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# Containerized water treatment plants


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## CONTAINERIZED WATER TREATMENT PLANTS - A SCANDINAVIAN DESIGN MODEL

Containerized water treatment plants for capacities up to 100 $m^3/h$ are the most pragmatic form of modernization / construction of any water treatment facility. Simplicity of form, combined with technical advancement guarantee rationally spent money. These types of facilities are dedicated in particular for:

- systems with a capacity of up to 1'800 $m^3/d$, treating deep or surface water with a low or medium degree of pollution;
- small and medium municipalities with limited financial resources;
- users for which modernization of existing water treatment plant buildings is technically and economically unjustified;
- users which have not permanent and qualified technical staff to operate traditional water treatment systems;
- industrial and manufacturing facilities where the demand for water may gradually increase along with the production growth;
- all those who rationally plan their investment expenditures.

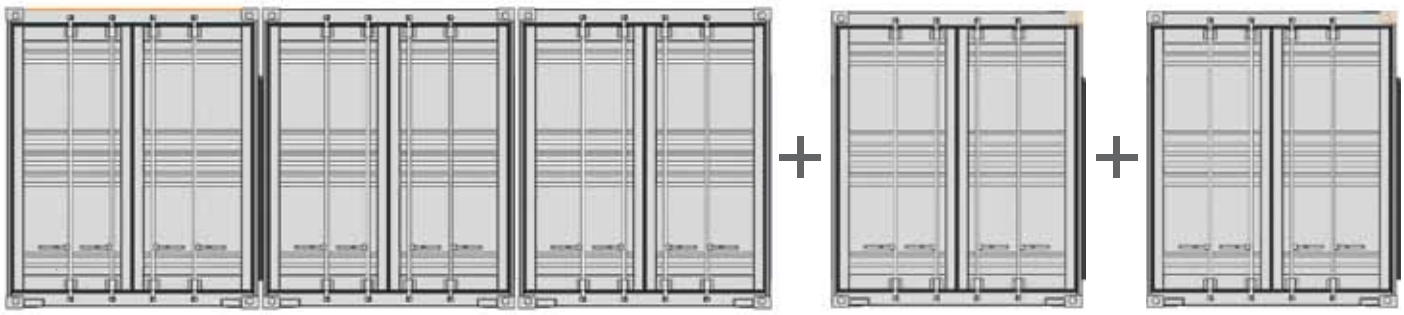

Most traditional water treatment plants with a capacity of up to 100 $m^3/h$ are built in much larger buildings than required by responsible and reasonable planning. This is mainly due to the fact that investors either rely on ready-made designs or modernize or renovate old buildings from the 1970s and 1980s. Of course, there is a tendency to use more minimalist forms in construction, but unfortunately, the design of the treatment plants, which are theoretically dedicated to automatic and unattended operation, are still taking into account the social rooms, duty rooms, storerooms, etc. But what for? The idea of containerized plants in this case is well thought out and fully justified. With the current level of technology and simultaneous efforts to reduce investment and operating costs, the containerized plants as an unmanned, small and fully automated facility is an ideal solution.

## CAPACITY BASED ON YOUR NEEDS - FLEXIBLE TECHNOLOGY

The main advantage of containerized water treatment plants is their modularity and the highest process flexibility available on the market. Anyone professionally involved with the subject of municipal water treatment plants knows that the overall technological layout of water treatment is often modified for reasons beyond the control of the user. These are most often:

- increased demand for water due to development of buildings in the area,
- deterioration of raw water quality resulting in the need to improve the water treatment process,
- changes in legal regulations concerning quality parameters of drinking water intended for human consumption (higher requirements),
- technical problems related to worn out equipment.

Knowing these limitations, Proffico as the first company in Poland, using Scandinavian designs, introduced containerized water treatment plants to regular production, taking into account their modular design. Thanks to that, the customer has a guarantee that the present choice of a given technical solution will not be a limitation in the future, but on the contrary, it will enable its possible modification according to needs. It is worth noting that many of the traditional water treatment plants in use today are simply oversized (often by as much as 100%) due to the fact that during the modernization process the rule of balancing water consumption with the „future" factor was applied. This results not only in an unjustified increase in investment costs but also in higher operating costs. These costs are mainly created by the excessive amount of water used for backwash processes (low production, temporary backwash of filters) as well as cubature of rooms. Therefore, for small and medium-sized water treatment plants the containerized plants are a perfect technical solution.



