TENNANT COMPANY

AMR BEST PRACTICES GUIDE

TABLE OF CONTENTS

CONNECT WITH US

Thank you for choosing Tennant Company AMR to be a part of your team and creating a cleaner, safer, healthier world.

We would like you to have a copy of what was discussed in training and provide you with best practices to optimize your machine's performance.

Customer Support

Rest assured that you have a team here to support you with any of your AMR needs. We can assist with reporting, training, or software updates. Requests can be sent via email to the **Customer Success Team** at **customersuccess@tennantco.com**.

If you are experiencing an issue with your machine and need assistance to submit a service request or order parts – please call the **Customer Service** line at **1-800-553-8033**.

Please have the machine's serial number ready when you call or include this in the email's subject line.

My Account - Online Customer Portal

Register for My Account to access online tools such as:

- Access Documents and Resources
- Schedule a Service Appointment
- Order Parts
- View Invoice History and Status

Sign up in 3 steps:

1. Go to www.tennantco.com
2. Click on the Sign Up button at the top-right of the home page
3. Enter your email address and your account number

OPERATING OVERVIEW

Approved Use Overview

Environments in which the robotic scrubber may be used

- Only use to clean areas which can be reasonably cleaned by a manual scrubber of comparable build/design/size,
- Only use in spaces that are monitored and designed for cleaning using industry standard practices for machinery and wet floor cleaning, including caution signage and barriers,
- Do not use too close to and cleaning areas shall not include inclines, stairs, drops, cliffs, escalators, ends of loading docks,
- Do not leave temporary elevated platforms (scaffolds or ladders) or electrical cords (or other low profile items) near the path of the machine while operating in robotic mode,
- Do not operate in robotic mode when in environments requiring fail-safe performance (areas where machine failure could lead to personal injury or property damage), and
- Intended for use in areas in which there is adequate cell coverage permitting cellular data communication

General Use Overview

- Do not attempt to ride the scrubber while in robotic mode.
- Remove key from ON/OFF key switch to prevent unauthorized use without disrupting robotic route.
- Do not grab steering wheel. Steering wheel may move rapidly and unexpectedly while in robotic mode.
- Do not leave electrical cords or other low profile items such as floor mats or forklift tines. Objects under 4 inches (smaller than a soup can) are outside of the machine's line of sight.
- Always operate machine in manual mode when going into elevators. Automatic doors should be avoided during autonomous cleaning.
- Place cones in front of escalators, elevators, objects under 4 inches, and other areas/objects the machine should avoid.
- The machine's onboard cameras may capture images of people who happen to be in its surrounding. There may be additional laws in your jurisdiction of operation relating to your use of technology with cameras. Please comply with all applicable laws, including using signage or obtaining consents as required.

COMPONENTS OVERVIEW

Autonomous Components

- User Interface (UI)
- Yellow Safety Straps
- Emergency stop button
- Blue start/stop button
- Turn indicators
- Sensor locations

Scrubber Components

- Power
- Battery light indicator
- Water flow indicator
- Warning light (!)
- Solution level
- Water level
- ec-H20 Nanoclean if applicable
- Scrub pressure level
- Forward/Reverse
- Vacuum button
- Scrub deck button- "1-Step button"
- Foot Pedals
- Horn
- Status Indicator
- Blue light if applicable
- Headlights (T16AMR only)

