Procurement Specification for A Small Automated Guided Vehicle (AGV)

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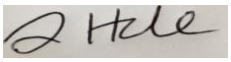
Procurement Lead Approval:	Gillian Hale		03/01/2024
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Verification Statement

This document has been verified and approved in accordance with NNL's procedures for the reporting of work.

History Sheet

Issue Number	Date	Comments
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1. Introduction

1.1. Project Background

National Nuclear Laboratory (NNL) are carrying out a Research and Development (R&D) project to develop and demonstrate technology that aims to fully automate operations in a nuclear store.

1.2. Purpose of Procurement Specification

NNL have a requirement to procure robotics equipment for proof of principle trials to be conducted at NNL's Workington site.

The purpose of this procurement specification is to specify the requirements for a small Automated Guided Vehicle (AGV) to carry out the trials work on a test rig, which has been constructed at the NNL Workington Laboratory.

The AGVs will be used to transport a number of platforms, with a range of equipment on top. A platform is shown in Figure 1 below.

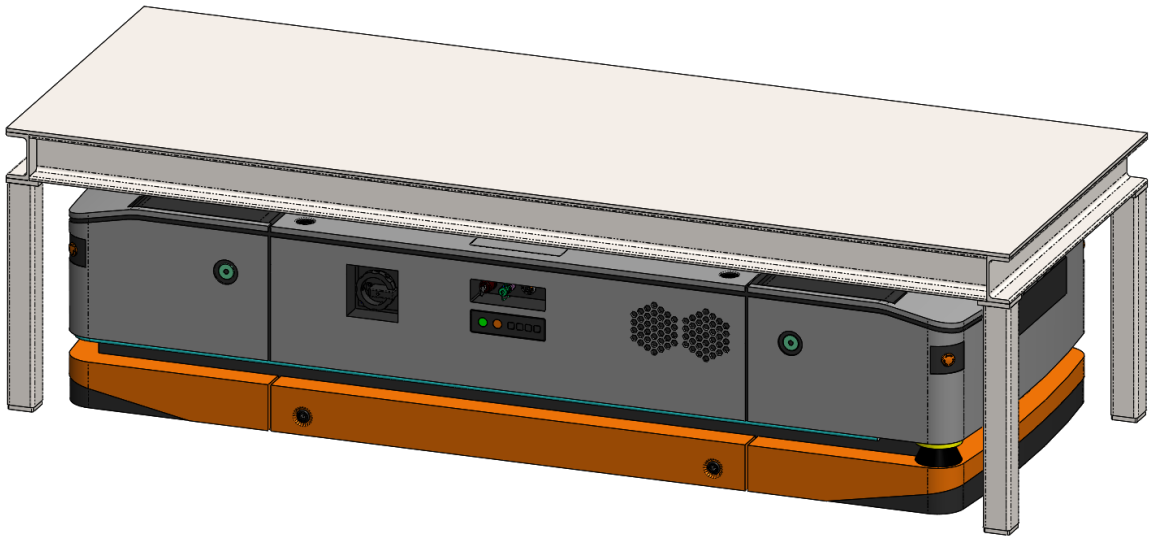

Figure 1 - AGV with platform

2. Request for Information

Please respond to this procurement specification with an estimated cost and lead time for procuring the following:

- One AGVs (and an additional price if two are purchased)
- Any associated development and run-time software system firmware, licences, installation media for AGV utilisation and training.

The following features should be included on each AGV:

- Electronic lift system
- Charging system
- Wireless communications
- Line following navigation system using optical guidance with QR codes
- Safety field protection (e.g. via a safety LiDAR system)
- Interfaces to high-level controller and safety PLC

See section 3 for further information on these requirements.

For the requirements specified in this document, if any cannot be met please specify which ones and why.

