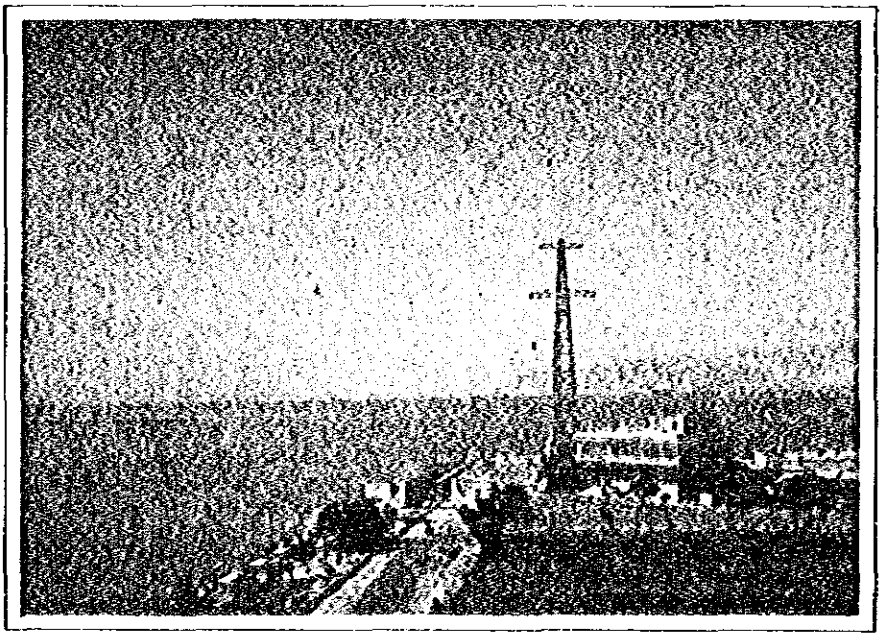
PART III. ANALYSIS OF ACCIDENTS



Suez Office of SCA

PART III ANALYSIS OF ACCIDENTS

III-1 Analysis of Accidents Records

(1) Analysis of Accident Records of the SCA

The Record of Accidents covering the 7-year period from 1976 to 1982 prepared by the SCA was subjected to a computer analysis whereby the following Tables III-1-(1)-1 through Table III-1-(1)-17 were obtained.

For easy comparative assessment of periods before and after the First Stage Development Project of the Canal, the period in question is divided into three groups: 1976 to 1980; 1981 and 1982; and 1976 to 1982.

Table III-1-(1)-1 Number of Accidents by Type and Year

Year	Grounding		Collision					Stuck to Bank	Touching Bank	Propeller Fouling	Total
	In Canal	In Port	Between Vessels in Canal	Between Vessels in Port	With Craft	With Buoys	With Others				
1976	89	19	2	24	38	35	23	4	12	8	254
1977	77	11	0	22	50	47	26	6	18	7	264
1978	99	6	0	27	49	56	31	2	27	3	300
1979	66	12	2	37	42	60	27	0	19	3	268
1980	85	26	1	36	50	54	19	0	13	11	295
1981	44	0	4	20	39	37	13	0	5	27	189
1982	30	26	2	22	38	33	14	1	8	0	174
Total	490	100	11	188	306	322	153	13	102	59	1,744

Table III-1-(1)-2 Kind and Number of Accidents by Day/Night and Position from 1976 to 1980

Kind / Time / Position	Grounding in Canal			Stuck to Bank			C. betw'n Vessels in Canal			C. betw'n Vessels in Port			Collision with Craft		
	Unknown	Day	Night	Unknown	Day	Night	Unknown	Day	Night	Unknown	Day	Night	Unknown	Day	Night
Port Said				1				5		20	53	42	43	10	8
Km 0 ~ 20	1	6	17					1					6		1
20 ~ 50	1	17	17										17		1
50 ~ 63	5	33	51	7				1					8	1	
63 ~ 75	1	7	17						1				3		1
75 ~ 81	5	18	33										15		
81 ~ 93		14	11										2		
93 ~ 116	5	21	14	1				3					22	1	
116 ~ 135	3	28	34	2									13	4	
135 ~ 161	1	30	21	1									13		
Suez										9	4	14	41	2	2
Unknown		1	3									1	12	2	1
Total	22	175	218	12				5	2	29	57	57	195	20	14
G. Total	415			12			7			143			229		

Kind / Time / Position	Collision with Buoys			Collision with Others			Propeller Fouling			Grounding at Port			Touching Bank			Total		
	Unknown	Day	Night	Unknown	Day	Night	Unknown	Day	Night	Unknown	Day	Night	Unknown	Day	Night	Unknown	Day	Night
Port Said	49			33			14			31			2			193	63	50
Km 0 ~ 20	6			9									6			28	7	18
20 ~ 50	11			8									9			56	17	18
50 ~ 63	23			7			7						27			84	35	52
63 ~ 75	11			6			1						5			27	7	19
75 ~ 81	8			3			3						3			37	18	33
81 ~ 93	13			5									9			29	14	11
93 ~ 116	9			7			3						3			50	25	14
116 ~ 135	75			14									11			118	32	34
135 ~ 161	36			10			3						14			78	30	21
Suez	7			8			1			41						107	6	16
Unknown	4			6						2						24	3	5
Total	252			126			32			74			89			831	257	291
G. Total	252			126			32			74			89			1,379		

Table III-1-(1)-3 Kind and Number of Accidents by Day/Night and Position from 1981 to 1982

Kind / Time / Position	Grounding in Canal			Stuck to Bank			C. betw'n Vessels in Canal			C. betw'n Vessels in Port			Collision with Craft			Collision with Buoys			Collision with Others			Propeller Fouling			Grounding at Port			Touching Bank			Total		
	Unknown	Day	Night	Unknown	Day	Night	Unknown	Day	Night	Unknown	Day	Night	Unknown	Day	Night	Unknown	Day	Night	Unknown	Day	Night	Unknown	Day	Night	Unknown	Day	Night	Unknown	Day	Night	Unknown	Day	Night
Port Said										4	19	9	26	8		10			15			2			36						93	27	9
Km 0 ~ 20		5	6						1				4			9			3									2			18	5	7
20 ~ 50		4	4													4			1									3			8	4	4
50 ~ 63		5	4	1									6			3			2									5			17	5	4
63 ~ 75		3	2										2			3															5	3	2
75 ~ 81		5	1										3			9												1			13	2	1
81 ~ 93		4											3			2												1			6	4	
93 ~ 116		7	3					4					3	1		5			2									1			11	12	3
116 ~ 135		13	3													8			2												10	13	3
135 ~ 161		2	2										3			9															12	2	2
Suez										1	6	3	16		1	4			1						17						39	6	4
Unknown			1				1						1			4			1												7		1
Total		48	26	1			1	4	1	5	25	12	67	9	1	70			27			2			53			13			239	86	40
G. Total	74			1			6			42			77			70			27			2			53			13			365		

Table III-1-(1)-4 Kind and Number of Accidents by Day/Night and Position from 1976 to 1982

Kind / Time / Position	Grounding in Canal			Stuck to Bank			C. betw'n Vessels in Canal			C. betw'n Vessels in Port			Collision with Craft			Collision with Buoys			Collision with Others			Propeller Fouling			Grounding at Port			Touching Bank			Total		
	Unknown	Day	Night	Unknown	Day	Night	Unknown	Day	Night	Unknown	Day	Night	Unknown	Day	Night	Unknown	Day	Night	Unknown	Day	Night	Unknown	Day	Night	Unknown	Day	Night	Unknown	Day	Night	Unknown	Day	Night
Port Said				1						24	72	72	69	18	8	59			48			16			67			2			286	90	59
Km 0 ~ 20	1	11	23					1	1				10		1	15			12									8			46	12	25
20 ~ 50	1	21	21										17		1	15			19									12			64	21	22
50 ~ 63	5	38	55	8				1	1				14	1		26			9			7						32			101	40	56
63 ~ 75	1	10	19						1				5		1	14			6			1						5			32	10	21
75 ~ 81	5	23	34										18			17			3			3						4			50	23	34
81 ~ 93		18	11										5			15			5									10			35	18	11
93 ~ 116	5	28	17	1				7					25	2		14			9			3						4			61	37	17
116 ~ 135	3	41	37	2									13	4		83			16									11			128	45	37
135 ~ 161	1	32	23	1									16			45			10			3						14			90	32	23
Suez										10	10	17	57	2	3	11			9			1			58						146	12	20
Unknown		1	4				1					1	13	2	1	8			7						2						31	3	6
Total	22	223	244	13			1	9	3	34	82	69	262	29	15	322			153			34			127			102			1,070	343	331
G. Total	489			13			13			185			306			322			153			34			127			102			1,744		

Table III-1-(1)-5 Kind and Number of Accidents by Position and Direction of Transit

Period	Kind / Position \ Direction	1 Unknown	1 North	1 South	2 Unknown	2 North	2 South	3 Unknown	3 North	3 South	4 Unknown	4 North	4 South	5 Unknown	5 North	5 South	6 Unknown	6 North	6 South	7 Unknown	7 North	7 South	8 Unknown	8 North	8 South	9 Unknown	9 North	9 South	10 Unknown	10 North	10 South	Total Unknown	Total North	Total South
(1976 ~ 1980)	Port Said						1				114	1		51	3	7	24	5	20	27	4	2	13		1	18	3	10	1	1		248	17	41
	Km 0 ~ 20	1	12	11				1							2	5	1	1	4	1	5	3								3	3	4	23	26
	20 ~ 50		16	19											5	13	1	4	6		7	11								4	5	1	36	54
	50 ~ 63	1	14	74			7	1		1				1		8	1	7	15	1		6	2	2	3					5	22	7	28	136
	63 ~ 75		16	9					1					2	1	1	4	3	4	2	2	2		1						2	3	8	26	19
	75 ~ 81		32	24										2	6	7	1	4	3		2	1		2	1					1	2	3	47	38
	81 ~ 93		10	15												2	1	4	8		1	4								4	5	1	19	34
	93 ~ 116	1	22	17		1		2	1					4	6	13		4	5	2	3	2		3							3	9	40	40
	116 ~ 135		25	40		2								1	13	3	18	21	36	5	3	6								4	7	24	68	92
	135 ~ 161		24	28		1								3	3	7	11	10	15		6	4		1						4	10	14	49	66
	Suez										27			25	9	11	2	5		4	2	2		1		17	10	14				75	27	27
	Unknown		1	3							1			4	5	6	2	1	1	2	2	2				2						11	9	12
	Total	3	172	240		4	8	4	2	1	142	1		93	53	83	66	69	117	44	37	45	15	10	7	37	13	24		28	60	405	389	585
	G. Total	415			12			7			143			229			252			126			32			74			89			1,379		
(1981 ~ 1982)	Port Said										32			30	3	1	5		5	14		1	2			15	8	13				93	11	20
	Km 0 ~ 20	1	7	3				1						1		3	6	2	1	2		1									2	11	9	10
	20 ~ 50		2	6													3		1		1										3	3	3	10
	50 ~ 63		2	7			1							3		3	2		1			2									5	5	2	19
	63 ~ 75		4	1										2			2		1													4	4	2
	75 ~ 81		4	2										2	1		6	1	2												1	8	6	5
	81 ~ 93		1	3										2		1			2												1	2	1	7
	93 ~ 116		6	4				4						2	1	1	1	2	2	1	1										1	8	10	8
	116 ~ 135		11	5													3	5		1		1										4	16	6
	135 ~ 161		3	1										1		2	3	2	4													4	5	7
	Suez										10			13	4		2	2		1						11	4	2				37	10	2
	Unknown			1				1								1	1	3		1												3	3	2
	Total	1	40	33			1	6			42			56	9	12	34	17	19	20	2	5	2			26	12	15			13	187	80	98
	G. Total	74			1			6			42			77			70			27			2			53			13			365		
(1976 ~ 1982)	Port Said						1				146	1		81	6	8	29	5	25	41	4	3	15		1	33	11	23	1	1		346	28	61
	Km 0 ~ 20	2	19	14				2						1	2	8	7	3	5	3	5	4								3	5	15	32	36
	20 ~ 50		18	25											5	13	4	4	7		8	11								4	8	4	39	64
	50 ~ 63	1	16	81			8	1		1				4		11	3	7	16	1		8	2	2	3					5	27	12	30	155
	63 ~ 75		20	10					1		1			4	1	1	6	3	5	2	2	2		1						2	3	12	30	21
	75 ~ 81		36	26										4	7	7	7	5	5		2	1		2	1					1	3	11	53	43
	81 ~ 93		11	18										2		3	1	4	10		1	4								4	6	3	20	41
	93 ~ 116	1	28	21		1		6	1					6	7	14	1	6	7	3	4	2		3							4	17	50	48
	116 ~ 135		36	45		2								1	13	3	21	26	36	6	3	7								4	7	28	84	98
	135 ~ 161		27	29		1								4	3	9	14	12	19		6	4		1	2					4	10	18	54	73
	Suez										37			38	13	11	4	7		5	2	2		1		28	14	16				112	37	29
	Unknown		1	4				1			1			4	5	7	3	4	1	3	2	2				2						14	12	14
	Total	42	212	273		4	9	10	2	1	184	1		149	62	95	100	86	136	64	39	50	17	10	7	63	25	39	1	28	73	592	469	683
	G. Total	489			13			13			185			306			322			153			34			127			102			1,744		

*Kind of Accident
1. Grounding in Canal
2. Stuck to Bank
3. Collision between Vessels in Canal
4. Collision between Vessels in Port
5. Collision with Craft
6. Collision with Buoys
7. Collision with Others
8. Propeller Fouling
9. Grounding at Port
10. Touching Bank

Table III-1-(1)-6 Kind and Number of Accidents by Position and Month from 1976 to 1980

	Kind of Accident \ Month	Unknown	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
Port Said	Grounding in Canal													
	Stuck to Bank					1								
	Collision between Vessels in Canal													
	Collision between Vessels in Port	5	8	7	14	11	11	5	11	8	8	10	6	11
	Collision with Craft	2	4	2	7	13	2	1	4	10	2	5	4	5
	Collision with Buoys		4	7	5	5	3	4	5	4	3	2	2	5
	Collision with Others		6	2	3	2	3	3	2	1	3	5	2	1
	Propeller Fouling		4	2	1			1	3		1	1	1	
	Grounding at Port		2	2	2	4	1	3	4	2	5	1	1	4
	Touching Bank								1	1				
	Total	7	28	22	32	36	20	17	30	26	22	24	16	26
Km 0 ~ 20	Grounding in Canal	1	5	1	3	1			2	2		1	2	6
	Stuck to Bank													
	Collision between Vessels in Canal		1											
	Collision between Vessels in Port													
	Collision with Craft		3		2	1						1		
	Collision with Buoys			1	1	1		2						1
	Collision with Others		1	1	1								2	3
	Propeller Fouling													
	Grounding at Port													
	Touching Bank				2		1			1		1	1	
	Total	1	9	3	10	3	2	2	2	3		3	5	10
Km 20 ~ 50	Grounding in Canal		4	4	6	4		1	1	2	2	3	4	4
	Stuck to Bank													
	Collision between Vessels in Canal													
	Collision between Vessels in Port													
	Collision with Craft		1	4	4	2	2		3		1			1
	Collision with Buoys			1	2	2	1		1		1	1	1	1
	Collision with Others			2	2	2		3	2	1	1	2	1	2
	Propeller Fouling													
	Grounding at Port													
	Touching Bank		1	1		1		1	2	2	1			
	Total		6	12	14	11	3	5	9	5	6	6	6	8

