Introduction, Service Manual

The information in this Service Manual covers models **FR18S/23S-2A** and **FR15DR-2A.**

Federal and State laws require that operators be completely trained in the safe operation of trucks in accordance with OSHA regulation 1910.178.

An Operator's Manual is sent with every **Komatsu** forklift truck when it is manufactured. If the Operator's Manual is missing from the truck, a new manual may be obtained by contacting:

Komatsu Forklift U.S.A., Inc.

14481 Lochridge Blvd., Bldg. 2

Covington, Georgia 300014

(770) 788-3612

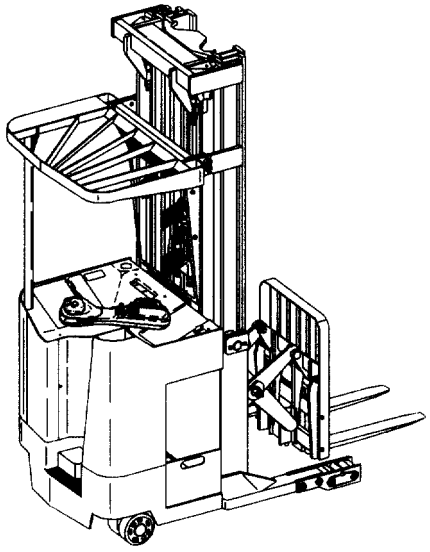
This Service Manual is not a training manual. The information contained in this service manual is intended as a guide to help trained, qualified, and authorized technicians safely service the truck.

The Service Manual is divided into four separate sections, which cover needed information for servicing the truck types. The main subject for each of the sections are as described below.

SECTION	SUBJECT
M	MACHINE INFORMATION
P	PLANNED MAINTENANCE
S	SERVICE INSTRUCTIONS
O	OPTIONS

Contents, Section M

1. Machine Information



General Product Information

1. Presentation of the Rider Trucks.

The **FR18S/23S-2A** are battery powered reach trucks. The **FR15DR-2A** is a battery powered deep reach truck.

These trucks are intended solely to be operated handling pallets or similar load carriers indoors. The trucks are equipped with a steering wheel with all the controls for operating within easy access.

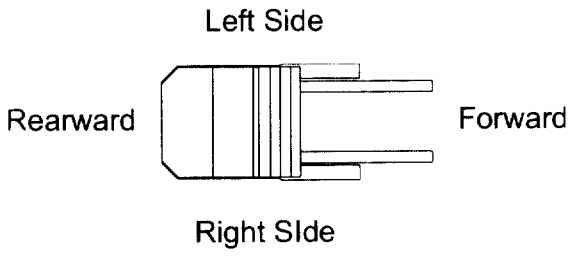
The trucks have various maximum lifting capacities (review data plate on the truck to note the maximum lifting capacity) and are equipped with a 24V or 36V electrical system. Speed of the truck is regulated by means of a transistor controller to provide infinite control of acceleration and speed while driving.

The forks and auxiliary functions are controlled by means of a transistor controller. Control of the lift and auxiliary functions are done electrically with the levers on the control pod. Control of the speed and positioning of the forks when stacking is done by the position of the levers.

The trucks can be fitted with different accessories including sideshifter, warning light, lights/fan package, travel alarm, and adjustable driving lights. The trucks can be specially equipped to work in cold conditions.

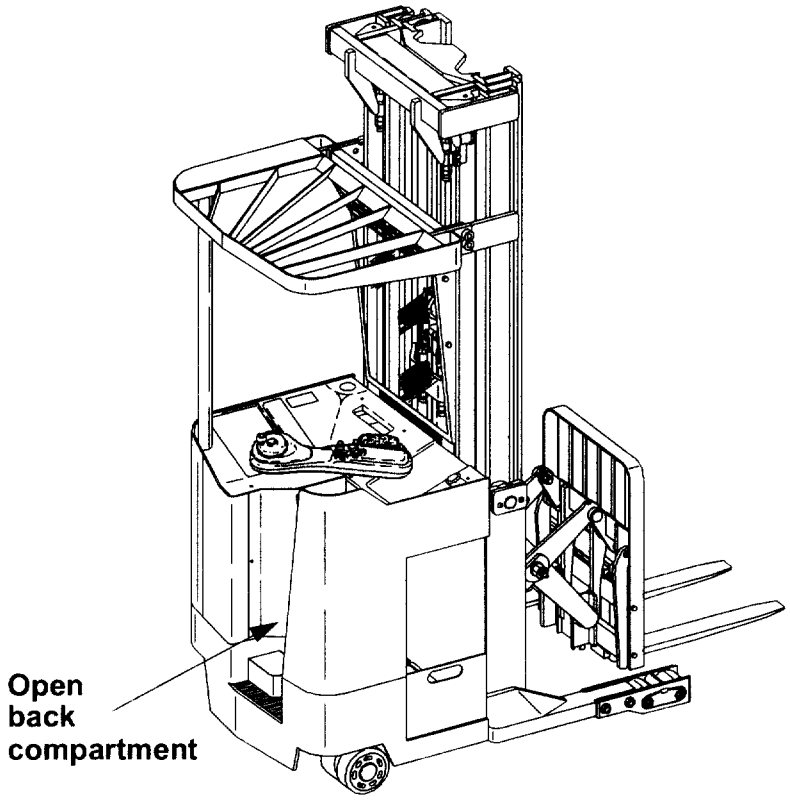
1.1. Truck Side Views

The terms rearward and forward used indicate the front and back side of the truck as viewed from the operator's line of sight for proper operation of truck. The terms right-hand and left-hand used indicate the right and left side of the truck as viewed from the operator's line of sight for proper operation of truck.



