CATERPILLAR®

DEALER BEST PRACTICE SERIES

Payload Management

Maintenance | **Application** | Component Life Management | Component Rebuild | MARC Management

November 2012
0707-1.1-1089

1.0 Introduction

Off highway truck payload management is a fundamental requirement for proper equipment management. Proper payload management results in the following benefits:

1. Enhanced safety
2. Productivity optimization - Best possible ROI / Asset utilization
3. Fuel consumption optimization
4. Improved tire life management
5. Improved component life management
6. Improved frame and body life management
7. Improved body and bucket fill factors
8. Overall cost per ton improvements
9. Documented target payload
10. Sustainable payload management practices
11. Integral Historical data sets

Payload Management practices provides the most benefit when implemented and applied throughout the life of a machine. This will include implementation of practices prior to the order of the first machine and practices applied through the life of the machine.

There are many tools used to achieve successful Payload Management. Tools such as tare weight scales, or full size scales, and volumetric scanning can improve customer operations.

The tools are used to ensure proper bucket and body sizing prior to placing the machine orders, to adhere to target payloads and proper load placement, to recording and managing periodically gathered data. These are steps that will be discussed in greater detail throughout this document.

Whenever dealers enter into a contract with a customer guaranteeing Component Cost per Hour and Availability, they should include a requirement that the customer follows a **truck payload agreement which would be based on Caterpillar's Truck Payload Policy "10/10/20".**

Compliance to the **Large Mining Truck - Truck Payload Policy "10/10/20"** and diligent truck payload management are also requirements when requesting participation from Caterpillar in support of warranty considerations, maintenance and repair contracts (MARC's) for Mining Trucks, and risk partnering agreements. It should be agreed that regularly validated VIMS data is the agreed and accepted source for payload data.

Non-compliance to the **Large Mining Truck - Truck Payload Policy "10/10/20"** and poor truck payload management will increase risk and raise the following concerns:

1. Safety, exceeding steering, brake and ROPS (roll over protection structure) certification.
2. Loss in productivity due to under- or over-loads.
3. Tire life reduction from impact damage (spillage) or exceeding TKPH/TMPH value of the tire.
4. Decreased component life.
5. Increase in quantity, severity and frequency of frame/body cracks.
6. Increase in haul road maintenance cost and frequency.

A customer who is non-compliant to the dealer **Truck Payload Agreement** in a contract agreement/policy could result in the dealer cancelling the guarantee or entire contract.

Non-compliance to the **Caterpillar's Large Mining Truck - Truck Overload Policy "10/10/20"** could result in warranty claims being denied due to failures outside defective parts and workmanship, goodwill support being denied due to not managing the customer and their requirements, and the Risk Partnering agreement being canceled or modified. All of the above financially impact the dealer and customer.

2.0 Best Practice Description

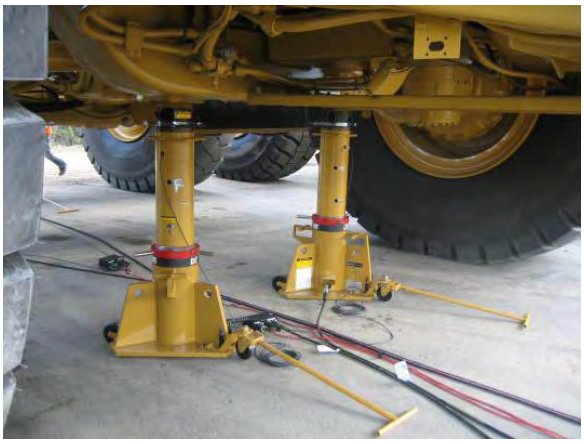
Off Highway Truck payload management involves multiple steps and systems. To achieve the best cost per ton value, trucks need appropriately sized bodies (matched to the loading tool wherever possible), accurate payload targets, properly updated off- and on-board software, and hardware that is correctly configured and calibrated. An ongoing maintenance, support and service program also needs to be in place to ensure that the on-board system is monitored and maintained to deliver consistent data. Once the data is off-board it needs to be correctly interpreted, reported and archived. Reports must be completed as necessary so that safety, productivity, and component lives are optimized. Any contractual deviations and training requirements need to be quickly identified and resolved.

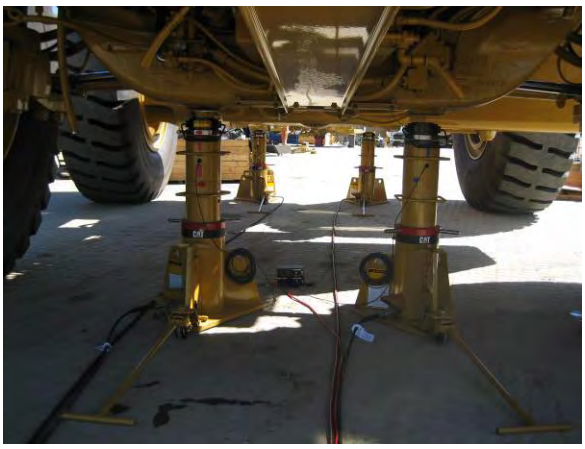
Key Segments 10/10/20 Policy

- Material density studies will deliver material weight which can be used to better determine bucket and body sizes. Utilizing the correct bucket and body sizes will deliver the correct pass match, eliminate partial bucket fills and additional passes to complete the load. Additional passes can increase cost per ton by 5–10%

Example of TVS (Volumetric Scanning)

- Correct target payload will deliver the payload that the loading tool operators should achieve on every load. Target Payload is Target Gross Machine Weight minus Empty Weight equaling Target Payload.



