

# SURFACE VEHICLE RECOMMENDED PRACTICE

**SAE** J1032

REV.  
APR87

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Submitted for recognition as an American National Standard

## DEFINITIONS FOR MACHINE AVAILABILITY (OFF-ROAD WORK MACHINES)

1. **Scope**—This recommended practice applies to construction and general purpose industrial machines as categorized in SAE J1116. It describes the parameters related to the inherent availability of the covered classes of Off-Road Self-Propelled Work Machines.

1.1 **Purpose**—The purpose of this SAE Recommended Practice is to provide a set of recognized definitions as a universally understood means of communication among all people interested in the inherent availability of Off-Road Work Machines. It is not the intent of this document to provide an absolute measure of unit availability. The intent is to provide common definitions for classifying and evaluating operation, repair, and maintenance data.

### 2. References

2.1 **Applicable Publications**—The following publications form a part of the specification to the extent specified herein. Unless otherwise indicated the latest revision of SAE publications shall apply.

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

SAE J1116—Categories of Off-Road Self-Propelled Work Machines

### 3. Definitions

#### 3.1 Availability Indexes (AI)

3.1.1 AVAILABILITY TIME INDEX ( $ATI_1$ ) FOR LESS THAN 24 H/DAY OPERATION (NO OFF-SHIFT REPAIR)—The ratio of operating time (OT) to the sum of operating time, total repair time (TRT), and routine scheduled maintenance time (SMT).

3.1.2 AVAILABILITY TIME INDEX ( $ATI_2$ ) FOR LESS THAN 24 H/DAY OPERATION—The ratio of operating time (OT) to the sum of operating time and total repair time (TRT) for malfunctions that cause a machine shutdown.

3.1.2.1 The definition in 3.1.2 assumes that routine scheduled maintenance and repairs which do not cause a shutdown of the observed machine can be accomplished at a time when the machine is not scheduled for productive work. Only malfunctions which cause a shutdown of the observed machine during scheduled operation should be counted in the total repair time (TRT).

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- 3.2 Operable Condition**—That mechanical condition of the observed machine which permits the machine and/or its components to perform the intended function at a required performance level and in a manner not detrimental to the machine or the operator.
- 3.3 Malfunction**—A condition of the machine in which some part, component, or system does not function in the manner intended.
- 3.4 Classes of Malfunctions**—This procedure categorizes equipment malfunctions in three classes as follows:
- 3.4.1 CLASS A MALFUNCTIONS—Those malfunctions which cause a shutdown of the observed machine for any length of time during scheduled operation.
- 3.4.2 CLASS B MALFUNCTIONS—Those malfunctions which do not cause a shutdown of the machine during a period of scheduled operation. Such malfunctions could be repaired at the next period of scheduled maintenance or off-shift, and the required repair time (RT) shall be entered in the log sheet.
- 3.4.2.1 Anticipated malfunctions might be noted on a log sheet such as shown in Figure 1, with cumulative operating time (OT) noted at the time of observation. The incident of an anticipated malfunction would not be classified as a malfunction until a repair had been made and the repair time (RT) recorded.
- 3.4.3 CLASS C MALFUNCTIONS—Malfunctions that can be definitely attributed to error or negligence, malfunction of external monitoring instrumentation, accidents, etc.
- 3.4.3.1 Downtime caused by the class of malfunction described in 3.4.3 or the repair time (RT) should not be reflected in the availability index (AI) for the observed machine.
- 3.4.3.2 Parts replacement or part alteration for reasons other than Class A, B or C malfunctions might be recorded, but should not be classified as a malfunction.
- 3.5 Operating Time (OT)**—The number of clock hours of actual operation of the machine.
- 3.6 Mean Time Between Malfunctions (MTBM)**—The total number of hours of operation of the machine divided by the number of malfunctions of the specified classes encountered during the period of operation.
- 3.6.1 Class A, B or C Malfunctions or any combination of these classes can be used in computing mean time between malfunctions (MTBM) for the observed machine.
- 3.7 Repair Time and Maintenance**
- 3.7.1 REPAIR TIME (RT)—The number of clock hours required for diagnosis and accomplishment of the corrective repair of the specified malfunction.
- 3.7.1.1 Time lost waiting for parts, mechanic's movement of equipment, etc., should not be counted as part of the repair time (RT), but might be recorded for reference in the description column of a data log sheet such as shown in Figure 1.
- 3.7.1.2 Malfunction of a component on the machine could be repaired by replacement of the subassembly of which the component is a part. If a replacement assembly or subassembly is used, the subsequent time to repair the subassembly or assembly should not be counted as part of the repair time (RT) in the data log for the machine, but it might be recorded that a replacement assembly was used.
- 3.7.2 TOTAL REPAIR TIME (TRT)—The sum of the repair times (RTs) for a specified class or classes of malfunctions in clock hours.