	Kind of Accident \ Month	Unknown	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
Km 50 ~ 63	Grounding in Canal	2	4	6	11	13	7	6	3	3	5	7	12	10
	Stuck to Bank		1				1	1	2				2	
	Collision between Vessels in Canal				1						1			
	Collision between Vessels in Port													
	Collision with Craft		1	1	2	1	2				1		1	
	Collision with Buoys	1	6	1	2	2	1	2		1	1	1	3	2
	Collision with Others				2	1				1	1		1	1
	Propeller Fouling	1		1			1							4
	Grounding at Port													
	Touching Bank		1		2	1	5	2	1	2	4	1	5	3
	Total	4	13	9	20	18	17	11	6	7	13	9	24	20
Km 63 ~ 75	Grounding in Canal		5		2	1	2	2	1	1	2	1	3	5
	Stuck to Bank													
	Collision between Vessels in Canal				1									
	Collision between Vessels in Port													
	Collision with Craft	1					1		1					1
	Collision with Buoys	1				1	1			1	1	3	1	2
	Collision with Others		1			1	1			2				1
	Propeller Fouling		1											
	Grounding at Port													
	Touching Bank					1			1	1	1		1	
	Total	2	7		3	4	5	2	3	5	4	4	5	9
Km 75 ~ 81	Grounding in Canal		5	1	9	7	3	3	3	3	6	5	1	10
	Stuck to Bank													
	Collision between Vessels in Canal													
	Collision between Vessels in Port													
	Collision with Craft		5	2	1	1	1			2	1	1		1
	Collision with Buoys		1		2	1		1	1		1		1	
	Collision with Others											1		2
	Propeller Fouling					1							1	1
	Grounding at Port													
	Touching Bank							1		1			1	
	Total		11	3	12	10	4	5	4	6	9	6	4	14

	Kind of Accident \ Month	Unknown	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
Km 81 ~ 93	Grounding in Canal		2	2	5	1	4		2			2	4	3
	Stuck to Bank													
	Collision between Vessels in Canal													
	Collision between Vessels in Port													
	Collision with Craft							1						1
	Collision with Buoys		1	2	3	1		1	1	2		1		1
	Collision with Others			1	1		1		1		1			
	Propeller Fouling													
	Grounding at Port													
	Touching Bank			2	3	1	1						2	
	Total		3	7	12	3	6	2	4	2	1	3	6	5
Km 93 ~ 116	Grounding in Canal		4	5	5	7	2	2		3	1	3	5	3
	Stuck to Bank													1
	Collision between Vessels in Canal				1	1		1						
	Collision between Vessels in Port													
	Collision with Craft		3	2	1	6	1	2		1	2	1	1	3
	Collision with Buoys		1		1	4								3
	Collision with Others		1	1		1	1	1	1		1			
	Propeller Fouling		1		1	1								
	Grounding at Port													
	Touching Bank			1		1					1			
	Total		10	9	9	21	4	6	1	4	5	4	6	10
Km 116 ~ 135	Grounding in Canal	1	5	4	13	8	1	2	1	4	3	8	4	11
	Stuck to Bank		1						1					
	Collision between Vessels in Canal													
	Collision between Vessels in Port													
	Collision with Craft			2	1	2	4	1	2	1		2	2	
	Collision with Buoys	1	5	4	12	9	8	4	4	1	5	5	9	8
	Collision with Others		1		3	1	1		2		2		3	1
	Propeller Fouling													
	Grounding at Port													
	Touching Bank		1		2	1	1	1	1		2		1	1
	Total	2	13	10	31	21	15	8	11	6	12	15	19	21

	Kind of Accident \ Month	Unknown	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
Km 135 ~ 161	Grounding in Canal		12	1	10	4	3	2	3	4	1	4	5	3
	Stuck to Bank				1									
	Collision between Vessels in Canal													
	Collision between Vessels in Port													
	Collision with Craft		1		2	3			2	2		1	1	1
	Collision with Buoys	1	2	6	3	8	1	3				6	3	3
	Collision with Others	1	1	1	1				1				4	1
	Propeller Fouling	1	1									1		
	Grounding at Port													
	Touching Bank		4		3		1	1	1	1	1	1	1	
	Total	3	21	8	20	15	5	6	7	7	2	13	14	8
Suez	Grounding in Canal													
	Stuck to Bank													
	Collision between Vessels in Canal													
	Collision between Vessels in Port			2	2	3	3	1	1		2	2	4	7
	Collision with Craft	2	4	5	5	4	2	1	1	2	3	3	6	7
	Collision with Buoys		1		1	1	2	1					1	
	Collision with Others		1	1		2	1				1	1		1
	Propeller Fouling						1							
	Grounding at Port		5	3	5	5	3	2	5		1	7	2	3
	Touching Bank													
	Total	2	11	11	13	15	12	5	7	2	7	13	13	18
Unknown	Grounding in Canal			1		2					1			
	Stuck to Bank													
	Collision between Vessels in Canal													
	Collision between Vessels in Port													
	Collision with Craft		1		6	2	1	2	1				1	1
	Collision with Buoys		1	1		1			1					
	Collision with Others			1	1	1		1	1					1
	Propeller Fouling													
	Grounding at Port		1								1			
	Touching Bank													
	Total		3	2	8	6	2	2	3	1	2		1	2

	Kind of Accident \ Month	Unknown	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Total
TOTAL	Grounding in Canal	4	46	25	64	48	22	18	16	22	21	34	40	55	415
	Stuck to Bank		2		1	1	1	1	3				2	1	12
	Collision between Vessels in Canal				4	1		1			1				7
	Collision between Vessels in Port	5	8	9	17	14	14	6	12	8	10	12	10	18	143
	Collision with Craft	5	23	18	31	35	16	8	14	18	10	14	16	21	229
	Collision with Buoys	4	22	23	32	36	17	18	13	9	12	19	21	26	252
	Collision with Others	1	12	9	14	11	10	7	10	6	11	8	13	14	126
	Propeller Fouling	2	7	3	2	2	2	1	3		1	2	2	5	32
	Grounding at Port		8	5	7	9	4	5	9	2	7	8	3	7	74
	Touching Bank		7	4	12	6	9	6	7	9	10	3	12	4	89
	Total	21	135	96	184	163	95	71	87	74	83	100	119	151	1,379

Table III-1-(1)-7 Kind and Number of Accidents by Position and Month from 1981 to 1982

	Kind of Accident \ Month	Unknown	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
Port Said	Grounding in Canal													
	Stuck to Bank													
	Collision between Vessels in Canal													
	Collision between Vessels in Port	6	2	1	2	3	3		2	3	3	2	3	2
	Collision with Craft		6	6	1	6	5	1	3		1	3	1	1
	Collision with Buoys		1	2			2	1	1	1	2			
	Collision with Others		4	3	2	1	3		1			1		
	Propeller Fouling			1					1					
	Grounding at Port		3	6	1	4	5	3	3	3	1	1	2	4
	Touching Bank													
	Total	6	16	19	6	14	18	5	11	7	7	7	6	7
Km 0 ~ 20	Grounding in Canal	1				1		5	1	1		2		
	Stuck to Bank													
	Collision between Vessels in Canal											1		
	Collision between Vessels in Port													
	Collision with Craft			1	1			1			1			
	Collision with Buoys		1	1	1	3	1	1				1		
	Collision with Others		1	1					1					
	Propeller Fouling													
	Grounding at Port													
	Touching Bank								1		1			
	Total	1	2	3	2	4	1	7	3	1	2	4		
Km 20 ~ 50	Grounding in Canal		2				1			1			1	3
	Stuck to Bank													
	Collision between Vessels in Canal													
	Collision between Vessels in Port													
	Collision with Craft													
	Collision with Buoys				1		1					1	1	
	Collision with Others						1							
	Propeller Fouling													
	Grounding at Port													
	Touching Bank		1	1		1								
	Total		3	1	1	1	3			1		1	2	3

Section	Kind of Accident \ Month	Unknown	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
Km 50 ~ 63	Grounding in Canal		2	1		1					1	2	2	
	Stuck to Bank												1	
	Collision between Vessels in Canal													
	Collision between Vessels in Port													
	Collision with Craft				-		1		1	1		2	1	
	Collision with Buoys				1							1	1	
	Collision with Others								1					
	Propeller Fouling													
	Grounding at Port													
	Touching Bank					1	1			1	1	1		
	Total		2	1	1	2	1	1	1	3	3	4	6	1
Km 63 ~ 75	Grounding in Canal		1	1	1				2					
	Stuck to Bank													
	Collision between Vessels in Canal													
	Collision between Vessels in Port													
	Collision with Craft					1						1		
	Collision with Buoys				1	1					1			
	Collision with Others													
	Propeller Fouling													
	Grounding at Port													
	Touching Bank													
	Total		1	1	2	2			2		1	1		
Km 75 ~ 81	Grounding in Canal			2	1			1						2
	Stuck to Bank													
	Collision between Vessels in Canal													
	Collision between Vessels in Port													
	Collision with Craft			2			1							
	Collision with Buoys			2	2			1	1		1		1	1
	Collision with Others													
	Propeller Fouling													
	Grounding at Port													
	Touching Bank													
	Total			6	3		1	2	1		1		1	4

Section	Kind of Accident \ Month	Unknown	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
Km 81 ~ 93	Grounding in Canal				1						1	1		1
	Stuck to Bank													
	Collision between Vessels in Canal													
	Collision between Vessels in Port													
	Collision with Craft			1							1			1
	Collision with Buoys			1								1		
	Collision with Others													
	Propeller Fouling													
	Grounding at Port													
	Touching Bank					1								
	Total			2	1	1					2	2		2
Km 93 ~ 116	Grounding in Canal	1	3		1	2	2							1
	Stuck to Bank													
	Collision between Vessels in Canal			2			1							1
	Collision between Vessels in Port													
	Collision with Craft			2										2
	Collision with Buoys			1		1	1	1						1
	Collision with Others	1				1								
	Propeller Fouling													
	Grounding at Port													
	Touching Bank											1		
	Total	2	3	5	1	4	4	1				1		5
Km 116 ~ 135	Grounding in Canal		1	4	2	1	1	1	1	1		1		1
	Stuck to Bank													
	Collision between Vessels in Canal													
	Collision between Vessels in Port													
	Collision with Craft													
	Collision with Buoys			3		1				1		1		2
	Collision with Others									1		1		
	Propeller Fouling													
	Grounding at Port													
	Touching Bank													
	Total		1	7	2	2	1	1	1	3		5		3

	Kind of Accident \ Month	Unknown	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
Km 135 ~ 161	Grounding in Canal			3									1	
	Stuck to Bank													
	Collision between Vessels in Canal													
	Collision between Vessels in Port													
	Collision with Craft					1						1	1	
	Collision with Buoys	1	1	2	1	2				1			1	
	Collision with Others													
	Propeller Fouling													
	Grounding at Port													
	Touching Bank													
	Total	1	1	5	1	3				1		1	3	
Suez	Grounding in Canal													
	Stuck to Bank													
	Collision between Vessels in Canal													
	Collision between Vessels in Port	2	1		1					1	1	2	2	
	Collision with Craft		1	1	1	3	1		1	1	3	2		3
	Collision with Buoys							1		1	1	1		
	Collision with Others													1
	Propeller Fouling													
	Grounding at Port		4	2	1	3	1		1		2		2	1
	Touching Bank													
	Total	2	6	3	3	6	2	1	2	3	7	5	4	5
Unknown	Grounding in Canal		1											
	Stuck to Bank													
	Collision between Vessels in Canal	1												
	Collision between Vessels in Port													
	Collision with Craft				1									
	Collision with Buoys			1			1					1	1	
	Collision with Others											1		
	Propeller Fouling											1		
	Grounding at Port													
	Touching Bank													
	Total	1	1	1	1	1	1					3	1	

	Kind of Accident \ Month	Unknown	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Total
TOTAL	Grounding in Canal	2	10	11	6	5	4	7	4	3	2	8	4	8	74
	Stuck to Bank												1		1
	Collision between Vessels in Canal	1		2			1					1		1	6
	Collision between Vessels in Port	8	3	1	3	3	3		2	4	4	4	5	2	42
	Collision with Craft		7	13	3	12	7	3	4	2	7	7	4	8	77
	Collision with Buoys	1	3	13	7	8	6	5	2	4	5	6	5	5	70
	Collision with Others	1	5	4	2	2	4		3	2		2	1	1	27
	Propeller Fouling			1					1						2
	Grounding at Port		7	8	2	7	6	3	4	3	3	1	4	5	53
	Touching Bank		1	1		3	1		1	1	2	2		1	13
	Total	13	36	54	23	40	32	18	21	19	23	31	24	31	365

Table III-1-(1)-8 Kind and Number of Accidents by Position and Month from 1976 to 1982

Position	Kind of Accident \ Month	Unknown	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
Port Said	Grounding in Canal													
	Stuck to Bank					1								
	Collision between Vessels in Canal													
	Collision between Vessels in Port	11	10	8	16	14	14	5	13	11	11	12	9	13
	Collision with Craft	2	10	8	8	19	7	2	7	10	3	8	5	6
	Collision with Buoys		5	9	5	5	5	5	6	5	5	2	2	5
	Collision with Others		10	5	5	3	6	3	3	1	3	6	2	1
	Propeller Fouling		4	3	1			1	4		1	1	1	
	Grounding at Port		5	8	3	8	6	6	7	5	6	2	3	8
	Touching Bank								1	1				
	Total	13	44	41	38	50	38	22	41	33	29	31	22	33
Km 0 ~ 20	Grounding in Canal	2	5	1	3	2		5	3	3		3	2	6
	Stuck to Bank													
	Collision between Vessels in Canal				1							1		
	Collision between Vessels in Port													
	Collision with Craft		3	1	3	1		1			1	1		
	Collision with Buoys		1	2	2	4	1	3				1		1
	Collision with Others		2	2	1		1		1				2	3
	Propeller Fouling													
	Grounding at Port													
	Touching Bank				2		1		1	1	1	1	1	
	Total	2	11	6	12	7	3	9	5	4	2	7	5	10
Km 20 ~ 50	Grounding in Canal		6	4	6	4	1	1	1	3	2	3	5	7
	Stuck to Bank													
	Collision between Vessels in Canal													
	Collision between Vessels in Port													
	Collision with Craft		1	4	4	2	2		3		1			1
	Collision with Buoys			1	3	2	2		1		1	2	2	1
	Collision with Others			2	2	2	1	3	2	1	1	2	1	2
	Propeller Fouling													
	Grounding at Port													
	Touching Bank		2	2		2		1	2	2	1			
	Total		9	13	15	12	6	5	9	6	6	7	8	11

Section	Month / Kind of Accident	Unknown	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
Km 50 ~ 63	Grounding in Canal	2	6	7	11	14	7	6	3	3	6	9	14	10
	Stuck to Bank		1				1	1	2				3	
	Collision between Vessels in Canal				1						1			
	Collision between Vessels in Port													
	Collision with Craft		1	1	2	1	2	1		1	2		3	1
	Collision with Buoys	1	6	1	3	2	1	2		1	1	2	4	2
	Collision with Others				2	1			1	2	1		1	1
	Propeller Fouling	1		1			1							4
	Grounding at Port													
	Touching Bank		1		2	2	6	2	1	3	5	2	5	3
	Total	4	15	10	21	20	18	12	7	10	16	13	30	21
Km 63 ~ 75	Grounding in Canal		6	1	3	1	2	2	3	1	2	1	3	5
	Stuck to Bank													
	Collision between Vessels in Canal				1									
	Collision between Vessels in Port													
	Collision with Craft	1				1	1		1			1		1
	Collision with Buoys	1			1	2	1			1	2	3	1	2
	Collision with Others		1			1	1			2				1
	Propeller Fouling		1											
	Grounding at Port													
	Touching Bank					1			1	1	1		1	
	Total	2	8	1	5	6	5	2	5	5	5	5	5	9
Km 75 ~ 81	Grounding in Canal		5	3	10	7	3	4	3	3	6	5	1	12
	Stuck to Bank													
	Collision between Vessels in Canal													
	Collision between Vessels in Port													
	Collision with Craft		5	4	1	1	2			2	1	1		1
	Collision with Buoys		1	2	4	1		2	2		2		2	1
	Collision with Others										1			2
	Propeller Fouling					1							1	1
	Grounding at Port													
	Touching Bank							1		1			1	1
	Total		11	9	15	10	5	7	5	6	10	6	5	18