1.2. Open Back Compartment

The truck compartment has an open back design. The United States Department of Labor Occupational Safety and Health Administration (OSHA) has determined that when a stand up narrow aisle lift truck tips over the operator should be trained to step off the truck. The open back design allows the operator to make the quickest exit from the truck should the truck begin to tip over or fall from an elevated height such as a loading dock or ramp. The ease of entering and exiting the open back design also minimizes operator fatigue.



1.3. Intended Truck Application

The trucks are solely designed and manufactured to handle goods. The trucks should be fitted with the appropriate accessories relevant to the application.

1.4. Prohibited Truck Application

The trucks are designed for handling goods indoors. It is not permitted to use the trucks for other purposes including the following:

- As a towing tractor for trailers.
- To tow other trucks.
- To transport/lift passengers.
- To drive on gravel or grass.

1.5. Truck Data

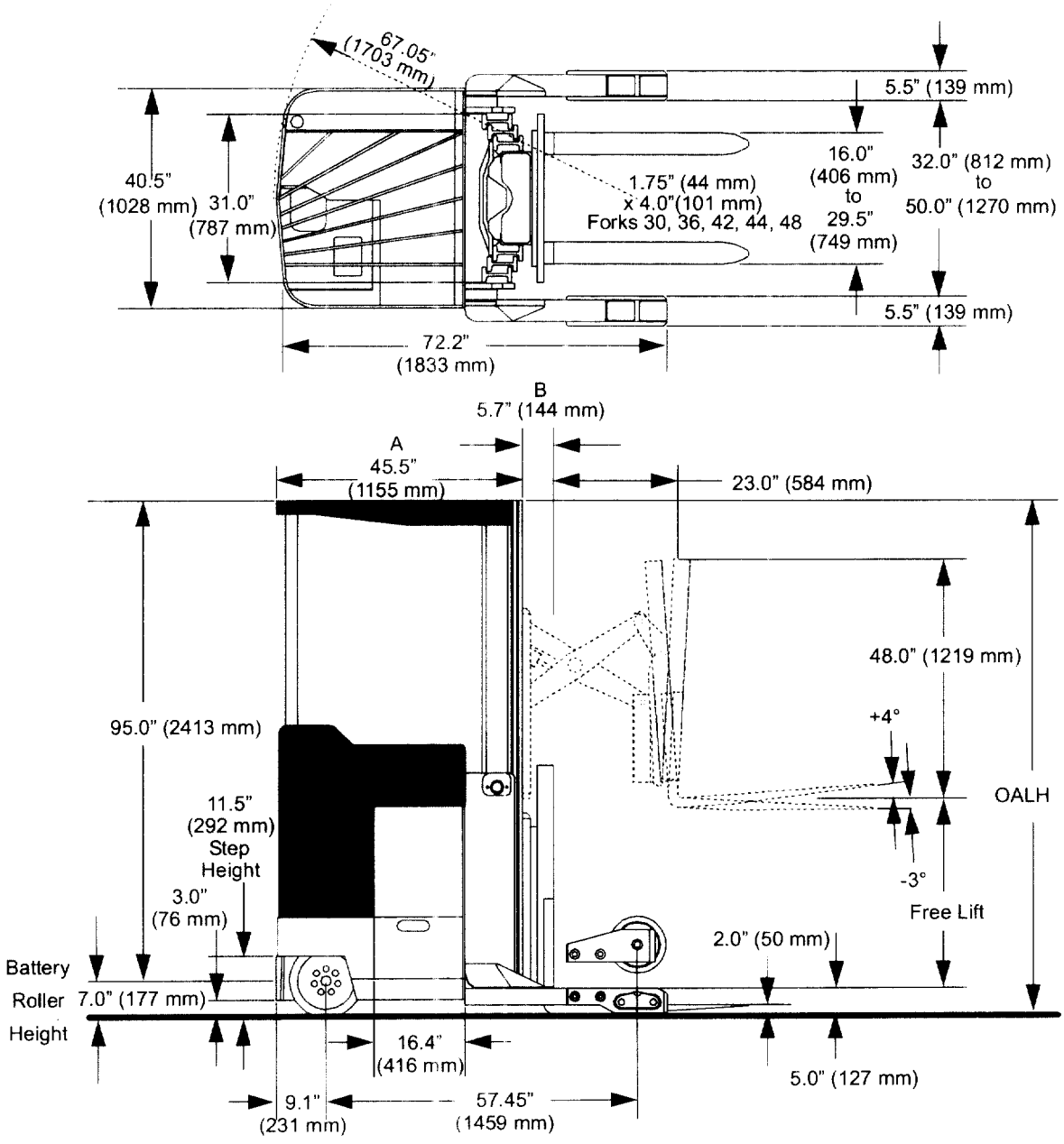
The following table provides information regarding some technical data which is of value with daily use of the trucks.

