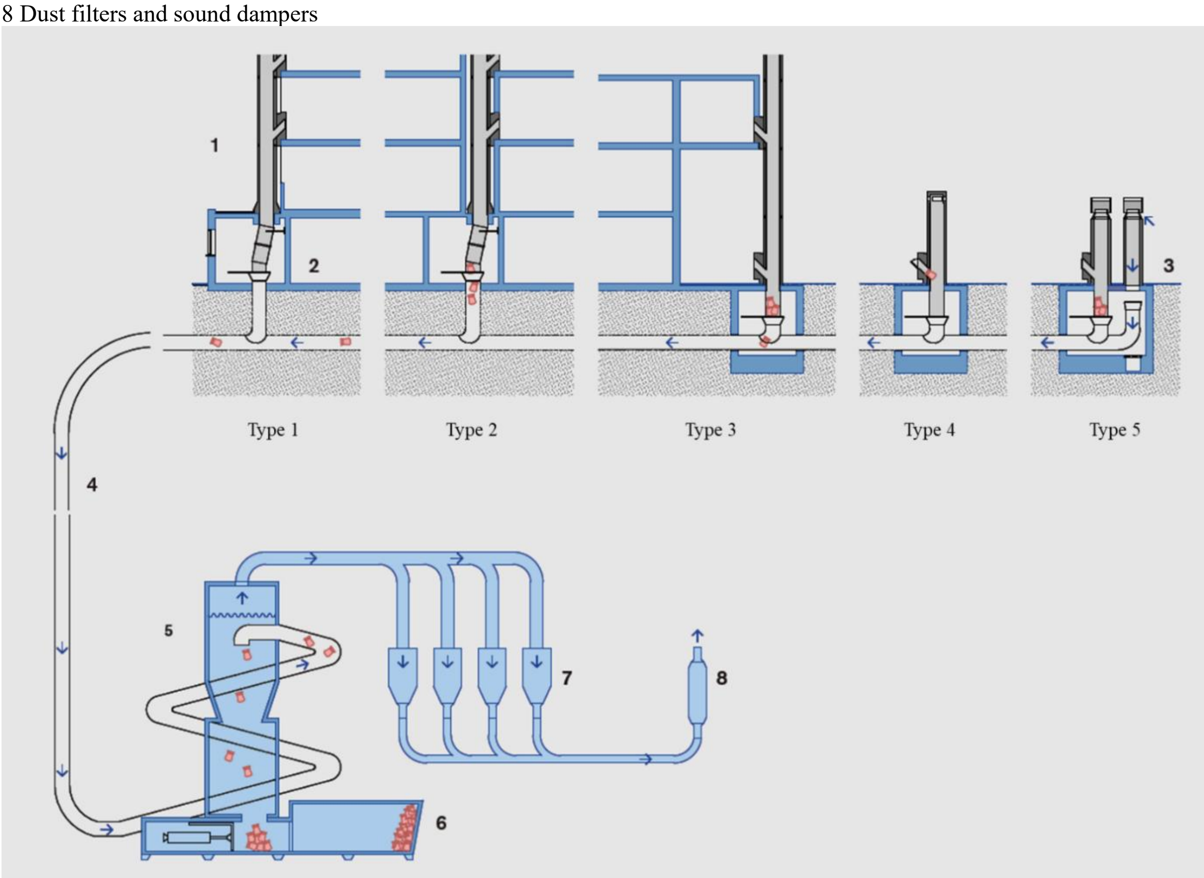

Figure 2: Diagram of the system (Illustrated by the author)

Figure 3: Waste compactor

Figure 4: Containers

Figure 5: Vacuum turbine

Figure 6: Rail system for containers

Figure 7: Control centre

(Figure 3-7: Photo by the author)

II. PROBLEMS OF THE SYSTEM

2.1 BLOCKAGE

The waste disposal system was shut down due to recurring blockages in the pipes. In September 2017, a section near a main junction on Straßbergerstraße became blocked, followed by four further sections. This affects 90% of the entire system [21]. During the time it was in operation, blockages that endangered the entire system occurred repeatedly. An emergency plan for a possible failure of the system was prepared as early as 1999 [19]. According to ODBG, if the pipes become blocked, a staff must crawl into the affected pipe and remove the blockage manually, as the distances between inspection hatches are 60 meters. At this distance, problems cannot be solved with normal tools such as rods and hooks. This process is not only time-consuming, but also very dangerous. However, if 90% of the system is affected by blockages, this manual remediation is no longer possible. Another option would be using a high-pressure water jet, which would be very costly [22].

As long as the system is in use, there is a continued risk of blockages [21]. The blockages can be explained almost entirely as a result of users disposing unsuitable waste in a system, which is designed purely for small-scale residual waste. Cardboard boxes and empty packages easily get stuck in the pipes due to the curves and branches in the system. The increasing popularity of online shopping has recently caused a significant rise in blockages. Furthermore, the air flow cannot carry very compact, heavy waste such as bundles of newspapers, books, carpets, etc., which have apparently been thrown in repeatedly. Many non-resident workers, e.g. craftsmen, cleaning staff and nursing staff, are not properly informed about what are not allowed to throw into the chutes [22]. For example, construction waste or nappies must not be thrown into the chutes.

2.2 Waste separation

There is no sorting facility at the waste chutes. In the Olympic Village, residents are expected to take organic waste, plastic waste, paper and glass to the recycling containers themselves. The convenience of the pneumatic system reduces motivation for recycling. As mentioned above, throwing paper boxes, plastic buckets, etc. into the chutes often causes blockages in the pipes [22].

