SAE International

SURFACE VEHICLE STANDARD

SAE J743 DEC2011

Issued 1951-10
Cancelled 2011-12

Superseding J743 MAR1992

Lift Capacity Calculation and Test Procedure Pipelayer and Sideboom

RATIONALE

Superseded by ISO 8813.

Foreword—This Document has not changed other than to put it into the new SAE Technical Standards Board Format.

1. Scope—This SAE Standard describes a method to calculate and a test procedure to validate rated lift capacity as presented in commercial literature for pipelayers and tractors or loaders (wheel or crawler), equipped with a hydraulic or mechanically operated sideboom. Rated lift capacity considers hoist mechanism limits, tipping loads, and rope factor. After the lift capacity is validated by testing, a reduction factor is applied to establish the rated lift capacity for the specific pipelayer or sideboom configuration.

1.1 Purpose—The purpose of this SAE document is to provide a uniform method to establish the rated lift capacity of a specific pipelayer or sideboom configuration.

1.2 Field of Application—This SAE document applies to pipelayers and sidebooms having a rated lift capacity greater than 1000 Kg when used in lifting applications. It includes pipelayers and sidebooms as defined in SAE J1295 and tractors and loaders as defined in SAE J1057.

2. References

2.1 Applicable Publications—The following publications form a part of this specification to the extent specified herein.

2.1.1 SAE PUBLICATIONS—Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

SAE J959 MAY91—Lifting Crane, Wire Rope Strength Factors, Appendix A only.
SAE J1057 SEP88—Identification Terminology of Earthmoving Machines
SAE J1295 JUN89—Identification Terminology and Specification Definitions—Pipelayers and Sidebooms, Tractor or Loader mounted.

2.1.2 ISO PUBLICATION—Available from ANSI, 11 West 42nd Street, New York, NY 10036-8002.

ISO DIS8813—Earthmoving Machinery—Lift capacity of pipelayers and wheel tractors or loaders equipped with sideboom (Technically equivalent)

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3. *Definitions*

3.1 **Load—**The external weight including the weight of the attaching equipment in kilograms applied at the load hook. See Figures 1 and 2.

3.2 **Lift Point Line—**Vertical line through the center of the load hook.