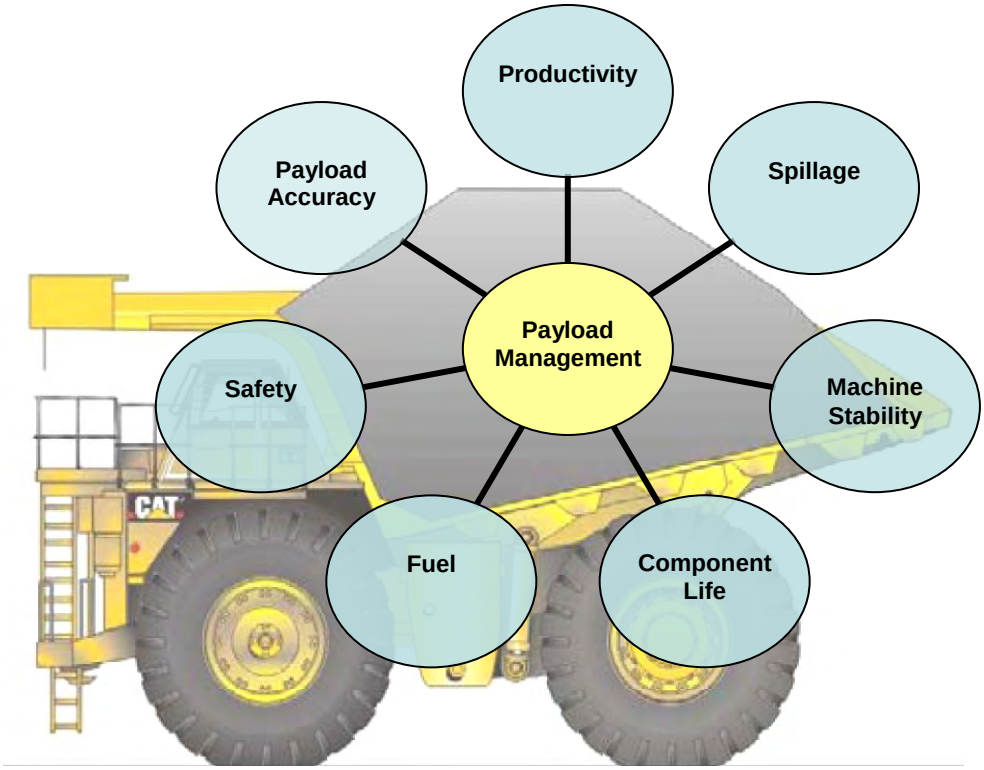


Example of truck tare weight system

Ongoing measurement and understanding of payloads is an exercise that must be performed several times per year to gain a clear understanding of operational changes and improvements. An annual weighing will not deliver the sampling to effectively manage change.

Example of truck weight and scanning system

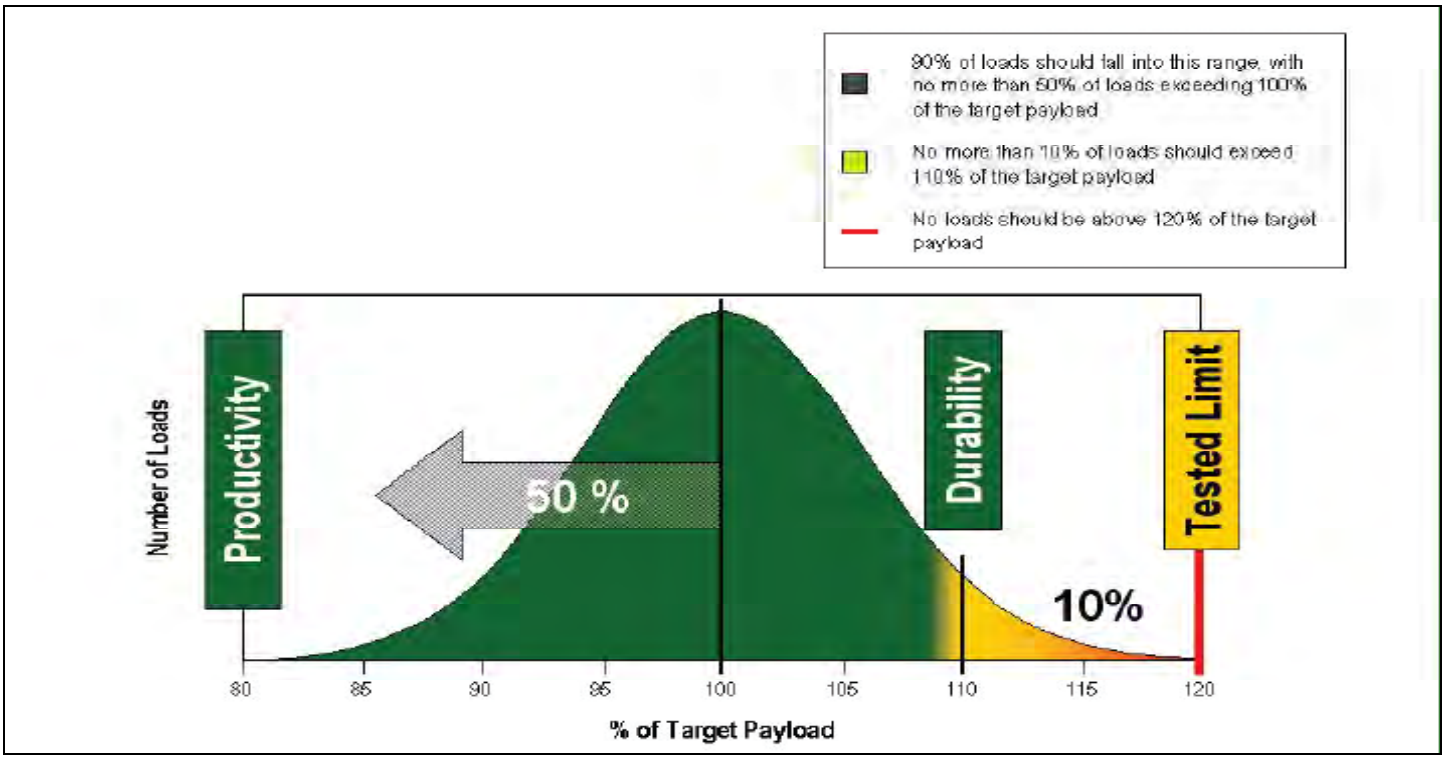
- Training
  - Operations – to understand the importance and effects of truck spotting and load placement on payload management
  - Maintenance – to understand the importance and effect that cylinder maintenance and proper strut pressure has on payload management
- Systems – VIMS (Vital Information Management System), TPMS (Truck Payload Management System), RAC (Road Analysis Control)
- Effects of Payload Management
  - Machine durability – struts, tires, components
  - Machine stability, spillage
  - Cycle time / productivity
  - Accurate target payloads
  - Fuel consumption improvement

