Knight/Jacobs Joint Venture WORK INSTRUCTION	Work Instruction No.: 713 Revision: 1	Pages: 17
	Previous Revision date: 02/18/2003	Current Revision date: 02/28/2003
Subject: **Title: Critical Lifts**	Prepared By: Department Approval: Project Management Approval: 03-04-03	

1.0 PURPOSE

This Work Instruction (WI) provides guidance to establish criteria for the definition and execution of critical lifts on the SNS construction project. All critical lifts as defined by this WI shall be properly planned and documented by on site subcontractors using a critical lift permit as required by this WI.

2.0 SCOPE

The Knight/Jacobs Joint Venture (KJ/JV) Environmental Safety and Health Plan provides the minimum requirements to be followed when critical lifts are planned to occur on-site.

This WI applies to all on-site subcontractors engaged in lifting operations on the SNS construction project.

3.0 DEFINITIONS AND RESPONSIBILITIES

3.1 A lift will be considered a Critical Lift when any one of the following conditions exist:

3.1.1 All lifts over 50 tons.

3.1.2 When the:

- Loads covered by the Steel Erection Standard exceeds 75% or
- Loads for general construction exceeds 85%

of the cranes (including all load bearing components) capacity as shown on applicable crane manufacturer's load capacity charts for the configuration to be used. If the percent of capacity is larger than 95 %, the lift must be reevaluated.

3.1.3 Use of a crane or lifting device in an application that deviates from manufacturer's recommendations including, but not limited to:

- Boom configuration not per boom make-up chart.
- Moving a crane with longer boom than recommended.

- Exceeding capacities or restrictions shown on the load chart.
- Exceeding capacities of load bearing components.

Note: All deviation from manufacturer's recommended use must first have written approval from the manufacturer.

3.1.4 Lifts near high voltage lines.

3.1.5 When a lift involves more than one crane or other motorized lifting device lifting a common load.

3.1.6 Any lift where collision, upset, or dropping could result in any of the following:

- Unacceptable risk of personnel injury or significant adverse health impact (onsite or offsite).
- Significant release of radioactive or other hazardous material or other undesirable conditions.
- Undetectable damage that would jeopardize future operations or the safety of a facility.
- Damage that would result in unacceptable delay to schedule or other significant program impact such as, loss of vital data.

3.1.7 Any lift where the load requires exceptional care in handling because of size, weight, close tolerance installation, high susceptibility to damage, or other unusual factors.

3.2 There are several other conditions which may constitute a Critical Lift and should be evaluated by the subcontractor.

3.2.1 Lifts that are made where the load or crane boom could fall on pipelines or reactors containing flammable gases or liquids.

3.2.2 Lifts in confined spaces.

3.2.3 Lifts involving non-rigid objects like tank shells.

3.2.4 Lifts using rigs over 150 ton capacity and/or 200 feet of boom. This restriction does not apply to the CM supplied 4600 Ringer crane.

3.2.5 Lifts with lifting points below the center of gravity of the load.

3.3 Site Management Responsibilities

3.3.1 The KJ/JV Construction Manager (CM) has overall responsibility for implementation of the requirements found in this WI.

3.3.2 The Subcontractor has ownership and responsibility for the detail implementation of the requirements found in this WI.

3.3.3 The Critical Lift Permit must be developed by the Subcontractor in conjunction with it's Environmental Safety and Health Plan and obtain reviews from the following personnel:

- The CM or his designee must review all Critical Lifts on the site.
- The KJ/JV Project Manager (PM) or his designee if the lift exceeds 50 tons.
- Subcontractor Lift Supervisor.
- Crane Operators who will be performing the lift.
- A Safety Watch is required to monitor overhead high voltage line clearances.

3.4 Subcontractors Safety Representative

The subcontractors Site Safety Representative shall assist the subcontractor in compliance with the requirements of this WI.

3.5 K/J JV Health and Safety Department

The K/J JV Health and Safety Department will assist the CM in compliance with this WI.