Truck data	FR18S-2A	FR23S-2A	FR15DR-2A		
Lifting capacity rated load lb (kg)	3500 (1587)	4500 (2041)	3000 (1360)		
Lift height, inches (mm)	192-270 (4876-6858)	210-402 (5334-10210)	210-402 (5334-10210)		
Operating speed without load, mph	**24 Volt** 6.0 mph **36 Volt** 6.5 mph	**36 Volt** 6.5 mph	**36 Volt** 6.5 mph		
Operating speed with load, mph	**24 Volt** 5.5 mph **36 Volt** 6.0 mph	**36 Volt** 6.0 mph	**36 Volt** 6.0 mph		
Service weight without battery, lb (kg)	**240 Mast** 5595 (2537)	**210 Mast** 5915 (2682)	**330 Mast** 6945 (3150)		
Service weight including battery, lb (kg)	Above + battery weight	Above + battery weight	Above + battery weight (2600 min)		

The lifting capacity, lifting height, and weight of the truck can be found on the truck data plate.

1.6. FR18S-2A Dimensions

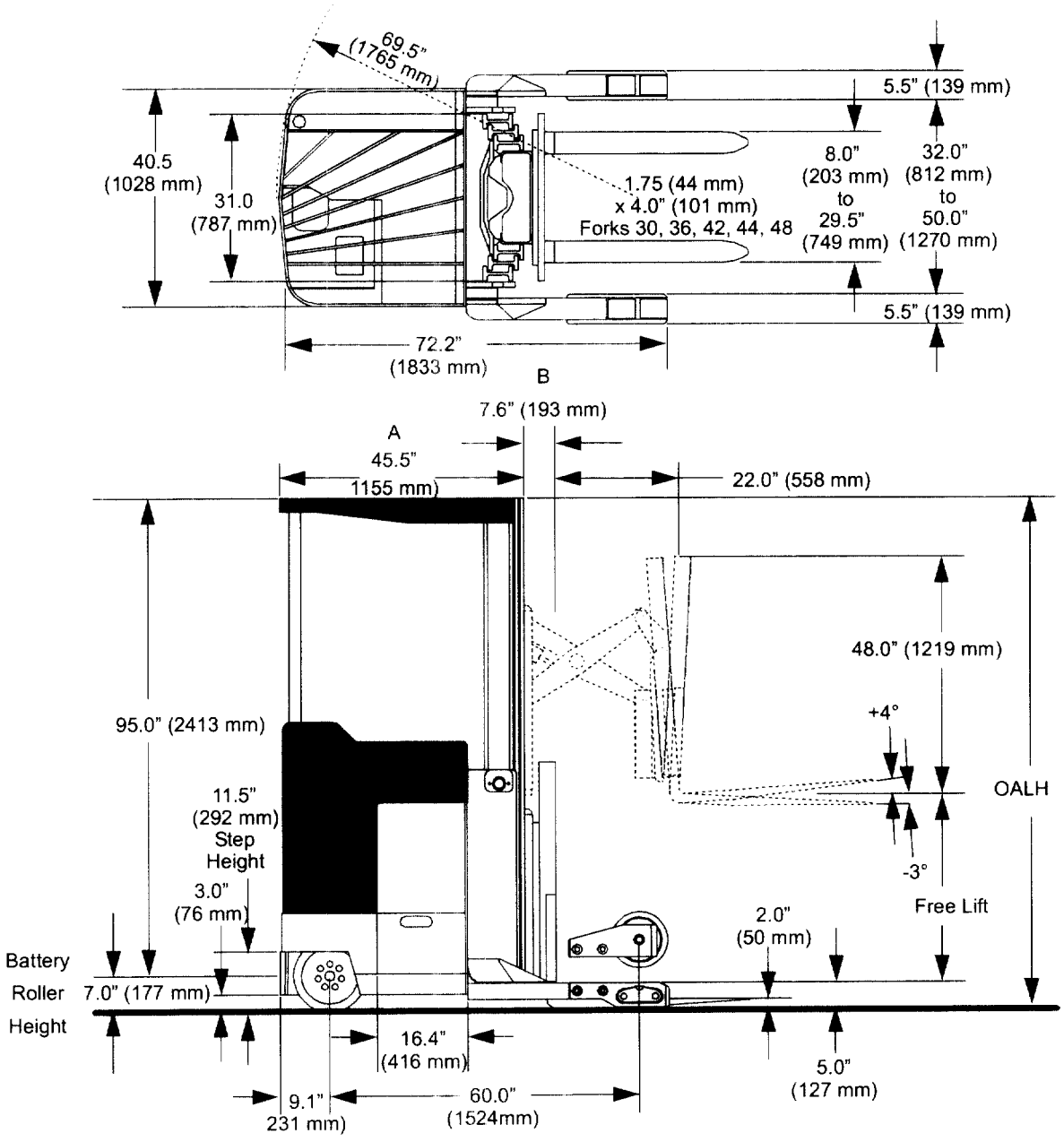
The following diagram shows external dimensions for the FR18S-2A truck in its standard design.