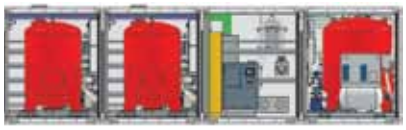
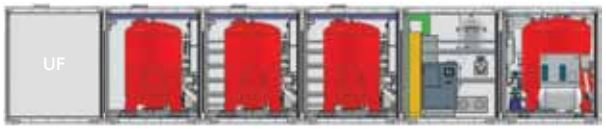
Starter set - 3 containers (2+1)
30 $m^3/h$

4th container
+ 30 $m^3/h$

5th container
+ 30 $m^3/h$

Such investment philosophy seems to be very rational due to the fact that a given water treatment plant can be tailored to the user's needs. Not only does it allow for further expansion in the event of an increase in water consumption, but it also allows for the selection of water treatment technology between single-stage filtration and two-stage filtration. The selection of the right technology obviously depends on the quality of the raw water to be treated, but the final decision is not easy. With single-stage filtration there is a risk that the required water parameters will not be achieved, while using a two-stage filtration system may involve significant oversizing of the technology. Therefore, it is a perfect engineering solution to be able to switch the technology from single-stage to two-stage filtration on a facility in operation under real conditions. Thanks to this, by observing the treated water parameters for a certain capacity of the plant, we can always choose the optimal filtration model, both technically and in terms of costs. Every Proffico containerized plant has such a functionality.

The standard configuration of Proffico containerized water treatment plants includes the following options:

| Containers arrangement | Opiton | Easy water [1] single-stage filtration | Hard water[1] two-stage filtration |
|---|---|---|---|
|  | I | 30 $m^3/h$ [2]<br>600 $m^3/d$ [2]<br>6'000 inhabitants [3] | 15 $m^3/h$ [2]<br>300 $m^3/d$ [2]<br>3'000 inhabitants [3] |
|  | II | 60 $m^3/h$ [2]<br>1'200 $m^3/d$ [2]<br>12'000 inhabitants [3] | 30 $m^3/h$ [2]<br>600 $m^3/d$ [2]<br>6'000 inhabitants [3] |
|  | III | 90 $m^3/h$ [2]<br>1'800 $m^3/d$ [2]<br>18'000 inhabitants [3] | 45 $m^3/h$ [2]<br>900 $m^3/d$ [2]<br>9'000 inhabitants [3] |
|  | IV | ultrafiltration module is added to option I or II or III to ensure the highest efficiency of water treatment [4] | |

1) by "easy water" is meant water containing moderate content of iron and manganese compounds and low content of ammonium ion together with low values of oxidizability. Waters with higher values should be considered as "difficult waters". The presented arrangement is conventional and in no way discredits the necessity of performing possible pilot tests on a semi-technical scale confirming preliminary technological assumptions.

2) hourly and daily capacities refer to filtration rate (filter hydraulic load) of 9.7 m/h. If it is necessary to use other filtration rates for specific water qualities, these capacities will be proportionally corrected.

3) the number of equivalent inhabitants served by the option was determined based on two assumptions: the average water consumption per inhabitant per day is 100 liters, and the irregularity in water consumption is covered by an external treated water storage tank.

4) ultrafiltration module provides the reasonably highest quality of municipal water treatment. It can be assumed that these modules retain all solids that are larger than 1 nm ($10^{-6}$ mm) including bacteria, viruses, pollen, yeast, colloids. Ultrafiltration does not solve water hardness problems.

## WATER TREATMENT TECHNOLOGY

Containerized water treatment plants offer what is used on large and very large plants based on pressure filtration. These facilities can treat both deep well water and surface water with low and medium degree of pollution. Due to the unmanned operating of the plants, no technical limitations were applied in designing the technological system. Proffico's design philosophy in this regard was clear from the beginning: "*If a containerized water treatment plant is to operate unmanned for 30-40 years, you cannot save on technology and use so-called half-measures*". The result of such understanding of the investment process are containerized water treatment plants, which in their external form may not belong to the most magnificent, but in terms of applied technical solutions and quality of construction are superior to many currently operated facilities

### WATER AERATION SYSTEM

Basic technical parameters of the raw water aeration system:

- primary aeration using a static mixer with a removable cartridge, air nozzles, manometers;
- secondary aeration in a pressure aerator (4.60 $m^3$, contact time 3 ÷ 9 minutes);
- Mankenberg + manual venting;
- aeration between first and second stage of filtration - static mixer;
- oil-free scroll compressor - Atlas Copco;
- air control system dedicated for static mixer, pressure aerator, static mixer between first and second filter stage includes flow control (valve + rotameter), pressure control, by-pass, solenoid valves, ball valves and safety valves.


