Table 6.4.3-1-3 (3)
Required Number of Rubber Tired Gantry (RTG) Type Yard Cranes - 3/4
((6+1)Rows x (4+1)Tier Type)
(Design Data taken from S2 Container Terminal)

2. Required Number of the Cranes - 3/4:
Required number of the Yard Cranes is calculated by adopting the following formula:

(2) Land-side Operation: To/from the railway station and outside of the terminal through the terminal gate. - 2/2

Nyl = (Qy x Rp x Th) / (Py x Ra x Dw x Hw x Rw x Rh)

The results of the calculation are shown on the table below:

Case-2 (3 Berths)

Marks	Descriptions	Units	2014	2017	2020	Remarks
Qid	Import dry container quantity	boxes/year	124,600	153,800	189,400	
Qir	Import reefer container quantity	boxes/year	2,300	2,800	3,500	
Qie	Import empty container quantity	boxes/year	17,300	21,400	26,300	
Qit	Import transit container quantity	boxes/year	12,800	22,000	38,200	
Qis	Import tranship container quantity	boxes/year	13,200	22,700	39,300	
Qiy	Total import container quantity	boxes/year	170,200	222,700	296,700	
Rp	Peak ratio	-	1.25	1.25	1.25	
Thi	Average handling times	-	1.8	1.8	1.8	Including container rehandling*
Pya	Yard crane productivity(average)	boxes/hour	32	32	32	
Ra	Crane availability ratio	-	1	1	1	
Dw	Working days per year	days/year	345	345	345	Subtracted holidays, maintenance, etc.
Hw	Working hours per days	hours/day	22	22	22	
Rw	Crane working hour ratio	-	0.92	0.93	0.95	
Rh	Cargo handling hour ratio	-	0.74	0.76	0.80	
Nyli	Number of yard crane for import	units	2.3	2.9	3.6	
Qed	Export dry container quantity	boxes/year	103,300	127,400	157,000	
Qer	Export reefer container quantity	boxes/year	600	700	900	
Qee	Export empty container quantity	boxes/year	40,400	49,800	61,400	
Qet	Export transit container quantity	boxes/year	12,800	22,000	38,200	
Qes	Export tranship container quantity	boxes/year	13,200	22,700	39,300	
Qey	Total export container quantity	boxes/year	170,300	222,600	296,800	
Rp	Peak ratio	-	1.25	1.25	1.25	
The	Average handling times	-	1	1	1	Including container rehandling**
Pya	Yard crane productivity(average)	boxes/hour	32	32	32	
Ra	Crane availability ratio	-	1	1	1	
Dw	Working days per year	days/year	345	345	345	Subtracted holidays, maintenance, etc.
Hw	Working hours per days	hours/day	22	22	22	
Rw	Crane working hour ratio	-	0.92	0.93	0.95	
Rh	Cargo handling hour ratio	-	0.74	0.76	0.80	
Nyle	Number of yard crane for export	units	1.3	1.6	2.0	
Nyl	Total number of yard crane	units	3.6	4.5	5.6	Including cranes for import & export
	say	units	4	5	6	

Note*: Container stacking height(average): 2.5, first come first serve service
**: Container stacking height(average): 3.0, as per vessel loading plan

Table 6.4.3-1-3 (3)
Required Number of Rubber Tired Gantry (RTG) Type Yard Cranes - 4/4
((6+1)Rows x (4+1)Tier Type)
(Design Data taken from S2 Container Terminal)

2. Required Number of the Cranes - 4/4:
Required number of the Yard Cranes is calculated by adopting the following formula:

(3) Total Number of Yard Cranes Required:

Ny = Nys + Nyl

The results of the calculation are shown on the table below:

Case-1 (2 Berths)

Marks	Description	Units	-	2008	2011	Remarks
Nysa	Average sea-side yard cranes	sets	-	3	4	
Nysm	Maximum sea-side yard cranes	sets	-	6	8	
Nyl	Land-side yard cranes	sets	-	3	3	
Nya	Total average yard cranes	sets	-	6	7	Too strict
Nym	Total maximum yard cranes	sets	-	9	11	Can be decreased
	Recommended number of cranes	sets	-	8	10	By accommodating land-side yard crane

Case-2 (3 Berths)

Marks	Description	Units	2015	2017	2020	Remarks
Nysa	Average sea-side yard cranes	sets	5	6	7	
Nysm	Maximum sea-side yard cranes	sets	10	12	14	
Nyl	Land-side yard cranes	sets	4	5	6	
Nya	Total average yard cranes	sets	9	11	13	Too strict
Nym	Total maximum yard cranes	sets	14	17	20	Can be decreased
	Recommended number of cranes	sets	12	14	16	By accommodating land-side yard crane

Table 6.4.3-1-3 (4)

Required Number of Rail Mounted Gantry (RMG) Type Railway Station Cranes - 1/3

(Design Data taken from S2 Container Terminal)

1. Number of Trains to be Accommodated - (20 Wagons/Train)

The number of trains to be accommodated per day is calculated by adopting the following formula:

$Nt = (Qr \times Rp) / (Dw \times Nw \times Nbw)$

The results of the calculation are shown on the table below:

Case - 1 (2 Berths)

Marks	Description	Units	-	2008	2011	Remarks
Qrod	Outbound dry container q'tity	boxes/year	-	55,700	71,000	
Qrot	Outbound transit container q'tity	boxes/year	-	1,500	2,600	
Qroe	Outbound empty container q'tity	boxes/year	-	7,700	9,900	
Qro	Total outbound container q'tity	boxes/year	-	64,900	83,500	
Rp	Peak ratio	-	-	1.25	1.25	
Dw	Working days per year	days/year	-	345	345	Subtracted holidays, maintenance, etc.
Nw	Number of wagon per train	wagons/train	-	20	20	
Nbw	Ave. number of box on wagon	boxes/wagon	-	1.67	1.67	1.6TEU/box (20ft: 40%, 40ft: 60%)
Nto	Number of outbound trains per day	trains/day	-	7.0	9.1	
	say:	trains/day	-	7	9	
Qrid	Inbound dry container q'tity	boxes/year	-	46,200	58,800	
Qrit	Inbound transit container q'tity	boxes/year	-	1,500	2,600	
Qrie	Inbound empty container q'tity	boxes/year	-	18,000	23,000	
Qri	Total inbound container q'tity	boxes/year	-	65,700	84,400	
Rp	Peak ratio	-	-	1.25	1.25	
Dw	Working days per year	days/year	-	345	345	Subtracted holidays, maintenance, etc.
Nw	Number of wagon per train	wagons/train	-	20	20	
Nbw	Ave. number of box on wagon	boxes/wagon	-	1.67	1.67	1.6TEU/box (20ft: 40%, 40ft: 60%)
Nti	Number of inbound trains per day	trains/day	-	7.1	9.2	
	say:	trains/day	-	7	9	
Nt	Total number of trains to be accom.	trains/day	-	14	18	
Nl	Number of railway lines	lines	-	2	2	

Case - 2 (3 Berths)

Marks	Description	Units	2014	2017	2020	Remarks
Qrod	Outbound dry container q'tity	boxes/year	87,300	107,600	132,600	
Qrot	Outbound transit container q'tity	boxes/year	4,500	7,700	13,300	
Qroe	Outbound empty container q'tity	boxes/year	9,500	11,700	14,500	
Qro	Total outbound container q'tity	boxes/year	101,300	127,000	160,400	
Rp	Peak ratio	-	1.25	1.25	1.25	
Dw	Working days per year	days/year	345	345	345	Subtracted holidays, maintenance, etc.
Nw	Number of wagon per train	wagons/train	20	20	20	
Nbw	Ave. number of box on wagon	boxes/wagon	1.67	1.67	1.67	1.6TEU/box (20ft: 40%, 40ft: 60%)
Nto	Number of outbound trains per day	trains/day	11.0	13.8	17.4	
	say:	trains/day	11	14	18	
Qrid	Inbound dry container q'tity	boxes/year	72,300	89,200	109,900	
Qrit	Inbound transit container q'tity	boxes/year	4,500	7,700	13,300	
Qrie	Inbound empty container q'tity	boxes/year	28,300	34,900	43,000	
Qri	Total inbound container q'tity	boxes/year	105,100	131,800	166,200	
Rp	Peak ratio	-	1.25	1.25	1.25	
Dw	Working days per year	days/year	345	345	345	Subtracted holidays, maintenance, etc.
Nw	Number of wagon per train	wagons/train	20	20	20	
Nbw	Ave. number of box on wagon	boxes/wagon	1.67	1.67	1.67	1.6TEU/box (20ft: 40%, 40ft: 60%)
Nti	Number of inbound trains per day	trains/day	11.4	14.3	18.0	
	say:	trains/day	11	14	18	
Nt	Total number of trains to be accom.	trains/day	22	28	36	
Nl	Number of railway lines	lines	2	3	3	

Table 6.4.3-1-3 (4)

Required Number of Rail Mounted Gantry (RMG) Type Railway Station Cranes - 2/3

(Design Data taken from S2 Container Terminal)

2. Category of the Crane Operation:

There are two(2) major categories of container handling operation at the Railway Station:

(1) Direct Handling Operation: Between Terminal Trailer and Railway Wagon

(2) Indirect Handling Operation:

Between Terminal Trailer and Buffer Storage / Buffer Storage and Railway Wagon

Note: This operation requires double handling for each container, and will require more than double numbers of the crane comparing with the Direct Handling Operation. Therefore, the Indirect Handling Operation is not preferable to this Project.

