Safe and Efficient Dump Body Removal and Installation by Means of the KIMBO Dump Body Exchange System

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There is a growing trend in open-cast mining operations to use larger haul trucks, as the increased hauling capacity benefits productivity and cost optimization. The dump body of the haul truck is a primary wear item and replacement of this dump body, which can weigh in excess of 50 tonnes, presents a major challenge to maintenance crews. The standard method for dump body removal and installation is by means of one or two high-capacity mobile cranes. Such an operation is labour-intensive, time-consuming and working with such a large suspended load is extremely hazardous. The KIMBO Dump Body Exchange System, designed and manufactured by Novamine, based in Chile, addresses all of these issues by changing the standard method of operation from a "suspended load" to a "supported load" scenario, by means of a hydraulic lift system.

INTRODUCTION

In order to optimize hauling capacity and running costs, more and more open-cast mining operations are using larger haul trucks. The dump body of the haul truck is a primary wear item and, depending on the type of ore being hauled, the operating lifespan of the dump bodies can range from 7000 (e.g., iron ore) to 20 000 (e.g., coal) operating hours before requiring refurbishing. The replacement of these dump bodies, which can weigh in excess of 50 tonnes, presents a major challenge to maintenance crews and is a very hazardous operation.

The standard method for the dump body removal and installation is by means of one or two high-capacity mobile cranes, as shown in Figure 1. These cranes have to be operated with precise coordination. Normally, this requires a crew of a minimum of five skilled people per crane plus two low boy truck operators for the transportation of the dump body. Feedback from maintenance crews around the world shows that between seven and fourteen persons are being assigned to this operation.

Extreme precision is required from the operators to ensure the problem-free removal of the hoist cylinder pins. The operation has to be done in an open and levelled area and it is not uncommon for it to last more than 30 hours. A critical aspect is that special attention has to be given to all safety procedures to minimize the inherent risks of working with a "suspended" load that, in some cases, can be over 50 metric tonnes. Weather conditions can often adversely affect its progress and safety. Wind, in particular, is of concern and activities are normally halted if wind speeds exceed 35 km/h.

The main concerns or disadvantages of the traditional "suspended load" dump body removal and install procedure, as reported by our customers, are as follows:

Figure 1. Typical method of dump body removal / installation executed with the use of two mobile cranes.

- Safety concerns: The suspended load can be as high as 52 plus tonnes (CAT 797 Dump Body case). Service crews are forced to execute the task of removing the dump body and hoist cylinder pins under a suspended load.
- Accessories: Use of lifting devices (cables, chain, rope) represent a high risk if not maintained, inspected and installed and used carefully.
- Cranage: Availability of mobile cranes, suitable to handling the dump body weight, can be problematic, as few operations have cranes that are dedicated to only this task.
- Weather: Unpredictable weather conditions can result in delays or cancellation of the task.
- Manpower: Significant manpower is required to complete the operation. Normally the people involved in this operation can be as many as seven (using one crane) to fourteen persons (using two cranes), comprising one lead supervisor, one safety expert, two or four mechanics to control the position cables ("wind control" cables), two or four riggers to assist the crane operator by signals, one or two skilled crane operators and two low boy truck operators.
- Pin removal: Removal of the pins is a major challenge for the service crews when using the two-crane method. Because the four lifting points cannot be individually controlled, pins tend to get stuck and this issue is regularly cited as the bottleneck, resulting in delays in the procedure.
- Dump body transportation costs: The almost inevitable delays can result in increased transportation costs as lowboy trucks frequently have to wait for the task to be completed before a dump body can be transported.
- Haul truck downtime: Planning departments normally schedule two eight-hour shifts for a dump body change. It is, however, very common for this allocation to be exceeded because the operation is affected by numerous variables and uncontrolled events. The result is that the operation can easily end up taking between 24 and 36 hours.

The KIMBO Dump Body Exchange System, designed and manufactured by Novamine, based in Chile, addresses all of these issues by changing the standard method of operation from a "suspended load" to a "supported load" scenario, by means of a hydraulic lift system.

THE KIMBO DUMP BODY EXCHANGE SYSTEM

Description

The KIMBO System (Patents involved: CL Pat. 293, CL Pat. 50.242 and CL Pat. 49.677; Patent Pending: CL2014-001442) was developed and manufactured by Novamine SpA., a specialized company in the field of development and manufacturing of innovative mining solutions located in Antofagasta, Chile. Over the past 12 years, the system has been refined and optimized to provide an extremely safe and efficient means of changing out haul truck dump bodies.

The system, as illustrated in Figure 2, consists of six hydraulically operated columns that are positioned to form two work zones, dedicated to perform the operation of removal and installation the truck dump body. The two central columns are able to rotate by 180 degrees to allow operation in both work zones.