4.0 METHOD (PROCEDURE)

4.1 All persons involved in critical lifts shall be knowledgeable of the requirements of this WI.

4.2 Approvals and Documentation

4.2.1 All Critical Lift Permits must include the following information: Subcontract Number, Location, Client, Date of Lift, Time, and Brief Description.

4.2.2 Critical Lift Permits shall be submitted to the CM nominally two (2) working days prior to making the lift.

4.2.3 The Critical Lift Permit must be developed by the Subcontractor in conjunction with it's Environmental Safety and Health Plan and obtain reviews from the following personnel:

- The CM or his designee must review all Critical Lifts on the site.

- The KJ/JV Project Manager (PM) or his designee if the lift exceeds 50 tons.
- Crane Operators who will be performing the lift.
- Subcontractor Lift Supervisor.
- Any engineering personnel involved in designing equipment for the lift.

4.2.4 Required Attachments

- Crane Operator Certifications must be issued through a Certified Competent Person and must be up-to-date. All Operator Certifications must be attached to the Critical Lift Permit.
- Type, size, capacity rating, manufacturer, capacity certificates, and inspection reports for all cranes and other lifting equipment must be attached.
- Type, size, capacity, engineered designs, and manufacturer of shackles, hooks jacks, rollers, come-a-longs, spreader bars and slings must be attached. (Include bill of materials for any items.)
- The completed rigging diagram must be attached and include the entire rigging process and the following minimum information when it applies:
  - Type and capacity of lifting equipment (erection crane, tailing crane, jin poles, etc.).
  - Crane boom length, radius, and location of outriggers.
  - A plot of the path and travel including all vertical and horizontal clearances from such items as adjacent equipment, power lines, and other encumbrances or hazards.
  - Location, size and capacities of lifting lugs, slings, and other rigging accessories as well as the method of attachment.
  - Position of load in relation to the boom to show hook clearance and distance between the boom and the load.
  - Type of tow tractor, including size, capacity, turning radius, trailer attachment mechanism, etc. This information is particularly important in narrow, limited width plant access roads and for lifts in confined spaces.

- Description, size, capacity, and location of miscellaneous equipment such as dollies, jacks, hand wrenches, rollers, etc.
- Location of mats and cribbing used before, during, and after the lift. Include specifications for the size of the matting.
- Location and orientation of equipment.
- Location of underground lines (utility lines, electrical duct banks, cables, etc.), abandoned vessels and tanks, and foundations.
- Position of survey equipment.

- Lift Geometry and Free Body Diagrams shall be developed by a Qualified Person designated by the Subcontractor.
  - The Lift Geometry and Free Body Diagrams are needed to illustrate the individual tensions of each sling involved in the lift. They will also show if there will be any shift of weight when the load is lifted.
  - Please refer to Attachment 2 for an example.

4.3 Pre-Lift Planning Guidelines

Pre-Plan data required - All critical lift operations require a complete investigation in order to select the most effective method to be used for the lift. The following list outlines the basic information required before developing a lift plan.

4.3.1 Make an inventory of all required lifting equipment to assure that it is available.

4.3.2 Weather Conditions

- Crane rating charts apply up to a stated maximum wind speed. Avoid operating when the wind exceeds the crane design wind velocity.
- Wind pressure on the lift equipment and the load to be lifted shall be determined in accordance with ANSI/ASCE 7 (1995) (old ANSI A58.1): Minimum Design Loads for Buildings and Other Structures.
- No lifts will be made during electrical storms.

4.3.3 General Safety Precautions

- Always specify the use of outriggers on truck and hydraulic cranes.
- Always maintain clear area under suspended loads so as not to endanger others. Have plans made to evacuate personnel working in the lift area.
- All vessels shall be emptied of liquids or other viscous flowable material prior to lifting.
- Always use the shortest boom practical.
- For lifts with traveling cranes, measure the actual radius. Do not rely on boom indicators.

