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SURFACE VEHICLE STANDARD

SAE J1371

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Hydraulic Excavator Swing Performance and Rating Procedure

1. Scope—This SAE Standard provides a uniform method for calculating and specifying swing performance characteristics of hydraulic excavators 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. The latest issue of SAE publications shall apply.

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

SAE J745 APR87—Hydraulic Power-Pump Test Procedure
SAE J746 MAR86—Hydraulic Motor Test Procedure
SAE J896 OCT85—Machine Slope Operation Test Code
SAE J1057 JUN81—Identification Terminology of Earthmoving Machines
SAE J1097 NOV88—Hydraulic Excavator Lift Capacity Calculation and Test Procedure
SAE J1166 JUN86—Categories of Off-Road Self-Propelled Work Machines
SAE J1193 NOV84—Nomenclature and Dimensions for Hydraulic Excavators
SAEJ1349 JUN90—Engine Power Test Code—Spark Ignition and Compression Ignition Net Power Rating

3. Definitions

3.1 General Items

3.1.1 SWING is the rotation of the upperstructure with respect to the undercarriage.

3.1.2 RATED ENGINE SPEED "Nr" as used in this document is defined in SAE J1349 and is specified in revolutions per minute.

3.1.3 PINION RATIO "Pr" is dimensionless and shall be the reduction ratio of the pinion gear to swing bearing gear. It shall be determined using the following formula:

$$Pr = \frac{\text{Number of teeth of swing bearing gear}}{\text{Number of teeth of swing drive pinion}} \quad \text{(Eq. 1)}$$

3.1.4 SWING MOTOR SPEED "Sm"—Output shaft rotational velocity, in revolutions per minute, as determined according to SAE J746 at the hydraulic pressure differential required to sustain swing motion on a level surface.

3.1.5 SWING MOTOR TORQUE "Tm"—Maximum output torque, in Newton·meters, of the hydraulic drive motor(s), at maximum hydraulic system pressure differential and with motor output shaft rotating at 1 rpm as determined according to SAE J746.

3.1.6 HYDRAULIC PUMP DELIVERY "Qp"—Output flow in liters per minute, with engine at "rated engine speed," of pump supplying oil or flow limit of swing control valve to hydraulic swing motor(s) as determined according to SAE J745 and at the hydraulic pressure differential required to sustain swing on a level surface.

3.1.7 SWING CONTROL VALVE—Valve or valve section that controls the flow of hydraulic oil to operate the swing motor(s). Valve controls clockwise and counterclockwise swing operation.

3.1.8 GEAR REDUCTION RATIO "Rg"—The total gear reduction ratio between the swing motor and pinion gear.

3.1.9 GEAR EFFICIENCY "Eg"—Proportion of power expressed as a percentage, transmitted through the total gear system. For the purpose of developing uniform ratings within this document, an efficiency of no greater than 98% should be used for each set of gears. "Eg" shall be the multiple of all individual gear set efficiencies.

3.1.10 SWING CONTROL—Lever that either mechanically or hydraulically activates pump or swing control valve to operate swing in clockwise or counterclockwise direction.

3.2 Upperstructure Operating Mass and Weight

3.2.1 OPERATING MASS "M" shall be the total mass specified in kilograms of an upperstructure in 5.1 and ready to perform its intended function, including all working equipment and tools, a 75 kg allowance for an operator, full fuel tank, but not including any load in the bucket or other tools. Also included is the mass of all oils and greases necessary to fill oil reservoirs and lubrication compartments to the specified levels.

