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Patria Mud Body Modification Study on Komatsu HD785-7 Unit for Overburden Transportation

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Keywords: mud body modification; Komatsu hd785-7; overburden transportation.

ABSTRACT

Coal mining activities require reliable means of transportation to support productivity and safety. PT AMM site ABP Energy uses a Komatsu HD785-7 off-highway dump truck with a Mud Body vessel and a Std Light Vessel which has significant differences in empty weight and payload capacity. The heavier Vessel Mud Body increases fuel consumption and the risk of overloading. This study aims to examine the modification of the Mud Body vessel to be lighter without reducing the payload capacity. The methods used include secondary data collection from technical specifications and modification simulation analysis. The results of the study show that the partial cutting of the side wall vessel of the Mud Body can reduce the empty weight by up to 3,345 kg, close to the specifications of the standard vessel. These modifications improve fuel efficiency, minimize the risk of overloading, and maintain the reliability of the unit. In conclusion, planned modifications are effective in improving operational efficiency and lowering operational costs without sacrificing safety and productivity.

Introduction

In coal mining activities, PT. ABP Energy's AMM site uses the Open Pit mining method with the operation of mechanical equipment such as excavators for loading and dump trucks for transporting overburden and coal (Manurung, Joko, & Santosa, 2020). Overburden transportation is carried out from the front to disposal using an off-highway dump truck Komatsu HD785-7, through a mining road that is unsurfaced. In overburdened transportation activities, it is necessary to carry them out safely, effectively, and efficiently to support productivity and safety aspects. (Farahpoor, Esparza, & Soriano, 2023).

The off-highway dump truck unit Komatsu HD785-7 is owned by PT. ABP Energy's own AMM site has different unit configurations. Of the total HD785-7 units

available, there are 5 units that have a Mud Body vessel configuration from the Patria carousel manufacturer. As for the other units, it has a Std Light Vessel vessel configuration which is also made by the carousel manufacturer Patria (McFarlane et al., 2017).

In terms of specifications, there is a difference between a Mud Body vessel and a Std Light Vessel. Units with Mud Body vessels have a tailgate and the purpose of its application is to transport materials in the form of mud or mud and has a relatively stronger vessel structure so that the empty weight of the Mud Body vessel is also relatively heavier. (Wang, Yang, Chen, & Shah, 2015). Meanwhile, the unit with the Std Light Vessel vessel does not have a tailgate and its application is to transport overburdened materials and has a lighter empty weight than the Mud Body vessel. With a larger empty weight of the Mud Body vessel, there is a potential for the HD785-7 unit to carry a larger carryback load, and this will certainly affect the increase in fuel consumption of the unit. Modifications need to be made so that the empty weight of the Mud Body vessel becomes lighter, to get more efficient fuel consumption. (Felsch et al., 2019).

In addition, there are also significant or striking differences in geometry. The most striking difference is that the Mud Body Vessel can be seen to be taller in size compared to the Std Light Vessel. (Mustopa & Wiratama, 2022). The shape of the hull or hull of the vessel in the two types of vessels also has a striking difference. The Vessel Std Light Vessel has a convex hull or hull when compared to the Mud Body vessel when viewed from the rear of the unit. (Sari, 2021).

With the field conditions as described above, as well as to maximize the utilization of Komatsu HD785-7 unit assets at ABP Energy's job site and to optimize the productivity efficiency of HD785-7, PT. ABP Energy's AMM site decided to study related to the modification of the Patria Mud Body on the Komatsu HD785-7 unit for overburdened transportation. The preparation of this technical study prioritizes the safety and security aspects of operators when operating the unit, as well as considering the reliability factor of the unit based on existing technical specifications. (Patria, 2019).

The purpose of the Patria mud body modification study on the Komatsu HD785-7 unit for overburden transportation is as follows:

1. Ensuring the safety aspect of mining operations
2. Know the benefits & costs to operations.

Method

Data Collection

Secondary data collection was carried out in the preparation of a technical study on the modification of the Patria mud body on the Komatsu HD785-7 unit for overburden transportation. Secondary data is in the form of Komatsu HD785-7 unit specifications, and Patria mud body specifications.

Methodology

The methodology used in the preparation of this technical study uses a literature study. Literature study is done by developing and calculating technical studies in accordance with the engineering data of Komatsu and Patria manufacturers.

