



## Hydraulic System Performance on the Caterpillar 305.5E2 Excavator Unit

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**ABSTRACT:** Excavators are one of the most widely used types of heavy equipment due to their ability to operate in tight spaces with high efficiency. One crucial component in supporting excavator performance is the hydraulic system, which functions to move main parts such as the boom, arm, and bucket through fluid pressure. Disruptions in this system can reduce productivity and trigger damage to other components. This study aims to evaluate whether the hydraulic system on the Caterpillar 305.5E2 Excavator unit works optimally and according to technical specifications. Testing was carried out through two main methods, namely pressure tests and operational tests, with the help of pressure gauges and stopwatches. The test results showed that all main functions of the boom, stick, bucket, blade, swing, and travel can operate properly without symptoms of damage or delayed response. Although the hydraulic system may still be operationally functioning normally, there may be indications of internal damage or improper pressure adjustments, which could affect the unit's long-term performance. Therefore, further technical evaluation is required as part of a preventive maintenance program.

**KEY WORDS:** Control Valve, Hydraulic Excavator, Pressure Test, Performance Test.

### INTRODUCTION

As the industrial world advances in this modern era, we are increasingly required to continuously improve our ability to maintain the performance of production machines, especially heavy equipment. The ability to maintain machine performance is an absolute requirement for every human resource (HR) directly involved in the heavy equipment industry. Different HR backgrounds can lead to varying understandings and perceptions. Heavy equipment is a large tool used by humans to perform heavy work. Excavators, in particular, are the most vital heavy equipment units in the land exploitation process at mining sites. On the other hand, land exploitation processes in mining areas must meet production targets with units operating 24 hours a day. With such dense working hours, heavy equipment components, especially excavators, are prone to various damages. One component that is vulnerable to damage is the hydraulic component, such as the main control valve. The main control valve is a hydraulic system component used in heavy equipment units, which functions to control the hydraulic flow in the system partially (in part) or as a whole and consists of several valves that have different shapes and functions, so that analysis of the performance of the main control valve on the performance of the excavator unit needs to be carried out to ensure that the hydraulic implement functions properly [1].

The complexity of excavator hydraulic circuits and the demanding working conditions that require continuous performance improvement to ensure the reliability of the system are always a serious consideration [2]. Analysis of hydraulic system operation shows that the reliability of the system and its components will depend on a large number of factors, namely pressure, flow, temperature, viscosity, and particulate contaminants [3]. Related to contaminants and hydraulic system operation, it was concluded that hydraulic oil contamination analysis, namely the detection of metal particulates, offers a reliable way to measure hydraulic component wear in real-time [4]. CAT Ltd stated that the concentration of wear particles in the oil is a key indicator of potential component problems. Therefore, oil analysis techniques for condition monitoring offer significant potential benefits to operators [5]. To analyze the power of the excavator hydraulic pump, the power of the excavator boom when moving, and to determine the power on the excavator arm and to get the power value, calculations are also carried out on the maximum pressure of the hydraulic pump, the flow of the hydraulic pump, and the power of the hydraulic pump [6, 7]. Testing by testing the hydraulic performance of the excavator with pumps and valves combined with separate inlet and outlet meter circuits [8]. Likewise, research on the hydraulic performance of the excavator boom by conducting pressure and flow tests based on independent measurement circuits [9].

Damage to the hydraulic boom cylinder of the excavator due to performance disturbances in the boom cylinder components can be caused by several factors, including contamination of the boom cylinder components, internal or external leaks, and the occurrence of overhead on the components of the boom cylinder has also been carried out using the FMEA method [10, 11].

**METHOD**

This study used an experimental method to test the performance of the Caterpillar 305.5E2 excavator's hydraulic system through various tests, as follows:

**1) Operational Test**

In the operational test step, several systems on the heavy equipment unit were tested by measuring their cycle time. Some of the systems tested included the implement system (boom, stick, and bucket), the swing system, and the travel system [14][15].

**Boom Speed Test**

Boom speed tests are conducted to determine the general condition of the boom cylinder and boom system by measuring the hydraulic cylinder's movement time.