3. Required Number of the Cranes - (20 Wagons / Train)

Required number of the Cranes is calculated by adopting the following formula:

(1) Crane Speeds: (Hoist: 15/30 m/min, Trolley Traverse: 90 m/min), Average Cycle Time: 75 sec)

$Nt = [\{(Tba \times Nw \times Nbw \times Th) + Ts\} \times Nt] / (60 \times 60 \times Rw \times Rh \times Wh)$

The results of the calculation are shown on the table below:

Case 1 (2 Berths)

Marks	Descriptions	Units	-	2008	2011	Remarks
Tba	Required time per box(average)	sec/box	-	75	75	
Nw	Number of wagons per train	wagons/train	-	20	20	
Nbw	Number of boxes per wagon(averag	boxes/wagor	-	1.67	1.67	
Th	Handling times	-	-	2	2	Import + Export
Ts	Required time for train shifting	min/train	-	35	35	Before: 15, after:20
Tt	Required time per train(average)	min/train	-	118.5	118.5	
Rw	Crane working hour ratio	-		0.90	0.90	
Rh	Cargo handling hour ratio	-		0.80	0.80	
Tt'	Required time per train(average)	min/train		164.6	164.6	
Nt	Number of trains per day	trains/day	-	14	18	
Wh	Working hour per day	hours/day	-	22	22	
Nr	Number of RMG cranes	Units	-	1.7	2.2	
	say	Units	-	2	3	

Case 2 (3 Berths)

Marks	Descriptions	Units	2014	2017	2020	Remarks
Tba	Required time per box(average)	sec/box	75	75	75	
Nw	Number of wagons per train	wagons/train	20	20	20	
Nbw	Number of boxes per wagon(averag	boxes/wagor	1.67	1.67	1.67	
Th	Handling times	-	2	2	2	Import + Export
Ts	Required time for train shifting	min/train	35	35	35	Before: 15, after:20
Tt	Required time per train(average)	min/train	118.5	118.5	118.5	
Rw	Crane working hour ratio	-	0.90	0.90	0.90	
Rh	Cargo handling hour ratio	-	0.80	0.80	0.80	
Tt'	Required time per train(average)	min/train	164.6	164.6	164.6	
Nt	Number of trains per day	trains/day	22	28	36	
Wh	Working hour per day	hours/day	22	22	22	
Nr	Number of RMG cranes	Units	2.7	3.5	4.5	
	say	Units	3	4	5	

Table 6.4.3-1-3 (4)

Required Number of Rail Mounted Gantry (RMG) Type Railway Station Cranes - 3/3

(Design Data taken from S2 Container Terminal)

2. Category of the Crane Operation:

There are two(2) major categories of container handling operation at the Railway Station:

(1) Direct Handling Operation: Between Terminal Trailer and Railway Wagon

(2) Indirect Handling Operation:

Between Terminal Trailer and Buffer Storage / Buffer Storage and Railway Wagon

Note: This operation requires double handling for each container, and will require more than double numbers of the crane comparing with the Direct Handling Operation. Therefore, the Indirect Handling Operation is not preferable to this Project.

3. Required Number of the Cranes - (20 Wagons / Train)

Required number of the Cranes is calculated by adopting the following formula:

(2) Crane Speeds: (Hoist: 20/40 m/min, Trolley Traverse: 140 m/min), Average Cycle Time: 65 sec

$Nt = [\{(Tba \times Nw \times Nbw \times Th) + Ts\} \times Nt] / (60 \times 60 \times Rw \times Rh \times Wh)$

The results of the calculation are shown on the table below:

Case 1 (2 Berths)

Marks	Descriptions	Units	-	2008	2011	Remarks
Tba	Required time per box(average)	sec/box	-	65	65	
Nw	Number of wagons per train	wagons/train	-	20	20	
Nbw	Number of boxes per wagon(averag	boxes/wagor	-	1.67	1.67	
Th	Handling times	-	-	2	2	Import + Export
Ts	Required time for train shifting	min/train	-	35	35	Before: 15, after:20
Tt	Required time per train(average)	min/train	-	107.4	107.4	
Rw	Crane working hour ratio	-		0.90	0.90	
Rh	Cargo handling hour ratio	-		0.80	0.80	
Tt'	Required time per train(average)	min/train		149.2	149.2	
Nt	Number of trains per day	trains/day	-	14	18	
Wh	Working hour per day	hours/day	-	22	22	
Nr	Number of RMG cranes	Units	-	1.6	2.0	
	say	Units	-	2	3	

Case 2 (3 Berths)

Marks	Descriptions	Units	2014	2017	2020	Remarks
Tba	Required time per box(average)	sec/box	65	65	65	
Nw	Number of wagons per train	wagons/train	20	20	20	
Nbw	Number of boxes per wagon(averag	boxes/wagor	1.67	1.67	1.67	
Th	Handling times	-	2	2	2	Import + Export
Ts	Required time for train shifting	min/train	35	35	35	Before: 15, after:20
Tt	Required time per train(average)	min/train	107.4	107.4	107.4	
Rw	Crane working hour ratio	-	0.90	0.90	0.90	
Rh	Cargo handling hour ratio	-	0.80	0.80	0.80	
Tt'	Required time per train(average)	min/train	149.2	149.2	149.2	
Nt	Number of trains per day	trains/day	22	28	36	
Wh	Working hour per day	hours/day	22	22	22	
Nr	Number of RMG cranes	Units	2.5	3.2	4.1	
	say	Units	3	4	5	

Table 6.4.3-1-4 (1) Container Ground Slot and Gantry Crane Calculation Sheet : Case 1

			Containerised Cargo											Dwelling Time						Groundslot Requirement							Required Number of Lanses net	Box Ratio	Move Boxes						Gantry Cranes		
					Trade					Trans.			Total		Trade			Trans		Trade				Trans	Total	Plan			Trade			Trans	Total	Net	Plan	
			Exp.	Exp.	Imp.	Imp.	S-ttl	Load.	Load.	Disc.	Disc.	S-ttl		Notes	Exp.	Exp.	Imp.	Imp.	S-ttl	Exp.	Exp.	Imp.	Imp.	S-ttl	S-ttl		West	East		Exp.	Exp.	Imp.	Imp.	S-ttl	S-ttl			West	East
			Ld.	Ey.	Ld.	Ey.		Ld.	Ey.	Ld.	Ey.		Total		Ld.	Ey.	Ld.	Ey.		Ld.	Ey.									Ld.	Ey.	Ld.	Ey.						
No.	No.	Year	1000 teus	1000 teus	1000 teus	1000 teus	1000 teus	1000 teus	1000 teus	1000 teus	1000 teus	1000 teus	1000 teus		day	day	day	day	day	teu	teu	teu	teu	teu	teu	teu	lane	lane	lane		1000 M. Box	1000 M. Box	1000 M. Box	1000 M. Box	1000 M. Box	1000 M. Box	1000 M. Box	unit	unit	unit
			1	2	3	4	5	6	7	8	9	10	11		12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37
													5+10							F1	F1	F1	F1		F1	21+22	F2	given	given		1/27	2/27	3/27	4/27		10/27	32+33	34/ 75000	given	given
		1991																																				
		1992																																				
		1993																																				
		1994																																				
		1995																																				
		1996																																				
		1997																																				
		1998																																				
														Base Year																									
		1999																																				
		2000																																				
		2000	51.3	5.1	42.3	14.1	112.9	0.0	0.0	0.0	0.0	0.0	112.9		3	8	10	10	6	135	48	621	207	1012	0	1012	5.6			1.50	34.2	3.4	28.2	9.4	75.2	0.0	75.2	1.0		
1		2001	57.8	5.8	47.5	16.1	127.2	0.0	0.0	0.0	0.0	0.0	127.2		3	8	10	10	6	204	54	697	236	1191	0	1191	6.6			1.53	37.8	3.8	31.1	10.5	83.1	0.0	83.1	1.1		
2		2002	64.5	6.4	53.0	17.9	141.9	0.0	0.0	0.0	0.0	0.0	141.9		3	8	10	10	6	227	61	778	262	1328	0	1328	7.4			1.53	42.1	4.2	34.7	11.7	92.7	0.0	92.7	1.2		
3		2003	72.8	7.3	59.9	20.2	160.2	0.0	0.0	0.0	0.0	0.0	160.2		3	8	10	10	6	256	68	879	296	1500	0	1500	8.3			1.56	46.7	4.7	38.4	12.9	102.7	0.0	102.7	1.4		
4		2004	81.4	8.1	66.7	22.9	179.1	0.0	0.0	0.0	0.0	0.0	179.1		3	8	10	10	6	287	76	978	336	1677	0	1677	9.3	14	0	1.56	52.2	5.2	42.7	14.7	114.8	0.0	114.8	1.5	3	0
5		2005	92.0	9.2	75.6	25.6	202.4	6.9	0.7	5.7	2.0	15.2	217.6		3	9	9	9	6	324	97	998	338	1757	134	1891	10.5			1.57	58.6	5.9	48.2	16.3	128.9	16.2	145.1	1.9		
6	1	2006	102.3	10.2	83.8	28.7	225.1	8.6	0.9	7.3	2.2	18.9	243.9		3	7	8	8	6	360	84	984	337	1765	166	1931	10.7			1.57	65.2	6.5	53.4	18.3	143.4	20.1	163.4	2.2		
7	2	2007	114.8	11.5	94.5	31.8	252.6	10.5	1.1	8.4	3.2	23.1	275.7		3	7	8	8	6	404	94	1109	373	1981	203	2184	12.1			1.58	72.7	7.3	59.8	20.1	159.8	24.4	184.3	2.5		
8	3	2008	127.0	12.7	104.4	35.3	279.4	12.4	1.2	10.2	3.4	27.3	306.7		3	6	7	7	6	447	89	1072	363	1972	240	2212	12.3			1.58	80.4	8.0	66.1	22.4	176.9	28.9	205.7	2.7		
9	4	2009	141.7	14.2	116.3	39.6	311.7	15.4	1.5	13.1	3.9	33.9	345.6		3	6	7	7	6	499	100	1194	406	2199	298	2497	13.9			1.59	89.1	8.9	73.1	24.9	196.0	35.6	231.6	3.1		
														Short term																									
10	5	2010	156.0	15.6	128.0	43.6	343.2	18.4	1.8	15.2	5.0	40.5	383.7	Stage	3	5	6	7	6	549	92	1127	448	2215	356	2572	14.3	14	6	1.59	98.1	9.8	80.5	27.4	215.8	42.5	258.4	3.4	4	2
11	6	2011	167.7	16.8	137.7	46.7	368.9	20.3	2.0	17.0	5.3	44.6	413.4		3	5	6	6	6	590	98	1212	411	2312	392	2705	15.6			1.60	104.8	10.5	86.1	29.2	230.5	46.5	277.0	3.7		
12	7	2012	180.4	18.0	147.6	50.8	396.9	23.0	2.3	18.9	6.4	50.5	447.4		3	5	6	6	6	635	106	1299	448	2488	445	2933	16.3			1.60	112.8	11.3	92.3	31.8	248.1	52.7	300.8	4.0		
13	8	2013	193.4	19.3	158.5	54.2	425.5	25.7	2.6	20.8	7.6	56.6	482.1		3	5	6	6	6	681	113	1396	477	2667	498	3165	17.6			1.60	120.9	12.1	99.1	33.9	265.9	59.1	325.0	4.3		
14	9	2014	207.5	20.7	170.5	57.7	456.5	28.6	2.9	22.7	8.7	62.8	519.3		3	4	5	5	6	731	97	1251	423	2502	553	3055	17.0			1.60	129.7	13.0	106.8	36.1	285.3	65.6	350.9	4.7		
15	10	2015	222.7	22.3	182.8	62.2	489.9	31.5	3.1	25.5	9.1	69.2	559.1		3	4	5	5	6	784	105	1341	456	2686	609	3295	18.3	14	12	1.60	139.2	13.9	114.2	38.9	306.2	72.2	378.4	5.0	4	3
16	11	2016	238.2	23.8	196.1	66.0	524.1	35.3	3.5	29.2	9.5	77.6	601.7		3	4	5	5	6	839	112	1438	484	2873	683	3556	19.8			1.60	148.9	14.9	122.6	41.2	327.6	81.0	408.5	5.4		
17	12	2017	254.0	25.4	208.8	70.6	558.9	40.9	4.1	33.1	11.9	90.0	648.8		3	4	5	5	6	895	119	1532	518	3064	792	3856	21.4			1.60	158.8	15.9	130.5	44.2	349.3	93.9	443.2	5.9		
18	13	2018	270.2	27.0	221.8	75.4	594.4	45.8	4.6	37.8	12.5	100.7	695.0		3	4	5	4	6	951	127	1627	443	3147	886	4034	22.4			1.60	168.9	16.9	138.6	47.1	371.5	105.1	476.5	6.4		
19	14	2019	286.7	28.6	235.0	79.3	628.5	51.6	5.2	42.7	14.1	113.6	742.1		3	4	5	4	6	1006	134	1724	465	3329	1000	4329	24.0			1.60	178.6	17.9	146.9	49.6	392.8	118.5	511.4	6.8		
														Master Plan																									
20	15	2020	300.6	30.1	246.6	84.1	661.3	58.5	5.9	47.7	16.7	128.7	790.0	Stage	3	4	5	4	6	1058	141	1809	493	3502	1133	4635	25.7			1.60	187.9	18.8	154.1	52.5	413.3	134.3	547.7	7.3		
25	20	2025																																					
30	25	2030																																					
35	30	2035																																					
40	35	2040																																					