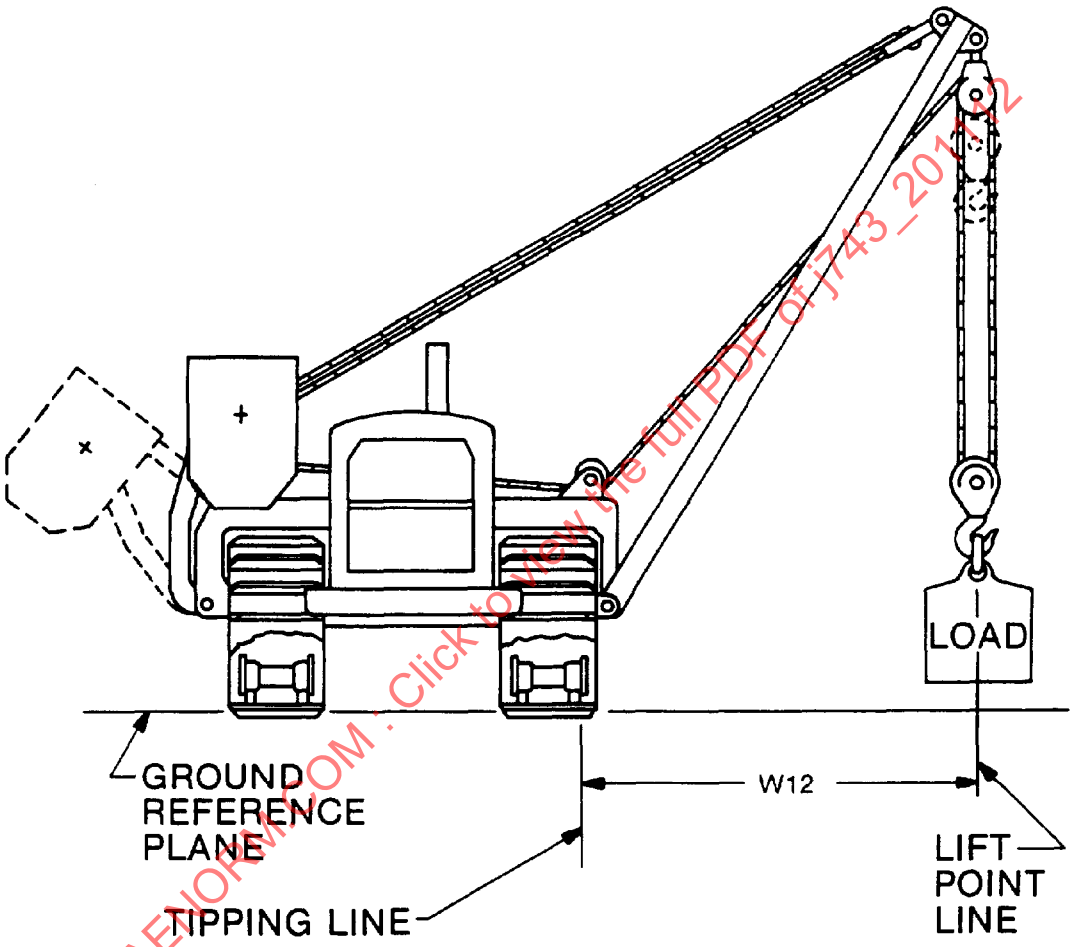

FIGURE 1—PIPELAYER

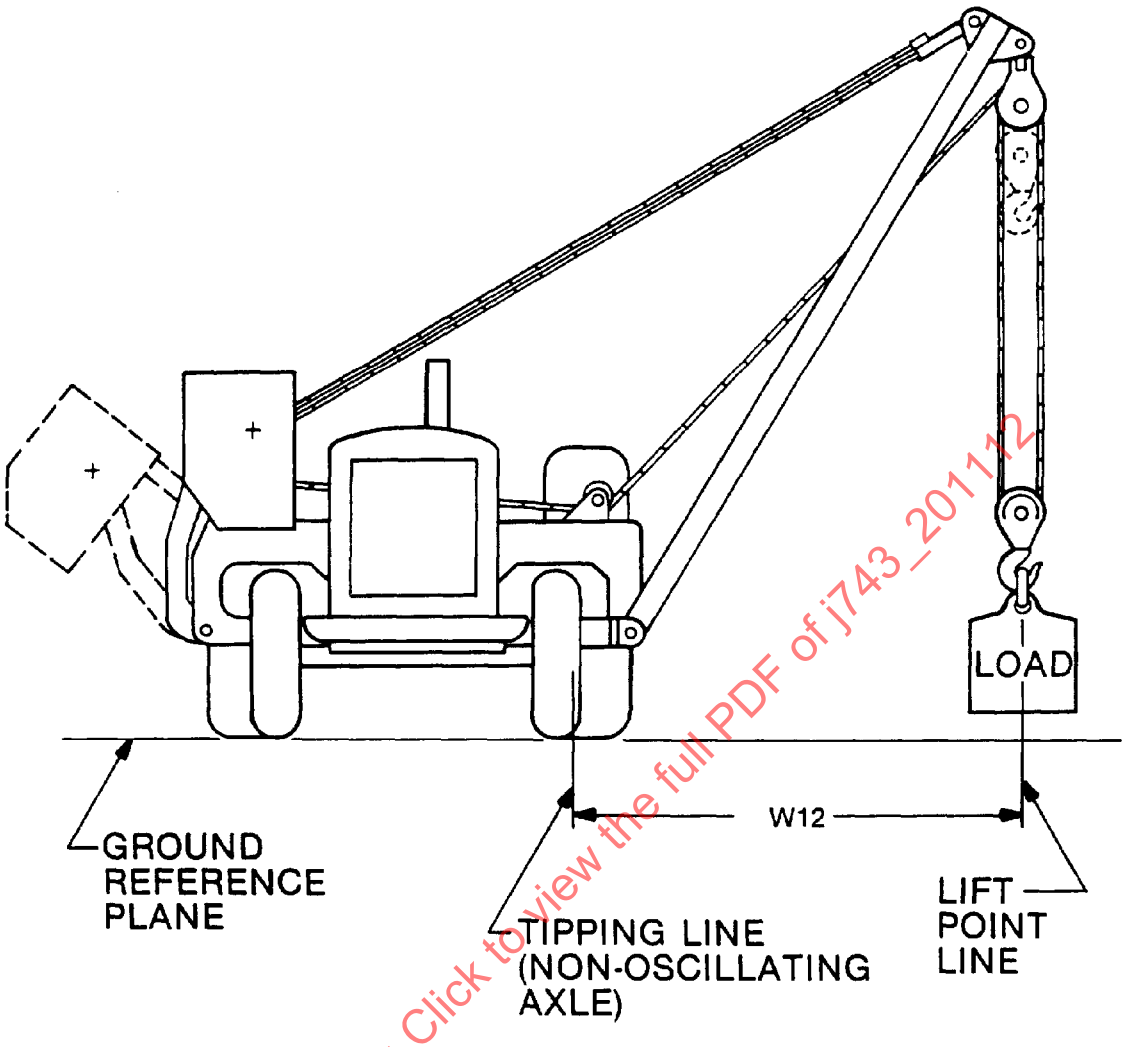

FIGURE 2—WHEEL MACHINE STEERED STRAIGHT

3.3 Outriggers—Extendable or fixed arms attached to the base machine which rest on the supporting surface to define the balance point fulcrum. See Figures 3 and 4.