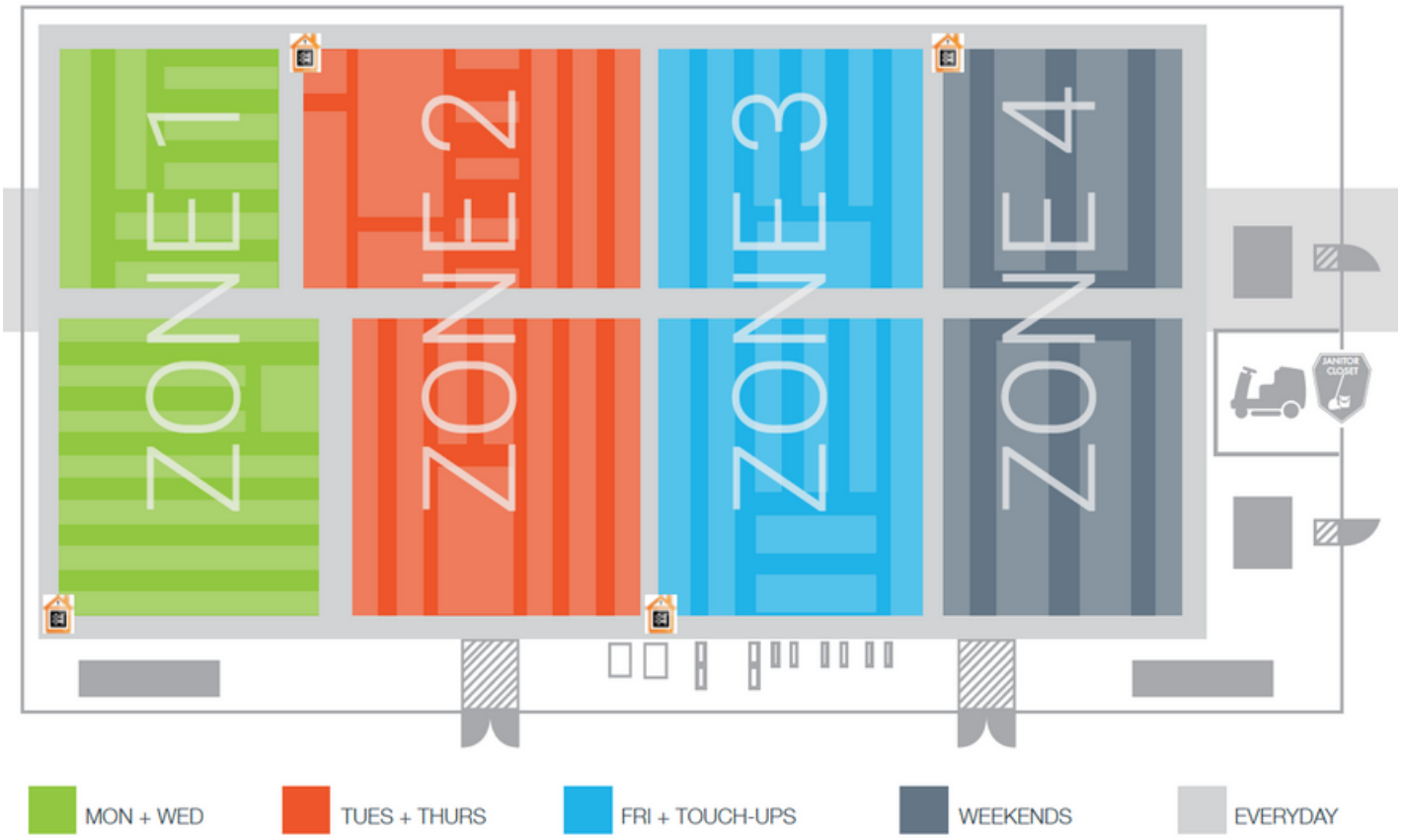
Model shown is T7AMR. See operator's manual for model specific components and additional detail.

BEST PRACTICES

Planning for Autonomous Use

There are many considerations when planning cleaning routes to maximize and optimize your robotic scrubber performance. It's important to create a logical cleaning strategy that works for your specific space and its unique configuration, size and features. Aim to keep routes less than 30 minutes in autonomous mode. Utilize consecutive routing feature to connect multiple routes from the same home marker.

