# PASSENGER BOARDING BRIDGES

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Early gangway design and evolution



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Taking a look at modern day examples of gangway designs. Ship ranges closer together, newer terminals taller.

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3 recently finished projects, and the analysis required to arrive at the selected designs.





### WHEN ARE BOARDING BRIDGES NECESSARY?

#### **ENVIROMENTAL**

Large tidal ranges, wave activity, other environmental factors.

#### SERVICING THE DESIGN FLEET

To accommodate larger ships with PAX loads in excess of 3,500. Accessing low-reach and high-reach doors. Servicing operations on apron.

#### HOMEPORT / PORT-OF-CALL

Homeports will likely require at least 1 PBB, with larger ships requiring 2+. More than 5-10 turnarounds per month.

#### **IMPROVING PASSENGER EXPERIENCE**

Optimize embark/debark process. More comfortable for passengers (ADA, A/C, aesthetics, etc). Should compliment new/refurbished architecture.



## **DESIGN VESSELS**

#### **IDENTIFYING THE DESIGN FLEET**

Critical to the design of the SPBB's is the fleet of vessels to be serviced. As the complexity and size of ships has evolved, designs have changed drastically. A few key factors include:

- Shell door locations (some doors in excess of +50' awl. Overboard lifeboats, structural overhangs
- PAX count. (Some vessels nearing >7,000 passengers)
- Apron level servicing (provisioning, luggage, bunkering, etc)

• Design vs operating draft Bermello Ajamil & Partners







## **HOMEPORT** and **PORT-OF-CALL**

#### IS A BOARDING BRIDGE RIGHT FOR YOU?

All homeports will likely require at least 1 gangway. In order to service today's class of vessels, 2+ boarding bridges will be required.

Ports-of-call experiencing more than 5-10 turnarounds per month may want to consider PBBs.









## PASSENGER EXPERIENCE

#### PASSENGER COMFORT AND CONVENIENCE

Successful first impressions are imperative. Offer convenient shore-to-ship access in comfort and style. Embark/Disembark process should not be a burden to PAX. Amenities such as ADA accessible walkways, A/C, integration into architecture, safety, etc. all make for an improved passenger experience.

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### HISTORY

### • VERY SIMPLE SYSTEMS

- Single planks, bridges, stairs, etc
- Apron level
- ADA

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• Established 1:12 gradient

### • EVOLUTION

- Shell doors have gone from apron level to +50' awl.
- Main embarkation promenade higher.
   How many floors?
- PAX load increased exponentially
- Tidal ranges from 2' to 20'
- As ships have evolved, so have boarding bridges. Tunnels in excess of 100' LF and ranges of more than 30'.









### **EVOLUTION**

#### RESULT

- "Box" PBB
- Tunnels in excess of 100'
- Mobile along pier
- Steel framed gantry
- Glazed
- Telescopic
- Auto-leveling
- Wheels or rail
- Clearance for service vehicles















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### **MODERN EXAMPLES**



















### **PROCUREMENT APPROACH**

#### **ESTABLISH DESIGN BUILD PACKAGE**

Can be included w/ terminal/concourse, FF&E, etc. Coordinate with bldg./fire.



anticipated commissioning.



#### **COMPARE SUBMITTALS**

Review all submittals and rank based on adherence/deviation from specs.



### APPROACH





#### COORDINATION

Creating a bid package for all Coordinating final installation invited bidders. of PBB and integration with terminal/apron. 18 mos. in advance **BUDGET** BIDS INSTALL SPECS **BUDGET AND SCHEDULE EVALUATE** Evaluate and recommend a Based on specified preferred bidder based on requirements, establish a design build bid submitta budget and schedule.



### **CASE STUDIES**



### TERMINAL A – RCI – MIAMI, FL

SPBB design for new terminal.
Began as single tunnel design,
evolved into retrofit of existing
switchback system



#### PIER 66 – SEATTLE, WA

Scope included addition of a new concourse and single tunnel PBB to accommodate newer vessel, tides, and PAX.



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### **CAPE LIBERTY – BAYONNE, NJ**

New terminal design, fixed point PBB's installed for centralized embarkation points and ease of apron servicing.