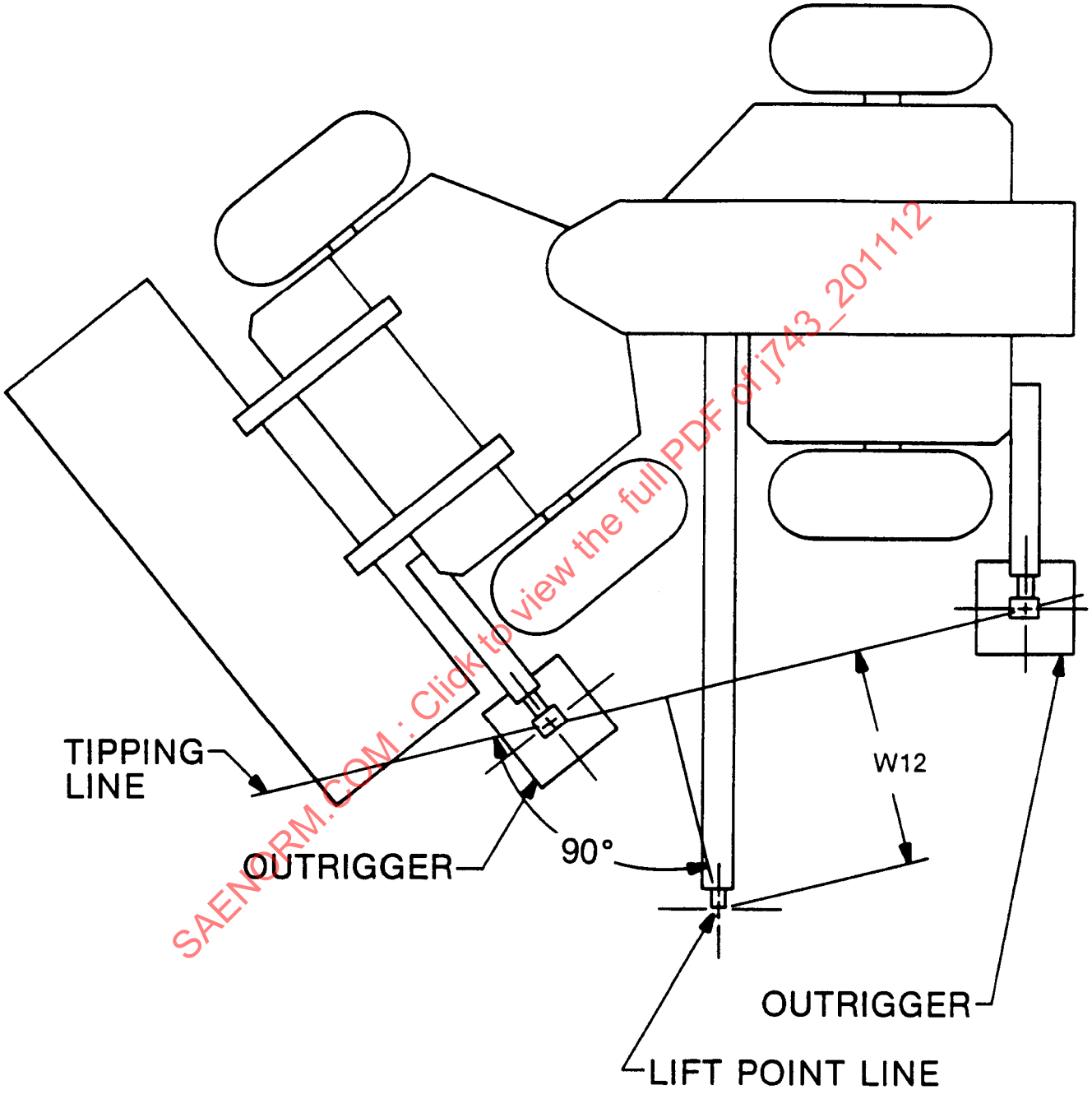

FIGURE 3—ARTICULATED MACHINE USING OUTRIGGERS STEERED LEFT

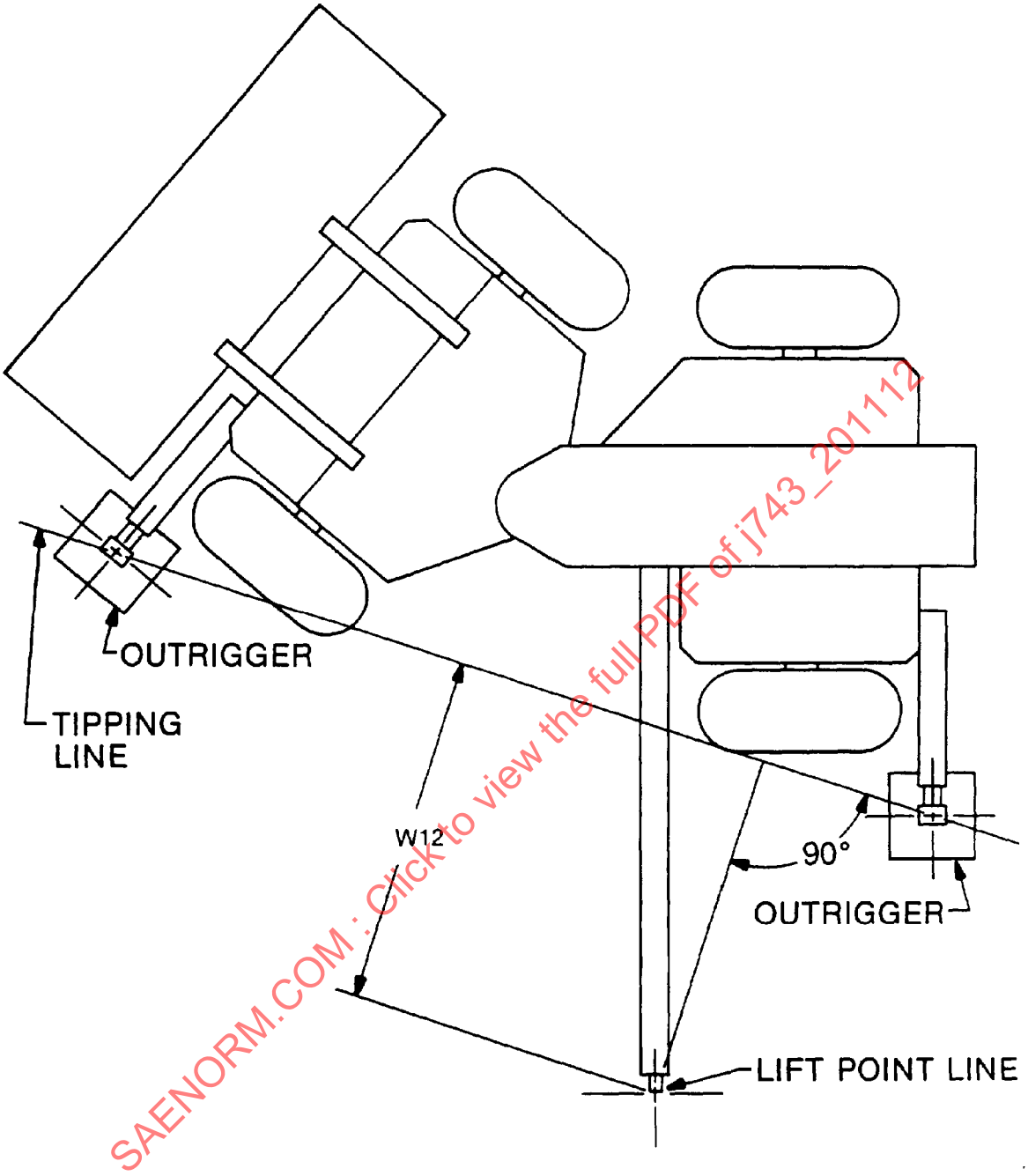

FIGURE 4—ARTICULATED MACHINE USING OUTRIGGERS STEERED RIGHT

3.4 Tipping Line

3.4.1 CRAWLER MACHINES—The outer edge of the track link rail on the boom side of the machine. See Figure 1.

3.4.2 WHEEL MACHINE WITH NON-OSCILLATING AXLE—A line connecting the centers of contact of the front and rear tires with the ground reference plane on the boom side of the machine. See Figures 2, 5, and 6.