4.3.4 Electrical Safety Precautions

- No rigging should be done over energized high voltage lines. High voltage lines are lines rated 220 V or greater. However, even 110 V is dangerous and caution should be used.
- No part of the rigging operation, including the boom cables, and the load, shall come closer to high voltage lines than specified below:

Required Clearances from Overhead
High - Voltage Lines

Nominal Voltage, kV (Phase to Phase)	Minimal Required Clearance (feet)
0 - 50	10
51 - 75	11
76 - 100	12
101 - 125	13
126 - 200	15
201 - 300	19
301 - 400	22
401 - 500	25
501 - 700	32
701 - 1,000	42

- A safety watch is required to monitor these overhead high voltage line clearances and should be located a safe distance away from the lift. This safety watch shall be positioned to accurately observe the distance between hoisting equipment and energized lines.

4.3.5 Safe Rigging Practices

- Determine the weight of the load before designing the method that will be used to lift it. Consider whether vessels will contain fluid, sludge, internal equipment, etc. These items can add significantly to the nominal weight and can create dynamic motion.
- If possible, distribute the load evenly on all legs of a sling.
- When using multiple leg slings, keep in mind that the load is not always divided equally.
- The 4-leg slings shall be rated as 3-leg slings, since it cannot always be determined that all legs will be loaded equally. Other multiple leg slings should be given due consideration for possible uneven loading.
- Check choker rotation to eliminate jerking or slipping while upending or laying down.
- When fastening chain hoists, or snatch blocks to permanent structures, verify that the structure is strong enough to support the load.
- Always refer to the manufacturer's specification chart for safe working loads of shackles.
- Never replace the shackle pin with a bolt; only the proper fitted pin shall be used.
- The crane rated loads do not account for the weight of rigging accessories, like blocks, auxiliary boom head, hooks, slings, spreader bars, jibs, material handling equipment, and other elements of lifting tackle. Their combined weight must be added to the total weight.
- The maximum safe working load of cranes is determined from static loads. The capacity charts do not take into account impact loads due to the dynamic motions of the load or crane.
- Are softeners required to reduce cutting to the slings?

4.3.6 Safety Precautions for Lifting in Tight Quarters and Confined Spaces

- Conduct a detailed investigation to identify all possible interference in the vicinity of the work including overhead, at grade or underground.
- Plot in detail the location of the crane and/or other equipment with respect to the work, including location of outriggers.
- Establish limits of allowable motion for the boom in both the vertical and horizontal directions for each crane location in order not to damage existing facilities.
- Devise and provide means to protect existing operating facilities. Mechanically protect small protrusions on operating equipment, such as valves, instrumentation, brackets, etc., which could be damaged if contact is made with the load.
- Consider shutting down and depressurizing operating equipment which could be jeopardized by the lift.

4.3.7 Method of Attachment and Handling

- If attachment points or lifting lugs are provided on the piece, verify that they are intended for handling operations to prevent damage.
- What are the manufacturer's care and control restrictions of the object to be lifted during handling the entire piece and not a component.
- Are there any requirements for shipping skids or other handling devices and their availability.
- Review the sequence of proper assembly or disassembly when the structure consists of components.

4.3.8 Lifting Lug Requirements

- Lifting lugs must be engineered to withstand the load plus an additional 125 % of the load as a safety factor.
- All engineering of the lugs must be done by a certified engineer.
- Welds on both old and new lifting lugs must be magnetic-particle tested to ensure soundness.

4.3.9 Matting Requirements

- Matting must be made of through bolted hard wood, or heavy duty 12" X 12" crane timbers.
- Matting must be thoroughly inspected before use.

4.3.10 Ground Stability

- Ascertain the load carrying capacity of the soil and beware of recently excavated and backfilled areas or areas with weak soils having limited bearing capacity. Examine the rigging diagram to verify that cranes, dollies, and trailers are adequately supported and that the diagram includes cribbing or mats under the crane and outriggers where required.
- Check the entire path of movement during the lift for all holes, rocks, and soft ground.
- Check all load restrictions on floors, structures and access roads.

4.3.11 Tag Line

Always use a tag line even for smaller lifts unless the tag line increases the hazard. It is much easier to maintain control of the lift than to regain control when it is swinging or spinning. There shall be no knots in the trailing end of tag lines.

4.3.12 Disconnecting and Connecting Means

Prior to lift, develop a method of unhooking and hooking up the load.