	Kind of Accident \ Month	Unknown	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
Km 81 ~ 93	Grounding in Canal		2	2	6	1	4		2		1	3	4	4
	Stuck to Bank													
	Collision between Vessels in Canal													
	Collision between Vessels in Port													
	Collision with Craft			1				1			1			2
	Collision with Buoys		1	3	3	1		1	1	2		2		1
	Collision with Others			1	1		1		1		1			
	Propeller Fouling													
	Grounding at Port													
	Touching Bank			2	3	2	1						2	
	Total		3	9	13	4	6	2	4	2	3	5	6	7
Km 93 ~ 116	Grounding in Canal	1	7	5	6	9	4	2		3	1	3	5	4
	Stuck to Bank													1
	Collision between Vessels in Canal			2	1	1	1	1						1
	Collision between Vessels in Port													
	Collision with Craft		3	4	1	6	1	2		1	2	1	1	5
	Collision with Buoys		1	1	1	5	1	1						4
	Collision with Others	1	1	1		2	1	1	1		1			
	Propeller Fouling		1		1	1								
	Grounding at Port													
	Touching Bank			1		1					1	1		
	Total	2	13	14	10	25	8	7	1	4	5	5	6	15
Km 116 ~ 135	Grounding in Canal	1	6	8	15	9	2	3	2	5	3	11	4	12
	Stuck to Bank		1						1					
	Collision between Vessels in Canal													
	Collision between Vessels in Port													
	Collision with Craft			2	1	2	4	1	2	1		2	2	
	Collision with Buoys	1	5	7	12	10	8	4	4	2	5	6	9	10
	Collision with Others		1		3	1	1		2	1	2	1	3	1
	Propeller Fouling													
	Grounding at Port													
	Touching Bank		1		2	1	1	1	1		2		1	1
	Total	2	14	17	33	23	16	9	12	9	12	20	19	24

	Month / Kind of Accident	Unknown	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
Km 135 ~ 161	Grounding in Canal		12	4	10	4	3	2	3	4	1	4	6	3
	Stuck to Bank				1									
	Collision between Vessels in Canal													
	Collision between Vessels in Port													
	Collision with Craft		1		2	4			2	2		2	2	1
	Collision with Buoys	2	3	8	4	10	1	3		1		6	4	3
	Collision with Others	1	1	1	1				1				4	1
	Propeller Fouling	1	1									1		
	Grounding at Port													
	Touching Bank		4		3		1	1	1	1	1	1	1	
	Total	4	22	13	21	18	5	6	7	8	2	14	17	8
Suez	Grounding in Canal													
	Stuck to Bank													
	Collision between Vessels in Canal													
	Collision between Vessels in Port	2	1	2	3	3	3	1	1	1	3	4	6	7
	Collision with Craft	2	5	6	6	7	3	1	2	3	6	5	6	10
	Collision with Buoys		1		1	1	2	2		1	1	1	1	
	Collision with Others		1	1		2	1				1	1		2
	Propeller Fouling													
	Grounding at Port		9	5	6	8	4	2	6		3	7	4	4
	Touching Bank													
	Total	4	17	14	16	21	14	6	9	5	14	18	17	23
Unknown	Grounding in Canal		1	1		2					1			
	Stuck to Bank													
	Collision between Vessels in Canal	1												
	Collision between Vessels in Port				1									
	Collision with Craft		1		6	3	1	2	1				1	1
	Collision with Buoys		1	2		1	1		1				1	1
	Collision with Others				1	1	1		1	1			1	1
	Propeller Fouling													
	Grounding at Port		1								1			
	Touching Bank													
	Total	1	4	3	8	7	3	2	3	1	2		3	3

	Kind of Accident / Month	Unknown	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Total
TOTAL	Grounding in Canal	6	56	36	70	53	26	25	20	25	23	42	44	63	489
	Stuck to Bank		2		1	1	1	1	3				3	1	13
	Collision between Vessels in Canal	1		2	4	1	1				1	1		1	13
	Collision between Vessels in Port	13	11	10	20	17	17	6	14	12	14	16	15	20	185
	Collision with Craft	5	30	31	34	47	23	11	18	20	17	21	20	29	306
	Collision with Buoys	5	25	36	39	44	23	23	15	13	17	25	26	31	322
	Collision with Others	2	17	13	16	13	14	7	13	8	11	10	14	15	153
	Propeller Fouling	2	7	4	2	2	2	1	4		1	2	2	5	34
	Grounding at Port		15	13	9	16	10	8	13	5	10	9	7	12	127
	Touching Bank		8	5	12	9	10	6	8	10	12	5	12	5	102
	Total	34	171	150	207	203	127	89	108	93	106	131	143	182	1,744

Table III-1-(1)-9 Number of Groundings in the Canal by Causes, Positions and Direction of Transit (1976 ~ 1980)

Cause	Sheer			Mooring Manoeuvrability			Stearing Gear Trouble			Engine Trouble			Projector Trouble			Bad Weather			Other Causes			Total		
Position \ Direction	Unknown	North	South	Unknown	North	South	Unknown	North	South	Unknown	North	South	Unknown	North	South	Unknown	North	South	Unknown	North	South	Unknown	North	South
Port Said	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Km 0 ~ 20	0	2	2	0	0	0	1	2	1	0	3	1	0	0	1	0	2	3	0	3	3	1	12	11
20 ~ 50	0	2	2	0	2	1	0	7	6	0	1	1	0	0	0	0	3	6	0	1	3	0	16	19
50 ~ 63	0	4	9	0	1	7	1	4	17	0	0	5	0	0	0	0	3	12	0	2	24	1	14	74
63 ~ 75	0	1	2	0	2	0	0	5	1	0	2	1	0	0	0	0	2	3	0	4	2	0	16	9
75 ~ 81	0	2	3	0	1	2	0	6	3	0	2	2	0	0	0	0	9	7	0	12	7	0	32	24
81 ~ 93	0	1	4	0	0	0	0	1	1	0	1	1	0	0	0	0	3	5	0	4	4	0	10	15
93 ~ 116	0	2	2	0	2	2	0	4	2	0	2	2	0	0	0	0	4	6	1	8	3	1	22	17
116 ~ 135	0	1	5	0	1	1	0	7	14	0	3	5	0	0	0	0	7	4	0	6	11	0	25	40
135 ~ 161	0	2	3	0	1	2	0	10	7	0	3	7	0	0	0	0	6	1	0	2	8	0	24	28
Suez	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Unknown	0	0	1	0	0	0	0	0	0	0	1	1	0	0	0	0	0	1	0	0	0	0	1	3
Total	0	17	33	0	10	15	2	46	52	0	18	26	0	0	1	0	39	48	1	42	65	3	172	240
G. Total	50			25			100			44			1			87			108			415		

Table III-1-(1)-10 Number of Groundings in the Canal by Causes, Positions and Direction of Transit (1981 ~ 1982)

Cause / Direction / Position	Sheer			Mooring Manoeuvrability			Stearing Gear Trouble			Engine Trouble			Projector Trouble			Bad Weather			Other Causes			Total		
	Unknown	North	South	Unknown	North	South	Unknown	North	South	Unknown	North	South	Unknown	North	South	Unknown	North	South	Unknown	North	South	Unknown	North	South
Port Said	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Km 0 ~ 20	0	0	2	0	0	0	1	0	1	0	2	0	0	0	0	0	4	0	0	1	0	1	7	3
20 ~ 50	0	0	0	0	0	0	0	0	3	0	0	2	0	0	0	0	1	0	0	1	1	0	2	6
50 ~ 63	0	0	0	0	0	0	0	1	2	0	0	0	0	0	0	0	1	1	0	0	4	0	2	7
63 ~ 75	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	2	1	0	4	1
75 ~ 81	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	2	0	2	0	0	4	2
81 ~ 93	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	1	1	0	1	3
93 ~ 116	0	0	1	0	0	1	0	0	0	0	1	0	0	0	0	0	2	0	0	3	2	0	6	4
116 ~ 135	0	1	0	0	0	0	0	3	3	0	3	1	0	0	0	0	1	0	0	3	1	0	11	5
135 ~ 161	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	2	0	0	0	0	0	3	1
Suez	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Unknown	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1
Total	0	1	3	0	0	1	1	7	9	0	8	4	0	0	0	0	11	6	0	13	10	1	40	33
G. Total	4			1			17			12			0			17			23			74		

Table III-1-(1)-11 Number of Groundings in the Canal by Causes, Positions and Direction of Transit (1976 ~ 1982)

Cause / Direction / Position	Sheer			Mooring Manoeuvrability			Stearing Gear Trouble			Engine Trouble			Projector Trouble			Bad Weather			Other Causes			Total		
	Unknown	North	South	Unknown	North	South	Unknown	North	South	Unknown	North	South	Unknown	North	South	Unknown	North	South	Unknown	North	South	Unknown	North	South
Port Said	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Km 0 ~ 20	0	2	4	0	0	0	2	2	2	0	5	1	0	0	1	0	6	3	0	4	3	2	19	14
20 ~ 50	0	2	2	0	2	1	0	7	9	0	1	3	0	0	0	0	4	6	0	2	4	0	18	25
50 ~ 63	0	4	9	0	1	7	1	5	19	0	0	5	0	0	0	0	4	13	0	2	28	1	16	81
63 ~ 75	0	1	2	0	2	0	0	6	1	0	3	1	0	0	0	0	2	3	0	6	3	0	20	10
75 ~ 81	0	2	3	0	1	2	0	7	3	0	3	2	0	0	0	0	9	9	0	14	7	0	36	26
81 ~ 93	0	1	4	0	0	0	0	1	1	0	1	1	0	0	0	0	3	7	0	5	5	0	11	18
93 ~ 116	0	2	3	0	2	3	0	4	2	0	3	2	0	0	0	0	6	6	1	11	5	1	28	21
116 ~ 135	0	2	5	0	1	1	0	10	17	0	6	6	0	0	0	0	8	4	0	9	12	0	36	45
135 ~ 161	0	2	3	0	1	2	0	11	7	0	3	8	0	0	0	0	8	1	0	2	8	0	27	29
Suez	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Unknown	0	0	1	0	0	0	0	0	0	0	1	1	0	0	0	0	0	2	0	0	0	0	1	4
Total	0	18	36	0	10	16	3	53	61	0	26	30	0	0	1	0	50	54	1	55	75	4	212	273
G. Total	54			26			117			56			1			104			131			489		

Table III-1-(1)-12 Number of Groundings in the Canal by Causes, Positions and Day/Night (1976 ~ 1980)

Cause / Direction / Position	Sheer			Mooring Manoeuvrability			Stearing Gear Trouble			Engine Trouble			Projector Trouble			Bad Weather			Other Causes			Total		
	Unknown	Day	Night	Unknown	Day	Night	Unknown	Day	Night	Unknown	Day	Night	Unknown	Day	Night	Unknown	Day	Night	Unknown	Day	Night	Unknown	Day	Night
Port Said	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Km 0 ~ 20	0	0	4	0	0	0	1	1	2	0	1	3	0	0	1	0	2	3	0	2	4	1	6	17
20 ~ 50	0	3	1	0	1	2	0	5	8	0	1	1	0	0	0	0	4	5	1	3	0	1	17	17
50 ~ 63	0	7	6	0	5	3	1	5	16	0	3	2	0	0	0	0	7	8	4	6	16	5	33	51
63 ~ 75	0	1	2	0	1	1	0	1	5	0	2	1	0	0	0	0	2	3	1	0	5	1	7	17
75 ~ 81	0	1	4	0	2	1	0	3	6	0	2	2	0	0	0	0	9	7	5	1	13	5	18	33
81 ~ 93	0	3	2	0	0	0	0	1	1	0	2	0	0	0	0	0	3	5	0	5	3	0	14	11
93 ~ 116	0	3	1	0	1	3	0	4	2	0	1	3	0	0	0	0	6	4	5	6	1	5	21	14
116 ~ 135	0	1	5	0	1	1	0	6	15	0	7	1	0	0	0	0	5	6	3	8	6	3	28	34
135 ~ 161	0	2	3	0	2	1	0	11	6	0	5	5	0	0	0	0	7	0	1	3	6	1	30	21
Suez	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Unknown	0	1	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	1	0	0	0	0	1	3
Total	0	22	28	0	13	12	2	37	61	0	24	20	0	0	1	0	45	42	20	34	54	22	175	218
G. Total	50			25			100			44			1			87			108			415		

Table III-1-(1)-13 Number of Groundings in the Canal by Causes, Positions and Day/Night (1981 ~ 1982)

Cause / Direction / Position	Sheer			Mooring Manoeuvrability			Stearing Gear Trouble			Engine Trouble			Projector Trouble			Bad Weather			Other Causes			Total		
	Unknown	Day	Night	Unknown	Day	Night	Unknown	Day	Night	Unknown	Day	Night	Unknown	Day	Night	Unknown	Day	Night	Unknown	Day	Night	Unknown	Day	Night
Port Said	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Km 0 ~ 20	0	1	1	0	0	0	0	0	2	0	0	2	0	0	0	0	4	0	0	0	1	0	5	6
20 ~ 50	0	0	0	0	0	0	0	1	2	0	2	0	0	0	0	0	1	0	0	0	2	0	4	4
50 ~ 63	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	2	0	0	3	1	0	5	4
63 ~ 75	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	1	2	0	3	2
75 ~ 81	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	2	0	0	1	1	0	5	1
81 ~ 93	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	2	0	0	4	0
93 ~ 116	0	1	0	0	0	1	0	0	0	0	1	0	0	0	0	0	2	0	0	3	2	0	7	3
116 ~ 135	0	0	1	0	0	0	0	5	1	0	4	0	0	0	0	0	1	0	0	3	1	0	13	3
135 ~ 161	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	1	1	0	0	0	0	2	2
Suez	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Unknown	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1
Total	0	2	2	0	0	1	0	9	8	0	9	3	0	0	0	0	15	2	0	13	10	0	48	26
G. Total	4			1			17			12			0			17			23			74		

Table III-1-(1)-14 Number of Groundings in the Canal by Causes, Positions and Day/Night (1976 ~ 1982)

Cause / Direction / Position	Sheer			Mooring Manoeuvrability			Stearing Gear Trouble			Engine Trouble			Projector Trouble			Bad Weather			Other Causes			Total		
	Unknown	Day	Night	Unknown	Day	Night	Unknown	Day	Night	Unknown	Day	Night	Unknown	Day	Night	Unknown	Day	Night	Unknown	Day	Night	Unknown	Day	Night
Port Said	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Km 0 ~ 20	0	1	5	0	0	0	1	1	4	0	1	5	0	0	1	0	6	3	0	2	5	1	11	23
20 ~ 50	0	3	1	0	1	2	0	6	10	0	3	1	0	0	0	0	5	5	1	3	2	1	21	21
50 ~ 63	0	7	6	0	5	3	1	5	19	0	3	2	0	0	0	0	9	8	4	9	17	5	38	55
63 ~ 75	0	1	2	0	1	1	0	2	5	0	3	1	0	0	0	0	2	3	1	1	7	1	10	19
75 ~ 81	0	1	4	0	2	1	0	4	6	0	3	2	0	0	0	0	11	7	5	2	14	5	23	34
81 ~ 93	0	3	2	0	0	0	0	1	1	0	2	0	0	0	0	0	5	5	0	7	3	0	18	11
93 ~ 116	0	4	1	0	1	4	0	4	2	0	2	3	0	0	0	0	8	4	5	9	3	5	28	17
116 ~ 135	0	1	6	0	1	1	0	11	16	0	11	1	0	0	0	0	6	6	3	11	7	3	41	37
135 ~ 161	0	2	3	0	2	1	0	12	6	0	5	6	0	0	0	0	8	1	1	3	6	1	32	23
Suez	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Unknown	0	1	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	1	4
Total	0	24	30	0	13	13	2	46	69	0	33	23	0	0	1	0	60	44	20	47	64	22	223	244
G. Total	54			26			117			56			1			104			131			489		

Table III-1-(1)-15 Number of Groundings in the Canal by Causes, Positions and Months (1976 ~ 1980)

