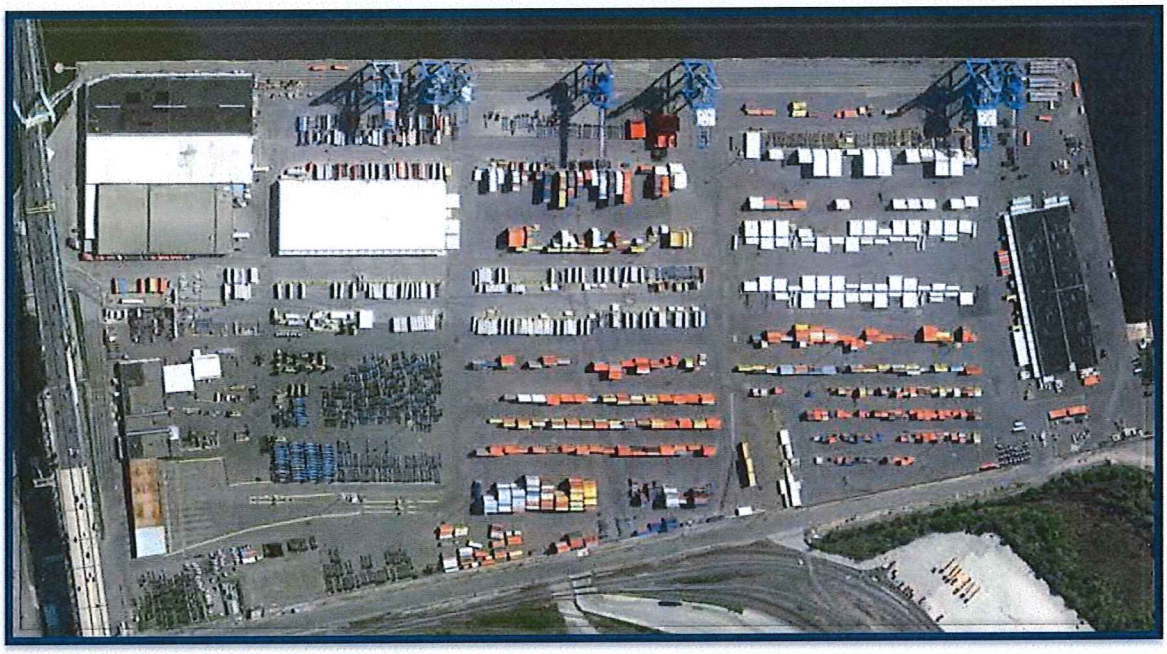
Feasibility Study
of
STS Gantry Cranes & Dock
at
Packer Avenue Marine Terminal (PAMT)

for

Astro Holdings, Inc.



October 01, 2013
Rev. 2

BOOS | NAVARRE
Consulting Engineers

TABLE OF CONTENTS

INTRODUCTION

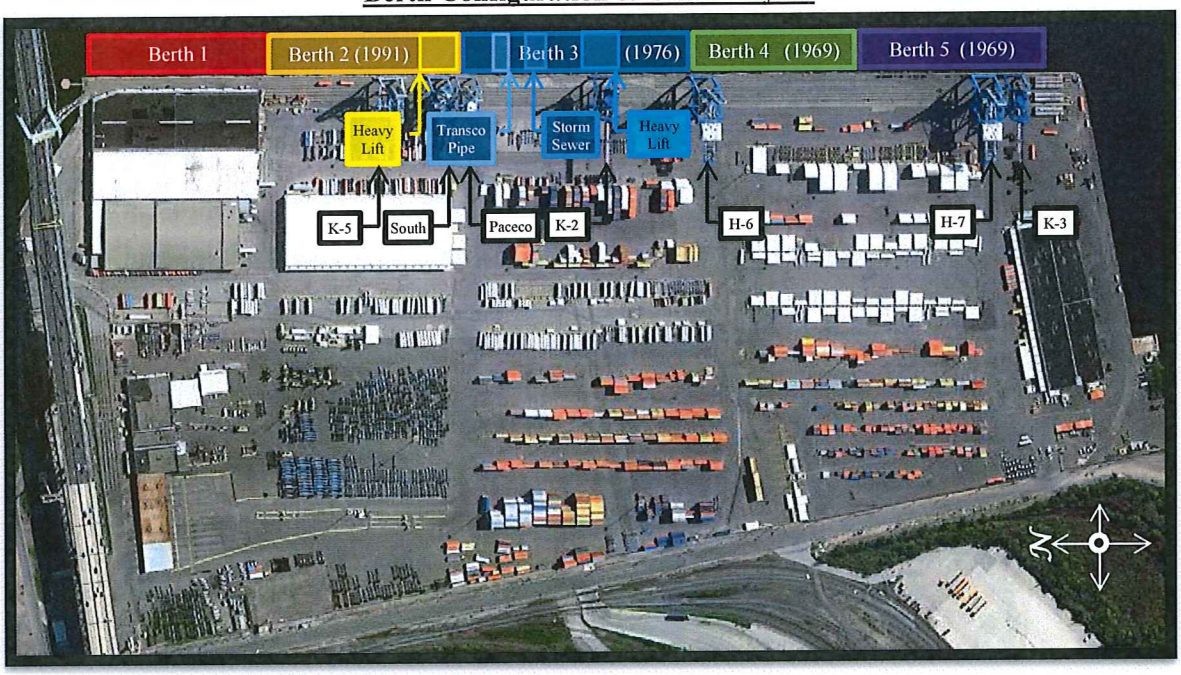
Astro Holdings, Inc. requested that Boos Navarre, LLC (BN) study the dock modifications required for unrestricted operation of the existing 65 LT HHI STS Cranes (H-6, H-7), future 65 LT rated capacity Post Panamax (PPMX) and future Super Post Panamax (SPPMX) ship-to-shore (STS) container handling gantry cranes the full length of the existing Packer Avenue Marine Terminal (PAMT). The PPMX and SPPMX STS crane configurations will enable container handling operations along Berth(s) 2, 3, 4 & 5 for container vessels up to 18 rows wide and 22 rows wide, respectively.

The study was to provide an order of magnitude budgetary cost for:

- the modifications required to the existing dock gantry rail structure and/or installation of a new gantry rail system,
- procurement of future PPMX and SPPMX STS, and
- providing temporary high voltage power supply for electric STS Crane operation.

As a basis for this study, Astro Holdings, Inc. provided BN with the PAMT Dock Crane Rail Support Structure Analysis Report prepared in 2005 which identifies the different phases of dock constructions and gantry rail capacities along Berths 2–5.

Berth Configuration & Crane Layout



Currently, PAMT has seven (7) diesel powered container handling cranes of various configurations, capacity, manufacturer, and vintage operating on Berths 2–5 as listed in Appendix A. The two (2) newest STS cranes (H-6, H-7) are 65 LT rated capacity cranes, manufactured by Hyundai Heavy Industries (HHI), placed into service in 2004. The other five (5) cranes were placed into service in 1970, 1972, 1979, 1984 & 1989. While some of these cranes are still used for container handling operations, the modification and refurbishment of these five (5) cranes was not considered as a viable option to provide the required outreach, performance, and capacity to adequately support future PAMT container

handling operations. As these five (5) cranes near their design useful life, they should be considered for replacement with all electrical more efficient container handling cranes.

The HHI STS Cranes (H-6, H-7) are the primary cranes for container handling operations. These cranes are capable of working container vessels up to 17 rows wide; however, their rated load capacity at the maximum outreach is currently restricted due to limitations of the allowable landside and waterside gantry rail dock construction.

There are currently three (3) STS crane gantry rails along Berths 2–5: a waterside crane rail, a landside crane rail set at a gage of 83'-6", and a landside crane rail set at a gage of 90'-0".

The PAMT dock system is of cellular construction with independent pile supported waterside and landside gantry crane rail beams. Berths 2-5 are comprised of three distinct phases of construction. (Ref. Table 5) While each of the phases of construction are similar, the allowable gantry rail loading along Berths 2-5 differs due to varying gantry rail support configuration. (Ref. Table 5). Berth 2 & 3 each include a heavy left section of approximately 191 ft. The gantry rail support system at Berth 3 spans across a Transco pipeline and the Hoyt Street storm sewer culvert. The limited allowable gantry rail loading across these two obstructions is the cause for the operational restrictions of the HHI STS cranes.