10% Gradient Performance-Loaded

1.7. FR23S-2A Dimensions

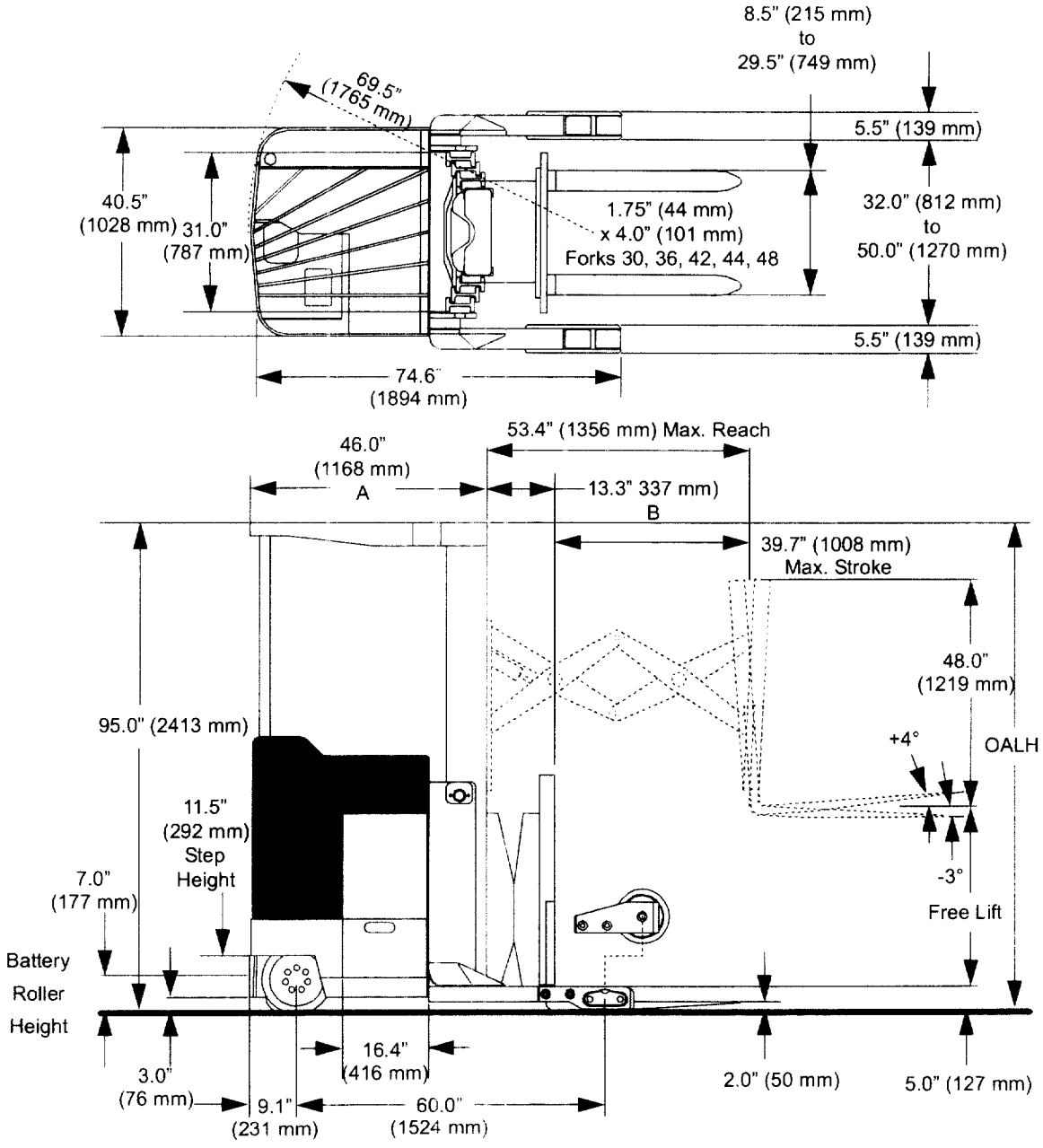
The following diagram shows external dimensions for the FR23S-2A truck in its standard design.



10% Gradient Performance-Loaded

1.8. FR15DR-2A Dimensions

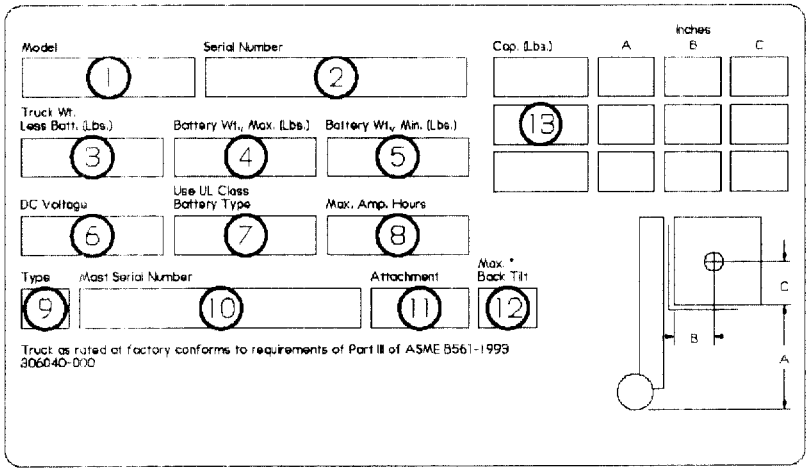
The following diagram shows external dimensions for the FR15DR-2A truck in its standard design.



10% Gradient Performance-Loaded

1.11. Data Plate

The illustration below shows the data plate used on the truck.