Position	Cause \ Month	Unknown	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
Km 0 ~ 20	Sheer	0	0	1	1	0	0	0	0	0	0	1	0	1	4
	Mooring Manoeuvrability	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Stearing Gear Trouble	1	1	0	0	0	0	0	0	0	0	0	1	1	4
	Engine Trouble	0	0	0	0	1	0	0	1	0	0	0	0	2	4
	Projector Trouble	0	1	0	0	0	0	0	0	0	0	0	0	0	1
	Bad Weather	0	1	0	1	0	0	0	1	0	0	0	1	1	5
	Other Causes	0	2	0	1	0	0	0	0	2	0	0	0	1	6
	Total	1	5	1	3	1	0	0	2	2	0	1	2	6	24
Km 20 ~ 50	Sheer	0	0	0	2	0	0	0	0	0	0	1	1	0	4
	Mooring Manoeuvrability	0	1	2	0	0	0	0	0	0	0	0	0	0	3
	Stearing Gear Trouble	0	2	1	1	4	0	1	1	0	1	1	1	0	13
	Engine Trouble	0	0	0	1	0	0	0	0	0	0	1	0	0	2
	Projector Trouble	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Bad Weather	0	1	1	1	0	0	0	0	1	0	0	1	4	9
	Other Causes	0	0	0	1	0	0	0	0	1	1	0	1	0	4
	Total	0	4	4	6	4	0	1	1	2	2	3	4	4	35
Km 50 ~ 65	Sheer	0	0	1	2	0	0	0	1	0	0	0	7	2	13
	Mooring Manoeuvrability	0	3	2	0	0	0	0	0	0	1	0	1	1	8
	Stearing Gear Trouble	2	0	1	1	3	2	3	0	0	2	3	1	4	22
	Engine Trouble	0	0	2	1	0	0	0	0	0	1	0	0	1	5
	Projector Trouble	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Bad Weather	0	0	0	1	4	3	1	0	1	1	2	2	0	15
	Other Causes	0	1	0	6	6	2	2	2	2	0	2	1	2	26
	Total	2	4	6	11	13	7	6	3	3	5	7	12	10	89
Km 65 ~ 75	Sheer	0	0	0	0	0	0	0	1	0	0	1	0	1	3
	Mooring Manoeuvrability	0	1	0	0	0	0	0	0	0	0	0	1	0	2
	Stearing Gear Trouble	0	3	0	1	0	0	0	0	0	0	0	1	1	6
	Engine Trouble	0	0	0	0	0	0	0	0	0	1	0	0	2	3
	Projector Trouble	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Bad Weather	0	0	0	1	0	1	1	0	0	1	0	0	1	5
	Other Causes	0	1	0	0	1	1	1	0	1	0	0	1	0	6
	Total	0	5	0	2	1	2	2	1	1	2	1	3	5	25
Km 75 ~ 81	Sheer	0	0	0	2	0	0	0	0	0	2	0	0	1	5
	Mooring Manoeuvrability	0	1	0	0	1	0	0	1	0	0	0	0	0	3
	Stearing Gear Trouble	0	0	0	0	1	0	0	1	1	2	0	0	4	9
	Engine Trouble	0	0	0	1	2	1	0	0	0	0	0	0	0	4
	Projector Trouble	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Bad Weather	0	2	1	4	1	1	1	0	0	0	2	0	4	16
	Other Causes	0	2	0	2	2	1	2	1	2	2	3	1	1	19
	Total	0	5	1	9	7	3	3	3	3	6	5	1	10	56
Km 81 ~ 93	Sheer	0	1	1	2	0	0	0	0	0	0	0	1	0	5
	Mooring Manoeuvrability	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Stearing Gear Trouble	0	0	1	1	0	0	0	0	0	0	0	0	0	2
	Engine Trouble	0	0	0	0	0	0	0	1	0	0	0	0	1	2
	Projector Trouble	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Bad Weather	0	0	0	1	1	1	0	0	0	0	1	2	2	8
	Other Causes	0	1	0	1	0	3	0	1	0	0	1	1	0	8
	Total	0	2	2	5	1	4	0	2	0	0	2	4	3	25

Table III-1-(1)-15 (Continued)

Position	Cause \ Month	Unknown	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
Km 93 ~ 116	Sheer	0	1	1	0	1	0	0	0	1	0	0	0	0	4
	Mooring Manoeuvrability	0	0	0	1	3	0	0	0	0	0	0	0	0	4
	Stearing Gear Trouble	0	0	1	3	1	0	0	0	0	0	0	1	0	6
	Engine Trouble	0	0	0	0	1	0	1	0	0	1	1	0	0	4
	Projector Trouble	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Bad Weather	0	1	2	1	1	1	0	0	0	0	1	1	2	10
	Other Causes	0	2	1	0	0	1	1	0	2	0	1	3	1	12
	Total	0	4	5	5	7	2	2	0	3	1	3	5	3	40
Km 116 ~ 135	Sheer	0	1	0	2	1	0	0	0	0	0	0	0	2	6
	Mooring Manoeuvrability	0	1	0	1	0	0	0	0	0	0	0	0	0	2
	Stearing Gear Trouble	1	1	2	2	3	0	0	0	1	2	4	3	2	21
	Engine Trouble	0	0	0	0	2	0	2	0	0	1	1	0	2	8
	Projector Trouble	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Bad Weather	0	2	2	1	1	1	0	1	0	0	1	1	1	11
	Other Causes	0	0	0	7	1	0	0	0	3	0	2	0	4	17
	Total	1	5	4	13	8	1	2	1	4	3	8	4	11	65
Km 135 ~ 161	Sheer	0	1	1	0	0	0	1	0	0	0	1	1	0	5
	Mooring Manoeuvrability	0	1	0	1	0	0	0	0	0	0	0	1	0	3
	Stearing Gear Trouble	0	4	0	4	1	3	0	3	2	1	1	0	0	19
	Engine Trouble	0	2	0	1	2	0	0	0	1	0	2	1	0	9
	Projector Trouble	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Bad Weather	0	1	0	3	0	0	1	0	0	0	0	0	2	7
	Other Causes	0	3	0	1	1	0	0	0	1	0	0	2	1	9
	Total	0	12	1	10	4	3	2	3	4	1	4	5	3	52
Unknown	Sheer	0	0	1	0	0	0	0	0	0	0	0	0	0	1
	Mooring Manoeuvrability	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Stearing Gear Trouble	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Engine Trouble	0	0	0	0	1	0	0	0	0	1	0	0	0	2
	Projector Trouble	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Bad Weather	0	0	0	0	1	0	0	0	0	0	0	0	0	1
	Other Causes	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Total	0	0	1	0	2	0	0	0	0	1	0	0	0	4
Total	Sheer	0	4	6	11	2	0	1	2	1	2	4	10	7	50
	Mooring Manoeuvrability	0	8	4	3	4	0	0	1	0	1	0	3	1	25
	Stearing Gear Trouble	4	11	6	13	13	3	4	5	4	8	9	8	12	100
	Engine Trouble	0	2	2	4	9	2	3	2	1	5	5	1	8	44
	Projector Trouble	0	1	0	0	0	0	0	0	0	0	0	0	0	1
	Bad Weather	0	8	6	14	9	8	4	2	2	2	7	8	17	87
	Other Causes	0	12	1	19	11	9	6	4	14	3	9	10	10	108
	Total	4	46	25	64	48	22	18	16	22	21	34	40	55	415

Table III-1-(1)-16 Number of Groundings in the Canal by Causes, Positions and Months (1981 ~ 1982)

Position	Cause \ Month	Unknown	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
Km 0 ~ 20	Sheer	0	0	0	0	0	0	1	1	0	0	0	0	0	2
	Mooring Manoeuvrability	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Stearing Gear Trouble	1	0	0	0	0	0	0	0	0	0	1	0	0	2
	Engine Trouble	0	0	0	0	0	0	0	0	1	0	1	0	0	2
	Projector Trouble	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Bad Weather	0	0	0	0	0	0	4	0	0	0	0	0	0	4
	Other Causes	0	0	0	0	1	0	0	0	0	0	0	0	0	1
	Total	1	0	0	0	1	0	5	1	1	0	2	0	0	11
Km 20 ~ 50	Sheer	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Mooring Manoeuvrability	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Stearing Gear Trouble	0	1	0	0	0	0	0	0	0	0	0	1	1	3
	Engine Trouble	0	1	0	0	0	1	0	0	0	0	0	0	0	2
	Projector Trouble	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Bad Weather	0	0	0	0	0	0	0	0	0	0	0	0	1	1
	Other Causes	0	0	0	0	0	0	0	0	1	0	0	0	1	2
	Total	0	2	0	0	0	1	0	0	1	0	0	1	3	8
Km 50 ~ 65	Sheer	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Mooring Manoeuvrability	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Stearing Gear Trouble	0	2	0	0	0	0	0	0	0	0	1	0	0	3
	Engine Trouble	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Projector Trouble	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Bad Weather	0	0	1	0	0	0	0	0	0	1	0	0	0	2
	Other Causes	0	0	0	0	1	0	0	0	0	0	1	2	0	4
	Total	0	2	1	0	1	0	0	0	0	1	2	2	0	9
Km 65 ~ 75	Sheer	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Mooring Manoeuvrability	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Stearing Gear Trouble	0	0	0	0	0	0	0	1	0	0	0	0	0	1
	Engine Trouble	0	0	0	1	0	0	0	0	0	0	0	0	0	1
	Projector Trouble	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Bad Weather	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Other Causes	0	1	1	0	0	0	0	1	0	0	0	0	0	3
	Total	0	1	1	1	0	0	0	2	0	0	0	0	0	5
Km 75 ~ 81	Sheer	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Mooring Manoeuvrability	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Stearing Gear Trouble	0	0	0	0	0	0	0	0	0	0	0	0	1	1
	Engine Trouble	0	0	1	0	0	0	0	0	0	0	0	0	0	1
	Projector Trouble	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Bad Weather	0	0	0	0	0	0	1	0	0	0	0	0	1	2
	Other Causes	0	0	1	1	0	0	0	0	0	0	0	0	0	2
	Total	0	0	2	1	0	0	1	0	0	0	0	0	2	6
Km 81 ~ 93	Sheer	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Mooring Manoeuvrability	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Stearing Gear Trouble	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Engine Trouble	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Projector Trouble	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Bad Weather	0	0	0	0	0	0	0	0	0	0	1	0	1	2
	Other Causes	0	0	0	1	0	0	0	0	0	1	0	0	0	2
	Total	0	0	0	1	0	0	0	0	0	1	1	0	1	4

Table III-1-(1)-16 (Continued)

Position	Cause \ Month	Unknown	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
Km 93 ~ 116	Sheer	0	1	0	0	0	2	0	1	0	0	0	0	0	3
	Mooring Manoeuvrability	1	0	0	0	0	0	0	0	0	0	0	0	0	1
	Stearing Gear Trouble	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Engine Trouble	0	0	0	0	0	0	0	0	0	0	0	0	1	1
	Projector Trouble	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Bad Weather	0	1	0	0	1	0	0	0	0	0	0	0	0	2
	Other Causes	0	1	0	1	1	0	0	0	0	0	0	0	0	3
	Total	1	3	0	1	2	2	0	0	0	0	0	0	1	10
Km 116 ~ 135	Sheer	0	0	0	0	0	0	0	1	0	0	0	0	0	1
	Mooring Manoeuvrability	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Stearing Gear Trouble	0	0	1	2	0	0	1	0	1	0	1	0	0	6
	Engine Trouble	0	1	0	0	1	1	0	0	0	0	1	0	0	4
	Projector Trouble	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Bad Weather	0	0	1	0	0	0	0	0	0	0	0	0	0	1
	Other Causes	0	0	2	0	0	0	0	0	0	0	1	0	1	4
	Total	0	1	4	2	1	1	1	1	1	0	3	0	1	16
Km 135 ~ 161	Sheer	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Mooring Manoeuvrability	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Stearing Gear Trouble	0	0	1	0	0	0	0	0	0	0	0	0	0	1
	Engine Trouble	0	0	0	0	0	0	0	0	0	0	0	1	0	1
	Projector Trouble	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Bad Weather	0	0	2	0	0	0	0	0	0	0	0	0	0	2
	Other Causes	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Total	0	0	3	0	0	0	0	0	0	0	0	1	0	4
Unknown	Sheer	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Mooring Manoeuvrability	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Stearing Gear Trouble	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Engine Trouble	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Projector Trouble	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Bad Weather	0	1	0	0	0	0	0	0	0	0	0	0	0	1
	Other Causes	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Total	0	1	0	0	0	0	0	0	0	0	0	0	0	1
Total	Sheer	0	1	0	0	0	0	1	2	0	0	0	0	0	4
	Mooring Manoeuvrability	1	0	0	0	0	0	0	0	0	0	0	0	0	1
	Stearing Gear Trouble	1	3	2	2	0	0	1	1	1	0	3	1	2	17
	Engine Trouble	0	2	1	1	2	2	0	0	1	0	2	1	1	12
	Projector Trouble	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Bad Weather	0	2	4	0	0	0	5	0	0	1	1	0	3	17
	Other Causes	0	2	4	3	2	2	0	1	1	1	2	2	2	23
	Total	2	10	11	6	5	4	7	4	3	2	8	4	8	74

Table III-1-(1)-17 Number of Groundings in the Canal by Causes, Positions and Months (1976 ~ 1982)

Position	Cause \ Month	Unknown	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
Km 0 ~ 20	Sheer	0	0	1	1	0	0	1	1	0	0	1	0	1	6
	Mooring Manoeuvrability	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Stearing Gear Trouble	2	1	0	0	0	0	0	0	0	0	1	1	1	6
	Engine Trouble	0	0	0	0	1	0	0	1	1	0	1	0	2	6
	Projector Trouble	0	1	0	0	0	0	0	0	0	0	0	0	0	1
	Bad Weather	0	1	0	1	0	0	4	1	0	0	0	1	1	9
	Other Causes	0	2	0	1	1	0	0	0	2	0	0	0	1	7
	Total	2	5	1	3	2	0	5	3	3	0	3	2	6	35
Km 20 ~ 50	Sheer	0	0	0	2	0	0	0	0	0	0	1	1	0	4
	Mooring Manoeuvrability	0	1	2	0	0	0	0	0	0	0	0	0	0	3
	Stearing Gear Trouble	0	3	1	1	4	0	1	1	0	1	1	2	1	16
	Engine Trouble	0	1	0	1	0	1	0	0	0	0	1	0	0	4
	Projector Trouble	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Bad Weather	0	1	1	1	0	0	0	0	1	0	0	1	5	10
	Other Causes	0	0	0	1	0	0	0	0	2	1	0	1	1	6
	Total	0	6	4	6	4	1	1	1	3	2	3	5	7	43
Km 50 ~ 65	Sheer	0	0	1	2	0	0	0	1	0	0	0	7	2	13
	Mooring Manoeuvrability	0	3	2	0	0	0	0	0	0	1	0	1	1	8
	Stearing Gear Trouble	2	2	1	1	3	2	3	0	0	2	4	1	4	25
	Engine Trouble	0	0	2	1	0	0	0	0	0	1	0	0	1	5
	Projector Trouble	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Bad Weather	0	0	1	1	4	3	1	0	1	2	2	2	0	17
	Other Causes	0	1	0	6	7	2	2	2	2	0	3	3	2	30
	Total	2	6	7	11	14	7	6	3	3	6	9	14	10	98
Km 65 ~ 75	Sheer	0	0	0	0	0	0	0	1	0	0	1	0	1	3
	Mooring Manoeuvrability	0	1	0	0	0	0	0	0	0	0	0	1	0	2
	Stearing Gear Trouble	0	3	0	1	0	0	0	1	0	0	0	1	1	7
	Engine Trouble	0	0	0	1	0	0	0	0	0	1	0	0	2	4
	Projector Trouble	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Bad Weather	0	0	0	1	0	1	1	0	0	1	0	0	1	5
	Other Causes	0	2	1	0	1	1	1	1	1	0	0	1	0	9
	Total	0	6	1	3	1	2	2	3	1	2	1	3	5	30
Km 75 ~ 81	Sheer	0	0	0	2	0	0	0	0	0	2	0	0	1	5
	Mooring Manoeuvrability	0	1	0	0	1	0	0	1	0	0	0	0	0	3
	Stearing Gear Trouble	0	0	0	0	1	0	0	1	1	2	0	0	5	10
	Engine Trouble	0	0	1	1	2	1	0	0	0	0	0	0	0	5
	Projector Trouble	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Bad Weather	0	2	1	4	1	1	2	0	0	0	2	0	5	18
	Other Causes	0	2	1	3	2	1	2	1	2	2	3	1	1	21
	Total	0	5	3	10	7	3	4	3	3	6	5	1	12	62
Km 81 ~ 93	Sheer	0	1	1	2	0	0	0	0	0	1	0	1	0	6
	Mooring Manoeuvrability	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Stearing Gear Trouble	0	0	1	1	0	0	0	0	0	0	0	0	0	2
	Engine Trouble	0	0	0	0	0	0	0	1	0	0	0	0	1	2
	Projector Trouble	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Bad Weather	0	0	0	1	1	1	0	0	0	0	2	2	3	10
	Other Causes	0	1	0	2	0	3	0	1	0	0	1	1	0	9
	Total	0	2	2	6	1	4	0	2	0	1	3	4	4	29

