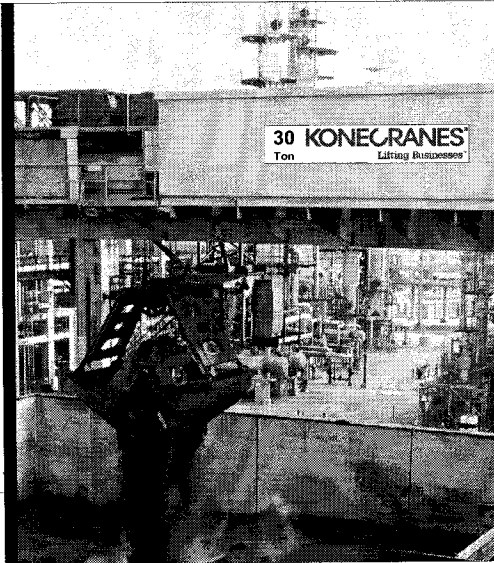


**Improving the
Safety, Reliability and
Productivity
of Coke Handling Bucket Cranes**

Don Paulino
Product Specialist

Coking.com Safety Seminar
May 7-10, 2007 - League City, TX

Coking.com



**Improving Safety, Reliability and Productivity of Coke Handling
Bucket Cranes.**

Safety, reliability and productivity are all prime concerns for coker operators using bucket cranes for moving coke. A principal obstacle to this is the minimal time available for weekly maintenance, and infrequent outages for major repairs. To help avoid down-time, Konecranes' approach to Coker Cranes is to include features that reduce the need for maintenance, and to make things easier to repair when maintenance is required.

This presentation outlines the many maintenance-reducing features that Konecranes has incorporated into the design of coker cranes, based on years of working with our customers. By comparing our experience to theirs, we are continually making improvements in safety, reliability and productivity.

- Don Paulino

User's List Coker Cranes by Konecranes

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Ordered	Customer	Project	Qty.	Capacity	Bucket	Type
2007	Fluor	Marathon, Garyville, LA	1	30 Ton	17 Yd. Mech.	Bridge Crane
2006	Bechtel - France	Reliance India	2	35 MT	20 Yd. Mech.	Bridge Crane
2006	Fluor	Tesoro Golden Eagle	1	44 Ton	25 Yd. Mech.	Bridge Crane
2006	Foster Wheeler Iberia	BP Spain	1	17 MT	8 M Mech.	Semi-Gantry
2005	Bechtel, ConocoPhillips	Borger Refinery, TX	1	30 Ton	17 Yd. Mech.	Bridge Crane
2004	ConocoPhillips	Alliance Refinery, LA	1	18 Ton	10.5 Yd. Mech.	Bridge Crane
2003	Larsen & Toubro	Indian Oil Co., Panipat	1	44 MT	25 M. Mech.	Semi-Gantry
2001	Bechtel	Hovensa, St.Croix	1	45 Ton	25 Yd. Mech.	Bridge Crane
2000	Foster Wheeler	Sincor, Ven.	2	25 m-ton	11.5 M. Mech.	Semi-Gantry
2000	SK Engineering	PEMEX, Madero	2	27 ton	18 Yd. Mech.	Semi-Gantry
2000	Bechtel	Marathon, Garyville, LA	1	27 Ton	17 Yd. Mech.	Bridge Crane
1998	Consorcio Contrina	VEHOP, Venezuela	2	22 m-ton	12.5 Yd. Mech.	Bridge Crane
1997	Chiyoda Corp.	Melaka Refinery	1	15 m-ton	8 M. Mech.	Bridge Crane
1996	Foster Wheeler	Lyondell Citgo	2	27 ton	18 Yd. Mech.	Semi-Gantry
1991	Bechtel / Conoco	Billings, MT	1	8 ton	4 Yd. Mech.	Bridge Crane
1990	Bechtel	Star - Port Arthur	1	25 ton	17 Yd. Mech.	Bridge Crane
1984	Texaco	Anacortes, WA	1	17 Ton	8 Yd. Hyd.	Semi-Gantry
1983	Fluor	Puget Sound Plant	1	14 ton	8 Yd. Hyd.	Bridge Crane
Total			23			

Rev. Jan-10-2007

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Coker Cranes From Konecranes 2007 2

This is a list of projects with Konecranes. It shows the crane and coke bucket sizes.

Noteworthy is the recent progression towards ever larger buckets and cranes.

When Konecranes supplied it's first coker crane about 10 years ago, the average bucket size was under 17 cubic yards. Most recently the bucket sizes are above 20 cubic yards and some approaching 30 yards. The biggest crane and bucket on this list is the 25 cubic meter (33 cubic yard) bucket on a 44 metric ton (48 short tons) single leg gantry for Indian Oil Company Ltd..

Principal Issues

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Safety

Konecranes Solutions

Design for Improved Safety



Crane Operator's Environment:

- Enclosed A/C Cab with HEPA particulate filter
- Purafil chemical filter.
- Enclosed environmentally controlled E-Room
- Filtered air
- Out of elements electrical maintenance
- AutoPilot Semi-Automation
- Independent Traveling Cab

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Coker Cranes From Konecranes 2007 3

Lessons learned from industry feedback via interviews with refinery personnel, have triggered R & D efforts to adapt new technologies to address the issues. Operator safety has been addressed in this process and some of the key safety features are listed.

The cab is pressurized with a particulate filter (last stage is a HEPA filter) for the make-up air. Purafil chemical filters are used for more severe environments.

