CHAPTER SEVENTEEN

Available Tankage Capacity

In an export refinery, the estimates of the total tankage capacity available for storage of various product groups are required for preparing inventory availability forecasts for product shipping. In single-ownership refineries, the entire tankage capacity is available to sustain the export operation. In joint-ownership refineries, the available tankage capacity for every product group is split between the participants in the ratio of their equity in the refinery. Each participant then uses its share of tankage capacity to hold its inventory for its product shipping.

The procedure for estimating the total available tankage capacity and its allocation to the participants is described in this chapter.

Each participant must maintain its product inventory levels within the storage capacity allocated to it. The tankage capacity allocation is necessary to prepare inventory forecasts of the participants, which is discussed in later chapters.

ESTIMATION OF TOTAL AVAILABLE CAPACITY

The procedure for estimating the total available tankage capacity for a product group is as follows:

1. All available tanks in the given product group service are listed. Only tanks in service for the given product group are considered. The tanks in service of a given product group keep changing. Every time a tank goes out of service for scheduled or unscheduled maintenance or a new tank is added in the service of a given product group, the tankage list must be updated.

2. Tanks in service in each group are listed along with the following data:

   Maximum gross volume (the physical volume of the tank).
   Maximum net volume (the total gross volume multiplied by a factor to compute the maximum net for a group).
   Working ullage (the space required in tanks for operational reasons, such as correcting tank composition or disengaging vapors; a working ullage is specified for a group of tanks).
   Minimum heel (the volume of tank below minimum gauge).
   Available working stock (the volume above the minimum gauge to provide suction head to the pump transferring products from the tank).

MINIMUM AND MAXIMUM INVENTORY (LI AND HI)

Each tank has some dead storage volume, which is necessary to separate any solid entrainment and water and so forth. This inventory or holdup is not available for export but, nevertheless, is necessary for operation of the tank. The total minimum inventory volume, which must be maintained for operational reasons, is termed LI. A tank LI is calculated as follows:

$$\text{LI} = R + S$$

where R is the minimum heel and S is the available working stock.

The tank volume between the operational maximum level and tank's physical volume is termed HI. This volume is used to correct the tank blend composition, if so required. A tank HI is calculated as follows:

$$\text{HI} = P - Q$$

where P is the maximum net volume of tank and Q is the working ullage.

TANKAGE CAPACITY AVAILABLE FOR PRODUCT STORAGE

The tank volume between LI and HI is actually available for storage of the products. Therefore,

$$\text{Available capacity} = \text{HI} - \text{LI}$$

PRODUCT GROUPS

Refinery product grades are combined into groups. For example, all light naphtha grades with a specific range of density, RVP, or distillation specifications constitute the LSR group, and the different grades of gasolines come under the gasoline group. A typical refinery might group products as follows:

GROUP	PRODUCT
LSR	LIGHT NAPHTHAS
WSR	WHOLE RANGE NAPHTHAS
KEROSENE	KEROSENE/JET FUELS
DIESEL	AUTOMOTIVE DIESELS
BDSL	BLACK OR MARINE DIESELS
HVGO	HEAVY VACUUM GAS OILS
FO	FUEL OILS
ASPHALT	ASPHALT GRADES

ALLOCATION OF TANKAGE CAPACITY

In joint-ownership refineries, HI and LI are computed for every group of tanks, and the HI and LI for the group are split in the ratio of the participants' equity in the refinery.

EXAMPLE 17-1

In a joint-ownership refinery, participant AOC has a 60% share and participant BOC has 40% share. The tanks in service for each product group and the tank data are shown in Tables 17-1 to 17-10. Estimate the tankage capacity available to each participant.