Table III-1-(1)-17 (Continued)

Position	Cause \ Month	Unknown	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
Km 93 ~ 116	Sheer	0	2	1	0	1	0	0	0	1	0	0	0	0	5
	Mooring Manoeuvrability	1	0	0	1	3	0	0	0	0	0	0	0	0	5
	Stearing Gear Trouble	0	0	1	3	1	0	0	0	0	0	0	1	0	6
	Engine Trouble	0	0	0	0	1	0	1	0	0	1	1	0	1	5
	Projector Trouble	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Bad Weather	0	2	2	1	2	1	0	0	0	0	1	1	2	12
	Other Causes	0	3	1	1	1	3	1	0	2	0	1	3	1	17
	Total	1	7	5	6	9	4	2	0	3	1	3	5	4	50
Km 116 ~ 135	Sheer	0	1	0	2	1	0	0	1	0	0	0	0	2	7
	Mooring Manoeuvrability	0	1	0	1	0	0	0	0	0	0	0	0	0	2
	Stearing Gear Trouble	1	1	3	4	3	0	1	0	2	2	5	3	2	27
	Engine Trouble	0	1	0	0	3	1	2	0	0	1	2	0	2	12
	Projector Trouble	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Bad Weather	0	2	3	1	1	1	0	1	0	0	1	1	1	12
	Other Causes	0	0	2	7	1	0	0	0	3	0	3	0	5	21
	Total	1	6	8	15	9	2	3	2	5	3	11	4	12	81
Km 135 ~ 161	Sheer	0	1	1	0	0	0	1	0	0	0	1	1	0	5
	Mooring Manoeuvrability	0	1	0	1	0	0	0	0	0	0	0	1	0	3
	Stearing Gear Trouble	0	4	1	4	1	1	0	3	2	1	1	0	0	18
	Engine Trouble	0	2	0	1	2	1	0	0	1	0	2	2	0	11
	Projector Trouble	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Bad Weather	0	1	2	3	0	0	0	0	0	0	0	0	2	8
	Other Causes	0	3	0	1	1	1	1	0	1	0	0	2	1	11
	Total	0	12	4	10	4	3	2	3	4	1	4	6	3	56
Unknown	Sheer	0	0	1	0	0	0	0	0	0	0	0	0	0	1
	Mooring Manoeuvrability	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Stearing Gear Trouble	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Engine Trouble	0	0	0	0	1	0	0	0	0	1	0	0	0	2
	Projector Trouble	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Bad Weather	0	1	0	0	1	0	0	0	0	0	0	0	0	2
	Other Causes	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Total	0	1	1	0	2	0	0	0	0	1	0	0	0	5
Total	Sheer	0	5	6	11	2	0	2	4	1	2	4	10	7	54
	Mooring Manoeuvrability	1	8	4	3	4	0	0	1	0	1	0	3	1	26
	Stearing Gear Trouble	5	14	8	15	13	3	5	6	5	8	12	9	14	117
	Engine Trouble	0	4	3	5	10	4	3	2	2	5	7	2	9	56
	Projector Trouble	0	1	0	0	0	0	0	0	0	0	0	0	0	1
	Bad Weather	0	10	10	14	10	8	9	2	2	3	8	8	20	104
	Other Causes	0	14	5	22	14	11	16	5	15	4	11	12	12	131
	Total	6	56	36	70	53	26	25	20	25	23	42	44	63	489

(2) Analysis of Accident Records in Preliminary Study Team Format

An analysis was made on 181 sheets of Accident Records covering the period from February, 1983 to December 1984 in a format designed and prepared by the Preliminary Study Team and entered by the SCA at their request, with the results as tabulated in the following Tables.

Table III-1-(2)-1 Number of Causes by Kind of Accident

Causes \ Kind of Accident	Collision with Vessels & Crafts	Grounding	Fire	Engine Trouble	Propeller Trouble	Rudder Trouble	Damage to Buoys & Other Equipment	Others	Total
Erroneous Operation									
Negligent Look Out	5	10		1	2		10		28
Unconfirmed Position		6				1			7
Against Sailing Rules	2						2		4
Unskilled Manoeuvring	17	17		1	2		11	1	49
Unconfirmed Navigation Aid		1							1
Unconfirmed Compass Error		1							1
No Chance to Evacuate	1								1
Negligence of Weather and Sea Conditions	2	6					1	1	10
Faulty Maintenance of Hull and Other Equipment (excluding engine)	1	7		1		9	2	3	23
Misselection of Anchoring Position		2							2
Insufficient Hydrographic Research		1					1		2
Others	3	15	1	24	3	4	4	6	60
Sub Total	31	66	1	27	7	14	31	11	188
Use of Engine									
Bad Maintenance	1	7		23	3	1			35
Mishandling	15	17		2	2	1	8		45
Others	1	7	1	1		3	7	2	22
Sub Total	17	31	1	26	5	5	15	2	102
Loading									
Misloading		1							1
Others		2					1		3
Sub Total		3					1		4
Quality of Material and Structure									
Structural Failure							1		1
Others		1		2	1		2		6
Sub Total		1		2	1		3		7
Force Majeure									
Fault of Other Vessel	4						1		5
Poor Port and Harbour Facilities	2						2		4
Abnormal Weather	1	11							12
Others	1				1		1		3
Sub Total	8	11			1		4		24
Total	56	112	2	55	14	19	54	13	325

Table III-1-(2)-2 Kind and Number of Accidents by Vessel's Position in Convoy

Kind of Accident / Position in Convoy	Collision with Vessels & Crafts	Ground-ing	Fire	Engine Trouble	Propeller Trouble	Rudder Trouble	Damage to Buoys & Other Equipment	Others	Total
Top Vessels	1	5		1	1		2		10
0 ~ 20%	2	1		1		2	2		8
20 ~ 40%	2	5		5	3	3	4	4	26
40 ~ 60%		15	1	6		1	4	4	31
60 ~ 80%	1	11		2		4	1	1	26
80 ~ 100%		11		7		1	3	2	24
Last Vessels		6		4	1	3	3		17
No Convoy or Unknown	21	7		2	2		11	2	45
Total	27	61	1	28	7	14	30	13	181

Table III-1-(2)-3 Kind and Number of Accidents by Formation of Convoy

Kind of Accident / Formation of Convoy	Collision with Vessels & Crafts	Ground-ing	Fire	Engine Trouble	Propeller Trouble	Rudder Trouble	Damage to Buoys & Other Equipment	Others	Total
1 ~ 5 Vessels		6		1		2		1	10
6 ~ 10		18		5	1	1	3	1	29
11 ~ 15		4		1	1	1			7
16 ~ 20		6	1	7	1	3	3	1	22
21 ~ 25	6	19		11	1	7	10	8	62
26 ~		2		1	1		3		7
No Convoy or Unknown	21	6		2	2		11	2	44
Total	27	61	1	28	7	14	30	13	181

Table III-1-(2)-4 Kind and Number of Accidents by Day/Night and Location

Kind of Accident / Location of Accident	Collision with Vessels & Crafts			Grounding			Fire			Engine Trouble			Propeller Trouble			Rudder Trouble			Damage to Bouys & Crafts Equipment			Others			Total
Day/Night	Day	Un-known	Night	Day	Un-known	Night	Day	Un-known	Night	Day	Un-known	Night	Day	Un-known	Night	Day	Un-known	Night	Day	Un-known	Night	Day	Un-known	Night	
Port Said & Waiting Area (~ Km 2)	10	4	7	2		4				2	1		1				1	1	6		4	3		3	49
Around Port Said Bypass (Km 2~20)				1		5				1		2				1		2	1					1	14
Km 20~50				2		1										1			1			1			6
Around El-Ballah Bypass (Km 20~62)				14	2	7				3		2	1		2						2				33
Km 62 ~ 73						3	1			1															5
Around Timsah Lake (Km 73~82)	1			5		2				1		1	1								1				12
Km 82~94	1			1						2															4
Around Great Bitter Lake (Km 94~116)	3			1	1	1				7		1	1			3			3			1	1		23
Around Little Bitter Lake (Km 116~134)				3	1					1						2			5		1				13
Km 134 ~ 155	1			2						3			1			1		1				1		1	11
Around Port Taufiq (Km 155~162)						1										1			1	1					4
Suez & Waiting Area (Km 162~)				2															2		1	1			6
Unknown																				1					1
Sub Total	16	4	7	33	4	24	1	0	0	21	1	6	5	0	2	9	1	4	19	2	9	7	1	5	
Total	27			61			1			28			7			14			30			13			181

Table III-1-(2)-5 Kind and Number of Accidents by Direction of Transit and Location

Location of Accident \ Kind of Accident / Direction	Collision with Vessels & Crafts			Grounding			Fire			Engine Trouble			Propeller Trouble			Rudder Trouble			Damage to Bouys & Crafts Equipment			Others			Total
	North	Un-known	South	North	Un-known	South	North	Un-known	South	North	Un-known	South	North	Un-known	South	North	Un-known	South	North	Un-known	South	North	Un-known	South	
Port Said & Waiting Area (~ Km 2)	9	8	4	2	1	3				1	1	1		1				1	1	1	5	1		5	48
Around Port Said Bypass (Km 2~20)				3		3						3				2		1	1			1			14
(Km 20~50)						3										1		1			1			1	7
Around El-Ballah Bypass (Km 20~62)				2		21				1		4	1		2						2				33
(Km 62~73)						3			1		1														5
Around Timsah Lake (Km 73~82)			1	3		4				2			1								1				12
(Km 82~94)			1			1						1	1												4
Around Great Bitter Lake (Km 94~116)	1		2			3				2		6				1	1	1	1		2	1		1	22
Around Little Bitter Lake (Km 116~134)				2		2						2				1		1	2	1	3				14
(Km 134~155)	1					2				2		1			1			2				1		1	11
Around Port Taufiq (Km 155~162)						1												1	1		1				4
Suez & Waiting Area (Km 162~)				1	1														3			1			6
Unknown																			1						1
Sub Total	11	8	8	13	2	46	0	0	1	9	1	18	3	1	3	5	1	8	13	2	15	5	0	8	
Total	27			61			1			28			7			14			30			13			181

Table III-1-(2)-6 Kind and Number of Accidents by Size of Vessel

Size of Vessel (GT) \ Kind of Accident	Collision with Vessels & Crafts	Grounding	Fire	Engine Trouble	Propeller Trouble	Rudder Trouble	Damage to Buoys Other Equipment	Others	Total
0 ~ 1,000		1		1					2
1,001 ~ 5,000	6	7	1	2	1	3	4	3	27
5,001 ~ 10,000	3	6		9	1		3	3	25
10,001 ~ 20,000	12	27		9	3	4	10	4	69
20,001 ~ 50,000	3	13		4	1	6	11	1	39
50,001 ~	3	7		3	1	1	2	2	19
Total	27	61	1	28	7	14	30	13	181

Table III-1-(2)-7 Kind and Number of Accidents by Type of Vessel

Type of Vessel \ Kind of Accident	Collision with Vessels & Crafts	Grounding	Fire	Engine Trouble	Propeller Trouble	Rudder Trouble	Damage to Buoys Other Equipment	Others	Total
General Cargo Vessel	17	32	1	16	2	2	6	5	81
Container Vessel	4	6		1		3	8	3	25
Car Carrier					1				1
Tanker	3	7		5		3	4	3	25
Bulk Carrier		15		3	2	4	6	1	31
Tug							1		1
Others	3	1		3	2	2	5	1	17
Total	27	61	1	28	7	14	30	13	181

Table III-1-(2)-8 Kind and Number of Accidents by Condition of Vessel's Movement

Movement \ Kind of Accident	Collision with Vessels & Crafts	Grounding	Fire	Engine Trouble	Propeller Trouble	Rudder Trouble	Damage to Buoys Other Equipment	Others	Total
Under Way									
Proceeding	6	38	1	15	3	12	20	7	102
Drifting									
Making fast to pier or buoy, anchoring or Leaving	20	20		7	4		6	2	59
Sub Total	26	58	1	22	7	12	26	9	161
At Anchor									
At Buoy		2							2
At Anchorage	1			6		2	4	4	17
At Pier		1							1
Sub Total	1	3		6		2	4	4	20
Total	27	61	1	28	7	14	30	13	181

Table III-1-(2)-9 Kind and Number of Accidents by Analysis of Accidents

Kind of Accident / Analysis of Accident	Collision with Vessels & Crafts	Grounding	Engine Trouble & Grounding	Propeller Trouble & Grounding	Rudder Trouble & Grounding	Other Trouble & Grounding	Total
Interference by Other Vessels							
None		46			2	1	49
Navigating in Same Direction	3	5					8
Crossing	3						3
Others	13	1					14
Unknown							
Sub Total	19	52			2	1	74
Radar							
Non-equipped							
In Use	3	28			1		32
Not in Use	19	25			1		45
Unknown						2	2
Sub Total	22	53			2	2	79
Auto Pilot							
In Use							
Not in Use	21	51			2	1	75
Unknown	1					1	2
Sub Total	22	51			2	2	77
Engine Remote Control							
Non-equipped	1	8			1	1	11
In Use	3	8			1		12
Not in Use	17	36				1	54
Unknown if in Use		1					1
Unknown	1						1
Sub Total	22	53			2	2	79
Speed just before Collision or Grounding							
0 Knots	6	4					10
0 ~ 2 Knots	6	14					20
2 ~ 4 Knots	1	3					4
4 ~ 6 Knots	2	7			1		10
6 ~ 8 Knots	5	19				1	25
8 ~ 12 Knots	1	4			1		6
12 ~ 16 Knots		1					1
16 ~ 20 Knots	1	1					2
Moving Astern							
Sub Total	22	53			2	1	78
Number of Duty Persons on Deck							
1 person		1					1
2 persons							
3 persons		1				1	2
4 persons	2	3					5
None	1						1
Unknown	16	44			2	1	63
Sub Total	19	49			2	2	72

Table III-1-(2)-9 (Continued)

Analysis of Accident \ Kind of Accident	Collision with Vessels & Crafts	Grounding	Engine Trouble & Grounding	Propeller Trouble & Grounding	Rudder Trouble & Grounding	Other Trouble & Grounding	Total
Measure for Avoidance just before Collision or Grounding							
Reducing Speed	8	31			2	1	42
Steering Wheel	6	9					15
Reducing Speed & Signal for Reducing							
None		2					2
Unknown	5	10					15
Sub Total	19	52			2	1	74
Grounding (Place of Grounding)							
Bank		38			2	1	41
Shallow Water		15					15
Sub Total		53			2	1	56
Collision (Situation)							
Crossing Situation	4						4
Overtaking Situation	3						3
Sub Total	7						7
Collision (Meeting)							
Others	11						11
None	1						1
Unknown	2						2
Sub Total	14						14
Collision (Opposite Vessel or Object)							
Passenger & Ferry	1						1
General Cargo or Carrying only One Kind of Goods	6						6
Container	1						1
Tug	9						9
Dredger	2						2
Other Vessel	6						6
Others	2						2
Sub Total	27						27
Total	193	416	0	0	16	12	637

III-2 Fire and Pollution

(1) Spill

Those spill accidents that have occurred in the 7 years to 1982 are as shown in Table III-2-(1)-1. Among other spill accidents, a relatively large scale accident occurred in February, 1977 involving "Safina Star" and causing a spill of 600 tons of crude oil over at Bitter Lakes Km 116, and another one occurred in February, 1979, involving "Skyron II", and causing a spill of more than 1,000 tons of crude oil at Km 155.

