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Maintenance Manual Authorization Memorandum

This Maintenance Manual is made for performing general maintenance on the AGV. This document has been carefully verified, assessed and it is the latest version as per our knowledge.

We continue our work to develop and update this document with latest information. For any updated information or changes please contact G&R Machine Tool, Inc.

Author

Raj Puppala

Raj Puppala

Jr. Project Manager

engineering1@gnrmachinetool.com

Office: 734-641-6560

Reviewed & Approved by

Robert Reiners

Robert Reiners

Project Manager

robert@gnrmachinetool.com

Office: 734-641-6560

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Maintenance Manual Summary

The purpose of this manual is to provide maintenance personnel with guidance on how to conduct a wide variety of activities to be performed during the life of the program.

This document is not intended to provide detailed guidance, but to give an understanding of the broad scope of activities required and methodologies available to maintain the systems efficiently and effectively.

This Maintenance Manual provides basic maintenance information only. This is not a service manual, nor does it provide technical instruction on performing service work to the AGV. An experienced and authorized technician/ personnel is required to perform any technical work to the AGV beyond the basic maintenance as outlined in this manual.

★ **Note:** Before using the AGV system read the following points carefully for safe use of the AGV.

1. The AGV is not water proof. Do not spill coffee, water or any kinds of liquids on the AGV.
2. The AGV travelling route which includes the floor should always be clean from all liquids, dust and dirt.
3. There should not be any electrical pluses near the AGV system which will interfere with the AGV electronics and results in AGV malfunction.
4. Do not try to move manually any electronically controlled moving components on the AGV with force. This results in malfunction of the component or entire system malfunction.
5. When using the lift handle make sure the AGV is stopped or else it might cause serious damage to the motor and it also might harm yourself.

Contents

1.0 Preventive Maintenance	6
1.1 Introduction	6
1.2 Schedule According to Use	6
1.2.1 Maintenance Schedule	6
1.2.2 Use a Record Keeping System.....	7
1.2.3 Required Tools	7
1.3 G-Cat Preventive Maintenance Sequence.....	7
1.3.1 Visual Inspection.....	7
1.3.2 Perform an Operational Test.....	8
1.3.3 Perform Maintenance	8
1.3.4 Repeat Operational Test.....	8
1.3.5 Record Completed Actions	8
2.0 Corrective Maintenance	8
2.1 Troubleshoot the AGV	8
2.2 Repair the AGV.....	9
2.3 Make Adjustments	9
3.0 AGV Caster Lubrication.....	12
3.1 Caster Lubrication.....	12
3.2 Floor Conditions.....	13
3.3 Caster Maintenance.....	15
Frame and Fasteners.....	15
Lubrication	15
Wheels	15
Casters.....	16
Proper Equipment Usage / Shock Loading / Excessive High Speeds.....	16
3.4 AGV Turn Radius for Single and Dual Motor Magnetic Track.....	17
4.0 Safety	18
4.1 Safety Bumper Care	18
4.2 Safety Laser Scanner Care	19
4.2.1 Safety Scanner Inspection	20
4.2.2 The daily inspection	21

4.2.3 Pre-check test while the machine operates..... 23

4.2.4 Regular (Periodical inspection) 23

4.2.5 Cleaning the Window 24

4.3 Daily Checkout..... 25

4.4 Laser Scanner & Bumper Testing..... 25

4.5 Manual Mode 26

4.6 Batteries and Charging System: 26

5.0 Trunnion Maintenance..... 26

5.1 Ambient Conditions..... 26

5.2 Measuring Surface Temperature 27

5.4 Operating Faults 27

6.0 Diagnosis and Repair 28

6.1 Replacement Parts 28

1.0 Preventive Maintenance

1.1 Introduction

Preventive maintenance is a systematic approach to AGV maintenance designed to prevent equipment down time by identifying potential problems before they occur. An effective preventive maintenance program will not necessarily prevent the need for corrective maintenance, but it will allow you the time necessary to plan a corrective maintenance procedure before the need becomes immediate. This allows time for scheduling equipment down time and parts procurement. An effective preventive maintenance system should include a schedule of all maintenance actions to be completed and a method to record or keep track of the maintenance actions completed.

1.2 Schedule According to Use

Maintenance must be planned; otherwise hit-or-miss servicing could occur. This eventually leads to extensive repairs and unit failures, usually at a critical time. Your AGV maintenance should be based upon the calendar days the AGV operates and the environment it is used in.

NOTE: Preventive maintenance is a preventive measure. Non-compliance with the instructions and maintenance intervals can result in compromised use and damage to the AGV.

Maintenance supervisors should ensure periodic maintenance is performed on a regular basis. They should follow the recommended AGV maintenance until situations require a change in maintenance interval. They should never increase the time between a recommended maintenance action. They have the authority to shorten it when the need becomes evident.

1.2.1 Maintenance Schedule

A master maintenance schedule, listing all maintenance to be performed during the year, should be maintained by the maintenance supervisor. A partial copy of the master schedule, showing only the maintenance actions scheduled in the immediate future should be posted in the maintenance area so that all maintenance personnel can refer to it. The schedules should prescribe maintenance actions at specific intervals.

Prescribed maintenance actions should be adequately described & detailed. This ensures that the action is performed in the same manner each time it is accomplished.

The schedules should enable the personnel involved to keep track of those actions completed and those which are still pending. A good maintenance practice would be to mount a schedule behind Plexiglas so that the maintenance person can mark off completed actions with a grease pencil or erasable marker.

1.2.2 Use a Record Keeping System

The Maintenance supervisor should maintain a master maintenance record of all completed maintenance actions both preventive and corrective for each AGV. This is necessary to ensure that the maintenance schedule remains flexible and helps the supervisor to predict system failures before they occur.

1.2.3 Required Tools

Most mechanical maintenance, on G&R Machine Tool AGV's, can be performed using standard hand tools and a torque wrench. When using compressed air, ensure that the air is low pressure, moisture and static free, and properly filtered. Most electronic maintenance can be performed using a digital multi-meter.