The solution is

$$\text{Participant AOC equity in refinery} = 40\%$$
$$\text{Participant BOC equity} = 60\%$$

A summary of HI and LI is made from the tankage data. The HI and LI are split in the ratio of the participants' equity. The capacity available to

Table 17-1
LPG Group Tanks

TANK NO.	MAXIMUM GROSS (1) *O*	MAXIMUM NET (2) $P = O \times 0.9570$	WORKING ULLAGE (3) *Q*	MAX. NET WORKING INVENTORY (4) $HI = P - Q$	MINIMUM HEEL (5) *R*	AVAILABLE WORKING STOCK (6) *S*	MINIMUM NET WORKING ULLAGE (7) $LI = R + S$
080	3.7	3.541			0.100		
081	3.7	3.541			0.100		
082	2.3	2.201			0.100		
083	2.3	2.201			0.100		
084	3.7	3.541			0.100		
085	3.7	3.541			0.100		
TOTAL	19.4	18.566	4.000	14.566	0.600	3.400	4.000

NOTES: *LI IS MINIMUM NET WORKING ULLAGE.*
HI IS MAXIMUM NET WORKING INVENTORY.
CALCULATION:
CALCULATE THE TOTAL HI AND LI FOR EACH PRODUCT GROUP.
THE CALCULATIONS OF HI AND LI PRESENTED HERE ARE SELF-EXPLANATORY.
ALL FIGURES ARE IN THOUSAND BARRELS.
ONLY TANKS IN SERVICE ARE CONSIDERED FOR COMPUTATION OF HI AND LI.
MAXIMUM NET IS COMPUTED FROM MAXIMUM GROSS BY MULTIPLYING WITH A FACTOR,
AND THIS FACTOR, 95.7% FOR GROUP LPG, MAY BE DIFFERENT FOR EVERY PRODUCT GROUP.
COLUMNS 4 AND 7 SHOW HI AND LI COMPUTATIONS.

Table 17-2
Light Naphtha Group Tanks

TANK NO.	MAXIMUM GROSS (1) *O*	MAXIMUM NET (2) $P=O\times0.9766$	WORKING ULLAGE (3) *Q*	MAX. NET WORKING INVENTORY (4) HI=*P*−*Q*	MINIMUM HEEL (5) *R*	AVAILABLE WORKING STOCK (6) *S*	MINIMUM NET WORKING ULLAGE (7) LI=*R*+*S*
356	19	18.555			2.000		
457	14	13.672			2.000		
459	12	11.719			2.000		
460	12	11.719			2.000		
476	19	18.555			2.000		
944	191	186.531			20.000		
945	187	182.624			21.000		
946	165	161.139			22.000		
TOTAL	619	604.515	50.000	554.515	73.000	50.000	123.000

NOTES: *LI IS MINIMUM NET WORKING ULLAGE.*
HI IS MAXIMUM NET WORKING INVENTORY.
CALCULATION:
CALCULATE THE TOTAL HI AND LI FOR EACH PRODUCT GROUP.
THE CALCULATIONS OF HI AND LI PRESENTED HERE ARE SELF-EXPLANATORY.
ALL FIGURES ARE IN THOUSAND BARRELS.
ONLY TANKS IN SERVICE ARE CONSIDERED FOR COMPUTATION OF HI AND LI.
MAXIMUM NET IS COMPUTED FROM MAXIMUM GROSS BY MULTIPLYING WITH A FACTOR,
AND THIS FACTOR IS 97.66% FOR THE GROUP LSR.
COLUMNS 4 AND 7 SHOW HI AND LI COMPUTATIONS.

Table 17-3
Whole Range Naphtha Group Tanks

TANK NO.	MAXIMUM GROSS (1) *O*	MAXIMUM NET (2) $P = O \times 0.9766$	WORKING ULLAGE (3) *Q*	MAX. NET WORKING INVENTORY (4) $HI = P - Q$	MINIMUM HEEL (5) *R*	AVAILABLE WORKING STOCK (6) *S*	MINIMUM NET WORKING ULLAGE (7) $LI = R + S$
965	527	514.668			41.000		
760	518	505.879			35.000		
925	120	117.192			16.000		
TOTAL 1	1165	1137.739	80.000	1057.739	92.000	50.000	142.000
TOTAL 2	638	623.071	55.000	568.071	51.000	30.000	81.000

NOTES: LI IS MINIMUM NET WORKING ULLAGE.
HI IS MAXIMUM NET WORKING INVENTORY.
CALCULATION:
CALCULATE THE TOTAL HI AND LI FOR EACH PRODUCT GROUP.
THE CALCULATIONS OF HI AND LI PRESENTED HERE ARE SELF-EXPLANATORY.
ALL FIGURES ARE IN THOUSAND BARRELS.
TANK 965 ALLOCATED FOR PARTICIPANT BOC USAGE ONLY.
ONLY TANKS IN SERVICE ARE CONSIDERED FOR COMPUTATION OF HI AND LI.
MAXIMUM NET IS COMPUTED FROM MAXIMUM GROSS BY MULTIPLYING WITH A FACTOR,
AND THIS FACTOR IS 97.66% FOR THE GROUP WSR.
COLUMNS 4 AND 7 SHOW HI AND LI COMPUTATIONS.
TOTAL 1 INCLUDES TANK 965 CAPACITY.
TOTAL 2 EXCLUDES TANK 965 CAPACITY.