Both cases occurred when the respective vessels came in contact with the bottom of the Canal or the bank but not by collision with other vessel. The range of the area affected by the spilled oil was a 4-km area extending from Km 116 to Km 112 in case of "Safina Star" and "Skyron II" case was a 13.6 km area from Km 155.6 to Km 142. In both cases, it took 2 days to control the entire accident. Dispersant was sprayed from small boats using fire pumps and educators, and from tug boats using monitors. Additionally, a skimmer (normally used for training purposes) was used in these cases of fairly large scale spills, but the skimmer failed to function properly, and spilled oil could not be recovered.

(2) Fire Fighting

SCA dealt with 7 vessels that caught fire in the 3 years, to 1982 3 happened outside of the breakwater of Port Said -- they were laden old general cargo vessels (1,000 – 5,000 gross tons), of which 2 caught fire in the engine room at anchorage and the other hit the breakwater and the cargo of carbide exploded on the breakwater.

SCA dispatched tug boats and small boats immediately and the tugs sprayed foam and sea water for firefighting. 2 vessels were towed from the anchorage to the shallow place near the breakwater.

4 were dealt with in the Suez area.

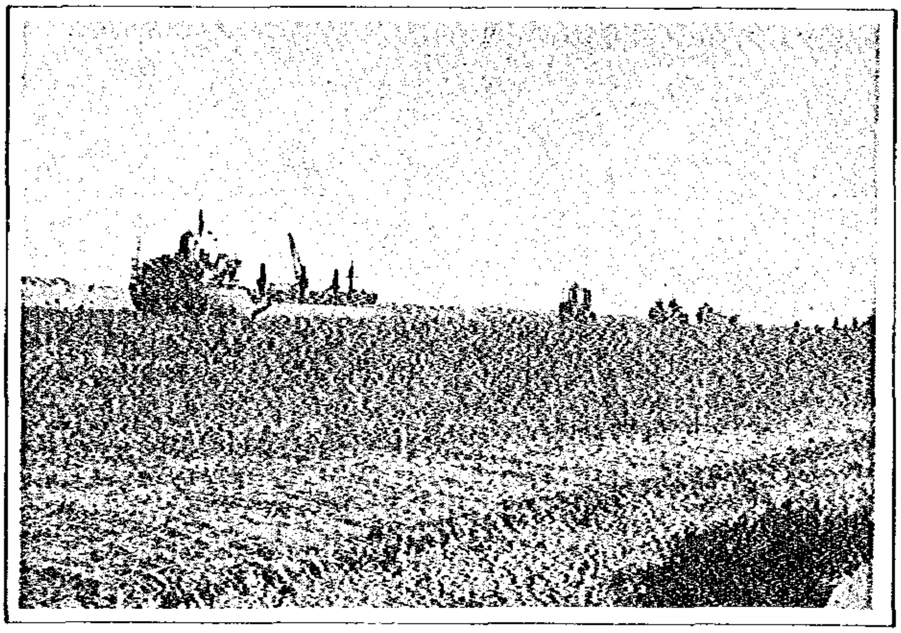
3 general cargo vessels (800 – 8,00 gross tons) caught fire at anchorage.

1 southbound general cargo vessel (4,000 gross tons) that was loaded with cotton goods caught fire during transit. SCA dispatched tug boats and small boats to extinguish the fire by using sea water, foam and dry chemical powder.

Table III-2-(1)-1 List of Spills

Month Year	Ship's Name	Location	Cause of Accident	Kind of Spilt Oil	Amount of Spilt Oil
November 1976	Stanros Cmhaneal	Ballah Km 59	Unknown	Fuel oil	1 ~ 3 tons
February 1977	Safina Star	Bitter Lakes Km 116	Touched Bottom	Crude oil	about 600 tons
November 1977	Man Ming	Km 93.6	Mistake	Bilge oil	Very minor
January 1978	Milos Majestic	Km 32	Touched Bank	Crude oil	1 ~ 3 tons
February 1979	Skyron II	Km 155	Touched Bank	Crude oil	More than 1,000 tons

PART IV. EVALUATION OF CANAL CONDITIONS



Ballah West Branch

PART IV EVALUATION OF CANAL CONDITIONS

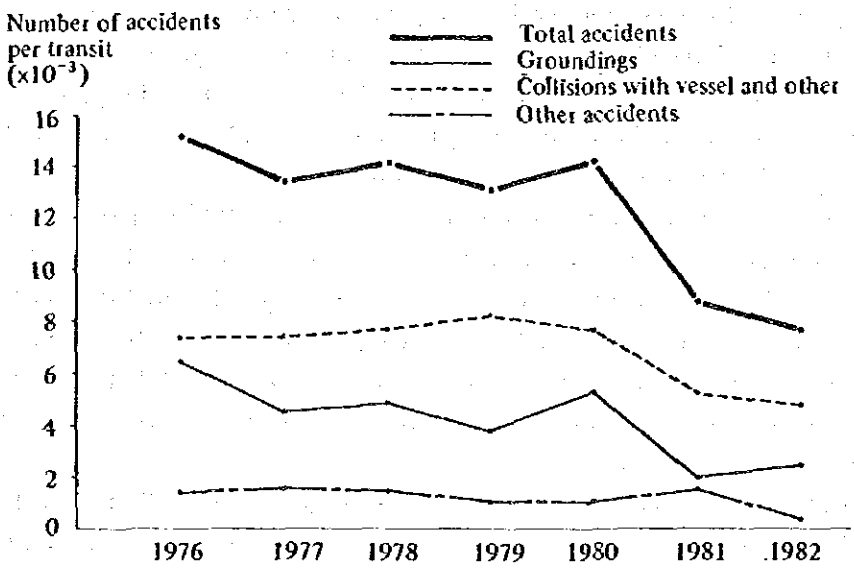
IV-1 Existing Risk Level

(1) Evaluation of the Accident Records of the SCA

1) Annual Changes in Risk Level

Fig. IV-1-(1)-1 shows the annual changes in risk level per transiting vessel in the period from 1976 to 1982 according to the accident records of the SCA, and compares the mean risk levels in the pre-widening/deepening period from 1976 to 1980 and the post-widening/deepening period from 1980 to 1981.

It is clear that the risk level of transiting vessels decreased from the widening/deepening of the Canal as shown in Table IV-1-(1)-1. Thus, the widening/deepening has definitely contributed to the enhancement of the safety of transiting vessels in the case of the Suez Canal.



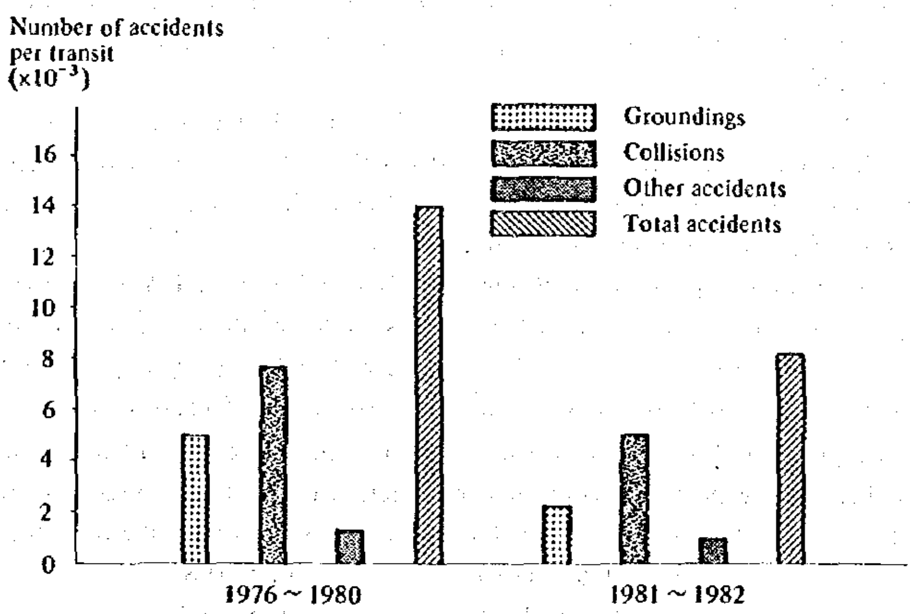


Fig. IV-1-(1)-1 Risk Level by Year

Table IV-1-(1)-1 Comparison of Risk Level between 1976 ~ 1980 and 1981 ~ 1982 by Kind of Accident

	1976 ~ 1980	1981 ~ 1982
Groundings	4.95×10^{-3} (100%)	2.27×10^{-3} (46%)
Collisions	7.66×10^{-3} (100%)	5.03×10^{-3} (66%)
Others	1.34×10^{-3} (100%)	0.93×10^{-3} (69%)
Total Accidents	3.96×10^{-3} (100%)	8.23×10^{-3} (59%)

2) Monthly Changes in Risk Level

Fig. IV-1-(1)-2 shows the number of accidents by month for the three periods, i.e., the pre-widening/deepening period, post-widening/deepening period and the 7-year period from 1976 to 1982. The statistical curves representing the pre-widening/deepening period have their peaks in March, April and in December which are analogous to those showing the frequency of wind exceeding 22 knots in Histogram of Wind Velocity (1978 ~ 1980) and suggesting that there are very close relations between the occurrence of groundings and collisions in particular and the strong winds caused by sandstorms with resultant restricted visibility.

The curves for the post-widening/deepening period from 1981 to 1982, on the other hand, show that the abovementioned correlation between accidents and sandstorms is not so significant, thus proving that the widening/deepening of the Canal has lowered the risk level caused by sandstorms. However, the seasonal trend featuring higher risk levels in the spring and winter and lower levels in the summer still remains. It is therefore considered that the establishment of effective measures against sandstorms is extremely important for the enhancement of the safety of vessels within the water of the Canal.

Fig. IV-1-(1)-3 to IV-1-(1)-9 show the risk levels by month at Port Said, El Ballah, Lake Tismah, Great Bitter Lake, El Kabrit, the section from Km 135 to 161, and Suez for the three periods, i.e., the pre-widening/deepening period from 1976 to 1980, post-widening/deepening period from 1981 to 1982 and the 7-year period from 1976 to 1982, respectively.

(i) Port Said

In the case of Port Said shown in Fig. IV-1-(1)-3, the frequency of collision accidents is much higher than for other types of accidents through the year. It is therefore considered important to establish effective safety measures against accidents, with emphasis laid on collisions in particular, irrelevant to time of year.

Although the peaks of collision accidents in March and April in the pre-widening/deepening period has been lowered in the post-widening/deepening period, peaks of leasser intensity still remain in January, February, April and May. Noting such a fact, it is considered necessary to establish safety measures against the effects of sandstorms as well.

Despite the fact that decreasing of the number of vessels of the northbound convoy pass through the port due to the new completion of the Port Said Bypass, the overall risk level in Port Said has not come down much as may be seen from the records as given below:

1976 ~ 1980	1981 ~ 1982
3.09×10^{-3}	2.92×10^{-3}

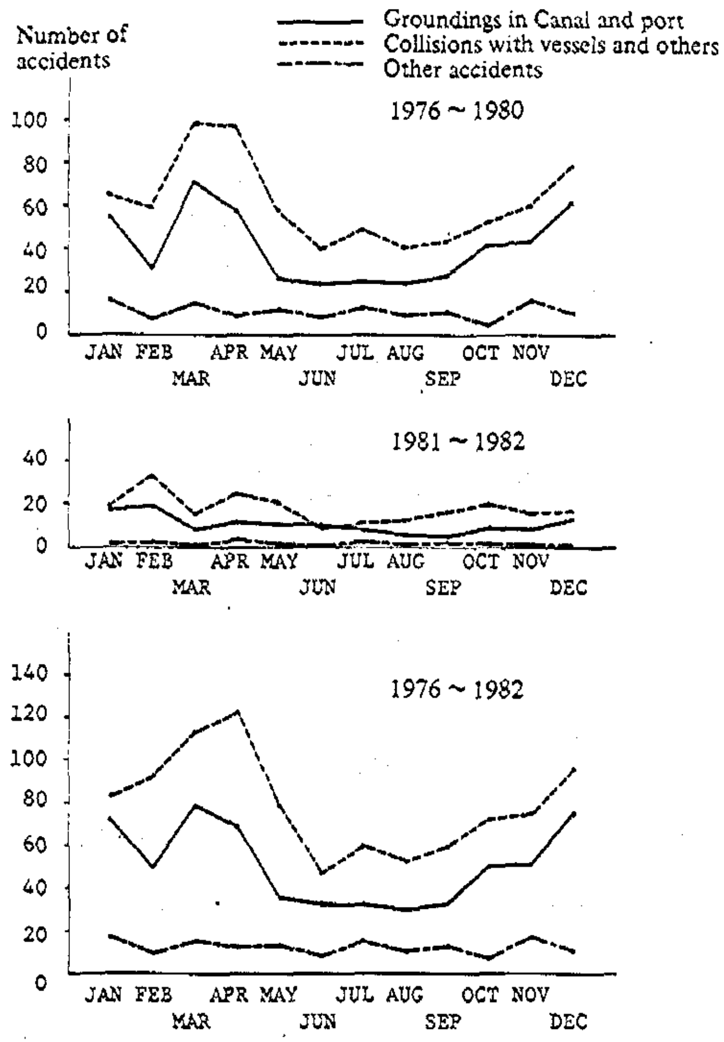


Fig. IV-1-(1)-2 Number of Accidents by Month

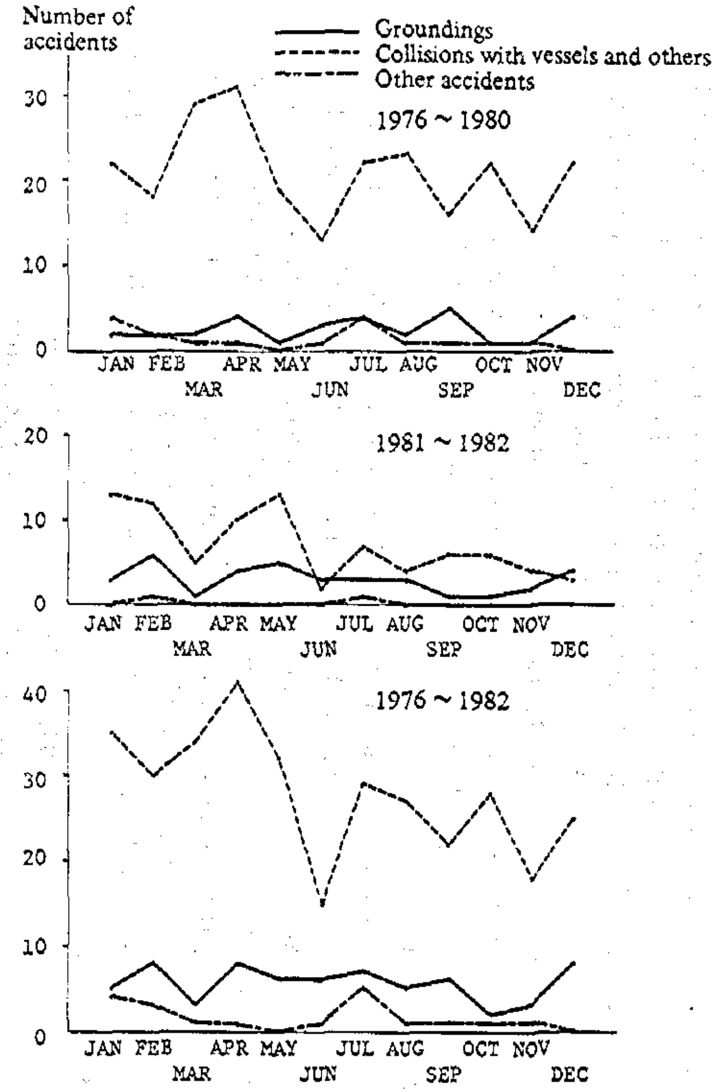


Fig. IV-1-(1)-3 Number of Accidents at Port Said by Month

(ii) El Ballah

In the water in the vicinity of El Ballah as shown in Fig. IV-1-(1)-4, the peaks of risk level in March, April, November and December in the pre-widening/deepening period have almost entirely diminished in the post-widening/deepening period. Thus it may be said that the effects of sandstorms in this area have decreased to a considerable extent by the widening/deepening of the Canal as far as the statistical results are concerned.