3. Functional Requirements

3.1. Hardware requirements

Criteria	Requirement
Lifting system	The lift system should include features for accurate positioning of the load.
Dimensions	Maximum size: 2000mm long x 900mm wide x 470mm high
Payload	600kg or more.
Positional accuracy	±10mm or better.
Navigation equipment	The navigation system must support use of optical guidance to drive along navigation lines using QR code tape and provide positioning feedback to a high-level controller. The navigation system must support turning on the spot, correcting for position with the use of QR codes during rotation, and accurately re-position onto a line after turning. It is desirable for the system to have omnidirectional drive such that it can navigate sideways from one guidance line to another parallel guidance line. It must also be possible to manually drive the AGV without line guidance during commissioning, recovery and maintenance.
Collision detection	The system must have a protective monitoring function for safety field protection (e.g., through a LiDAR system) that safely stops the AGV when a foreign object is detected within this safety field. Additional contact (e.g. emergency stop buttons) devices must be present on the vehicle and integrated into its safety system.

Criteria	Requirement
IP rating	IP 54 or better
CE marking	Off the shelf product that is already CE marked or provided with a declaration of conformity.
Weight	2000kg or less

3.2. Service Requirements

Criteria	Requirement
Battery Type	Does not emit hydrogen gas. The battery system should have a battery management system to prevent common faults, including short circuit protection, over and under temperature protection, over current protection, over voltage protection, and under voltage protection.
Battery Isolation	It should be possible to isolate the battery by means of an externally accessible isolation switch, without opening panels or guards.
AGV Battery capacity	Enable continuous operations of the platform and integrated equipment for at least 4 hours.
Battery charger	If the battery charger is floor mounted, it should be able to be mounted on a flat floor, without being recessed into the floor. Side mounted charging is also acceptable.
Charging technology	Ability to charge the robot AGV platform without manual plug-in (eg using conductive plates or similar).

Criteria	Requirement
	The system should be able to navigate itself automatically into its charging point.
Power to the payload	It should be possible to provide a power supply to a fixed payload, ideally 24V or 48V DC. Note that the AGV would not be expected to pick up and set down the payload if it is plugged in.

3.3. Software Requirements

Criteria	Requirement
Integration with External Hardware/Software	The AGV must provide a wired interface for integration with a high-level Beckhoff PLC controller to be installed onboard, communicating via industrial protocols such that it can receive navigation instructions to command it to specified positions, based on the positioning system provided by QR code tapes. It must also be possible to issue a PLC signal to the AGV to disable movements when required. The AGV must be able to provide operational data about the system to the PLC controller, including information about battery state-of-charge, currents and temperatures, vehicle position and velocity, system health, charging status, and status of any integrated sensors and other hardware. The AGV should have a wireless client module to allow it to communicate wirelessly with a remote system and come to a safe halt on loss of this communications during automatic drive mode.

Criteria	Requirement
Safety	It must be possible to integrate external safety signals to the AGV via Beckhoff TwinSAFE PLC, such as external emergency stops and door interlock signals, to trigger safety stop functions or inhibit AGV movement. Use of PROFIsafe communications is preferred, but other protocols such as Safety over EtherCAT (FSoE) is accepted. It should be possible to manually drive the AGV with a LiDAR safety field override under controlled conditions, but automatic drive must only be possible when all safety signal conditions are met. Loss of wireless communications must also stop the AGV in automatic drive mode and prevent any further operation in automatic mode. The AGV must provide a safety signal output for integration into a Beckhoff TwinSAFE PLC such that the status of safety stops, and health of all integrated safety systems are reported back. The AGV must have a (non-contact based) safety protective field monitoring function to prevent collisions with foreign objects, which should be changeable to different pre-configured field sizes based on inputs from a safety PLC. The AGV should also have a safe velocity monitoring function. Violations of either function must result in a safe stop.
Human Machine Interface (HMI)	An HMI (such as a remote controller) should be available for operators to see AGV status, as well as initiate manual control of the device.
Use in environment with people present	The AGV must be certified for safe operation in an environment with people present. This should safety features such as warning lights and beacons, audio warnings and easily accessible safety stops from all sides, in addition to safety protective field monitoring.
Device Software Security	Vendor provides regular security-focused updates for any software (including underlying system OSs) used by the AGV. Installing updates must not have any breaking changes to the AGV's setup and configuration that would impact its integration with other systems.