Table 17-4
Gasoline Group Tanks

TANK NO.	MAXIMUM GROSS (1) *O*	MAXIMUM NET (2) $P=O\times0.9570$	WORKING ULLAGE (3) *Q*	MAX. NET WORKING INVENTORY (4) $HI=P-Q$	MINIMUM HEEL (5) *R*	AVAILABLE WORKING STOCK (6) *S*	MINIMUM NET WORKING ULLAGE (7) $LI=R+S$
129	32	30.624			6.000		
250	12	11.484			1.000		
469	7	6.699			1.000		
470	7	6.699			1.000		
710	126	120.582			16.000		
905	127	121.539			16.000		
906	117	111.969			9.000		
915	121	115.797			17.000		
916	122	116.754			16.000		
924	115	110.055			16.000		
933	123	117.711			15.000		
934	121	115.797			15.000		
935	121	115.797			15.000		
TOTAL	1151	1101.507	325.000	776.507	144.000	155.000	299.000

NOTES: *LI IS MINIMUM NET WORKING ULLAGE.*
HI IS MAXIMUM NET WORKING INVENTORY.
CALCULATION:
CALCULATE THE TOTAL HI AND LI FOR EACH PRODUCT GROUP.
THE CALCULATIONS OF HI AND LI PRESENTED HERE ARE SELF-EXPLANATORY.
ALL FIGURES ARE IN THOUSAND BARRELS.
ONLY TANKS IN SERVICE ARE CONSIDERED FOR COMPUTATION OF HI AND LI.
MAXIMUM NET IS COMPUTED FROM MAXIMUM GROSS BY MULTIPLYING WITH A FACTOR, AND THIS FACTOR IS 95.70% FOR THE GROUP GASO.
COLUMNS 4 AND 7 SHOW HI AND LI COMPUTATIONS.

Table 17-5
Kerosene Group Tanks

TANK NO.	MAXIMUM GROSS (1) *O*	MAXIMUM NET (2) $P=O\times0.9821$	WORKING ULLAGE (3) *Q*	MAX. NET WORKING INVENTORY (4) HI=*P*−*Q*	MINIMUM HEEL (5) *R*	AVAILABLE WORKING STOCK (6) *S*	MINIMUM NET WORKING ULLAGE (7) LI=*R*+*S*
105	88	86.425			10.000		
114	75	73.658			15.000		
115	84	82.496			16.000		
730	124	121.780			16.000		
740	134	131.601			21.000		
751	449	440.963			55.000		
901	73	71.693			11.000		
902	77	75.622			11.000		
TOTAL	1104	1084.238	180.000	904.238	155.000	200.000	355.000

NOTES: *LI IS MINIMUM NET WORKING ULLAGE.*
HI IS MAXIMUM NET WORKING INVENTORY.
CALCULATION:
CALCULATE THE TOTAL HI AND LI FOR EACH PRODUCT GROUP.
THE CALCULATIONS OF HI AND LI PRESENTED HERE ARE SELF-EXPLANATORY.
ALL FIGURES ARE IN THOUSAND BARRELS.
ONLY TANKS IN SERVICE ARE CONSIDERED FOR COMPUTATION OF HI AND LI.
MAXIMUM NET IS COMPUTED FROM MAXIMUM GROSS BY MULTIPLYING WITH A FACTOR,
AND THIS FACTOR IS 98.21% FOR THE GROUP KERO.
COLUMNS 4 AND 7 SHOW HI AND LI COMPUTATIONS.