The overall risk levels in El Ballah decreased to an approximate level of 1/3 as below:

1976 ~ 1980	1981 ~ 1982
1.73×10^{-3}	0.59×10^{-3}

The effects of tug assistance rendered in the tying up operations of vessels may also be counted as a positive factor for this improvement.

(iii) Lake Timsah

With reference to water in the vicinity of the Lake Timsah shown in Fig. IV-1-(1)-5, the accident statistics concerned featured the highly frequent occurrences of grounding in March, April and December in the pre-widening/deepening period. This trend has become less significant. Note, however, that a new trend of higher risk level in collisions and groundings in February has surfaced in the post-widening/deepening period, and the establishment of seasonal safety measures may be considered necessary.

The overall risk levels in water in the vicinity of the Lake Timsah are as low as those shown below:

1976 ~ 1980	1981 ~ 1982
0.89×10^{-3}	0.36×10^{-3}

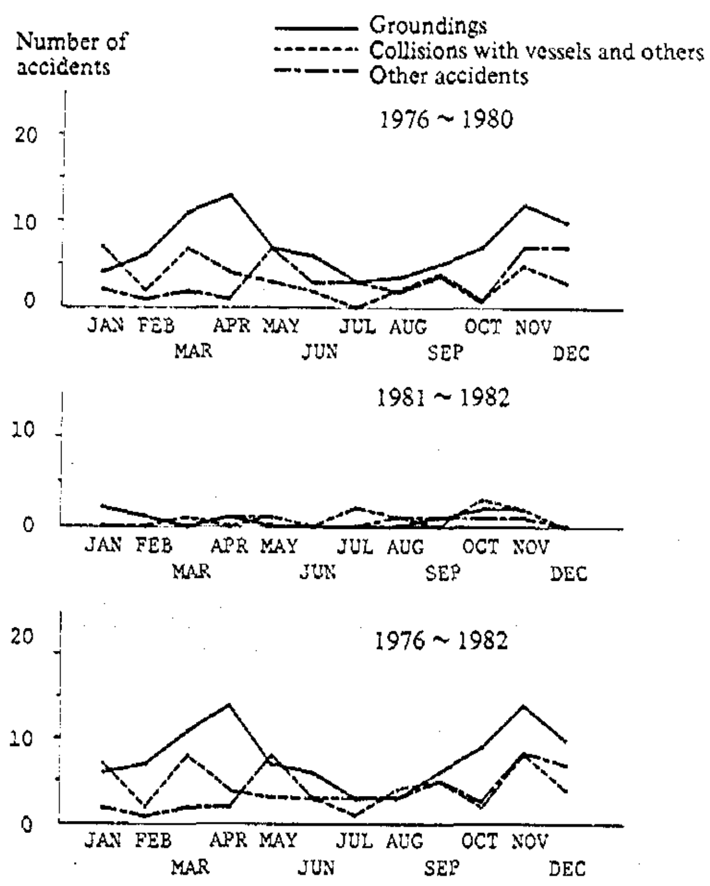


Fig. IV-1-(1)-4 Number of Accidents at El Ballah by Month
(Km 50 ~ 63)

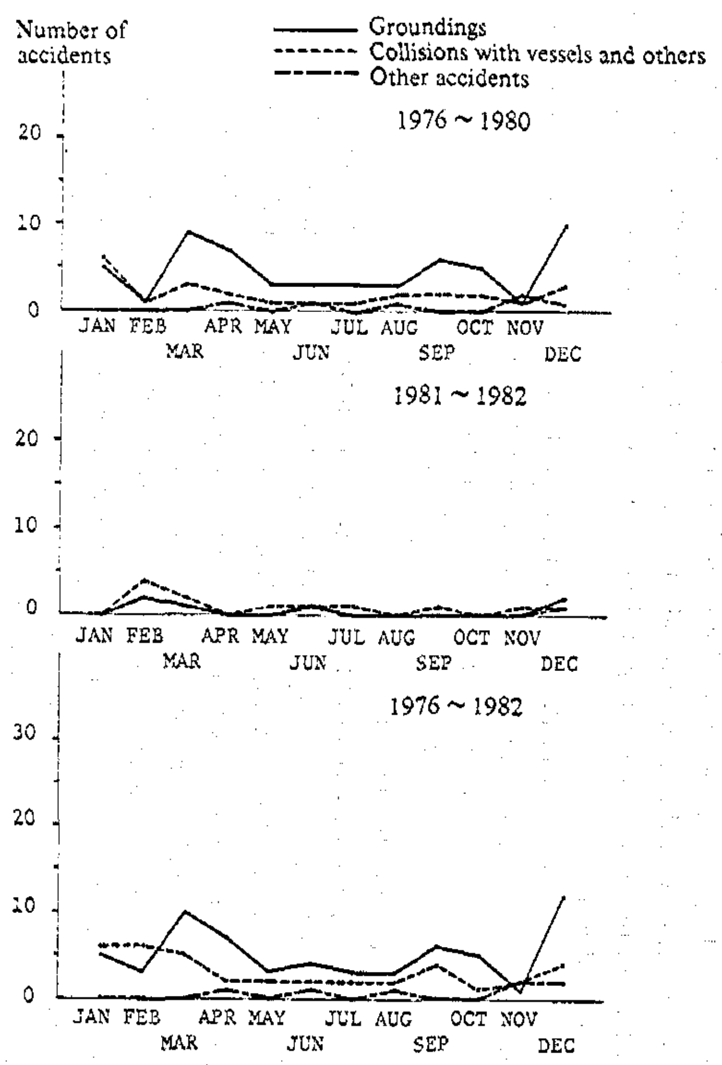


Fig. IV-1-(1)-5 Number of Accidents at Lake Timsah by Month
(Km 75 ~ 81)

(iv) Great Bitter Lake

Regarding the risk level in the Great Bitter Lake as shown in Fig. IV-1-(1)-6, it may be seen that the peaks of risk level involving collisions evident in April and December in the pre-widening/deepening period have shifted to February and December in the post-widening/deepening period with the seasonal trend of higher risk level in the winter and spring and lower level in the summer remaining unchanged. This may be considered attributable to the effect of sandstorms.

The overall risk levels in the Great Bitter Lake decreased to the levels shown below, but the decrease is not as significant as in other areas of the Canal:

1976 ~ 1980	1981 ~ 1982
0.90×10^{-3}	0.59×10^{-3}

(v) El Kabrit and Little Bitter Lake

In waters in the vicinity of El Kabrit and the Little Bitter Lake shown in Fig. IV-1-(1)-7, apparent peaks in the risk level of groundings which were in March, April and December, and of collisions in March, April, May, November and December in the pre-widening/deepening period have eased down in the post-widening/deepening period with a trend of occurrences of groundings and collisions in February.

The effects of widening and deepening coupled with the introduction of the multi-track system may be considered as the contributing factors for the improvement.

The overall risk levels in waters in the vicinity of El Kabrit and the Little Bitter Lake have come down remerkably as shown below:

1976 ~ 1980	1981 ~ 1982
1.86×10^{-3}	0.59×10^{-3}

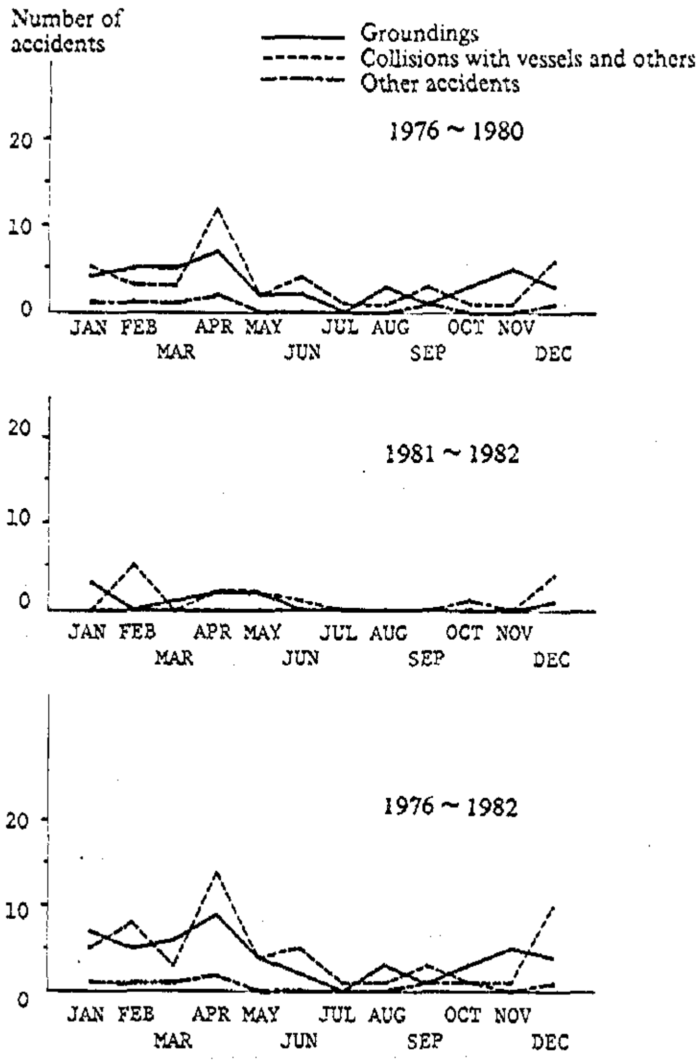


Fig. IV-1-(1)-6 Number of Accidents at Great Bitter Lake by Month

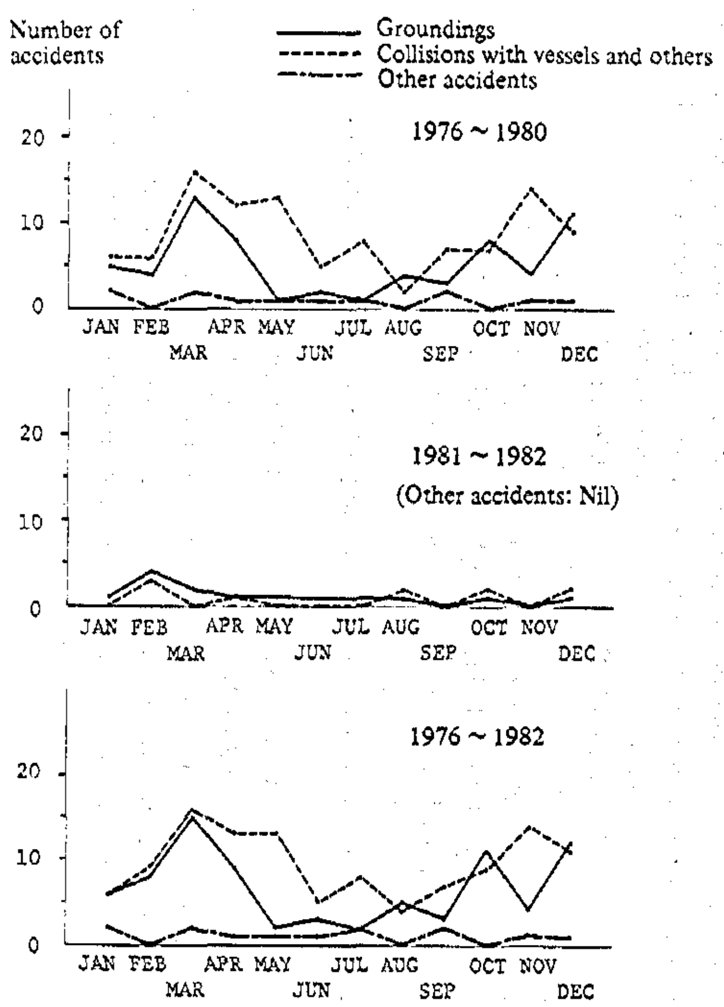


Fig. IV-1-(1)-7 Number of Accidents at El Kabrit and Little Bitter Lake by Month

(vi) Km 135 ~ 161

In the section of the Canal from Km 135 to 161 shown in Fig. IV-1-(1)-8, risk levels are high in the period from October to April and low in the period from May to September, and this trend remains even after the widening and deepening of the Canal, but the overall risk level in this area has demonstrated the greatest decrease in the Canal as shown below:

1976 ~ 1980	1981 ~ 1982
1.30×10^{-3}	0.36×10^{-3}

vii) Suez

The overall risk levels in Suez shown in Fig. IV-1-(1)-9 featuring the peaks in collision accidents in the period from February to May and again from November to December diminished in the period in and after 1981, and the seasonal trend in this area has vanished away in the absence of clear evidence.

The overall risk levels in water in the vicinity of Suez have not come down much as shown below:

1976 ~ 1980	1981 ~ 1982
1.30×10^{-3}	1.11×10^{-3}

The results of the above discussions on the monthly changes in risk level clearly show that establishment of effective safety measures to counter seasonal fluctuations in all waters of the Canal, Lakes and Ports is necessary where particular efforts must be made in establishing effective measures against sandstorms.