Figure A

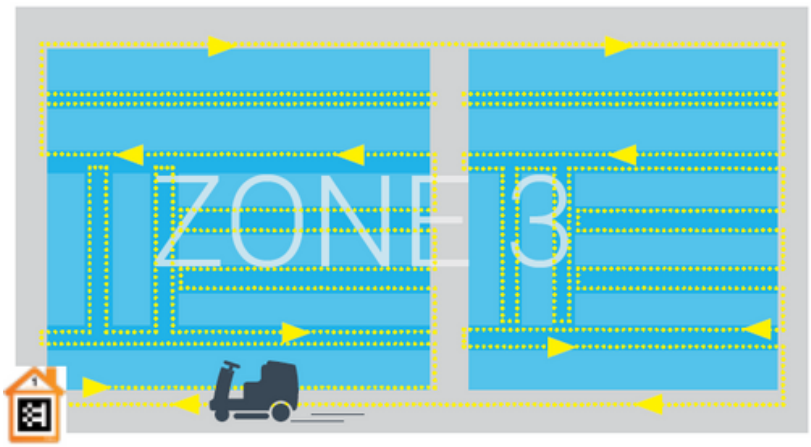


Path Creation Example

Figure A - Shows one large space that has been segmented into 4 zones

Figure B - Illustrates the importance of logical path planning. Pay particular attention to how many passes an aisle requires for optimal coverage. More details on the following page.

Figure B



BEST PRACTICES

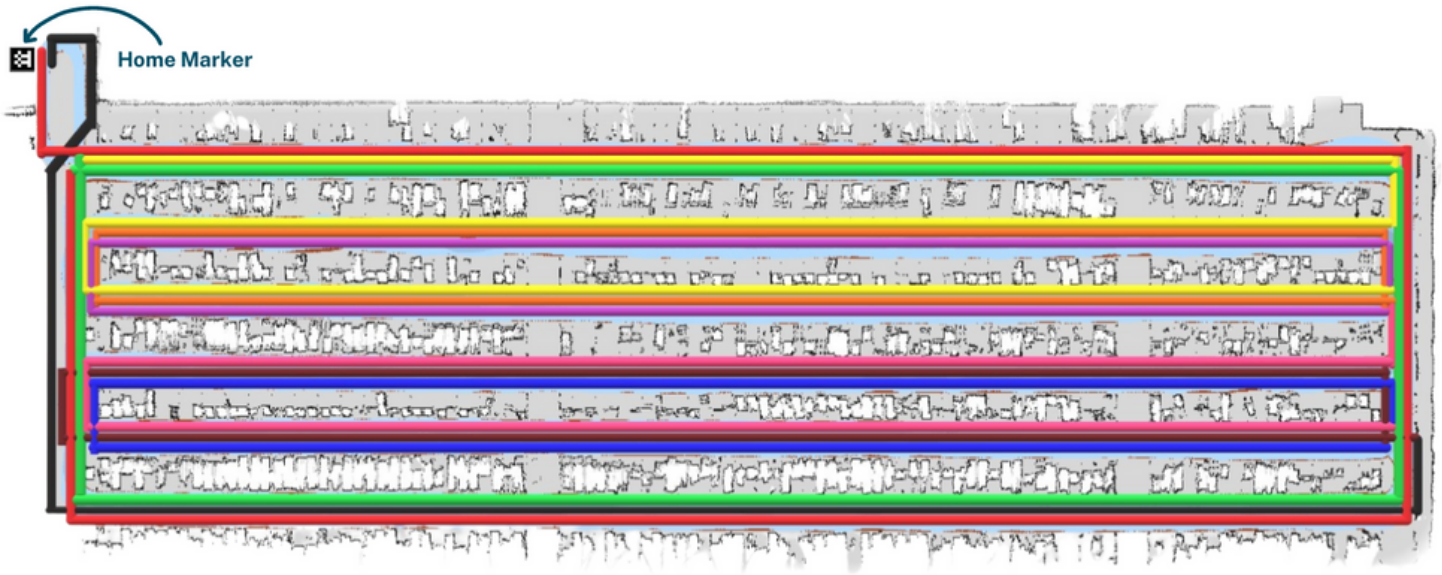
Large Environment Route Guide

Logical path planning in each zone helps optimize cleaning coverage. This is especially important in large environments with long aisles, hallways, or corridors. Examples of these environments are manufacturing/warehouses, airports, large stores.

Figure C below illustrates how to start and end a route once zones have been established. This zone includes 6 long and wide aisles.

Always start the route by training the full perimeter of the zone. For wide aisles requiring multiple passes, follow the example key below to ensure full coverage.