The controls are installed inside and a pressurized control room with climate control.

Principal Issues

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Maintenance

Konecranes Solutions

Limited Time Available for Maintenance:

- Short weekly maintenance intervals
- Infrequent turnarounds for major repairs



Maintenance Reducing Features:

- Control House, Pressurized, with A/C
- Wired-In Spare Inverters
- Regenerative Network Braking
- Platformed Maintenance Access for All Mechanical and Electrical Components
- Inverter Duty Motors
- Improving access to components
- Designing longer lifetimes

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Coker Cranes From Konecranes 2007 4

Feedback from our refinery customers has increased awareness of the limited crane maintenance windows. This awareness drives our crane designs to lower or extend the maintenance requirements and to find ways to speed the maintenance events. This slide lists some of the features that improve the crane's maintainability.

This is accomplished by making parts last longer and by making them easier to change. Built-in diagnostics systems reduce the trouble shooting down time.

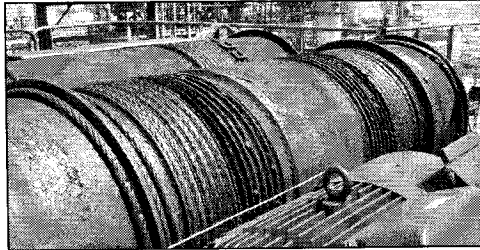
Principal Issues

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Konecranes Solutions

Designing for Higher Reliability

- Longer key component lifetime.
- Shorter repair times
- Quicker problem solving.



Reliability Improvements:

- Moment Isolation System
- 50,000 Hrs Bearing Life
- Carburized Gearing
- Grouped Lubrication Fittings
- Rope Over-wrap Preventors
- Rope storage on drum to re-reeve Bucket 3 Times
- Load Cells on Each Drum, with Summing
- Higher drum/sheave to rope ratios 30:1 vs. 24:1

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Coker Cranes From Konecranes 2007 5

Reliability Improvements are also related to maintainability.

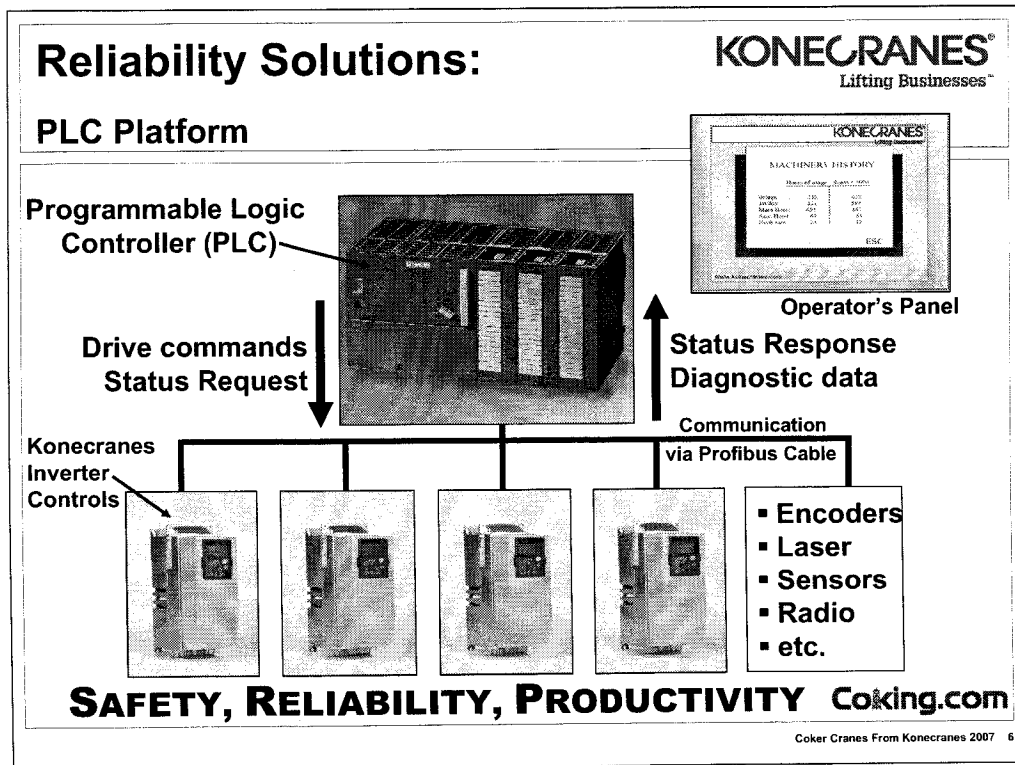
The items listed increase both the reliability as well as the lifetime of the crane parts.

Rope Over-wrap Prevention Device consists of rope retention rollers that are mounted near the hoist drums and they detect a harmful over-wrap condition and stop the drum rotation before the rope is damaged.

Generous storage space is provided on the closing line drum for re-reeving the bucket. This saves maintenance time and lowers wire rope consumption costs.

Load cells are used to prevent harmful mechanical overloads.

Increasing the hoist drum and bucket sheave diameters to a value 30 times greater than the rope diameter extends rope lifetimes as well as the lifetimes of the drums and sheaves.



For highest reliability, all Konecranes coker cranes are fitted with PLC based controls technology.

This system architecture allows multi-level access for data analysis and trouble shooting. Provides instant access to critical data about the crane condition.