Legend

1 Truck model number
2 Truck serial number
3 Weight less battery
4 Maximum battery weight
5 Minimum battery weight
6 Truck voltage DC
7 Battery type UL class
8 Battery maximum AMP hours
9 Truck type
10 Mast serial number
11 Attachment
12 Maximum degree rear tilt
13 Truck capacity

2. Main Components

1 Hydraulic valve:
The valves are located to provide easy access.

2 Battery:
24/36V with different capacities and weights.

3 Battery connector:
The truck is connected to the battery through the battery connector. When charging the battery, do not connect the battery charger to the battery connector at the truck chassis.

4 Hydraulic unit:
Pump motor and hydraulic pump are an integrated unit.

5 Drive unit with brake:
Drive motor, gears, drive wheel and electrical brake combined in the drive unit.

6 Electrical steering:
A servo steer motor drives a gear ring, enabling the drive unit to be rotated through 360 degrees in either direction.

7 Data plate:
See “Data Plate” on page 41.

8 Cover:
Removable to provide access for servicing.

9 Pedal:
Brake pedal.

10 Control console:
The control console can be adjusted to a suitable height and angle to obtain a comfortable working position. The steering, hydraulic functions, horn, parking brake, preset height, travel direction, key switch, and any extra hydraulic functions are all controlled from this console. The position of the console may be set in 1 of 3 positions; forward facing, 45 degrees, or side stance.

11 Instrument panel:
This provides information on the truck’s running hours, time display, error codes, travel direction, parking brake, steering angle and battery status.

12 Mast:
The mast is a clear view model.

13 Electronics:
The electronics are in a protected compartment.

14 Control circuit fuse: (for fuse size and part number see page 59)

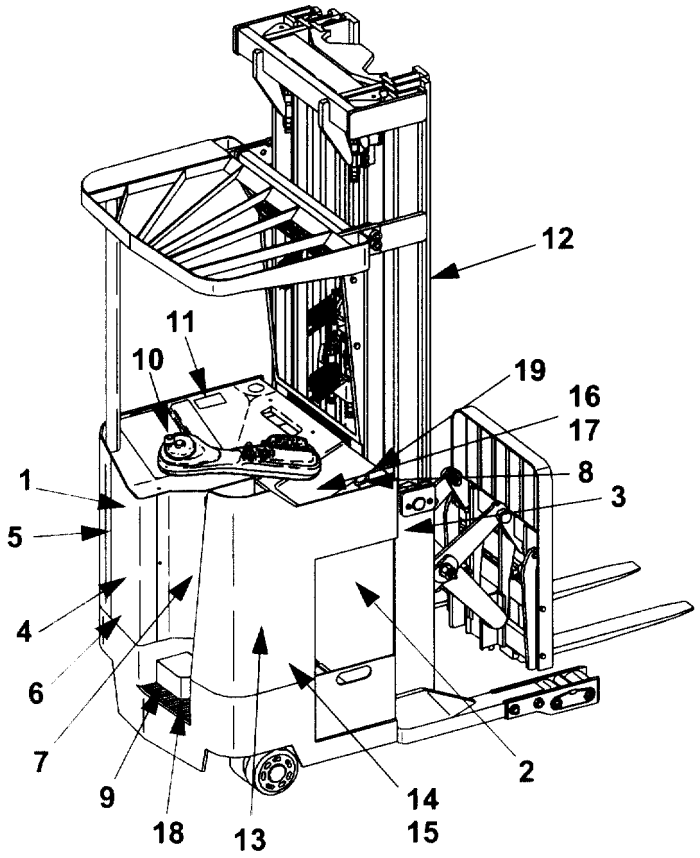
15 Steering circuit fuse: (for fuse size and part number see page 59)

16 Drive motor fuse: (for fuse size and part number see page 59)

17 Pump motor fuse: (for fuse size and part number see page 59)

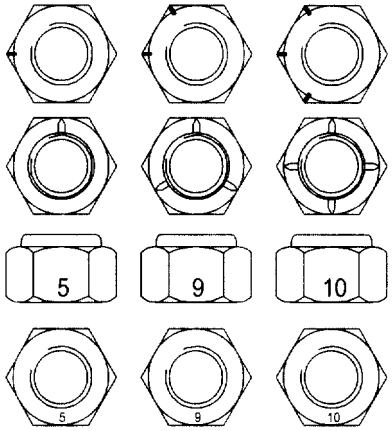
18 Right foot pedal
An operator must keep all of his or her body in the operator's compartment at all times. The area of the operator's compartment in the truck is designed so that an operator can do so. A red triangle (reminder light) will be displayed on the instrument panel if the right foot pedal is not depressed. This feature reinforces that the operator must take advantage of the area of the operator's compartment and keep all of his or her body in the compartment.