#### **NEW FLAGSHIP BUILDING**

- Preserve architecture
- Concourse elevation higher than other terminals
- Apron conditions
- Wide fleet range
- Board from a centralized point
- Design fleet newer vessels, minimal ramping
- Ships less than 3,000 PAX can opera on single boarding bridge
- Retrofit CT-E PBB's

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Ship	Shelldoor
Celebrity Millenium-Infinity	Pax
	Pay
	i ux
Dadianaa of the Coos	Main Day
Radiance of the Seas	Iviain Pax
	Pax
Celebrity Century-Mercury	Pax Embark
	Pax Embark
RCL-Voyager	Main Pax
	Pax/Tender/Baggage
Oasis of the Seas	Main Pax
NCI Proskaway	Dromonado
INCL DIEdkaway	Devi
	Рах
NCL Epic	Deck 7 Main Pax Gate
	Pax Embark
Celebrity Edge	Main Pax
Mein Schiff 5	Main Pax
Empress of the Seas	Main Pax
Freedom of the Cons	Main Davi
Freedom of the Seds	IVIdIII PdX
Quantum of the Seas	Main Pax Promenade
Voyager of the Seas	Main Pax Promenade
Sovereign of the Seas	Main Pax
-	















			Top of Apron	10
			MHHW	1.78
			MHW	1.72
			MLW	0.68
			MLLW	-0.41
C:-	1.	C:II F	1	
SIC	e ee	5111 E	levation	Sill Height
P	SB	High Lide	Low lide	Above WL
1	1	28.72	26.53	26.94
1	1	19.53	17.34	17.75
3	2	28.65	26.46	26.87
1	1	20.15	17.96	18.37
2	2	29.45	27.26	27.67
1	1	11.53	9.34	9.75
3	3	44.10	41.91	42.32
5	5	12.44	10.25	10.66
2	2	46.08	43.89	44.30
2	2	42.78	40.59	41.00
2	2	20.78	18.59	19.00
2	2	44.10	44.10	42.32
1	2	33.61	31.42	31.83
1	1	32.55	30.36	30.77
1	1	32.11	29.92	30.33
1	1	37.95	35.76	36.17
1	1	44.08	41 89	42 30
1	1	00	41.05	42.30
1	1	11 E 0	20.40	20.00
1	1	41.00	59.49	59.90
1	4	44.00	41.00	40.00
1	1	44.08	41.89	42.30
		20.00	24.55	24.54
1	1	36.69	34.50	34.91





### • NEW FLAGSHIP BUILDING

- Preserve architecture
- Concourse elevation higher than other terminals
- Apron conditions
- Wide fleet range
- Board from a centralized point
- Design fleet newer vessels, minimal ramping
- Ships less than 3,000 PAX can operate on single boarding bridge
- Retrofit CT-E PBB's, possible























RCCL Terminal A - Gangway
Range and tunnel length calculator
v3.0.11.21.16
2/19/2019 23:38
RCCL and Bermello Aiamil & Partners

#### **FIXED POINT PBB**

- Tunnel slopes at various tidal periods
  - Narrow fleet range
- Horizontal and vertical operational envelope
- Interface between boarding bridge and ship