Currently, all of the existing cranes are self-powered by diesel gensets; however, the STS container crane industry is moving away from diesel powered cranes. Diesel powered cranes are not a favorable environmental solution, they negatively affect non-attainment areas, they are less reliable and more maintenance intensive, and it is impractical to install a diesel genset on the larger SPPMX cranes. With these factors in mind, this study considers that:

- Power supply for all future PPMX and SPPMX cranes shall be from terminal high voltage electrical feed (not currently installed) in lieu of diesel gensets mounted on the cranes.
- Power supply to future cranes will require interim power feed from temporary diesel gensets if terminal high voltage electrical feed will not be commissioned prior to delivery of the future cranes.
- The HHI STS Cranes (H-6, H-7) cranes shall be retrofit for terminal high voltage power supply, after terminal power is available. Until electrified, these cranes will continue to have restriction on operational speeds.

The study considers the typical gantry rail wheel loadings for PPMX & SPPMX cranes supplied by reputable STS container crane manufacturers. Although the existing gantry rail gage is 90ft the study considers the advantages and disadvantages of modifying the existing 90ft gage or installing a new 100ft gage.

EXECUTIVE SUMMARY

To allow PAMT to be marketable and a preferred port of call for the growing volume of PPMX (18 wide) and SPPMX (22 wide) container handling vessels, larger PPMX and SPPMX STS cranes will be required and the existing container handling Berths 2-5 require an increase in gantry rail capacity and provisions for high voltage electrical power supply to the cranes. Although, PAMT Berths 2-5 are currently configured for STS cranes with 83'-6" gage and 90'-0" gage, the larger PPMX and SPPMX crane configuration design is better suited for 100'-0" gage for wheel load and stability considerations. Additionally, the installation of the 100'-0" rail will be less disruptive to current operations than modifying the existing 90'-0" landside rail. The cost associated with preparing PAMT for handling PPMX and SPPMX vessel calls includes the procurement of new, larger STS cranes, capacity upgrade of Berths 2-5, and conversion from diesel-genset power supply to terminal high voltage power supply. All future repairs and improvements should consider the channel depth is being increased from 40' to 45' and the terminal will be handling larger PPMX and SPPMX vessels. This report is limited to STS cranes and their support structure; other items such as vessel fenders, mooring bollard strength, etc. should also be reviewed.

STS Cranes

Based on the existing configuration and performance of the existing seven (7) STS cranes at PAMT, only the two (2) HHI STS cranes (H-6, H-7) manufactured in 2004 are considered for the long term planning of container handling operations. The remaining five (5) cranes, while sufficient for continuing to service smaller Panamax (PMX) vessels, would not contribute to the PAMT planning for future PPMX and SPPMX vessel calls.

The two (2) HHI STS cranes are currently restricted in operating outreach, rated load lifting capacity, and operational speeds. The restriction to outreach and capacity is due to limitations of the allowable gantry rail loadings while the restriction to operational speeds is due to limitations of the existing diesel-genset power supply. All restrictions can be eliminated through berth strengthening (summarized below) and terminal and crane electrification for terminal high voltage power supply.

As stated above, future PPMX and SPPMX cranes should be designed for 100'-0" gantry rail gage and terminal high voltage power supply. The future cranes shall be designed for 65 LT rated capacity with Twin-20 operation and to technical specifications with emphasis on performance, reliability, and maintainability. Based on BN firsthand knowledge of recent PPMX and SPPMX crane pricing, the budgetary cost of future cranes is as follows:

STS Qty.	Crane Class	Budgetary Procurement Price[1]	
		90 ft. gage[2]	100 ft. gage
1-3	PPMX	$ 10,200,000	$ 10,500,000
1-3	SPPPX	$ 11,200,000	$ 11,500,000

[1]Price per STS based on partial erected delivery with upper works final erection @ PAMT or on site stick erection due to bridge restrictions.
[2] 90 ft. gage STS procurement only recommended for PPMX if no SPPMX cranes will be considered.

Berth Modification

The full extent of the required berth modifications, as mentioned above for container handling Berths 2-5, depend on PAMT's plan for future STS cranes. If PAMT will consider only future PPMX STS cranes and not SPPMX STS cranes, the required berth modifications are limited to the waterside rail of Berth 2 and the waterside rail and 90'-0" landside rails at the Transco Pipeline and Hoyt St. Sewer in Berth 3. If PAMT intends to install a high voltage cable trench along the full length of Berths 2-5 for PPMX cranes only (90'-0" gage), significant additional cost is required for these berth modifications.

Berth 2 & 3 capacity modifications (w/high voltage trench in modification areas)	$ 2,250,000
High voltage cable trench installation for remaining length of Berths 2-5*	$2,000,000
Total Estimated Budgetary Cost for PPMX only Modifications	$4,250,000

(Reference Appendix B-1 – Preliminary Construction Schedule*)
*Construction schedule does not consider the installation of high voltage trench installation along full length of Berths 2-5

For consideration of future PPMX and SPPMX cranes, the required berth modifications include the entire waterside rail (in heavy lift areas only high voltage cable trench installation, not strengthening is required), the 90'-0" landside rails (for H-6 & H-7) at the Transco Pipeline and Hoyt St. Sewer, and the installation of a new 100'-0" landside rail.

Waterside Rail	$ 7,650,000
Landside Rail	$ 9,950,000
Total Estimated Budgetary Cost for Berth 2 -5 Modifications	$ 17,600,000

(Reference Appendix B-2 – Preliminary Construction Schedule)

STS Cranes High Voltage Electrical Power Supply

As previously mentioned, the existing two (2) HHI STS cranes are limited in operational speeds due to diesel genset sizing. These cranes are slightly smaller than typical PPMX configuration and are fitted with the largest practical diesel engines (size & weight) for the crane configuration; however, due to mechanical component limitations these engines cannot produce the required power for unrestricted operation of the cranes. As such, diesel genset power supply should not be a consideration for future PPMX and SPPMX STS cranes. These cranes should be powered by terminal high voltage electrical power supply.

The existing two (2) HHI STS cranes will require conversion from diesel genset power supply to terminal high voltage electrical power supply after the terminal power source is available. The diesel gensets can remain on the cranes as emergency backup power supply; but the primary power supply would be through a high voltage cable stored on a monospiral gantry cable reel located on the crane's portal beam. Additionally, new wiring and electrical devices for the power supply conversion will be required on the cranes, and a transfer switch will be required for utilizing the existing diesel gensets for emergency backup power.

Total Estimated Budgetary Cost for Electrification of two (2) HHI STS Cranes	$ 3,400,000

Future PPMX and SPPMX cranes will be equipped only for terminal high voltage electrical power supply and the cost of such equipment is included in the procurement cost of the cranes above. Similarly, the

costs associated with installing the necessary cable trench inboard of the water side rail, stress relief drums, and cable diverters are included in the SPPMX Berth modification costs above.

This report only considers terminal high voltage electrical power supply as the STS container crane industry is moving away from diesel powered cranes. Diesel powered cranes are not a favorable environmental solution, they negatively affect non-attainment areas, they are less reliable and more maintenance intensive, and it is impractical to install a diesel genset on the larger SPPMX cranes.

This study has assumed that terminal high voltage electrical power supply will not be available in time for the crane delivery; therefore interim diesel power supply will be required for any new PPMX and SPPMX cranes until the terminal high voltage power supply is available. Diesel gensets, sized as required for up to three (3) SPPMX STS cranes, will be located at the South end of Berth 5. While connected to the interim diesel gensets, the gantry travel of the future PPMX or SPPMX cranes will be limited to 1300 linear feet (Berth 4 and 5 and heavy lift area of Berth 3) and the high voltage gantry reeling cable will be placed on top of the dock (inboard side of the waterside rail) protected by temporary curbing.