Notes
1 Ld.: Laden, Ey: Empty
2 Dwelling time is given for each by length of day in the table.
3 Maximum stacking height in four (4)
4 Average yard utilization: Import 60% thus 2.4 high
5 Average yard utilization: Import 75% thus 3.0 high
6 Average yard utilization: Transit and Transshipment 60% thus 2.4 high
7 Peak factor is 1.25
8 An average annual working days in 355 days
9 Unit lane ground slot : 30 rows x 6lines = 180 slots
10 Figure in column Plan indicates the required facilities to start operation at that year for each Phase 1, 2 and 3
11 Box ratio : Number in TEUs / Number in Boxes If feu% is 50%, Ratio is 1.50
teu%+2*feu% = (teu%+feu%) + feu% = 100% + feu%
12 Double handling rate for the Transit and Transshipment containers: Truck/rail+canal+vessel = (1+ 1*2+ 1x2)/3= 1.67
13 Average annual move box per gantry crane: 75000 move boxes or 120000 teus , 75000*1.6=120000teus

Formula:
Required Groundslots
= (Container Cargo) x (Dwelling T.) X (Peak factor) / (Annual Days) x (Average Stacking Height).....F1

Required Ground Lanes
= Required Groundslots / Unit ground slots per lane (180 teus).....F2

Table 6.4.3-1-4 (2) Container Ground Slot and Gantry Crane Calculation Sheet : Case 2

			Containerised Cargo												Dwelling Time						Groundslot Requirement							Required Number of Lanses net	Plan		Box Ratio	Move Boxes							Gantry Cranes		
					Trade					Trans.				Total			Trade			Trans			Trade				Trans	Total						Trade			Trans	Total	Net	Plan	
			Exp.	Exp.	Imp.	Imp.	S-ttl	Load.	Load.	Disc.	Disc.	S-ttl			Notes	Exp.	Exp.	Imp.	Imp.	S-ttl	Exp.	Exp.	Imp.	Imp.	S-ttl	S-ttl			West	East		Exp.	Exp.	Imp.	Imp.	S-ttl	S-ttl			West	East
			Ld.	Ey.	Ld.	Ey.		Ld.	Ey.	Ld.	Ey.			Total		Ld.	Ey.	Ld.	Ey.		Ld.	Ey.	Ld.	Ey.							Ld.	Ey.	Ld.	Ey.						
No.	No.	Year	1000 teus	1000 teus	1000 teus	1000 teus	1000 teus	1000 teus	1000 teus	1000 teus	1000 teus	1000 teus		1000 teus		day	day	day	day	day	teu	teu	teu	teu	teu	teu	teu	lane	lane	lane		1000 M. Box	1000 M. Box	1000 M. Box	1000 M. Box	1000 M. Box	1000 M. Box	1000 M. Box	unit	unit	unit
			1	2	3	4	5	6	7	8	9	10		11		12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37
														5+10							F1	F1	F1	F1		F1	21+22	F2	given	given		1/27	2/27	3/27	4/27		10/27	32+33	W 75000	given	given
		1991																																						
		1992																																						
		1993																																						
		1994																																						
		1995																																						
		1996																																						
		1997																																						
		1998																																						
		1999													Base Year																										
		2000																																						
		2000	51.3	5.1	42.3	14.1	112.9	0.0	0.0	0.0	0.0	0.0		112.9		3	8	10	10	6	135	36	621	207	1000	0	1000	5.6			1.50	34.2	3.4	28.2	9.4	75.2	0.0	75.2	1.0		
1		2001	57.8	5.8	47.5	16.1	127.2	0.0	0.0	0.0	0.0	0.0		127.2		3	8	10	10	6	204	54	697	236	1191	0	1191	6.6			1.53	37.8	3.8	31.1	10.5	83.1	0.0	83.1	1.1		
2		2002	62.9	6.3	51.5	17.7	138.4	0.0	0.0	0.0	0.0	0.0		138.4		3	8	10	10	6	222	59	755	260	1296	0	1296	7.2			1.53	41.1	4.1	33.6	11.6	90.5	0.0	90.5	1.2		
3		2003	69.4	6.9	57.1	19.3	152.8	0.0	0.0	0.0	0.0	0.0		152.8		3	8	10	10	6	245	65	838	283	1430	0	1430	7.9			1.56	44.5	4.5	36.6	12.3	97.9	0.0	97.9	1.3		
4		2004	74.9	7.5	62.0	20.5	164.8	0.0	0.0	0.0	0.0	0.0		164.8		3	8	10	10	6	264	70	909	300	1543	0	1543	8.6	14	0	1.56	48.0	4.8	39.7	13.1	105.7	0.0	105.7	1.4	3	0
5		2005	82.5	8.3	67.4	23.4	181.6	6.9	0.7	5.7	2.0	15.2		196.8		3	9	9	9	6	281	87	890	309	1576	134	1711	9.5			1.57	52.6	5.3	42.9	14.9	115.6	16.2	131.9	1.8		
6	1	2006	89.1	8.9	73.3	24.8	196.0	8.6	0.9	7.3	2.2	18.9		214.9		3	7	8	8	6	314	73	860	290	1537	166	1703	9.5			1.57	56.8	5.7	46.7	15.8	124.9	20.1	144.9	1.9		
7	2	2007	97.3	9.7	79.8	27.2	214.1	10.5	1.1	8.4	3.2	23.1		237.2		3	7	8	8	6	343	80	937	320	1679	203	1882	10.5			1.58	61.6	6.2	50.5	17.2	135.5	24.4	159.9	2.1		
8	3	2008	104.4	10.4	86.1	28.7	229.7	12.4	1.2	10.2	3.4	27.3		257.0		3	6	7	7	6	368	74	885	295	1620	240	1861	10.3			1.58	66.1	6.6	54.5	18.2	145.4	28.9	174.2	2.3		
9	4	2009	114.0	11.4	93.2	32.2	250.7	15.4	1.5	13.1	3.9	33.9		284.6		3	6	7	7	6	401	80	957	331	1769	298	2087	11.5			1.59	71.7	7.2	58.6	20.2	157.7	35.6	193.3	2.6		
10	5	2010	121.6	12.2	100.0	33.8	267.5	18.4	1.8	15.2	5.0	40.5		308.0	Short term Stage	3	5	6	7	6	428	71	880	347	1727	356	2083	11.6	14	6	1.59	76.5	7.6	62.9	21.2	168.3	42.5	210.8	2.9	3	2
11	6	2011	128.0	12.8	105.3	35.5	281.6	20.3	2.0	17.0	5.3	44.6		326.1		3	5	6	6	6	451	75	927	312	1765	392	2157	12.0			1.60	80.0	8.0	65.8	22.2	176.0	46.5	222.5	3.0		
12	7	2012	133.7	13.4	109.9	37.1	294.1	23.0	2.3	18.9	6.4	50.5		344.6		3	5	6	6	6	471	78	967	327	1843	445	2288	12.7			1.60	83.5	8.4	68.7	23.2	183.8	52.7	236.5	3.2		
13	8	2013	140.3	14.0	115.4	38.9	309.6	25.7	2.6	20.8	7.6	56.6		365.2		3	5	6	6	6	494	82	1016	343	1934	498	2433	13.5			1.60	87.7	8.8	72.1	24.3	192.9	59.1	252.0	3.4		
14	9	2014	147.0	14.7	121.0	40.7	323.4	28.6	2.9	22.7	8.7	62.8		386.2		3	4	5	5	6	518	69	887	299	1773	553	2326	12.9			1.60	91.9	9.2	75.6	25.5	202.1	65.6	267.7	3.6		
15	10	2015	154.7	15.5	126.7	43.5	340.3	31.5	3.1	25.5	9.1	69.2		409.5		3	4	5	5	6	545	73	929	319	1866	609	2475	13.7	14	6	1.60	96.7	9.7	79.2	27.2	212.7	72.2	284.9	3.8	3	3
16	11	2016	163.4	16.3	134.2	45.6	359.5	35.3	3.5	29.2	9.5	77.6		437.1		3	4	5	5	6	575	77	984	334	1971	683	2653	14.7			1.60	102.1	10.2	83.9	28.5	224.7	81.0	305.6	4.1		
17	12	2017	173.1	17.3	141.8	48.8	380.9	40.9	4.1	33.1	11.9	90.0		470.8		3	4	5	5	6	610	81	1040	357	2088	792	2880	16.0			1.60	108.2	10.8	88.6	30.4	238.1	93.9	331.9	4.4		
18	13	2018	183.0	18.3	150.5	50.9	402.7	45.8	4.6	37.8	12.5	100.7		503.4		3	4	5	4	6	645	86	1104	298	2133	886	3019	16.8			1.60	114.4	11.4	94.1	31.8	251.7	105.1	356.8	4.8		
19	14	2019	194.0	19.4	159.3	54.1	426.8	51.6	5.2	42.7	14.1	113.6		540.4		3	4	5	4	6	683	91	1169	318	2260	1000	3260	18.1			1.60	121.3	12.1	99.6	33.8	266.8	118.5	385.3	5.1		
20	15	2020	205.2	20.5	168.3	57.4	451.4	58.5	5.9	47.7	16.7	128.7		580.1	Master Plan Stage	3	4	5	4	6	723	96	1235	337	2390	1133	3523	19.6			1.60	128.3	12.8	105.2	35.9	282.2	134.3	416.5	5.6		
25	20	2025																																						
30	25	2030																																						
35	30	2035																																						
40	35	2040																																						