There is an operator's display panel in the cab that is used to communicate with the crane operator. The panel displays the crane operating condition, faults, alarms, etc. The crane operator has access to all of the critical crane condition data.

All of the VF controls are connected with a Profibus communications link so that critical data is centralized. This facilitates maintenance diagnostics.

This technology enhances crane safety as well.

Productivity

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DynAGrab Hoist Control

Hoist Control Issues:

- Manual Joystick Control
Difficult to Learn
- Long Training Time Needed
- Inefficient Handling, Spillage
- Uneven Load Sharing
Between Hoists
- Overloading Motors,
Burn-Outs
- Snapped Ropes

Closing/Holding Drum

Synchronization:

- Reduced Operator Train-up
Time
- More Effective Load Handling
- Even Sharing of Load
Between Hoists
- Reduced Stress on Machinery
- Longer Rope Life

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Coker Cranes From Konecranes 2007 7

DynAGrab hoist control has a positive impact on the cranes maintainability and safety as well as its productivity.

This control is a proprietary PLC software that automates the most difficulty aspects of operating a four rope mechanical bucket. This control lowers the operator skill set needed for effective material handling. This automation technology makes crane operation an easier task.

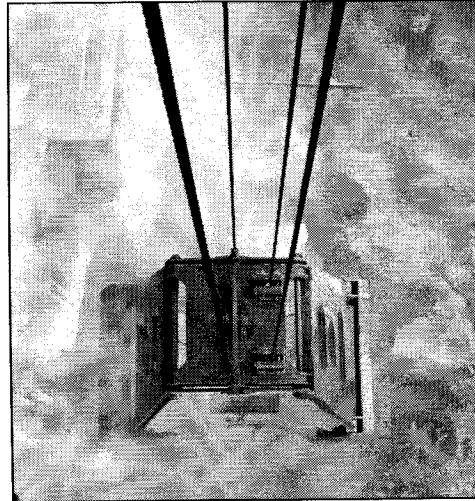
DynAGrab - The system drastically reduces slack rope condition that is harmful to hoist machinery as well as to rope life.

Hoist Control DynAGrab Synchronization Controller

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Features:

- Load Balancing
- Automatic Sinking & Filling
- Field Weakening
- Fast Stop / Slack Rope Control
- Drum Rotation Synchronization
- Fault Detection
- Jammed Grab Detection
- **SAFETY:** Overload Protection
- Less Demanding of Operator
- Higher Coke Handling Thru-put



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DynAGrab hoist control measures the rotational position of the two hoist drums relative to each other and automatically and without operator input, synchronizes that relative position during any combination of open/close or raise/lower movements so that the bucket is doing exactly what the operator intends. Coke spillage due to accidental loss of synchronization seen on most manual cranes, is eliminated.

The automatic sinking and filling feature allows the operator to precisely set the digging depth and bucket filling according to the coke density and consistency. This reduces overloads and optimizes the bucket filling on each cycle. The result is a productivity improvement.

If the bucket jams on some foreign object, the system detects the condition and reports it to the crane operator.

DynAGrab control can be tuned to the optimum bucket load for the coke density and with it's overload sensing will prevent operators from handling more than that defined optimum load.

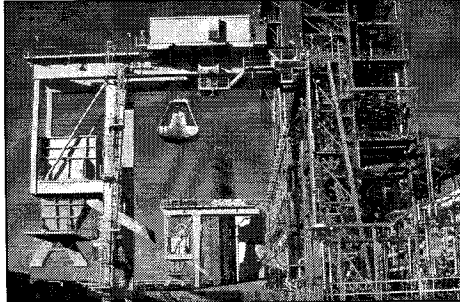
Load Control Issues

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DynAPilot Sway Control

Damage from Collisions:

- Bucket impacts on hopper
- Bucket impacts on pit wall
- Difficulties in fines basins
- Excessive load spillage



Sway Dampening / Zone Control:

- Reduced load sway
- Restricted areas (pit walls, hopper)
- Smart Limits / Reduced Creep Areas
- Quicker, safer movements
- Reduced spillage at hopper
- Eliminates lost time caused by load swinging

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DynAPilot Sway control is a patented technology that harnesses load swing in a way that enhances productivity.

The system helps prevent impacts with obstacles inside the crane operating space.

With **DynAPilot** switched on, the natural load swing caused by acceleration/deceleration of either the bridge or trolley movements is dampened so that it has no impact on the cycle time. The uncontrolled load swing is eliminated and shorter cycle times is the result.

Safety is enhanced with less opportunity for the operator to swing the bucket into an obstacle.

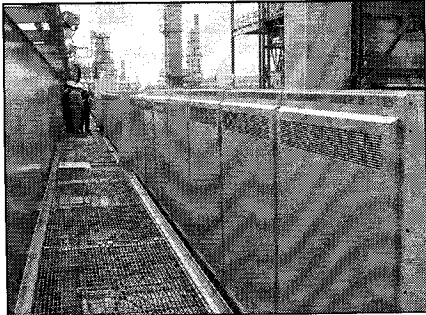
Maintenance Feedback

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Konecranes DynAReg

Resistor Bank Problems:

- Coke Dust on Resistors
- Reduced Resistance, Burn-Out
- Damage to Inverter Drives
- Maintenance Time for Cleaning



Regenerative Control:

- Eliminates Braking Resistors
- Reduced Risk of Failures
- Reduced Maintenance Time
- Active Front End Cleans Incoming Power, Protecting Drives
- Power Going Back to Grid is Cleaned, Protecting Adjacent Equipment