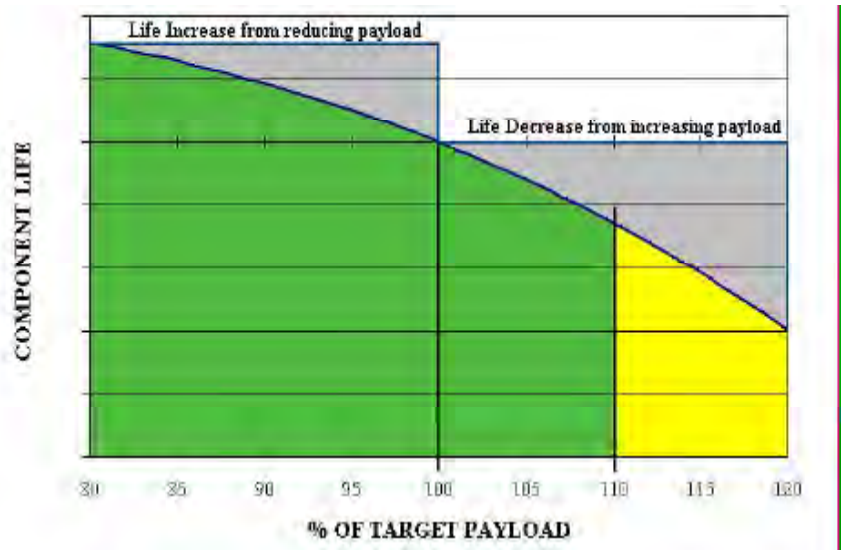


2.1 Large Mining Truck - Truck Payload Policy "10/10/20"

Caterpillar's payload policy, referred to as the "10/10/20" policy, states that.

"No more than 10 percent of payloads may exceed 110% the target payload; no single payload shall ever exceed the Maximum Allowable Payload, typically 120% of Target Payload. The mean of the payloads shall not exceed the target payload, hence no more than 50 percent of payloads may exceed the Target Payload. The rated capacity of the tires should always be considered in any evaluation."





Correct target payload:

- The correct target payload for each truck on site should be calculated and recorded. This can be performed and documented using a tare weight system.
- Chassis weight, truck configuration, body, tires, fuel tank, factory, debris and local attachments all need to be factored into the calculation in order to ensure correct target payload.
- Caterpillar has a weight configuration MS Excel file that is useful to calculate target payload if the “Tare Weight System” is unavailable. Contact the regional Caterpillar Global Mining Commercial Representative for access to this file or to schedule a tare weight system for the applicable model(s).
- The correct, documented target payload, should be programmed into the TPMS/VIMS system.
- Future attachments and additional body liners need to be monitored and the current Target Payload must be recalculated and adjusted if needed.
- “Carry back” in each body must be monitored and removed.
- Calibrated scales or a tare weight system must be used to verify tare weights.
- The data collected from the tare weight system or scales will only be recognized if the operator is in current certification.