Figure C



Key

- Starting perimeter pass
- Secondary perimeter pass
- Third pass completing first aisle/starting interior aisles 2 & 3
- Second pass of aisles 2 & 3
- Third pass of aisle 2 & 3
- Starting pass of aisles 4 & 5
- Second pass of aisles 4 & 5
- Third pass of aisles 4 & 5
- Final pass finishing aisle 6 and completing route

BEST PRACTICES

Home Marker Considerations

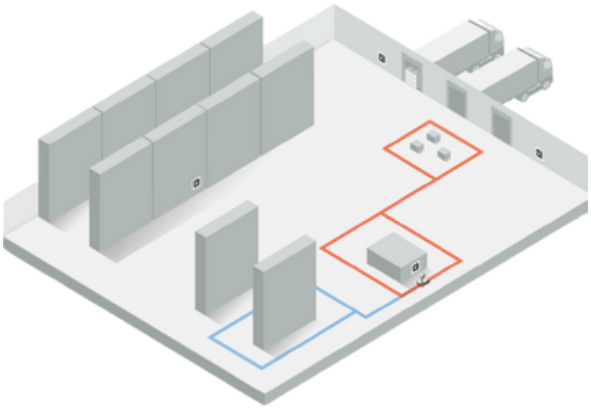
- You must start and end each route/cleaning at the same Home Marker location.
  - Up to 12 routes can be programmed per marker.
- Home Markers can be used for both Area Fill and Teach and Repeat routes.
- Home Marker needs to be flat and not at an angle and affixed to wall in a well lit area, 40 inches from the ground and robot scanned from a maximum distance of 55 inches
  - Place on a wall whenever possible; avoid posts, stanchions, fencing etc.
- Home markers should not be located near a shiny or reflective surface that could be causing issues with the scanning.
- Home marker used should be the actual placard, not a printout.
  - If a placard is lost or misplaced, you can call Tennant Service for a new one.
- Stay clear of the front of the robot and sensors when scanning the Marker and starting route.

Route Type: Teach and Repeat & Area Fill *(more on route training - page 9)*

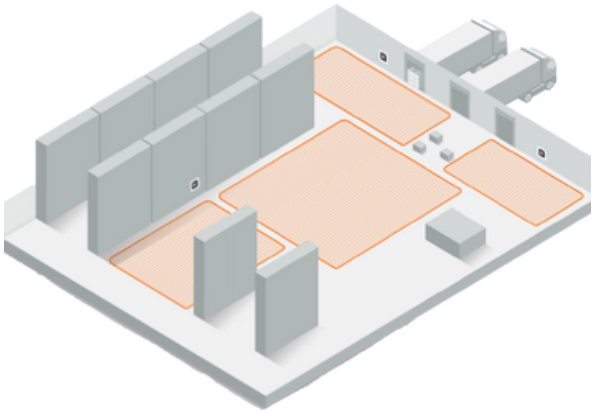
- Teach and Repeat routes are trained by manually driving the unit across the entire intended autonomous route.
- Teach and Repeat is best used in narrow or congested areas such as grocery store aisle ways, narrow hallways, etc.

- Area Fill routes are trained by manually driving around the perimeter of the area to be cleaned autonomously.
- Area Fill is best used in large open areas such as gymnasiums, cafeterias, long wide corridors, open docking manufacturing spaces, etc.

Example of spaces ideal for Teach & Repeat



Example of spaces ideal for Area Fill



Area Fill Quick Facts:

- If not pre-enabled on your machine, area fill can be turned on through the Settings > Preferences on the UI screen.
  - Area fill should not be utilized in retail stores or environments with small or narrow aisles.
- Map the area into segments vs. one large area. For example, if an area were an open “T” shape, map the top portion of the T as a separate area from the “leg” of the T.
- If possible, map an area when all objects (people/machines) are removed from the area. If this is a dynamic area and will always be cleaned when objects/people are moving in/out of the space – consider mapping the perimeter daily.