Activity Stages (Flowcart)

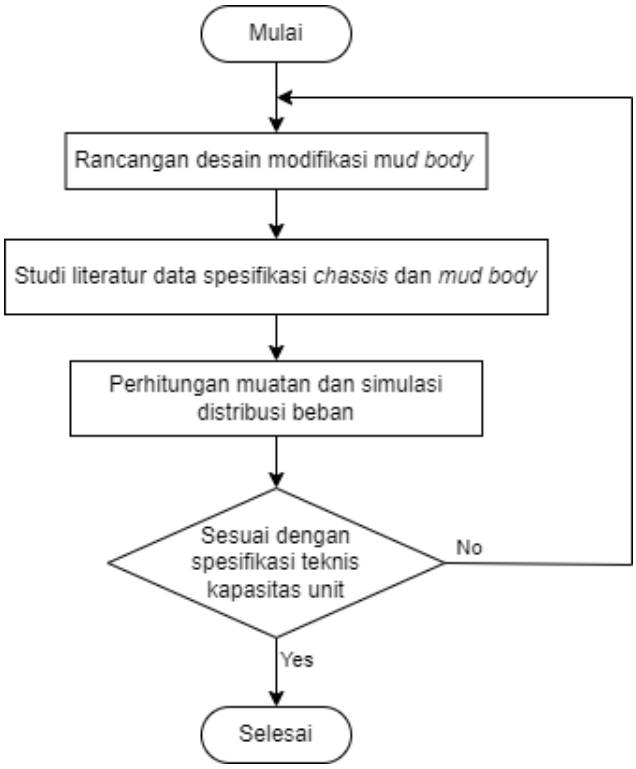


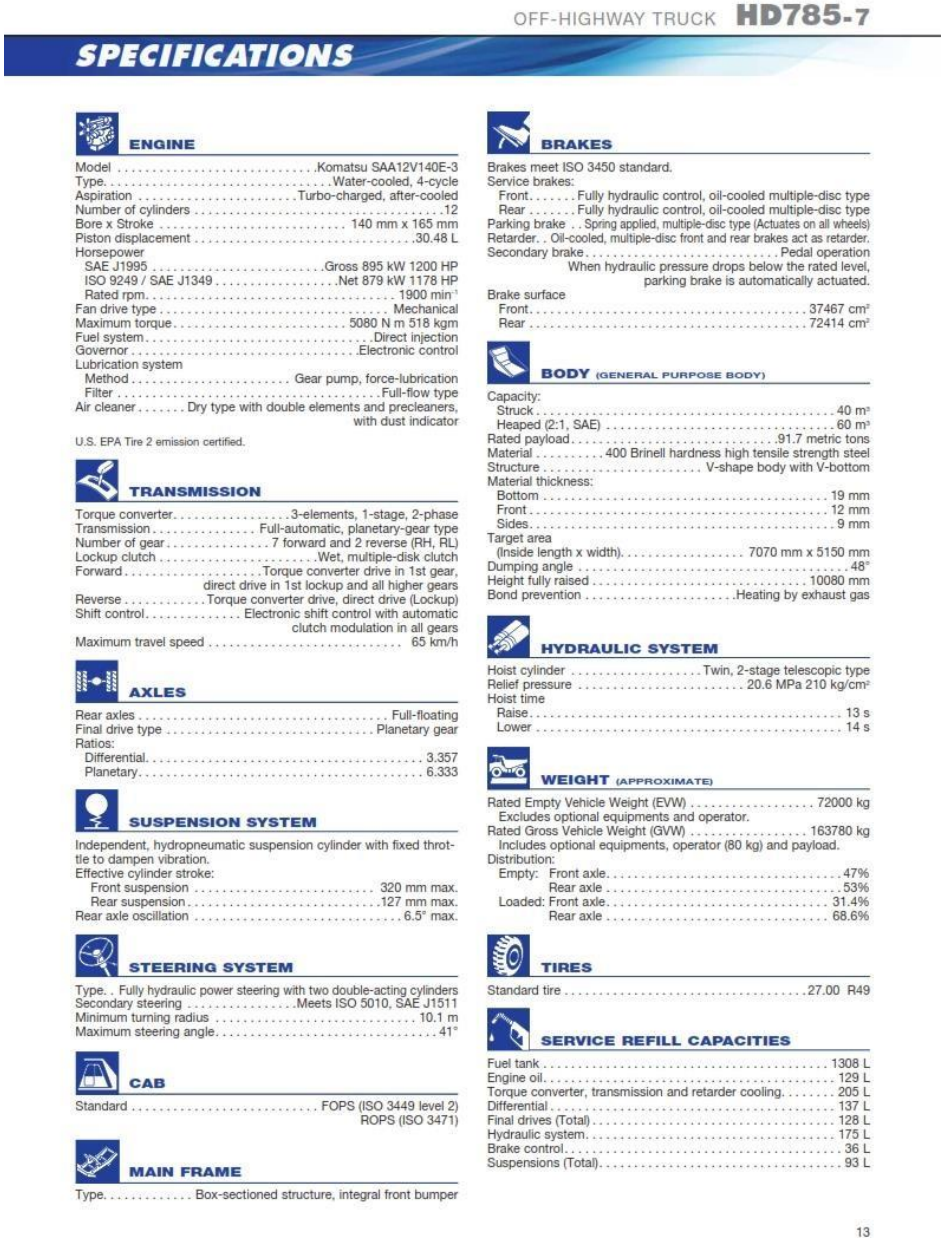
Figure 1

Activity Stages (Flowcart)

Results and Discussion

Unit Specifications

The Komatsu HD785-7 unit specification data is as follows:



OFF-HIGHWAY TRUCK **HD785-7**

SPECIFICATIONS

ENGINE

Model	Komatsu SAA12V140E-3
Type	Water-cooled, 4-cycle
Aspiration	Turbo-charged, after-cooled
Number of cylinders	12
Bore x Stroke	140 mm x 165 mm
Piston displacement	30.48 L
Horsepower	
SAE J1995	Gross 895 kW 1200 HP
ISO 9249 / SAE J1349	Net 879 kW 1178 HP
Rated rpm	1900 min⁻¹
Fan drive type	Mechanical
Maximum torque	5080 N m 518 kgm
Fuel system	Direct injection
Governor	Electronic control
Lubrication system	
Method	Gear pump, force-lubrication
Filter	Full-flow type
Air cleaner	Dry type with double elements and precleaners, with dust indicator

U.S. EPA Tire 2 emission certified.

TRANSMISSION

Torque converter	3-elements, 1-stage, 2-phase
Transmission	Full-automatic, planetary-gear type
Number of gear	7 forward and 2 reverse (RH, RL)
Lockup clutch	Wet, multiple-disk clutch
Forward	Torque converter drive in 1st gear, direct drive in 1st lockup and all higher gears
Reverse	Torque converter drive, direct drive (Lockup)
Shift control	Electronic shift control with automatic clutch modulation in all gears
Maximum travel speed	65 km/h

AXLES

Rear axles	Full-floating
Final drive type	Planetary gear
Ratios:	
Differential	3.357
Planetary	6.333

SUSPENSION SYSTEM