Notes
1 Ld.: Laden, Ey: Empty
2 Dewelling time is given for each by length of day in the table.
3 Maximum stacking height in four (4)
4 Average yard utilization: Import 60% thus 2.4 high
5 Average yard utilization: Import 75% thus 3.0 high
6 Average yard utilization: Transit and Transshipment 60% thus 2.4 high
7 Peak factor in 1.25
8 An average annual working days in 355 days
9 Unit lane ground slot : 30 rows x 6lines = 180 slots
10 Figure in column Plan indicates the required facilities to start operation at that year for each Phase 1, 2 and 3
11 Box ratio : Number in TEUs / Number in Boxes
teu%+2*feu% = (teu%+feu%) + feu% = 100% + feu%
12 Double handling rate for the Transit and Transshipment containers: Truck/rail+canal+vessel = (1+ 1*2+ 1x2)/3= 1.67
13 Average annual move box per gantry crane: 75000 move boxes or 120000 teus , 75000*1.6=120000teus

Formula:
Required Groundslots
= (Container Cargo) x (Dewlling T.) X (Peak factor) / (Annual Days) x (Average Stacking Height).....F1

Required Ground Lanes
= Required Groundslots / Unit ground slots per lane (180 teus).....F2

Table 6.4.3-1-4 (3) Container Terminals Construction Schedule

Forecast Case	Quay Alocation	Work Items	'01	'02	'03	'04	'05	'06	'07	'08	'09	'10	'11	'12	'13	'14	'15	'16	'17	'18	'19	'20
			Construction Work			Phase 1						Phase 2					Phase 3					
1	West	Quay Gantry Crane	Construction Work			3 Cranes						4 Cranes					4 Cranes					
		Berth	Construction Work			2 Berths						2 Berths					2 Berths					
		Lane	Construction Work			14 Lanes						14 Lanes					14 Lanes					
	East	Quay Gantry Crane						Construction Works				2 Cranes					3 Cranes					
		Berth						Construction Works				2 Berths					2 Berths					
		Lane						Construction Works				6 Lanes					12 Lanes					
2	West	Quay Gantry Crane	Construction Work			3 Cranes						3 Cranes					3 Cranes					
		Berth	Construction Work			2 Berths						2 Berths					2 Berths					
		Lane	Construction Work			14 Lanes						14 Lanes					14 Lanes					
	East	Quay Gantry Crane						Construction Works				2 Cranes					3 Cranes					
		Berth						Construction Works				2 Berths					2 Berths					
		Lane						Construction Works				6 Lanes					6(12) Lanes					

(2) Grain Terminal

For the analysis of required cargo handling equipment, following reference data was prepared for review:

Figure 6.4.3-2 Cargo Flow Chart - Grain Terminal (Total Grain Terminals & New Terminal)
Table 6.4.3-2-1 Project Scale - Grain Terminal (2,000,000 ton/yr Export)
Table 6.4.3-2-2 Cargo Handling Equipment - Grain Terminal (2,000,000 ton/yr Export)
Table 6.4.3-2-3 Annual Cargo Handling Capacity Calculation - Grain Terminal

Figure 6.4.3-2 Cargo flow Chart indicates cargo movement flow by volume and direction. Main input data are the traffic forecast data and estimated modal split by commodity. This is basic data to design the cargo handling equipment.

Based on the cargo volume forecast, project scale of the grain terminal was studied as indicated in the Table 6.4.3-2-1.

Table 6.4.3-2-2 shows the contents of major cargo handling equipment for the new grain terminal.

Table 6.4.3-2-3 indicates the annual cargo handling capacity of major cargo handling equipment for new grain terminal.

Two(2) 400 ton/hr pneumatic type unloaders and two(2) 800 ton/hr grain loaders with swing type telescopic chute, will be required up to the year of 2020.

Figure 6.4.3-2-1 Cargo Flow Chart -Total Grain Terminals - Case 1 - 2020

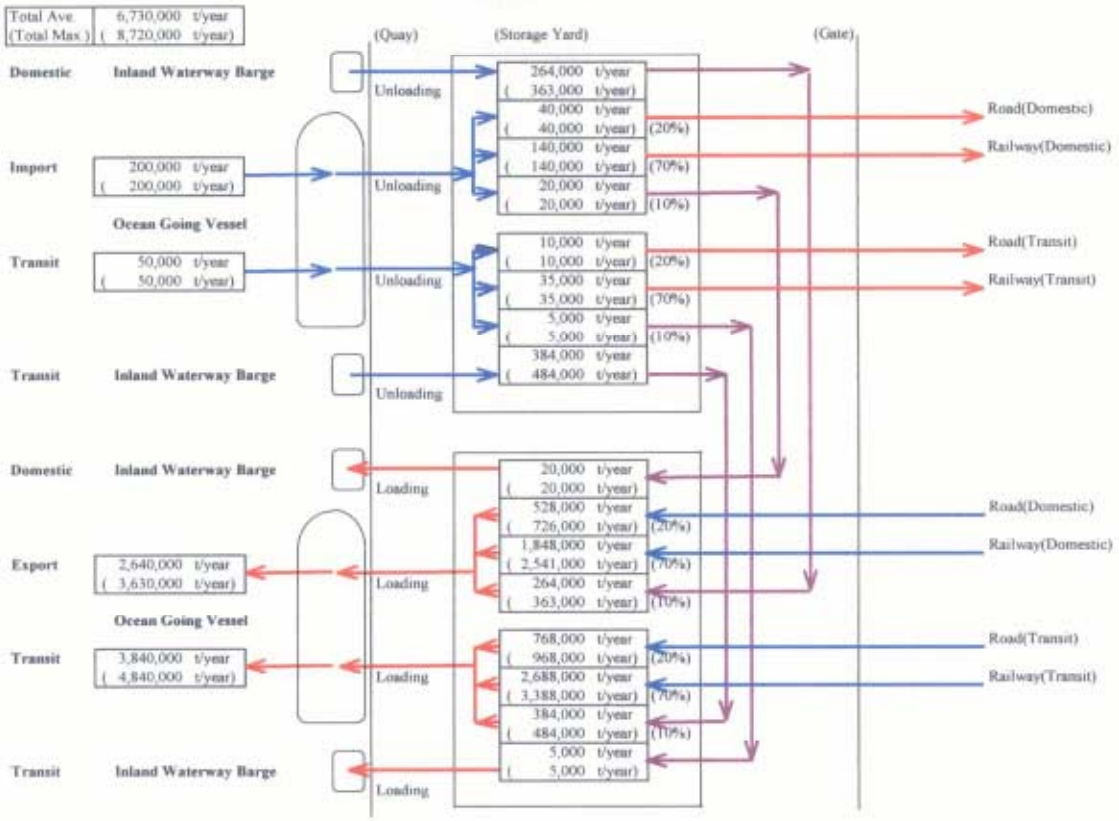

Figure 6.4.3-2-2 Cargo Flow Chart - Total Grain Terminals - Case 2 - 2020

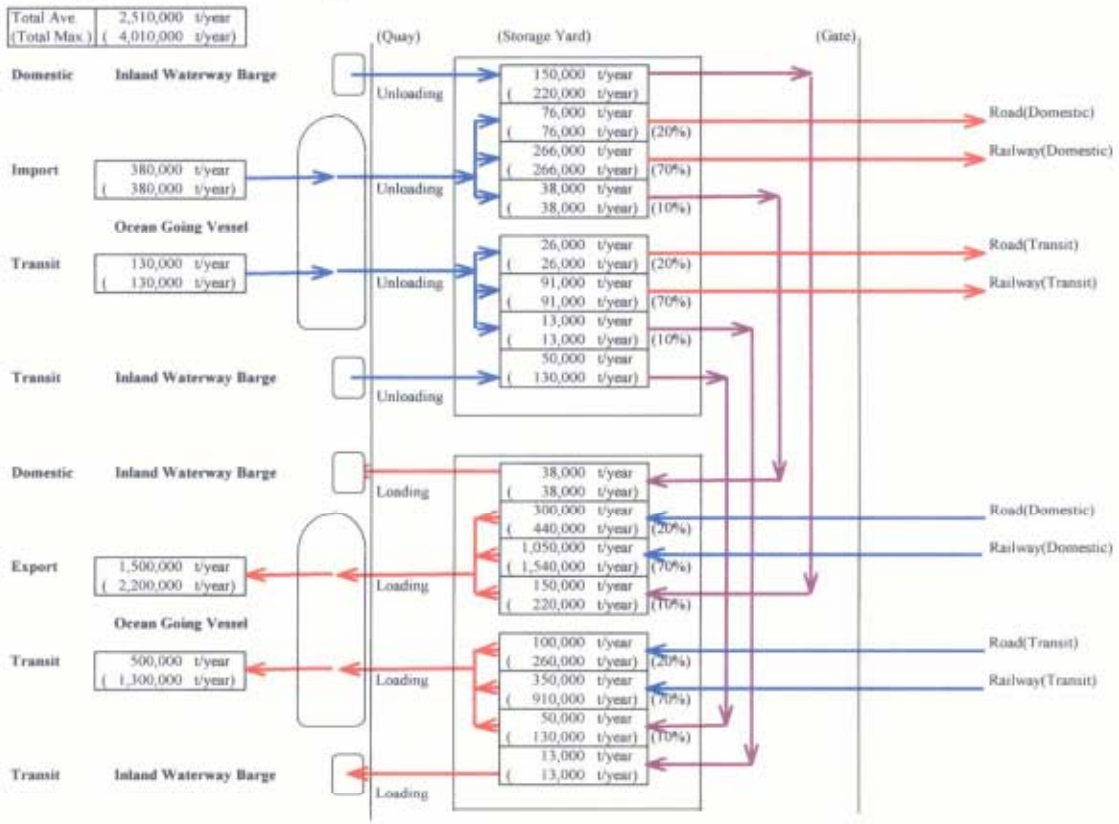

Figure 6.4.3-2-3 Cargo Flow Chart - New Grain Terminal (2.0 Million Tons/Year Export)

Total Export & Transit (Export) Cargo

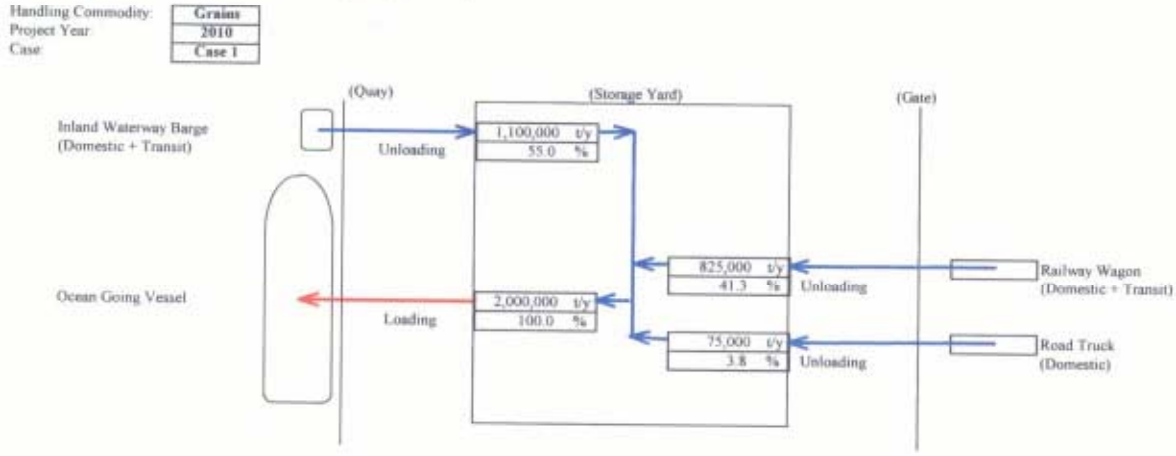

Figure 6.4.3-2-4 Cargo Flow Chart - New Grain Terminal (0.5 Million Tons/Year Import)