Table 17-6
Automotive Diesel Group Tanks

TANK NO.	MAXIMUM GROSS (1) *O*	MAXIMUM NET (2) $P=O\times0.9801$	WORKING ULLAGE (3) *Q*	MAX. NET WORKING INVENTORY (4) $HI=P-Q$	MINIMUM HEEL (5) *R*	AVAILABLE WORKING STOCK (6) *S*	MINIMUM NET WORKING ULLAGE (7) $LI=R+S$
701	125	122.513			3.000		
702	126	123.493			3.000		
706	604	591.980			8.000		
711	125	122.513			3.000		
721	124	121.532			3.000		
722	131	128.393			3.000		
731	123	120.552			3.000		
732	85	83.309			2.000		
913	126	123.493			3.000		
923	126	123.493			3.000		
452	7	6.861			0.200		
455	4	3.920			1.000		
41	1	0.980			0.000		
910	5	4.901			0.000		
917	1	0.980			0.000		
TOTAL	1713	1678.911	240.000	1438.911	35.200	175.000	210.200

NOTES: *LI IS MINIMUM NET WORKING ULLAGE.*
HI IS MAXIMUM NET WORKING INVENTORY.
CALCULATION:
CALCULATE THE TOTAL HI AND LI FOR EACH PRODUCT GROUP.
THE CALCULATIONS OF HI AND LI PRESENTED HERE ARE SELF-EXPLANATORY.
ALL FIGURES ARE IN THOUSAND BARRELS.
ONLY TANKS IN SERVICE ARE CONSIDERED FOR COMPUTATION OF HI AND LI.
MAXIMUM NET IS COMPUTED FROM MAXIMUM GROSS BY MULTIPLYING WITH A FACTOR, AND THIS FACTOR IS 98.01% FOR THE GROUP DSL.
COLUMNS 4 AND 7 SHOW HI AND LI COMPUTATIONS.

Table 17-7
Black or Marine Diesel Group Tanks

TANK NO.	MAXIMUM GROSS (1) *O*	MAXIMUM NET (2) $P = O \times 0.9842$	WORKING ULLAGE (3) *Q*	MAX. NET WORKING INVENTORY (4) HI = *P* − *Q*	MINIMUM HEEL (5) *R*	AVAILABLE WORKING STOCK (6) *S*	MINIMUM NET WORKING ULLAGE (7) LI = *R* + *S*
912	28	27.558			1.000		
TOTAL	28	27.558	5.000	22.558	1.000	5.000	6.000

NOTES: *LI IS MINIMUM NET WORKING ULLAGE.*
HI IS MAXIMUM NET WORKING INVENTORY.
CALCULATION:
CALCULATE THE TOTAL HI AND LI FOR EACH PRODUCT GROUP.
THE CALCULATIONS OF HI AND LI PRESENTED BELOW ARE SELF EXPLANATORY.
ALL FIGURES ARE IN THOUSAND BARRELS.
ONLY TANKS IN SERVICE ARE CONSIDERED FOR COMPUTATION OF HI AND LI.
MAXIMUM NET IS COMPUTED FROM MAXIMUM GROSS BY MULTIPLYING WITH A FACTOR,
AND THIS FACTOR IS 98.42% FOR THE GROUP BDSL.
COLUMNS 4 AND 7 SHOW HI AND LI COMPUTATIONS.

Table 17-8
Heavy Vacuum Gas Oil (HVGO) Group Tanks

TANK NO.	MAXIMUM GROSS (1) *O*	MAXIMUM NET (2) $P=O\times0.9577$	WORKING ULLAGE (3) *Q*	MAX. NET WORKING INVENTORY (4) $HI=P-Q$	MINIMUM HEEL (5) *R*	AVAILABLE WORKING STOCK (6) *S*	MINIMUM NET WORKING LLAGE (7) $LI=R+S$
111	90	86.193			4.000		
705	569	544.931			8.000		
TOTAL	659	631.124	20.000	611.124	12.000	30.000	42.000

NOTES: *LI IS MINIMUM NET WORKING ULLAGE.*
HI IS MAXIMUM NET WORKING INVENTORY.
CALCULATION:
CALCULATE THE TOTAL HI AND LI FOR EACH PRODUCT GROUP.
THE CALCULATIONS OF HI AND LI PRESENTED HERE ARE SELF-EXPLANATORY.
ALL FIGURES ARE IN THOUSAND BARRELS.
ONLY TANKS IN SERVICE ARE CONSIDERED FOR COMPUTATION OF HI AND LI.
MAXIMUM NET IS COMPUTED FROM MAXIMUM GROSS BY MULTIPLYING WITH A FACTOR,
AND THIS FACTOR IS 95.77% FOR THE GROUP HVGO.
COLUMNS 4 AND 7 SHOW HI AND LI COMPUTATIONS.