CATERPILLAR 793F MINING TRUCK MASS CONFIGURATOR

CATERPILLAR

DESCRIPTION		PART #	MASS (kg)	WEIGHT (lb)
COMMON ARRANGEMENT				
COMMON ARRANGEMENT		278-8500	42638	94000
MANDATORY ATTACHMENTS				
PAYLOAD MONITOR SYSTEM	PAYLOAD, INDICATOR	279-0714	18	40
LIGHTING SYSTEMS	LIGHT , FRONT/REAR, HALOGEN	278-8429	21	45
BODY MOUNTING GROUPS	MOUNTING, BODY DUAL,MSD II, X-Body	278-8460	583	1285
MIRRORS	MIRRORS, STANDARD	300-5797	51	113
CAB WINDOWS	WINDOW, PASSENGER DOOR, FIXED	318-2464	112	247
OPERATOR SEATS	SEAT, CAT, COMFORT, 3 PT BELT	276-6123	86	189
TRAINER SEATS	SEAT, CAT, NON-SUSP, COMPANION, B	276-6124	39	87
VISORS	VISOR, FLIPDOWN, FRONT	276-6126	3	7
CAB ACCESS	ACCESS, SIDE	279-0692	15	33
GROUND ACCESS	LADDER, FIXED	286-2035	76	168
FUEL LINES AND TANK	TANK, FUEL, 750 GALLONS	258-6997	1213	2674
FUEL TANK	FUEL,750 GALLONS (100 %)	--	2412	5318
WHEEL ARRANGEMENT	WHEEL STATION AND 32" RIMS	319-7917	30972	68281
FILTER CONFIGURATIONS	FILTRATION, LINES, REAR AXLE	278-8438	18	39
EXHAUST SYSTEM	MUFFLER	278-8436	176	389
STARTING SYSTEM	STARTER, AIR, TURBINE, INGERSOLL	278-8471	266	586
ENGINE	ENGINE, STANDARD	278-8422	11716	25830
VESSEL ARRANGEMENTS	VESSELS, PRES, W/AIR START	301-6857	6523	14381
RETARDING	RETARDER, STANDARD	278-8423	3943	8692
GREASE INJECTION SYSTEM	INJECTOR, GREASE, LINCOLN SL-1	300-1269	35	77
SERVICE INSTRUCTIONS	INSTRUCTIONS, ANSI	278-8444	0	0

COMMON ARRANGEMENT WEIGHT	42638	94000
TOTAL MANDATORY ATTACHMENT WEIGHT	58278	128482
TOTAL OPTIONAL ATTACHMENT WEIGHT	21495	47388
OPERATING CHASSIS WEIGHT	122699	270505
ROPS CERTIFICATION TEST MASS FOR 793F	156400	344803
BODY WEIGHT	34591	76260
OPERATING MACHINE WEIGHT	157290	346765
DEBRIS AS SPECIFIED	2404	5302
EMPTY OPERATING WEIGHT	159694	352066
TARGET GROSS MACHINE WEIGHT	386008	851000
TARGET PAYLOAD (TONNES/TONS)	227	249

Requested By : Tim Webb

Prepared By : Amber Leaf

Process Owner: 793F Technical Leader

*ROPS Certification Test Mass includes Machine Configuration, Mandatory Attachment and Optional Attachment Weights (Including Dealer/Customer Attachments and 100% fuel)

*Debris is estimated to be 4% of Operating Machine Weight. Debris can be added in the Dealer/Customer Attachments.

DESCRIPTION	PART #	MASS (kg)	WEIGHT (lb)
OPTIONAL ATTACHMENTS			
BASE BODY CONFIGURATION			
☐ BODY, W/CANOPY, MSDII 209 CYD	273-3921	---	---
☐ BODY, W/CANOPY, MSDII 230 CYD	273-3920	---	---
☑ BODY, W/CANOPY, MSDII 250 CYD	273-3922	97743	61163
☐ BODY, X, W/CANOPY, 195 CYD	306-2680	---	---
LINERS			
CONTACT ROD BULL FROM THE BODY TEAM: 217-475-4230 INSERT LINER WEIGHT (KG) INTO GREEN SHADED CELL	---	6848	15097
MACHINE SERVICE			
☐ GAUGE, BRAKE WEAR INDICATOR	278-8431	---	---
OPERATOR ENVIRONMENT			
☑ CAMERA, REAR VISION WAVS	278-8498	17	38
☑ LIGHTS, ADDITIONAL	300-1810	13	28
POWERTRAIN			
■			
■			
■			
INFORMATION MANAGEMENT			
☑ CONTROL, ROAD ANALYSIS (RAC)	192-7419	0	0
COLD WEATHER			
☑ STARTING, COLD WEATHER	284-2734	32	70
SERVICE CENTER			
☑ SERVICE CENTER, FASTFILL	278-8445	124	272
■			
MISCELLANEOUS			
☑ FIRE EXTINGUISHER, PORTABLE	3Z-4856	20	45
☐ HUB ODOMETER, MILES	143-2253	---	---
☐ HUB ODOMETER, KILOMETERS	143-2256	---	---
☑ WHEEL CHOCKS	143-2247	45	99
☐ CENTER TOW BUMPER	304-5217	---	---
☐ CABIN PRECLEANER	332-2270	---	---
RIM GUARDS			
☐ GUARD, RIM MOUNTING	208-8789	---	---
TIRES			
☐ BRIDGESTONE 40.00R57	1	---	---
☐ BRIDGESTONE 46.90R57	2	---	---
☐ GOODYEAR 40.00R57	3	---	---
☐ GOODYEAR 45.00R57 2PC REARS W/ 46/90R57 GY FRONTS	4	---	---
☐ GOODYEAR 46.90R57	5	---	---
☑ MICHELIN 40.00R57	6	21244	46836
☐ MICHELIN 50.80R57	7	---	---
☐ EUROTIRE 40.00R57	8	---	---
☐ BELSHINA 40.00R57	9	---	---

DEALER / CUSTOMER ATTACHMENTS			
FIRE SUPPRESSION SYSTEM		210	
COMMUNICATION SYSTEM		8	
DEBRIS % (use spinner to right)	2	2404	5302

Example of Caterpillar Payload Configuration Calculation MS Excel, files available from Global Mining Representative