BEST PRACTICES

Before Autonomous Use

Installation, Setup, and Inspect Machine Components

- Pre-sweep required for T380AMR and T7AMR, may be needed for T16AMR if there is heavy debris
- Check for obstacles and movable/temporary stands
- Place appropriate caution signage in areas where the scrubber is to be used
- Inspect hoses for blockages
- Attach squeegees, brushes or pads, add water, add cleaning solution
  - During initial use, check the squeegee's wiping and water pick up performance
- Ensure your robotic scrubber has sufficient battery charge to accommodate the number of routes you plan on training/running.
- Wipe sensors with microfiber cloth prior to autonomous use (***more details on page 12***)
- Check connectivity (Connectivity icon in upper right of UI screen is illuminated)
- Pair your phone to the AMR to receive mobile alerts for route completion and assists via BrainOS Mobile app or SMS Text. Follow instructions under Settings>Mobile Alerts (see common alerts below)

Route Teaching Guidelines

- Teach routes when the area is clear of obstacles and people that may block the scrubber's path. This may require teaching routes outside of your normal cleaning times.
- When teaching a route, make smooth wide turns, avoid narrow aisles, and do not drive in reverse.
- Water tank capacity varies by model type and will run out faster on different settings. Consider capacity when planning route duration. Estimated flow duration:

Setting	T380AMR	T7AMR	T16AMR
Water Tank Capacity	20 gal / 75 L	29 gal / 110 L	50 gal / 190 L
Low Solution Flow: ec-H20 Nanoclean	2 h 45 m	3 h 27 m	2 h 22 m
Medium Solution Flow: ec-H20 Nanoclean	1 h 20 m	1 h 56 m	1 h 54 m
High Solution Flow: ec-H20 Nanoclean	57 m	1 h 22 m	1 h 34 m
Low Solution Flow: Conventional	2 h 10 m	2 h 25 m	1 h 40 m
Medium Solution Flow: Conventional	57 m	1 h 22 m	50 m
High Solution Flow: Conventional	40 m	1 h 4 m	33 m

BEST PRACTICES

- Ensure proper clearance for autonomous cleaning for model type by using the chart below. *It is important to note that additional space may be needed if the machine will be driving by tall reflective surfaces.*

Model	Pass Through	Turn Ins	U-Turns
T7AMR	4 Feet	5 Feet	10 Feet
T16AMR	5 Feet	6.5 Feet	11.5 Feet
T360AMR	3.5 Feet	4.5 Feet	7.5 Feet

Types of Assists/Mobile Alerts

- Path is blocked
- Machine off path
- Scrubber component faults
- Route completion and time
- Water/battery/solution/tank indicators
- Sensor Error

Step by Step - Teaching a New Route

1. Log into Brain OS with PIN (1337)
2. On the User Interface (UI), select "Teach" and scan the Home Marker
3. Select an open route to train
4. Assign letter or name to route
5. Start training your route
6. Stop each route created at the same home marker as where you started
7. Scan the Home Marker and click "Save"

Testing Routes

- Test all routes to ensure the unit can run them successfully. Note any areas of difficulty.
- Watch the machine from behind to avoid being in the way of the machine. The scrubber requires more space when running autonomously compared to manually.
- If you notice the unit calling for many assists when testing your route, assess the environment and remove any obstructions.
- If the assists persist after obstructions are removed, the route you trained may include maneuvers that it cannot replicate autonomously. The best solution is to retrain the route.

When to Teach New Routes

New autonomous routes may be needed if:

- The environment changes significantly
  - e.g. remodeling, significant new features, obstructions, soil conditions change etc.
- The dimensions of the space have changed so much that the scrubber has difficulty navigating and calls for frequent assists
- Movable objects block the intended path or narrowed the dimensions of an aisle so that the scrubber lacks enough clearance to maneuver through
- New floor space opens up that was not previously covered, so new routes may be desired to include that area in autonomous cleaning

BEST PRACTICES

Deleting Routes

- Enter the Service menu from the UI home screen
- Select a route for deletion
- Delete a route
- Confirm the route has been deleted

Use in Manual Mode

- Use the scrubber in manual mode in areas such as narrow aisles, where scrubber will fit but not run properly in autonomous mode, or areas with movable furniture and/or frequently changing layout.