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Coker Cranes From Konecranes 2007 10

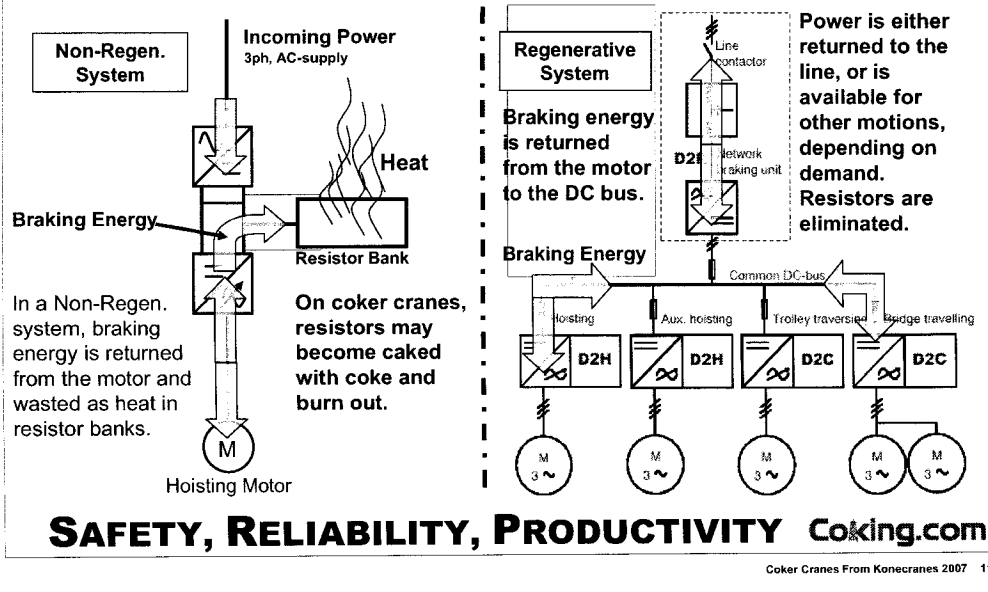
Introduction:

Konecranes has labeled its proprietary version of Regenerative variable frequency control as "**DynAReg**"

First used almost 10 years ago on high-value STS container cranes, **DynAReg** is today being adapted to other types of process cranes. Introduced to coker crane customers mid-2005, it is the Konecranes standard solution and is fast becoming the preferred technology for all new coker cranes.

Konecranes DynAReg Regenerative Control Energy Flow – Regeneration

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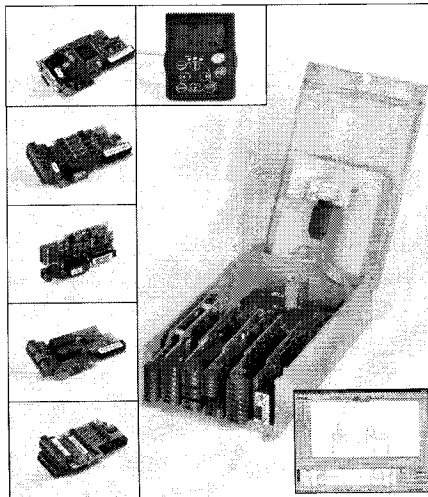


DynAReg - This slide compares the Regenerative type energy flow schematic on the right side with that of the non-regen control type on the left.

The Regen system illustrates that the energy produced by decelerating motors is returned to the common supply line (common DC bus) where it can be used by other motors that are working in non-decel mode. Excess braking energy not consumed by operating motors is returned thru the Network Braking Unit into the power supply line as clean power.

Konecranes DynAReg Regenerative Control Modular Design – Flexible Control Unit

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- Reduces spare parts
- Keeps physical module size smaller
- Easier handling
- Competitive technology
- Greater availability
- Maintenance friendly
- Facilitates diagnostics
- Reduced maintenance time means shorter downtimes

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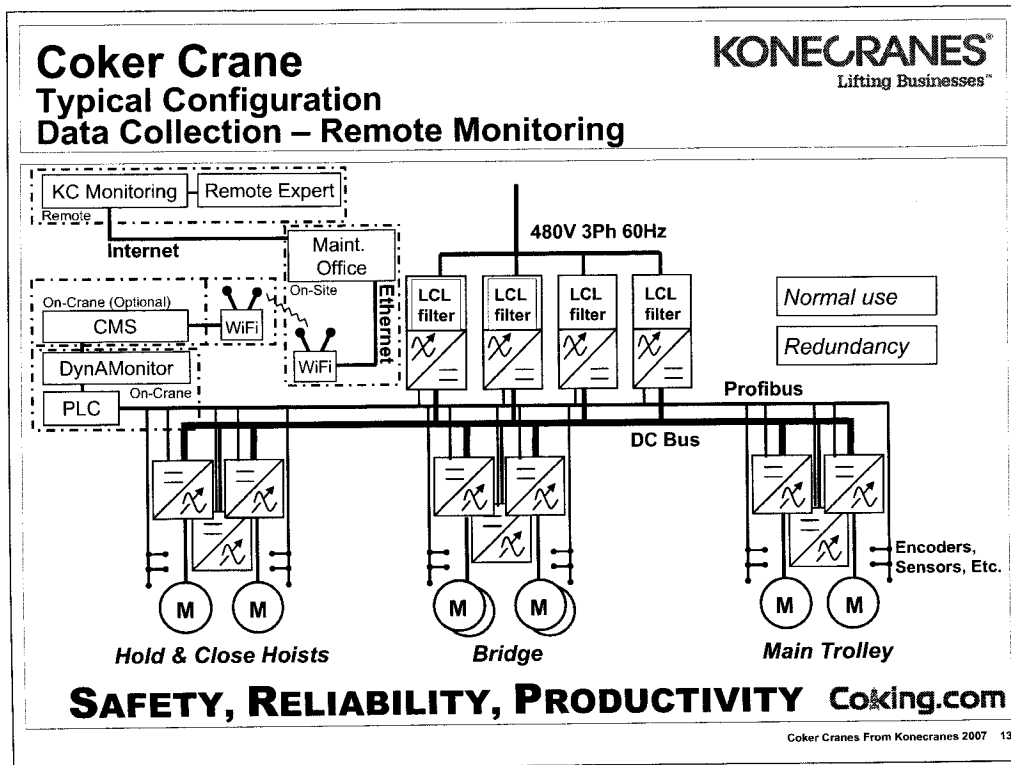
Coker Cranes From Konecranes 2007 12

