Mobile Cranes & Multi-Crane Lifts

Speaker:  Jim Worrell, PE
Lift-Think, LLC

Host:  Mike Parnell
President/CEO, ITI
ASME B30 Vice Chair (Cranes & Rigging)
ASME P30 Chair (Lift Planning)

The views expressed in this presentation are that of ITI and are not necessarily the views of the ASME or any of its committees.
WHO WE ARE

A world leader in crane and rigging training and consulting.

We Rig It Right!
WHO WE ARE

Serves a Variety of Industries

- Aerospace
- Chemicals
- Construction
- DOD
- DOE
- Electric Utility
- Hydro
- Manufacturing

- Maritime
- Mining
- Nuclear
- Oil & Gas
- Pulp & Paper
- Railroad
- Shipbuilding
- Wind Energy
OUR CUSTOMERS

The World's Greatest Organizations Trust ITI's Expertise with their Crane & Rigging Operations
SHOWCASE WEBINAR SERIES

Past Presentations:
Cranes, Rigging & Your Organization
Effective Crane & Rigging Training Methods for Your Employees
10 Audit Points for Your Crane & Rigging Operations: An HSE Perspective
Tackling the Challenges of Training Site Supervisors, Lift Directors, and other Leaders
4 Major Lifting Considerations in Power Gen Environments

Today's Presentation:
Mobile Cranes & Multi-Crane Lifts

WEBINAR TRAINING COURSES

• Lift Director & Site Supervisor
• Critical Lift Planning
• Rigging Gear Inspection for Supervisors
• Advanced Rigging: Load Distribution & Center of Gravity
• Advanced Rigging: Multi-Crane Lifts & Load Turns

Industrial Training International
iti.com
TRAINING • FIELD SERVICES • CERTIFICATION • BOOKSTORE • E-LEARNING
Mr. Parnell has a wealth of knowledge regarding cranes, rigging, and lifting activities throughout a variety of industries.

- 30+ years learning about wire rope, rigging, load handling, and lifting activities.
- Vice Chair of the ASME B30 Main Committee which sets the standards in the US for cranes and rigging
- Chair of the ASME P30 Main Committee which sets the standards for lift planning.

ASME standards are also adopted by many countries around the world.

The views expressed in this presentation are that of ITI and are not necessarily the views of the ASME or any of its committees.
ABOUT THE SPEAKER

Jim Worrell, PE, Lift-Think, LLC

• Jim is graduate of Louisiana State University in Civil Engineering (1963)

• He is a PE and RLS (Registered Land Surveyor-retired status) in Louisiana

• He is a semi-retired Heavy Lift and Transport Engineer and Project Manager with over 40 years of experience in this field - primarily along the Gulf Coast in the petrochemical, heavy industrial, and offshore fabrication areas. In addition to extensive experience with single and multi-crane lifts, his experience includes working with gin poles, guy derricks, stiff-leg derricks, and jacking towers (RMS), barge and rail transport, and over-the-road transport.

• Jim owns a small heavy lift consulting business and works from his home in Raleigh, North Carolina. His work includes third party lift plan reviews, long range planning, on-site presence for lifts, and related tasks.

• He is an ASCE life member and member of the ASCE Construction Institute Crane Safety Committee.

• He was formerly active in the Specialized Carriers and Rigging Association (SC & RA) - the organization for crane and rigging and over-dimensional transportation contractors. He was a member of the SC & RA Crane and Rigging Subcommittee for two terms and served for one term on the Board of Directors. He presented several “Rigging Job of the Year” contest winners.
Mobile Cranes & Multi-Crane Lifts
STIFF LEG DERRICK
STATICS PROBLEM - GUY DERRICK

Fig. P-9.22
LIFTING WITH A GUY DERRICK
AND TAILING WITH A STIFFLEG DERRICK
HISTORIC METHODS 1

- This lift utilizes both conventional cranes and gallows frame gin poles. The gin poles are mounted atop a tall structure
HISTORIC METHODS 2