Running Routes Autonomously

- Allow machine to fully boot up until the Brain Logo UI fully loads
- Visually inspect all sensors and wipe them down with a microfiber cloth before starting an autonomous route. Use flashlight and shine light on sensors to make sure they are free of dirt and smudges (***more details on page 12***).
- Select the home location code
- Select a route from the UI menu
- Pull yellow safety straps to front screws
- Remove key front on/off switch to prevent unauthorized use
- Press the blue start/stop button
- Run routes when the area is most free of people and freight. Identify the best times to run different routes based on how the environment changes.
- At the start of a route do not crowd the front of the machine. This may cause the scrubber to be unable to recognize its environment.
- During the first 30 seconds of running an autonomous route, monitor the machine's squeegee to ensure they're properly adjusted. Pause the route and adjust the squeegee if necessary.
- Check for and mop up any residual water after an assist
- Check for and vacuum or mop up any residual water post-scrubbing

Daily Care

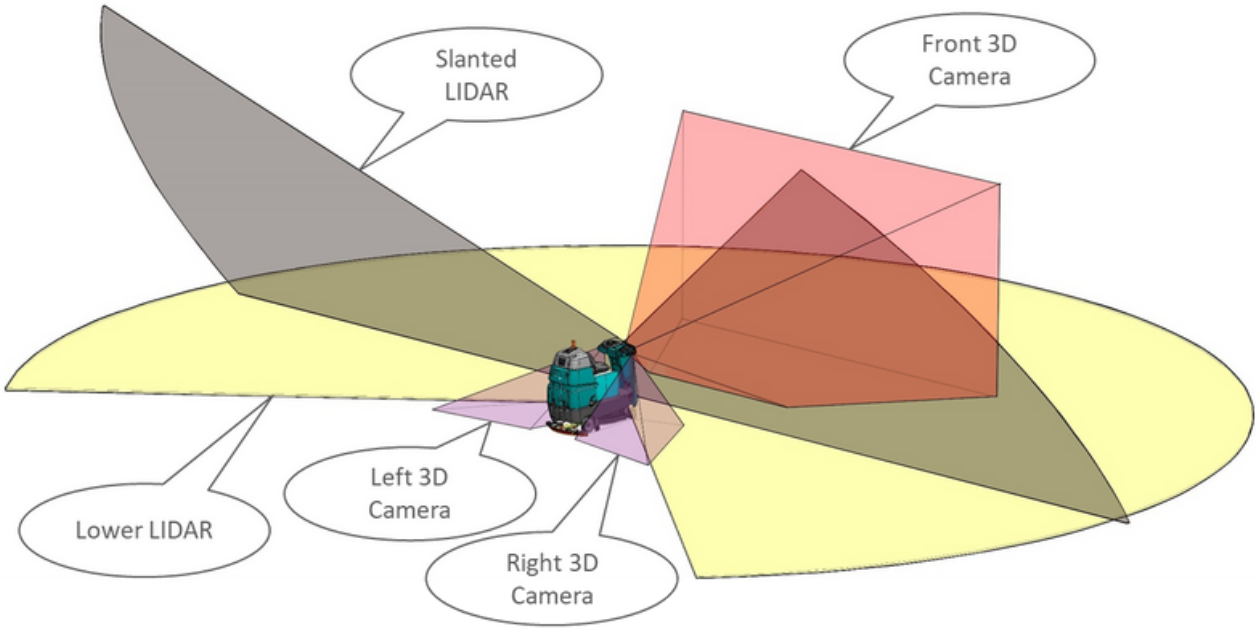
- Insure UI is fully booted before powering off the unit if quick shutdown is required
- Do not add more than recommended cleaning solution amount to tank
- Do not add additional cleaner to unused portion of cleaning solution (will become too concentrated)
- Avoid Water Alerts: Longer routes use lower solution flow setting, shorter routes can accommodate higher solution flow
- Stop if squeegee needs adjustments
- Check charger light is on before use and when connected to a wall outlet
- Flush hoses after each use to reduce clog potential
- Drain and rinse recovery tank after each use
- Do not top off, always drain before refilling tank
- Prep machine for next day (or empty solution tank if not used daily)
- Charge for a minimum required time after use. Lift seat for proper ventilation of flooded batteries.

BEST PRACTICES

How to Clean Robot Sensors

Through normal use, the LiDAR sensors can accumulate contamination on the surface of the sensors. For best performance, clean all **LiDAR sensors and cameras** regularly.