4.3.13 Orientation of Load

Always assure that rigging is placed to assure proper orientation of piece in final position.

4.3.14 Surveying equipment may be needed to insure that loads remain within vertical and horizontal limits and to assure stability during the lifting operation.

4.3.15 A Pre-Lift Meeting must be held immediately prior to the lift that includes all personnel involved in the lift. All Employees attending must sign the attendance sheet.

4.3.16 If in completing the critical lift permit it is determined that the lift exceeds 95% of the crane configuration capacity for the greatest radius the load will achieve during the lift, the lift will not be made. If by changing the crane configuration within specifications a greater gross capacity may be gained, the change shall be made. If not, a larger capacity crane shall be obtained and used.

4.3.17 All reviews/approvals that are required must be signed prior to the lift.

4.4 Computing Load and Capacity Calculations

4.4.1 Weight of Equipment to be lifted - When completing this section of the permit, always be assured that the equipment plus the weight of all the rigging equipment, jibs, headache balls, blocks and any other attachments that will reduce the net capacity of the crane.

4.4.2 Total Loads - The total load is a combination of the weight of the equipment plus the weight of all the rigging equipment, jibs, headache balls, blocks and any other attachments that will reduce the net capacity of the crane.

4.4.3 Capacities of the Crane - While filling this section out, you must be assured of the following items:

- The correct load chart is being used to obtain capacities.
- If the jib is to be used, be sure that the rated capacity of the lift does not exceed the jib capacity.
- Be sure that you are using enough parts of line so the hoisting capacity exceeds the lift capacity.

4.4.4 Percent of Capacity

- Use the total weight obtained from Part B and divide it by the rated capacity for the lift.
- If the percent of capacity is larger than 95%, the lift must be reevaluated.

4.4.5 Size of Slings

After obtaining the rated capacity of the slings from the manufacturer, compare hose capacities to the Free Body Diagram to assure the slings are within their capacities.

5.0 RELATED DOCUMENTATION (REFERENCES)

5.1 OSHA 29 CFR 1926.550: Cranes and Derricks

5.2 OSHA 29 CFR 1910.180: Crawler Locomotives and Truck Cranes

5.3 ANSI B30.5: Mobile and Locomotive Cranes

5.4 ANSI / ASCE 7 (1995) (old ANSI A58.1): Minimum Design Loads for Buildings and Other Structures

5.5 Knight/Jacobs Joint Venture Environmental Safety and Health Plan

6.0 RECORDS

6.1 Critical Lift Permit

7.0 ATTACHMENTS/APPENDICES

7.1 Attachment 1: Critical Lift Permit

7.2 Attachment 2: Examples of a Free Body Diagram, and A Lift Geometry Diagram

Attachment 1 Critical Lift Permit (Page 1 of 5)

CRITICAL LIFT PERMIT

Section I: Approvals and Documentation

A. Identification

Subcontract Number:_____ Location:_____

Lift Identification Name:_____

Date of Lift:_____ Time:_____

Lift Description:_____

B. Approvals (Signatures Required)

Subcontractor:_____ _____
Date

Subcontractor Lift Supervisor:_____ _____
(This individual is to be present during the lift) Date

Project Manager:_____ _____
If Over 50 Ton Date

Construction Manager:_____ _____
Date

Operator:_____ _____
Date

Engineering:_____ _____
If Engineering Designs Are Used Date

C. Attachments

_____ 1. Operator Certifications

_____ 2. Capacity Certificates and Inspection Reports for all other Lifting Equipment

_____ 3. Inspection Reports for all Rigging Equipment

_____ 4. Rigging Diagram

_____ 5. Free Body Diagram

Attachment 1 Critical Lift Permit (Page 2 of 5)