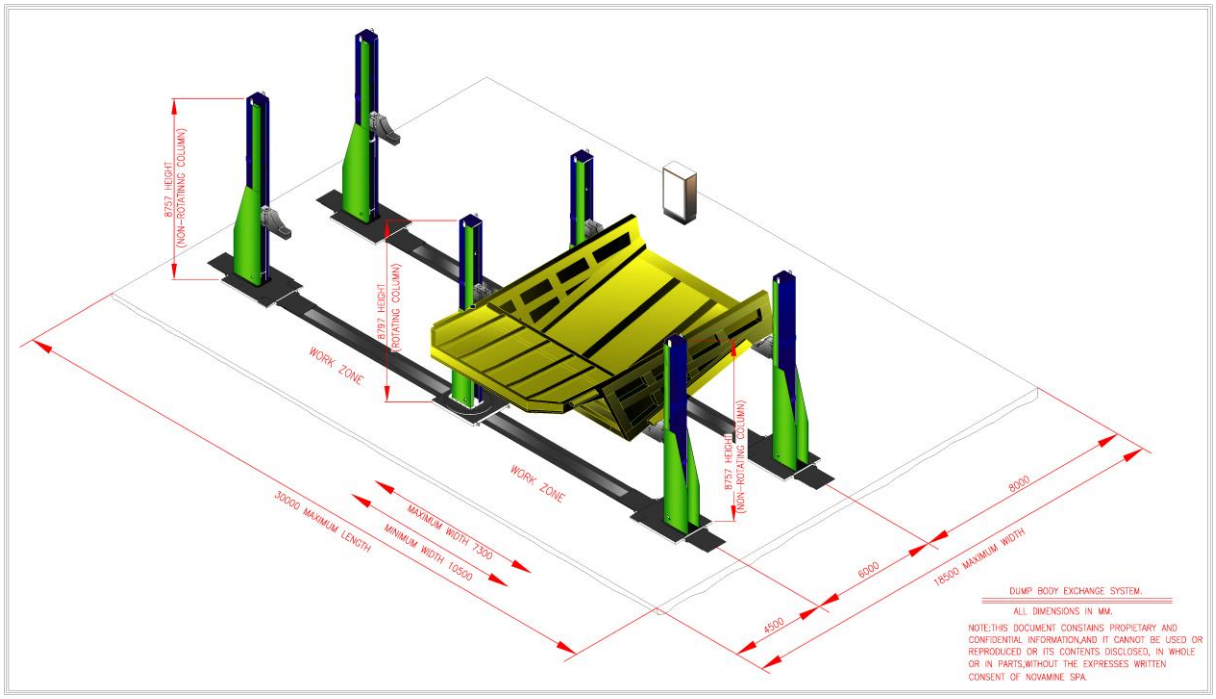

Figure 2. General arrangement drawing of the KIMBO Dump Body Exchange System.

Each work zone of the system operates with four support arms installed in four respective columns. The sideways or horizontal adjustment of the columns is designed to facilitate the positioning (entry and exit) of the truck.

The vertical adjustment of the support arms are dedicated to lift and manoeuvre the body to remove it from the truck and to positioning the dump body on four support stands or directly onto a low boy truck. The vertical movement of the support arms, combined with the horizontal movement of the columns, permits an extremely precise tri-axial adjustment (x,y,z). Vertical and horizontal movements are controlled by independent hydraulic systems.

The support arms on each column (vertical adjustment) can be raised and lowered by wireless remote control (Figure 3), enabling the operator to stay outside of the hazardous zone. The system enables three different types of individual movement, in front/back pairs or all four supports arms simultaneously. The vertical movement can also be controlled from the Human Machine Interface (HMI), in the KIMBO control cabinet (Figure 4).

Figure 3. Wireless remote control for the KIMBO system.

Figure 4. KIMBO control cabinet (HMI).

The horizontal movement of the columns is selected from the HMI, but is controlled by the operator from the lower part of each column, as shown in Figure 5.

Operation

The dual work zone of the KIMBO system makes it possible to prepare the new dump body in one of the zone prior to the haul truck arriving at the work area.

A new dump body would be brought in on a low boy truck.

- The low boy truck is positioned between the pillars of the first work zone (Figure 6).
- The four columns of the work zone are moved in horizontally until the support arms are in the correct position to lift the dump body.

Figure 5. Central, rotating column of the KIMBO system.

Figure 6. Front view one work zone of the KIMBO system – Low boy truck bringing a new dump body.