1. Turn the ignition key to the off position.
2. Use a flashlight to illuminate the LiDAR sensor.
    a. It is important to use a flashlight when inspecting the sensor so that it can be thoroughly cleaned. Any debris, streaks or surface light obstruction may deliver false environmental information to the robot.
3. Thoroughly wipe the sensor with a clean microfiber cloth until the sensor is clean.
    a. Cleaning is complete when there are no visible smears or residue on the sensor.
    b. **Note:** You may also use approved single-use anti-static wipes for electronics, such as *Endust* anti-static wipes. If substitute products are used, it is the responsibility of the operator to confirm that the product is approved for use on polycarbonate lenses. Non-approved products can cause damage to the sensors.



DIRTY

CLEAN

COMMON ENVIRONMENTAL CONSIDERATIONS

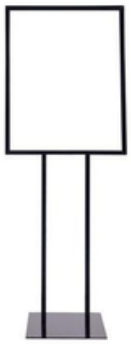
New Movable Objects with Wheels

Be careful when creating autonomous routes in areas with wheeled shelving and displays. If the environment is already very tight, slight movements to wheeled displays can create spaces that are too small for the scrubber to navigate. If you move the wheeled shelving, you must make sure that it is back to it's original spot from when you mapped it.

Flat Objects

The robot cannot detect objects less than 4 inches from the floor and will run them over in autonomous mode. If they appear in the robot's route, move them out of the way or retrain routes to avoid such objects.

- Signs or umbrellas with flat bases
- All-weather entrance mats
- Raised flooring



Floor to Ceiling, Reflective Windows

When scrubbing along an edge or glass partition, a reflection make cause the robot to perceive a false obstacle due to sensor interference and come to a stop. When teaching an autonomous route, stay 1-2 feet/30-60 cm away to prevent such assists from occurring. You may want to consider training a short route to test by these areas to ensure proper route scrubbing.

COMMON ENVIRONMENTAL CONSIDERATIONS

Ramps and Sloped Flooring

The robot cannot navigate up and down slopes. When making autonomous routes do not attempt to go up or down ramps and other sloped areas.

Sloped areas can serve as a natural barrier when segmenting a space between several different autonomous routes.

Uneven Flooring

Uneven flooring or areas with raised flooring less than 4 inches are undetectable by the robot's vision system. The scrubber may be able to drive over the uneven flooring manually but running autonomously can present issues with the robot's ability to see the depression or raised portion of the floor. If this happens while the robot is running autonomously, it may recognize the depressed area as a cliff and the raised area as a wall. Avoid uneven flooring while training routes keeping in mind that the robot sees the environment differently. You can place objects like cones or wet floor signs over the area you'd like the robot to avoid.

Circular Support Columns

These cannot be cleaned around in the same manner as commonly done by manual scrubbing. Often the driver will make several circles around the beam. When this maneuver is replayed in autonomous mode, the robot may detect it’s rear wheel is close to the column and calls for an assist.

