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DIVISION 41 - MATERIAL PROCESSING AND HANDLING EQUIPMENT

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MONORAILS WITH ELECTRIC, AIR, OR MANUAL POWERED HOIST

04/06

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References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC 348 (2000) Structural Joints Using ASTM A325 or A490 Bolts

ASME INTERNATIONAL (ASME)

ASME B30.11 (1998) Monorails and Underhung Cranes

ASME B30.16 (2003) Overhead Hoists (Underhung)

ASME HST-1 (1999; R 2004) Electric Chain Hoists

ASME HST-2 (1999; R 2004) Hand Chain Manually Operated Chain Hoists

ASME HST-3 (1999; R 2004) Manually Lever Operated Chain Hoists

ASME HST-4 (1999; R 2004) Overhead Electric Wire Rope Hoists

ASME HST-5 (1999; R 2004) Air Chain Hoists

ASME HST-6 (1999) Air Wire Rope Hoists

ASTM INTERNATIONAL (ASTM)

ASTM A 275/A 275M (2003) Magnetic Particle Examination of Steel Forgings

ASTM A 325 (2004b) Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength

ASTM A 325M (2004b) Structural Bolts, Steel, Heat Treated, 830 Mpa Minimum Tensile Strength (Metric)

ASTM A 563 (2004a) Carbon and Alloy Steel Nuts

ASTM A 563M	(2004) Carbon and Alloy Steel Nuts (Metric)
ASTM F 959	(2004) Compressible-Washer-Type Direct Tension Indicators for Use with Structural Fasteners
ASTM F 959M	(2002) Compressible-Washer-Type Direct Tension Indicators for Use with Structural Fasteners (Metric)
MONORAIL MANUFACTURERS ASSOCIATION (MMA)	
MMA MH27.1	(2003) Underhung Cranes and Monorail Systems
NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)	
NEMA MG 1	(2003; R 2004) Motors and Generators
NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)	
NFPA 70	(2005) National Electrical Code
U.S. GENERAL SERVICES ADMINISTRATION (GSA)	
FS RR-W-410	(Rev E) Wire Rope and Strand

1.2 SUBMITTALS

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list to reflect only the submittals required for the project. Submittals should be kept to the minimum required for adequate quality control.

A "G" following a submittal item indicates that the submittal requires Government approval. Some submittals are already marked with a "G". Only delete an existing "G" if the submittal item is not complex and can be reviewed through the Contractor's Quality Control system. Only add a "G" if the submittal is sufficiently important or complex in context of the project.

For submittals requiring Government approval on Army projects, a code of up to three characters within the submittal tags may be used following the "G" designation to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy, Air Force, and NASA projects.

Choose the first bracketed item for Navy, Air Force

and NASA projects, or choose the second bracketed item for Army projects.

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for [Contractor Quality Control approval.] [information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government.] The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Monorail[; G][; G, [_____]]

Drawings as specified.

SD-03 Product Data

Monorail Track Beam System[; G][; G, [_____]]
Electric Wire Rope Hoist[; G][; G, [_____]]
Electric Chain Hoist[; G][; G, [_____]]
Trolley[; G][; G, [_____]]
Pendant Pushbutton Station[; G][; G, [_____]]

Manufacturer's descriptive data and technical literature, performance charts and curves, catalog cuts, and installation instructions.

SD-05 Design Data

Design calculations[; G][; G, [_____]]

Load and sizing calculations as specified.

SD-06 Test Reports

Hook Test[; G][; G, [_____]]
Load test[; G][; G, [_____]]
No-Load Test[; G][; G, [_____]]
Post-Erection Inspection[; G][; G, [_____]]
Operational Tests[; G][; G, [_____]]
Rated Load Speed Test[; G][; G, [_____]]
Wire Rope Breaking Strength[; G][; G, [_____]]
Load Chain Proof Test[; G][; G, [_____]]
Hooks[; G][; G, [_____]]

Tests and inspections reports. Magnetic particle inspection of hook and hook nut results.