- The dump body is lifted off the truck in under 15 minutes and the truck is free to leave.
- The dump body is then lowered onto four support stands (Figure 7).
- The central pillars rotate 180º to face the second work zone.
- The haul truck is brought in and positioned between the pillars of the second work zone (also shown in Figure 7).
- The four columns of the work zone are moved in horizontally until the support arms are in the correct position to lift the dump body.
- The columns now lift the dump body to a point where the pins can be easily removed. The vertical movement of the support arms is slow and controlled, making precise, minute adjustments possible. The independent movement of the support arms makes it very easy to attain the sweet spot at which the pin can be pushed out easily.

Figure 7. Back view of the KIMBO system – Truck prepared to remove the old body and in the second work zone, a new one on support stands.

- Once the pins are removed, the haul truck pulls out of the second work zone.
- The old dump body is then lowered onto support stands.
- The central pillars rotate 180º to face the first work zone.
- The four columns of the work zone are moved in horizontally until the support arms are in the correct position to lift the new dump body.
- The new dump body is lifted and the support stands removed.
- The haul truck is brought in and positioned between the pillars of the first work zone.
- Assisted by the independent and axial (front and back) movements of the support arms, the dump body is lowered until it is in the precise position where the pins can be easily inserted.
- Once the pins are inserted, the columns are moved away sideways and the truck is ready to return to duty.
- The old dump body can either be worked on in its current position on the support stands or can be placed on a low boy truck for removal to a workshop.

Benefits

The KIMBO system makes it possible for a team of just three operators to complete the entire operation of removing the old body and replacing it with a new one in just 90 minutes. In extreme cases, such as when pins have been damaged or the rest of truck needs maintenance, the duration would be longer. The KIMBO system ensures a significant improvement in safety, as the working conditions under a heavy, suspended load are eliminated, and provides benefits in terms of efficiency, resources, and effectiveness. The advantages, as noted by our customers, can be summarized as follows:

- Risk is reduced by switching from "suspended load" to "supported load" approach.
- No cranes are required.
- The remote control allows the operator to choose best place from which to observe and control the lifting.
- Risk during pin removal is mitigated.
- No hoisting elements are required.
- Mechanical locks in the columns prevent the dump body from falling in the event of a system malfunction.
- The system allows truck maintenance to be carried out without body, whilst the body is repaired.

- A 10-fold reduction in process time can be achieved.
- Manpower requirements are cut to 30%.
- Two work zones are available.
- Low boy truck waiting costs are reduced.
- The system can be used in adverse weather conditions.
- Able to lift various dump body designs and sizes.
- Able to measure the wear of bushing without removing the pins.

Compatibility
The standard KIMBOO system has been designed to handle trucks ranging from the CAT 785 to the CAT 797. As Table I shows, it is also compatible with other trucks and dump bodies in that size range.

Table I. KIMBO system compatibility.

Truck manufacturer	Compatible models	Compatible non-standard bodies
Caterpillar	785 – 797	Westech DT Hiload Conymet
Komatsu	730 – 960	Westech (830 – 960) DT Hiload (830 – 960) Conymet (830 – 960)
Hitachi	EH4000ACII - EH5000AC3	
Liebherr	T264, T282C & T284	Westech (T282 C/B) DT Hiload (T282 C/B) Conymet (T282 C/B)

This list is not exhaustive and different dump bodies can be easily assessed by providing Novamine with the measurements indicated by the green arrows in Figure 8.

Novamine has taken note of the fact that, in Southern Africa, smaller trucks, such as the CAT 777, are very popular. The system can be adapted to suit a fleet of smaller trucks. The range of truck sizes which can be handled is only limited by the spacing between the front and back pillars. This can be adjusted for in the initial design for a particular installation.

There is a variety of aftermarket dump bodies in use around the world. The KIMBO system is able to handle these bodies, irrespective of their shape and size. The support arm is design so that it can be used for both square-edged and rounded bodies, as shown in Figure 9.

Figure 8. The green arrows indicate the "KIMBO dimension" required to assess whether the system can handle a particular dump body.

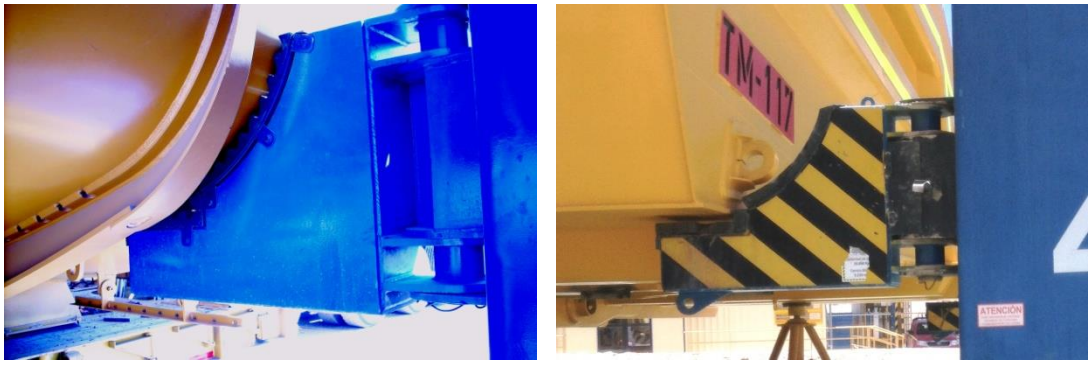

Figure 9. The support arm of the KIMBO system in use with curved and square bodies.