2.2 Training

2.2.1 Operations Training

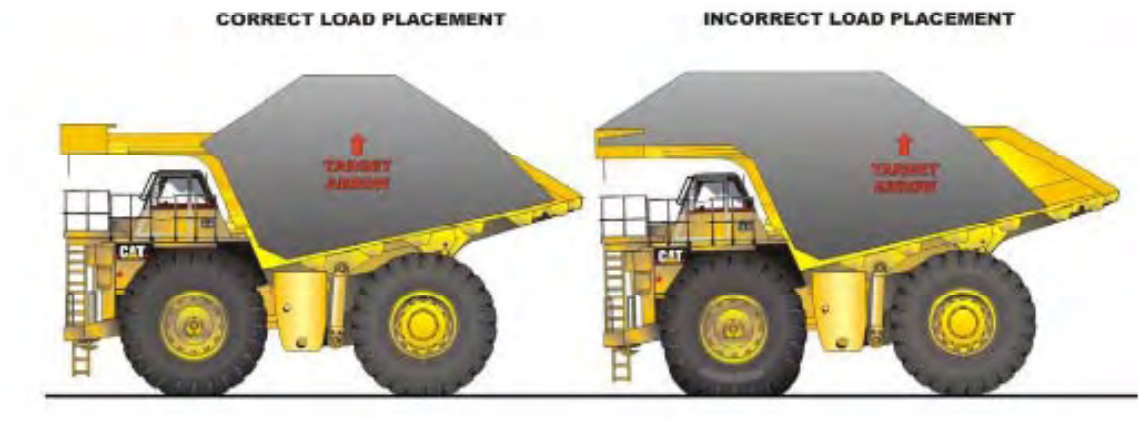
Operations Training is a key component of payload management. Both truck and loader operators as well as mine management (supervision, engineering, planning, etc.) need a good understanding of proper load placement and accurate target payloads. A detailed understanding of VIMS payload warnings, score board operation, payload lamp functions and the potential effects of poor payload management is also part of this key segment.

Placement of payload

There are three types of improper load placement: load shifted towards the front, load shifted towards the rear, and load shifted towards the side.

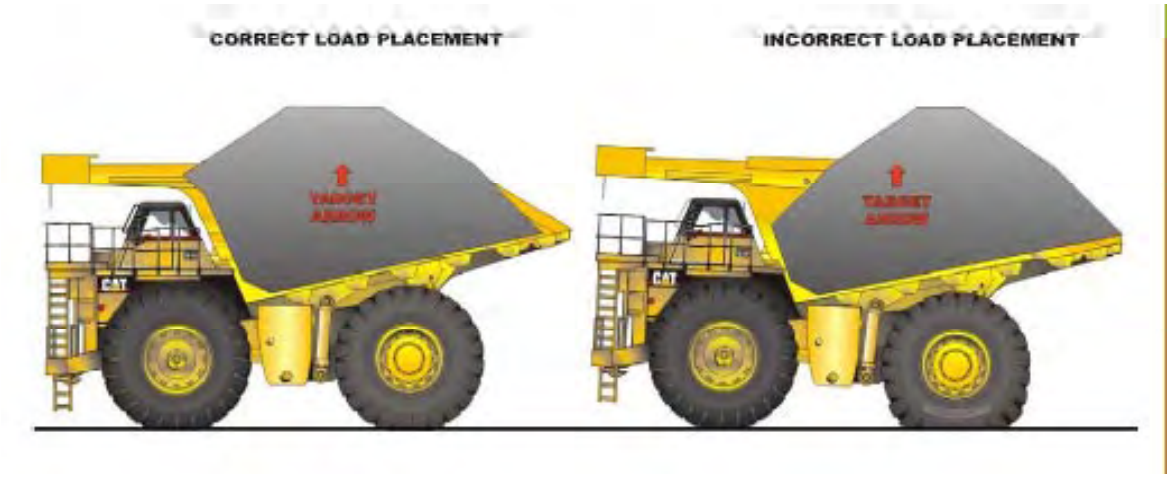
All three types of improper load placement negatively impact frame and body life. If the load is shifted towards the front, the front brakes, wheel bearings, front tires, front suspension, steering, hydraulic hoist system, body rest pads, and body canopy will be negatively impacted.

Moving the CG (center of gravity) forward will also result in the VIMS system recording an inaccurate light load.



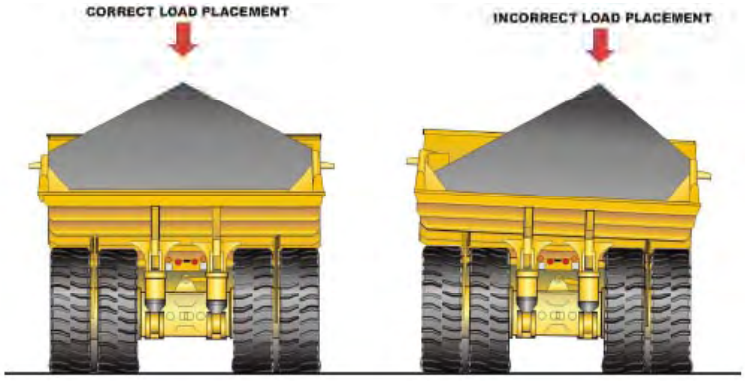
If the load is shifted towards the rear, the final drives, suspension cylinders, and rear tires will be negatively impacted. Furthermore, the payload will become unstable and may spill off the back of the body.

Moving the CG back will also result in the VIMS system recording an inaccurate heavy load.



If the load is shifted towards the side, the final drive, bearings, hoist cylinders, and pivot bore areas will be negatively impacted.

An off center load will also result in the VIMS system recording an inaccurate load.