This slide highlights advantages/benefits of modular design.

Maintenance personnel deal with smaller, easier to handle modules instead of complete VF drive units as on the previous generation VF drives.

Hardware pieces are interchangeable among the motor drive units and the AFE units.

Spare parts inventories and investments are much smaller.



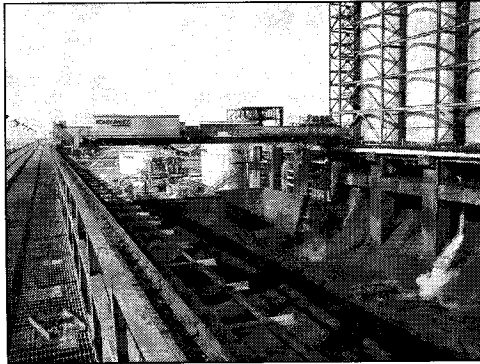
In addition, the customer can connect to the internet for access to Konecranes Remote Monitoring and **RemoteExpert** assistance for emergency trouble shooting...the fastest way to get an expert's eyes on the problem.

The expert can access all crane data (structural drawings, electrical drawings, material lists, Operation and Maintenance Manuals, etc. which are stored digitally on the CMS hard drive.

Condition Monitoring & Reporting DynAMonitor

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- Over 400 data points monitored on a typical process crane
- Voltage, current, temperature, over/under speed, brake wear, limit switches, etc.
- Reports on status, condition and faults on operator display panel.
- Remote data access option.
- Alert user to potential problems before they are catastrophic
- Analyze data from the manufacturing process
- Common in other industries
- Real time reporting.



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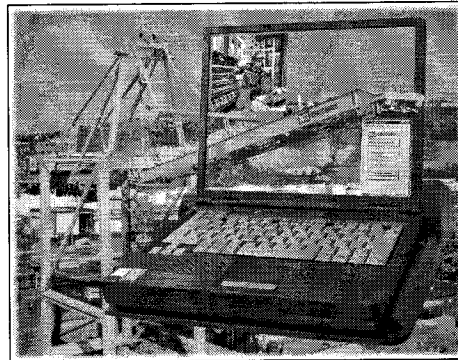
DynAMonitor is a PLC resident software that monitors about 400 data points on the crane and reports them through two display panels. One in the operator's cab and one in the control house. The software maintains a 2000 event rolling archive of the measured points and error messages.

When connected to a LAN, it provides current time data monitoring and has some limited reporting capability for written reports.

Maintenance Data Analysis CMS: Remote Monitoring

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- Real time data is available in multiple locations
- Troubleshoot problems before getting on crane
- Remote Expert Assistance
- Diagnose problem off line in clean, safe environment
- Predictive maintenance can adjust maintenance intervals to suit changing crane usage
- Promotes Pro-active vs. Re-active Maintenance
- Archives about 4 Years of Data



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CMS is an industrial PC with proprietary software. The unit is installed inside the pressurized control house and it provides a data collection and archiving system capable capturing and holding up to four years of crane data.

The system software has analysis and reporting modules to enhance the maintenance experience.

The system has provision for remote data access via wireless LAN.

This implements the **RemoteExpert** feature which makes available the best Konecranes controls trouble shooting engineers to assist in problem solving traveling to the job site.

This capability is expected to lead to significant reliability and up-time improvements.

Runway Structure Issues

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DynATrak

Structure Problems:

- Skewing of Bridge Effects Rail Alignment
- Damage to Rail Attachments
- Misalignment of Beams and Columns
- Wheel and Rail Wear
- Stress on Wheel Bearings and Crane Structure

Konecranes Auto-Steering Control:

- Harmful Lateral Loads Virtually Eliminated
- Dramatic Reduction in Wheel/Rail Wear
- Reduced Stress on Wheel Bearings
- Reduced Stress to Crane Structure
- Alignment of Runway Preserved
- Improves Safety by Limiting Structural Overloads

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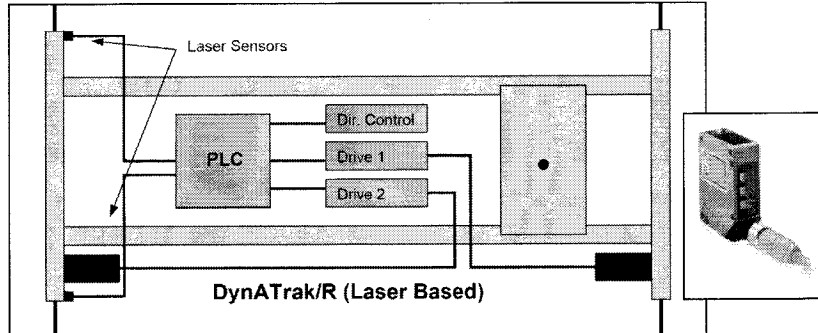
Coker Cranes From Konecranes 2007 16

Feedback from users of long span bridge type coker cranes (vs. gantry type) indicates tracking on the crane structure can be a problem. The patented **DynATrak** control automatically steers the crane along the runway to a centered position of the bridge wheels relative to the rail centerlines. The system minimizes or eliminates contact between the wheel flanges and the sides of the rail which reduces wear of the both components.