## FILTRATION SYSTEM

Basic technical parameters of the filtration system:

- filtration rate up to 9.7 m/h;
- drainage bottom - flat, mushroom nozzles with a long leg, with a longitudinal slot, allowing to evenly distribute the washing medium throughout the drainage bottom;
- drainage plate - flat, a thickness of min. 12 mm, reinforced (connected to the lower bottom with brackets);
- nozzles made of plastic (PP) with filtration slot width of s = 0.3 ÷ 0.5 mm;
- filter protected against corrosion from the inside with 150 ÷ 200 $\mu$m polyester resin with Polish Hygiene Institute certificate for contact with potable water, from the outside with 150 ÷ 200 $\mu$m epoxy-polyurethane paint with PHI certificate for contact with potable water, with increased UV resistance in red RAL 3020 color;
- filtration beds selected according to raw water quality (typically multi-layer beds with a catalytic layer; specific fraction min. 90%);
- possibility to switch from single-stage filtration to two-stage filtration;
- flow regulation on each filter (regulating throttle valve + flow meter);
- AVK throttles with double-acting pneumatic drive with limit switches;
- each filter has a control panel (operating status indicator lights, pressure gauges, flow meter);
- automatic and manual operation modes;
- water sampling taps on individual filter bed heights.


## FILTERS BACKWASH SYSTEM

Basic technical parameters of the filter backwash system:

- air-water backwash;
- air backwash 47 - 61 $m^3/m^2s$, approx. 2 min;
- water backwash 36 - 54 $m^3/m^2s$, 5÷10 min;
- final water wash for about 5 minutes;
- raw water wash from built-in retention tank;
- Lowara monoblock washing pump;
- capacity control of washing pump - flow meter + inverter;
- Atlas Copco oil-free Roots type positive displacement blower;
- blower capacity control - flow meter + inverter.

## DISINFECTION SYSTEM

Depending on the needs, water can be disinfected after the treatment process. The selection of the disinfection method should be made with reference to the physicochemical parameters of the water and the condition and size of the water supply system. The following physical and chemical disinfection systems can be installed in the Proffico containerized plants:


- Wedeco low-pressure UV lamp with automatic cleaning system;
- water disinfection system based on dosing of commercial sodium hypochlorite;
- water disinfection system based on dosing sodium hypochlorite produced on site from table salt;
- water disinfection system based on dosing of chlorine dioxide produced on site from dilute solutions of hydrochloric acid and sodium chlorite.

In accordance with current regulations in this regard, the chemical disinfection system is built in a separate room with an external entrance door.

## NETWORK PUMPING STATION

Basic technical parameters of the network pumping station:

- manufacturer - Lowara;
- number of pumps - 6 pcs. (4 working and 2 reserve);
- capacity of the set - 130.0 $m^3/h$ (normal states), 180.0 $m^3/h$ (exceptional states);
- each pump equipped with individual inverter, mounted on pump motor, pump body - cast iron, impeller - stainless steel.

## CONTROL SYSTEM

Basic technical parameters of the control system:

- Siemens controller;
- Siemens 15" touch panel;
- SCADA;
- remote data transmission;
- each filtration container equipped with separate power supply and control system.


## MEASUREMENTS

The measurement system of the containerized water treatment plant includes:

- raw water flow;
- water flow on each filter;
- backwash water flow;
- rinse air flow;
- 18 pressure transducers;
- oxygen and turbidity measurement - optional.