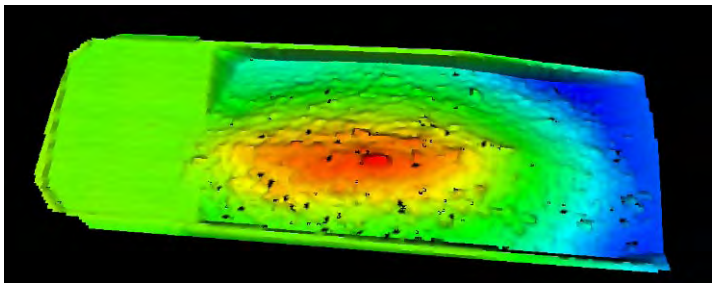


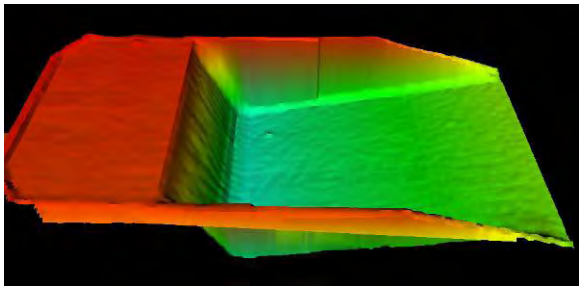
Loading trucks on uneven ground greater than 5% grade will also result in inaccurate payload under the loading tool. Second gear reweigh may improve the accuracy of the displayed / recorded payload.

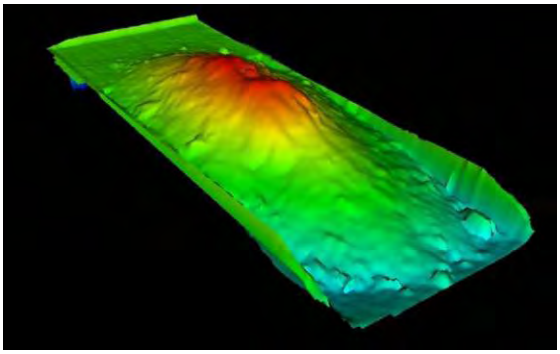
Loading trucks with one or both sets of the rear wheels contacting the load face or toe will negatively impact the tires, frame and suspension cylinders. This will also result in an inaccurate load under the loading tool. Second gear reweigh may improve the accuracy of the displayed / recorded payload.

It is important that the section of road where the truck initially changes from 1st to 2nd gear is as level and even as possible – this will optimize the 2nd gear reweigh and improve payload accuracy.

TVS (Volumetric Scanning) can be used to view and monitor load placement as well as assist in operator training.

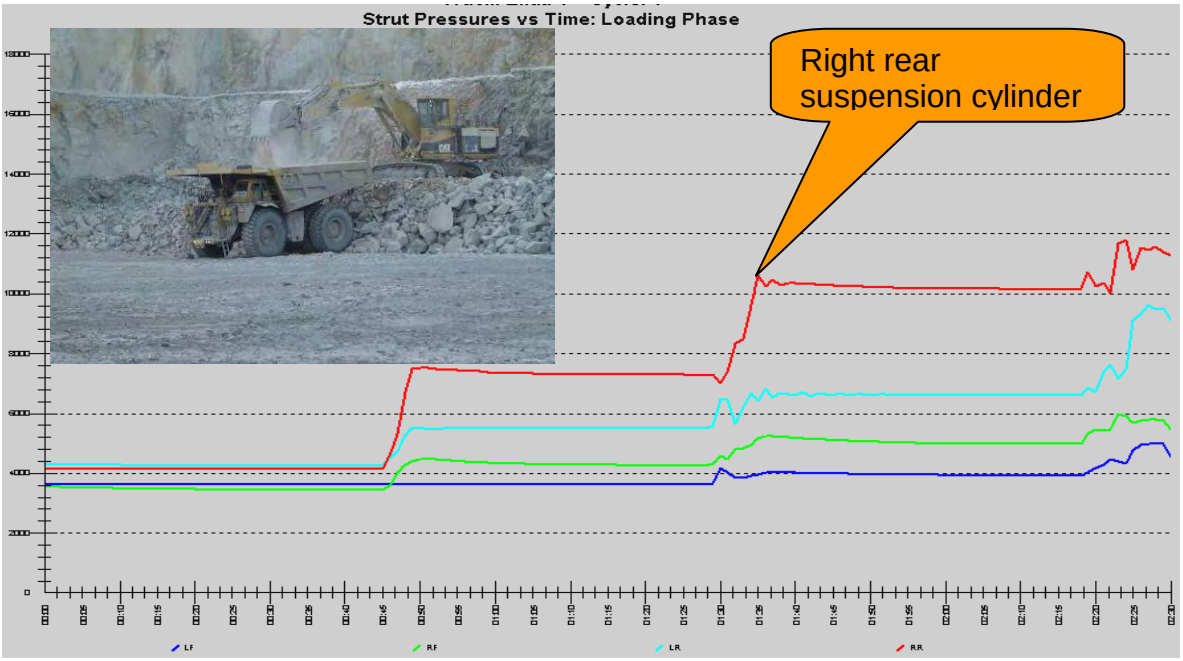






The data delivered from scales and scanning will document the load position with both primary numbers and a visual image. As load position is critical to TPMS accuracy, scales are the tool for taking these measurements and recording the data. During weight studies, it is important to determine if the body load indicator is in the correct location. This is gained by physically viewing the load position relative to the body load indicator whilst you have a best practice payload, IE optimal axle distributions and target payload.