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RCCL and Bermello, Ajam	il & Partners											
Ship/Class	Emb/Prom Dk #	Emb/Prom deck abv BL (mm)	Max draft (mm)	Emb/Prom Dk abv WL (mm)	Emb/Prom Dk abv WL (feet)	мннж	мнพ	MTL	MSL	MLW	MLLW	building elevation
VI/RH	5	21,750	7,750	14,000	45.9	47.7	47.7	46.6	46.6	45.6	45.5	47.5
VI/RH	5	21,500	7,750	13,750	45.1	46.9	46.8	45.8	45.8	44.8	44.7	47.5
GR/EN	5	21,750	7,800	13,950	45.8	47.5	47.5	46.5	46.5	45.5	45.4	47.5
GR/EN	5	21,400	7,800	13,600	44.6	46.4	46.3	45.3	45.3	44.3	44.2	47.5
LG/SP	4	18,860	7,900	10,960	36.0	37.7	37.7	36.7	36.6	35.7	35.5	47.5
Oasis	5	22,550	9,300	13,250	43.5	45.3	45.2	44.2	44.2	43.2	43.1	47.5
Voyager	4	21,400	8,800	12,600	41.3	43.1	43.1	42.0	42.0	41.0	40.9	47.5
Freedom	4	21,400	8,800	12,600	41.3	43.1	43.1	42.0	42.0	41.0	40.9	47.5
Quantum	5	20,950	8,800	12,150	39.9	41.6	41.6	40.6	40.6	39.6	39.5	47.5
Empress	6	21,100	7,100	14,000	45.9	47.7	47.7	46.6	46.6	45.6	45.5	47.5
Millennium	4	19,150	8,300	10,850	35.6	37.4	37.3	36.3	36.3	35.3	35.2	47.5
Sovereign	7	25,900	7,550	18,350	60.2	62.0	61.9	60.9	60.9	59.9	59.8	47.5
Radiance	5	19,400	8,600	10,800	35.4	37.2	37.2	36.1	36.1	35.1	35.0	47.5
Radiance	5	18,800	8,600	10,200	33.5	35.2	35.2	34.2	34.2	33.2	33.1	47.5
Edge	5	20,750	8,400	12,350	40.5	42.3	42.2	41.2	41.2	40.2	40.1	47.5
Solstice	5	21,000	8,500	12,500	41.0	42.8	42.7	41.7	41.7	40.7	40.6	47.5
lcon	5	22,100	9,150	12,950	42.5	44.3	44.2	43.2	43.2	42.2	42.1	47.5
Note: Camber on Embarko	ation/Promenade	deck not taken	into account									
Input tunnel slope 1 in	14											
Input building elevation	47.5											
	101/200											
MIAMI TIDES	NGVD29											 
MHHW	1.78											
MHW	1.72											
MTL	0.71											
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GR/EN	5	21,750	7,800	13,950	45.8	47.5	47.5	46.5	46.5	45.5	45.4	47.5
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	Corridor capacity (passengers per minute) Levels of service									
				Corrid	or width	in feet				
Leve	of service	8	10	12	14	16	18	20		
	LOS A	66	99	132	165	198	231	264		
	LOS B	77	115	154	192	231	269	308		
	LOS C	88	132	176	220	264	308	352		
	LOS D	98	146	195	244	293	342	390		
	LOS E	110	164	219	274	329	384	438		
	LOS F	124	185	247	309	371	433	494		
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#### **RETROFIT EXISTING BOARDING** BRIDGES

- Mobile elevating gangway
- Less \$\$
- Runs parallel along pier
- Switchback perpendicular to apron, less visual impact
- Does not interfere with servicing















## RETROFIT EXISTING BOARDING BRIDGES

- Mobile elevating gangway
- Less \$\$
- Runs parallel along pier on rail
- Switchback perpendicular to apron, less visual impact
- Apron 60', more efficient layout
- Does not interfere with servicing operations













#### • FUTURE SYSTEM?

- Concourse has been designed to accept single tunnel mobile elevating gangway.
- Potential to add in the future.



















### **CASE STUDIES**



### TERMINAL A – RCI – MIAMI, FL

SPBB design for new terminal.
Began as single tunnel design,
evolved into retrofit of existing
switchback system



#### PIER 66 – SEATTLE, WA

Scope included addition of a new concourse and single tunnel PBB to accommodate newer vessel, tides, and PAX.



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### **CAPE LIBERTY – BAYONNE, NJ**

New terminal design, fixed point PBB's installed for centralized embarkation points and ease of apron servicing.