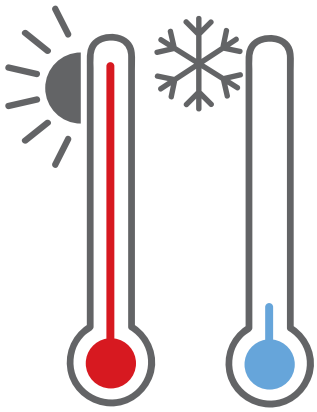
## PIPING AND FITTINGS

The piping and fitting system includes the following execution:

- stainless steel 316 L;
- full piping designation;
- 28 expansion joints;
- AVK fittings.

## HEATING SYSTEM

Also in this aspect, containers have an advantage over traditional buildings. Each container is covered from the inside with insulation panels of „sandwich" type. The construction (PVC - polyurethane - PVC) fully provides the required thermal insulation. The panel thickness of 2 to 4 cm, compared to conventional building insulation may not be impressive, but in the case of water treatment plants it is unquestionably sufficient both in winter and summer. This fact is mainly due to the temperature of the intake water, which in combination with a large heat exchange surface (tank shells, pipes, etc.) allows the optimum temperature of 5 to 10°C to be maintained throughout the year. In addition, for the full comfort of the user and in order to protect the facility against occasional frosts, each container is equipped with supplementary electric heating that starts automatically at temperatures below 5°C. In addition, it should be noted that the oil-free compressor used for aeration also generates significant amounts of heat during its work, which in this case additionally heats the interior of the container.



## AIR DRYING SYSTEM

Air drying inside each water treatment plant is a standard nowadays and there is no point in convincing anyone about the purpose of this solution. One can, of course, discuss which dryers are better - adsorptive or refrigeration ones, but a much better area for potential optimisation is limiting the cubature of the facility along with the inflow of humid air. Containerized plants, due to their technical features, are characterized by almost unbelievable efficiency in limiting the volume of the dried space, obtaining the production rate of 1 $m^3$ of water per hour at 2.5 $m^3$ of the facility's volume. Additionally, it should be noted that in our containerized water treatment plants the supply of fresh air for aeration and removal of excess air from this system is carried out without contact with the environment. This saves energy that is normally consumed in the drying process (unproductive drying of circulated technical air). Therefore the installed dryers will start only in the first hour to obtain the assumed - low - humidity, and then, due to the lack of significant inflow of fresh and humid air, they will switch on only occasionally. Low cubic index combined with limited humidity inflow gives us a certainty that drying system operation costs will be negligible.

## EASY TO CLEAN SURFACES

An obligatory requirement is the use of easily cleanable surfaces within the premises of the filter hall of each WTP. This condition is solely related to the need to maintain hygienic conditions in the production of water intended for human consumption. Previously described sandwich panels, in addition to their insulating role have the functionality of easily cleanable surfaces. Containers from inside are covered with smooth PVC panels, which allows to keep the walls properly clean and is characterized by the highest resistance to chemical agents (including chlorine compounds used in the process of disinfection).

EASY CLEAN

## CONTAINERS

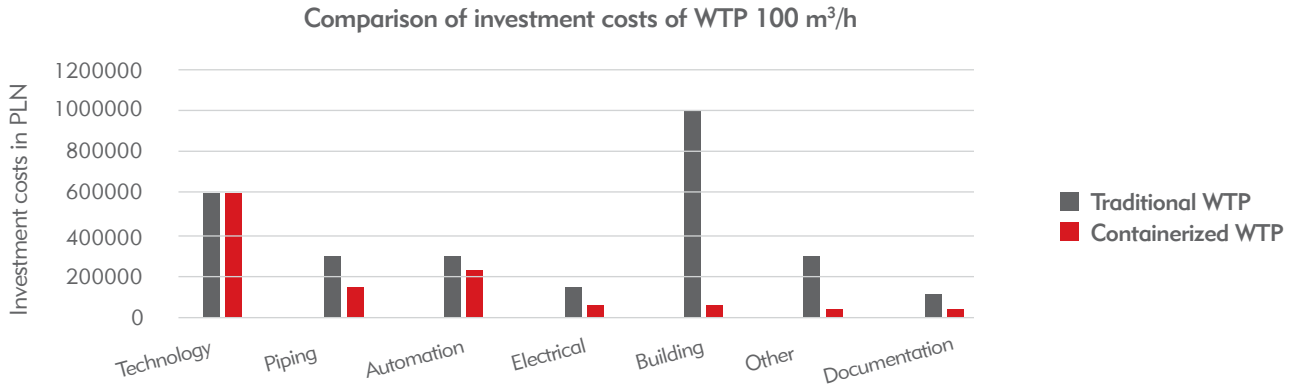
Proffico containerized water treatment plants are installed in original and new sea containers. These containers are made of a frame load-bearing structure and corrugated steel sheets. Their internal load capacity is 30 tons and the external load capacity is 210 tons. Corrosion protection allows their use in extremely severe weather conditions for up to 30 years (frost, heat, salt water, moisture, heavy rains, sea and road transport, loading and unloading). All these elements give us confidence that the durability of the containers in which our plants is built, is much longer than the technical lifetime of individual devices. For comparison, the thickness of the steel shell of the container is as much as 1.5 mm and is 3 times greater than the commonly known metal roofing tiles, the service life of which is calculated for 40 years