Criteria	Requirement
	Updates can be installed by end-user, or by a vendor-approved team.
Simulation	AGV motion can be simulated before being actioned using COTS software available from the supplier.
Navigation	The navigation system must be able to receive instructions from a higher-level PLC controller to drive to a target position (within a tolerance of ~10 mm), rotate on the spot, and, desirably, drive sideways between two optical guidance QR code lines. If the system encounters loss of a line over a specified distance (e.g., due to tape damage / wear & tear), it should come to a stop and report an error.

3.4. Other Requirements

Title	Description
Floor loading	The AGV will create a floor loading of less than 50kN/m^2, to avoid damage to the floor of the stores building. Please inform NNL of the floor loading that the AGV is likely to exert.
Reliability	The AGV system is expected to be able to run for at least 8 hours a day, 5 days a week. Please state equipment's likely Mean Time Before Failure (MTBF) based on above duty cycle, assuming normal use within specification.
Maintainability	The AGV should require minimal maintenance, preferably requiring maintenance every 6 months or less frequently. Please state equipment's routine maintenance requirements and frequency, assuming normal use within specification.
Operator supervision	The AGV system must provide sufficient information (e.g. via sensors and positional data feedback) to allow a remote operator to supervise and control the operations and know what the AGV is doing.

Title	Description
Lifetime	The AGV should have an expected operational lifespan of and vendor support for 10 years or more, given the expected operating conditions of being in service 8 hours a day, 5 days a week.
Obsolescence	The manufacturer should be able to provide spare parts, servicing, and support for a minimum of 5 years. If the model is due to be discontinued, the manufacturer should be able to offer an equivalent model with similar capabilities in the future.
Battery charging period	The AGV batteries must be capable of being fully charged in less than 16 hours
Stability	The AGV system must be capable of remaining stable at all times, whilst carrying its maximum payload at the maximum lift height.
Fail safe operation	In the event of a power failure, the AGV system shall come to an immediate complete and safe halt and maintain its current position. In the event of a communications failure, the AGV system shall fail safe by immediately stopping and remaining stationary.
Interaction with other AGVs	The AGV should be capable of working with other AGVs and coordinating movements to avoid collisions (this could be achieved with the support of a higher-level controller).
Environment	The AGV is intended for indoor use only Temperatures are expected to be in the range of 5 to 35 degrees C Humidity levels could vary from 0 to 80% The stores area has a conventional factory floor type of surface texture. Floor gradient is horizontal, with no steps present. The area has overhead standard industrial lighting, sufficient for current manual operations.
Recovery	The AGV shall be able to allow its load to be manually lowered in the event of equipment failure. The AGV shall be designed to allow recovery in the event of equipment failures (please specify what is possible); i.e. to enable the equipment to be easily recovered to a safe position and condition following a failure mode.

4. Policies and Standards

All equipment supplied is expected to be CE or UKCA marked or supplied with a declaration of incorporation, and compliant with all relevant directives and standards identified by the supplier.

A declaration of incorporation for partly completed machinery would be acceptable if the equipment cannot be CE marked as a standalone item.

Equipment shall be supplied to NNL's contract quality grade (CQR) 03. Please see document "IMS-CQR-03 v6 – Contract Quality Requirements for Quality Grade 03" for further information, available from NNL procurement.

A complete set of up to date Operating and Maintenance Instruction manuals should be supplied.

The equipment that is to be used at Sellafield site in the later phases of work may be required to meet additional Sellafield standards, but which standards will apply has not yet been confirmed. These Sellafield standards will not apply to the equipment that is to be supplied to NNL for the R&D phase of the project.

5. Other Requirements

5.1. Installation, Servicing, Training, & Technical Support

Please detail what support can be offered, and associated daily or hourly rates regarding technical support for installation, commissioning, servicing, and training.

Any servicing and support work would be carried out at NNL Workington Laboratory. This is a non-radioactive test facility, and does not require any special security clearance or training to work in.