Total Estimated Budgetary Cost for Interim Diesel Power Supply	$ 2,850,000

FEASIBILITY STUDY

Ship-to-Shore (STS) Container Handling Gantry Cranes

Today's larger container vessels are typically designated as Post Panamax (PPMX) when the containers can be stacked eighteen (18) rows across the deck of the vessel and Super Post Panamax (SPPMX) when the containers can be stacked across the deck in twenty two (22) rows. Following this naming convention, ship-to-shore (STS) container handling dockside gantry cranes are classified as PPMX and SPPMX based on the maximum operational outreach and the widest vessel able to be serviced.

The global trend is that larger container vessels (PPMX & SPPMX) are becoming more common. For PAMT to remain marketable and a preferred port of call, larger PPMX & SPPMX cranes will be required to service the growing fleet of PPMX and SPPMX vessels. At numerous container handling terminals along the East Coast of the USA, PPMX and SPPMX STS cranes are being placed into service in preparation for receiving these larger vessels.

Recommended STS Configuration & Performance Characteristics

The recommended geometry and performance characteristics of future PPMX and SPPMX STS cranes are provided below based on typical vessel beam width and stacking above deck as well as consideration of the PAMT berth construction including set back of the waterside rail from the berthing fenders:

Table 1 – Recommended Principle Crane Dimensions

Description	PPMX Cranes (18 wide)	SPPMX Cranes (22 wide) [2]
Gantry Rail Gage	30.48 m [100.0ft] 27.44 m [90.0ft] [1]	30.48 m [100.0ft]
Operating Outreach (from WS rail)	50.00 m [164.0ft]	60.00 m [196.8ft]
Operating Backreach (from LS rail)	22.86 m [75.0 ft.]	22.86 m [75.0 ft.]
Operating Hoist Height (from WS rail)	33.50 m [110.0ft]	42.68 m [140.0ft]
Operating Lower Depth (from WS rail)	16.77 m [55.0ft]	16.77 m [55.0ft]
Minimum Clearance Under Portal Beam	15.24 m [50.0ft]	15.24 m [50.0ft]
Maximum Crane Width (bumpers uncompressed)	27.00 m [88.5ft]	27.00 m [88.5ft]

[1] The industry standard is 100 ft. gage, however, the existing rail gage at PAMT is 90 ft
[2] New 100 ft. landside rail installed.

Table 2 – Recommended STS Crane Rated Capacity and Speeds

Description	PPMX Cranes (18 wide)	SPPMX Cranes (22 wide)
Rated Load Under Spreader (Twin Twenty)	65 LT	65 LT
Load Under Spreader (Single Container)	50 LT	50 LT
Cargo Beam Under Hook	75 LT	75 LT
Main Hoist w/ 65 LT	70 m/min [230 ft./min]	90 m/min [295 ft./min]
Main Hoist w/ Empty Spreader	170 m/min [558 ft./min]	180 m/min [590 ft./min]
Trolley Travel	240 m/min [787 ft./min]	240 m/min [787 ft./min]
Gantry Travel	45-60 m/min [150 – 197 ft./min]	45-60 m/min [150 – 197 ft./min]

STS Gantry Wheel Loading – 17, 18 and 22 wide

Operating and stowed wheel loads of the existing 17 wide STS cranes compared to the typical PPMX and SPPMX STS crane wheel loads are provided in Table 3, below. This wheel load data serves as the basis for estimation of the required dock modifications and budgetary cost to support future PPMX and SPPMX crane operations at PAMT.

Table 3 – Comparison of STS Crane Wheel Loads

Description	Existing Cranes H-6 & H-7 (17 wide)	PPMX Cranes (18 wide)		SPPMX Cranes (22 wide)	
Rail Gage	90 ft.	90 ft.	100 ft.	90 ft.	100 ft.
WS Operating[1]	24 k/ft	27 k/ft	30 k/ft	N/A	42 k/ft
LS Operating[1]	29 k/ft	29 k/ft	32 k/ft	N/A	42 k/ft
WS Stowed[2]	50 k/ft	50 k/ft	50 k/ft	N/A	60 k/ft
LS Stowed[2]	50 k/ft	50 k/ft	55 k/ft	N/A	65 k/ft

[1] Operating Wind Speed assumed at 28 m/s (54mph)
[2] Stowed Wind Speed assumed at 63m/s (140 mph)

Typical Procurement Process, Pricing, & Schedule

Procurement of STS cranes is handled a variety ways based on who is procuring the equipment, where the equipment is being placed into service, and how the procurement will be funded. The procurement process utilized by the entity procuring the equipment (i.e. terminal operator or terminal owner) will have an impact on the procurement cost, delivery period, quality, and reliability of the STS gantry cranes placed into service at an existing and/or new facility. While some terminals procure STS cranes based solely upon the crane manufacturer's standard technical specifications this procurement method is typically not in the best interest of the end user. The primary objective of a crane procurement project is to place equipment into service which will meet or exceed the specific performance, reliability, safety, maintenance, and useful life requirements of the terminal. Additionally, the procurement process, proposal evaluation, and crane manufacturer selection should consider the total life cycle cost of the equipment: initial procurement, maintenance costs, refurbishment costs, technical merit, and proven equipment durability and useful life.

STS gantry cranes require a custom design to meet the specific terminal structural, mechanical, and electrical requirements and interface. The preparation of a detail technical performance specification will define the design criteria for overall structure, mechanisms, and electrical components as well as major purchased components, performance parameters, and safety and maintenance requirements.

The two most common methods of STS crane procurement are through either an open competitive bid process or sole source negotiation with a limited number of preferred suppliers. While either method can meet the primary objective of the crane procurement, the overall cost and procurement schedule can vary.

Competitive Bid Process

The competitive bid process is typically utilized when required by the rules and regulations of the purchaser and/ or when there is no preferred manufacturer. This method has advantages/disadvantages depending on the restrictions of the purchaser after bid evaluation. In cases where the low bid must be selected, a lower procurement price may be obtained; however, this price may be provided by a less desirable supplier and may require a sacrifice of a certain level of quality.

The typical STS crane procurement schedule for equipment procured via a competitive bid process is approximately twenty-four (24) months as shown in the milestone schedule Appendix B-1. The competitive bid procurement process involves seven (7) distinct phases of procurement outlined as follows:

I. Planning
- Identify the STS Crane Principle Dimensions and Performance Characteristics
  - Current throughput (TEU) and anticipated growth
  - Vessel size & interface
  - Dock interface & gantry rail loading limitations
  - High voltage power supply source
- Prepare Budgetary Crane Procurement & Facility Modification Cost
- Prepare Equipment Procurement & Facility Modification Milestone Schedule
- Identify funding source / Secure funding and obtain approval to proceed with procurement

II. Bid
- Bid Document Preparation
  - Commercial and Bid Documents
  - STS Crane Technical Specifications
- Request Bidder Qualifications / Issue Bid Announcement
  - Bidders Pre-Qualifications
  - Bid Announcement
- Bid Period
  - 6-8+ weeks for bid preparation and submission

III. Bid Evaluation
- Original Bid Evaluation
  - Technical Evaluation
  - Commercial Evaluation
  - Identify 2 or 3 short listed suppliers based upon evaluation (if permitted)
  - Bid Clarification meeting with 2 or 3 short listed suppliers (if permitted)

- Best & Final Offer
  - Request Best & Final Offer based upon Bid Clarifications
  - Technical Evaluation
  - Commercial Evaluation
  - Identify preferred supplier considering total cost, technical compliance, delivery schedule, manufacturing experience, etc.