## OTHER EQUIPMENT

As part of standard equipment, each containerized water treatment plant has internal Led Philips lighting with 4000K light color, additional 230 and 400V connection sockets, and outside each container there are Ledvance floodlights installed. The power control system distinguishes first category devices (blower, compressor, pumps) from second category devices not directly involved in the water treatment process (dryer, heater, etc.). Additionally, the container is equipped with an alarm system and each lock is made in the „one key" system, which means that the user opens each door lock with one key.

## INVESTMENT COSTS

Analyzing the investment costs of a typical water treatment plant with a capacity of 100 $m^3/h$ and an equivalent Proffico containerized plant, we can see that significant differences in investment costs relate only to the building, pipelines and other works. Other integrated elements such as technology, electrical and automation remain at an equivalent price level.



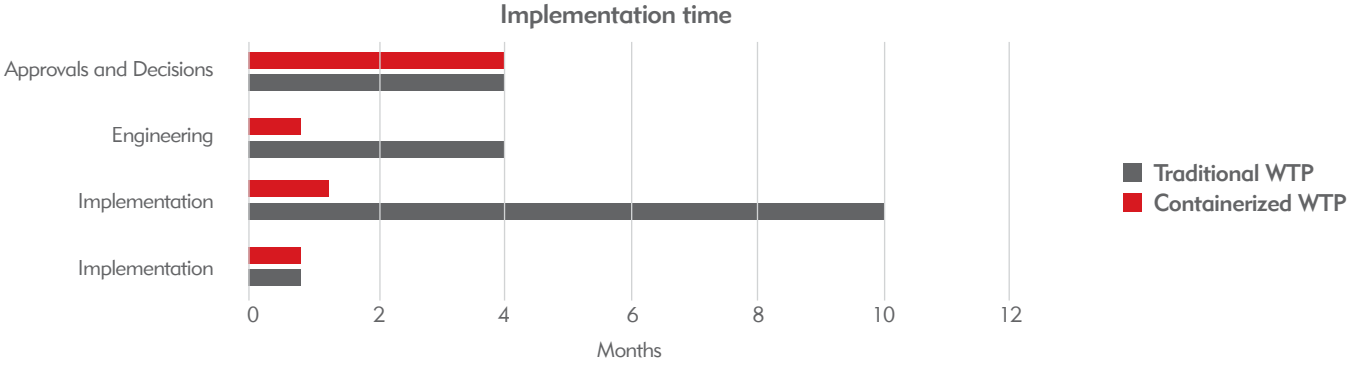

What does this mean in practice? Is it rational? The main conclusions are as follows:

- when deciding on a new water treatment plant in a traditional version, the highest costs are incurred not on what is most important, i.e. the water treatment technology, but on its packaging (the building of the WTP);
- the technical quality of the water treatment equipment and technological solutions is identical in both options;
- the difference in the costs of pipelines and electrical installations is due to the fact that in the containerized water treatment plant the equipment is built in a smaller space, thanks to which we incur lower costs associated with the routing of pipelines or cables;
- the cost of developing project documentation for containerized water treatment plant is half the cost of traditional WTP due to the standardization of construction solutions (traditional water treatment plants require an individual approach and solutions that must be matched to the existing or new building and infrastructure).

In the case of water treatment plant modernization, the disproportions remain at a similar level. Although there is no need to build a new building, however, the costs of its adaptation while maintaining the continuity of water supply to the network remain high.