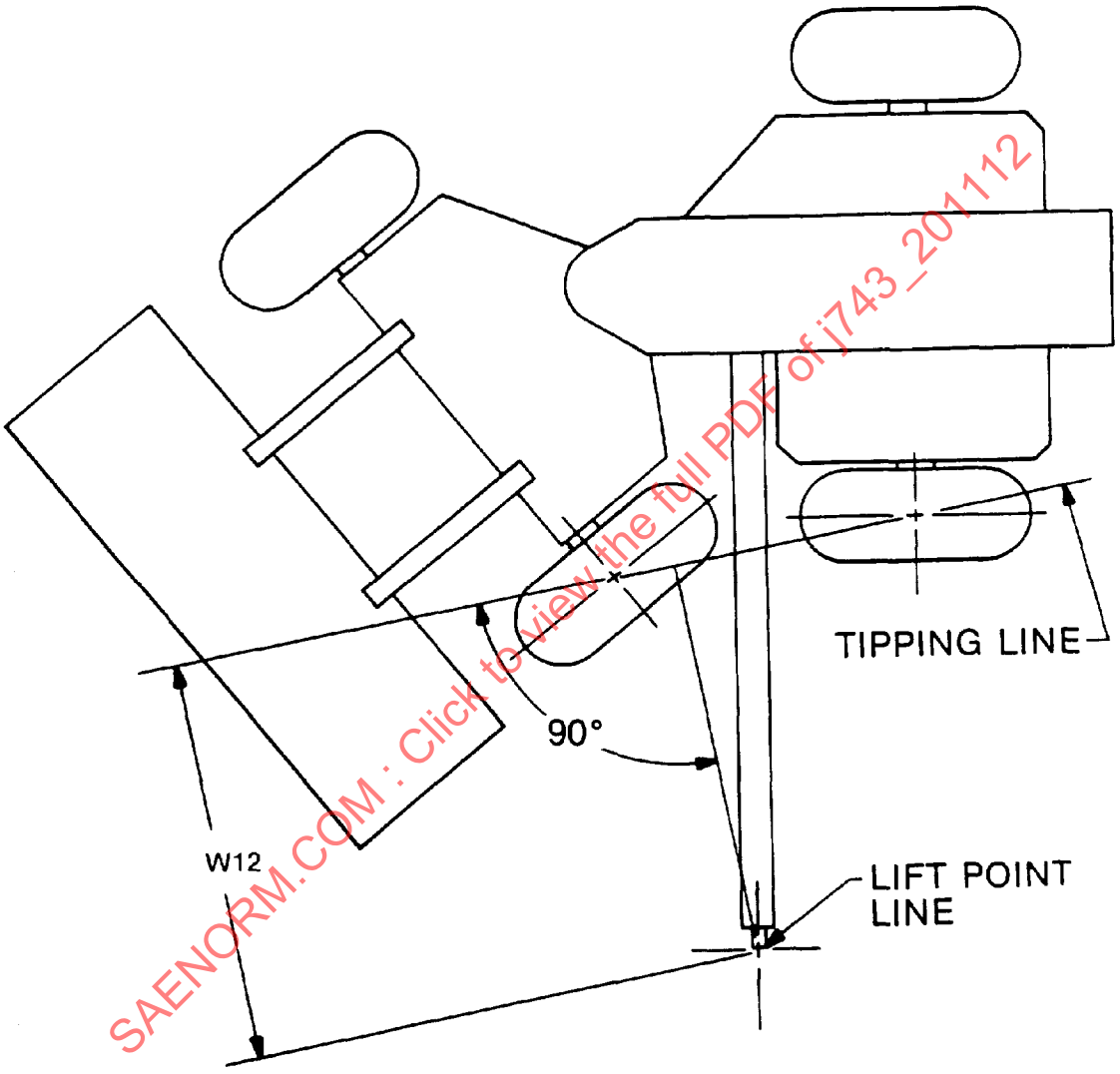

FIGURE 5—ARTICULATED WHEEL TRACTOR STEERED LEFT NON-OSCILLATING AXLE

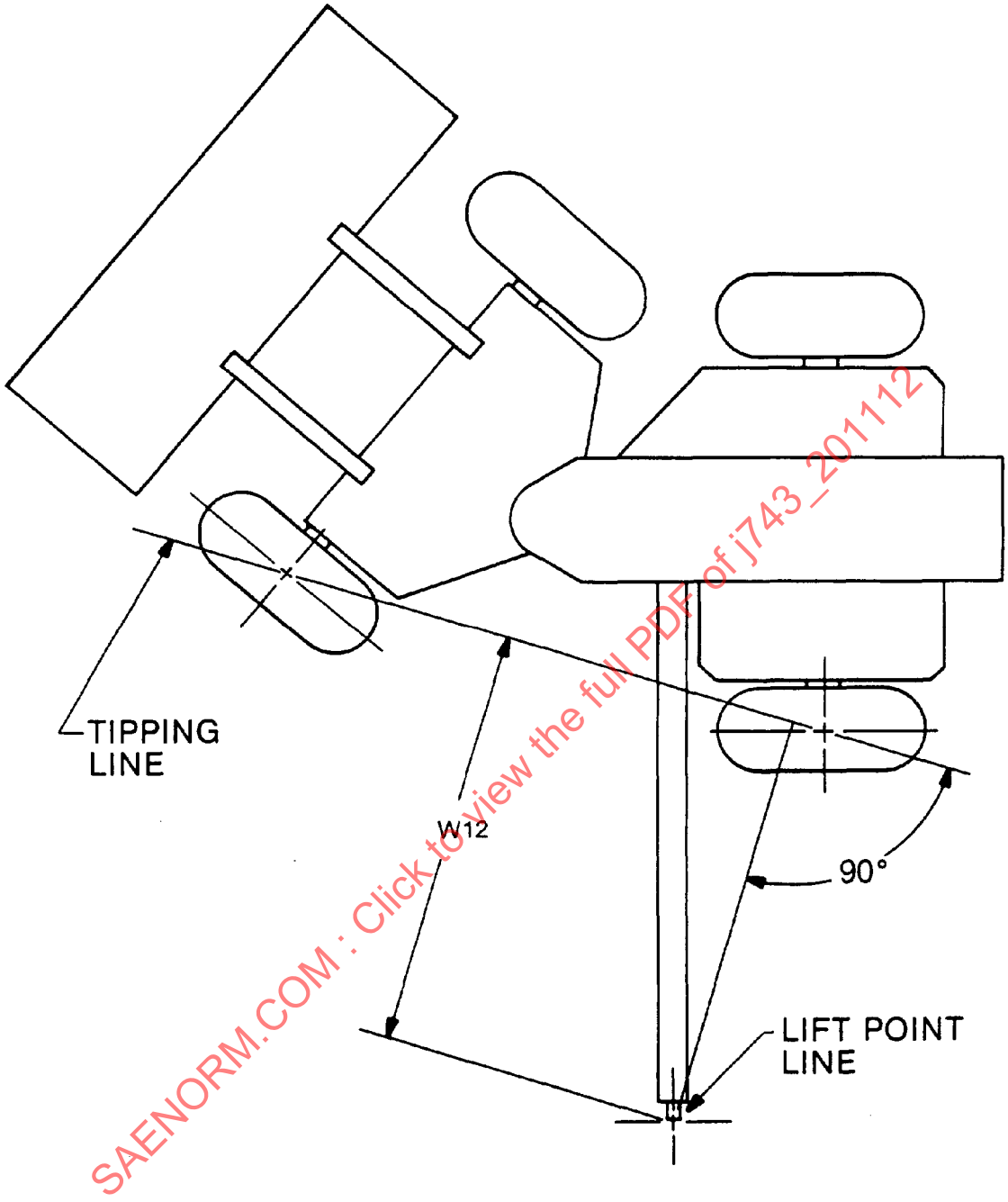

FIGURE 6—ARTICULATED WHEEL MACHINE STEERED RIGHT NON-OSCILLATING AXLE

3.4.3 WHEEL MACHINES WITH OSCILLATING AXLE—A line connecting the center of contact of the tire on the rigid axle with the ground reference plane on the boom side of the machine and the center of oscillation of the oscillating axle. See Figures 7 and 8.