In addition, eliminating the wheel flange to rail contact drastically reduces the lateral loads to the crane structure extending the lifetime of all affected components. Such as rail, rail clips, runway girders, girder connections, wheels, wheel bearings, etc.

Konecranes DynATrak Laser-Based DynATrak/R Configuration

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- PLC drives bridge via 2 separate inverters
- Laser measurement maintains constant flange-to-railhead distance

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The patented **DynATrak** Auto Steering system uses laser sensors to measure the distance to the rail head at two points along the end trucks on one rail. The sensor inputs are used to determine the amount of the offset between the rail and wheel centerlines. This information is converted into drive instructions for the two VF drives that operate the bridge drive motors. Each VF drive controls all the motors on one rail side. The speed differential between the two drives causes the bridge to “steer” back into alignment.

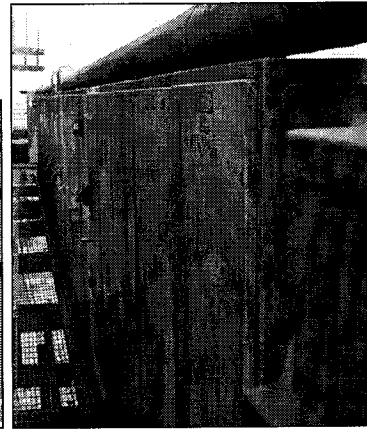
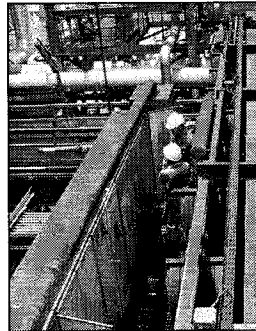
Environmental Issues

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Corrosive Coke Pit

Environment:

- Moisture / Steam
- Corrosive Fumes
- Ignitable Fumes
- Conductive Dust
- Exposed to Rain, Ice, Weather
- Abrasive Coke Dust
- Hazards for Operators



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Environmental Issues

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Konecranes Solutions

Corrosive Coke Pit

Environment:

- Moisture / Steam
- Corrosive Fumes
- Ignitable Fumes
- Conductive Dust
- Exposed to Rain, Ice, Weather
- Abrasive Coke Dust
- Hazards for Operators

Fully Enclosed Control

House:

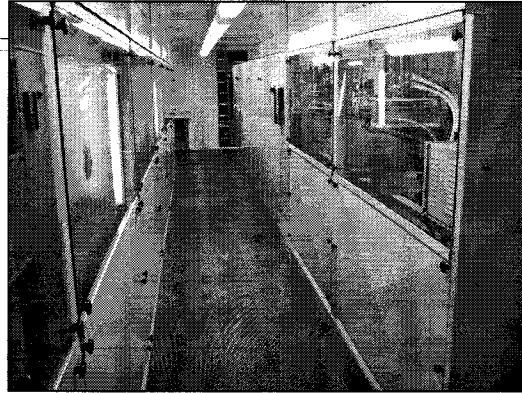
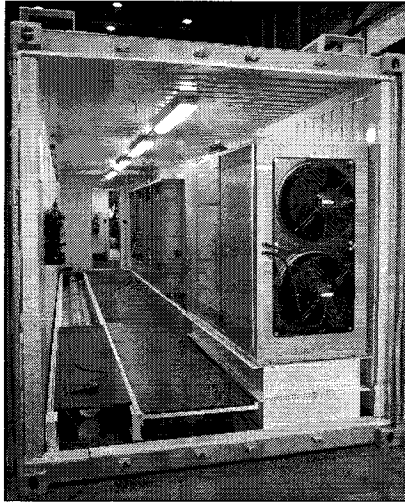
- Temperature & Humidity Controlled
- Dust Kept from Controls & Electronics
- Weather Protected Environment for Maintenance
- Clean, Safe, Lighted Work Area
- Pressurizing Filtration
- Redundant A/C Available
- Stainless Steel Exterior Available
- Chemical Filtration Available

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Environmental Issues Control House on Crane

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- Air-conditioned environment
- Maintenance without weather concerns
- Filtered, pressurized air supply
- Cable Channels
- Extends lifetime of electrical items.

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The pressurized, environmentally controlled house has been an important contributor to reliability of the crane electrical systems. It is a contributor to crane safety as well in that maintenance personnel can work on the crane controls inside a clean room instead of in the open air which can be hazardous in wet weather conditions.

As a option, the control house exterior can be clad in stainless steel for corrosion resistance.

A/C systems and pressurized filtration systems are used to control the room environment providing a safe haven for controls maintenance and extending lifetime of the electrical components inside.