1.3 G-Cat Preventive Maintenance Sequence

The recommended G-Cat maintenance items and their intervals are listed in Table 1. Arrange your preventive maintenance tasks into logical starting (intervals) and endings, stopping if necessary at a point that would not render the AGV totally non-operational or the risk of an emergency service.

1.3.1 Visual Inspection

Preventive maintenance should begin with a visual inspection of the AGV. If the AGV is inoperative, first repair the malfunction, then start the preventive maintenance process. Visually check and ensure that:

- Bent or otherwise damaged parts are repaired or replaced using G&R Machine Tool recommended replacement parts.
- Mechanical parts operate freely.
- Mounting hardware, such as lock washers, spacers, nuts, and bolts are present and properly secured.
- The AGV is reasonably clean especially the compartments containing electronics, and moving or rotating parts (i.e. casters).

1.3.2 Perform an Operational Test

The visual inspection should be followed by an operational test. Perform the test before all maintenance actions to ensure that the AGV operates correctly. If the AGV is inoperative, first correct the malfunction then start the operational test.

1.3.3 Perform Maintenance

Perform the scheduled maintenance. Follow procedure exactly as described on the maintenance schedule.

1.3.4 Repeat Operational Test

Completed maintenance actions should be followed by 2nd operational test to ensure that the AGV remains operational. If the AGV is inoperative, retrace, repeat your steps.

1.3.5 Record Completed Actions

Using the system prescribed by the maintenance supervisor, record the completed maintenance action.

2.0 Corrective Maintenance

Corrective Maintenance is maintenance designed to place the AGV back into service by repairing a known problem. In most cases, the maintenance is not scheduled. Arrange the corrective maintenance task into some logical starting and ending. (See the “Troubleshooting” chapter for details.) The steps required for corrective maintenance include, troubleshooting, repairing, and adjusting the AGV.

2.1 Troubleshoot the AGV

Using the information gained in the visual inspection, the operational test, and as provided in this service manual, locate the failures. To effectively troubleshoot the AGV the technician should:

1. Understand the operational characteristics of the AGV.
2. Know the capacity of the AGV and the limits the AGV is designed to operate within.
3. Understand the designed operation of the system. The AGV may be operating correctly but could show an apparent error, due to a change in the method that the AGV is being used.

4. Be certain that the battery is fully charged. Electronic failures may be caused by operating on a low battery.

2.2 Repair the AGV

Make the necessary repairs to return the AGV to normal use. Use G&R Machine Tool, Inc recommended parts only. See Spare Parts Drawing in “Parts” section for part numbers. If you were unaware of what the problem is, call our specialist to schedule service.

2.3 Make Adjustments

When repairs are made, the technician must be aware of any necessary adjustment which might be required to ensure normal AGV operation. See the “Repairs” chapter for information on specific repairs.

Table 1 Operational Test

No.	Test
1	Verify manual operation. The AGV drives and steers using the pendant. Verify the pendant brake switch releases and sets the brake
2	Verify the operation of all start, stop and emergency stop switches.
3	Verify the operation of all signal devices, including motion alarms, horn, warning lights, and turn signals.
4	Check to ensure the brake immediately sets in an emergency stop condition (laser scanner actuation or E-stop button). AGV is to stop within the collapsible distance of the laser scanner protection zone.
5	Check the charge on battery and charge as necessary prior to putting the AGV back into service. Check battery cables and connectors.

Table 2 Recommended AGV Maintenance

No.	Weekly Checks
1	Check the safety bumpers and test them if they are working properly. The bumpers won't work on the ends since a bumper cap is being installed.
2.	Check the batteries with a voltmeter and check if they were charging properly.
3.	Check the caster and wheels and clean all dirt for a smooth ride and increased life expectancy.
4.	Clean the magnetic tape and make sure there is no dust and all markers are in place.
5.	Clean the floor where the AGV's operate. (No water, oil or any liquids/fluids on the AGV path)

No.	Monthly Checks
1	Clean battery as necessary to remove any dirt from outside surfaces. See the Operator Guide chapter for further information.
2	Clean the scanner. (Refer to 4.2 Safety Scanner Care for specific instructions)
3	Check to ensure all electrical connections are tight on the motor, encoder, brake and temperature switch.
4	Check to ensure connectors and ribbon cables are secure on all Printed Circuit Boards.
5	Check to ensure printed circuit board assemblies are securely mounted using recommended mounting hardware.
6	Clean all AGV and electrical compartments, using low pressure, moisture and static free air, and a soft, clean, non-conductive brush.
7	Check all lights (LED's)

8	Check magnet sensors for damage and make sure that their electrical connections are tight. i.e. they must be level with floor and should be at the designated place on the AGV.
9	Check the AGV for obvious mechanical damage (especially the wheel surface & mounting areas).
10	Perform the AGV Guidance/Navigation Performance Testing. See the Troubleshooting chapter.

No.	Quarterly Checks
1	Check caster tire and mechanical parts for excessive wear. Replace as necessary.
2	Inspect the AGV travel areas (guide path). Verify that no excessive holes, bumps or other floor defects are noted. If any are found, repair immediately to avoid AGV/drive train damage.
3	Clean contactor contacts using suitable contactor cleaning solvent. NOTE: Do not use emery cloth, sandpaper, or files to clean pitted or damaged contactors. Replace them using recommended G&R Machine Tool parts. See AGV Spare Parts Drawing in the "Parts" section.

3.0 AGV Caster Lubrication

Every 6 months' lubrication is required to keep the G-Cat AGV fully operational. Maintenance personnel shall use a high quality general-purpose grease or machine oil when performing lubrication.