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#### **FLEET STUDY**

- Evaluate need for 1 or more passenger boarding bridge
- Constrained apron conditions
- Wide fleet range
- Design fleet newer vessels
- Retrofit existing system "Big Bertha"
- Extreme weather and tidal ranges
- Seismic
- Link bridge design



ba



PERSECRETSE ERVINA

VS5

	JOY	BLISS	BLISS III	BREAKAWAY	GETAWAY	ESCAPE	EPIC	DAWN	STAR	JEWEL	JADE	PEARL	GEM	SKY	SUN	SPIRIT	AMERICA
Vessel Class	Breakaway + Class	Breakaway + Class	Breakaway + Class	Breakaway Class	Breakaway Class	Breakaway+ Class	F3	Dawn Class	Dawn Class	lewel Class	lewel Class	lewel Class	lewel Class	Sun Class	Sun Class		
Built	Mever Werft	Mever Werft	Mever Werft	Mever Werft	Mever Werft	Mever Werft	STX	Mever Werft	Llovd Werft	Lovd Werft	Mever Werft	Llovd Werft					
June	Papenburg	Papenburg	Papenburg	Papenburg	Papenburg	Papenburg	St Nazaire	Papenburg	Papenburg	Papenburg	Papenburg	Papenburg	Papenburg	Bremerhaven	Bremerhaven	Papenburg	Bremerhaven
	Germany	Germany	Germany	Germany	Germany	Germany	France	Germany									
Year	2017	2018	2019	2013	2014	2015	2010	2002	2001	2005	2006	2006	2007	1999	2001	1998	2005
Callsign				C6ZJ3	C6ZJ4	C6BR3	C6XP7	C6FT7	C6FR3	C6TX6	C6WK7	C6VG7	C6VG8	C6PZ8	C6RN3	C6TQ6	WNBE
GRT	169,516			145,655	145,655	165,157	155,873	92,250	91,740	93,502	93,558	93,530	93,530	77,104	78,309	75,904	80,439
DWT	10,950			14,167	13,935	15,600	15,871	9,942	10,039	10,918	10,787	11,060	10,675	8,677	7,480	8,530	7,970
NRT	154,397			132,549	132,549	134,779	146,495	61,406	61,087	62,188	63,906	63,887	63,887	45,951	46,069	45,960	50,632
Displacement	78,500			69,821	69,821	78,400	79,346	49,464	50,260	50,260	50,281	50,260	50,266	37,000	39,000	42,343	45,397
LOA (m)	333.46			325.70	325.70	325.90	329.45	294.13	294.13	294.13	294.13	294.13	294.13	258.6	258.60	268.29	280.59
Beam (m)	41.40			39.70	39.70	41.40	40.64	32.20	32.20	32.20	32.20	32.20	32.20	32.20	32.20	32.20	32.21
Beam extreme (m)	47.85			51.70	51.70	54.60	53.00	38.10	38.10	38.10	38.10	38.10	38.10	36.00	37.80	36.80	36.50
Design Draught (m)	8.70			8.30	8.30	8.33	8.70	8.50	8.50	8.50	8.50	8.50	8.50	8.00	8.00	8.40	8.15
Air Draught (m)	58.70			55.0	55.00	61.00	61.00	51.30	51.30	51.30	51.30	51.30	51.30	51.20	51.20	49.10	53.30
Pax. No (D. Occup.)	4,088			3,969	3,969	4,266	4,228	2,332	2,348	2,376	2,402	2,394	2,394	2,004	1,936	2,018	2,138
Crew No	1,706			1,640	1,640	1,730	1,730	1,073	1,083	1,100	1,078	1,099	1,101	934	953	963	940
Flag	Bahamas			Bahamas	Bahamas	Bahamas	Bahamas	Bahamas	Bahamas	Bahamas	Bahamas	Bahamas	Bahamas	Bahamas	Bahamas	Bahamas	USA
Class	DNV			DNV	DNV	DNV	DNV	DNV	DNV	DNV	DNV	DNV	DNV	DNV	DNV	DNV	ABS/DNV
P & I	West of England			West of England	West of England	West of England	West of England	West of England	West of England	West of England	West of England	West of England	West of England	West of England	West of England	West of England	West of England
Design Speed	23.2			22.5	22.5	22.4	22.5	24	24	24	24	24	24	22	22	24	22
Cruising Speed	21.5			21.5	21.5	21.5	21	22.5	22.5	22.5	22.5	22.5	22.5	20	20	22.5	20.5
Thrusters	3 x bow			3 x bow	3xbow	3 x bow	4 x bow	3 x bow	2 x bow	3 x bow							
							2 x stern							2 x stern	2 x stern	1 x stern	
Ex-Name	Bliss	Bliss II		n/a	n/a	n/a	n/a	n/a	n/a	n/a	Pride of Hawaii	n/a	n/a	Norwegian Sky	n/a	Superstar Leo	n/a
														Pride of Aloha			
Propulsion	Diesel electric			Diesel electric	Diesel electric	Diesel Electric	Diesel electric	Diesel electric	Diesel electric	Diesel electric	Diesel electric	Diesel electric	Diesel electric	Diesel electric	Diesel electric	Diesel electric	Diesel electric
	44,000 kw			35,000 kw	35,000 kw	39,000kw	2 x 24,000 kw	38,000 kw	38,000 kw	38,000 kw	38,000 kw	38,000 kw	38,000 kw	30,000kw	30,000 kw	40,000 kw	24,000 kw
Propellers	2 Azipod			2 Azipod	2 Azipod	2 Azipod	2 FPP	2 Azipod	2 CPP	2 CPP	2 FPP	2 Azipod					