Independent, hydropneumatic suspension cylinder with fixed throttle to dampen vibration.

Effective cylinder stroke:	
Front suspension	320 mm max.
Rear suspension	127 mm max.
Rear axle oscillation	6.5° max.

STEERING SYSTEM

Type	Fully hydraulic power steering with two double-acting cylinders
Secondary steering	Meets ISO 5010, SAE J1511
Minimum turning radius	10.1 m
Maximum steering angle	41°

CAB

Standard	FOPS (ISO 3449 level 2) ROPS (ISO 3471)

MAIN FRAME

Type	Box-sectioned structure, integral front bumper

BRAKES

Brakes meet ISO 3450 standard.

Service brakes:	
Front	Fully hydraulic control, oil-cooled multiple-disc type
Rear	Fully hydraulic control, oil-cooled multiple-disc type
Parking brake	Spring applied, multiple-disc type (Actuates on all wheels)
Retarder	Oil-cooled, multiple-disc front and rear brakes act as retarder.
Secondary brake	Pedal operation When hydraulic pressure drops below the rated level, parking brake is automatically actuated.
Brake surface	
Front	37467 cm²
Rear	72414 cm²

BODY (GENERAL PURPOSE BODY)

Capacity:	
Struck	40 m³
Heaped (2:1, SAE)	60 m³
Rated payload	91.7 metric tons
Material	400 Brinell hardness high tensile strength steel
Structure	V-shape body with V-bottom
Material thickness:	
Bottom	19 mm
Front	12 mm
Sides	9 mm
Target area (Inside length x width)	7070 mm x 5150 mm
Dumping angle	48°
Height fully raised	10080 mm
Bond prevention	Heating by exhaust gas

HYDRAULIC SYSTEM

Hoist cylinder	Twin, 2-stage telescopic type
Relief pressure	20.6 MPa 210 kg/cm²
Hoist time	
Raise	13 s
Lower	14 s