SD-07 Certificates

Bolts[; G][; G, [_____]]
Nuts[; G][; G, [_____]]
Washers[; G][; G, [_____]]

Certificates of compliance.

SD-10 Operation and Maintenance Data

Maintenance[; G][; G, [_____]]

Submit Data Package 3 as specified.

1.3 VERIFICATION OF DIMENSIONS

The Contractor shall be responsible for the coordination of his work with the work of all trades involved and as it relates to the building structure. The Contractor shall verify all building dimensions that relate to fabrication of the monorail system, and shall notify the Contracting Officer of any discrepancy before order to the monorail manufacturer is finalized.

1.4 SYSTEM DESCRIPTION

Provide a monorail system with electric powered hoist[s] and [plain type (hand operated)] [hand chain operated] [electric powered] trolley[s] complete, tested and ready for operation. Monorails, hoist[s], trolley[s], equipment, materials, installation, examination, inspection, and workmanship shall be in accordance with the applicable requirements of NFPA 70, ASME B30.11, ASME B30.16, ASME HST-1, ASME HST-4, and MMA MH27.1, with modifications specified herein. Reference in these publications to the "authority having jurisdiction" shall be interpreted to mean the "Contracting Officer."

1.5 DELIVERY, STORAGE, AND HANDLING

1.5.1 Delivery and Storage

Inspect materials delivered to site for damage; unload and store with minimum handling. Store materials on-site in enclosures or under protective coverings. Protect materials not suitable for outdoor storage to prevent damage during periods of inclement weather, including subfreezing temperatures, precipitation, and high winds. Store materials susceptible to deterioration by direct sunlight under cover and avoid damage due to high temperatures. Do not store materials directly on ground. When special precautions are required, prominently and legibly stencil instructions for such precautions on outside of equipment or its crating.

1.5.2 Handling

Handle materials in such a manner as to ensure delivery to final location in undamaged condition. Make repairs to damaged materials at no cost to Government.

1.6 QUALITY ASSURANCE

1.6.1 Drawings: Monorail

Submit drawings showing the general arrangement of the track beam system, including curves and switches, clearances, principal dimensions, details of structural connections, air system details, and all component details. Manufacturer's catalog data will suffice for items of standard manufacturer.

1.6.2 Certificates: Load Chain

Submit certification of minimum wire rope breaking strength for each hoist.

Where applicable, submit factory certification of the load chain rated capacity.

1.6.3 Design Data: [Design Calculations](#)

Submit design calculations verifying the size of structural members, structural supports (fittings, rods, brackets, and components), and lifting beams for the track beam system. The calculations shall include stress and loading diagrams. Submit calculations with monorail drawings.

1.7 [MAINTENANCE](#)

Submit data package for the entire monorail system in accordance with Section [01 78 23](#) OPERATION AND MAINTENANCE DATA.

PART 2 PRODUCTS

2.1 OVERHEAD MONORAIL SYSTEM

NOTE: Plain type (hand operated) trolleys are recommended where trolley motion is infrequent or the distance is short. Plain type trolleys are not recommended for hoists of 3 metric ton (3 ton) capacity and greater, or for tracks higher than 6 m (20 feet) above the floor level. Hand chain operated trolleys are recommended where trolley motion is infrequent or the distance is short. They provide good load spotting ability and can be used for hoists of 5 metric ton (5 ton) capacity and under. Motor operated trolleys are recommended where the operating frequency, travel distance, rated load, or beam elevation makes other types of trolleys impractical.

This specification is written for a single monorail system and hoist. Edit the following paragraphs to reflect number, types, capacities of monorail track systems, hoists, trolleys, etc.

When there is one hoist on one monorail system, the monorail system capacity and the hoist capacity will be comparable. When there is more than one hoist on the monorail system, the capacity of the monorail system should be comparable to the total sum of the system hoists individual rated capacity with the following exception:

1. There are positive monorail track beam stops to restrict the approach of the hoists.

2. Calculations indicate that at the point of closest approach of the hoists, with rated capacity load on the hoists, the monorail track beam and monorail support points (and appurtenances) are not loaded in excess of the load condition imposed by any one hoist with rated load in any location.