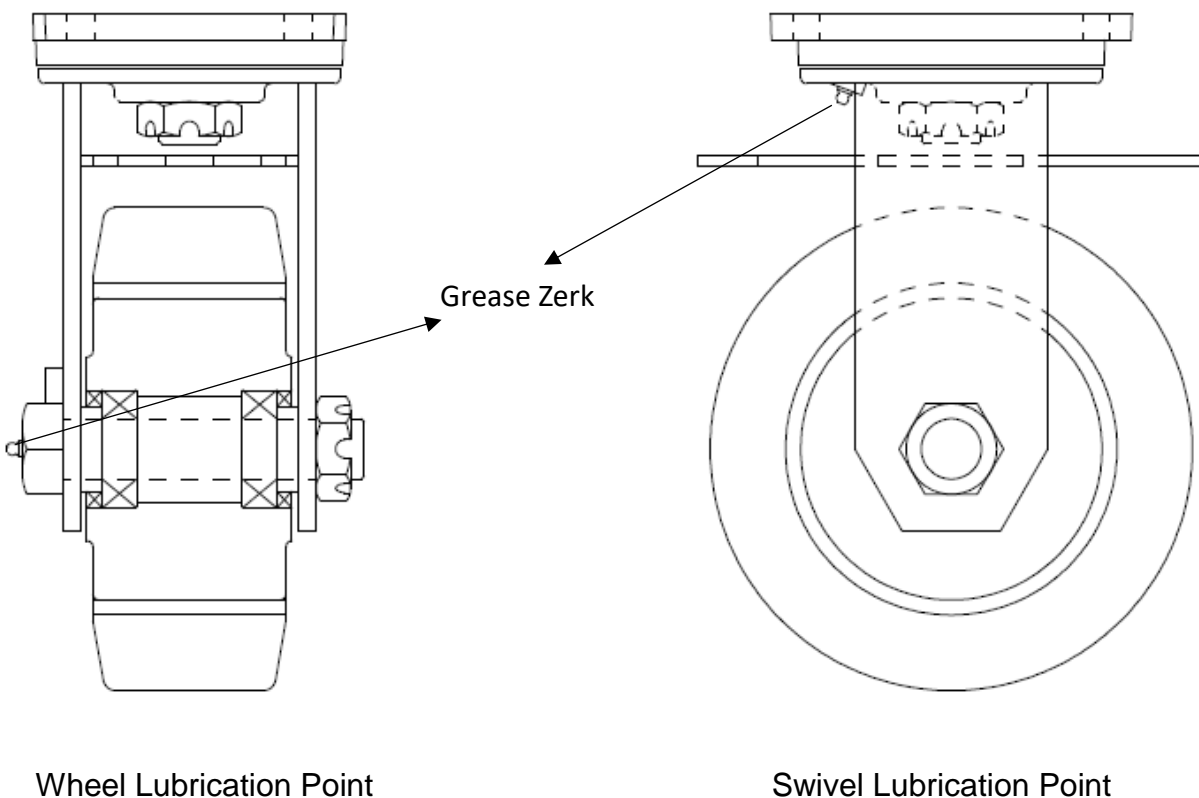
3.1 Caster Lubrication

Lubricate casters at the locations shown in Figure 1.

The lubricants recommended within this service manual may be dangerous to your health. Always follow the manufacturer's precautions and recommendations as provided on the label of the container.

NOTE: Synthetic and mineral type lubricants should not be mixed.

Figure 1 Typical Lubrication Point Diagram



3.2 Floor Conditions

For best life expectancy, the floor on which the AGV runs should conform to the following standards.

The following table will give you a good idea on floor conditions.

Building	<input type="checkbox"/> Existing	<input type="checkbox"/> New		
Floor	Floor Concrete Thickness	More than 150mm		Refer to Table 3
	Concrete Cover	More than 70mm		
	Floor Condition	1) Running area A. Slope: Less than 2% B. Step: Less than 2mm C. Groove: Less than 10mm 2) Loading/unloading area A. Slope: Less than 1% B. Step: Less than 2mm C. Groove: Not acceptable		Refer to Table 4
	Floor Coating	<input type="checkbox"/> No Concrete Exposed <input type="checkbox"/> Color Crete <input type="checkbox"/> Other		
	Buried Object	<input type="checkbox"/> No	<input type="checkbox"/> Yes	
	Crack, Damage	<input type="checkbox"/> No	<input type="checkbox"/> Yes	
Ambience	No material dust, spraying, condensation, rainwater, oil film, corrosive gas (such as hydrogen sulfide gas), and conductivity dust			
Temperature	5 ~ 40°C	Humidity	20 ~ 80°C	