Section II: Pre-Lift Planning

A. Pre-Lift Checklist

		(Initials) Yes	No
1.	Has an inventory of equipment been done?	_____	_____
2.	Have weather conditions been considered?	_____	_____
3.	Have the general safety precautions been reviewed?	_____	_____
4.	Have the electrical safety procedures been reviewed?	_____	_____
5.	Have the safe rigging practices been implemented?	_____	_____
6.	Have the safety precautions been reviewed?	_____	_____
7.	Has a method of attachment and handling been determined?	_____	_____
8.	Are all lifting lugs engineered to specifications?	_____	_____
9.	Has the matting been inspected and approved?	_____	_____
10.	Has the stability of the ground been assured?	_____	_____
11.	Is a tag line going to be used?	_____	_____
12.	Have disconnecting/connecting means been developed?	_____	_____
13.	Has the orientation of equipment been confirmed?	_____	_____
14.	Is survey equipment required?	_____	_____
15.	Is a Pre-Lift Meeting planned?	_____	_____
16.	Is a total weight below 95% of capacity?	_____	_____
17.	Are all required approvals signed?	_____	_____

Attachment 1 Critical Lift Permit (Page 3 of 5)

Section III - Load and Capacity Calculations

A. Weight of Equipment - Live Load

1. Equipment Condition New ( ) Used ( )
2. Weight of Equipment Empty _____ lbs.
3. Weight of Attachments:
   a. Platforms and Ladders _____ lbs.
   b. Piping and Accessories _____ lbs.
   c. Liquids Inside _____ lbs.
   d. Dirt and Debris _____ lbs.
   e. Internal Trays or Liners _____ lbs.
4. Total Weight of Equipment _____ lbs.

B. Total Load

Erection Crane

1. Percent of Equipment Weight	_____ %		7. Weight of Jib Erected	_____	lbs.
2. Amount of Equipment Weight	_____ lbs.		Stored	_____	lbs.
3. Weight of Headache Ball	_____ lbs.		8. Weight of Jib Headache Ball	_____	lbs.
4. Weight of Block	_____ lbs.		9. Weight of Cable (Load Fall)	_____	lbs.
5. Weight of Lifting Bar	_____ lbs.		10. Auxiliary Boom Head	_____	lbs.
6. Weight of Slings and Shackles	_____ lbs.		11. Other:_____	_____	lbs.

TOTAL WEIGHT _____ **lbs.**

Tailing Crane

1. Percent of Equipment Weight	_____ %		7. Weight of Jib Erected	_____	lbs.
2. Amount of Equipment Weight	_____ lbs.		Stored	_____	lbs.
3. Weight of Headache Ball	_____ lbs.		8. Weight of Jib Headache Ball	_____	lbs.
4. Weight of Block	_____ lbs.		9. Weight of Cable (Load Fall)	_____	lbs.
5. Weight of Lifting Bar	_____ lbs.		10. Auxiliary Boom Head	_____	lbs.
6. Weight of Slings and Shackles	_____ lbs.		11. Other:_____	_____	lbs.

TOTAL WEIGHT _____ **lbs.**

Source of Load Weight_____
(Name Plate, Drawings, Calculated, Weighed)

Weights Verified By:_____

Attachment 1 Critical Lift Permit (Page 4 of 5)

C. Capacities of the Crane

Erection Crane Configuration

1. Type of Crane _____
2. Rated Capacity _____ Tons
3. Lifting Arrangement
   a. Max. Radius During Lift _____ ft.
   b. Length of Boom _____ ft.
   c. Angle of Boom at Pick _____ deg.
   d. Angle of Boom at Set _____ deg.
   e. Rated Capacity Under Most Severe Conditions
      1. Over Rear _____ lbs.
      2. Over Front _____ lbs.
      3. Over Side _____ lbs.
   f. Rated Capacity for Lift _____ lbs.
4. Jib
   a. Is the Jib to be used _____
   b. Length of Jib _____ ft.
   c. Jib Angle _____ deg.
   d. Rated Jib Capacity _____ lbs.
5. Cable
   a. Number of Parts _____
   b. Size of Cable _____ inch.
   c. Maximum Capacity _____ lbs.

D. Percent of Cranes Capacity

$$\frac{\text{Total Weight X 100}}{\text{Rated Capacity}} = \_\_\_\_\_ \%$$

E. Size of Slings

1. Sling Selection
   a. Type of Arrangement _____
   b. Number of Slings to Hook _____
   c. Sling Size _____ inch.
   d. Sling Length _____ ft.
   e. Rated Capacity _____ lbs.