Should conditions 1 and 2 exist, than the capacity

of the monorail system may be comparable to the capacity of the highest rated individual hoist in the monorail track system. Do not specify a monorail system of greater capacity than required as this will increase the system cost.

NOTE: Unless otherwise specified, the nominal rated maximum speed of the hoists will be the manufacturer's standard within the limits of Table 1, for 2, 3, and 5 metric ton (2, 3, and 5 ton) capacity hoists.

Table 1. Standardized Hoists Lift Ranges and Rated Lifting Speed Ranges For 2, 3, and 5 metric ton Capacity

Rated Load Capacity (metric tons)	Hoist Lift Range (m)	Hoist Lifting Speed range (mm/s)	
		Low	High
2	3 to 10	30	160
3	3 to 10	30	85
5	3 to 10	30	60

Table 1. Standardized Hoists Lift Ranges and Rated Lifting Speed Ranges For 2, 3, and 5 ton Capacity

Rated Load Capacity (tons)	Hoist Lift Range (ft.)	Hoist Lifting Speed range (ft./min)	
		Low	High
2	10 to 30	6	32
3	10 to 30	6	17
5	10 to 30	6	12

NOTE: Do not specify a longer lift range than required as this will increase the building height and hoist cost.

Provide overhead monorail system conforming to MMA MH27.1, Class C, for [indoor] [outdoor] service, with an electric wire rope or chain hoist mounted on a movable trolley. Trolley shall be [plain type (hand operated)] [hand chain operated] [motor operated]. The [1/4] [1/2] [1] metric ton ton hoist and trolley shall meet the design requirements specified in ASME HST-5 or ASME HST-6 for the 2 metric ton ton hoist trolley. The hoist shall have a minimum rated capacity of [_____] metric ton tons. The monorail system shall have a minimum rated capacity of [_____] metric tons tons. The hook lift and speed shall be the manufacturer's standard within the limits specified in ASME HST-5 or ASME HST-6. [The hook lift shall be at its highest point a minimum of [_____] m feet above the finished floor, and at its lowest point, a minimum of [_____] m feet below the finished floor.]

2.1.1.1 Hooks

Hooks shall be of the safety type with hook nuts keyed to hook shanks by means of a setscrew installed in a plane parallel to the longitudinal axis of the hook shank, or by any other similar easily removable securing device. All hook components shall be magnetic-particle inspected over the

entire area in accordance with **ASTM A 275/A 275M**. The acceptance standard shall be one of no defects. A defect is defined as a linear indication revealed by magnetic-particle inspection that is greater than **3 mm 1/8 inch** long whose length is equal to or is greater than three times its width.

2.1.2 Hoist Wire Rope

Rope lengths shall be sufficient to maintain a minimum of two full wraps of rope at the dead end(s) of the drum, with the block in its lowest indicated position. Hoisting ropes shall conform to **FS RR-W-410**, improved or extra improved plow steel, regular lay, uncoated, 6 by 37 class construction, with an independent wire rope core.

2.1.3 Hoist Chain

Chain hoists of **3 m 10 foot** lift or more shall be equipped with a load chain bucket.

2.2 AIR POWERED HOIST

NOTE: Select the applicable paragraph(s) from the following:

Monorail system shall operate on [_____] volts AC, 60 Hz, [single] [three] phase power source. The hoist and trolley shall conform to **ASME HST-5** or **ASME HST-6**, [2] [3] [5] **metric ton ton**, for [general service] [protected indoor] [all weather outdoor (-18 to 38 degrees C 0 to 100 degrees F)] working conditions. 2 **metric ton ton** design criteria shall apply to hoists of 2 **metric ton ton**, or less, rated lifting capacity. Hoists of 2, 3, or 5 **metric ton ton** rated capacity, shall be equipped with an automatic mechanical load lowering brake.

2.2.1 Hook [Lift and] Speed

[For [1/4] [1/2] [and] [1] **metric ton ton** hoist(s), the hook lift shall be at its highest point a minimum of [_____] **m feet** above the finished floor and at its lowest point a [maximum] [minimum] of [_____] **m feet** [above] [below] the finished floor.] The hook [lift and] speed limits for 1/4, 1/2, and one **metric ton ton** rated capacity hoists shall be within the limits shown in the following table.