Table 4 Floor Details

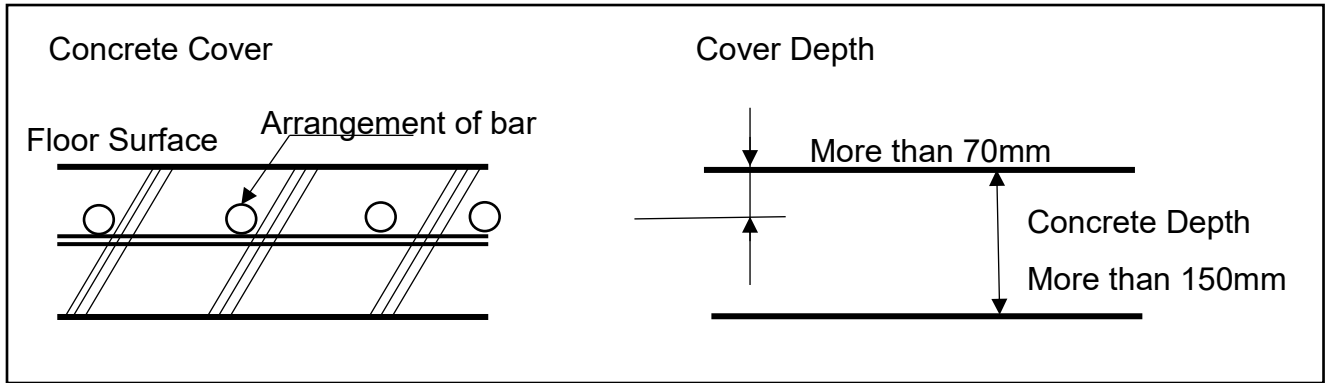
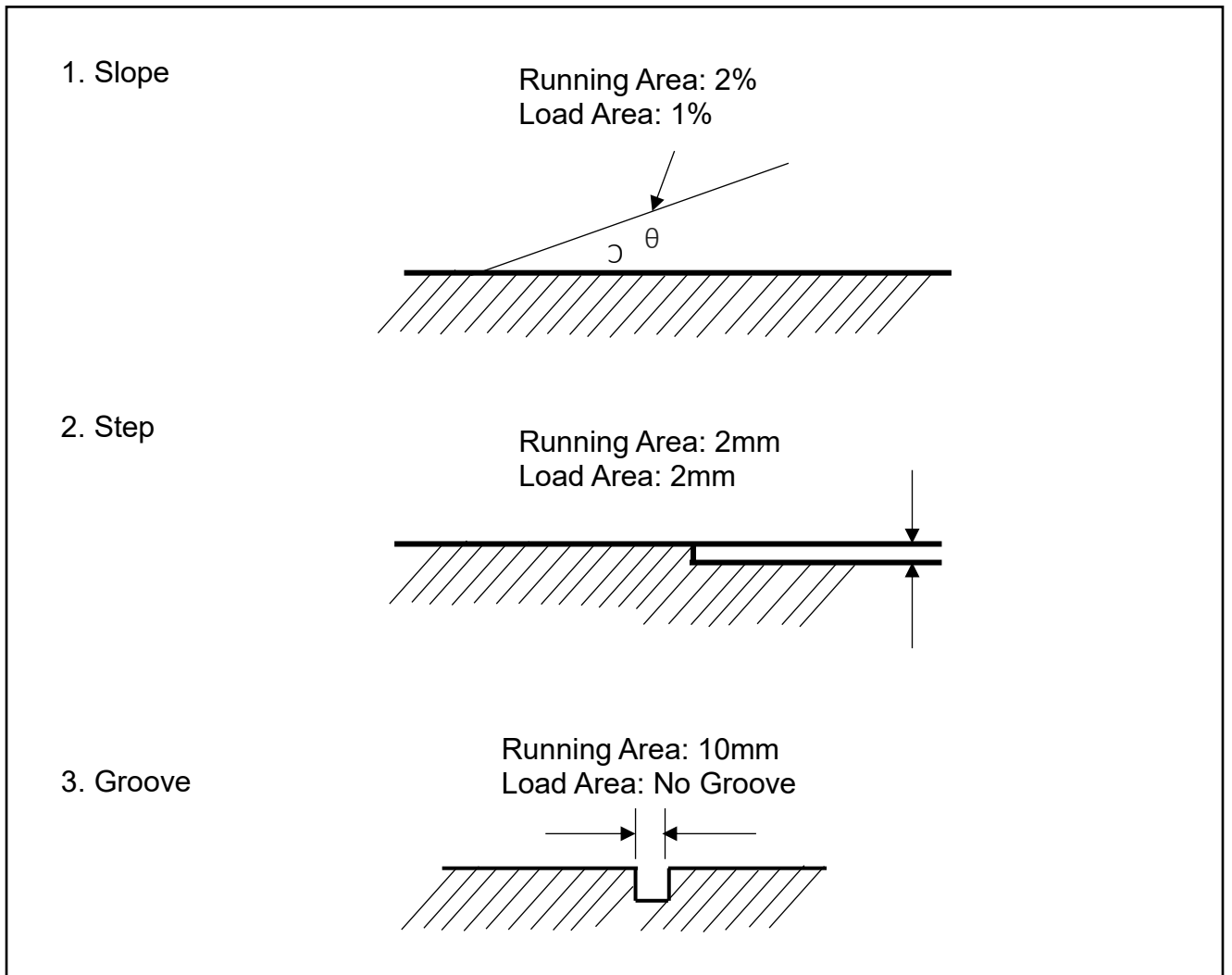


Table 5 Floor Condition



3.3 Caster Maintenance

Frame and Fasteners

- Tighten loose bolts and nuts and look for broken welds or deck boards.
- Look for frame distortion due to overloads or impact loads. A distorted frame can cause premature wheel failure because of abnormal loads on one or two casters.
- If casters are stem type, bolted or riveted in place, make sure the legs of the equipment are not bent and mounting bolts are properly secured.
- Always use lock nuts or lock washers in mounting casters.
- Be sure casters with expanding adapters in tubular equipment are held firmly in place.
- Cart or equipment frames should periodically be inspected for metal fatigue cracks (especially under shock loading conditions)

Lubrication

- All caster bearings need to be lubricated with a high quality multi-purpose grease that has good extreme pressure and anti-wear characteristics, as well as withstands temperature range that fits the application requirements. Wheel and swivel bearings last longer if lubricated regularly.
- Some lube applied to friction points on the wheel hub, washer and leg surfaces of straight roller bearing systems reduces drag and improves reliability.
- Normal conditions may warrant lubrication every six months, but once a month may be necessary in extreme applications, such as corrosive or exceptionally dirty environments.

Wheels

- Check for visible points of caster wear. Flat spots may indicate foreign material, such as string, thread, metal, etc., causing wheels to bind. Thread guards will delay build-up of such materials.
- Loose casters or frozen wheels may also produce flat spotting.
- Replace wheel and/or caster to avoid erratic rolling. After inspecting and making corrections, be sure axle nut is properly tightened.
- Use lock washers or nuts on all axles.
- Tighten loose axle immediately to avoid becoming cocked in the caster housing/rig and locking up.
- Keep replacement wheels and bearings on hand to avoid costly downtime.
- Discard abused or damaged wheels.

Casters

- If swivel assembly is loose, it may need to be replaced.
- If caster has a king bolt nut, make sure it is securely fastened.
- If swivel assembly does not turn freely, check raceways for corrosion or dirt.
- If equipment has rigid casters at one end, make sure caster housing/rig is not bent.
- When necessary, retighten caster mounting bolts and, if casters are welded to equipment, check the welded elements for cracks.

Proper Equipment Usage / Shock Loading / Excessive High Speeds

- Place loads gently onto any cart, truck, or bin attached to any casters. Overloading or dropping loads (shock loading) on carts, trucks, or bins may cause sudden wheel or equipment failure.
- High speeds on rough floors can quickly create severe damage to tread and wheels.

Precaution

Do not use the AGV for human transportation. This G-Cat AGV is not designed for human or any animal transportation.