IV. Award & Notice to Proceed
- Obtain Board or Management Approval for Award (typically 2-4 weeks)
- Issuance of Notice to Proceed
- Finalize Commercial Documents & Financing

V. Design & Manufacture
- Design Review – Technical Compliance Verification
- Manufacturing Oversight
- Initial Testing & Commissioning
- Pre-shipment Authorization

VI. Shipment & Site Erection
- Transportation & Offload at Delivery Site
- Final Erection Oversight

VII. Commissioning & Handover
- Final Testing & Commissioning Oversight
- Issue Substantial Completion
- STS Handover and Operation
- Punchlist Oversight
- Issue Final Completion

Sole Source Negotiation Process

If the purchaser's equipment procurement rules and regulations allow sole source negotiations with select preferred suppliers, the overall delivery period can typically be reduced to approximately 20 months. The schedule reduction is accomplished by streamlining the bid and award process (phases I – IV) as shown in the milestone schedule Appendix B-2 and outlined as follows:

I. Planning
- Identify the STS Crane Principle Dimensions and Performance Characteristics
  - Current throughput (TEU) and anticipated growth
  - Vessel size & interface
  - Dock interface & gantry rail loading limitations
  - High voltage power supply source
- Prepare Budgetary Crane Procurement & Facility Modification Cost
- Prepare Equipment Procurement & Facility Modification Milestone Schedule
- Identify funding source / Secure funding and obtain approval to proceed with procurement

II. Bid
- Bid Document Preparation
  - STS Crane Technical Specifications

Commercial and Bid Documents

Request for Bidder Qualifications / Bid Announcement
- *(not required)*

Bid Period
- *Issuance of Bid Documents to 2 or 3 preferred suppliers*
  - 6-8+ weeks for bid preparation and submission

III. Bid Evaluation / Best & Final Phase
- Technical Evaluation
- Commercial Evaluation
- *Combine Clarification / Best & Final Offer meeting with 1-2 short listed supplier(s)*
- Identify preferred supplier considering total cost, technical compliance, delivery schedule, manufacturing experience, etc.

IV. Award & Notice to Proceed
- Obtain Board or Management Approval for Award *(less than 7 days)*
- Issuance of Notice to Proceed

- Finalize Commercial Documents & Financing

(Note: Items V – VII same as Competitive Bid Process)

VIII. Design & Manufacture
- Design Review – Technical Compliance Verification
- Manufacturing Oversight
- Initial Testing & Commissioning
- Pre-shipment Authorization

IX. Shipment & Site Erection
- Transportation & Offload at Delivery Site
- Final Erection Oversight

X. Commissioning & Handover
- Final Testing & Commissioning Oversight
- Issue Substantial Completion
- STS Handover and Operation
- Punchlist Oversight
- Issue Final Completion

As a result of increased competitiveness in the container handling equipment market and the current global economic challenges, several crane manufacturers have moved their manufacturing facilities to areas with lower labor costs (typically within Asia) in order to maintain a competitive price. The challenge for both the crane manufacturer and purchaser is to ensure specification compliance, quality of fabrication, shipment method control, and maintaining the delivery schedule at these new, less experienced facilities. While a high level of quality can be achieved at these new facilities, it often requires increased effort for both the manufacturer and the buyer for quality assurance.

BN has firsthand knowledge of the technical capabilities, manufacturing capabilities, delivery records, quality of equipment, and reliability of the major global crane suppliers. BN is able to provide the required expertise during the buyer's preferred crane procurement process to assist the buyer in meeting or exceeding their procurement objectives.

STS Crane Pricing

The pricing of STS cranes placed into service at terminals around the world can vary significantly, even when they are of similar configuration. The main parameters which can affect pricing are:

- Currency exchange rate
- Owner financing
- Design Codes & Local Code Requirements
- Shipment Method & Restrictions (fully erected, partial erected due to bridge / other clearance restrictions, or onsite stick erection)
- Owner's site labor rates (union/non-union)

Based on the recommended PPMX and SPPMX STS crane configuration and performance parameters, technical specification similar to the existing 17 wide STS cranes (H-6, H-7), delivery restrictions due to bridge clearance, and cost of labor in Philadelphia, budgetary procurement prices of new STS cranes are anticipated as follows:

Table 4: PPMX and SPPMX STS Crane Budgetary Procurement Prices

STS Qty	Crane Class	Budgetary Procurement Price[1]		Procurement Duration	
		PPMX 90 ft. gage[2]	SPPMX 100 ft. gage	Bid Process	Sole Source
1-3	PPMX	$ 10,200,000	$ 10,500,000	24 months	20 months
1-3	SPPPX	$ 11,200,000	$ 11,500,000	24 months	20 months

[1]Price per STS based on partial erected delivery with upper works final erection or stick type erection @ PAMT due to bridge restrictions.
[2] 90 ft. gage STS procurement only recommended for PPMX if no SPPMX cranes will be considered.
(Reference Appendix B-1, B-2 – Typical Crane Procurement Schedule)

Berth Construction & Gantry Rail Capacity

Existing Berth Construction

The PAMT berths are comprised of three distinct phases of construction, noted by year of construction as 1969, 1976, and 1991, as depicted in Table 5. In general, the PAMT dock system is of cellular construction with independent pile supported waterside and landside gantry crane rail beams. There are three (3) STS crane gantry rails along Berths 2–5: a waterside crane rail, a landside crane rail set at a gage of 83'-6" (Berth 2-4), and a landside crane rail set at a gage of 90'-0" (Berth 2-5). The 83'-6" gage landside gantry rail is used only for the operation of the existing 45 LT STS crane, designated by PAMT as "South" Crane, which is used for smaller vessel operations; therefore no modifications are required to the 83'-6" gage landside rail.

The basis of the following recommendation and pricing do not consider repair of any deterioration of the existing dock construction. In areas where there may be impairment of the integrity of the rail support system, these areas should be investigated to determine the extent, if any, of the deficiency and repaired as required to properly support the future gantry rail loads required for 17 -22 wide 65 LT operation.

While the berths are of similar cellular construction, the allowable gantry rail loading along Berths 2-5 differs due to varying gantry rail support configuration as noted in Table 5. Berths 2 and 3 (1976,1991 phases) each include a heavy left section of approximately 191 ft. Berth 3 gantry rail support system also spans across a Transco pipeline and the Hoyt Street storm sewer culvert which limit the STS operating capacity in these areas.

The findings and recommendations for modifications to the existing Berth 2-5 gantry rail support system as described in the PRPA 2005 PAMT Crane Rail Structure Analysis are used as the basis for budgetary modification requirements. Revised budgetary pricing is provided for the recommended repairs of the waterside and 90ft gage landside gantry rail support system.

The installation of a new 100ft gage landside gantry rail system, in lieu of modification of the full length of the existing 90ft gage landside rail support system appears to be the most cost effective approach to obtain the required gantry rail capacity for SPPMX STS crane operation along Berths 2-5. It is recommended that the existing 90ft gage landside gantry rail support system should be only modified as needed to allow unrestricted, full rated capacity operation of the existing HHI STS cranes (H6 & H7). It also appears that the installation of a new 100 ft gage landside rail will be less disruptive to existing operations during construction than modifying the existing 90ft gage landside rail.