Standardized hoist lift ranges and rated lifting speed ranges for 1/4, 1/2, and 1 metric ton rated capacity

Rated load capacity (metric tons)	Hoist lift range (meter)	Hoist lifting speed range (mm/s)		
		Low		High
1/4	3 to 15	120	to	350
1/2	3 to 12	80	to	250
1	3 to 10	40	to	225

Standardized hoist lift ranges and rated lifting speed
ranges for 1/4-, 1/2-, and 1-ton rated capacity

Rated load capacity (tons)	Hoist lift range (feet)	Hoist lifting speed range (feet per minute)		
		Low		High
1/4	10 to 50	24	to	70
1/2	10 to 40	16	to	50
1	10 to 30	8	to	45

2.2.2 Electric Wire Rope Hoist

**NOTE: Specify double reeved hoist if true vertical
lift is required.**

ASME HST-4, Class H3, except as modified herein. [Hoist shall be double reeved.]

2.2.3 Electric Chain Hoist

Electric chain hoist shall conform to ASME HST-1, Class H3, except as modified herein. Provide load chain proof test results.

2.2.4 Hoist Limit Switch

Hoists shall be equipped with upper and lower hoist limit switches/devices.

2.2.5 Control Pendant

Electric hoist [and trolley] shall be controlled from a pendant pushbutton station. Arrange pushbuttons in accordance with ASME B30.11 recommendations. Locate station [1.2 m 4 feet] [_____] above the finished floor. Control pendant shall extend [_____] below the underside of the track beam.

2.3 MANUAL HOIST AND TROLLEY

Provide manual hoist and trolley, ASME HST-2, ASME HST-3, trolley suspension. Trolley and wheels shall be suitable for operation on the steel monorail track beam provided, and shall have not less than four wheels.

2.4 TROLLEY

Trolley shall have a [manual] [geared manual] [air motor powered] [electric] drive and shall be designed to operate from [_____] track beam section [the track beam section furnished under this contract]. Where two or more hoists are located on the same monorail beam, the trolleys shall be equipped with rubber bumper devices designed to prevent contact of any part or parts of the hoists.

2.5 MONORAIL TRACK BEAM SYSTEM

Track system shall conform to MMA MH27.1, for powered hoists. Track beams shall be patented track sections fabricated by a manufacturer regularly engaged in production of this type of beam. The maximum allowable deflection shall not exceed 1/600 of the unsupported span, with the hoist(s) at rated load(s) and at any location(s). The track beam system shall have trolley stops at all open end locations. The stops shall be designed to retain the hoist on the track. Wheel stops shall interface with the trolley wheel treads on both sides of the track web simultaneously and shall not interface with the trolley wheel flanges. The air supply valve specified shall be of the quick shutoff type, readily accessible from the floor, and located within proximity to the monorail system.

2.5.1 Track Suspension System

NOTE: Flexible suspension is preferred if there is
adequate headroom to install it.

Monorail suspension shall be [flexible] [rigid] type. Make bolted connections to supporting structure, excluding hanger rods, with ASTM A 325M ASTM A 325 bolts, ASTM A 563M ASTM A 563 nuts, and ASTM F 959M ASTM F 959 load indicator washers. ASTM A 325M ASTM A 325 bolts shall be fully pre-tensioned in accordance with AISC 348. Support monorail track system from the structural members shown. Provide additional supports as required to carry monorail track system loads to the structural members shown. Materials for additional supports shall conform to the material requirements contained in Section 05 12 00 STRUCTURAL STEEL.

2.5.2 Sheaves

Sheaves shall be steel or ductile cast iron. Pitch diameter of running sheaves shall not be less than 16 times the rope diameter. Pitch diameter of non running sheaves shall not be less than 12 times the rope diameter.