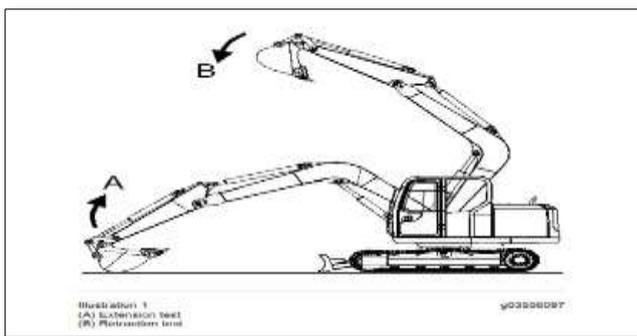


Figure 1. Boom speed test

The boom speed test begins by starting the engine with the engine speed dial set to "10" and ensuring the AEC Switch is in the off position. Position the bucket and stick cylinder in the full retraction position. Position the boom cylinder in the full retraction position. Move the joystick to raise the boom until the hydraulic cylinder is fully extended. Then record the measurement results. Move the joystick to lower the boom until the hydraulic cylinder is fully retracted. Then record the measurement results.

**Stick speed test**

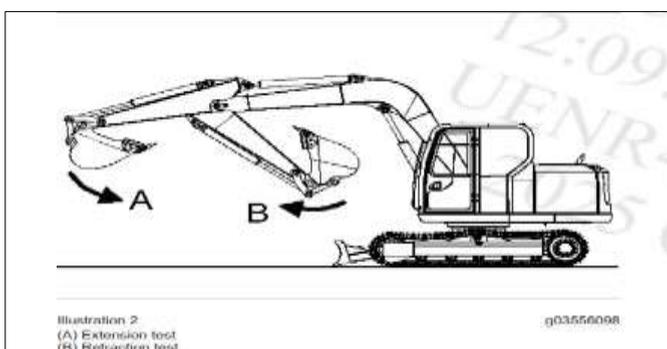
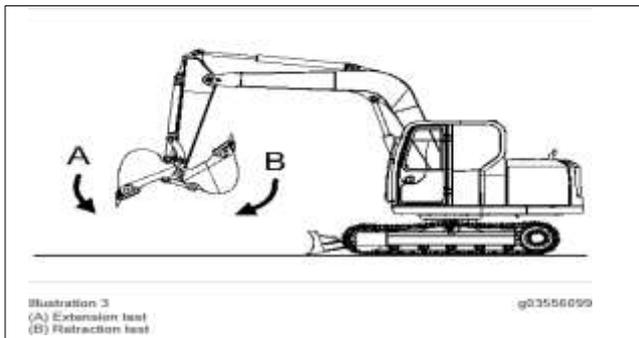


Figure 2. Stick speed test

A stick speed test is performed to determine the general condition of the stick cylinder and stick system by measuring the hydraulic cylinder's movement time. The procedure involves starting the engine and setting the engine speed dial to "10," then ensuring the AEC switch is in the off position. Position the top of the boom parallel to the ground. Position the bucket cylinder in a fully extended position, as shown in Figure 2.

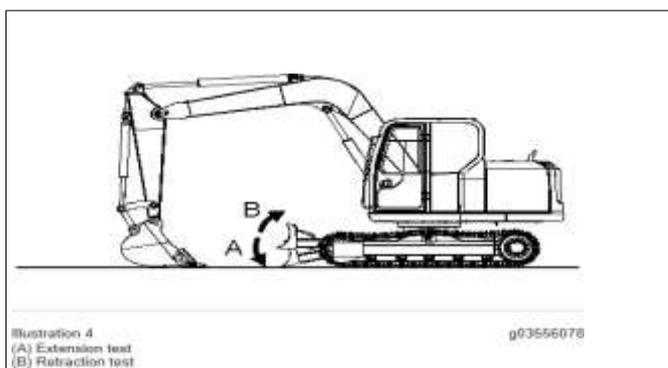
**Bucket speed test**



**Figure 3. Bucket speed test**

Bucket speed test is performed to determine the condition of the bucket cylinder and bucket system in general by measuring the movement time of the hydraulic cylinder. Bucket speed test can be done by starting the engine and setting the engine speed dial to "10" then ensure the AEC switch is in the off position. Position the stick perpendicular to the ground surface as shown in figure 4. Position the bucket full extend as shown in figure 4. Move the joystick to retract the bucket cylinder. Use a stopwatch to measure the movement time of the bucket cylinder. Record the results. Move the joystick to extend the bucket cylinder. Use a stopwatch to measure the movement time of the bucket cylinder. Record the results.