- 3.7.3 MEAN REPAIR TIME (MRT)—The total repair time (TRT) divided by the number of malfunctions for the specified class or classes of malfunctions included in the total repair time (TRT).
- 3.7.4 REPAIR TIME RATIO (RTR)—The ratio of total repair time (TRT) for a specified class or classes of malfunctions to the accumulated operating time (OT).
- 3.7.5 SCHEDULED MAINTENANCE TIME (SMT)—The time required to perform scheduled maintenance.
- 3.7.6 SCHEDULED MAINTENANCE TIME RATIO (SMTR)—The ratio of total scheduled maintenance time (SMT) to the accumulated operating time (OT).
- 3.7.7 REPAIR AND MAINTENANCE TIME RATIO (RMTR)—The ratio of the sum of the repair time (RT) and scheduled maintenance time (SMT) in clock hours to the accumulated operating time (OT).

#### 4. **Recording Of Data**

- 4.1 **Machine Data Log**—A continuous data log such as shown in Figure 1 might be prepared for each machine to record relevant data daily. Some examples of relevant data which might be taken are as follows:

- Date
- Machine identification
- Job application (operation)
- A description of ambient conditions (temperature and barometer)
- Quantity of fuel and oil used
- Operating hours and type of time measuring device
- Scheduled maintenance time
- Repair time in clock hours
- Details of malfunctions and repairs

- 4.2 **Data Reduction and Analysis**—Sample calculations illustrating the application of various definitions of this document are shown in Figure 2.

NOTE—Where a specific column is not provided in a data log sheet such as Figure 1, information could be recorded in the operation/repair/maintenance/description column. A completed sample data log sheet is shown in Figure 1.

- 5. **Pre- And Post-Operation Inspection**—In order that machine log data and the possible subsequent application of the definitions of this document might be most meaningful, pre- and post-operation inspections of the observed machine may be helpful. Pre- and post-operation inspections might insure that the machine functional characteristics of components and systems are within acceptable limits during the time of operation.

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LOG SHEET

CLASS TYPE

MODEL Wheel Loader MACHINE MAKE XYZ

ATTACHMENTS: 2 yd<sup>3</sup> Bucket, 2000 lb. Counterweight

OPERATOR Smith JOB LOCATION Jonesville

- A Immediate Shutdown Malfunction
- B Delayable Shutdown Malfunction
- C Malfunction due to Accident, Etc.
- D Maintenance Action
- O Operation

DATE	CUMULATIVE OPERATING TIME (OT) HOURS	OPERATION/REPAIR/MAINTENANCE/DESCRIPTION	CLASS OF MALFUNCTION/ MAINTENANCE/ OPERATION					REPAIR TIME OR MAINTENANCE
			A	B	C	M	O	CLOCK HOURS
8/18	565	Loaded sand into 10 yd <sup>3</sup> highway trucks					x	
8/18	565	78 gal fuel: gal hyd oil 78°F. 29.62" HG					x	
8/19	571	Loaded sand into 10 yd <sup>3</sup> highway trucks					x	
8/19	571	Replaced leaking O-ring on rt. lift cyl line		x				1.0
8/20	579	Charged hopper w/gravel 300' load and carry					x	
8/20	579	125 hr service				x		2.0
8/21	580	Replaced transmission w/exchange transmission	x					15.0
8/21	580	Adjusted bucket control linkage		x				0.5
8/23	587	Charged hopper w/pea gravel 150' load and carry					x	

FIGURE 1—SAMPLE LOG SHEET