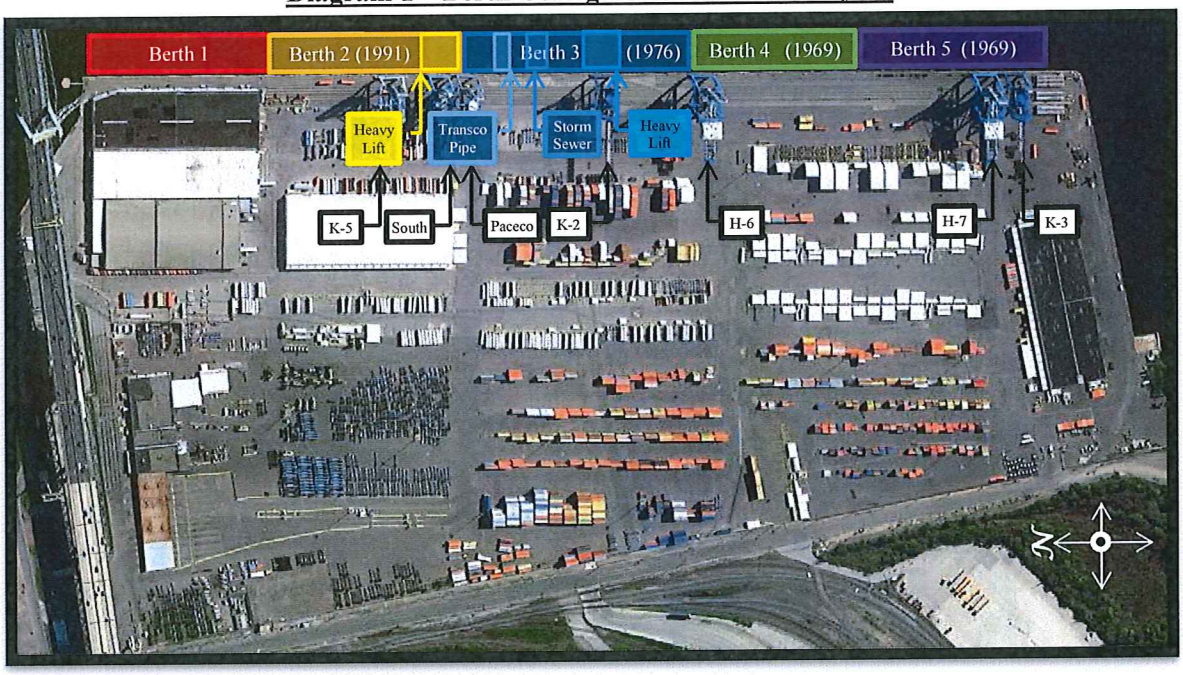
Although all existing cranes are self-powered by a diesel genset located on each crane, it is not recommended that future PPMX and SPPMX STS cranes be purchased with diesel genests. As such, recommended modifications to the waterside gantry rail support structure will include the installation of a high voltage cable trench system for the future power feed to the existing HHI STS cranes as well as all future PPMX and SPPMX cranes. Currently, the HHI STS crane performance is restricted due to the mechanical limitations of the diesel genset components. To obtain full speeds and accelerations available on these cranes, they will need to be converted to terminal high voltage power supply. Modification costs provided also consider that:

- Dock power supply will not be available prior to delivery of new STS cranes.
- Power supply for all future PPMX and SPPMX cranes shall be from the terminal high voltage electrical feed in lieu of diesel gensets mounted on the cranes.
- Power supply to cranes placed into service shall require interim power feed from temporary diesel gensets until terminal high voltage electrical feed is operational.
- The two (2) existing HHI STS cranes (H-6, H-7) will need to be retrofit for future high voltage terminal power supply, after terminal power is available. These cranes will continue to have restrictions on operational speeds and accelerations until terminal power is available.

Existing Gantry Rail Capacity

The following aerial view of PAMT identifies the berth configuration and the order of the existing STS cranes along the Berths:

Diagram 1 – Berth Configuration & Crane Layout



As identified in the above diagram, the description and basic information of the existing cranes is provided in Appendix A. The following table summarizes the existing Berth configuration and existing gantry rail capacity:

Table 5 – Berth Configuration & Existing Gantry Rail Capacity

Berth	Year of Construction	Length of Berth	Existing Waterside Rail Capacity (k/ft.)	Existing 90' Landside Rail Capacity (k/ft.)	Existing 83'-6" Landside Rail Capacity (k/ft.)
Berth 1	N/A	N/A	N/A	N/A	N/A
Berth 2	1991	394'	23	31	N/A
Berth 2 Heavy Lift Area	1991	191'	70	53	N/A
Berth 3 (std)	1976	539'	33	36	N/A
Berth 3 Transco Pipeline	1976		18	21	N/A
Berth 3 Hoyt Storm Sewer	1976		17	12	N/A
Berth 3 Heavy Lift Area	1976	191'	112	115	N/A
Berth 4	1969	573.5'	27	29	N/A
Berth 5	1969	573.5'	27	29	N/A
Total Length		2,462'			

[1] Color coding of table refers to color code of Berths in Diagram 1.

Berth Modifications - Existing HHI STS (17 wide) & PPMX (18 wide) STS Crane Operation

To correct the existing PAMT gantry rail capacity deficiency in order to lift the operational restriction and enable full rated load, outreach operation of the HHI STS Cranes (H6 & H7) along Berths 2-5 and for the installation of new PPMX (18 wide) STS cranes, modifications are required at three (3) locations:

- Berth 2 (standard construction) waterside rail
- Berth 3 Hoyt St. Sewer waterside and landside rail spans
- Berth 3 Transco Pipe Line waterside and landside rail spans

After completion of the above berth modifications the upgraded gantry rail capacity along Berth 2-5 will be as follows:

Table 6 – Upgraded Gantry Rail Capacity
HHI (H6 & H7) & PPMX (18 w) STS Crane Operation

Berth	Year of Construction	Length of Berth	Existing WS Rail Capacity (k/ft.)	Existing LS 90' Rail Capacity (k/ft.)	Upgraded WS Rail Capacity (k/ft.)	Upgraded LS 90' Rail Capacity (k/ft.)
Berth 1	N/A	N/A	N/A	N/A	N/A	N/A
Berth 2	**1991**	**394'**	**23**	**31**	**45**	**Ok**
Berth 2 Heavy Lift Area	1991	191'	70	53	Ok	Ok
Berth 3 (std)	1976	539'	33	36	Ok	Ok
Berth 3 Transco Pipeline	**1976**		**18**	**21**	**45**	**40**
Berth 3 Hoyt Storm Sewer	**1976**		**17**	**12**	**45**	**40**
Berth 3 Heavy Lift Area	1976	191'	112	115	OK	Ok
Berth 4	1969	573.5'	27	29	Ok	Ok
Berth 5	1969	573.5'	27	29	OK	OK

[1] Color coding of table refers to color code of Berths in Diagram 1.

Berth Modifications Budgetary Cost

Total Estimated Budgetary Cost for Berth 2 & 3 modifications:

WS Rail Strengthening	$ 1,750,000
Transco Pipe/Hoyt St. Span Strengthening	$ 500,000
Total	$ 2,250,000

Note: Reference Appendix B-1 – Preliminary Construction Schedule
Engineering design cost not included

In addition to the required modifications for dock capacity, PAMT will need to also consider the cost of installing a high voltage cable trench for the entire length of Berths 2-5 for crane electrification. The above costs consider the installation of the cable trench in the areas of modification. For the remaining length of Berths 2-5, the installation of the high voltage cable trench, cable horns, etc. will be:

High voltage cable trench installation for remaining length of Berths 2-5*	$2,000,000

Berth Modifications Description

The following modification work will be required for unrestricted operation of the two (2) HHI STS cranes and future PPMX 90'-0" gage cranes.

Berth 2 - Waterside Rail

- Strengthening of approximately 394 linear ft. of the existing pile supported concrete reinforced gantry rail support beam between the heavy lift section and the north end of Berth 2.
- Installation of a new concrete reinforced beam located on the inboard side of the existing waterside gantry rail support beam. The new beam will be supported by concreted filled piles placed on 8' centers (approx. depth +/- 95ft) and doweled into the existing waterside support beam.
- Installation of 394 linear ft. of STS crane high voltage cable trench installed for future electrical STS crane operation

Berth 3 - Waterside Rail

- Strengthening of the waterside gantry rail support beam at the Hoyt St. Sewer and Transco Pipeline spans. (approx. 40' @ each span)
- Installation of a new concrete reinforced beam located on the inboard side of the existing waterside gantry rail support beam. The new beam will be doweled into the existing waterside support beam.
- Installation of 80 linear ft. STS crane high voltage cable trench installed for future electrical STS crane operation

Berth 3 – Landside Rail

- Strengthening of the landside 90ft gage gantry rail support beam at the Hoyt St. Sewer and Transco Pipeline spans. (approx.40' @ each span)
- Removal of the existing concrete support beam and installation of a new concrete reinforced beam with tie in to the existing end piles.