**Blade speed test**



**Figure 4. Blade speed test**

The blade speed test is performed to determine the condition of the blade cylinder by measuring the hydraulic cylinder movement time. The procedure is to start the engine and set the engine speed dial to "10" then ensure the AEC switch is in the off position. Position the blade on the ground. 3. Fully retract the blade cylinder. Use a stopwatch to measure the time required for the blade to descend until it touches the ground. Use a stopwatch to measure the time required for the blade cylinder to fully retract, as shown in Figure 4.

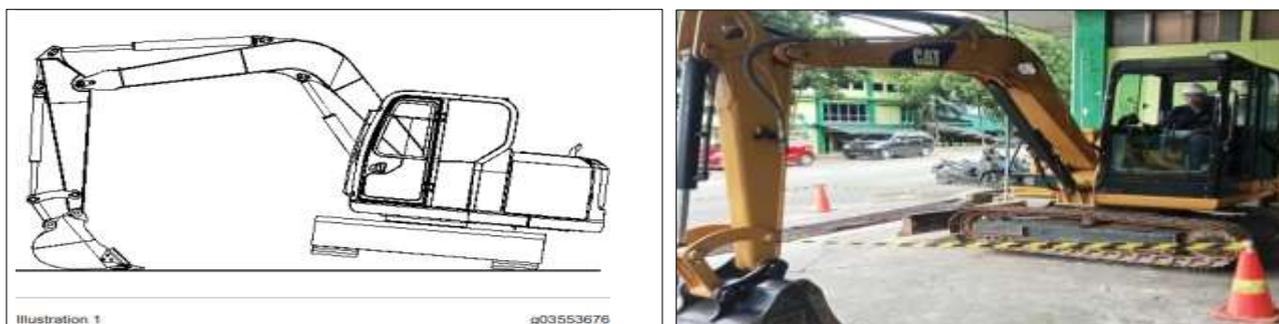
**Swing speed test**



**Figure 5. Blade speed test**

A swing speed test is performed to determine whether the swing drive system and motor are working properly. Swing speed testing can be performed by starting the engine and setting the engine speed dial to "10," then ensuring the AEC switch is in the off position. Move the swing joystick until it moves 180° from its starting position. Use a stopwatch to measure the time it takes for the swing to move and record the results. Perform the above test for the right and left swings, as shown in Figure 5.

**Travel speed test**



**Figure 6. Travel speed test**

A travel speed test is performed to determine the performance of the travel system, and specifically the travel motor, by measuring the track's cycle time. To perform a travel speed test, start the engine and set the engine speed dial to "10," then ensure the AEC switch is in the off position. Lift the track by pressing the bucket to the ground as shown in Figure 6. Mark one side of the track with a marker to serve as the measurement target. Use a stopwatch to measure the track's operating time for three full rotations. Measure the forward and reverse tracks with the travel speed control switch in the high position. Measure the forward and reverse tracks with the travel speed control switch in the low position. Record the measurement results on a worksheet.

**Preparation of Equipment and Work Documents**

To carry out this work, we will need several pieces of equipment and documents to support the work. These are listed in Table 1 below:

**Table 1. Key Data Points: Indonesia Renewable Energy & Community Energy**

No	Nama Peralatan/Dokumen	Jumlah
1.	Pressure Test Group	1 pc
2.	Stop wach	1 pc
3.	Jobsheet Performance Test 320D2	1 sheet
4	System Informatin Service	1 pc

Flowchart

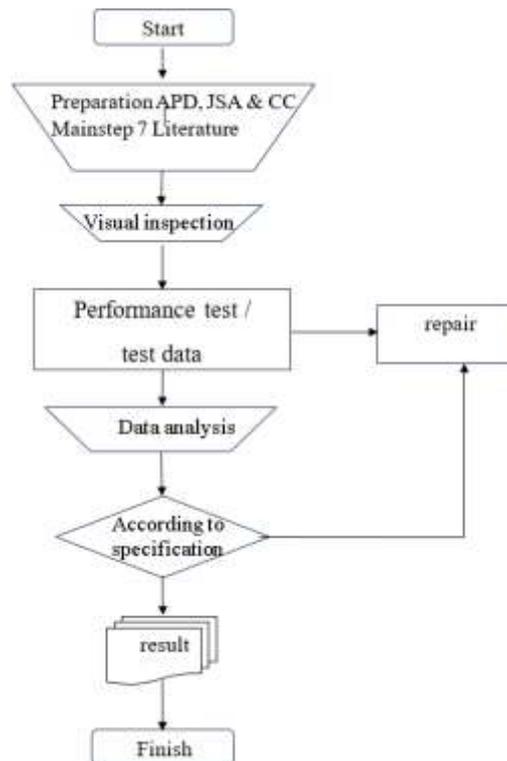


Figure 7. Flowchart

RESULT AND DISCUSSION

Boom Speed Performance Testing

Based on the results of the boom speed test, the test results are shown in Table 2:

Table 2. Result boom speed test

No	Description	Current (s)	Specification (s)
1	Boom cylinder extend	2,70	2.3 - 3.1
2	Boom cylinder retract	2,10	1.7 - 2.5

Based on the specifications required by the operational manual of the Caterpillar 305.5E2 excavator for the boom speed test, the extended condition is 2.3 – 3.1 seconds, while the actual test result obtained was 2.70 seconds, so the component is categorized as functioning within standard conditions. Likewise, the boom cylinder retract condition is also standard.

Stick Speed Performance Testing

Based on the results of the stick speed test, the test results are shown in Table 3:

Table 3. Result stick speed test

No	Description	Current (s)	Specification (s)
1	Stick cylinder extend	2,70	2.3 - 3.1
2	Stick cylinder retract	2,30	1.9 - 2.7



The stick speed test in the extended condition is 2.3-3.1 seconds, while the actual test result obtained is 2.70 seconds, indicating that the component is still functioning within standard. Similarly, the stick cylinder retract condition is also standard.

### Bucket Speed Performance Testing

Based on the results of the bucket speed test, the test results are shown in Table 4:

**Table 4. Result bucket speed test**

No	Description	Current (s)	Specification (s)
1	Bucket cylinder extend	2,10	1.7 - 2.5
2	Bucket cylinder retract	1,60	1.2 - 2.0

The testing of bucket speed in the extended condition is 1.7-2.5 seconds, while the actual test result obtained is 2.10 seconds, which means the component is still functioning within standard. Likewise, the bucket cylinder retract cycle time obtained is also still within standard.

### Swing Speed Performance Testing

Based on the results of the swing speed test, the test results are shown in Table 5:

**Table 5. Result swing speed test**

No	Description	Current (s)	Specification (s)
1	Right swing (90 <sup>0</sup> )	2.10	2.6 – less
2	Left swing (90 <sup>0</sup> )	2.10	2.6 - less

The swing speed testing conditions, both for swinging to the right and to the left, are standard at 2.10 seconds out of 2.6 seconds.

### Travel Speed Performance Testing

Based on the results of the travel test, the test results are shown in Table 6.

**Table 6. Result travel speed test**

No	Description	Current (s)	Specification (s)
1	Track forward (high)	9.50	9.5-12.5
2	Track Reserve (high)	9.50	9.5-12.5
3	Track forward (low)	15.60	15.6-20.6
4	Track Reserve (low)	15.60	15.6-20.6

During the testing of travel speed on the forward and reverse tracks in both high and low conditions, it is still within standard conditions.

### Blade Speed Performance Testing

Based on the results of the Blade test, the test results are shown in Table 7.

**Table 4. Result bucket speed test**

No	Description	Current (s)	Specification (s)
1	Blade cylinder extend	0,9	0.7 - 1.1
2	Blade cylinder retract	0,6	0.4 - 0.8



Testing the bucket speed in the extended condition is 0.7-1.1 seconds, while the actual test result obtained is 0.9 seconds, meaning the component is still functioning within standard. Similarly, the bucket cylinder retract cycle time obtained is also still within standard.

## CONCLUSION

Conducting a performance test on a 305.5E2 excavator machine according to standard operating procedures (SOPs) and the specifications in the SIS (Systems Operational System). Overall, the 305.5E2 heavy equipment unit's system conditions are normal and ready for use. Although the hydraulic system may still be operationally functioning normally, there may be indications of internal damage or improper pressure adjustments, which could affect the unit's long-term performance. Therefore, further technical evaluation is required as part of a preventive maintenance program.

Performance testing is a very common task in heavy equipment maintenance. The author hopes this information will assist readers who wish to conduct performance testing and ensure they meet established standards.

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