WEIGHT (APPROXIMATE)

Rated Empty Vehicle Weight (EVW)	72000 kg
Excludes optional equipments and operator.	
Rated Gross Vehicle Weight (GVW)	163780 kg
Includes optional equipments, operator (80 kg) and payload.	
Distribution:	
Empty: Front axle	47%
Rear axle	53%
Loaded: Front axle	31.4%
Rear axle	68.6%

TIRES

Standard tire	27.00 R49

SERVICE REFILL CAPACITIES

Fuel tank	1308 L
Engine oil	129 L
Torque converter, transmission and retarder cooling	205 L
Differential	137 L
Final drives (Total)	128 L
Hydraulic system	175 L
Brake control	36 L
Suspensions (Total)	93 L

13

Figure 1
Komatsu HD785-7 unit specifications

The data specification data of the Patria Mud Body vessel carousel on the Komatsu HD785-7 is as follows:

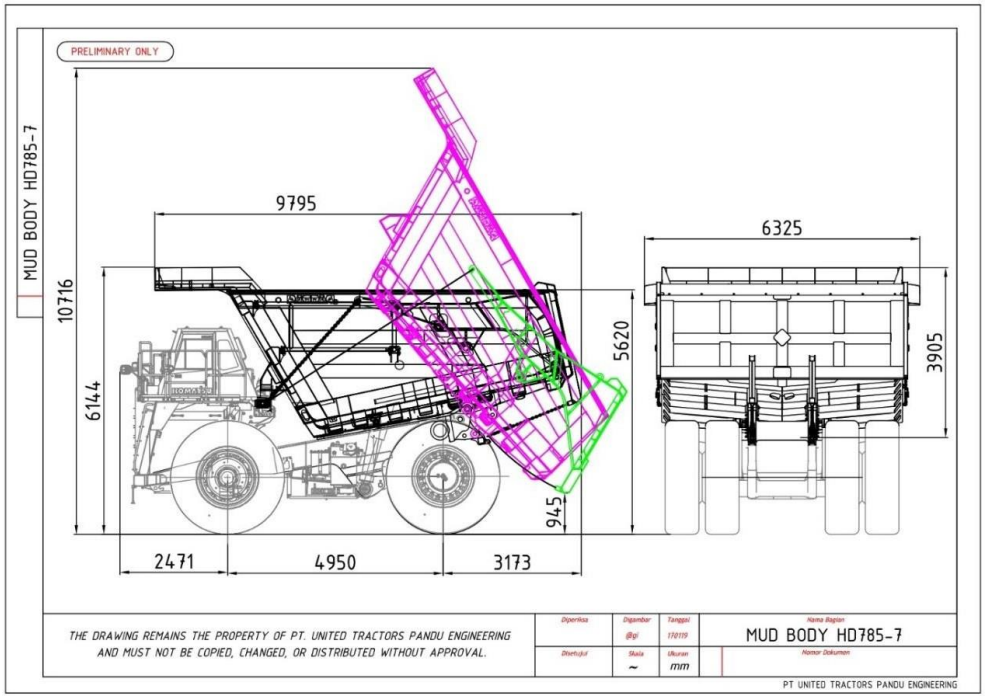


Figure 2
General Assembly Drawing Mud Body Patria on Komatsu HD785-7 unit

The Komatsu standard vessel specification data on the Komatsu HD785-7 unit is as follows:

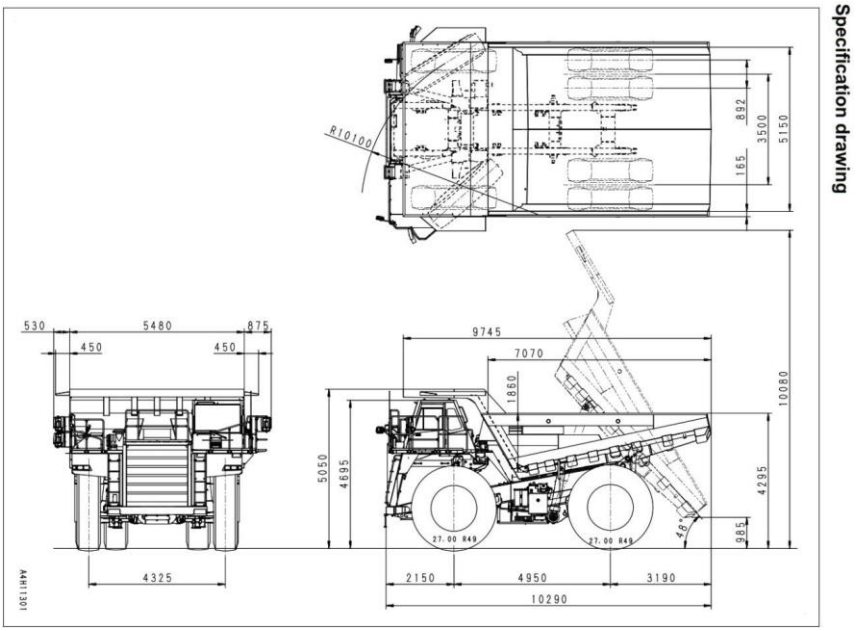


Figure 3
General Assembly Drawing vessel standard Komatsu manufacturer

Mud Body Modification Design

Initially, the Mud Body vessel installed on the Komatsu HD785-7 unit was designed by the Patria manufacturer to transport mud or mud materials. However, along with operational needs, the Mud Body is planned to be used for transporting overburdened materials.

Figure 4
Illustration of the Komatsu HD785-7 unit with Mud Body attached

Based on Patria's Mud Body specification data, the volume capacity of the Mud Body vessel is 60 M3, with a vessel and tailgate weight of 18,445 kg. Based on Komatsu standard vessel specification data, the volume capacity of the vessel is 40 M3 and the weight of the standard Komatsu vessel is 15,100 kg. If the Mud Body is compared to the standard vessel, there is a volume difference of 20 M3, and the weight difference reaches 3,345 kg. If the two vessels both function as overburden carriers, then there is a potential loss of 3,345 kg of payload weight per trip and greater fuel use, because there is a difference in the weight of the vessel empty. Therefore, to increase productivity to prevent overloading the Komatsu HD785-7 unit chassis and to achieve fuel efficiency, the Mud Body vessel will be modified to reduce volume by cutting part of the side wall of the Mud Body vessel, so that the empty weight of the vessel becomes lighter, but still has a volume capacity that is not much different from the Komatsu standard vessel so that it is expected not to reduce operational productivity.

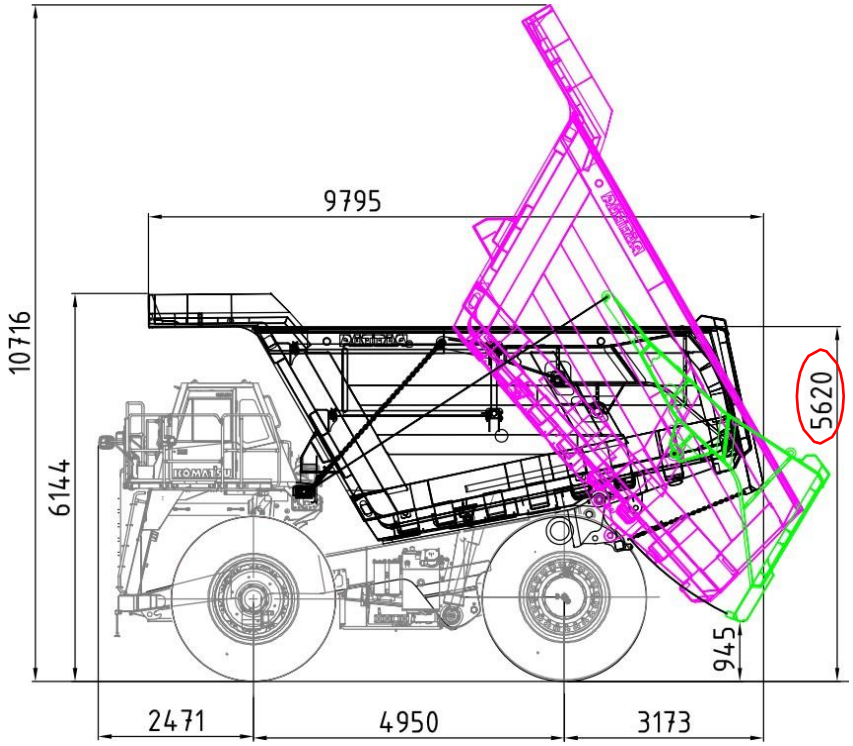


Figure 6
Specifications of Patria's Mud Body vessel on the Komatsu HD785-7 unit

Based on the data of the Mud Body Patria vessel specifications on the Komatsu HD785-7 unit, the Mud Body vessel has a height of 5620 mm or equivalent to 5.6 meters as shown in the image above. When compared to the standard Komatsu vessel height specification as in the picture below, which has a height of 4295 mm, there is a difference of 1325 mm or about 1.3 meters.