Another view of the arrangement
HISTORIC METHODS 3
Lifting Device Utilizing The Crane Draw Works
REFINERY COLUMN BEING ERECTED IN TWO PIECES
A MULTIPLE CRANE LIFT:

A FOUR CRANE LIFT DICTATED BY THE LIFT POINTS AND THE CAPACITIES OF AVAILABLE CRANES
TWO-CRANE LIFTS: POINTS TO REMEMBER

• Keep level
• The movement of one crane affects the other
• De-rate crane capacity
• Most tandem lifts are considered ‘Critical’
• Requires a high degree of planning
• If possible, try to balance the crane’s percentage of chart
• Keep load falls plumb
• In general, for every advantage gained with a two crane lift, there may be a corresponding disadvantage
CENTER OF GRAVITY AND LOAD DISTRIBUTION:

VERY IMPORTANT FOR MULTI-CRANE LIFTS
PEDESTRIAN BRIDGE UNSUITED FOR A SINGLE CRANE LIFT

(NOTE THE DEFORMATION IN THE LOWER CHORDS- THE BRIDGE WAS ATTEMPTED TO BE ERECTED WITH A SINGLE CRANE, BUT HAD TO BE LATER LIFTED WITH TWO CRANES)
TWO CRAWLER CRANES LIFTING A 300 TON SLUG CATCHER
TWO TELESCOPIC BOOM CRANES OFFLOADING A KILN SECTION FROM TRANSPORTERS
TWO CRANES LOADING A GENERATOR ON TRANSPORTERS
TWO CRAWLER CRANES WALKING A PIPERACK MODULE
ONTO A BARGE
TWO CRANE LIFT OF A HORIZONTAL STORAGE TANK
TWO CRANES ROLLING A PRESSURE VESSEL WITH ROLLING SHEAVES AND A WHIP LINE

THE WHIP LINE IS NOT VISIBLE AS THE ROLLING HAS BEEN COMPLETED - FOR HIGHWAY TRAVEL
TWO CRANE LIFT OF A SIMPLE BEAM
TWO CRANES LIFTING WHERE THE CENTER-OF-GRAVITY IS AN ISSUE
ERECTION OF A PEDESTRIAN WALKWAY WITH TWO CRAWLER CRANES
TWO MATCHED CRAWLER CRANES ERECTING A DOCKSIDE GANTRY COMPONENT INTO PLACE
TWO CRANE LIFT OF A FURNANCE CONVECTION SECTION- DUE TO MULTIPLE LIFT POINTS
TWO CRANES MAKING A HIGH LIFT WITH POOR VISIBILITY BETWEEN CRANES
TWO CRANES LIFTING CONVEYOR SYSTEM ON A SLOPE
LOAD TRANSFER OVER A LIVE PIPE RACK
TWO CRANES ERECTING A TRANSPORTABLE BUILDING ON LOW PIERS
TANDEM LIFT ON A STRUCTURAL DOCK

NOTE FENDER SYSTEM AND DISTANCE BACK FROM THE EDGE OF DOCK AS WELL AS FULL MATTING OF THE CRANES
TWO UNMATCHED CRANES CONNECTED BY AN INVERTED LIFT BEAM - OFFLOADING A COMPACT REACTOR COMPONENT ON A STRUCTURAL DOCK
TWO CRANES OFFLOADING A TRANSFORMER FROM A SMALL SHIP
ONTO AN EARTHFILL AND CONCRETE DOCK
TANDEM CRANES SWINGING THROUGH WITH A LOAD OFFLOADED FROM A BARGE
TWO UNEQUAL CRANES OFFLOADING A PRESSURE VESSEL FROM A BARGE
THE CENTER-OF-GRAVITY IS NOT NEAR THE PHYSICAL CENTER
TWO UNEQUAL CRANES LOADING MOORING PILES ONTO A BARGE - OUTBOARD PILES
TWO UNEQUAL CRANES LOADING MOORING PILES ON A BARGE - INBOARD PILES
TWO CRANE LIFT WITHOUT A BEAM - MATCHED CRANES
TWO UNMATCHED CRANES LIFTING A TALL COLUMN FROM TOP HEAD LIFT LUGS
ERECTING A TALL REFINERY COLUMN WITH TWO MATCHED CRANES FROM LIFTING POINTS DOWN FROM THE VESSEL TOP
TWO UNCONNECTED CRANES LIFTING A TALL STACK FROM TRUNNIONS LOCATED ABOVE THE CENTER OF GRAVITY
TWO CRANES ERECTING THE MAST FOR A SHIP’S MAST CRANE
TWO UNMATCHED CRANES WITH NO BEAM AND UNEQUAL LOADINGS