Environmental Issues

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Konecranes Solutions

Hazardous Coke Pit

Environment:

- Moisture / Steam
- Corrosive Fumes
- Ignitable Fumes
- Exposed to Rain, Ice, Weather
- Abrasive Coke Dust
- Hazards for Operators

Fully Enclosed

Operator's Cab:

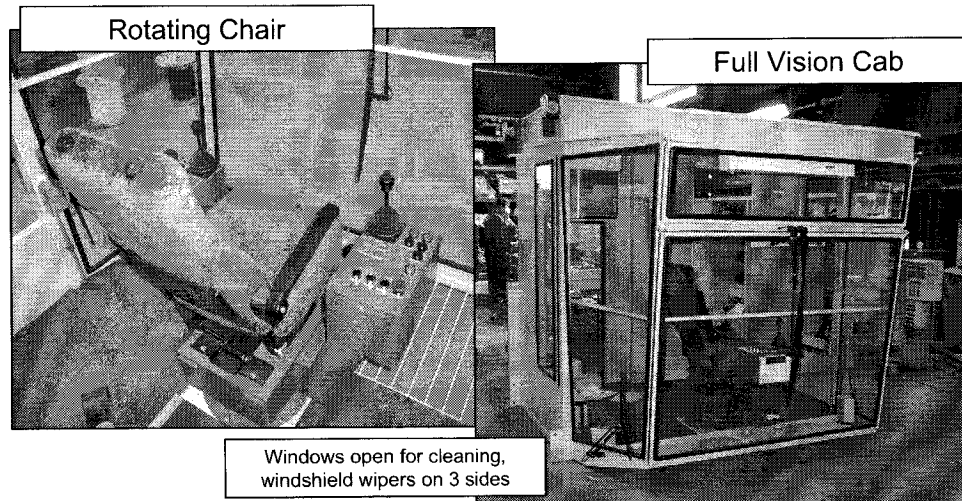
- Temperature & Humidity Controlled
- Protected Environment for Operator
- Ergonomic Chair and Controls
- Windows Arranged for Maximum Visibility
- Safe, Comfortable Work Area
- Pressurizing Filtration
- Redundant A/C Available
- Stainless Steel Exterior Available
- Chemical Filtration Available

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Environmental Issues Operator's Cab

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Coker Cranes From Konecranes 2007 22

Environmentally controlled cab space.

A/C and pressurization with a multistage filtration/pressurization unit. HEPA filter in last stage.

Purafil chemical filters available as price option when warranted by specific environment.

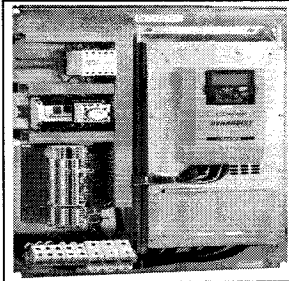
Control Issues

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Konecranes Solutions

Large Control Components:

- Significant time and effort to change out a failed inverter
- Rewiring necessary
- Large, heavy components
- Crane down during change-outs



Wired-In Spare Inverters:

- Increase Crane Reliability Proposition
- Quick switch over from problem VF Drive Unit to Stand-by
- Allows "Off Line" repair when time available
- Prolongs lifetime of Spare Drives with Energized Environment.
- Significant savings in unplanned down time.

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Coker Cranes From Konecranes 2007 23

A recent technical innovation is the addition of spare VF drive units, pre-wired inside the control house. These spare units, one each for the hoist, trolley and bridge are pre-wired so that they can be switched over in a short time.

This allows the crane operation to continue with minimum interruption until there is a time window to service the problem drive.

This feature provides a major benefit to crane up-time.

Gearing Issues

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Low Quality Gearing:

- Long Lead / Expensive Spares
- Must open gearbox to remove drum
- Hoist gear quality traditionally low, AGMA 4 to 6
- Failures can be catastrophic, damaging hoist machinery

High-Quality Gearing:

- All gearing 58 HRC, carburized, finish ground
- AGMA Class 11 minimum
- Moment isolation mounting preserves alignment
- 50,000 hrs Bearing Life exceeds CMAA Class F



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The industry standard has been CMAA Class E cranes with lower classes of gearing, AGMA 4 to 6 Class. Supplying cranes with higher quality gearing (**AGMA Class 11**) sized for the work load in addition to the torque load results in much longer lifetime and lower maintenance costs. Properly designed and maintained gearing should last the lifetime of the crane.

Replacement of hoist gearboxes is a costly event that takes the crane out of service for at least a day.

Mechanical Issues

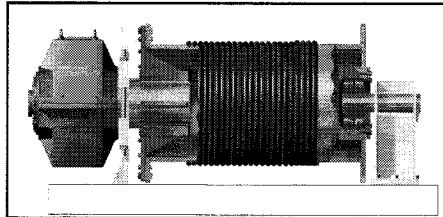
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Reported Problems:

Konecranes Solutions

Hoist Machinery Problems:

- Cracked Drum Welds
- Leaking Oil Seals
- Drum Gear Misalignment
- Complicated Disassembly
- Fatigue in Drum Shaft



Konecranes Moment Isolating Machinery Mounting:

- Eliminates Drum Gear Misalignment
- Eliminates Cracking of Drum Welds
- Drum Removable Without Opening Gear Box
- No Fatigue on Non-Rotating Drum Shaft