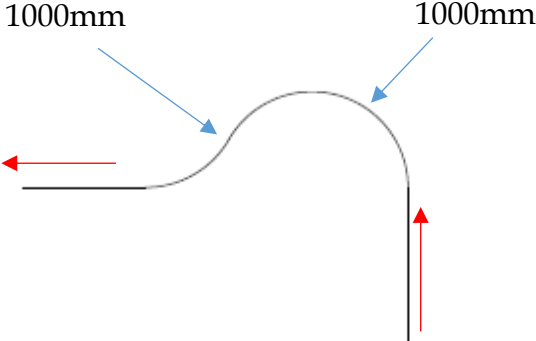
AGV's can cause injury or damage if improperly used or maintained.

Make sure the AGV operating area is very clean of dust, water, oil and other liquids. Injury or death might cause to any personnel slipping on oil or other liquids and falling on the AGV. Always keep the environment clean.

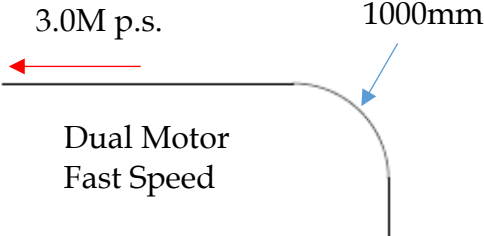
3.4 AGV Turn Radius for Single and Dual Motor Magnetic Track

Fast = 3.0 Meters per min
Regular = 1.5 Meters per min

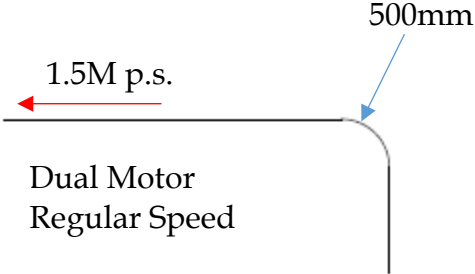
Single Motor
Turn + Straightening
Fast or Regular



Single Motor will need
longer distance to
straighten.



Single Motor will need
longer distance to
straighten.



4.0 Safety

The G-Cat AGV is equipped with Safety Bumpers and Safety Scanners which prevent the AGV from having collisions with other objects.

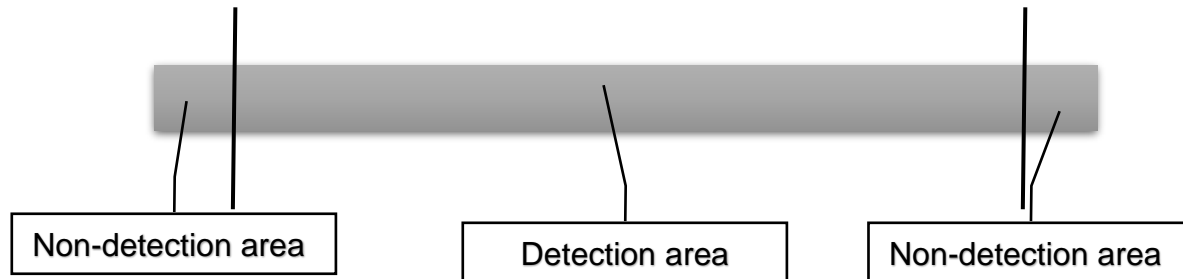
4.1 Safety Bumper Care

The bumpers are designed to be as fail safe as possible, however, like any electromechanical device, they can fail or be inactivated. Therefore, they need to be checked daily.

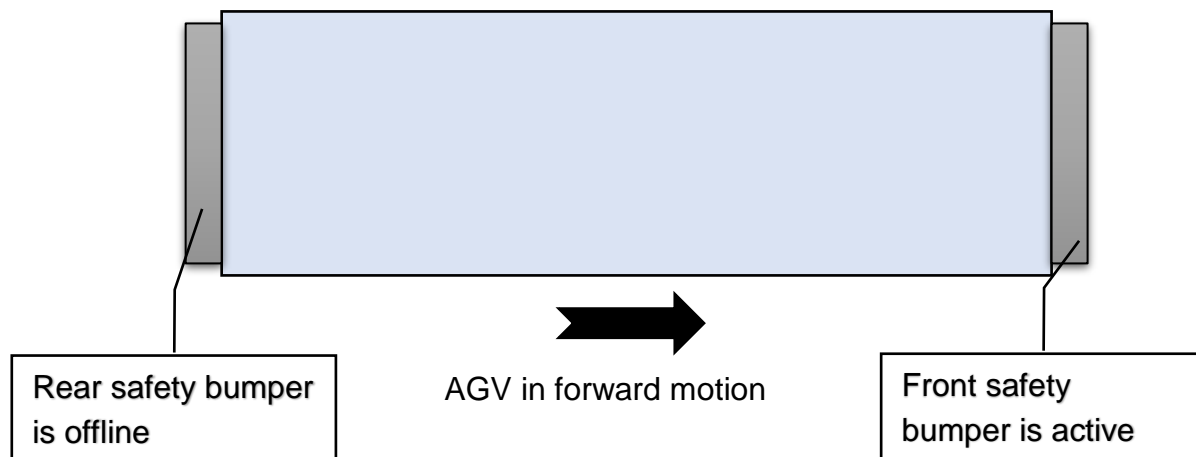
Caution: In case of breakdown or damage to the product, contact G&R Machine Tool immediately. Do not try to repair the product yourself since it may accidentally cause permanent damage to the product, impairing the safety of the device which in turn could lead to serious injury to personnel.

Knowing your safety Bumper work zones

The safety bumper won't detect anything at the edge of the bumpers due to the presence of bumper caps.



When the AGV is in forward motion, the safety bumper at the rear end of the AGV will be offline and the AGV won't stop if the rear bumper is in contact with any object.



4.2 Safety Laser Scanner Care

The safety laser scanner installed on your automatic guided vehicle (AGV) are used as primary safety devices. The emitted laser light senses fixed obstacles and if the obstacle infringes on the long-range detection zone the AGV slows down. When the object infringes on the short-range detection zone, the AGV immediately sets its brake and stops.