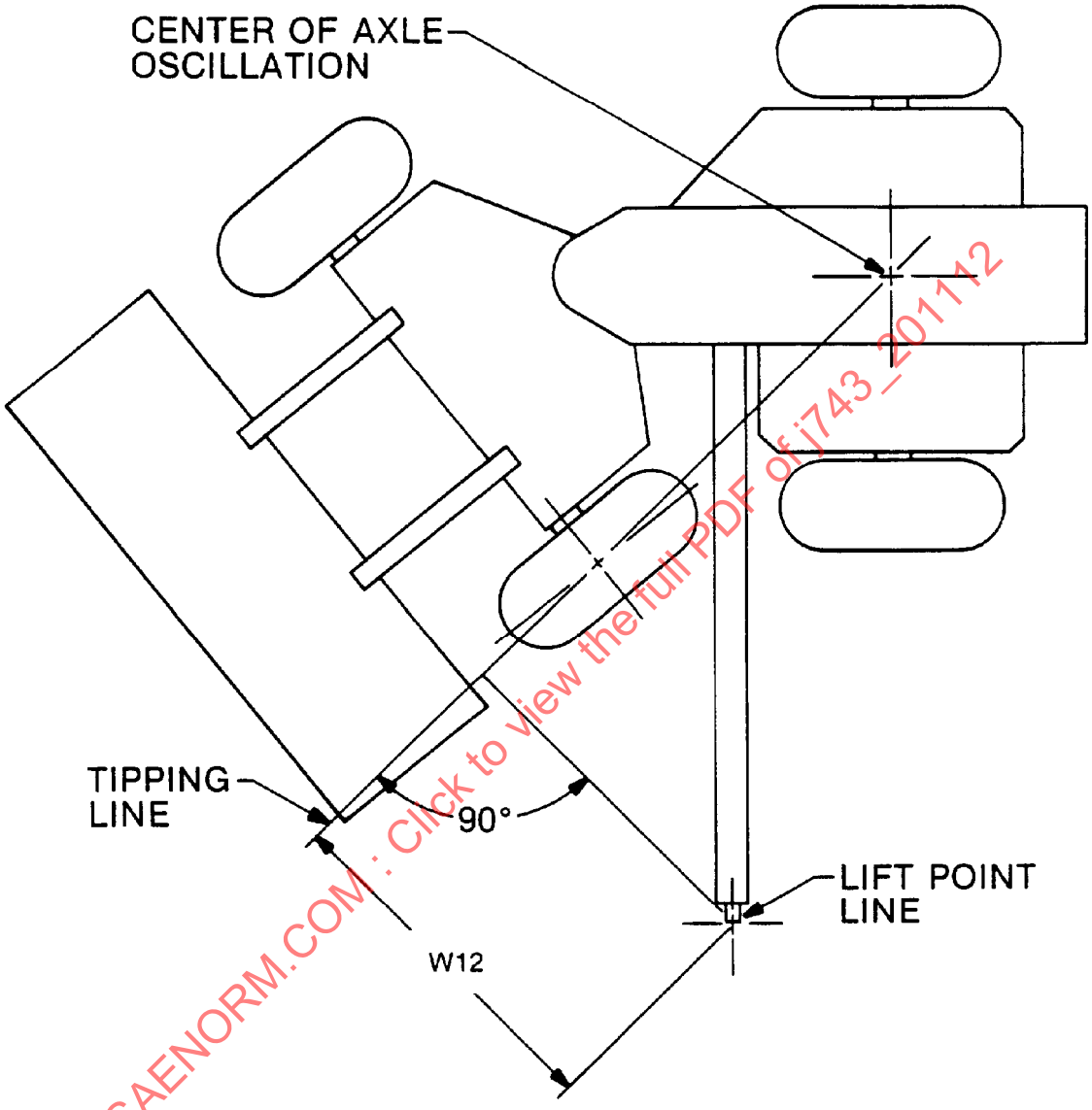

FIGURE 7—ARTICULATED WHEEL TRACTOR STEERED LEFT OSCILLATING AXLE

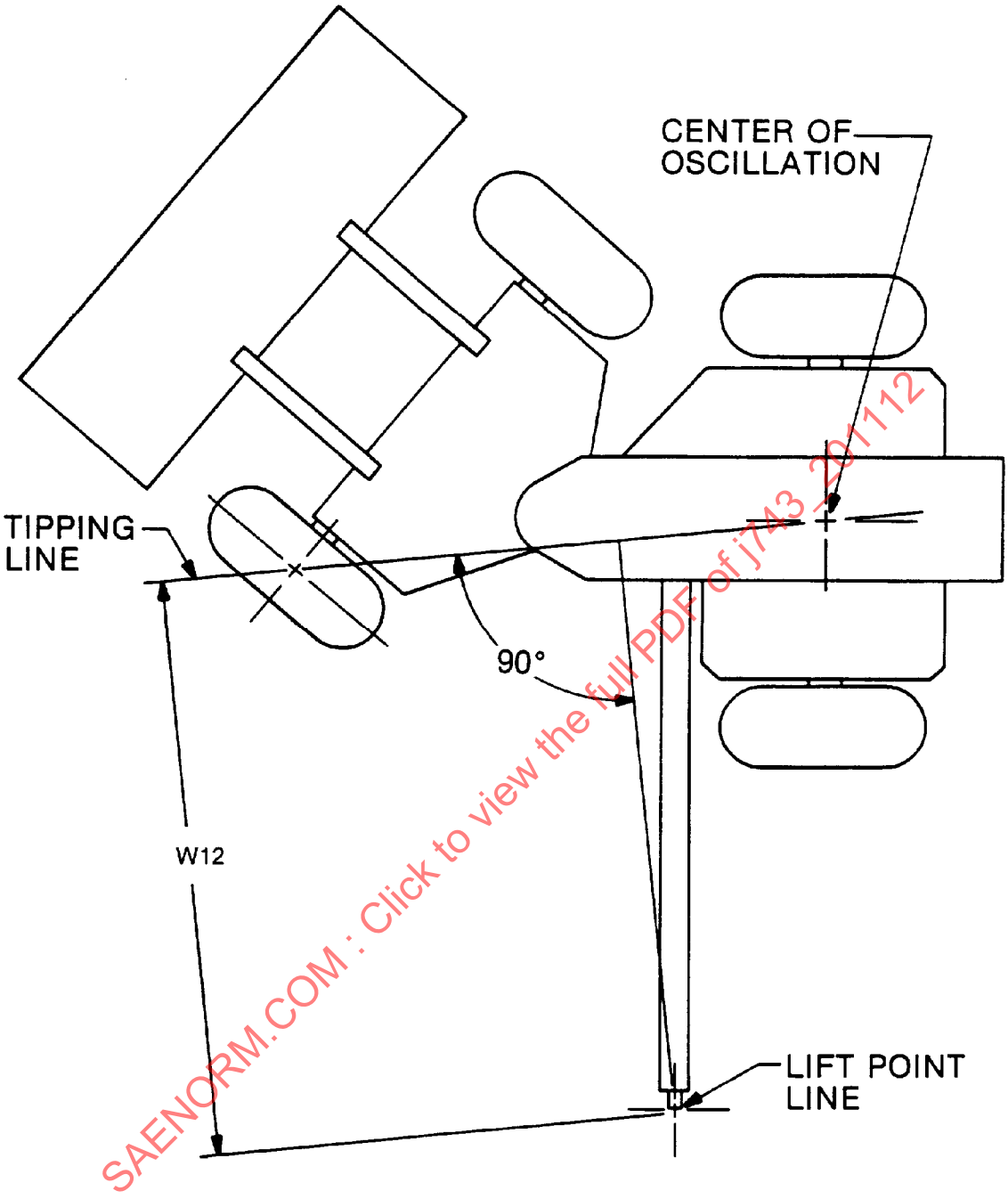

FIGURE 8—ARTICULATED WHEEL MACHINE STEERED RIGHT OSCILLATING

3.4.4 MACHINE WITH OUTRIGGERS—A line connecting the center of contact of the outrigger pads with the ground reference plane on the boom side of the machine. See Figures 3 and 4.

3.5 Load Overhang—The horizontal and perpendicular distance from the tipping line to the lift point line. See Figure 1, W12.

3.6 Moment—The product of a force acting through the lift point line and the load overhang.

3.7 Balance Point

3.7.1 CALCULATED—The moment acting to overturn the machine at a specific load overhang which is equal to the moment of the machine available to resist overturning.

3.7.2 MEASURED

3.7.2.1 Crawler Machines—The moment acting to overturn the machine at a specific load overhang without causing any track roller on the track opposite to the boom side to lift more than 6 mm from the track link.

3.7.2.2 Wheel Machine—The moment acting to overturn the machine at a specific overhang that will not cause any tire on the side opposite the boom to lift more than 1.6 mm from the ground reference plane.

3.7.2.3 Machine With Outriggers—The moment acting to overturn the machine at a specific overhang that will not cause any tire or outrigger pad on the side opposite to the boom to lift more than 1.6 mm from the ground reference plane.

3.8 Tipping Load—The vertical load applied at the load hook at a specific load overhang which achieves the balance point.

3.9 Rope—Regular lay wire rope used for the boom support or the load line.

3.10 Rope Factor—Rope breaking strength divided by rope load.

3.11 Draw Works

3.11.1 MECHANICAL DRAW WORKS—The drums and mechanical drive systems that operate the boom position and the load hoist lines.

3.11.2 HYDRAULIC DRAW WORKS—Hydraulic pumps, motors, valves, lines, and cylinders that position boom and operate the load hoist lines.

3.12 Hydraulic Pressure

3.12.1 WORKING CIRCUIT PRESSURE—That nominal pressure applied to the specific circuit by the pump(s).

3.12.2 HOLDING CIRCUIT PRESSURE—The maximum static pressure in a specific circuit, limited by a relief valve pressure that is measured at a flow no greater than 10% of rated circuit flow.