Specifications
The general technical specifications of the system are the following:

- Columns hoist capacity (per column): 20 tonnes.
- Total hoist capacity: 80 tonnes.
- Distance between columns (depth): 6 m.
- Maximum width per work zone: 10.5 m.
- Minimum Width per work zone: 7.3 m.
- Hoist displacement: 5.25 m.
- Lift time: 8 minutes.
- Maximum hydraulic pressure: 3000 psi.
- Hydraulic pump flow rate: 22.7 L/min.
- Electrical power supply: 380 V, 50–60 Hz.
- Electric motor power: 7.5 kW.
- Fully functional wireless remote control.
- Internet-linked system monitoring.
- Accessories (see Figure 10).

Figure 10. KIMBO accessories: (left) Mobile support stands; (centre) Stand-alone hydraulic lift stands for lifting dump bodies of low boy trucks; (right) Trolley for easy manoeuvring of the support stands.

CUSTOMER BASE

The KIMBO system has been installed at ten open-cast mining operations in Chile. The list of customers can be seen in Table II. Figure 11 shows the inauguration of the KIMBO system at BHP Billiton's Escondida Mine in Chile.

Table II. Novamine KIMBO customer base.

Mine	Company	Location	Since
Mantos Blancos Mine	Anglo American	Antofagasta Region II	2003
Codelco Norte Radomiro Tomic Division	Codelco	Calama Region II	2004
El Abra Mine	FreePort – McMoran Copper & Gold	Calama Region II	2006
El Tesoro Mine	Antofagasta Minerals S.A. (AMSA)	Antofagasta Region II	2009
Candelaria Mine	FreePort – McMoran Copper & Gold	Copiapó Region III	2009
Codelco Norte Chuquicamata Division	Codelco	Chuquicamata Region II	2012
Codelco Andina Division	Codelco	Los Andes Region V	2013
Los Pelambres Mine	Antofagasta Minerals S.A. (AMSA)	Salamanca Region IV	2013
Escondida Mine	BHP Billiton	Antofagasta Region II	2013
Codelco Ministro Hale Division	Codelco	Calama Region II	2013

COST BENEFIT ANALYSIS

The main benefit of installing the KIMBO system is the effect it has on improving the safety of the dump body removal and installation operation. This is clearly recognised by Novamine's customers. Several customers do not have large-haul truck fleets, and for such haul operations the installation of the system cannot be easily justified on a financial basis alone. In modern mining operations, the drive for safety and zero fatalities has, however, become a paramount consideration to most mining houses. That said, the efficiency of the system does result in major savings in manpower and equipment hire

costs, and, of course, drastically reduces haul-truck downtime. For a large mining operation, the cost savings in conjunction with the improved safety makes installation of the system easy to justify.

The breakdown shown in Table III illustrates the financial benefits realized by one of Novamine's customers as a result of installing the KIMBO system. The customer operates a fleet of 40 trucks, consisting of CAT 793s, CAT 797s, Komatsu 830s and Komatsu 930s.

Table III. Cost/benefit for KIMBO system.

	Before KIMBO	Cost (USD)	After KIMBO	Cost (USD)
Downtime of haul trucks	36 h	46 800.00	3 h	3 900.00
Labour requirement	9 persons	9 720.00	3 persons	270.00
Crane hire	2 x 65 t	24 480.00	0	0.00
Low boy truck waiting costs	1 day	600.00	0	0.00
TOTAL		81 600.00		4 170.00
Cost saving per dump body exchange				77 430.00
Body change-outs/year		12	12	
Annual saving				929 160.00
Annual depreciation				121 315.42
Initial cost (including civils for concrete platform)				2 069 731.27
Assuming depreciation 15 years				
Payback period				2.56 years

Figure 11. Inauguration of KIMBO System at BHP Billiton's Escondida Mine, Chile, July 2013.

CONCLUSIONS

The KIMBO Dump Body Exchange System provide a safe and efficient alternative to the standard suspended load approach. The system is able to adapt to different truck sizes and dump body designs without requiring any retooling. It eliminates the hazards normally associated with the change-out procedure while at the same time reducing labour, operating costs and haul truck downtime.

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Patents

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