Usage Environment

DANGER

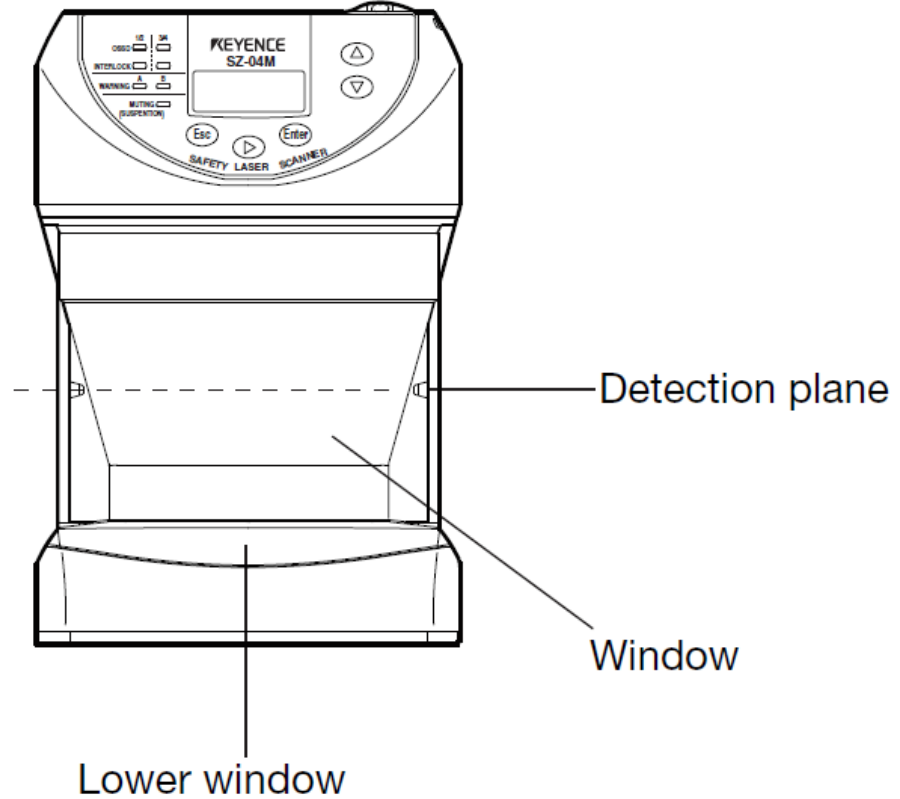
- Do not use the safety scanner in an environment (temperature, humidity, interfering light, etc.) that does not conform to the specifications contained in this user's manual.
- Do not use wireless devices such as cellular phones or transceivers in the vicinity of the safety scanner.
- The safety scanner is not designed to be explosion-proof. Never use it in the presence of flammable or explosive gases or elements.
- Do not use the safety scanner in the presence of substances, such as heavy smoke, particulate matter, or corrosive chemical agents, that may induce deterioration in product quality.
- Install the safety scanner in such a way so that no direct or indirect light from inverter-type fluorescent lights (rapid-start type lights, high-frequency operation type lights, etc.) enters the optical window.
- Be sure to absolutely confirm that there is nobody in the hazardous zone, before the interlock is released (i.e. the machine system restarts) by the interlock reset mechanism.
- Failure to follow this warning may result in a significant harm to the machine operators, including serious injury or death.
- Be sure to confirm that there is nobody in the hazardous zone, before the override is activated. Failure to follow this warning may result in a significant harm to the machine operators, including serious injury or death.

Testing & Maintenance

- You must always perform the pre-check test in accordance with the pre-check test procedures, after maintenance, adjustment or alignment of the target machine or the safety scanner and before the machine startup.
- If the safety scanner does not operate properly when you perform pre-check test in accordance with the pre-check test procedures specified in this user's manual, do not operate the machine.
- You must periodically examine the machine to verify that all brakes, other stop mechanisms, and control devices operate reliably and correctly in addition to checking the safety scanner.

- The responsible personnel must perform maintenance procedures as specified in this user's manual at least once every six months to ensure safety to the machine and safety scanner.

Do not disable or alter any safety devices installed on all AGV's.



4.2.1 Safety Scanner Inspection

You are fully responsible for performing the risk assessment on your machine application, taking into account performing maintenance and inspections, which are critical factor for appropriate risk assessment.

In addition, it is a responsibility for the responsible personnel to train the machine operators regarding inspection and maintenance of the machine and the safety scanner.

Note that the following inspection items comprise only a bare minimum inspection. KEYENCE Corporation strongly recommends including the necessary checking items into this checklist based on the judgment of the responsible personnel since additional criteria may be necessary depending on both the machine to which the safety scanner is installed and the laws, rules, regulations and standards in the country or region in which the safety scanner is used/installed.

You must keep the inspection result along with the machine log.

 DANGER

Do not use the machine on which the SAFETY SCANNER is installed if the safety scanner does not operate according to any of the inspection items as listed below. Failure to follow this warning results in a significant harm to the machine operators, including serious injury or death.

4.2.2 The daily inspection

The SAFETY SCANNER operation and the machine operation should be performed based on the following check items.

(1) Pre-check for installation conditions

- The safety scanner is installed so that the machine operator cannot go into or approach the hazardous area or hazards without passing through the protection zone of the safety scanner.
- The safety scanner is installed so that the machine operator cannot go into or approach the hazardous area or hazards without passing through any of the protection zone of the safety scanner belonging to the bank switching function.
- The safety scanner is installed at a location free from light interference, for example an incandescent lamp and a halogen lamp.
- There is no damage to the cable insulation. Additionally, the protection against the disconnection or short-circuit of cable, which might be caused by crushing or being caught in a machine, is taken into account.

(2) Pre-check test while the machine is stopped

You should do the following pre-check test with the test piece in order to make sure the operation of the safety scanner while the machine is stopped. In this case, you should supply the power only to the safety scanner.

Test piece should match the minimum detectable object size you chose.

- The OSSD indicator lights in red when the test piece is present in the specified protection zone. This test must be performed for the whole specified protection zone. If the bank switching function is applied to the safety scanner, this test must be performed for the whole and every specified protection zone. If the muting function is applied to a part of the protection zone, this test must be performed during muted condition for the whole specified protection zone, except for muting zone.