2.5.3 Drum

Drum shall be steel or ductile cast iron. Pitch diameter of the drum shall not be less than 18 times the rope diameter. Not less than two dead wraps of the hoisting rope shall remain on each anchorage when the hook is in its extreme low position.

2.6 MOTORS

NOTE: Single speed motors are sufficient for slow
operating speeds. When two-speed motors are
specified, the slow speed will be 1/3 to 1/4 of the
rated speed. Squirrel cage motors normally have a
high acceleration/deceleration rate. Specifying
reduced voltage starting, acceleration, and
deceleration for the trolley will reduce this rate
and improve load spotting and handling ability.

Motors shall conform to NEMA MG 1. Hoist [and trolley] motor[s] shall be [single] [two] speed AC squirrel cage induction type. [Trolley motor shall

be [single] [two] speed AC squirrel cage induction type.] Motor insulation shall be Class B minimum. Provide totally enclosed non-ventilated (TENV) motor enclosures. Maximum motor speed shall not exceed 1800 RPM. Provide [single] [two] speed magnetic control for the hoist [and trolley]. [Provide [single] [two] speed magnetic controls for the trolley.] [Provide reduced voltage starting, acceleration and deceleration for the trolley drive.]

2.7 BRAKES

**NOTE: Specify trolley brake for motor operated
trolley. Select "100 percent" for outdoor monorails
and "50 percent" for indoor monorails.**

Provide hoist with an electro-mechanical holding brake and a mechanical load brake, each capable of holding 130 percent of the rated hoist capacity. Hoist holding brake shall be capable of being released to test the load brake. [Provide trolley with an electro-mechanical brake. Provide trolley brake with a minimum torque rating of [100] [50] percent of the drive motor rated torque. Trolley brake torque shall be adjustable down to 85 percent of its torque rating.]

2.8 LOAD BLOCK AND HOOK

**NOTE: A minimum hook throat opening may be required
to accommodate special slings or other devices.
Check with user.**

Construct load blocks of steel. Provide forged steel, swivel type hook, with hook nut keyed to hook shank by means of a setscrew installed in a plane parallel to the longitudinal axis of the hook shank, or other similar easily removable securing device. [Hook throat opening shall not be less than [_____] mm inches.] Provide hook with spring loaded steel safety latch for closing the hook throat opening. The hook and hook nut shall be unpainted. Permanently mark hook and hook nut with an identification number. Magnetic particle inspect the hook and nut over the entire area in accordance with ASTM A 275/A 275M. Acceptance standard shall be no defects. A defect is defined as a linear indication that is greater than 3 mm 1/8 inch long whose length is equal to or greater than three times its width.

2.9 BEARINGS

All bearings except those subject to a small rocker motion shall be anti-friction type. Bearings not considered lifetime lubricated by the manufacturer shall be provided with a means for lubrication.

2.10 EQUIPMENT COLOR

**NOTE: For corrosive atmospheres, specify
appropriate protective requirements.**

Equipment color shall be the manufacturer's standard brilliant yellow.

2.11 IDENTIFICATION PLATES

The manufacturer shall furnish and install identification plates of noncorrosive metal. Information and data on the plates shall include, in clearly legible permanent lettering, the manufacturer's name, model number, capacity rating, and other essential information. In addition, the monorail track beam system shall be furnished with identification plates showing the capacity of the system, which shall be legible from the floor and from either side of the monorail track beam.

PART 3 EXECUTION

3.1 ERECTION AND INSTALLATION

Erect and install the monorail system, complete in accordance with the approved submittals and in condition to perform the operational and acceptance tests.

3.2 ERECTION SERVICES

Provide supervisory erection services from the monorail system manufacturer.

3.3 FIELD QUALITY CONTROL

3.3.1 Post-Erection Inspection

After erection, the Contractor and the Contracting Officer shall jointly inspect the monorail and hoist systems and components to determine compliance with specifications and approved submittals. The Contractor shall notify the Contracting Officer [_____] days before the inspection. Provide a report of the inspection indicating the monorail system is considered ready for operational tests.

3.3.2 Operational Tests

NOTE: Determine if Government test loads are
available. If not, test loads must be provided by
the Contractor.