Total Import & Transit (Import) Cargo

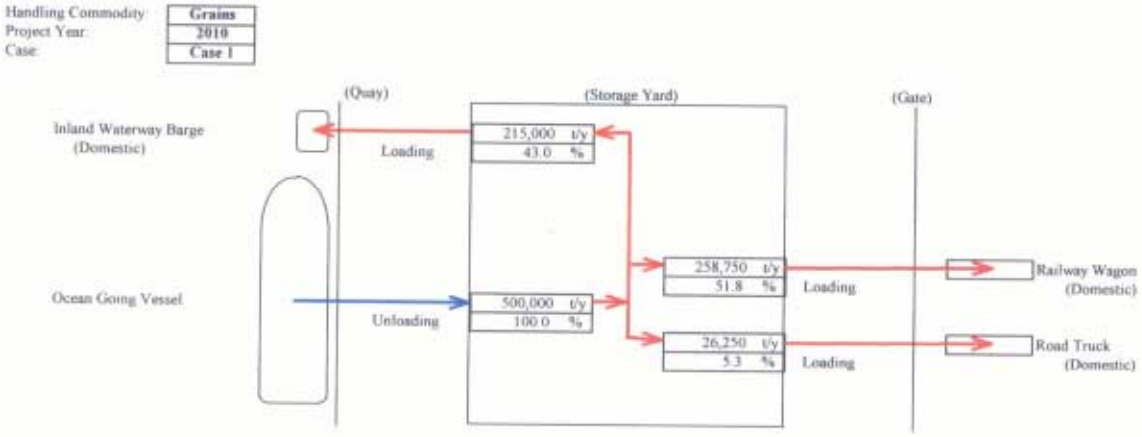

Table 6.4.3-2-1 Project Scale - New Grain Terminal

(2.0 Million Tons/Year Export / 0.5 Million Tons/Year Import)

Destination	Direction	Transportation	Cargo Volume (Tons/year)	Handling Equipment
Export	Receiving from:	Barges	1,100,000	2 x 400 t/h Pneumatic Unloader
		Railway Wagons	825,000	2 x 400 t/h Receiving System
		Road Trucks	75,000	1 x 100 t/h Receiving System
		Total	2,000,000	-
	Delivery to:	Vessels	2,000,000	2 x 800 t/h Bulk Loader
Import	Receiving from:	Vessels	500,000	Same Pneumatic Unloader for Export
	Delivery to:	Barges	215,000	Same Bulk Loader for Export
		Railway Wagons	258,750	1 x 200 t/h Loading System
		Road Trucks	26,250	1 x 100 t/h Loading System
		Total	500,000	-

Table 6.4.3-2-2 Cargo Handling Equipment - Grain Terminal

(Basic Model for the Purpose of Estimating Project Scale)

No.	System	Equipment		Capacity	Remarks
01	Barge/Ship Unloading System	Ship Unloader		2 x 400 tons/hour	Pneumatic
		Inter-Systems Handling Equipment		2 x 400 tons/hour	
			Conveyors	2 x 400 tons/hour	Chain Conveyor
02	Railway Wagon Receiving System	Receiving Hopper		2 x 400 tons/hour	
		Inter-Systems Handling Equipment		2 x 400 tons/hour	
			Bulk Weigher	2 x 400 tons/hour	
			Conveyors	2 x 400 tons/hour	
			Elevators	2 x 400 tons/hour	
03	Truck Receiving System	Tipping Platform		1 x 100 tons	
		Receiving Hopper		1 x 100 tons/hour	
		Buffer Silos	Wet Grain	2 x 500 tons	
			Dry Grain	1 x 500 tons	
		Tower Dryer		1 x 100 tons/hour	
		Inter-Systems Handling Equipment		1 x 100 tons/hour	
			Conveyors	1 x 100 tons/hour	Chain Conveyor
			Elevators	1 x 100 tons/hour	
04	Transfer System	Inter-Systems Handling Equipment		2 x 400 tons/hour	
			Elevators	5 x 400 tons/hour	
			Bulk Weigher	2 x 400 tons/hour	
05	Storage System	Main Silos		10 x 10,000 tons	Galvanized Steel Sheets
		Inter-Systems Handling Equipment		2 x 800 tons/hour	Chain Conveyor
06	Transfer System	To Ship Loading System		2 x 800 tons/hour	Chain Conveyor
		To Railway Wagon Loading System		1 x 200 tons/hour	Chain Conveyor
		ToTruck Loading System		1 x 100 tons	Chain Conveyor
07	Ship Loading System	Ship Loader		2 x 800 tons/hour	Swing Type Telescopic Chute
08	Railway Wagon Loading System	Loading Chute		1 x 200 tons/hour	
09	Truck Loading System	Loading Chute		1 x 100 tons	

Table 6.4.3-2-3 Annual Cargo Handling Capacity Calculation - Grain Terminal

Annual cargo handling capacity of the terminal is calculated by adopting the following formula:

1. Berth Occupancy Ratio

$$Rbo = Hb / (365 \times 24)$$
$$= (Hba + Hbb) / (365 \times 24)$$
$$= \{(Ha \times Nva) + (Hb \times Hvb)\} / (365 \times 24)$$
$$= [\{(Vsa / Pe) \times Nva\} + \{(Vsb / Pe) \times Hvb)\}] / (365 \times 24)$$
$$= [\{(Vsa / Pe) \times (Q \times Vda) / Vsa\} + \{(Vsb / Pe) \times (Q \times Vdb) / Vsb\}] / (365 \times 24)$$

where:

Marks	Description	Units	Remarks
Rbo	Berth Occupancy Ratio	-	Rbo = Hb / (365 x 24)
Hb	Total Berthing Hours	hours	Hb = (Hba + Hbb)
Hba	Total Berthing Hours by Vessel (A)	hours	Hba = Ha x Nva
Hbb	Total Berthing Hours by Vessel (B)	hours	Hbb = Hb x Nvb
Ha	Working Hours for Vessel (A)	hours	Ha = Vsa / Pe
Hb	Working Hours for Vessel (B)	hours	Hb = Vsb / Pe
Q	Cargo Handlig Capacity per Berth per Equip't	tons/year	
Nva	Number of Vessel (A)	number	Nva = (Q x Vda) / Vsa
Nvb	Number of Vessel (B)	number	Nvb = (Q x Vdb) / Vsb
Vsa	Vessel (A) Size	tons	DWT
Vsb	Vessel (B) Size	tons	DWT
Vda	Vessel (A) Distribution Ratio	-	
Vdb	Vessel (B) Distribution Ratio	-	

2. Annual Cargo Handling Capacity per 1 Berth, per 1 Equipment

$$Q = (365 \times 24 \times Rw \times Rh \times Rbo \times Pe) / [\{(Vsa \times Vda) / Vsa\} + \{(Vsb \times Vdb / Vsb\}]$$
$$= (365 \times 24 \times Rw \times Rh \times Rbo \times Pe) / (Vda + Vdb)$$
$$= 365 \times 24 \times Rw \times Rh \times Rbo \times Pe$$

3. Annual Cargo Handling Capacity of the Terminal

$$Qt = 365 \times 24 \times Rw \times Rh \times Rboa \times Nb \times Pe \times Ne \times Ree \times Ee$$

where:

Marks	Description	Units	Remarks
Nb	Number of Berth per Terminal	number	
Rboa	Allowable Berth Occupancy Ratio	-	Nb=1: 0.50, Nb=2: 0.55
Rw	Equipment Working Hour Ratio	-	working hour/berthing hour
Rh	Cargo Handling Hour Ratio	-	handling hour/working hour
Pe	Theoretical Equipment Productivity	tons/hour	
Ne	Number of Equipment per Berth	number	
Ree	Equipment Effectiveness Ratio	-	Ne=1: 1.0, Ne=2: 0.9, Ne=3 :0.8
Ee	Average Equipment Efficiency	-	
Qt	Annual Cargo Handing Capacity	tons/year	

4. Average Operation Time per Vessel

$$Tr = (Sv \times Rl) / (Rw \times Rh \times Pe \times Ne \times Ree \times Ee)$$

where:

Marks	Description	Units	Remarks
Sva	Vessel Size, average	DWT	
Rl	Loading Ratio to Vessel Size	-	
Tr	Average Operation Time per Vessel	hour	

Table 6.4.3-2-3 Annual Cargo Handling Capacity Calculation - Grain Terminal

Annual cargo handling capacity of the terminal is calculated by adopting the following formula:

Qt = 365 x 24 x Rw x Rh x Rbo x Nb x Pe x Ne x Ree x Ee

The results of the calculation are shown on the table below:

Unloader (Number of Berth: 2, Number of Equipment/Berth: 1, BOR: 0.55)

Marks	Description	Units	Study 1	Study 2	Study 3	Remarks
Nb	Number of Berth per Terminal	number	2	2	2	
Rbo	Berth Occupancy Ratio	-	0.55	0.55	0.55	Nb=1: <0.50, Nb=2: <0.55
Rw	Equipment Working Hour Ratio	-	0.90	0.90	0.90	working hour/berthing hour
Rh	Cargo Handling Hour Ratio	-	0.70	0.70	0.70	handling hour/working hour
Pe	Theoretical Equipment Productivity	tons/hour	300	400	500	
Ne	Number of Equipment per Berth	number	1	1	1	
Ree	Equipment Effectiveness Ratio	-	1.0	1.0	1.0	Ne=1: 1.0, Ne=2: 0.9, Ne=3 :0.8
Ee	Average Equipment Efficiency	-	0.50	0.50	0.50	Pneumatic Unloading Operation
Qt	Annual Cargo Handing Capacity	tons/year	910,602	1,214,136	1,517,670	>Required Unloading Capacity
Sb	Average Bulk Carrier Barge Size	DWT	2,000	2,000	2,000	
Nb	Number of Barges per Conboy	-	5	5	5	
Vc	Cargo Volume (0.90 x DWT)	tons/convoy	9,000	9,000	9,000	
Tr	Required Hours to Unload 1 Convoy	hour	95.2	71.4	57.1	
Dr	Required Days to Unload 1 Convoy	Days	4.0	3.0	2.4	
Note	Year	year	2020			
	Required Unloading Capacity	tons/year	1,100,000			