Empty axle split is also critical to TPMS accuracy. If attachments are added and the factory empty axle split is change, TPMS system will be affected and impact the accuracy of the data.



Example of truck contacting the bench. Notice how the pressure in the right rear suspension cylinder is dramatically higher than the other cylinders.

2.2.2 Maintenance Training

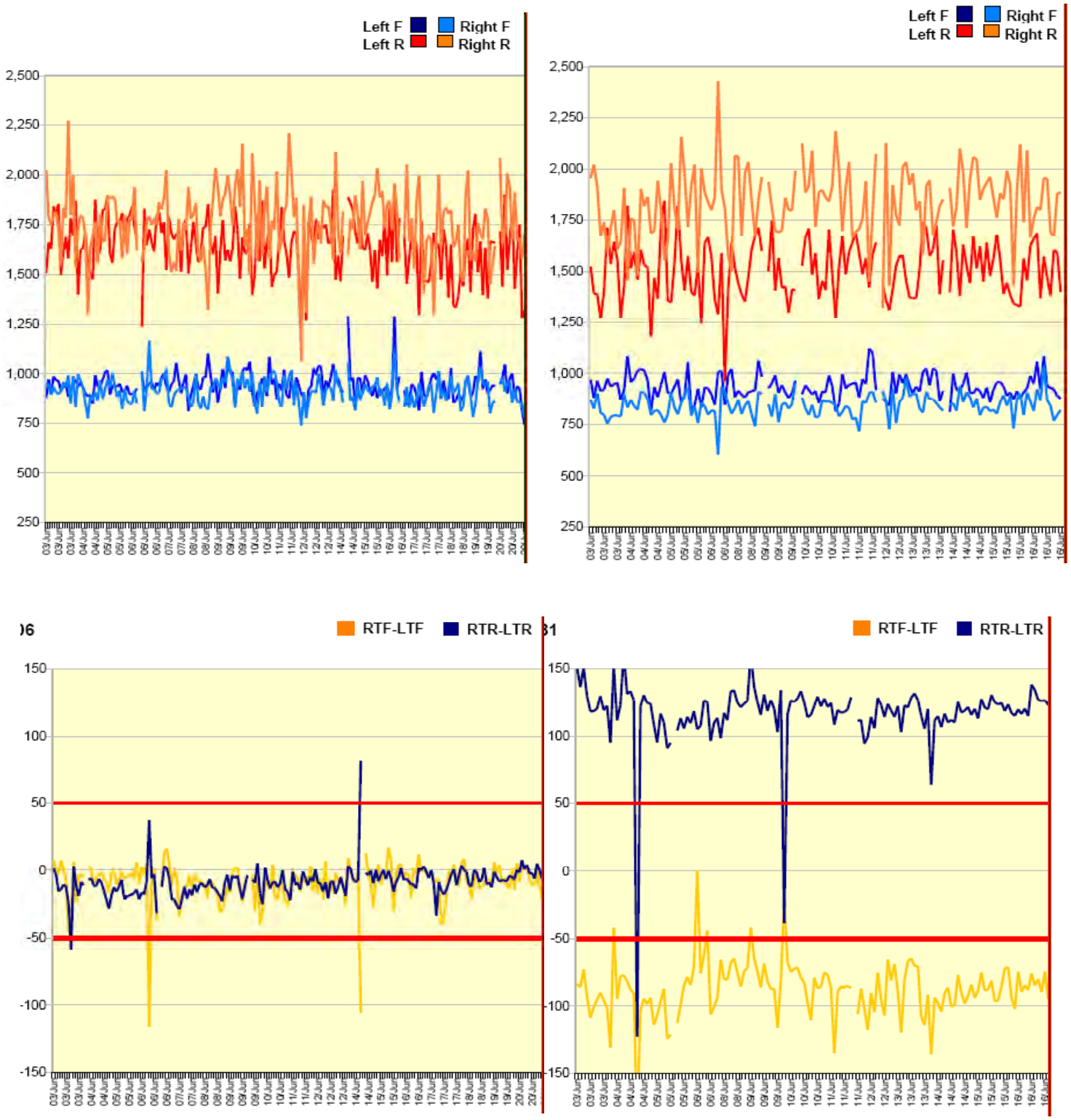
Suspension cylinder maintenance:

- The accuracy of the data from each suspension cylinder is critical to the system accuracy.
- The mechanical function of the cylinders need to be maintained with the correct oil and nitrogen charge, adequate grease for the front cylinders, and adequate lubrication for all suspension link/cylinder pins *(refer to SEHS9411-10 Servicing the Suspension Cylinders For Off Highway Trucks for more information).*
- The sensing function needs to be maintained. Strut pressure sensors, harness, harness plugs and the seals/valves in the sensing block all need to be in good working order.
- The suspension cylinders and sensing system should be a part of the site maintenance program. Ride height, nitrogen charge, and sensor accuracy should be checked at least once per year or every 6000 SMU.
- The suspension cylinder pressure trends, left to right pressure variance, and event list should be monitored on a weekly basis using VIMSpc, VIMS supervisor, or MineStar Health. The trends can show trucks with pressure sensing events or nitrogen leaks. The VIMS event list will show any intermittent or active fault codes.