Attachment 1 Critical Lift Permit (Page 5 of 5)

C. Capacities of the Crane (continued)

Tailing Crane Configuration

1. Type of Crane _____
2. Rated Capacity _____ Tons
3. Lifting Arrangement
   - a. Max. Radius During Lift _____ ft.
   - b. Length of Boom _____ ft.
   - c. Angle of Boom at Pick _____ deg.
   - d. Angle of Boom at Set _____
   - e. Rated Capacity Under Most Severe Conditions
     1. Over Rear _____ lbs.
     2. Over Front _____ lbs.
     3. Over Side _____ lbs.
   - f. Rated Capacity for Lift _____ lbs.
4. Jib
   - a. Is the Jib to be used _____
   - b. Length of Jib _____ ft.
   - c. Jib Angle _____ deg.
   - d. Rated Jib Capacity _____ lbs.
5. Cable
   - a. Number of Parts _____
   - b. Size of Cable _____ inch.
   - c.. Maximum Capacity _____ lbs.

D. Percent of Cranes Capacity

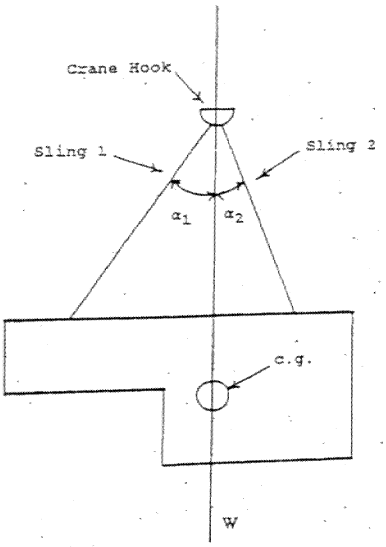
$$\frac{\text{Total Weight X 100}}{\text{Rated Capacity}} = \text{_____ \%}$$

E. Sizing of Slings

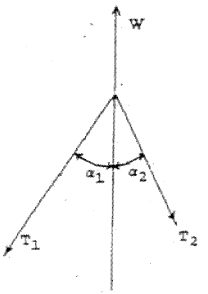
1. Sling Selection
   - a. Type of Arrangement _____
   - b. Number of Slings to Hook _____
   - c. Sling Size _____ inch.
   - d. Sling Length _____ ft.

e. Rated Capacity _____ lbs.

Attachment 2 Examples of a Free Body Diagram, and A Lift Geometry Diagram



LIFT GEOMETRY



FREE BODY DIAGRAM

W = weight of load, lb.
α_1 = angle from vertical of sling 1, degrees
α_2 = angle from vertical of sling 2, degrees
T_1 = tension in sling 1, lb.
T_2 = tension in sling 2, lb.

Problem: Find T_1 and T_2 when α_1, α_2, and W are known.

Solution: For equilibrium to exist, the summation of forces in both the vertical and horizontal directions must be equal to zero.

Therefore:

a) Vertical direction:
$\cos \alpha_1 (T_1) + \cos \alpha_2 (T_2) = W$

b) Horizontal direction:
$\sin \alpha_1 (T_1) = \sin \alpha_2 (T_2)$

Let

$W = 100{,}000$ lb.
$\alpha_1 = 40$ | $\sin 40 = 0.643$, $\cos 40 = 0.766$
$\alpha_2 = 20$ | $\sin 20 = 0.342$, $\cos 20 = 0.940$

Then

a) $0.766 (T_1) + 0.940 (T_2) = 100{,}000$

b) $0.643 (T_1) = 0.342 (T_2)$

Solving equation b):
$T_2 = (0.643/0.342) T_1 = 1.880 (T_1)$

Solving equation a):
$0.766 (T_1) + 0.940 (1.880) T_1 = 100{,}000$

$2.533 (T_1) = 100{,}000$

$T_1 = 39{,}474$ lb.

and

$T_2 = 1.880 (T_1) = 1.880 \times 39{,}474$

$= 74{,}211$ lb.

As can be seen sling 2 carries 1.9 times the load of sling 1 (74,211/39,474 = 1.9)