The load distribution on the lifting lugs was 57% and 43%.
TWO AMERICAN 1100 SERIES GUY DERRICKS REMOVING A CAT CRACKER REACTOR
TANDEM LIFT WITH UNMATCHED CRANES AND INVERTED LIFT BEAM

This allows a better division of the load between the two cranes
TWO CRANES WITH BEAM: ADVANTAGES

- Increases capacity by reducing the boom length
- Increases capacity by reducing the radius of each crane
TWO CRANES WITH BEAM: DISADVANTAGES

• Limited swing of each crane

• Limited rotation of the load unless a swivel is used

• Communication and signaling requires a higher degree of planning and ability
TWO CRANES LIFTING THE MOCK SPACE SHUTTLE “ENTERPRISE”

CONNECTED BY A SPECIAL LIFT FRAME
ERECITION OF A PRESSURE VESSEL WITH TWO UNMATCHED CRANES CONNECTED BY AN INVERTED LIFT BEAM
UPENDING A PRESS WITH TWO CRANES CONNECTED WITH AN INVERTED LIFT BEAM
ERECTION OF A PRESSURE VESSEL WITH TWO CRANES CONNECTED WITH AN INVERTED LIFT BEAM AND A LOWER BEAM
TWO CRANE LIFT OF A PRESSURE VESSEL CONNECTED WITH AN INVERTED LIFT BEAM AND A LOWER BEAM
TWO CRANES CONNECTED BY AN INVERTED LIFT BEAM—AN EXTREME EXAMPLE
A TYPICAL TWO CRANE TILT-UP LIFT WITH TWO LIFT BEAMS
FLIPPING A CONE SECTION WITH TWO CRANES
A THREE CRANE OPERATION- FLIPPING A BUCKET WHEEL

The Liebherr LTM 1500-8.1, LTM 1400-7.1 and LTM 1350-6.1 wheeled mobile telescopic cranes lift the excavator bucket wheel from its assembly position.
TAILING

- Requires a higher level of planning, engineering, communication, and execution

- Load falls must be kept plumb

- Work slowly and perform only one function at a time with each crane

- The load distribution varies throughout the lift

- Signaling is of the most importance and should be performed by only one experienced person
TAILING TO THE VERTICAL

FIGURE 4: Crane loads during a tandem lift.
TAILING A “DRESSED” TOWER WITH A CRAWLER CRANE

‘DRESSED’ REFERS TO THE ADDITION OF LADDERS, PLATFORMS, PIPING, ETC. PRIOR TO ERECTION
LIFTING ATTACHMENTS:
TAILING WITH A CHOKER HITCH
TAILING WITH A SINGLE CHOKER HITCH
LIFTING ATTACHMENTS: TAILING LUG
TAILING WITH A FIXED CRANE WITH TAIL LUGS ON THE BOTTOM OF THE MODULE
TAILING FROM THE SIDE DUE TO TAIL LUG PLACEMENT
SINGLE TAIL CRANE ON THE SIDE DUE TO LUG LOCATION
TAILING FROM THE SIDE WITH A CRAWLER CRANE AND LIFTING WITH TWO MAIN LIFT CRANES
TAILING FROM THE SIDE WITH A FIXED TAIL CRANE:

LET THE MAIN LIFT CRANE DO MOST OF THE WORK- SLIDE 1
TAILING FROM THE SIDE WITH A FIXED TAIL CRANE - SLIDE 2
LIFTING A FRAGILE LOAD - STARTING THE LIFT
TAILING A FRAGILE VESSEL - NEARING THE LOAD TRANSFER POINT
LIFTING A FRAGILE LOAD- AFTER THE LOAD TRANSFER
TAILING IN AN ENCLOSED SPACE: PLAN VIEW
TAILING IN AN ENCLOSED SPACE-2
TAILING IN AN ENCLOSED SPACE- EXCAVATION
REMOVING A PRESSURE VESSEL IN VERY TIGHT SURROUNDINGS

SLIDE 1
REMOVING A PRESSURE VESSEL IN VERY TIGHT SPACES

SLIDE 2
BOTTOM HEAD TAILING LUG
RIGGING ON STACK INCLINED TO MISS PLATFORM
TAILING OVER A LIVE PIPERACK
TWO CRANE LIFT WITH A WEAK TAIL CRANE- SLIDE 1
TWO CRANE LIFT WITH A WEAK TAIL CRANE- SLIDE 2
LIFTING A REACTOR WITH TWO MATCHED CRANES LINKED WITH A SPREADER BEAM AND TAILED WITH A CRAWLER CRANE
TAILING WITH TWO CRAWLER CRANES CONNECTED BY AN INVERTED LIFT BEAM TO A SINGLE TAIL LUG

• This allows the tracks and load fall to not interfere with each other
• Both cranes cannot operate directly over the rear in this case
• The beam must be kept level
TAILING WITH TWO HIGHLY UNMATCHED CRANES CONNECTED WITH AN INVERTED SPREADER BEAM
TAILING A PRESSURE VESSEL WITH TAILING TRUNNIONS- WITH TWO FIXED OUTRIGGER CRANES
ALTERNATE TAILING- TRACK MOUNTED TAILING DEVICE
TAILING DEVICE MOUNTED ON TRANSPORTERS
TAILING DIAGRAM FOR A COMPLEX OPERATION:
LOAD VERSUS CAPACITY AT VARYING RADII

M-999 (S-1) w/ 80' BOOM
CRANE CAPACITY

CALCULATED TAILING LOAD

START

WALK

SWING

WALK

Radius (in feet)

35

Capacity (in Kips)

0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
360
ACCIDENT CAUSED BY A HOME MADE CRANE, WHICH DID NOT HAVE HAD THE ABILITY TO SWING- IT ALSO HAD NO OUTRIGGERS
In addition to the difficulties in reinforcing the cage for lifting and the difficulties of choosing rigging that will lessen the bending of the cage, many operations do not follow the crane manufacturer’s limits on:

- Drift
- Side Load
- The use of two hooks

In addition, many cages that should be tailed with a crane- are not.
REBAR CAGE ACCIDENT
MULTIPLE CRANE LIFTS
(MORE THAN TWO CRANES)

• Except for roll-ups, lifting up and down should be the only actions allowed

• De-rating the cranes is essential

• Planning, communication, and signaling are most important

• Determining accurate load distribution may be difficult, but necessary
THREE CRANE PICK WITH INVERTED LIFT BEAM CONNECTING TWO CRANES
THREE CRANE LIFT DICTATED BY LOAD REQUIREMENTS
A THREE CRANE LIFT
MULTIPLE CRANES LIFTING A LARGE ROOF SECTION
MULTIPLE CRANES: JACKET ROLL UP
The Second lift was accomplished on October 24, 1978. Although a duplicate of the first, was again a display of courage and expertise on the part of all concerned.
LiFT EQUIPMENT
The industry source for equipment that moves personnel and material aloft.

Lift Equipment First Annual Safety Report
10309 E. Independence Ave.
Independence, Mo. 64053

Photo by Bruce Eatington
CONCLUSIONS

- In general, the use of multi-crane lifts has decreased in recent years, but the need for such lifts remains.

- If a multi-crane lift is the best solution, the planning and execution must be elevated to a higher plane.

- This includes an emphasis on weights, center of gravity, and load distribution as well as planning for all movements and situations, communications, and signaling.

- And remember—go slow, keep it level, keep the load falls plumb, and attempt to minimize executing more than one task at a time with either crane.