Loader (Number of Berth: 1, Number of Equipment/Berth: 2, BOR: 0.50)

Marks	Description	Units	Study 1	Study 2	Study 3	Remarks
Nb	Number of Berth per Terminal	number	1	1	1	
Rbo	Berth Occupancy Ratio	-	0.50	0.50	0.50	Nb=1: <0.50, Nb=2: <0.55
Rw	Equipment Working Hour Ratio	-	0.90	0.90	0.90	working hour/berthing hour
Rh	Cargo Handling Hour Ratio	-	0.70	0.70	0.70	handling hour/working hour
Pe	Theoretical Equipment Productivity	tons/hour	600	800	1,000	
Ne	Number of Equipment per Berth	number	2	2	2	
Ree	Equipment Effectiveness Ratio	-	0.9	0.9	0.9	Ne=1: 1.0, Ne=2: 0.9, Ne=3 :0.8
Ee	Average Equipment Efficiency	-	0.60	0.60	0.60	Loading Operation
Qt	Annual Cargo Handing Capacity	tons/year	1,788,091	2,384,122	2,980,152	>Required Loading Capacity
Sb	Average Bulk Carrier Vessel Size	DWT	27,500	27,500	27,500	
Vc	Cargo Volume (0.90 x DWT)	tons/vessel	24,750	24,750	24,750	
Tr	Required Hours to Load 1 Vessel	hour	60.6	45.5	36.4	
Dr	Required Days to Load 1 Vessel	Days	2.5	1.9	1.5	
Note	Year	year	2010			
	Required Loading Capacity	tons/year	2,000,000			

(3) Edible Oil Terminal

For the analysis of required cargo handling equipment, following reference data was prepared for review:

Figure 6.4.3-3 Cargo Flow Chart - Edible Oil Terminal
Table 6.4.3-3-1 Project Scale - Edible Oil Terminal
Table 6.4.3-3-2 Cargo Handling Equipment - Edible Oil Terminal
Table 6.4.3-3-3 Annual Cargo Handling Capacity Calculation - Edible Oil Terminal

Figure 6.4.3-3 Cargo flow Chart indicates cargo movement flow by volume and direction. Main input data are the traffic forecast data and estimated modal split by commodity. This is basic data to design the cargo handling equipment.

Based on the cargo volume forecast, project scale of the edible oil terminal was studied as indicated in the Table 6.4.3-3-1.

Table 6.4.3-3-2 shows the contents of major cargo handling equipment for the new edible oil terminal.

Table 6.4.3-3-3 indicates the annual cargo handling capacity of major cargo handling equipment for new edible oil terminal.

Two(2) 100 ton/hr truck receiving systems, two(2) 100 ton/hr railway wagon receiving systems, and two(2) 100 ton/hr barge/ship loading/unloading will be required up to the year of 2020, as well as four(4) 3,000 tons edible oil tanks to handle 250,000 tons/year cargoes.

Figure 6.4.3-3 Cargo Flow Chart - Edible Oil Terminal - Case 1 & 2 - 2020

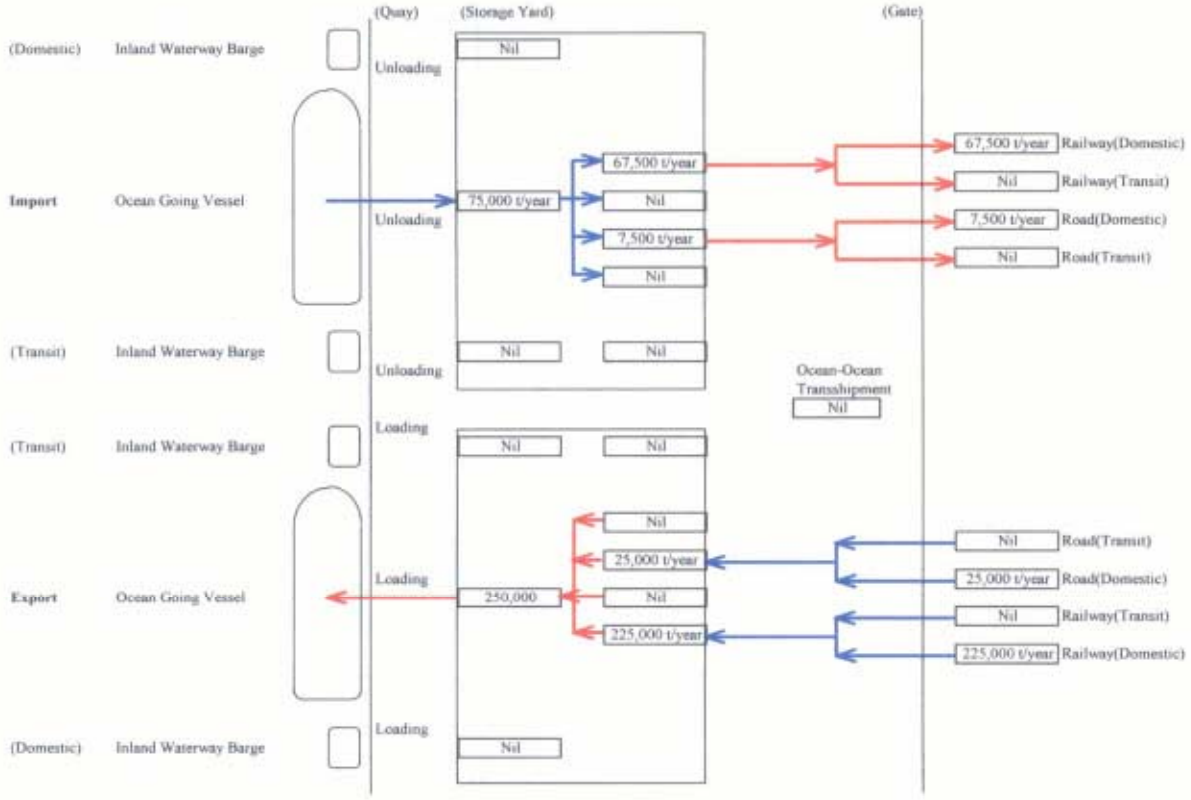

Table 6.4.3-3-1 Project Scale - Edible Oil Terminal

Cargo Volume Forecast (21. Feb. 2001. By Manju)

Operation	Category	Case 1 & 2				-			Balance		
		2020				Cargo Handling Capacity			Remaining Cargo Volume		
		Average		Maximum*							
		Volume	unit	Volume	unit	Volume	unit	Equipment	Volume	unit	Required Equipment
Loading	Export	-	mt/year	250,000	mt/year						
	Transit	-	mt/year	0	mt/year						
	Domestic	-	mt/year	0	mt/year						
	Total	-	mt/year	250,000	mt/year	0	mt/year	-	250,000	mt/year	2 x 100t/h Loading/Unloading Arms
Unloading	Import	-	mt/year	75,000	mt/year						
	Transit	-	mt/year	0	mt/year						
	Domestic	-	mt/year	0	mt/year						
	Total	-	mt/year	75,000	mt/year	0	mt/year	-	75,000	mt/year	
Total		-	mt/year	325,000	mt/year	0	mt/year	-	325,000	mt/year	-

*: To be considered for Equipment Planning

Table 6.4.3-3-2 Cargo Handling Equipment - Edible Oil Terminal

No.	System	Equipment	Capacity	Remarks
01	Truck Receiving System	Pipeline	2 x 100 tons/hour	with Metering Device
02	Railway Wagon Receiving System	Pipeline	2 x 100 tons/hour	with Metering Device
03	Barge/Ship Loading/Unloading System	Loading/Unloading Arm	2 x 100 tons/hour	with Metering Device
40	Storage System	Edible Oil Tank	4 x 3,000 tons	Stainless Steel Sheets

Table 6.4.3-3-3 (1) Annual Cargo Handling Capacity Calculation - Edible Oil Terminal

Annual cargo handling capacity of the terminal is calculated by adopting the following formula:

1. Berth Occupancy Ratio

$$Rbo = Hb / (365 \times 24)$$
$$= (Hba + Hbb) / (365 \times 24)$$
$$= \{(Ha \times Nva) + (Hb \times Hvb)\} / (365 \times 24)$$
$$= [\{(Vsa / Pe) \times Nva\} + \{(Vsb / Pe) \times Hvb)\}] / (365 \times 24)$$
$$= [\{(Vsa / Pe) \times (Q \times Vda) / Vsa\} + \{(Vsb / Pe) \times (Q \times Vdb) / Vsb\}] / (365 \times 24)$$

where:

Marks	Description	Units	Remarks
Rbo	Berth Occupancy Ratio	-	Rbo = Hb / (365 x 24)
Hb	Total Berthing Hours	hours	Hb = (Hba + Hbb)
Hba	Total Berthing Hours by Vessel (A)	hours	Hba = Ha x Nva
Hbb	Total Berthing Hours by Vessel (B)	hours	Hbb = Hb x Nvb
Ha	Working Hours for Vessel (A)	hours	Ha = Vsa / Pe
Hb	Working Hours for Vessel (B)	hours	Hb = Vsb / Pe
Q	Cargo Handlig Capacity per Berth per Equip't	tons/year	
Nva	Number of Vessel (A)	number	Nva = (Q x Vda) / Vsa
Nvb	Number of Vessel (B)	number	Nvb = (Q x Vdb) / Vsb
Vsa	Vessel (A) Size	tons	DWT
Vsb	Vessel (B) Size	tons	DWT
Vda	Vessel (A) Distribution Ratio	-	
Vdb	Vessel (B) Distribution Ratio	-	

2. Annual Cargo Handling Capacity per 1 Berth, per 1 Equipment

$$Q = (365 \times 24 \times Rw \times Rh \times Rbo \times Pe) / [\{(Vsa \times Vda) / Vsa\} + \{(Vsb \times Vdb / Vsb)\}]$$
$$= (365 \times 24 \times Rw \times Rh \times Rbo \times Pe) / (Vda + Vdb)$$
$$= 365 \times 24 \times Rw \times Rh \times Rbo \times Pe$$

3. Annual Cargo Handling Capacity of the Terminal

$$Qt = 365 \times 24 \times Rw \times Rh \times Rboa \times Nb \times Pe \times Ne \times Ree \times Ee$$

where:

Marks	Description	Units	Remarks
Nb	Number of Berth per Terminal	number	
Rboa	Allowable Berth Occupancy Ratio	-	Nb=1: 0.50, Nb=2: 0.55
Rw	Equipment Working Hour Ratio	-	working hour/berthing hour
Rh	Cargo Handling Hour Ratio	-	handling hour/working hour
Pe	Theoretical Equipment Productivity	tons/hour	
Ne	Number of Equipment per Berth	number	
Ree	Equipment Effectiveness Ratio	-	Ne=1: 1.0, Ne=2: 0.9, Ne=3 :0.8
Ee	Average Equipment Efficiency	-	
Qt	Annual Cargo Handing Capacity	tons/year	