Vessel Name:	LOA	Beam	Door Side:	Height Above:
	(ft)	(ft)	Stbd/Port*	SWL (ft)
F3 Epic	1,080.9'	131.9'	S/P	21.33'
			S/P	31.83'
			S/P	42.32'
			S/P	42.32'
			Р	21.33'
			S	31.83'
			Р	31.83'
Breakaway	1,062.0'	130.3'	S/P	Deck 7 (41.0')
Getaway			S/P	Deck 7 (41.0')
			S	Deck 7 (41.0')
			Р	Deck 7 (41.0')
Breakaway Plus	1,069'	136.0'	S/P	Deck 7 (42.6')
Escape			S/P	Deck 7 (42.6')
Bliss			S/P	Deck 7 (42.6')
			- /	
Spirit	879.2'	105.6'	S	12.14'
			S/P	41.0'
			S/P	12.14'
			S/P	21.16'
Sky	848.4'	105.6'	S/P	29.95'
Sun			S/P	11.32'
			·	
Dawn	964.9'	105.6'	S/P	19.85'
Jewel			S	28.87'
Star			S	28.87'
Jade			S/P	10.83'
			S/P	19.85'



- BELL STREET CRUISE TERMINAL
  - Evaluate need for 1 or more passenger boarding bridge
  - Constrained apron conditions
  - Wide fleet range
  - Design fleet newer vessels
  - Retrofit existing system "Big Bertha"
  - Extreme weather and tidal ranges
  - Seismic