3.13 Lift Mechanism Lift Capacity—The load that can be lifted at the load hook by a force generated by any combination of mechanical or hydraulic power to the draw works and/or hydraulic cylinder(s) at a specific boom overhang without exceeding any of the following limits:

a. Tipping load
b. Hydraulic working or holding circuit pressure in any circuit
c. Rope factor in either the load or boom hoist line

Some of the possible combinations of power to the load and boom hoist line include:

a. Mechanical draw works power to the load and boom hoist line
b. Hydraulic draw works power to the load and boom hoist line
c. Mechanical power to the draw works for the load hoist line and hydraulic cylinder(s) for the boom hoist line
d. Hydraulic cylinders for the load and boom hoist line

3.13.1 MECHANICAL DRAW WORKS LIFT CAPACITY—The lift capacity obtained by applying mechanical power to the load and boom hoist draw works without exceeding tipping load or rope factor.

3.13.2 HYDRAULIC LIFT CAPACITY—The lift capacity obtained by applying working circuit pressure to the hydraulically actuated draw works and/or lift cylinder(s) without exceeding holding circuit pressure in any circuit, tipping load, or rope factor.

3.13.3 ROPE FACTOR LIFT CAPACITY—Lift capacity limited when the rope factor is no less than 4.0, or under special provisions, as low as 2.5.

3.14 Rated Lift Capacity—The maximum load that can be raised without exceeding the rated tipping load lift capacity, rated lift mechanism lift capacity, or the rated rope factor lift capacity as shown in 7.1.

3.15 Operating Mass—The mass of the base machine with all equipment specified by the manufacturer, 75 kg operator, full fuel tank and full lubricating, hydraulics, and cooling systems. Equipment such as dozers and buckets, if included in the manufacturer's specifications, shall be in the transport position recommended by the manufacturer. Buckets shall be empty.

4. Lift Capacity Calculation Procedure

4.1 All lift capacity calculations will be made with adjustable counterweights fully extended and the machine on a firm level surface.

4.2 Attachment Variations—Because of the number of attachment variations available, the manufacturer must publish revised lift capacity charts if these variations decrease the machine rated lift capacity by more than 5%.

4.3 Tipping Load Calculations—A calculation at a given load overhang position to determine the tipping load. Sufficient load overhang positions must be utilized to develop the lift capacity chart. See Figure 9.

4.3.1 PIPELAYER—Calculations shall be made at standard machine configuration.

4.3.2 WHEEL MACHINE—Preliminary calculations shall be made using the load overhang lines defined in 3.5 with the machine steered straight ahead, steered fully left, and steered fully right. These preliminary calculations are to be used to select the steering position that results in minimum tipping load. The steering position that results in minimum tipping load shall be used for both oscillating and non-oscillating axle configuration machines and shall be used to develop the lift capacity chart.

4.3.3 MACHINE WITH OUTRIGGERS—Tipping load calculations shall be made to develop lift capacity charts both with and without outriggers in use.

4.3.3.1 When making calculations for the machines using outriggers, the provisions of 4.3.2 apply.

4.3.3.2 When making calculations for the machines using outriggers, the steering position that results in minimum tipping load will be used to develop the lift capacity chart.

4.4 Lift Mechanism Lift Capacity Calculations—A calculation at a load overhang to determine the load that can be lifted at the load hook when the load from the lift mechanism (defined in 3.13) is less than the tipping load. Sufficient load overhang dimensions must be utilized to develop the lift capacity chart. See Figure 9.