4. Average Operation Time per Vessel

$$Tr = (Sv \times Rl) / (Rw \times Rh \times Pe \times Ne \times Ree \times Ee)$$

where:

Marks	Description	Units	Remarks
Sva	Vessel Size, average	DWT	
Rl	Loading Ratio to Vessel Size	-	
Tr	Average Operation Time per Vessel	hour	

Table 6.4.3-3-3 (2) Annual Cargo Handling Capacity Calculation - Edible Oil Terminal

Annual cargo handling capacity of the terminal is calculated by adopting the following formula:

Qt = 365 x 24 x Rw x Rh x Rbo x Nb x Pe x Ne x Ree x Ee

The result of the calculation are shown on the table below:

Unloading Arm(Number of Berth: 1, Number of Equipment/Berth: 2, BOR: 0.50)

Marks	Description	Units	Study 1	Study 2	Study 3	Remarks
Nb	Number of Berth per Terminal	number	1	1	1	
Rbo	Berth Occupancy Ratio	-	0.50	0.50	0.50	Nb=1: <0.50, Nb=2: <0.55
Rw	Equipment Working Hour Ratio	-	0.90	0.90	0.90	working hour/berthing hour
Rh	Cargo Handling Hour Ratio	-	0.70	0.70	0.70	handling hour/working hour
Pe	Theoretical Equipment Productivi	tons/hour	75	**100**	150	
Ne	Number of Equipment per Berth	number	2	**2**	2	
Ree	Equipment Effectiveness Ratio	-	0.9	0.9	0.9	Ne=1: 1.0, Ne=2: 0.9, Ne=3 :0.8
Ee	Average Equipment Efficiency	-	0.75	0.75	0.75	Pneumatic Unloading Operation
Qt	Annual Cargo Handing Capacity	tons/year	279,389	**372,519**	558,779	
St	Average Liquid Bulk Tanker Size	DWT	2,000	2,000	2,000	
Vc	Cargo Volume (0.90 x DWT)	tons/vessel	1,800	1,800	1,800	
Tr	Required Hours to Unload 1 Vess	hour	28.2	21.2	14.1	
Dr	Required Days to Unload 1 Vesse	Days	1.2	**0.9**	0.6	
Note	Year	year	2020			
	Cargo Demand Forecast	tons/year	75,000			

Loading Arm(Number of Berth: 1, Number of Equipment/Berth: 2, BOR: 0.50)

Marks	Description	Units	Study 1	Study 2	Study 3	Remarks
Nb	Number of Berth per Terminal	number	1	1	1	
Rbo	Berth Occupancy Ratio	-	0.50	0.50	0.50	Nb=1: <0.50, Nb=2: <0.55
Rw	Equipment Working Hour Ratio	-	0.90	0.90	0.90	working hour/berthing hour
Rh	Cargo Handling Hour Ratio	-	0.70	0.70	0.70	handling hour/working hour
Pe	Theoretical Equipment Productivi	tons/hour	75	**100**	150	
Ne	Number of Equipment per Berth	number	2	**2**	2	
Ree	Equipment Effectiveness Ratio	-	0.9	0.9	0.9	Ne=1: 1.0, Ne=2: 0.9, Ne=3 :0.8
Ee	Average Equipment Efficiency	-	0.75	0.75	0.75	Pneumatic Unloading Operation
Qt	Annual Cargo Handing Capacity	tons/year	279,389	**372,519**	558,779	
St	Average Liquid Bulk Tanker Size	DWT	2,000	2,000	2,000	
Vc	Cargo Volume (0.90 x DWT)	tons/vessel	1,800	1,800	1,800	
Tr	Required Hours to Unload 1 Vess	hour	28.2	21.2	14.1	
Dr	Required Days to Unload 1 Vesse	Days	1.2	**0.9**	0.6	
Note	Year	year	2020			
	Cargo Demand Forecast	tons/year	250,000			

Loading/Unloading Arm(Number of Berth: 1, Number of Equipment/Berth: 2, BOR: 0.50)

Marks	Description	Units	Study 1	Study 2	Study 3	Remarks
Nb	Number of Berth per Terminal	number	1	1	1	
Rbo	Berth Occupancy Ratio	-	0.50	0.50	0.50	Nb=1: <0.50, Nb=2: <0.55
Rw	Equipment Working Hour Ratio	-	0.90	0.90	0.90	working hour/berthing hour
Rh	Cargo Handling Hour Ratio	-	0.70	0.70	0.70	handling hour/working hour
Pe	Theoretical Equipment Productivi	tons/hour	75	**100**	150	
Ne	Number of Equipment per Berth	number	2	**2**	2	
Ree	Equipment Effectiveness Ratio	-	0.9	0.9	0.9	Ne=1: 1.0, Ne=2: 0.9, Ne=3 :0.8
Ee	Average Equipment Efficiency	-	0.75	0.75	0.75	Pneumatic Unloading Operation
Qt	Annual Cargo Handing Capacity	tons/year	279,389	**372,519**	558,779	
St	Average Liquid Bulk Tanker Size	DWT	2,000	2,000	2,000	
Vc	Cargo Volume (0.90 x DWT)	tons/vessel	1,800	1,800	1,800	
Tr	Required Hours to Unload 1 Vess	hour	28.2	21.2	14.1	
Dr	Required Days to Unload 1 Vesse	Days	1.2	**0.9**	0.6	
Note	Year	year	2020			
	Cargo Demand Forecast	tons/year	**325,000**			

(4) Steel Products Terminal (Multi-Purpose General Cargo Terminal)

Preliminary study for the required major equipment of the integrated steel product terminal has been carried out based on the future demand and present situation of equipment at site. Main target to integrate should be rise of operation efficiency by scale merit. At this moment, operational and institutional consideration has been omitted.

For the analysis of required cargo handling equipment, following reference data was prepared for review:

Table 6.4.3-4 Annual Cargo Handling Capacity Calculation - Steel Products Terminal

Based on the forecast cargo volume, capacities of existing cargo handling equipment are studied.

Table 6.4.3-4 indicates the annual cargo handling capacity of existing cargo handling equipment at the terminal. According to the study results, the existing cargo handling equipment at the terminal has enough capacity for handling forecast cargo volume in 2020.

It is recommended that this terminal is used for multi-purpose general cargo handling, mainly steel products.

Table 6.4.3-4 (1) Required Number of Quay Cranes for Steel Products Terminal

Plan 1: South Port (Berth 108, 109, 110 & 117 & 118)

Annual cargo handling capacity of the Quay Cranes is calculated by adopting the following formula:

Qb = Nq x Pqt x Hw x Dw x Rb x Rw x Rh x Re

The results of the calculation are shown on the table below:

Berth 108, 109 & 110

Marks	Descriptions	Units	6.3t Crane	20t Crane	Remarks
Nb	Total Number of berth	-	5	5	per Terminal
Nq	Number of quay cranes	sets	4	2	
Lr	Rated Load	tons	6.3	20	
La	Average Lifting Load	tons	5.0	16.0	Average Lifting Load/Rated Load=0.8
T	Cycle Time	cycles/hour	15	10	
Pqt	Theoret'l ave. productivity of crane	tons/hour	75	160	Pqt = La x T
Hw	Working hours per day	hours/day	22	22	
Dw	Working days per year	days/year	355	355	Subtracted holidays
Rb	Berth occupancy ratio	-	0.6	0.6	Nb=1:0.4, Nb=2:0.5,Nb=3:0.55,Nb=>4:0.60
Rw	Crane working hour ratio	-	0.90	0.90	working hour/berthing hour
Rh	Cargo handling hour ratio	-	0.70	0.70	handling hour/working hour
Pqn	Nominal ave. productivity of crane	-	47	101	Pqn = Pqt x Rw x Rh
Re	Crane effectiveness factor	-	0.8	0.8	Nc/Nb=1:1,Nc/Nb=2:0.9, Nc/Nb=3:0.8
Q	Annual cargo handling capacity	tons/year	708,523	755,758	
Qst	Sub-Total	-	1,464,281		

Berth 117 & 118

Marks	Descriptions	Units	6.3t Crane	20t Crane	Remarks
Nb	Total Number of berth	-	5	5	per Terminal
Nq	Number of quay cranes	sets	4	2	
Lr	Rated Load	tons	6.3	20	
La	Average Lifting Load	tons	5.0	16.0	Average Lifting Load/Rated Load=0.8
T	Cycle Time	cycles/hour	15	10	
Pqt	Theoret'l ave. productivity of crane	tons/hour	75	160	Pqt = La x T
Hw	Working hours per day	hours/day	22	22	
Dw	Working days per year	days/year	355	355	Subtracted holidays
Rb	Berth occupancy ratio	-	0.6	0.6	Nb=1:0.4, Nb=2:0.5,Nb=3:0.55,Nb=>4:0.60
Rw	Crane working hour ratio	-	0.90	0.90	working hour/berthing hour
Rh	Cargo handling hour ratio	-	0.70	0.70	handling hour/working hour
Pqn	Nominal ave. productivity of crane	-	47	101	Pqn = Pqt x Rw x Rh
Re	Crane effectiveness factor	-	0.8	0.8	Nc/Nb=1:1,Nc/Nb=2:0.9, Nc/Nb=3:0.8
Q	Annual cargo handling capacity	tons/year	708,523	755,758	
Qst	Sub-Total	-	1,464,281		

Qt	Total cargo handling capacity	tons/year	2,928,562	Total terminal
Note:	Target Year		2020	
	Cargo Throughput per year	tons/year	2,000,000	0.68

Table 6.4.3-4 (2) Required Number of Quay Cranes for Steel Products Terminal

Plan 2: North Port (Berth 56, 57, 58, 59 & 60)

Annual cargo handling capacity of the Quay Cranes is calculated by adopting the following formula:

Qb = Nq x Pqt x Hw x Dw x Rb x Rw x Rh x Re

The results of the calculation are shown on the table below:

Berth 56

Marks	Descriptions	Units	6.3t Crane	20t Crane	Remarks
Nb	Total Number of berth	-	5	5	per Terminal
Nq	Number of quay cranes	sets	2	1	
Lr	Rated Load	tons	6.3	20	
La	Average Lifting Load	tons	5.0	16.0	Average Lifting Load/Rated Load=0.8
T	Cycle Time	cycles/hour	15	10	
Pqt	Theoret'l ave. productivity of crane	tons/hour	75	160	Pqt = La x T
Hw	Working hours per day	hours/day	22	22	
Dw	Working days per year	days/year	355	355	Subtracted holidays
Rb	Berth occupancy ratio	-	0.6	0.6	Nb=1:0.4, Nb=2:0.5,Nb=3:0.55,Nb=>4:0.60
Rw	Crane working hour ratio	-	0.90	0.90	working hour/berthing hour
Rh	Cargo handling hour ratio	-	0.70	0.70	handling hour/working hour
Pqn	Nominal ave. productivity of crane	-	47	101	Pqn = Pqt x Rw x Rh
Re	Crane effectiveness factor	-	0.8	0.8	Nc/Nb=1:1,Nc/Nb=2:0.9, Nc/Nb=3:0.8
Q	Annual cargo handling capacity	tons/year	354,262	377,879	
Qst	Sub-Total	-	732,141		