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• Link bridge design







		Gangway 1				Gangway 1				Gangway 2				Gangway 2			
ip	Door sill above WL	Lowest Tide		Max slope height	Tunnel length	Highest tide		Max slope height	Tunnel length	Lowest Tide		Max slope height	Tunnel length	Highest tide		Max slope height	Tunnel length
ekaway Plus	42.5	36.08	6.42	10	197.5	24.72	17.78	20	328.8	35.25	7.25	10	197.5	23.89	18.61	20	328.8
ekaway	41	36.08	4.92	10	197.5	24.72	16.28	20	328.8	35.25	5.75	10	197.5	23.89	17.11	20	328.8
ntury	37.88	36.08	1.8	10	197.5	24.72	13.16	20	328.8	35.25	2.63	10	) 197.5	23.89	13.99	20	328.8
npress	37.13	36.08	1.05	10	197.5	24.72	12.41	20	328.8	35.25	1.88	10	) 197.5	23.89	13.24	20	328.8
ilennium	36.7	36.08	0.62	10	197.5	24.72	11.98	20	328.8	35.25	1.45	10	) 197.5	23.89	12.81	20	328.8
vereign	35.15	36.08	-0.93	5	197.5	24.72	10.43	20	328.8	35.25	-0.1	5	197.5	23.89	11.26	20	328.8
ariana	33.76	36.08	-2.32	5	197.5	24.72	9.04	10	197.5	35.25	-1.49	5	197.5	23.89	9.87	10	197.5
viera	33.76	36.08	-2.32	5	197.5	24.72	9.04	10	197.5	35.25	-1.49	5	197.5	23.89	9.87	10	197.5
diance	33.76	36.08	-2.32	5	197.5	24.72	9.04	10	197.5	35.25	-1.49	5	197.5	23.89	9.87	10	197.5
Epic	31.83	36.08	-5.55	10	328.8	3 24.72	7.11	10	197.5	35.25	-3.42	5	197.5	23.89	7.94	10	197.5
Istice	30.53	36.08	-6.13	10	328.8	3 24.72	5.81	10	197.5	35.25	-4.72	5	197.5	23.89	6.64	10	197.5
У	29.95	36.08	-6.13	10	328.8	3 24.72	5.23	10	197.5	35.25	-5.3	10	328.8	23.89	6.06	10	197.5
wel	28.87	36.08	-7.21	10	328.8	3 24.72	4.15	10	197.5	35.25	-6.38	10	328.8	23.89	4.98	10	197.5
ar	28.87	36.08	-7.21	10	328.8	3 24.72	4.15	10	197.5	35.25	-6.38	10	328.8	23.89	4.98	10	197.5
gatta	28.71	36.08	-7.37	10	328.8	3 24.72	3.99	10	197.5	35.25	-6.54	10	328.8	23.89	4.82	10	197.5
autica	28.71	36.08	-7.37	10	328.8	3 24.72	3.99	10	197.5	35.25	-6.54	10	328.8	23.89	4.82	10	197.5
signia	28.71	36.08	-7.37	10	328.8	3 24.72	3.99	10	197.5	35.25	-6.54	10	328.8	23.89	4.82	10	197.5
rena	27.49	36.08	-8.59	10	328.8	3 24.72	2.77	10	197.5	35.25	-7.76	10	328.8	23.89	3.6	10	197.5
diance	27.03	36.08	-9.05	10	328.8	24.72	2.31	10	197.5	35.25	-8.22	10	328.8	23.89	3.14	10	197.5



#### • LINK BRIDGE DESIGN

- Retrofit existing system "Big Bertha"
- Link bridge to allow existing gangway to operate further along the pier.
- Help connecting back to concourse
- Extreme weather and tidal ranges
- Seismic



















## PASSENGER CONCOURSE AND BOARDING BRIDGE

- Very narrow apron
  - Longer concourse allows for gradual ramping to board bridge
  - Necessary due to tides and door locations
- Extreme weather and tidal ranges
- Seismic

Bermello Ajamil & Partners





















### **CASE STUDIES**



#### TERMINAL A – RCI – MIAMI, FL

SPBB design for new terminal.
Began as single tunnel design,
evolved into retrofit of existing
switchback system



#### PIER 66 – SEATTLE, WA

Scope included addition of a new concourse and single tunnel PBB to accommodate newer vessel, tides, and PAX.



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### **CAPE LIBERTY – BAYONNE, NJ**

New terminal design, fixed point PBB's installed for centralized embarkation points and ease of apron servicing.



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### **CAPE LIBERTY - NJ**

- **Designed to service newer** generation vessels
  - Centralized boarding location
  - Design fleet newer vessels, minimal ramping
  - Minimize LF of sterile corridor
  - Terminal not centered on pier, concourse required to extend further east.
  - 130' apron

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- 130' apron











FLOW DIAGRAM - DISEMBARKATION





Cape Liberty Cruise Terminal Bayonne, New Jersey





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	WITH MANA AND CML
	CONTRACTORS.

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### **CAPE LIBERTY - NJ**

























#### PERMITTING

For new buildings, separating PBB and building tender has typically caused a big mess.

#### RFP

Min. 2 bidders. 18 mos. lead time. Competition scarce at the moment



### **KEY LESSONS**





#### **BIGGER AND BETTER**

As vessels increase in size, so must boarding bridges. Increased flows, higher embarkation points, etc.

#### **PORT-ARCH-MANUFACTURER**

Communication between port authorities, cruise lines, A/E, contractor, and PBB manufacturer essential.