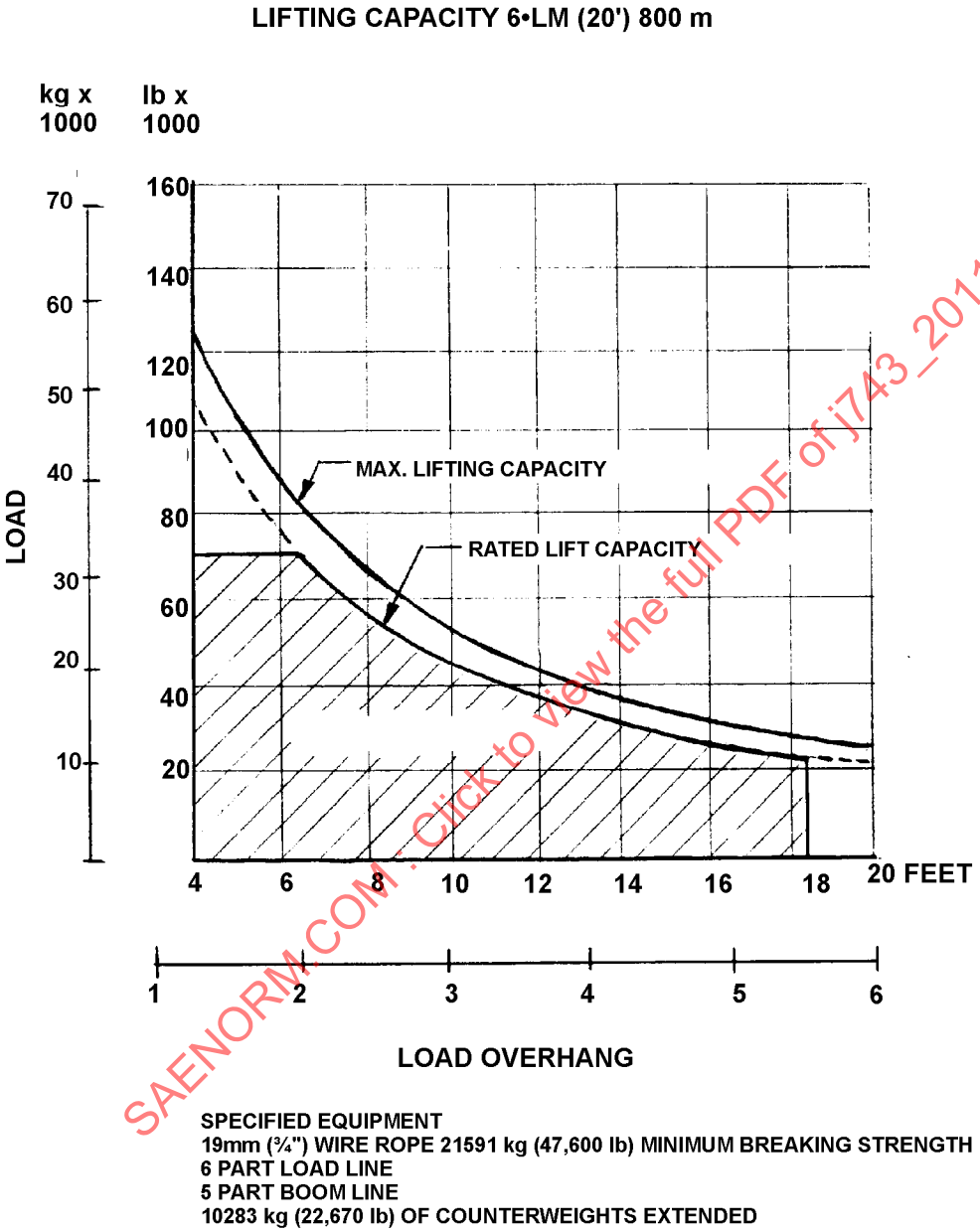

FIGURE 9—TYPICAL RATED LIFT CAPACITY CHART

5. Verification Testing, Test Results, and Validation of Calculations

5.1 Test Site—Shall consist of a firm horizontal concrete, steel, or equally firm surface and shall be level within 1%.

5.1.1 DEAD WEIGHT TEST SITE—The load is applied by lifting on a fixed anchor and adjusting the lifting force to achieve the balance point.

5.1.2 LIVE WEIGHT TEST SITE—The load is applied by a weight of a known mass with the load overhang adjusted to achieve the balance point.

5.2 Test Equipment

5.2.1 A force transducer of sufficient capacity or weights of known mass.

5.2.2 A means to measure the load overhang distance.

5.2.3 A means to determine that the lift point is perpendicular to the ground reference plane.

5.2.4 A means to monitor pressure in all hydraulic circuits that will be under pressure during the lift capacity tests.

5.2.5 Accuracy of the instrumentation shall be within ±2.5% of the parameter measured.

5.3 Test Conditions

5.3.1 Lift capacity shall be determined under static conditions.

5.3.2 The machine used for tests shall conform in all significant aspects with the machine specifications used for calculation.

5.3.2.1 Wheel machines shall be tested at the steering position that results in the minimum tipping load as established in 4.3.2.

5.3.2.2 Machines with outriggers shall be tested with and without the outriggers in use and in the configuration established in 4.3.3.

5.3.3 Track tension on crawler machines shall be adjusted to manufacturer's recommendation.

5.3.4 Tires on wheel machines are to be inflated and ballasted to the machine manufacturer's recommendations.

5.3.5 Prior to test, the machine shall be cleaned, in operating condition and operated until the engine and lifting component fluids are at normal operating temperature.

5.3.6 All lifting systems, rope, and reeving shall be in accordance with the machine manufacturer's specifications. If hydraulic lift mechanisms are utilized, the system working and the holding circuit pressure(s) shall be checked for compliance with the manufacturer's recommendations.

5.3.7 Safety precautions must be observed while conducting these tests. This includes all operating instructions furnished by the manufacturer of the machine to be tested and the test equipment being used. Means shall be provided for preventing the machine from overturning during the tests but shall not influence the test results.

5.4 Verifying Test Methods

5.4.1 All static lift capacity tests shall be run with adjustable counterweights in the extended position.

5.4.2 DEAD WEIGHT TESTS—Set the boom in the prescribed overhang positions to verify designated calculations. Measure the magnitude of the force and the overhang distance that achieves the balance point or the lift mechanism force limit. Keep the load lift line vertical (within ±0.5 degrees) during the test.

5.4.3 LIVE WEIGHT TESTS—The load is applied by a weight of a known mass and the load overhang is adjusted to verify the balance point or lift mechanism force limit. The live weight shall be kept less than 0.5 m from the ground reference plane while conducting the tests to reduce the possibility of the machine overturning.

5.4.4 Pipelayer lift capacity tests shall be conducted at these overhang positions if applicable:

a. 1.25 m (±10%) or at minimum overhang distance obtainable if greater than 1.25 m.
b. Within 1.0 m of the maximum load overhang distance.
c. If the lift mechanism lift capacity is reached before the tipping load, that load shall be used in place of test "b".

5.4.5 Wheel machine lift capacity tests shall be conducted at these load overhang positions if applicable:

a. 1.25 m (±10%) or at minimum overhang obtainable if greater than 1.25 m with the machine steered straight.
b. Mid-range load overhang with the articulated machine steered full left.
c. Within 1.0 m of the maximum load overhang with the articulated machine steered full right.
d. If the lift mechanism lift capacity is reached before the tipping load, that load shall be used in place of test "b" or "c".

5.4.6 Machines equipped with outriggers shall be tested both without outriggers applied and with outriggers applied in their most favorable positions.

5.5 Test Results

5.5.1 The test results and data from the machines tested shall be recorded on a test summary sheet similar to that shown in Figure 10.

5.6 Validation of the Calculated Values

5.6.1 The measured loads at the measured overhang distances should be within 95% of the calculated values. If not, the calculated values shall be adjusted based on a correction factor determined from the measured value.

6. Performance Requirements, Rated Lift Capacity, and Load Rating Chart

6.1 Rope Factor Guidelines

6.1.1 Rated lift capacity shall not create a rope factor (as defined in 3.10) for ropes that wind on drums or pass over sheaves that is less than 4.0 unless the special provisions of 6.1.2 are applied. The rope factor shall be determined based on the manufacturer's approved rope, reeving, the nominal breaking strength of new rope, and with load and booming stationary.