Berth 57

Marks	Descriptions	Units	6.3t Crane	20t Crane	Remarks
Nb	Total Number of berth	-	5	5	per Terminal
Nq	Number of quay cranes	sets	3	0	
Lr	Rated Load	tons	6.3	20	
La	Average Lifting Load	tons	5.0	16.0	Average Lifting Load/Rated Load=0.8
T	Cycle Time	cycles/hour	15	10	
Pqt	Theoret'l ave. productivity of crane	tons/hour	75	160	Pqt = La x T
Hw	Working hours per day	hours/day	22	22	
Dw	Working days per year	days/year	355	355	Subtracted holidays
Rb	Berth occupancy ratio	-	0.6	0.6	Nb=1:0.4, Nb=2:0.5,Nb=3:0.55,Nb=>4:0.60
Rw	Crane working hour ratio	-	0.90	0.90	working hour/berthing hour
Rh	Cargo handling hour ratio	-	0.70	0.70	handling hour/working hour
Pqn	Nominal ave. productivity of crane	-	47	101	Pqn = Pqt x Rw x Rh
Re	Crane effectiveness factor	-	0.8	0.8	Nc/Nb=1:1,Nc/Nb=2:0.9, Nc/Nb=3:0.8
Q	Annual cargo handling capacity	tons/year	531,392	0	
Qst	Sub-Total	-	531,392		

Berth 58

Marks	Descriptions	Units	6.3t Crane	20t Crane	Remarks
Nb	Total Number of berth	-	5	5	per Terminal
Nq	Number of quay cranes	sets	2	1	
Lr	Rated Load	tons	6.3	20	
La	Average Lifting Load	tons	5.0	16.0	Average Lifting Load/Rated Load=0.8
T	Cycle Time	cycles/hour	15	10	
Pqt	Theoret'l ave. productivity of crane	tons/hour	75	160	Pqt = La x T
Hw	Working hours per day	hours/day	22	22	
Dw	Working days per year	days/year	355	355	Subtracted holidays
Rb	Berth occupancy ratio	-	0.6	0.6	Nb=1:0.4, Nb=2:0.5,Nb=3:0.55,Nb=>4:0.60
Rw	Crane working hour ratio	-	0.90	0.90	working hour/berthing hour
Rh	Cargo handling hour ratio	-	0.70	0.70	handling hour/working hour
Pqn	Nominal ave. productivity of crane	-	47	101	Pqn = Pqt x Rw x Rh
Re	Crane effectiveness factor	-	0.8	0.8	Nc/Nb=1:1,Nc/Nb=2:0.9, Nc/Nb=3:0.8
Q	Annual cargo handling capacity	tons/year	354,262	377,879	
Qst	Sub-Total	-	732,141		

Table 6.4.3-4 (3) Required Number of Quay Cranes for Steel Products Terminal

Berth 59

Marks	Descriptions	Units	6.3t Crane	20t Crane	Remarks
Nb	Total Number of berth	-	5	5	per Terminal
Nq	Number of quay cranes	sets	0	1	
Lr	Rated Load	tons	6.3	20	
La	Average Lifting Load	tons	5.0	16.0	Average Lifting Load/Rated Load=0.8
T	Cycle Time	cycles/hour	15	10	
Pqt	Theoret'l ave. productivity of crane	tons/hour	75	160	Pqt = La x T
Hw	Working hours per day	hours/day	22	22	
Dw	Working days per year	days/year	355	355	Subtracted holidays
Rb	Berth occupancy ratio	-	0.6	0.6	Nb=1:0.4, Nb=2:0.5,Nb=3:0.55,Nb=>4:0.60
Rw	Crane working hour ratio	-	0.90	0.90	working hour/berthing hour
Rh	Cargo handling hour ratio	-	0.70	0.70	handling hour/working hour
Pqn	Nominal ave. productivity of crane	-	47	101	Pqn = Pqt x Rw x Rh
Re	Crane effectiveness factor	-	0	1	Nc/Nb=1:1,Nc/Nb=2:0.9, Nc/Nb=3:0.8
Q	Annual cargo handling capacity	tons/year	0	472,349	
Qst	Sub-Total	-	472,349		

Berth 60

Marks	Descriptions	Units	6.3t Crane	20t Crane	Remarks
Nb	Total Number of berth	-	5	5	per Terminal
Nq	Number of quay cranes	sets	0	1	
Lr	Rated Load	tons	6.3	20	
La	Average Lifting Load	tons	5.0	16.0	Average Lifting Load/Rated Load=0.8
T	Cycle Time	cycles/hour	15	10	
Pqt	Theoret'l ave. productivity of crane	tons/hour	75	160	Pqt = La x T
Hw	Working hours per day	hours/day	22	22	
Dw	Working days per year	days/year	355	355	Subtracted holidays
Rb	Berth occupancy ratio	-	0.6	0.6	Nb=1:0.4, Nb=2:0.5,Nb=3:0.55,Nb=>4:0.60
Rw	Crane working hour ratio	-	0.90	0.90	working hour/berthing hour
Rh	Cargo handling hour ratio	-	0.70	0.70	handling hour/working hour
Pqn	Nominal ave. productivity of crane	-	47	101	Pqn = Pqt x Rw x Rh
Re	Crane effectiveness factor	-	0	1	Nc/Nb=1:1,Nc/Nb=2:0.9, Nc/Nb=3:0.8
Q	Annual cargo handling capacity	tons/year	0	472,349	
Qst	Sub-Total	-	472,349		

Qt	Total cargo handling capacity	tons/year	2,940,372	Total terminal
Note:	Target Year		2020	
	Cargo Throughput per year	tons/year	2,000,000	0.68

(5) Timber Terminal (Multi-Purpose General Cargo Terminal)

The main aim to this terminal is the same with the steel product terminal. Preliminary study for the required major equipment of the gathering steel product terminal has been carried out based on the estimated future traffic demand and present situation of equipment at site. The main target to this effort should be increase of operation efficiency by scale merit. At this moment, operational and institutional considerations have not been considered.

For the analysis of required cargo handling equipment, following reference data was prepared for review:

Table 6.4.3-5 Annual Cargo Handling Capacity Calculation - Timber Terminal

Based on the forecast cargo volume, capacities of existing cargo handling equipment are studied.

Table 6.4.3-5 indicates the annual cargo handling capacity of existing cargo handling equipment at the terminal. According to the study results, the existing cargo handling equipment at the terminal has enough capacity for handling forecast cargo volume in 2020. Cargo expected in 2020 is not used for the planning since it is less than those in 2010.
It is strongly recommended that this terminal is used for multi-purpose general cargo handling, mainly timbers. Other commodities should be handled also.

Timber cargo is currently for the exports. It is recorded that sharp timber export increase was observed by the end of last century. As shown in Part II Chapter 3, forecasted future timber cargo demands, however, indicates a weak demand. It is estimated that timber export will decrease after the peak volume in 2010.

It is recommended to review the cargo traffic of timber exports before the decision making of investment. It is also recommended to start the construction after the concession contract with private operators are carried out.

Table 6.4.3-5 Required Number of Quay Cranes for Timber Terminal

Annual cargo handling capacity of the Quay Cranes is calculated by adopting the following formula:

Qb = Nq x Pqt x Hw x Dw x Rb x Rw x Rh x Re

The results of the calculation are shown on the table below:

Berth 45, 46, 47 & 48

Marks	Descriptions	Units	6.3t Crane	20t Crane	Remarks
Nb	Total Number of berth	-	6	6	per Terminal
Nq	Number of quay cranes	sets	7	2	
Lr	Rated Load	tons	6.3	20	
La	Average Lifting Load	tons	5.0	16.0	Average Lifting Load/Rated Load=0.8
T	Cycle Time	cycles/hour	15	10	
Pqt	Theoret'l ave. productivity of crane	tons/hour	75	160	Pqt = La x T
Hw	Working hours per day	hours/day	22	22	
Dw	Working days per year	days/year	355	355	Subtracted holidays
Rb	Berth occupancy ratio	-	0.6	0.6	Nb=1:0.4, Nb=2:0.5,Nb=3:0.55,Nb=>4:0.60
Rw	Crane working hour ratio	-	0.90	0.90	working hour/berthing hour
Rh	Cargo handling hour ratio	-	0.70	0.70	handling hour/working hour
Pqn	Nominal ave. productivity of crane	-	47	101	Pqn = Pqt x Rw x Rh
Re	Crane effectiveness factor	-	0.8	0.8	Nc/Nb=1:1,Nc/Nb=2:0.9, Nc/Nb=3:0.8
Q	Annual cargo handling capacity	tons/year	1,239,916	755,758	
Qst	Sub-Total	-	1,995,674		

Berth 49 & 50

Marks	Descriptions	Units	6.3t Crane	20t Crane	Remarks
Nb	Total Number of berth	-	5	5	per Terminal
Nq	Number of quay cranes	sets	10	1	
Lr	Rated Load	tons	6.3	20	
La	Average Lifting Load	tons	5.0	16.0	Average Lifting Load/Rated Load=0.8
T	Cycle Time	cycles/hour	15	10	
Pqt	Theoret'l ave. productivity of crane	tons/hour	75	160	Pqt = La x T
Hw	Working hours per day	hours/day	22	22	
Dw	Working days per year	days/year	355	355	Subtracted holidays
Rb	Berth occupancy ratio	-	0.6	0.6	Nb=1:0.4, Nb=2:0.5,Nb=3:0.55,Nb=>4:0.60
Rw	Crane working hour ratio	-	0.90	0.90	working hour/berthing hour
Rh	Cargo handling hour ratio	-	0.70	0.70	handling hour/working hour
Pqn	Nominal ave. productivity of crane	-	47	101	Pqn = Pqt x Rw x Rh
Re	Crane effectiveness factor	-	0.8	0.8	Nc/Nb=1:1,Nc/Nb=2:0.9, Nc/Nb=3:0.8
Q	Annual cargo handling capacity	tons/year	1,771,308	377,879	
Qst	Sub-Total	-	2,149,187		

Qt	Total cargo handling capacity	tons/year	4,144,861	Total terminal
Note:	Target Year		2010	
	Cargo Throughput per year	tons/year	1,130,000	0.27

Number of cranes can be reduced.

(6) Barge Terminal

The barge terminal is one of core project among the Master Plan components. However no equipment is considered since this terminal is mainly for the standby and preparation areas for the next trip to up-stream. Even so any equipment is required, it will be provided by the related private sectors, thus no equipment is provided here.

In order to accelerate the utilization of barge terminal, supporting facilities will be provided. Supporting system is the space of offices, car parking area and minimum utilities. Utilities will include the facilities such as water supply system, power supply and lighting system.

Discussion of these will be carried out Part II Chapter 7.