19 Emergency stop
The emergency stop switch will stop all control and power functions.



Main Components of Truck

Inch (SAE) and Metric Fasteners



1. Introduction

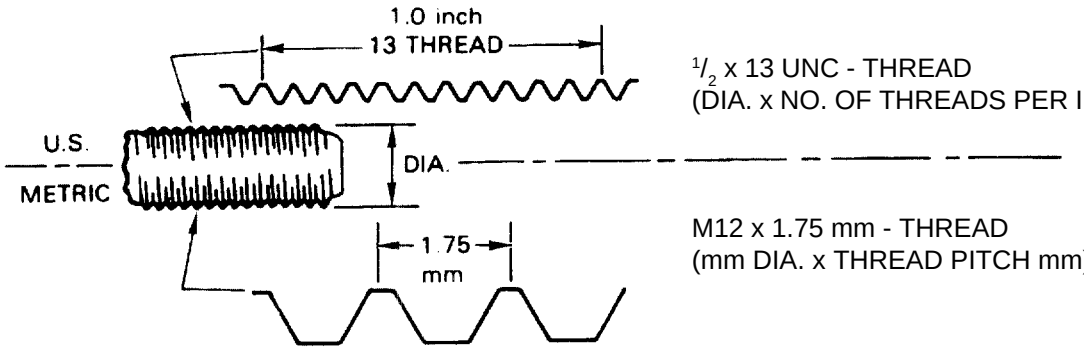
Threaded fasteners such as bolts, nuts, cap screws, and studs are made to specifications that describe the mechanical strength and hardness of the fastener. A fastener used in a design application is selected in accordance with its specifications. Parts used on this truck are purchased from many countries. Many of these fasteners are similar but cannot be used as direct replacements.

Service persons must use replacement fasteners that have the same specifications. Fasteners made to each specification have identification marks for that specification. This specification is commonly called “grade” for SAE standards and “property” for metric standards. This section describes the identification of some common fasteners.

The metric system used is described as Sl (International System of Units, also called SI in all languages). The SI system of measurement is described in ISO Standard 1000, 1973.

2. Nomenclature, Threads

The thread design is specified by a series of numbers and letters for inch and metric fasteners (see figure below). The diameter of the shank of the fastener is shown first in the series, e.g. M12=12 mm, M20=20 mm (1/2=1/2 inch, 3/4=3/4 inch).



The number of threads per inch is normally not shown for inch nomenclature and only the UNC (Unified National Coarse) or UNF (Unified National Fine) is shown. This number of threads per inch is not shown because a UNC or UNF fastener has a standard number of threads per inch for a specific diameter.

The length of a shank is often indicated as part of the description of a fastener. This length is shown in inches for inch fasteners and in millimeters for metric fasteners.

A cap screw will have the following description:

Inch	Metric
1/2 x 13 UNC x 1-1/2 A B C D	M12 x 1.75 x 50 A B C
A = Shank diameter B = Number of threads per unit of length C = Type of thread D = Shank length	A = Thread size B = Pitch C = Length

3. Strength Identification

The most common property classes for metric fasteners are 8.8 and 10.9. The property class is marked with a number on the head of the cap screw or on a nut. Property classes less then 8,8 are often not marked. Grades for inch bolts go from 2 to 8. Grade 2 fasteners normally do not have marks. The following tables show the marks that identify the grades and property classes for different fasteners.

⚠ **WARNING**	When fasteners must be replaced the new fasteners must be of the same strength or greater than the original fasteners. The new fasteners must also be the correct size.

NOTE!	Identification marks are according to bolt strength. The higher the number, or the increase in the number of marks, indicates increased bolt strength.

Table 1. Bolt and Screw Designations

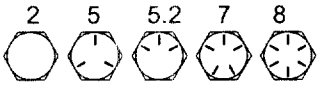
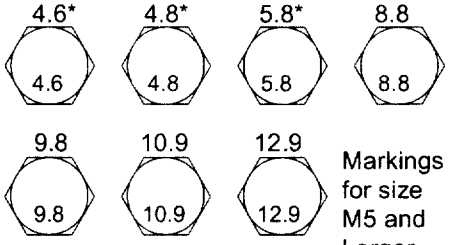
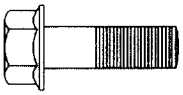
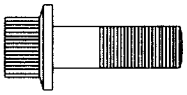
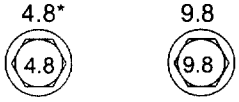
Types of Fasteners	**Inch Fasteners** Strength Levels: SAE Grades	**Metric Fasteners** Strength Levels: Property Classes * Markings Not Required
 Hex Head Bolts & Cap Screws		 Markings for size M5 and Larger
 Hex Head Flange Screws		Same As Above
 12 Point Flange Screws		
 Hex Socket Head Cap Screws	Markings Not Required	
 SEMS		

Table 2. Stud and Nut Designations

Types of Fasteners	**Inch Fasteners** Strength Levels: SAE Grades * Markings Not Required	**Metric Fasteners** Strength Levels: Property Classes * Markings Not Required
Studs	5* 5.2* 8* 8.1	4.6* 4.8* 5.8* 8.8 (4.6 4.8 5.8 8.8) 9.8 10.9 12.9 (9.8 10.9 12.9) Markings for size M5 and Larger or Optional Geometric Symbols for Size M5 through M11 ONLY.
Hex Nuts	2 5 8 or	5 8 9 (5 8 9) or 10 12 (10 12)
Hex Slotted Nuts	Markings Not Required	5 8 9 10 12
Hex Flange Nuts	Markings Not Required	5 8 9 10 12

