

Mobile Manipulator System



BASIC DESCRIPTION

PaR's Mobile Manipulator is specifically designed to apply compatible processes to transport aircraft. The system has excellent dexterity to maneuver and position itself around the aircraft. From each position, the manipulator axes can reach large portions of the aircraft and deploy processes such as coating removal, inspection, etc. The system includes a custom mobile platform with an elevator axis and a six axis servo controlled manipulator. The operator positions the platform adjacent to the aircraft and sets the elevator axis to allow the manipulator to reach either above the aircraft or below. The system then uses the ScanPlan software to move the process head across the aircraft surface. The laser standoff distance sensors provide feedback for adaptive control to follow the surface maintaining a predefined standoff distance and surface normality. When each area is complete, either the elevator or the platform is repositioned for the next area.



ADVANTAGES

- ▲ **Mobility, Dexterity** – The platform is maneuvered on four hydraulic drive/steer wheelsets allow omni-directional movement of the platform with excellent precision.
- ▲ **Patented, Telescoping Boom**– PaR's patented telescoping tube design provides extended reach.
- ▲ **Large Work Envelope** – The boom extension coupled with the boom swing and boom pivot axes allow access over large surface areas from each platform position.
- ▲ **3 Axis Wrist** – The wrist axes at the end of the boom allow orienting the process head normal to the aircraft surface in the proper direction for travel across the surface.

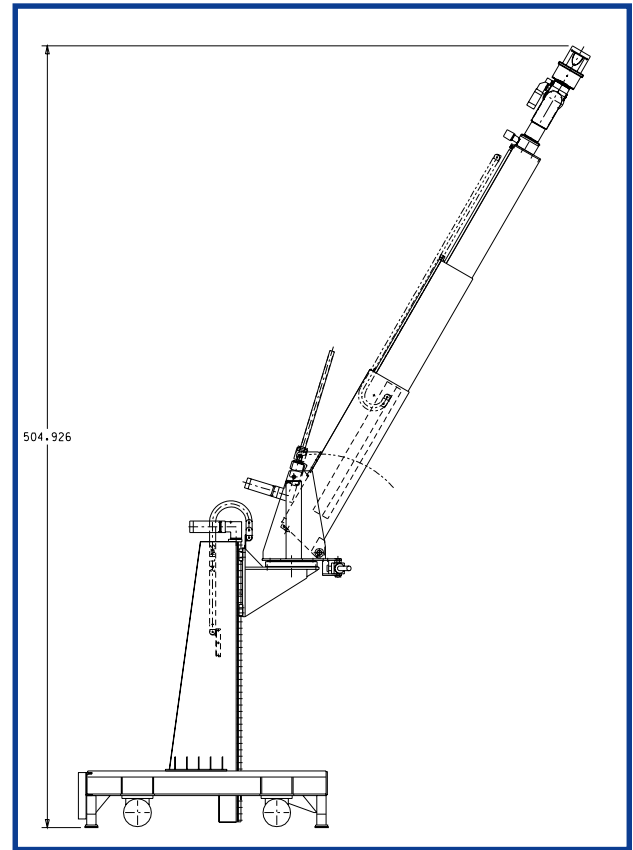


MOBILE MANIPULATOR COMPONENTS OVERVIEW

- ▲ **Platform** — A large welded platform provides the unitized base to support the elevator and manipulator. A set of four hydraulic wheel sets gives the platform the mobility to position anywhere around the aircraft. The elevator mounts to the platform and raises and lowers the servo manipulator.
- ▲ **Servo Manipulator** — The servo manipulator provides boom swing, pivot, and extend. Each of these axes are actuated by large ball screws with the boom extend axis incorporating a patented dual ball screw design.
- ▲ **Wrist** — The wrist attaches to the end of the boom and provides three rotational axes of motion yaw, pitch, and roll. The wrist axes allow the system to maintain the process head at the proper orientation relative to the aircraft surface during scanning.
- ▲ **Controller** — The CIMROC® 5000NT is a 5-axis CNC controller using integrated kinematics for separate, simultaneous control of supervisory, trajectory, and servo functions. The controller is network compatible and includes a teach pendant.

SPECIAL FEATURES

- ▲ **Class I Div. II Certification** – PaR has designed the platform height so that anything below 18” from the floor is Class I Division II compliant. In addition, the entire boom and wrist assemblies, which might reach over or under a fuel-containing element, are Class I Division II certified.
- ▲ **ScanPlan Programming** – This software package allows the user to lead/teach the manipulator through a relatively low number of points yet define the contour of large areas of the aircraft surface. By teaching points on the perimeter of the area, the ScanPlan software interpolates to allow the operator to scan the process across the area in subsequent indexed strokes. The amount of index for each stroke is defined by the operator or process controller and is independent of the mobile manipulator program.
- ▲ **Standoff Sensors** – The mobile manipulator incorporates laser range sensors integrated mounted on the process head. These sensors measure the distance to the aircraft surface and provide feedback to the CIMROC 5000NT controller. The controller interprets this data and uses adaptive control algorithms to maintain a constant standoff distance and surface normality during teaching and during scanning.
- ▲ **Registration System** – This system facilitates precise location of the mobile manipulator relative to the actual location of the aircraft. The system consists of a pair of transmitters; a pair of receivers mounted on the platform and a hand held wand with receivers. The receivers determine their location relative to the transmitters. The operator uses the wand to point out features on the aircraft. The system controls determine the location of the aircraft. The receivers on the platform then provide the operator with feedback as he relocates the platform to each position.



MOBILE MANIPULATOR COMPONENTS OVERVIEW

Axis	Travel	Range
Wheel Sets	Omni Directional Drive/Steer 4" Lift	0" to 4" Above Floor
Elevator	132"	Boom pivot point moves from 45" to 177" above the floor
Boom Swing	+/- 45°	
Boom Pitch	60° up, 15° down	Max reachable height is 40 feet off floor with elevator fully raised, boom fully extended
Boom Extend	168"	Wrist center moves from 161" from boom pivot to 329"
Yaw	+/- 185°	
Pitch	+/- 135°	
Roll	+/- 220°	