3.2.2 OPERATING WEIGHT "W" is specified in units of force, Newtons, where:

$$W = 9.807\ M \text{ (Newtons)} \qquad \text{(Eq. 2)}$$

3.3 Rated Swing Speed

3.3.1 SWING SPEED "Sn" AT RATED ENGINE SPEED "Nr" shall be determined using the following formula and is specified in revolutions per minute.

$$Sn = \frac{Sm}{(Pr)(Rg)} \quad \text{(rpm)} \qquad \text{(Eq. 3)}$$

3.4 Rated Swing Torque

3.4.1 RATED SWING TORQUE "Ts" shall be determined using the following formula and is specified in Newton meters:

$$Ts = (Tm)(Rg)(Pr)Eg) \quad (N \cdot m) \qquad \text{(Eq. 4)}$$

3.5 Time to Swing 90 Degrees—The time in seconds from the start of the swing control movement for the upperstructure to rotate through 90 degrees starting from a stop.

3.6 Swing Angle of Deceleration—The angle measured in degrees of rotation of the upperstructure with respect to the undercarriage while the swing motion is decelerated from rated swing speed to zero rpm.

3.7 Swing Brake—A device or system to bring the rotation of the upperstructure to a stop in any position.

3.8 Swing Parking Brake—A device or system to hold the upperstructure for an indefinite period of time after stopping in any position.

3.9 Swing Lock—A mechanical device not dependent on friction to hold the upperstructure in a fixed position with respect to the undercarriage.

4. Rating Procedure and Performance Requirements

4.1 Rated Swing Speed and Swing Torque—The manufacturer must be able to verify the published "Rated Swing Speed" and "Swing Torque" specifications by actual tests with resulting values determined from tests exceeding 95% of published values.

4.2 Time to Swing 90 Degrees—This is a measured value starting at the time of swing control movement. The time to swing 90 degrees is to be established with the engine speed control set at maximum. Test results to verify "Rated Time to Swing 90 Degrees" must not exceed published values by more than 5%.

4.3 Swing Angle Deceleration—This is a measured angle starting at the point of swing control movement to neutral until upperstructure comes to a complete stop. Use of the swing brake or reversing the control lever is acceptable if it is a normal operating procedure recommended by manufacturer. Test results to verify "Rated Swing Angle Deceleration" must not exceed published values by more than 5%.

4.4 Swing Brake

4.4.1 All machines shall have a swing brake.

4.4.2 The swing brake shall be capable of bringing the upperstructure to a complete stop from rated speed ten times without the swing angle of deceleration increasing more than 20% of the measured angle in 4.3. These ten actuations are to be applied sequentially as rapidly as the upperstructure can be accelerated to rated swing speed and decelerated to full stop.

4.4.3 If the swing brake will not hold the upperstructure from rotating after stopping in any position, a swing parking brake is required. The swing parking brake must have torque capacity of at least 105% of the maximum swing motor torque and be capable of preventing upperstructure rotation regardless of front linkage position. The swing parking brake shall be either manually or automatically applied and be capable of being applied without engine running.

4.4.4 If the machine is not equipped with a swing parking brake, the swing brake must apply or be capable of being applied without the engine running.

4.5 Swing Lock

4.5.1 A swing lock is not mandatory.

4.5.2 The swing torque capacity of the swing lock shall be such that if the swing control lever is fully engaged with the swing lock in the locked position and engine at full throttle, the swing lock mechanism must not be damaged.

4.6 Swing Control Interlock

4.6.1 A means shall be provided to lock (prevent) the movement of the swing control lever or to make the movement of the swing control ineffective.

5. Test Conditions

5.1 The basic excavator and equipment shall be specified by the manufacturer and shall be the same as that used for “Rated Lift Capacity” SAE J1097. For test purposes the machine must be level within 1%.

5.2 When measuring the “Time to Swing 90 Degrees” and “Swing Angle of Deceleration,” the working equipment must be extended to maximum radii with the bucket empty as shown in SAE J1193, Dimension BA.

5.3 Because of the large number of attachment options and other machine variations available, the manufacturer must publish additional specifications for other machine configurations if these variations would increase “Time to Swing 90 Degrees” and “Swing Angle of Deceleration” by more than 5% or must specifically state which machine configurations are included in and/or excluded from the specifications.

5.4 The tolerances in this document are the sum of the actual deviations plus the measuring error.

PREPARED BY THE SAE MACHINE TECHNICAL COMMITTEE