After erection and inspection, test the hoist, and trolley as specified herein. Test the systems in service to determine that each component of the system operates as specified, is properly installed and adjusted, and is free from defects in material, manufacturer, installation, and workmanship. Rectify all deficiencies disclosed by testing and retest the system or component to prove the monorail system is operational. The Contractor shall furnish [loads for testing,] operating personnel, instruments, and all other necessary apparatus. [The Contracting Officer will furnish loads for testing; the Contractor shall receive and transport the loads from a location not more than [_____] km miles from the job site and shall return them to that location after the tests have been completed.]

3.3.3 Test Data

Record test data on appropriate test record forms suitable for retention for the life of the monorail system. Record operating and startup current measurements for electrical equipment (motors and coils) using appropriate instrumentation (i.e., clamp-on ammeters). Compare recorded values with

design specifications or manufacturer's recommended values; abnormal differences (i.e., greater than 10 percent from manufacturer's or design values) shall be justified or appropriate adjustments performed. In addition, high temperatures or abnormal operation of any equipment or machinery shall be noted, investigated, and corrected. Record hoist [and trolley] speeds during each test cycle.

3.3.4 Hook Test

Measure hook for hook throat spread before and after load test. Establish a throat dimension base measurement by installing two tram points and measuring the distance between these tram points (plus or minus 0.4 mm 1/64 inch). Record this base dimension. Measure the distance between tram points before and after load test. An increase in the throat opening by more than 5 percent from the base measurement shall be cause for rejection.

3.3.5 No-Load Test

- a. Hoist: Raise the load hook the full operating lift distance and verify satisfactory operation of hoist, upper limit switch, lower limit switch, and the hoisting and lowering speeds. [Operate the hoist at low and high speed in both directions.]
- b. Trolley: Operate trolley assembly the full length of the monorail in both directions. [Operate trolley at low and high speed in each direction.] Verify satisfactory operation and verify trolley speed. [Operate all rail switches.]

3.3.6 Load Test

NOTE: Load Brake Test and Loss of Power Test (items c. and d. below) will be performed at low speed for two speed hoists.

125 Percent (plus 5 percent minus 0) of rated capacity

- a. Hoist Static Test: Raise test load approximately one foot above the floor and hold for 10 minutes. Observe load lowering that may occur which will indicate malfunction of hoisting component or brake. Lower the test load to the floor until the hoist line is slack.
- b. Hoist Dynamic Test: Raise the test load to approximately 1.5 m 5 feet above the floor [using both speed points in the process]. Lower the load back to the floor [using both speed points]. Stop the test load at least once while lowering [at high speed] and observe proper brake operation. Wait 5 minutes, then repeat the above cycle.
- c. Load Brake Test: Raise test load approximately 1.5 m 5 feet. With the hoist controller in the neutral position, release the holding brake. The load brake should hold the test load. Again with the holding brake in the released position, start the test load down [at low speed] and return the controller to off position as the test load lowers. The load brake should prevent the test load from accelerating. (Note that it is not necessary for the load brake to halt the downward motion of the test load.)

- d. Loss of Power Test: Raise the test load approximately 1 m 3 feet and while lowering test load [at low speed], cut main power to hoist. Load should stop.
- e. Trolley Test: With test load hoisted to a height of 300 mm one foot above the floor, operate trolley the full distance of the monorail in both directions [using both speed points in the process]. Observe for any malfunctioning of the trolley assembly and monorail system. [Operate all rail switches.]

3.3.7 Rated Load Speed Test

With the hoist loaded to rated capacity, raise and lower the load verifying that the hoisting and lowering speeds are provided as specified. [With the hoist loaded to rated capacity, operate trolley along the monorail beam verifying that the trolley speed is provided as specified. Further, verify that the trolley stops in each direction within a distance (in feet) equal to 10 percent of rated capacity high speed (in feet per minute) when initially travelling at high speed and carrying the rated capacity load.] Record voltage, amperage, hoisting and lowering speeds, [trolley travel speed,] and motor speed for each motor.

-- End of Section --