- The OSSD indicator lights in red when the safety scanner detects the test piece at the intended detection plane (height) while the test piece vertical to the detection plane moves in the protection zone.
- The OSSD indicator lights in green when the safety scanner starts normal operation after power on (when "Now Loading" is changed to "Normal Operation" on the information display) and detects no object in the protection zone with "Automatic/Automatic" for the configuration of start/restart mode.
- The OSSD indicator continues to light in red and the interlock indicator lights in yellow, when the safety scanner starts normal operation after power on (when "Now Loading" is changed to "Normal Operation" on the information display) with either "Manual/Manual" or "Manual/Automatic" for the configuration of start/ restart mode. Continuously, the OSSD indicator lights in green and the interlock indicator lights off in the event of reset operation, if the safety scanner detects no object in the protection zone at that time.
- The OSSD indicator lights in red and the interlock indicator lights in yellow when the safety scanner detects the test piece in the protection zone with "Manual/Manual" for the configuration of start/restart mode. Continuously, the OSSD indicator continues to light in red and the interlock indicator lights off when the test piece is removed from the protection zone.
- The OSSD indicator lights in green after the specified delay time has been passed if the restart delay (ON-delay) function is applied to the safety scanner.
- The safety scanner does not go to the muted condition even if the muting inputs are activated in accordance with the specified sequence and time difference, when the safety scanner detects an object in the protection zone other than the muting zone. This is only applicable if the muting function is applied.
- The safety scanner does not go to the muted condition if the muting inputs are activated with different sequence from the specified one. The safety scanner does not also go to the muted condition if the muting inputs are activated exceeding the specified time difference.
- The safety scanner does not go to the suspension in teaching mode even if the teach input and teach ready input are activated in accordance with the specified sequence and time difference, when the safety scanner detects an object in the protection zone. This is only applicable if the suspension in teaching mode is applied.
- The protection zone can be switched according to the signal combination of bank inputs.
- If there is an unprotected space between the protection zone and the protective structure, test piece is always detected by the safety scanner when it goes through that

space. This is only applicable if the safety scanner is used for the access protection (the application where the angle of the approach exceeds $\pm 30^\circ$ to the detection plane).

The OSSD indicator lights in red when the protective structure moves exceeding the tolerance of reference point. This is only applicable if the safety scanner is used for the access protection (the application where the angle of the approach exceeds $\pm 30^\circ$ to the detection plane).

4.2.3 Pre-check test while the machine operates

The purpose of this pre-check test is to make sure that the machine (hazards) stops its operation. This test must be performed after you completely make sure that there is nobody in the hazardous zone.

Machine (hazard) stops its operation if the test piece is present in the specified protection zone. If the bank switching function is applied to the safety scanner, this test must be performed for the whole and every specified protection zone.

The machine (hazard) still stops its operation as long as the test piece is present in the specified protection zone. If the bank switching function is applied to the safety scanner, this test must be performed for the whole and every specified protection zone.

The machine (hazard) stops its operation when the power for the safety scanner is disconnected.

The machine (hazard) stops its operation when the interlock indicator lights in yellow.

The response time for overall safety-related control system (from the intrusion of test piece in the protection zone to the machine stop) is less than overall response time (T) used for the calculation of safety distance.

4.2.4 Regular (Periodical inspection)

The responsible personnel must perform a regular inspection at least once every six months. Additionally, you should perform the regular inspection if you make any change to the configuration on the safety scanner and on the machine on which the safety scanner is installed. Regular (periodical) inspection items include the following, in addition to the "7-3 Daily inspection" (page 7-6).

(1) Additional inspection items

The safety scanner is installed without losing the screws for fixture, in accordance with the specification of tightening torque in this manual.

The screw on the connector cable is fastened tightly to the safety scanner.

The safety scanner does not have any change on its position. (Safety distance is ensured, and the detection plane is not changed.)

- The shielded wire is securely grounded.
- All of wires are correctly connected to external device, and the connection is securely performed.
- There is sufficient life left in terms of how many times the safety relay has been opened and closed.
- There is no damage to the safety scanner that may impair the performance of its protective IP65 structure.
- The surface of the window is not dirty or damaged.
- The OSSD indicator lights in red due to an error caused by the open-circuit of the EDM input while the test piece is present in the protection zone. This is only applicable if the EDM function is applied.
- The muted condition is terminated if the specified maximum muting period of time has been passed.
- The override condition is terminated if the specified maximum override period of time has been passed.
- The bank error occurs if the bank is switched according to unspecified sequence in case where the bank sequence monitoring is applied to the safety scanner.

4.2.5 Cleaning the Window

The safety scanner window is a critical part of the detection system. You must clean the window whenever there is dust or pollution on it. You should wipe off the pollution in the area indicated by the diagonal lines with a soft cloth moistened with a mild detergent that will not corrode polycarbonate. Only use G&R specified soft cloth & cleaner only.

Note:

- OSSD might go to the OFF-state if the window has a scratch, because the safety scanner falsely detects that scratch as the object approaching into the protection zone. Be sure to take care that the window has no scratch on it.
- Be careful static electricity while cleaning because of avoiding dust collection. You should use a cloth that will be hard to generate static electricity when rubbed on polycarbonate.
- Detection capability might be decreased due to the attenuation of light if the window has a pollution.
- OSSD goes to the OFF-state before the pollution on the window leads to loss of detection capability because the safety scanner has a function to monitor the pollution on the window.

- Furthermore, OSSD might go to the OFF-state if the window has a pollution because the safety scanner detects that
- pollution as the object approaching into the protection zone.
- Be sure to keep clean on the window to avoid unnecessary OFF-state of OSSD.

4.3 Daily Checkout

- Do not place any AGV into service with a known safety issue. You could damage the AGV or Injury the operator/personnel in the area, or damage to the materials the AGV handles could occur.
- Laser scanner bumpers and all other installed safety devices should be checked daily before the AGV is placed into normal operation. Repair any known problems before placing the AGV into operation.
- Do not expose the scanner to fog, rain, snow, vapors, smoke or dust. Clean the screens monthly as required.