Table 7 – 17 wide and PPMX (18 wide) STS Crane Capacity Gantry Rail Support Beam Length of Reinforcing Summary

Berth	Waterside Rail	Landside Rail	WS High Voltage Cable Trench
2	394'	0'	394'
3 (Hoyt St. Sewer)	40'	40'	40'
3 (Transco Pipeline)	40'	40'	40'
4	0'	0'	0'
5	0'	0'	0'
Total	**474'**	**80'**	**474'**

Berth Modifications - SPPMX (22 wide) STS Gantry Crane Operation

Due to the operating and stowed wheel loads as well as overall stability and dead weight distribution of SPPMX cranes, future PPMX and SPPMX cranes should be specified for 100 ft gantry rail gage. The modifications and associated budgetary cost to increase the existing PAMT gantry rail system capacity to enable 22 wide outreach, 100' gage, 65 LT STS Crane container handling operation along Berths 2-5 requires installation of a new 100 ft gage landside rail along the full length of Berths 2-5, waterside rail capacity increase in all but the heavy lift areas, and installation of a high voltage cable trench system along the full length of Berths 2-5.

After completion of the above berth modifications the upgraded gantry rail capacity along Berth 2-5 will be as follows:

Table 8 - Upgraded Gantry Rail Capacity
100 ft. Gage SPPMX (22w) STS Crane Operation

Berth	Year of Construction	Length of Berth	Existing Waterside Rail Capacity (k/ft.)	Existing Landside 90' Rail Capacity (k/ft.)	Upgraded Waterside Rail Capacity (k/ft.)	New Landside 100' Rail Capacity (k/ft.)
Berth 1	N/A	N/A	N/A	N/A	N/A	N/A
Berth 2	1991	394'	23	31	45	50
Berth 2 Heavy Lift Area	1991	191'	70	53	Ok	N/A
Berth 3 (std)	1976	539'	33	36	45	50
Berth 3 Transco Pipeline	1976		18	21	45	50
Berth 3 Hoyt Storm Sewer	1976		17	12	45	50
Berth 3 Heavy Lift Area	1976	191'	112	115	Ok	N/A
Berth 4	1969	573.5'	27	29	45	50
Berth 5	1969	573.5'	27	29	45	50

[1] Color coding of table refers to color code of Berths in Diagram 1.

Berth Modifications Budgetary Cost

Total Estimated Budgetary Cost for Berth 2 -5 modifications:

Waterside Rail	$ 7,650,000
Landside Rail	$ 9,950,000
Total	$ 17,600,000

Note: Reference Appendix B-2 – Preliminary Construction Schedule
The description of Berth modifications and budgetary cost are stand alone cost assuming the 17-18 wide modifications are not implemented. If the 17-18 wide Berth 2 waterside gantry rail support strengthening is completed prior to the start of the 22 wide waterside rail strengthening, deduct $ 1,750,000.
Engineering design cost not included

Berth Modifications Description

The following modification work will be required for operation of future PPMX and SPPMX STS Cranes.

Berth 2

Waterside Rail (Standard Construction – 394 linear ft)

- Strengthening of approximately 394 linear ft. of the existing pile supported concrete reinforced gantry rail support beam between the heavy lift section and the north end of Berth 2. (Same as 90' gage strengthening)
- Installation of a new concrete reinforced beam located on the inboard side of the existing waterside gantry rail support beam. The new beam will be supported by concreted filled piles placed on 8' centers (approx. depth +/- 95ft) and doweled into the existing waterside support beam.
- Installation of STS crane high voltage cable trench installed for future electrical STS crane operation

Waterside Rail (Heavy Lift Area – 191 linear ft)

- Strengthening is not required for the 191 linear ft. along the heavy lift gantry rail support beam section; however, installation of the high voltage cable trench on the inboard side of the existing rail beam will be required for the future electrification of the HHI STS cranes and future PPMX and SPPMX STS Cranes.
- Installation of a new concrete reinforced beam located on the inboard side of the existing waterside gantry rail support beam and doweled into the existing beam.

Berth 3

Waterside Rail (Standard Construction – 539 linear ft)

- Strengthening of approximately 250 linear ft. of the existing pile supported concrete reinforced gantry rail support beam between the heavy lift section and the south end of Berth 3.
- Strengthening of approximately 289 linear ft. of the existing pile supported concrete reinforced gantry rail support beam between the heavy lift section and the north end of Berth 3. Strengthening will include the gantry rail support beam span at the Hoyt St. Sewer and Transco Pipeline spans.
- Installation of a new concrete reinforced beam located on the inboard side of the existing waterside gantry rail support beam. The new beam will be supported by concreted filled piles placed on 8' centers (approx. depth +/- 95ft) and doweled into the existing waterside support beam.
- Installation of STS crane high voltage cable trench installed for future electrical STS crane operation

Waterside Rail (Heavy Lift Area – 191 linear ft)

- Strengthening is not required for the 191 linear ft. along the heavy lift gantry rail support beam section; however, installation of the high voltage cable trench on the inboard side of the existing rail beam will be required to interface with the future electric STS Cranes.
- Installation of a new concrete reinforced beam located on the inboard side of the existing waterside gantry rail support beam and doweled into the existing beam.

Berth 4

Waterside Rail (573.5 linear ft)

- Strengthening of approximately 573.5 linear ft. of the existing pile supported concrete reinforced gantry rail support beam the full length along Berth 4.
- Installation of a new concrete reinforced beam located on the inboard side of the existing waterside gantry rail support beam. The new beam will be supported by concreted filled piles placed on 8' centers (approx. depth +/- 95ft) and doweled into the existing waterside support beam.
- Installation of STS crane high voltage cable trench installed for future electrical STS crane operation

Berth 5

Waterside Rail (573.5 linear ft)

- Strengthening of approximately 573.5' linear ft. of the existing pile supported concrete reinforced gantry rail support beam the full length along Berth 5.
- Installation of a new concrete reinforced beam located on the inboard side of the existing waterside gantry rail support beam. The new beam will be supported by concreted filled piles placed on 8' centers (approx. depth +/- 95ft) and doweled into the existing waterside support beam.
- Installation of STS crane high voltage cable trench installed for future electrical STS crane operation

Berth 2-5

Landside Rail (2462')

- Installation of a new 100ft gage landside gantry rail beam in lieu of strengthening of the existing 90ft gage landside gantry rail beam,
- Installation of approximately 2462 linear ft. of new pile supported concrete reinforced gantry rail support beam the full length along Berths 2-5. The new beam will be supported by concreted filled piles placed on 8' centers (approx. depth +/- 95ft). Lateral support beams to be doweled into the existing 90' gage landside gantry rail support beam or batter piles will be required.
- Installation of new gantry rail support beam including spans at the Hoyt St. Sewer and Transco Pipeline spans.
- Installation of new 171 lbs./yd. gantry rail.
- Transition asphalt along the inboard side of the new rail system to the grade of the existing yard.
- Installation of one (1) gantry rail frog to interface with the existing yard railway system.

Table 9 – PPMX (18 wide) & SPPMX (22 wide) STS Crane Capacity Gantry Rail Support Beam Length of Reinforcing Summary

Berth	Waterside Rail	Landside Rail	WS High Voltage Cable Trench
2	394'	585'	394'
2 (Heavy Lift)	191'	191'	191'
2	250'	250	250'
3 (Standard Construction)	289'	289'	289'
3 (Heavy Lift)	191'	191'	191'
4	573.5'	573.5'	573.5'
5	573.5'	573.5'	573.5'
Total	**2462'**	**2462'**	**2462'**

STS Cranes High Voltage Electrical Power Supply

The berth modification budgetary cost for strengthening along PAMT Berth 2-5 waterside gantry rail includes the installation of a high voltage cable trench system on the inboard side of the waterside rail for PPMX and SPPMX cranes. The cable trench will be the full length along PAMT only if the complete waterside rail strengthening and modifications are implemented for the 22w SPPMX berth modifications. If the trench is not installed, the cable will need to lay on top of the dock in a protective curb with the electric STS crane operation limited to Berths 4 & 5.

Once the permanent cable trench system is installed it will supply power for the future electrification of the existing HHI STS Cranes (H-6, H-7) cranes and future PPMX & SPPMX STS Cranes. The trench system will interface with up to eight (8) STS gantry crane high voltage cables.

