

Revision #: 9 January 30, 2009

Engr. Spec. #	Importance	Source	Specification (description)	Unit of Measure	Marginal Value	Ideal Value
ES01	1	CN07	Arm is capable of incorporating the hand	boolean		TRUE
ES02	1	CN11	Designs are open and adaptable to future projects	boolean		TRUE
ES03	3	CN12	Human interface can be understood quickly	minutes	20	5
ES04	1	CN01	Wrist has same number of degrees of freedom as the human hand	degrees of freedom	2	2
ES05	1	CN02	Forearm has same number of degrees of freedom as the human hand	degrees of freedom	1	1
ES06	1	CN03	Elbow has same number of degrees of freedom as the human hand	degrees of freedom	1	1
ES07	2	CN07	Provides enough power to be able to manuver previous hand	lbf	(arm's own weight)	(weight of arm and hand)
ES08	1	CN08,CN09,CN10	SolidWorks CAD model of every part	boolean		TRUE
ES09	3	CN04,CN05,CN06	Length of a arm, shoulder to fingertips ¹	inches	20-40	30
ES10	3	CN04	Hand length, wrist to fingertips ¹	inches	5-15	7
ES11	3	CN06	Bicep length ¹	inches	10-15	12
ES12	3	CN05	Forearm length ¹	inches	9-17	12
ES13	2	CN09	Computer model needs to be able to predict collisions	boolean		TRUE
ES14	2	CN08,CN09	Computer model needs to be able to predict the forces acting on the arm components	boolean		TRUE
ES15	1	CN09,CN10	Computer model needs to prove the design feasibility	boolean		TRUE
ES16	2	CN07	Maximum Manageable Weight	lbs	10	20
ES17	2	CN04	Wrist Sagittal Flexion replicates human motion (Wrist Down)	degrees	60	80
ES18	3	CN13	Position Tolerance for Both the SolidWorks Model and the Prototype	degrees	±8	±1
ES19	2	CN04	Wrist Sagittal Extension replicates human motion (Wrist Up)	degrees	55	70
ES20	3	CN13	Position Tolerance for Both the SolidWorks Model and the Prototype	degrees	±7	±1
ES21	2	CN04	Wrist Radial Deviation replicates human motion (Wrist Left)	degrees	15	20
ES22	3	CN13	Position Tolerance for Both the SolidWorks Model and the Prototype	degrees	±2	±1
ES23	2	CN04	Wrist Ulnar Deviation replicates human motion (Wrist Right)	degrees	20	30
ES24	3	CN13	Position Tolerance for Both the SolidWorks Model and the Prototype	degrees	±2	±1.5
ES25	2	CN05	Forearm Pronation (thumb in) resembles human motion (Rotate CCW)	degrees	60	80
ES26	3	CN13	Position Tolerance for Both the SolidWorks Model and the Prototype	degrees	±8	±1
ES27	2	CN05	Forearm Supination (thumb out) resembles human motion (Rotate CW)	degrees	60	80
ES28	3	CN13	Position Tolerance for Both the SolidWorks Model and the Prototype	degrees	±8	±1
ES29	2	CN06	Elbow Flexion resembles human motion (Elbow)	degrees	135	150
ES30	3	CN13	Position Tolerance for Both the SolidWorks Model and the Prototype	degrees	±15	±1
ES31	2	CN04	Wrist Movement speed (median)	deg/s	60	180
ES32	2	CN05	Forearm Movement speed (median)	deg/s	90	210
ES33	2	CN06	Elbow Movement speed (median)	deg/s	180	215
ES34	1	CN13	Control system able to control both SolidWorks and Prototype	boolean		TRUE
ES35	1	CN14	Control system able to take feedback from both SolidWorks and Prototype	boolean		TRUE
ES36	2	CN15	Control system operates fast enough to control prototype (USB, Relay, DAQ, and Calculation delay)	milliseconds	100-500	<100

Engr. Spec. #: enables cross-referencing (traceability) and allows mapping to lower level specs within separate documents

Source: Customer need #, regulatory standard (eg. EN 60601), and/or "implied" (must exist but doesn't have an associated customer need)

Description: quantitative, measureable, testable details

<http://www.pasco.com/biology/physiology/human-arm-model.cfm>

<http://www.jneuhaus.com/human.html>