Table 3. Torque Nut Designations

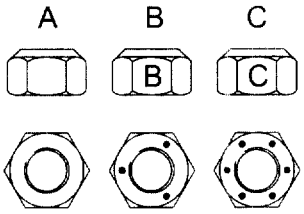
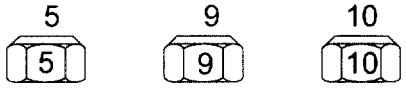
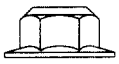
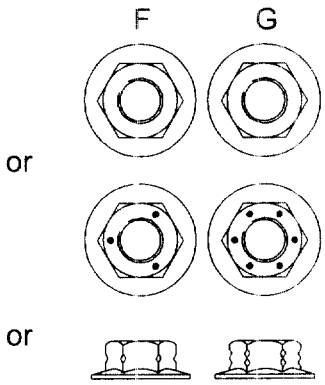
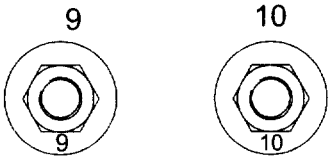
Types of Fasteners	**Inch Fasteners** Strength Levels: SAE Grades	**Metric Fasteners** Strength Levels: Property Classes
 All Metal Prevailing Torque Nuts		
 All Metal Prevailing Torque Flange Nuts		

Table 4. Torque Nut with Nylon Insert Designations

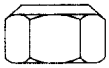
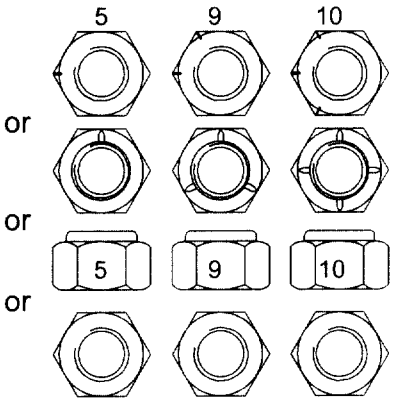
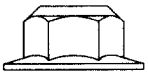
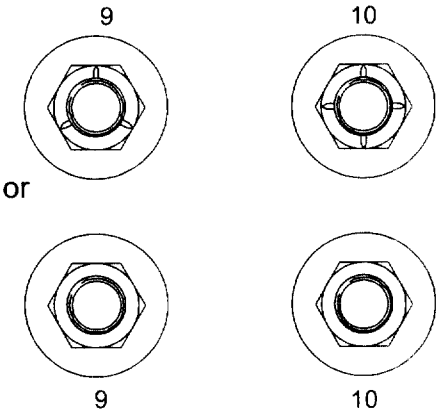
Types of Fasteners	**Inch Fasteners** Strength Levels: SAE Grades	**Metric Fasteners** Strength Levels: Property Classes
 Nylon Insert Prevailing Torque Nuts	Markings Not Required	
 Nylon Insert Prevailing Torque Flange Nuts	Markings Not Required	

Table 5. Fastener Torque Values

Size and Pitch	Property, Class 8.8*		Property, Class 10.9**		Property, Class 12.9***	
	N•m	in-lb	N•m	in-lb	N•m	in-lb
M5 x 0.8	5-6	44-53	7-8	62-71	8-10	71-88
M6 x 1	8-10	71-88	12-14	106-124	14-16	124-142
M8 x 1.25	20-25	177-221	30-35	----------	----------	----------
	N•m	ft-lb	N•m	ft-lb	N•m	ft-lb
M8 x 1.25	----------	----------	----------	22-26	34-40	26-30
M10 x 1.5	40-45	30-33	60-65	44-48	70-75	52-55
M12 x 1.75	70-80	30-33	100-110	74-81	115-130	85-96
M14 x 2	110-125	52-59	155-180	114-133	180-210	133-155
M16 x 2	170-190	125-140	240-270	177-199	280-320	207-236
M20 x 2.5	340-380	251-280	450-500	332-369	550-600	406-443
M24 x 3	580-650	428-479	800-900	590-664	900-1050	664-774
M30 x 3.5	1150-1300	848-959	1600-1800	1180-1328	1850-2100	1364-1549
M36 x 4	2000-2250	1479-1660	2800-3150	2065-2323	3250-3700	2397-2729

* Property class 8.8, Protective Treatment CMHC Specification “H” (zinc phosphate), applies also to internally threaded fasteners made of property class 8 material.

** Property class 10.9, Protective Treatment CMHC Specification “H” (zinc phosphate), applies also to internally threaded fasteners made of property class 10 material.

*** Property class 12.9, Protective Treatment CMHC Specification “H” (zinc phosphate), applies also to internally threaded fasteners of property class 12 material.

Truck Torque Specifications	
Description	**Torque Specification**
Steering motor gear mounting bolt	88 in-lb (10 N•m)
Motor terminals	140 in-lb (15.82 N•m)
Motor pole piece screws	250-300 in-lb (28-33 N•m)
Pump motor mounting bolts	14-18 ft-lb (19-24 N•m)
Pump motor electrical power cable nuts	100-120 in-lb (11.3-13.6 N•m)
Drive motor mounting bolts	20-25 ft-lb (30-35 N•m)
Transmission mounting bolts	50-59 ft-lb (68-80 N•m)
Drive wheel nuts	65 ft-lb (88 N•m)
Overhead guard mounting bolts	200 ft-lb (271 N•m)
Drive axle retaining bolts	81 ft-lb (109 N•m)
Steering gear ring bolts	50-59 ft-lb (68-80 N•m)
Steer motor shaft	Loctite® 243®
Drive tire lug nut	95 ft-lb (129 N•m)
Transmission axle bearing preload	9-14 in-lb (1.01-1.58 N•m)
Transmission bevel gear nut	90 ft-lb (122 N•m)
Transmission pinion nut	110-120 ft-lb (149-162 N•m)
Transmission pinion bearing preload	5-8 in-lb (0.56-0.90 N•m)
Transmission cover bolts	18 ft-lb (24 N•m)
Transmission case	Loctite® 515®
Hydraulic collar mounting bolts	44.4 in-lb (5.01 N•m)
Tilt cylinder piston nut (FR23S-2A, FR15DR-2A)	60-65 ft-lb (81-88 N•m)
Lift chain adjusting nuts and locknuts	200 ft-lb (271 N•m)
Control valve assembly hose fastener nut Control valve double solenoid screw and mounting screw Control valve plug Control valve block screw Control valve spring ball screw	480 ± 25 in lb (54 N•m) 14.75 ft-lb (20 N•m) 11.06 ft-lb (15 N•m) 5.9 ft-lb (8 N•m) 8.85 ft-lb (12 N•m)