## IMPLEMENTATION TIME

This issue is indisputable. As far as the formal matters are concerned - the design stage in the case of containerized plant is much shorter than in the case of traditional WTP due to the applied standardization and repeatability of solutions, while the acquisition of formal approvals and decisions will be comparable in both cases and depends on local conditions and procedures in state administration offices. In terms of the stage of implementation, in contrast to traditional water treatment plants, containerized plants can be installed virtually all year round, without significant weather conditions. The advantage of this solution is also the time of implementation of the investment, which in some cases can be as little as 30 days.

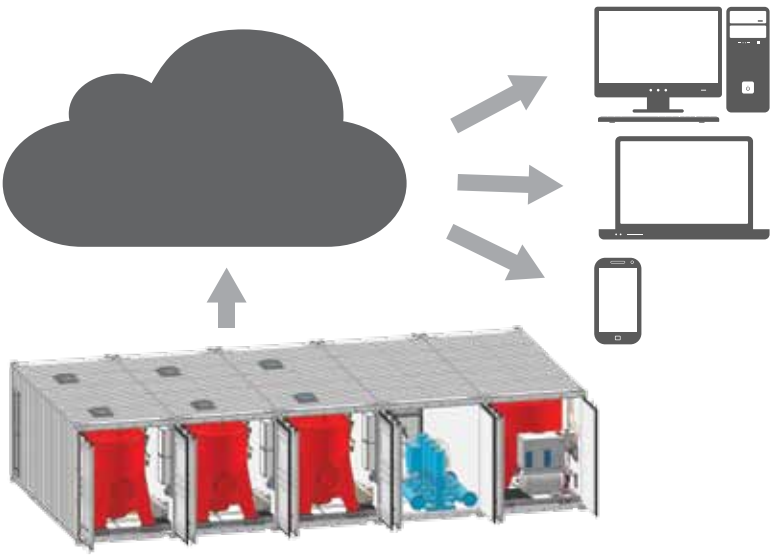


## SERVICE AND FAULT REMOVAL TIME

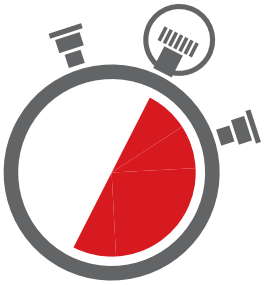
Proffico, as part of the manufacturing and supply of containerized water treatment plants provides 24/7 warranty and post-warranty service. Each of our service technicians is appropriately trained and qualified to carry out complex facility inspections and repairs. All service vehicles are equipped with the necessary tools to properly perform the service work. Portable analyzers ensure quick and reliable determination of the treated water quality at all critical points of the plant. After each service visit, a report is always drawn up informing the user about the work carried out and giving operational recommendations. The "Service Net" and "Half day repair" principles are an important addition to our service quality system.


### SERWIS NET – REMOTE OVERVIEW AND MONITORING OF WTP OPERATION

Additionally as a part of Proffico service it is possible to provide Serwis-Net system. Within this service, Customer has remote preview of working installation (on phone, tablet or computer) and has possibility not only to monitor WTP operation status but also to remove some failures quickly. This functionality provides all necessary process data such as pressures, flows, operating states of individual devices, both in tabular and graphical form. All of this data are of course archived, so it is possible to analyze them over a longer period of time. An additional remote viewing allows the identification of any malfunctions in the plant before they occur, possibly resulting in a shutdown of the WTP.



## HALF A DAY FOR REPAIR



Due to the well-developed modular design of our treatment plants, a high standardization of the structural solutions and the equipment used was possible. Due to this technical philosophy we guarantee the repair of any damage within 12 hours from the time of notification (arrival + repair). Such a short response time is possible due to the fact that we have a special mobile warehouse of spare parts and equipment built in the large cargo space of a VW Crafter. When a failure occurs and the fault is located, the component is not repaired but replaced with a new and functional one. The faulty component is then repaired at Proffico's service center while the water treatment plant is operating in its normal mode. The mobile warehouse contains the following components / equipment:

- compressor, blower, washing pump;
- throttles, check valves, vent valves;
- flow meters, pressure gauges;
- pneumatic drives, positioners, limit switches, solenoid valves, reducers;
- main pipeline sections, gaskets;
- control and automation system components.

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