Note: The bumpers should be cleaned as mentioned if the user ends up with scratches on the scanner screen, the scanner won't work properly and G&R Machine Tool is not responsible for the damages.

4.4 Laser Scanner & Bumper Testing

Only properly trained personnel should operate the automatic AGV system and automatic guided AGVs.

Use the following procedure to test safety laser scanner bumpers on a daily basis:

DO NOT use your body to perform the test.

1. Program the loaded AGV for automatic operation. Select proper path for the section of guide path on which the AGV is to be tested.
2. Place an inanimate test object in the AGV's path of travel. The object must be large enough and properly positioned to cause infringement on the protection zones.
3. Start the AGV and observe its operation as it travels the guide path.
4. Verify the AGV "Emergency Stops" once the laser scanner bumper senses the object.
5. Repeat this test procedure to test each laser scanner bumper installed on the AGV.
6. If a safety laser scanner bumper fails to function as designed, make repairs to the device before returning the AGV to normal use. The AGV **MUST** be removed from normal use until the safety device has been repaired.

4.5 Manual Mode

Safety laser scanner bumpers are NOT operational in manual mode

When a AGV is manually operated, the safety laser scanner bumpers are *not* operational and will *not* stop the AGV. This allows AGV movement after a collision, or when the laser scanner is damaged and needs repair. Safe operation of the AGV in manual mode is the responsibility of the operator. Only trained operators should manually operate the AGV.

4.6 Batteries and Charging System:

The user should maintain the batteries and charging system as per the manufacturer conditions. Do not use any other batteries to replace the manufacturer provided batteries. Any damage caused by changing the batteries will be the user's responsibility.

5.0 Trunnion Maintenance

The Trunnion gear box comes with lifetime lubrication. Always keep the surface of the gearbox clean of dirt, water and other liquids.

Technical Data

The Gearbox Max. permissible operating temperature is 90°C. Sealed bearing washers were used.

5.1 Ambient Conditions.

For smooth operation and to maximize the gearbox service life, note the following:



- Ensure sufficient gearbox convection.
- Ensure that the gearbox can dispel heat sufficiently via the output flange.
- The motor and other external sources of heat may heat up the gearbox.
- To ensure the protection class in dusty atmospheres, the cover screw in the input flange must be screwed back in and sealed.
- Do not use compressed air to clean the gearbox.
- Make sure there are no leaks.
- Never use the gearbox with damaged parts.
- Only have gearbox repaired by G&R authorized technician.
- Check for running noise. A louder running noise may indicate malfunction/defect in the motor.
- During the first hour of operation, check the gearbox for leaks.
- Check the tightening torques of the motor and application screw connection, including the motor shaft's clamp connection.
- Operate the gearbox until the drive train is in a thermally steady state and measure the temperature on the gearbox

- Ensure that the permissible gearbox temperature of 90 °C is not exceeded.

5.2 Measuring Surface Temperature

If the gearbox's maximum permissible operating temperature is exceeded, the gearbox may be damaged by overheating.

Switch off the system if the max. permissible operating temperature is exceeded.

Note: The maximum operating temperature is based on normal ambient, attachment, and application conditions. Even slight deviations may have a major impact on temperatures. It is therefore imperative that the surface temperature is measured with maximum loading. Ensure that all components are correctly connected.

- The maximum surface temperature in a thermally steady state is attained when the temperature increase is no more than 2 °C per hour.
- Add 10 °C to the measured temperature to obtain the gearbox core temperature.
- Use this temperature to calculate the service life of the lubricant from the diagram.
- Dispose of greases and oils separately.
- The gearbox and packaging materials should be disposed of in line with environmental legislation.
- Observe the applicable national regulations on proper disposal.

5.3 Sound Emission

Generally speaking, gearboxes with helical gearing are quieter than those with straight gearing.

- A higher ratio in a planetary stage results in lower sound emissions.
- The sound emission stated for a series is determined at a ratio of $i = 5$. The sound pressure level is measured at a distance of 1 m and at an input speed of $n_1 = 3,000$ rpm without load.
- Please note that the subjectively perceived sound emission is greatly affected by the damping behavior of the machine/ system.

5.4 Operating Faults

DANGER	POSSIBLE CAUSE	SOLUTION
Unusual or loud running noise	Bearing damage	Contact G&R Service
	Gearing damage	
Increased operating temperature	Restricted air supply	Ensure sufficient cooling
	Motor is heating the gearbox	Ensure sufficient cooling
	The gearbox is not suitable for the load cycle, ambient conditions.	Check the technical data
Contact G&R Service		
Lubricant escaping	Seal defective	Contact G&R Service

6.0 Diagnosis and Repair

- (a) Only authorized personnel shall be permitted to maintain, repair, adjust, and inspect vehicle systems.
- (b) Modifications and/or additions to hardware or software which affect rated capacity, safe operation, or any emergency control or device shall not be performed without the manufacturer's verifiable approval. Where such authorization is granted, capacity, operation, and maintenance instruction plates, tags, or decals shall be changed accordingly.
- (c) Care shall be taken to ensure that all replacement parts are interchangeable with the original parts and of a quality and performance at least equal to that provided in the original equipment.

6.1 Replacement Parts

The safety devices on the G-Cat automatic guided AGVs are specifically selected and extensively tested for AGV use. Safety devices must **never** be altered or modified by anyone other than trained and experienced repair personnel. Use only G&R Machine Tool recommended replacement parts.

The spare parts are listed in the BOM which is provided to you with this document, always save it safely for ordering any spare parts as needed. As part of the procedure to replace the laser scanner unit, a G&R Machine Tool approved configuration file is downloaded into the new unit.

Contact G&R Machine Tool, Inc for any inquiries or information needed regarding this AGV Maintenance Manual.

----- Thank You -----



G&R Machine Tool, Inc.

20410 Superior Rd, Taylor, MI 48180, USA

Phone: (734) 641-6560

Fax: (734) 641-6562

Email: robert@gnrmachinetool.com

Website: www.gnrmachinetool.com

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