Truck Torque Specifications	
Description	**Torque Specification**
Lower mast mounting bolts	400 ft-lb (543 N•m)
Overhead guard post base bolts	25 ft-lb (34 N•m)
Reach cylinder piston locknut (FR18S/23S-2A, FR15DR-2A)	47.94 ft-lb (65 N•m)
Mast mounting plate bolts	85 ft-lb (115 N•m)
Sideshifter lower hook bolts Sideshifter lower hook set screw (FR18S-2A S/N 27091-000-28075000; FR23S-2A S/N 2709 1000-28266000; FR15DR-2A S/N 27091000-28266000)	55 ft-lb (74 N•m) 42 ft-lb (57 N•m)
Sideshifter lower hook bolts Sideshifter lower hook set screw Sideshifter safety screw Sideshifter cylinder hydraulic fittings (FR18S-2A S/N 28075001 - UP; FR23S-2A S/N 28266001 - UP; FR15DR-2A S/N 28266001 - UP)	65 ft-lb (88 N•m) 21 ft-lb (28 N•m) 70 ft-lb (95 N•m) 56 ft-lb (76 N•m)
Reach outer arm jam nut (FR18S-2A)	34.36 ft-lb (47 N•m) Loctite® 243®
Reach outer arm jam nut (FR18S/23S-2A, FR15DR-2A)	Loctite® 243®

4. Conversion of Metric and English Units

AREA					
Multiply	**By**	**To Get**	**Multiply**	**By**	**To Get**
inches²	6.451	centimeters² (cm²)	centimeters²	0.155	inches² (in²)
feet²	0.093	meters² (m²)	meters²	10.764	feet² (ft²)

LINEAR					
Multiply	**By**	**To Get**	**Multiply**	**By**	**To Get**
inches	25.4	millimeters(mm)	millimeter	0.039	inches (in)
feet	0.305	meters (m)	meter	3.280	feet (ft)
yards	0.914	meters (m)	meter	1.094	yards (yd)
miles	1.609	kilometers (km)	kilometer	0.621	miles (mi)

MASS					
Multiply	**By**	**To Get**	**Multiply**	**By**	**To Get**
ounces (oz)	28.49	grams (g)	grams	0.035	ounces (oz)
pounds (lb)	0.454	kilograms (kg)	kilograms	2.205	pounds (lb)
tons (2000 lb)	907.18	kilograms (kg)	kilograms	0.001	tons (2000 lb)
tons (2000 lb)	0.907	metric ton (t)	metric ton	1.102	tons (2000 lb)

POWER					
Multiply	**By**	**To Get**	**Multiply**	**By**	**To Get**
horsepower	0.746	kilowatts (kW)	kilowatts	1.34	horse-power(hp)

PRESSURE					
Multiply	**By**	**To Get**	**Multiply**	**By**	**To Get**
pounds/in²	6.895	kilopascal (kPa)	kilopascals	0.145	pounds/in² (psi)
pounds/in²	0.007	megapascal (MPa)	megapascals	145.04	pounds/in² (psi)

TEMPERATURE					
Multiply	**By**	**To Get**	**Multiply**	**By**	**To Get**
(Fahrenheit -32)	0.56	Celsius (C)	(Celsius x 1.8)	+32	Fahrenheit (F)
TORQUE					
Multiply	**By**	**To Get**	**Multiply**	**By**	**To Get**
inch pound	0.113	Newton meter (N•m)	Newton meter	8.851	inch pounds in-lb
feet pound	1.356	Newton meter (N•m)	Newton meter	0.738	foot pounds ft-lb
VELOCITY					
Multiply	**By**	**To Get**	**Multiply**	**By**	**To Get**
miles/hour	1.609	kilometer/hour (km/h)	kilometer/ hour	0.621	miles/hour (mph)
VOLUME					
Multiply	**By**	**To Get**	**Multiply**	**By**	**To Get**
inches^3	16.387	centimeters^3 (cm^3)	centimeters^3	0.061	inches^3 (in^3)
inches^3	0.016	liters	liters	61.024	inches^3 (in^3)
quarts, U.S.	0.946	liters	liters	1.057	quarts, U.S. (qt)
quarts, U.S.	0.83	quarts, Imp. (qt)	quarts, Imp.	1.205	quarts, U.S. (qt)
gallons, U.S.	3.785	liters	liters	0.264	gallons, U.S. (gal)
gallons, U.S.	0.83	gallons, Imp. (gal)	gallons, Imp.	1.205	gallons, U.S. (gal)
ounces	29.57	milliliters (ml)	milliliters	0.034	ounces (oz)