Table 17-9
Fuel Oil Group Tanks

TANK NO.	MAXIMUM GROSS (1)	MAXIMUM NET (2)	WORKING ULLAGE (3)	MAX. NET WORKING INVENTORY (4)	MINIMUM HEEL (5)	AVAILABLE WORKING STOCK (6)	MINIMUM NET WORKING ULLAGE (7)
COL NO.	*O*	*P* = *O* × 0.9725	*Q*	HI = *P* − *Q*	*R*	*S*	LI = *R* + *S*
703	122	118.645			3.000		
713	123	119.618			3.000		
714	84	81.690			2.000		
715	333	323.843			6.000		
723	121	117.673			3.000		
724	123	119.618			3.000		
734	208	202.280			5.000		
743	329	319.953			6.000		
904	89	86.553			2.000		
914	127	123.508			3.000		
TOTAL	1659	1613.378	350.000	1263.378	36.000	270.000	306.000

NOTES: *LI IS MINIMUM NET WORKING ULLAGE.*
HI IS MAXIMUM NET WORKING INVENTORY.
CALCULATION:
CALCULATE THE TOTAL HI AND LI FOR EACH PRODUCT GROUP.
THE CALCULATIONS OF HI AND LI PRESENTED HERE ARE SELF-EXPLANATORY.
ALL FIGURES ARE IN THOUSAND BARRELS.
ONLY TANKS IN SERVICE ARE CONSIDERED FOR COMPUTATION OF HI AND LI.
MAXIMUM NET IS COMPUTED FROM MAXIMUM GROSS BY MULTIPLYING WITH A FACTOR, AND THIS FACTOR IS 97.25% FOR THE GROUP FO.
COLUMNS 4 AND 7 SHOW HI AND LI COMPUTATIONS.

Table 17-10
Asphalt Group Tanks

TANK NO.	MAXIMUM GROSS (1) *O*	MAXIMUM NET (2) $P=O\times0.9523$	WORKING ULLAGE (3) *Q*	MAX. NET WORKING INVENTORY (4) $HI=P-Q$	MINIMUM HEEL (5) *R*	AVAILABLE WORKING STOCK (6) *S*	MINIMUM NET WORKING ULLAGE (7) $LI=R+S$
180	14	13.332			0.400		
171	6	5.714			0.200		
172	6	5.714			0.200		
181	13	12.380			0.300		
183	14	13.332			0.400		
170	6	5.714			0.200		
907	15	14.285			0.300		
908	12	11.428			0.300		
TOTAL	86	81.898	20.000	61.898	2.300	12.000	14.300

NOTES: *LI IS MINIMUM NET WORKING ULLAGE.*
HI IS MAXIMUM NET WORKING INVENTORY.
CALCULATION:
CALCULATE THE TOTAL HI AND LI FOR EACH PRODUCT GROUP.
THE CALCULATIONS OF HI AND LI PRESENTED HERE ARE SELF-EXPLANATORY.
ALL FIGURES ARE IN THOUSAND BARRELS.
ONLY TANKS IN SERVICE ARE CONSIDERED FOR COMPUTATION OF HI AND LI.
MAXIMUM NET IS COMPUTED FROM MAXIMUM GROSS BY MULTIPLYING WITH A FACTOR,
AND THIS FACTOR IS 95.23% FOR THE GROUP ASPH.
COLUMNS 4 AND 7 SHOW HI AND LI COMPUTATIONS.

each participant is the difference between HI and LI for every product group. These calculations are shown in Table 17-11.

ULLAGE

Ullage is the difference between HI and the actual inventory volume in a tank. Such data are important for scheduling the product offloading and the size of individual shipments.