2.3 Corrosion of the pipes.

Following the last shutdown, a camera inspection was performed. The results confirmed that, after approx. 50 years, the underground pipes are extensively corroded. Compared to the disposal chutes, the underground transport pipes are difficult to maintain. Original pipe wall thickness of 10 millimeters has been reduced to only 2-3 millimeters. Thin walls cannot longer withstand heavy loads from soil pressure and transportation. Pipe collapses can cause cracks and subsidence in the grounds beneath parks and underground car parks [22].

III. PROPOSED SOLUTIONS

3.1 Solutions proposed by the ODBG

The entire pneumatic system has been decommissioned. According to ODBG, completely replacing the pipes would be technically almost impossible, because many of them are located under the basement of car parking area and cross many high-rise buildings and roads. If more inspection hatches were planned or if it were possible to replace the chutes and pipes, the system could probably still be used for a few more years [21].

The proposal of ODBG is to install rubbish bins at the existing disposal points and set up collection points. The bins would be positioned next to all the pneumatic waste chutes, taken to the collection points and emptied twice a week [22]. A total of 80 large-capacity bins with a capacity of 1.1 m^3 and 49 bins with a capacity of 0.24 m^3 have been ordered from AWM [21]. Waste collection vehicles drive along the fire lanes. This temporary solution not only causes noise in the “car-free” Olympic Village, but also damages the paving. The waste chutes in the student accommodation area were already removed during the renovation a few years ago. Waste from the student flats is disposed via waste containers, which are collected by the building intendants and transferred centrally to the AWM’s vehicles [22]. The costs for this solution remain almost the same as before: the costs for electricity, maintenance and renovation of the pneumatic system are saved. However, the costs of waste collection are rising due to increasing waste volumes. In addition, a waste disposal charge from AWM applies. How to deal with the underground pipe system has not yet been definitively decided. Due to the problems mentioned, the pipes could be filled with sand and concrete to avoid the formation of voids.

Figure 8-9: rubbish bins with a capacity of 1.1 m^3

Figure 10-12: rubbish bins with a capacity of 0.24 m^3

3.2 Suggestions from Residents

Residents also made suggestions on how to retain the pneumatic waste disposal system or how waste could be disposed of alternatively in future. In an issue of the village newsletter published in early 2018, the ODBG commented on this and explained why the proposed solutions were not technically feasible. However, there are positive aspects to be found among the proposed solutions from the perspective of heritage conservation.

Table 2: Analysis of different Suggestions.

Suggestions	Technical perspective	Perspective of heritage preservation
Install new pipes inside the existing ones, possibly multiple pipes for waste separation	Due to curves and branches, it would not be possible to install new pipes inside the existing ones [22].	It would be an ideal solution if it were feasible, as the external appearance of the system would remain unchanged, and the original function could continue to be performed.
Continue to use the waste chutes as drop pipes and place rubbish containers at the bottom	This would cause fire safety issues. The external staircase of the high-rise buildings are emergency staircases. If a fire were to break out in the rubbish container, flames and smoke could travel up the waste chute and reach the upper floors. [22].	The shaft valves had to be removed so that the containers could be placed under the fall pipe. However, visible parts of the system, the waste chutes and the hatches, could be retained and continue to fulfil their original functions.
Install a new system	Building a new system would be very expensive. And blockages could not be completely avoided.	Although the function and form of the waste disposal system would remain unchanged, the original parts would be removed and replaced with new ones.
Underground waste containers The underground waste container consists of a small chute, which looks like a rubbish bin, and a large underground storage chamber. Crane trucks are required to empty the underground containers.	The containers would require an enormous amount of space, and there are already many underground pipes in the Olympic Village. As a result, the underground containers could only be installed at four locations. Furthermore, the distances would be too long for residents to walk to dispose of their waste [22].	This solution has no clear advantage over the conventional solution using rubbish bins. The waste disposal system would not be retained.

It has not been decided yet what will happen to the shafts. In addition to the expected corrosion of the metal tubes, which will progress in the short to medium term until they are completely damaged, the concrete components will also require renovation in the longer term due to normal aging processes. To prevent the structures from falling into disrepair in the long term, new purposes for the pipes must be found to ensure their ongoing maintenance. Like Hans Hollein's Media Line in the Olympic Village, the shafts could also function as design elements or lighting structures. Due to their height, the shafts can be seen from a distance and aid in orientation.

Due to the size of the building structure and the density of the residents, the building services systems are a key component of such large 1970s buildings. However, these systems are often no longer compliant with current health and safety or technical standards. In most cases, they are removed or replaced during renovation. Upon closer inspection, these technical systems are actually specific solutions that adapt to the floor plan typologies, and together with other elements such as terraces, façades and outdoor spaces, they shape the character of the respective buildings. Consequently, the removal or replacement of such building services systems should not be viewed as the only option.

IV. CONCLUSION

The pneumatic waste disposal system in Munich's Olympic Village is a representative case of building services technology from the late 20th century, offering advantages in reducing disruption caused by waste collection. However, following years of operation, the system has revealed design limitations: the pipes are unsuitable for specific waste types, there is no sorting function, maintenance is difficult, and corrosion is severe. Following its decommissioning, the operating company's proposed conventional bin solution, although feasible, compromises the "car-free village" concept and causes noise and pavement damage. Technical upgrades of the system are difficult to implement due to existing constraints, whilst a decision still needs to be made regarding the final fate of the underground pipes. From a heritage preservation perspective, the system is not merely functional but also an integral part of the technical characteristics of large-scale housing estates from the 1970s. Therefore, instead of demolition or replacement, consideration should be given to the possibility of retaining and transforming certain components, such as the waste chutes, into iconic features or lighting installations, thereby preserving their historical and spatial value.

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