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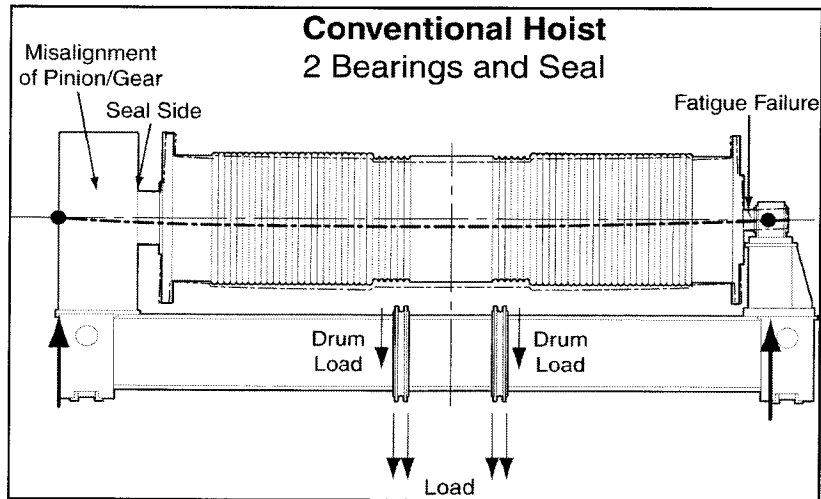
Moment Isolation Machinery Mounting is a unique design that eliminates the harmful stress concentrations in the drum shaft and drum to gearbox connection. This area has been reported as a common failure zone on older coker cranes with the traditional mounting methods.

This failure mode does not exist on the Moment Isolation Design that eliminates the stress concentrations.

This design has an additional maintenance benefit in that it allows replacement of the hoist drums without the need to open the gearbox avoiding the time consuming re-alignment of the drum gear.

Mechanical Issues Konecranes Moment Isolation

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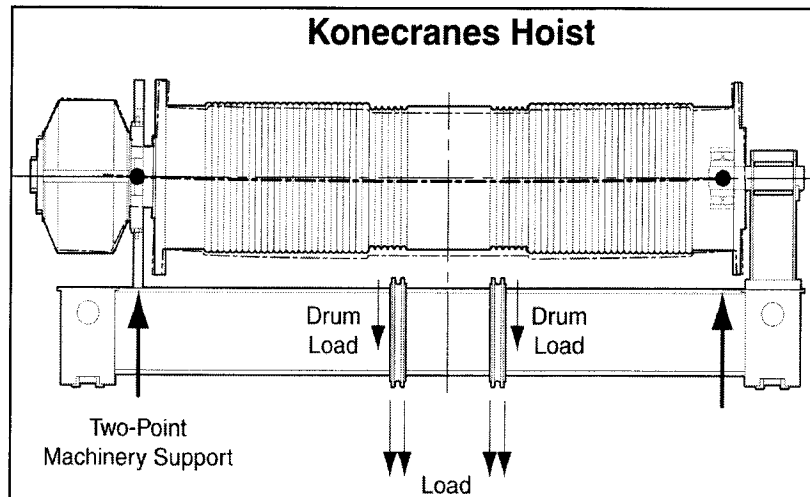
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Conventional design showing gearbox, drum shaft, drum and tail bearing. Deflection of the drum under load generates stress concentrations at the shaft transition into the rigidly mounted gearbox. The shaft bending/deflection alters the loading pattern on the drum gear, accelerating wear.

Replacement of the drum, shaft or the drum gear requires opening the gearbox and then realigning the drum gear mesh by shimming the tail bearing support. This alignment procedure can take most of a day under good conditions.

Mechanical Issues Konecranes Moment Isolation

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The Moment Isolation Design separates the gearbox from the hoist with a drum hub that is machined to interlock with and match the drum flange. There is no need for realignment of the drum gear or even to open the gearbox when changing the drum. The machined interface between the drum hub and the drum assures precise alignment when the drum flange is bolted to the hub. There is a self aligning bearing at the tail end that accommodates the shaft bending without over stressing. Changing the drum with this design is much faster and a lot less work.

Buyer-Seller Partnership

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Crane Buyer

- Process Knowledge
- Equipment Knowledge
- Operational Experience
- Maintenance History
- Lessons Learned

Crane Vendor


- Proven Applications
- R&D Efforts
- Economies of Scale
- Crane Expertise
- Global Perspective
- Experience In Other Industries/Regions

Partnership

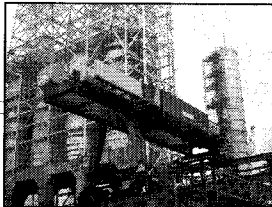
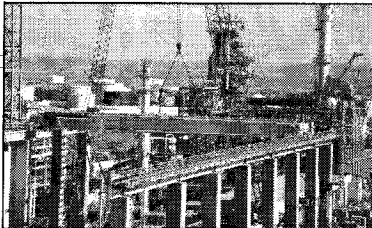
Best fit of
Product
to Project

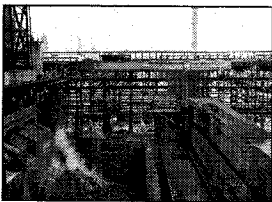
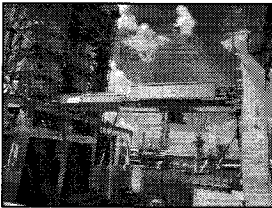

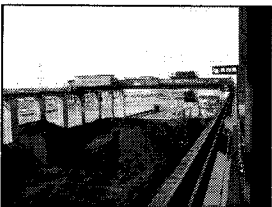
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