TANK OWNED BY ONE PARTICIPANT

In joint-ownership refineries, a participant may build a tank exclusively for its own use. The capacity allocation procedure, in that case, is modified as follows:

1. Calculate the HI and LI for the group, including the exclusive tank as a part of the group.
2. Calculate the HI and LI for the group, assuming the tank is excluded.
3. The delta between the two HI and LI gives HI and LI for the exclusive tank.
4. Next HI and LI corresponding to calculations without the exclusive tank are used to allocate tankage capacity.
5. HI and LI of the exclusive tank are added to HI and LI of the participant for whose use the exclusive tank was provided.

EXAMPLE 17-2

Consider Tank 965 (Table 17-3), a WSR (naphtha) group tank built for the exclusive use of participant BOC. The calculation of LI and HI for the two participants follows:

	LI, mb	HI, mb
TOTAL EXCLUDING TANK 965	81	568
TOTAL INCLUDING TANK 965	142	1058
ESTIMATE FOR TANK 965	61	490
AOC ALLOCATION	$=0.6\times 81$	$=568\times 0.6$
	$=48.6$	$=340.8$
BOC ALLOCATION	$=81\times 0.4+61$	$=568\times 0.4+490$
	$=93.4$	$=717.2$

Table 17-11
Allocation of Available Tankage Capacity (All Figures in Thousand Barrels)

PRODUCT GROUP	TOTAL LI (1)	TOTAL HI (2)	REFINERY AVAILABLE CAPACITY (3=2−1)	AVAILABLE CAPACITY ALLOCATION		ALLOCATION OF LI		ALLOCATION OF HI	
				AOC (4=3×0.6)	BOC (5=3×0.4)	AOC (6=1×0.6)	BOC (7=1×0.4)	AOC (8=2×0.6)	BOC (9=2×0.4)
LPG	4	15	11	7	4	2	2	9	6
LSR	123	555	432	259	173	74	49	333	222
WSR	142	1058	916	550	366	85	57	635	423
GASOLINE	299	777	478	287	191	179	120	466	311
KEROSENE	355	904	549	329	220	213	142	542	362
DIESEL	210	1439	1229	737	492	126	84	863	576
BLACK DIESEL	6	23	17	10	7	4	2	14	9
HVGO	42	611	569	341	228	25	17	367	244
FUEL OIL	306	1263	957	574	383	184	122	758	505
ASPHALT	14	62	48	29	19	8	6	37	25

NOTE: AVAILABLE CAPACITY FOR ANY PRODUCT GROUP IS THE DIFFERENCE BETWEEN ITS HI AND LI WHICH IS ALOCATED TO PARTICIPANTS IN THE RATIO OF THEIR EQUITY; IN THIS EXAMPLE, 60/40.

CEDING OF REFINERY CAPACITY

Ceding is a situation in which one participant in the joint refinery chooses not to utilize its full share of refinery capacity for a prolonged period. In such a situation, it has the option to offer the unutilized capacity to the other participant. If the other participant agrees to accept the unutilized capacity, the receiving participant has to pay agreed-on charges to the leasing participant to compensate it for the depreciation of its assets and amortization of its investment in the refinery. If a participant leases part of unutilized processing unit capacity, the tankage capacity is also ceded to the receiving participant in that proportion.

Consider, for example, a refinery with crude running capacity at 260 mbpcd. The capacity rights of AOC and BOC are 60/40. The crude distillation unit capacity is split as follows:

AOC capacity share, CDU = 156 mbpcd

BOC capacity share, CDU = 104 mbpcd

If BOC wishes to run only, say, 40 mbpcd for a prolonged period, BOC can cede $(104 - 40) = 64$ mbpcd of its unutilized refining capacity. If AOC accepts this ceded capacity, its capacity would be $(156 + 64) = 220$ mbpcd and BOC's refining capacity would be 40 mbpcd during the period of ceding. The capacity of the downstream units ceded under the ceding agreement would equal (64/260) or 0.2461 times the downstream unit capacity, as shown in Table 17-12.