The following is a summary of the STS Crane and PAMT high voltage electrical power supply interface considerations:

Berth Modifications

- Procurement and installation of a complete high voltage cable trench system (Panzerbelt or equivalent) for the full travel lengths of Berths 2–5 for the PPMX & SPPMX Berth Modification.
- High voltage cable stress relief drums and cable horns installed

Temporary Power Supply

- Temporary STS Crane high voltage power will be supplied via diesel gensets installed at the South end of Berth 5 with capacity to meet the maximum demand for three (3) new SPPMX STS cranes.
- Installation of approximately 1400 linear ft. of temporary protective curb along the inboard side of the waterside rail for placement of the high voltage power supply cable (lay on top of the existing dock)
- Installation of temporary diesel fuel tanks and spill retention barrier

STS Crane Electrification

- All future STS cranes will include a high voltage monospiral gantry trailing cable reel and cable sized such that:
  - Travel when connected to the temporary diesel genset(s) will be approximately 1300 ft. from the south end of Berth 5 (along Berths 4 & 5).
  - Travel when connected to the permanent PAMT terminal power supply, the cranes will be able to travel the full length of the Berths 2–5.
- The existing two (2) HHI PPMX cranes will be converted from diesel power supply to terminal electrical supply after terminal electrical supply is available.

Table 10: Temporary Electrification Budgetary Cost Summary

Description	Budgetary Cost	
	Per STS	Qty (3) SPPMX
Diesel Genset	$ 875,000	$ 2,650,000
H.V. Cable Protective Curb & Fuel Tanks	-	$ 200,000
Total		$ 2,850,000

Note: Engineering design cost not included

Table 11: Crane H6 & H7 Electrification Budgetary Cost Summary

Description	Budgetary Cost	
	Per STS	Qty (2) SPPMX
Electrification HHI STS (H6 & H7)	$ 1,700,000	$ 3,400,000

Note: Engineering design cost not included

Items Not Included in this study:

- Any cost associated with installation of new terminal high voltage power feed to the PAMT terminal
- Construction/installation of a terminal substation and switch gear
- Terminal modifications for power supply from the switch gear to the waterside rail cable pits.
- Engineering Costs

REFERENCES

The following documentation was utilized as a reference for the site inspection, analysis, and report preparation:

- Philadelphia Regional Port Authority Packer Avenue Marine Terminal Crane Rail Structure Analysis, September 2005.

APPENDIX A

PAMT Existing STS Crane Description

Principle Dimensions

Description	K-5		South	Paceco	K-2	H-6	H-7	K-3
	Containers	Heavy Lift						
Date of Manufacture	1979		1984	1989	1970	2004	2004	1972
Gantry Rail Gage	90 ft		83.5 ft	90 ft	90 ft	90 ft	90 ft	90 ft
Max Vessel Size	13 w	N/A	12 w	14 w	12 w	17 w	17 w	13 w
Operating Outreach (from WS rail)	113.5 ft	62 ft	115 ft	125	111.5	150	150	121.5
Operating Backreach (from LS rail)	37.5 ft		26.25 ft	50 ft	94 ft	80 ft	80 ft	94 ft
Operating Hoist Height (from WS rail)	90 ft		82 ft	90 ft	78.5 ft	110 ft	110 ft	78.5 ft
Operating Lower Depth (from WS rail)	40 ft	17 ft	48 ft	50 ft	51.5 ft	45 ft	45 ft	51.5 ft
Boom Height Above Dock	106 ft		106 ft	104.3 ft	102.5 ft	127 ft	127 ft	102.5 ft
Minimum Clearance Under Portal Beam								
Minimum Clearance Between Legs	62 ft		45 ft	55 ft	62 ft	60 ft	60 ft	62 ft
Overall Boom Width	33 ft		29 ft	25.3 ft	32.7 ft	29.5 ft	29.5 ft	32.7 ft
Maximum Crane Width (bumpers uncompressed)	110 ft		80 ft	84.5 ft	83 ft	88 ft	88 ft	86 ft

[1] The industry standard is 100 ft. gage, however, the existing rail gage at PAMT is 90 ft.

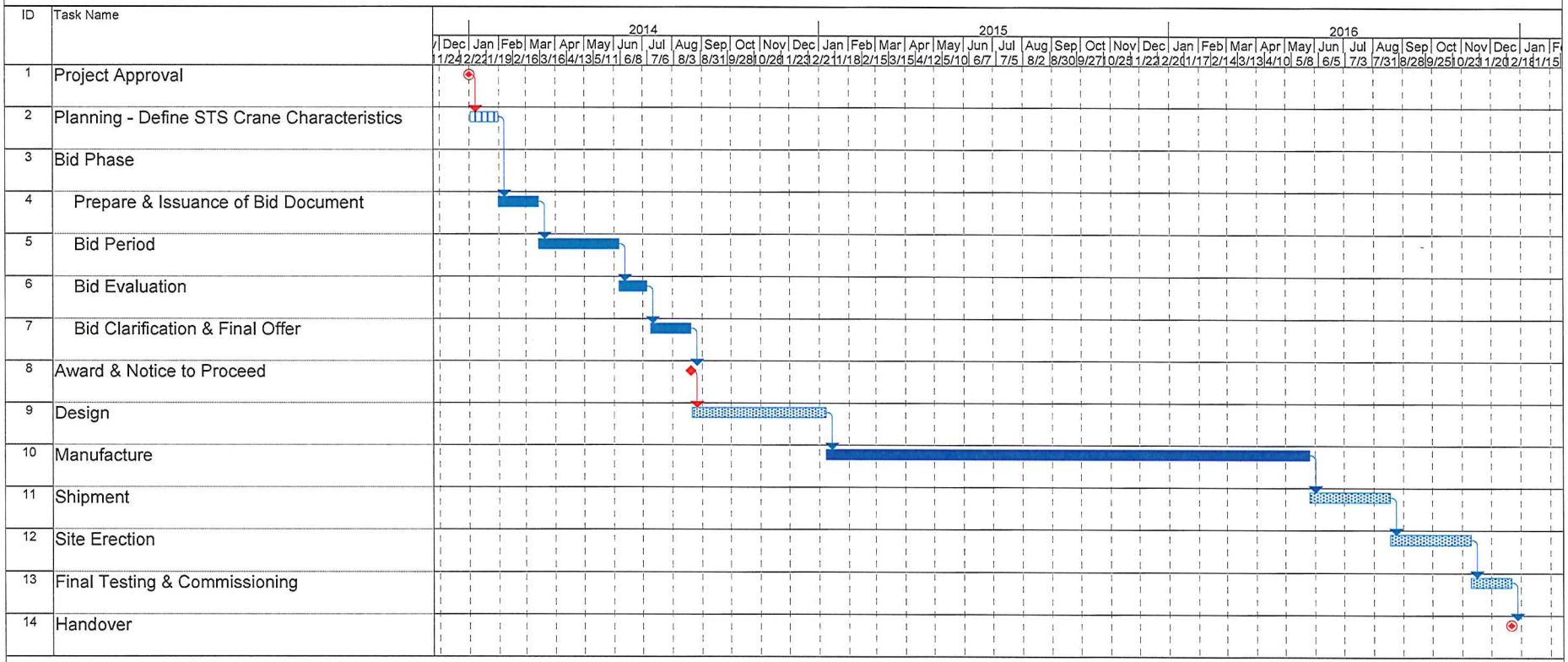
Rated Capacity & Speeds

Description	K-5		South	Paceco	K-2	H-6	H-7	K-3
	Containers	Heavy Lift						
Rated Load Under Spreader (Twin Twenty)	N/A		N/A	Empty Only	Empty Only	65 t	65 t	Empty Only
Load Under Spreader (Single Container)	45 t	375 t	45 t	45 t	45 t	50 t	50 t	45 t
Cargo Beam Under Hook	50 t		50 t	50 t	50 t	75 t	75 t	50 t
Main Hoist (loaded)	90 fpm		110 fpm	150	150	174	174	150
Main Hoist w/ Empty Spreader	180 fpm		220 fpm	360	300	558	558	300
Trolley Travel (all conditions)	400 fpm		410 fpm	500	480	787	787	480
Gantry Travel								