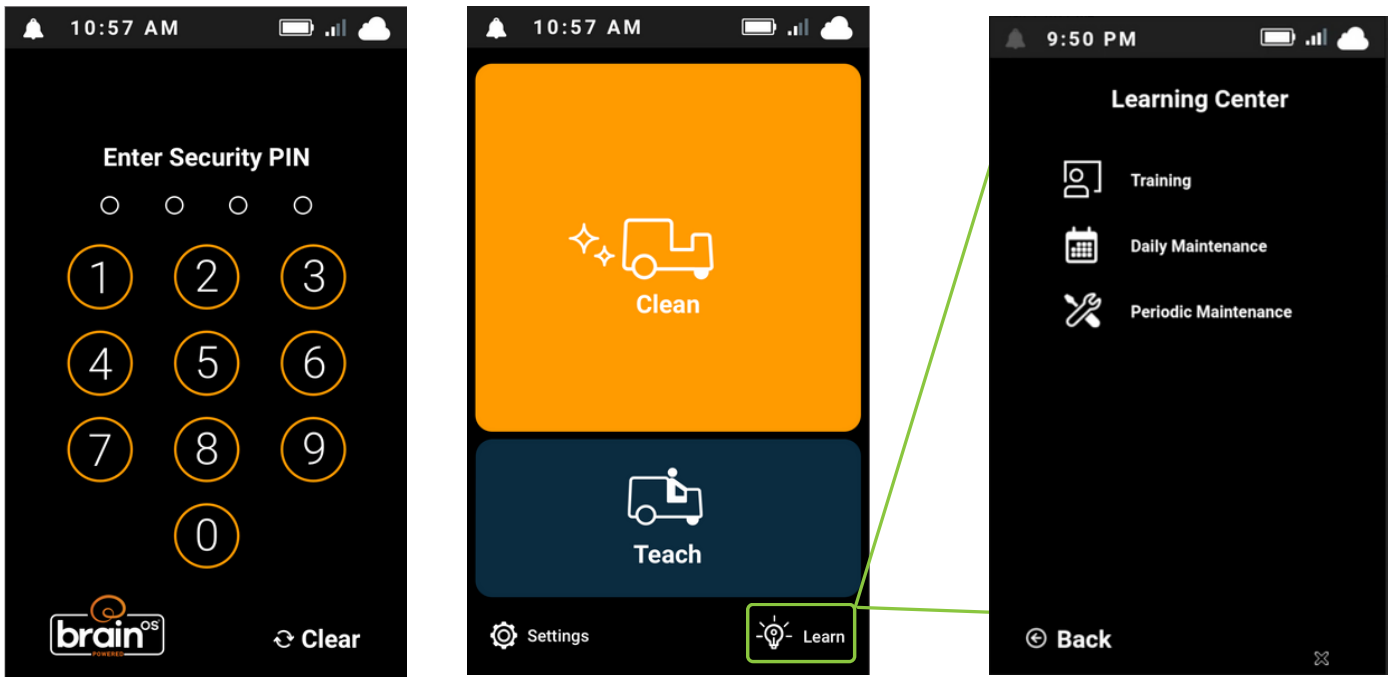
You may want to avoid the columns or beams all together, however, if the column is large enough to make wide turns around the structure, the robot may navigate the area without issue. Test first.

RESOURCES

Learning Center Videos

Many training videos can be viewed right on your AMR machine!

- Follow the screenshots below to access videos.



AMR Resources Online

- Please visit the **AMR Resources Page** to watch videos and review a variety of documents. There are many helpful documents on this page that you may want to reference in the future. More documents are unlocked on both pages once you've registered and sign in to your My Account.

TROUBLESHOOTING CHECKLIST

If your AMR is not performing to your expectations, assess the machine for common issues described below.

- ☐ Does the machine power-up?
  - Did the main power contactor click?
  - Does UI (User interface) screen power-up?
- ☐ Test the machine operations
  - Does the machine scrub manually?
  - Does the machine scan or scrub autonomously?
- ☐ UI Fault Codes? - Take picture of faults/alerts if present
- ☐ E-stops tripped/reset?
- ☐ Hard Reboot – Disconnect the red Anderson battery connector for 30 seconds
- ☐ ROC connectivity – Is the machine connected to the cloud? Connectivity indicator in the upper right of the User Interface should be illuminated.
- ☐ Environmental changes?
  - Lighting, shelves, reflective materials, forklifts, dark paint/tiles/obstacles, etc.
  - Ensure area meets minimum clearance requirements (***see page 9***), space 18" away from glass when necessary.
- ☐ Assess Home Marker Placement (***see page 8***)
- ☐ Verify the problem with the Operator (Machine issues, route failure, faults)
- ☐ Sensor check (***see page 12***)
  - Inspect & clean with a dry microfiber cloth – 3D camera, 2D cameras, LIDARs
  - Inspect for damage (including protective brackets)
  - Is there damage or are they dirty/dusty? Clean with a dry microfiber cloth only.

If you are still experiencing the issue after completing this checklist, please have your serial number ready and contact:

- Customer Service for suspected mechanical or parts issues
  - 1-800-553-8033
  - service@tennantco.com
- AMR Customer Success for issues with repeated assists, usage reporting, software updates
  - customersuccess@tennantco.com