CEDING OF TANKAGE CAPACITY

The procedure for ceding tankage capacity follows the principle of ceding unit capacities. In the preceding example, the ceded tankage capacity in every product group is (64/260) of available tankage capacity. After ceding, the split of available tankage capacity is as follows:

PARTICIPANT	BEFORE CEDING	AFTER CEDING
AOC	0.6000	0.8461
BOC	0.4000	0.1539
TOTAL	1.0000	1.0000

Table 17-12
Ceded Downstream Unit Capacities (in mbpcd)

UNIT	TOTAL	AOC BEFORE CEDING	BOC BEFORE CEDING	CEDED	AOC AFTER CEDING	BOC AFTER CEDING
CRUDE DISTILLATION	260.0	156	104	64	220	40
FCCU	36.0	21.6	14.4	8.9	30.5	5.5
HYDROCRACKER	50.0	30.0	20.0	12.3	42.3	7.7
VISBREAKER	20.0	12.0	8.0	4.9	16.9	3.1
CAT REFORMER	15.0	9.0	6.0	3.7	12.7	2.3
DIESEL HDS	20.0	12.0	8.0	4.9	16.9	3.1

NOTES: AOC CRUDE DISTILLATION UNIT (CDU) CAPACITY = 60% AND BOC CDU CAPACITY = 40% TOTAL REFINERY CDU CAPACITY WITHOUT CEDING. CEDING OF DOWNSTREAM UNITS = (CDU CEDED CAPACITY)/(TOTAL CDU CAPACITY) × (UNIT TOTAL CAPACITY).

The split of total HI and LI for every group tankage is done in this ratio. Tankage capacity available to participants after ceding is shown in Table 17-13.

It is important to analyze the effect of tankage ceding on the operability of participant BOC's part of the refinery. Depending on the size and frequency of lifting, minimum ullage equal to about 17 days production is required. Referring to Table 17-14, the available storage capacity

Table 17-13
Tankage Situation under Ceding (in mb)

GROUP	TOTAL LI	AOC LI	BOC LI	TOTAL HI	AOC HI	BOC HI	TOTAL CAPACITY	AOC CAPACITY	BOC CAPACITY
LPG	4	3	1	15	13	2	11	9	2
LSR	123	104	19	555	470	85	432	366	66
WSR	142	120	22	1058	895	163	916	775	141
GASO	299	253	46	777	657	120	478	404	74
KERO	355	300	55	904	765	139	549	465	84
DSL	210	178	32	1439	1218	221	1229	1040	189
BDSL	6	5	1	23	19	4	17	14	3
HVGO	42	36	6	611	517	94	569	481	88
FUEL	306	259	47	1263	1069	194	957	810	147
ASPH	14	12	2	62	52	10	48	41	7
TOTAL	1501	1270	231	6707	5675	1032	5206	4405	801

Table 17-14
Effect of Tankage Ceding on Refinery Operability

PRODUCT GROUP	BOC AVAILS, mb (1)	BOC PROD. RATE mb (2)	AVAILABLE ULLAGE days (3=1/2)	REQUIRED ULLAGE, mb (4=2×17)	ULLAGE SHORTFALL, mb (5=4−1)
LPG	1.7	0		0	−1.7
LSR	66.5	5.4	12.3	91.8	25.3
WSR	140.9	5.8	24.3	98.6	−42.3
GASO	73.5	3.5	21.0	59.5	−14.0
KERO	84.5	6	14.1	102	17.5
DSL	189.1	13.3	14.2	226.1	37.0
BDSL	2.6	0.2	13.1	3.4	0.8
HVGO	87.5	0		0	−87.5
FUEL	147.2	7.9	18.6	134.3	−12.9
ASPH	7.4	1.5	4.9	25.5	18.1
TOTAL	800.9	43.6	18.4	741	

NOTES: (1) AVAILABLE CAPACITY (HI − LI) IS FROM THIS TABLE.
(2) APPROXIMATE YIELD PATTERN FROM PARTICIPANT BOC UNIT CAPACITIES AFTER CEDING.
(3) NUMBER OF DAYS OF ULLAGE FROM RATED PRODUCTION.
(4) VOLUME REQUIRED TO CONTAIN 17 DAYS OF RATED PRODUCTION.
(5) POSITIVE FIGURES INDICATE SHORTFALLS AND NEGATIVE FIGURES DENOTE SURPLUS IN ULLAGE, COL 5 = COL 4 − COL 1.

after ceding, in certain product groups is less than the minimum required, while in some others, the available tankage capacity is more than that required for operational reasons. Therefore, tankage capacity would have to be rationalized by switching tanks from one product group to another in such a manner that every product group has a minimum ullage equal to 17 days of its estimated production rate after ceding.