APPENDIX B-1

New STS Procurement Schedule Competitive Bid Process

APPENDIX B-1
(Qty 2) STS Crane Procuement Schedule
Competitive Bid Process

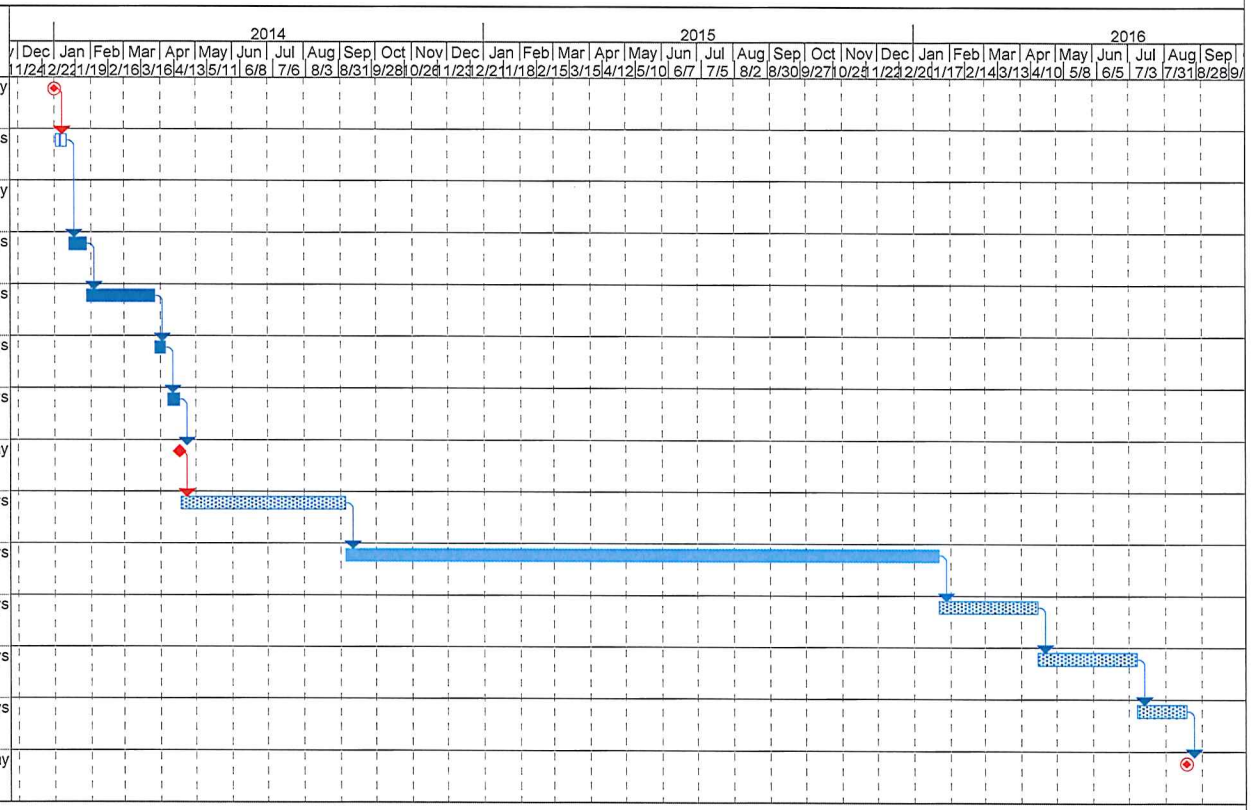


APPENDIX B-2

New STS Procurement Schedule Sole Source Negotiation Process

APPENDIX B-2
(Qty 2) STS Crane Procuement Schedule
Sole Source Negotiation Process

ID	Task Name	Duration
1	Project Approval	1 day
2	Planning - Define STS Crane Characteristics	7 days
3	Bid Phase	1 day
4	Prepare & Issuance of Bid Document	11 days
5	Bid Period	42 days
6	Bid Evaluation	7 days
7	Bid Clarification & Final Offer	8 days
8	Award & Notice to Proceed	1 day
9	Design	100 days
10	Manufacture	360 days
11	Shipment	60 days
12	Site Erection	60 days
13	Final Testing & Commissioning	30 days
14	Handover	1 day

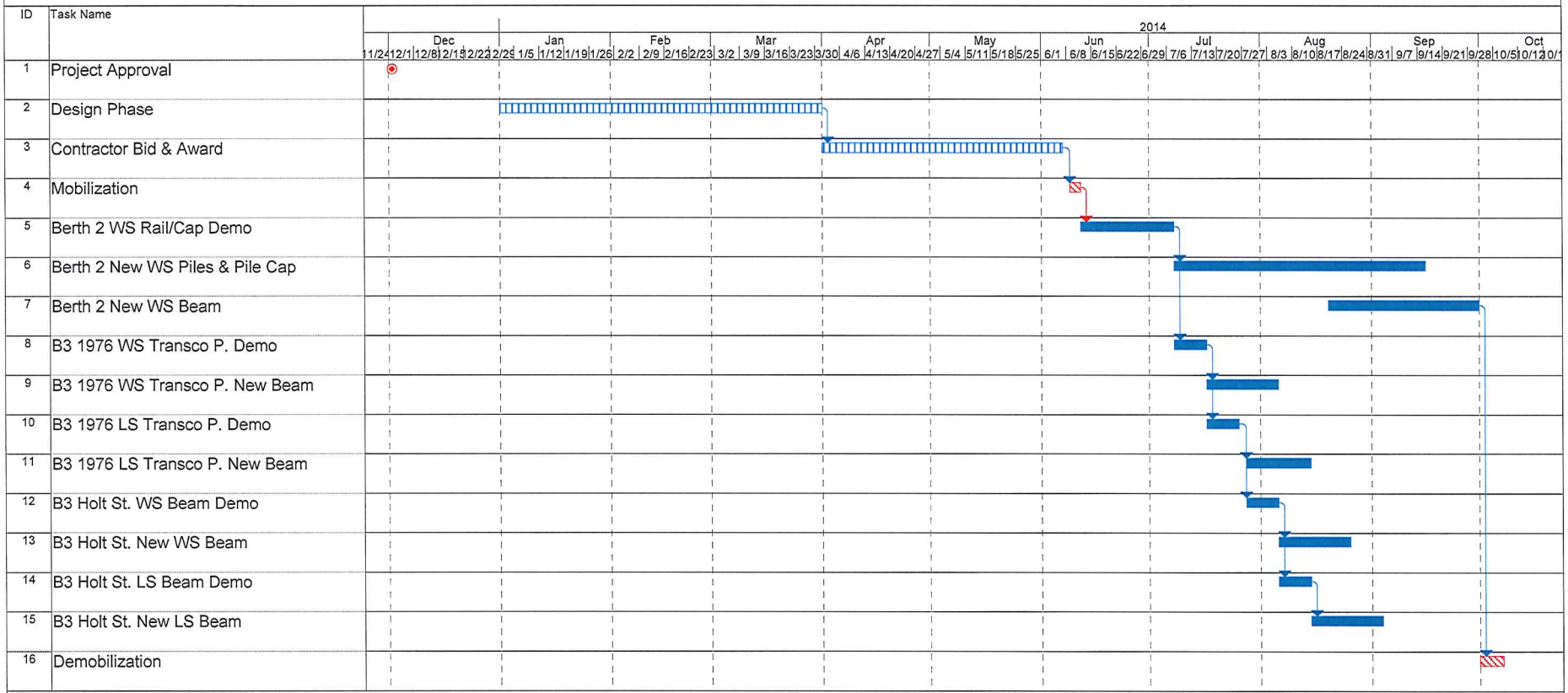


Task	External Tasks	Duration-only	External Tasks		
Split	External Milestone	Manual Summary Rollup	External Milestone		
Milestone	Inactive Milestone	Manual Summary	Progress		
Summary	Inactive Summary	Start-only	Deadline		
Project Summary	Manual Task	Finish-only			

APPENDIX C

17-18 wide STS Crane PAMT Berth Modification Preliminary Construction Schedule

APPENDIX C
17-18 Wide STS Crane Operation
Berth 2 & 3 Modifications



APPENDIX D

22 wide STS Crane PAMT Berth Modification Preliminary Construction Schedule

APPENDIX D
SPPMX (22 Wide) STS Crane Operation
Berth 2-5 Modifications