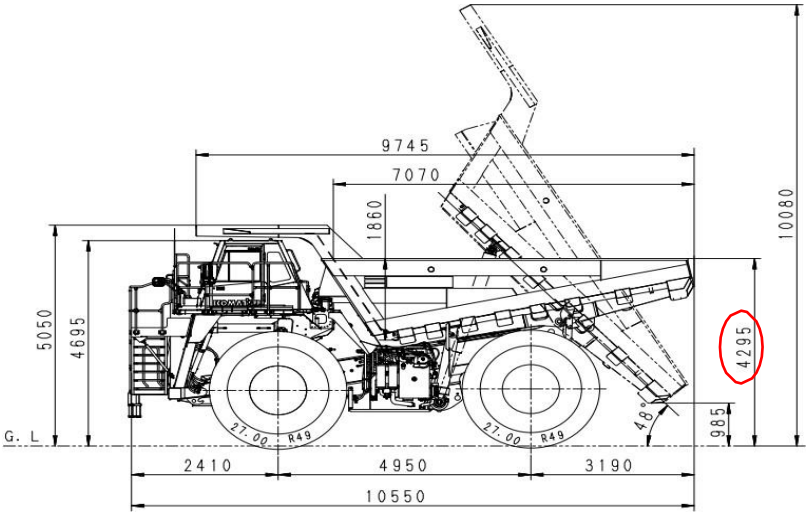


Figure 7
Komatsu standard vessel high-specification

If a modification simulation is carried out in the form of cutting part of the side wall of the Mud Body Patria vessel, right at the top of the longitudinal side wall member, then the illustration of the vessel is shown in the following figure.

Figure 8

Illustration of Cutting the Mud Body Patria vessel

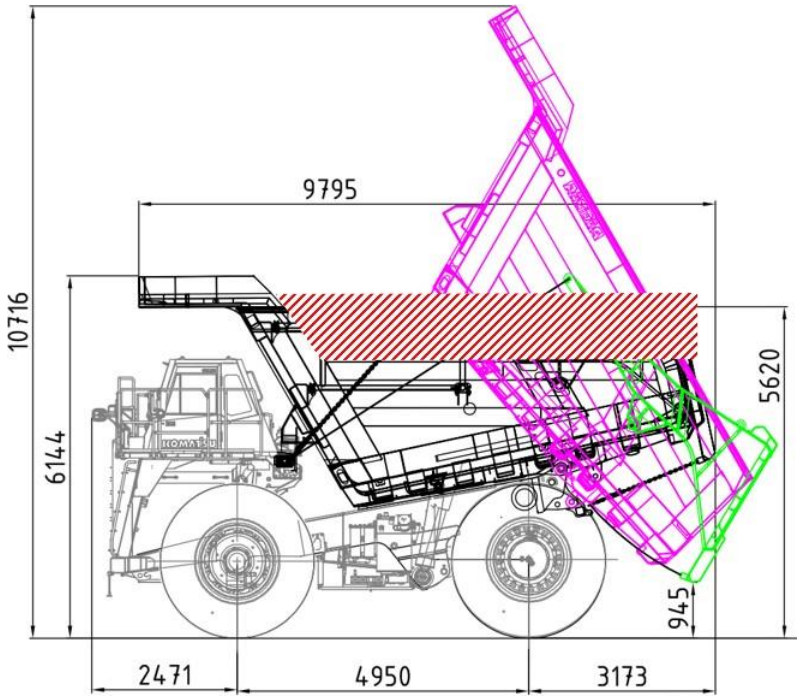


Figure 9
Illustration of the estimated height of the vessel after modification

In accordance with the drawing vessel of Patria's Mud Body, the overall length of the unit is 10.59 meters by 6.3 meters wide. With the dimensions of the unit, the planned location of the Mud Body modification activity is in an outdoor base with a flat surface and with location dimensions reaching 12.8 meters x 17.2 meters.

Figure 10
Layout Plan Location of Mud Body Modification Activity

Load Calculation and Load Distribution

The load calculation and load distribution were carried out to determine the impact of vessel modifications on the change in load distribution on the Komatsu HD785-7 chassis. After modifications, it is estimated that the volume of the Mud Body vessel will be the same as the volume of the standard Komatsu vessel. Therefore, the load distribution will also be the same according to the standard conditions of the unit as in the specifications below. This load distribution is by the technical specifications of the unit capacity of the Komatsu HD785-7 vessel is loaded according to the vessel capacity.