PSI	Front Left	Front Right	Rear Left	Rear Right	RTF-LTF Suspcyl Empty	RTR-LFR Suspcyl Empty
	>10%				>50 PSI	
08-101	970	852	1,710	1,663	-16	-25
08-102	931	897	1,685	1,626	-6	25
08-103	958	907	1,560	1,800	-80	-1
08-104	887	924	1,728	1,588	-42	40
08-105	954	923	1,626	1,656	-23	-10
08-106	942	906	1,615	1,727	-13	-9
08-107	945	943	1,842	1,467	79	-131
08-108	934	890	1,666	1,687	5	-76
Avg:	**946**	**927**	**1,699**	**1,664**		

Example of a custom MineStar suspension cylinder exception report

This report indicates any units with individual cylinder pressures that deviate 10% outside the fleet average. The report also shows any left to right cylinder differences with a positive or negative variance greater that 50 PSI. This allows trucks with active or potential problems to be identified so corrective steps can be taken.



Example of custom MineStar trend graphs

Left hand set show a normal trend, right hand set shows a truck with problems.

- Mechanical and charge problems typically impact all cylinder trend lines, if one cylinder is under charged, the other three cylinders carry more load.
- Electrical issues typically impact a single trend line, as the other cylinders are still carrying their typical load.
- May be indicating a Front-Right load placement condition.

2.3 Systems – VIMS, TPMS, RAC

2.3.1 VIMS

Refer to the following:

RENR2630: *Systems Operation - 784C – 797B Off Highway Truck / Tractors Vital Information Management System (VIMS)*
RENR2635: *Systems Operation - 784C – 797B Off Highway Truck / Tractors VIMS Truck Payload System*
KENR5955-02: *Systems Operation - 773F, 773F OEM, 777F and 777F OEM Off-Highway Truck/Tractors and 775F and 775F OEM Quarry Truck Vital Information Management System (VIMS)*
KENR9023-04: *Systems Operation - 793F and 797F Off-Highway Truck VIMS, Monitoring and Payload*

2.3.2 TPMS

Refer to the following:

SENR4733: *Systems Operation and Testing and Adjusting – 69D – 793 Off Highway Truck / Tractor and 771D-775E Quarry Trucks Payload System*

2.3.3 RAC

Refer to the following:

RENR2636: *Systems* Operation – Off Highway Truck Road Analysis Control (RAC)

2.4 Effects of Payload Management

Refer to the following Cornerstone Technical Sales Presentation:

AEXC0614: *Mining Machine Applications*
AERQ0021-01: *Haul Road Design & Management*
AEXC0638: *Truck Tire Management*

3.0 Implementation Steps

- Conduct density analysis using TVS (Transcale Volumetric Scanning) when sizing truck and loading tool bodies and buckets. This will deliver material density and offer greater details when sizing fleets based on different material densities. Perform a scale study to validate target payload, body capacity and TPMS accuracy.
- Perform a tare weight (target payload) study at the time of commissioning to establish and verify target payload.
- Create systems to record and document payload data and operations.
- Conduct training with maintenance, and operations personnel.
- Establish strut maintenance and calibration programs.

- Assign personnel responsible for reporting abnormal or an out of spec condition.
- Maintain and re-evaluate implementation steps on a semi or quarterly basis or as needed after abnormal or out of spec condition is identified.

4.0 Benefits

Off highway truck payload management is a fundamental requirement for good equipment management. It is also a factor in optimizing owning and operating costs. Focus on payload management can result in the following benefits:

1. Enhanced safety
2. Productivity optimization (cost per ton reduction)
3. Fuel consumption optimization
4. Improved tire life management
5. Improved component life management
6. Improved frame and body life management
7. Target Payload accuracy
8. More accurate body and bucket sizing
9. TPMS management and data accuracy

Good payload management can be used to support warranty and goodwill claims along with these additional benefits:

- Managing payloads and max GVW will place the truck in a safe range when considering structures and braking designs of the hauling units
- Managing consistent target payloads will reduce operating costs of the hauling fleet thus reducing cost per ton
- When hauling units are operated in the max GVW range, Cat mechanical drive trucks will perform in 2nd gear on 12% total effective grade at a lower engine RPM than in 1st gear, max RPM which will increases fuel burn and reduces engine life
- Documented material density, which helps with proper bucket and body sizing, less free board, reduced tare weights and greater payloads. Proper bucket and body sizing can also reduce partial passes reducing cost per ton
- These tools will also validate the accuracy of the on-board systems on a regular basis

5.0 Resources Required

The size of the fleet and the level of detail required in the reports will drive the required resources. Payload management should be part of the equipment management process on site.

If the fleet is large enough and the site has a dedicated Fleet Analyst, payload management should be part of their responsibility. Tare weight, full size scales and volumetric scanning system should be considered as on site validation tools.

The computers and programs at site level should already be in place for VIMS and ET (electronic technician). If not, a notebook computer and subscriptions to VIMSpc and VIMS Supervisor will be required.

- For large fleets, various wireless communication options and EMS reporting packages are available to provide exception based and detailed reports on a daily, weekly and monthly basis.
- Calibrated scales should be used when possible for setting target payload and calibrating suspension cylinders. Dealers and Caterpillar can assist in obtaining these resources. These systems are also designed to communicate with the systems we have in place today.

6.0 Supporting Attachments / References

Caterpillar Mining Trucks Payload Management Guidelines AEX0250-02.pdf
Road Analysis Control Salesgram TELQ4461.pdf
Truck Production System Salesgram YEXQ0274.pdf
Machine ECM and VIMS Set-Up Information.pdf

7.0 Related Best Practices

None at this time.

8.0 Acknowledgements

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