Weight distribution	Empty	(front)	kg	33,980 (47%)
		(rear)	kg	38,320 (53%)
	Gross	(front)	kg	51,440 (31.5%)
		(rear)	kg	111,860 (68.5%)

Figure 11
Specification of Weight Distribution unit with Komatsu standard vessel

Risk Analysis

Risk analysis was carried out to determine the potential hazards, and risks that arise and control/control of the potential hazards and risks that exist from the modification work of the Patria Mud Body vessel on the Komatsu HD785-7.

	Activity Details		Potential Hazards		Risks Arising	Control
1	Parking the HD785 Unit	1.1	Unit Maneuver	1.1.1	Ran over	Engineering: - Administration: - Work practices: - The driver is the one who has the SIMPER unit and has been tested for eligibility - 2-way communication with the driver - Spotter helps with traffic flow and gives cues to unit testers - AMM-ABP-IK-PLANT-085-R0 DIRECTS THE PARKING UNIT AND OR MOVES - Not in the maneuvering area of the unit Personal Protective Equipment: Safety Boots, Safety Helmet, Safety Glasses, Hand Gloves, Mask
				1.1.2	Hit	Engineering: - Administration: - Work practices: - The driver is the one who has the SIMPER unit and has been tested for eligibility - 2-way communication with the driver - Spotter helps with traffic flow and gives cues to unit testers - AMM-ABP-IK-PLANT-085-R0 DIRECTS THE PARKING UNIT AND OR MOVES - Not in the maneuvering area of the unit Personal Protective Equipment: Safety Boots, Safety Helmet
2	Washing Unit HD785	2.1	*Pressurized* water canon	2.1.1	Sprayed *water canon*	Engineering: - Administration: - Work practices: - P5M - AMM-ABP-IK-PLANT-62 – Washing the unit in the Wash Pad Personal Protective Equipment: Safety Boots, Safety Helmet, Safety Glasses
		2.2	Slippery work area	2.2.1	Slip	Engineering: - Administration: - Work practices: - P5M - AMM-ABP-IK-PLANT-62 – Washing the unit in the Wash Pad Personal Protective Equipment: Safety Boots, Safety Helmet, Safety Glasses
3	Cutting *Vessels* Using Oxygen & Acetylene	3.1	Sparks from cutting	3.1.1	Burn	Engineering: - Substitution of hose material by standards - Modified Tube Equipped with Flashback Arrestor Administration: -

					Work Practice: - Implementation of P5M - Implementation of the initial inspection of the supervisor's shift - Socialization of cutting procedures using Oxy Acetilyne - Socialization of oxygen acetylene welding procedures - Setting up the fire extinguisher - Welder Certification
					Personal Protective Equipment: Welding Masks, Welding Masks, Welding Aprons, Welding Gloves, Safety Shoes
		3.2	Part of a hot workpiece	3.2.1	Exposure to Heat
					Engineering: - Substitution of hose material by standards
					Administration: -
					Work practices: - Implementation of P5M - Implementation of the initial inspection of the supervisor's shift - Use fire blanked - Use a welding mask - Use a blower - Socialization of cutting procedures using Oxy Acetilyne - Welder Certification - AMM-ABP-IK-PLANT-055-R0 CUTTING USING CUTTING TORCH
					Personal Protective Equipment: Welding Masks, Welding Masks, Welding Aprons, Welding Gloves, Safety Shoes
		3.3	Work at height	3.3.1	Fall
					Engineering: - Provide Hand Rail
					Administration: -
					Work practices: - Using Body Harnes - Training working at height - Implement 3 points of contact
					Personal Protective Equipment: Welding Masks, Welding Masks, Welding Aprons, Welding Special Gloves, Safety Shoes, Body Harness
4	Smoothing the surface with hand grinding	4.1	Non-standard cable condition (frayed)	4.1.1	Electrocuted
					Engineering: - Compliant cable material substitution
					Administration: -
					Work Practice: Work Practice: - Implementation of the initial inspection of the supervisor's shift - AMM-ABP-IK-PLANT-120 OPERATION OF HAND GRINDING MACHINE
					Personal Protective Equipment:

					Welding Masks, Welding Masks, Welding Aprons, Welding Gloves, Safety Shoes
		4.2	Sparks from the grinder	4.2.1	Burn	Engineering: - Administration: - Work Practice: Work Practice: - Implementation of the initial inspection of the supervisor's shift - AMM-ABP-IK-PLANT-120 OPERATION OF HAND GRINDING MACHINE Personal Protective Equipment: Welding Masks, Welding Masks, Welding Aprons, Welding Gloves, Safety Shoes
		4.3	Work at height	4.3.1	Fall	Engineering: - Provide Hand Rail Administration: - Work practices: - Using Body Harnes - Training working at height - Implement 3 points of contact Personal Protective Equipment: Welding Masks, Welding Masks, Welding Aprons, Welding Special Gloves, Safety Shoes, Body Harness
5	Welding Using Electric Welding	5.1	The condition of the wires on the welding machine is not standard (chipped)	5.1.1	Electrocuted	Engineering: - Substitution of welding machine cable material by standards Administration: - Work Practice: Work Practice: - Implementation of the initial inspection of the supervisor's shift - Making check sheet P2H welding machine - Socialization of electric arc welding procedures - The welding process is not in a muddy place/Waterlogged - Welder Certification - AMM-ABP-IK-PLANT-054-R0 WELDING USING A WELDING MACHINE - AMM-ABP-SP-PLT-005-R0 CABLE CLASSIFICATION AND MAXIMUM CURRENT DELIVERED Personal Protective Equipment: Welding Masks, Welding Masks, Welding Aprons, Welding Gloves, Safety Shoes
		5.2	Sparks from welding	5.2.1	Burn	Engineering: - Modification with welding mask during welding Administration: -

				Work practices: Work Practice: - Implementation of the initial inspection of the supervisor's shift - Making check sheet P2H welding machine - Socialization of electric arc welding procedures - The welding process is not in a muddy place/Waterlogged - Welder Certification - AMM-ABP-IK-PLANT-054-R0 WELDING USING A WELDING MACHINE - AMM-ABP-SP-PLT-005-R0 CABLE CLASSIFICATION AND MAXIMUM CURRENT DELIVERED
				Personal Protective Equipment: Welding Masks, Welding Masks, Welding Aprons, Welding Gloves, Safety Shoes
5.3	Work at height	5.3.1	Fall	Engineering: - Provide Hand Rail
				Administration: -
				Work practices: - Using Body Harnes - Training working at height - Implement 3 points of contact
				Personal Protective Equipment: Welding Masks, Welding Masks, Welding Aprons, Welding Special Gloves, Safety Shoes, Body Harness

Benefit & Cost Analysis

1. Benefit

The modification of the Patria Mud Body vessel on the Komatsu HD785-7 unit for overburden transportation provides advantages including:

1) Minimizing the potential for overload due to reduced empty vessel weight.
2) Minimizing the potential for reduced unit reliability with reduced overload potential.

2. Cost Analysis

The modification of the Patria Mud Body vessel on the Komatsu HD785-7 unit for overburden transportation completes the estimated cost of Rp 3,220,000 per unit and requires an estimated allocation of work time for 4 shifts carried out by a total of 4 manpower people.

It	Items	Volume	Estimated Cost
	Man Power		
1	Labour	4	Rp 1.920.000

	Material			
1	Mild Steel Plate th: 0.8 mm	0,5	Rp	250.000
2	Oxygen	2	Rp	220.000
3	Acetylene	2	Rp	830.000
Total Cost			**Rp**	**3.220.000**

Implementation Plan and Monitoring

If the modification of the Patria Mud Body vessel on the Komatsu HD785-7 unit for overburden transportation is implemented, then a form of cargo monitoring, payload monitoring, and productivity monitoring of the Komatsu HD785-7 unit will be carried out.

Conclusion

Based on the results of calculations, simulations, and risk analysis that have been carried out, the following conclusions are obtained:

1. The volume specification of the Mud Body Patria vessel is 60 M3, with a height of 5620 mm. The volume specification of the Mud Body Patria vessel is 40 M3, with a height of 4295 mm.
2. The design of the modification of the Patria Mud Body vessel is to cut part of the side wall, which is right at the top of the longitudinal side wall member on the Mud Body vessel, and the volume specification of the vessel will change to around 40 M3 or in accordance with the standard Komatsu vessel volume.
3. Vessel modification is predicted to have no negative impact on the reliability and safety aspects of the Komatsu HD785-7 unit if loaded according to the vessel's capacity.

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