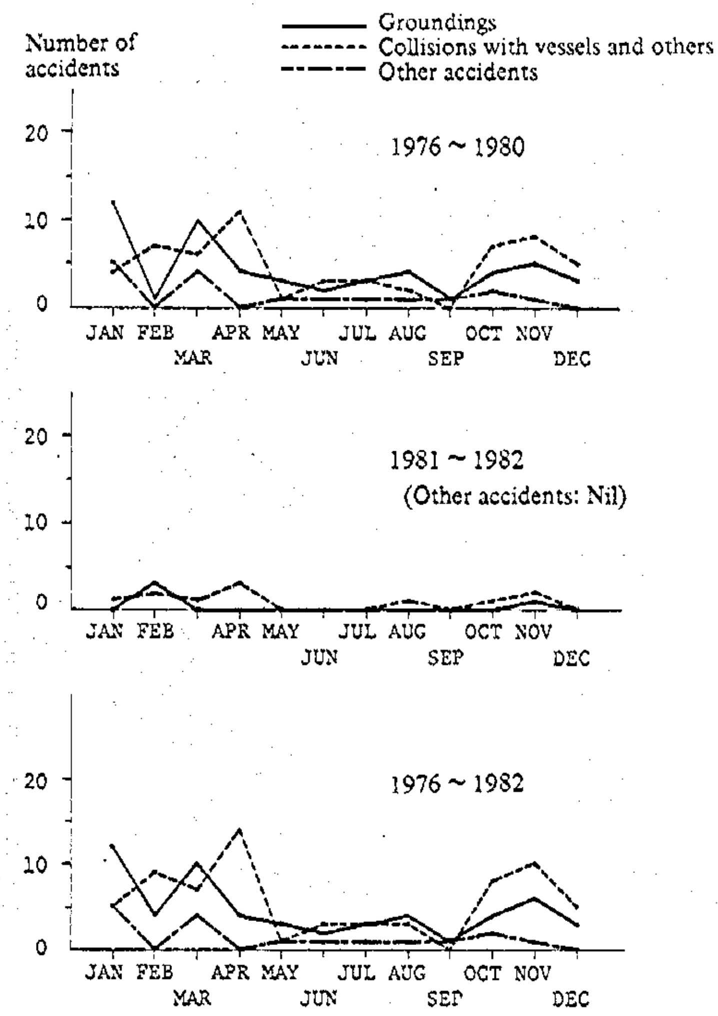


Fig. IV-1-(1)-8 Number of Accidents at Km 135 ~ 161 by Month

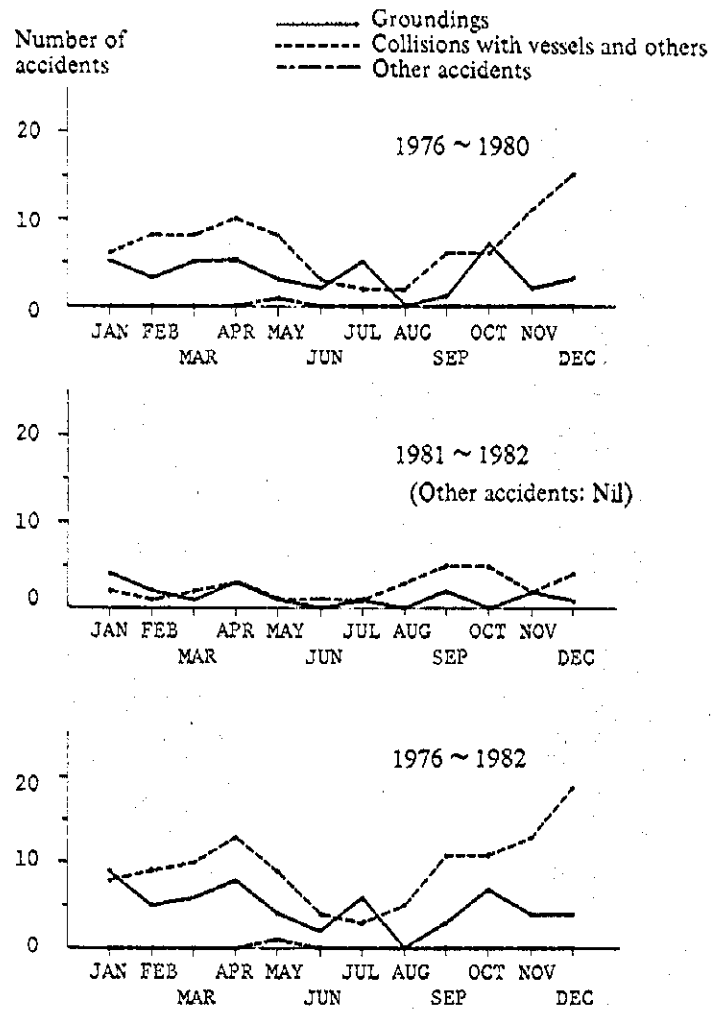


Fig. IV-1-(1)-9 Number of Accidents at Suez by Month

3) Locational Changes in Risk Level

Fig. IV-1-(1)-10 shows the locational changes in risk level in the three periods, i.e., the period from 1976 to 1980, from 1981 to 1982 and the total period from 1976 to 1982, and Table IV-1-(1)-2 compares the risk levels in the period from 1976 to 1980 and the period from 1981 to 1982 by location.

It may be seen that the collision cases in the period from 1976 to 1980 are highly concentrated in Port Said with a much smaller peak in El Kabrit, but those in other areas are more or less on the same level. Grounding cases have three peaks in El Ballah, Lake Timsah and El Kabrit.

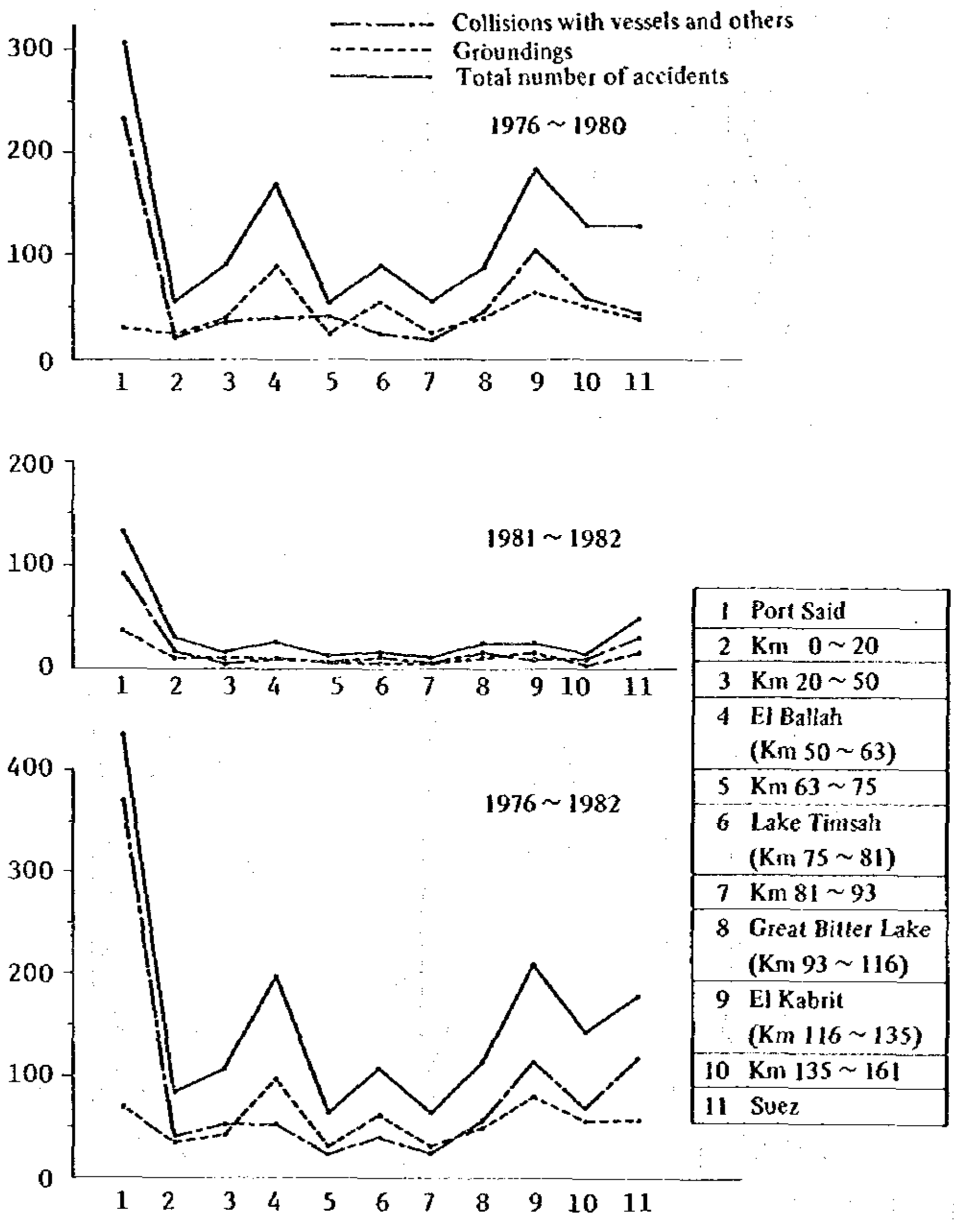


Fig. IV-1-(1)-10 Number of Accidents by Position

Table IV-1-(1)-2 Comparison of Risk Level by Position

Position	Risk Level	
	1976 ~ 1980	1981 ~ 1982
1. Port Said	3.09×10^{-3}(100%)	2.92×10^{-3} (94%)
2. Km. 0 ~ 20	0.54×10^{-3}(100%)	0.68×10^{-3} (126%)
3. Km. 20 ~ 50	0.92×10^{-3}(100%)	0.36×10^{-3} (39%)
4. El Ballah (Km. 50 ~ 63)	1.73×10^{-3}(100%)	0.59×10^{-3} (34%)
5. Km. 63 ~ 75	0.54×10^{-3}(100%)	0.23×10^{-3} (43%)
6. Lake Timsah (Km. 75 ~ 81)	0.89×10^{-3}(100%)	0.43×10^{-3} (40%)
7. Km. 81 ~ 93	0.55×10^{-3}(100%)	0.23×10^{-3} (42%)
8. Great Bitter Lake (Km. 93 ~ 116)	0.90×10^{-3}(100%)	0.59×10^{-3} (66%)
9. Kabrit (Km. 116 ~ 135)	1.86×10^{-3}(100%)	0.59×10^{-3} (32%)
10. Km. 135 ~ 161	1.30×10^{-3}(100%)	0.36×10^{-3} (28%)
11. Suez	1.30×10^{-3}(100%)	1.11×10^{-3} (85%)
Unknown	0.32×10^{-3}(100%)	0.18×10^{-3} (56%)
Total	13.94×10^{-3}(100%)	8.27×10^{-3} (59%)

In the assessment of the period from 1981 to 1982, significant peaks are seen in Port Said and Suez for both collisions and groundings, whereas the risk levels in the intermediate canal and lakes assume relatively flat curves. This may be interpreted that the widening and deepening of the Canal have resulted in the overall decrease of accidents within the Canal waters with average locational differences in risk level.

When comparison is made on the risk levels between the period from 1976 to 1980 and the period from 1981 to 1982, the level of Port Said is 94% and that of Suez is 85% if the level in the former period is taken as 100%. Thus the risk levels in the post-widening/deepening period are characterized by slight decreases. From this, we can conclude that establishment of measures for the enhancement of the safety of vessels in Port Said and Suez, especially in Port Said is of paramount importance.

Following Port Said and Suez, the risk level in the Great Bitter Lake shows a 66% rate of decrease, thus establishment of safety measures in these areas is also considered necessary.

In waters of the Canal other than ports and lakes, the risk levels have come down to 30 ~ 40%, and hence, it may be fair to say that the widening and deepening of te Canal has contributed to the reduction of risk levels in all the Canal water areas to 30 ~ 40%. This decrease of the risk level is due to the widening and the deepening of the Canal, the completion of the execution and also to the improvement of the navigation aids and the mooring operations.

4) Investigation of Risk Levels by Northbound/Southbound and by Daytime/Nighttime

Fig. IV-1-(1)-11 shows the risk levels in the three periods, i.e., the period from 1976 to 1980, the period from 1981 to 1982 and the overall period from 1976 to 1982 as classified by transiting direction, i.e., northbound and southbound. (In this figure, those with direction of transit unidentifiable are not included. The apparent low risk levels in Port Said and Suez are caused by this statistical procedure.)

Fig. IV-1-(1)-12 shows the risk levels in the three periods classified by daytime and nighttime.

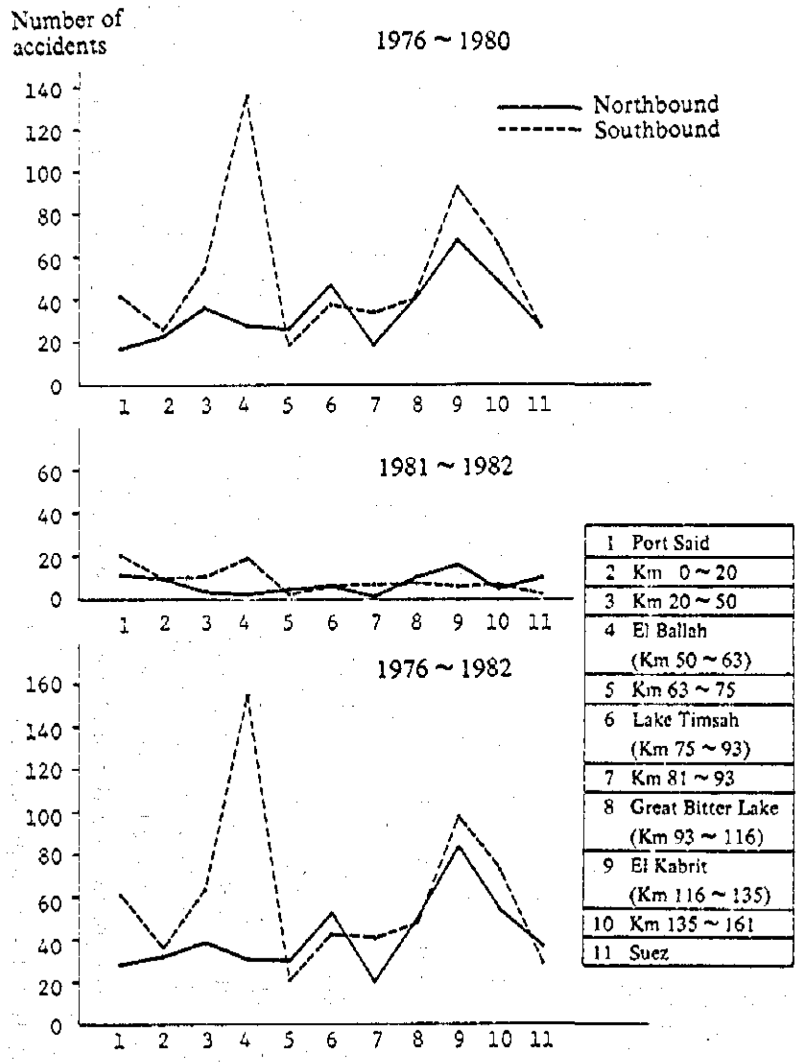


Fig. IV-1-(1)-11 Number of Accidents by Direction of Transit and Position

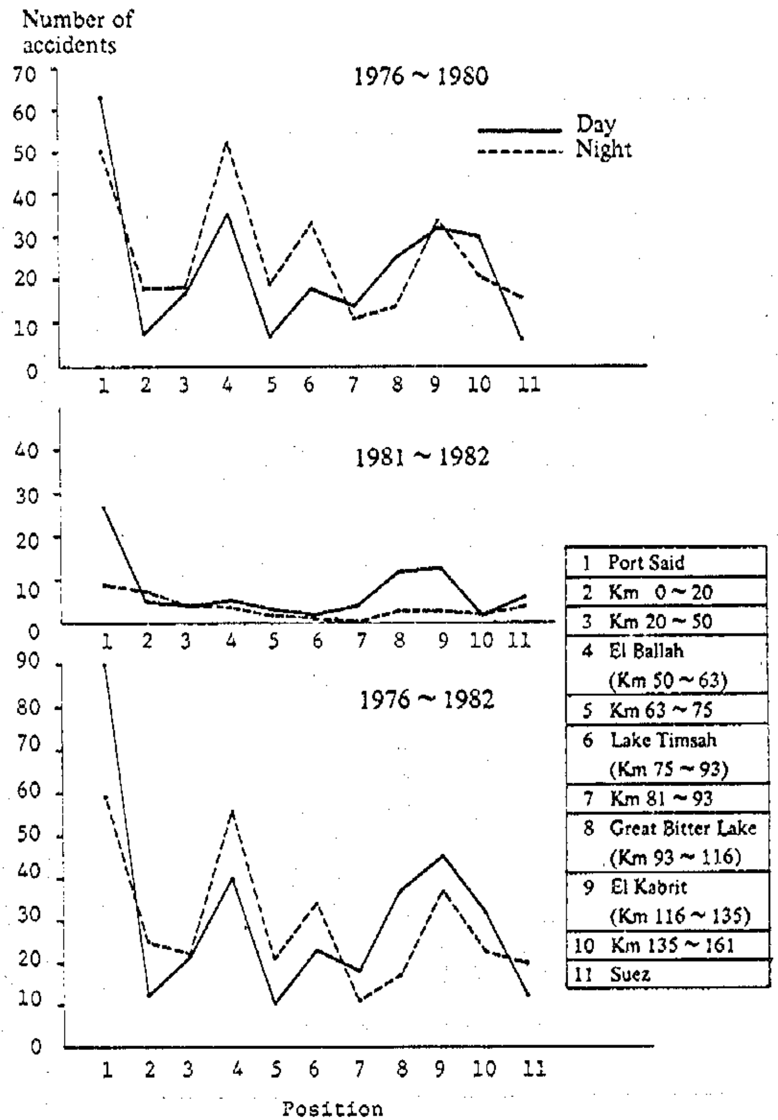


Fig. IV-1-(1)-12 Number of Accidents by Day/Night and Position

In our investigation on the risk levels by transiting direction, it was found in the period before the widening/deepening that those accidents caused by vessels of the southbound convoy in the vicinity of El Ballah are particularly significant followed by those caused by vessels of the southbound convoy in El Kabrit. In the case of vessels of the northbound convoy, a peak is seen in El Kabrit though it is not so remarkable as in the case of vessels in the southbound convoy.

As distinct from the above, after the widening/deepening period, changes at one each peak can be noted in El Ballah involving vessels in the southbound convoy and in El Kabrit in vessels in the northbound convoy. The reason behind the low risk level in the vicinity of El Kabrit involving vessels in the northbound convoy in the period from 1981 to 1982 may be the effects of the widening and deepening of the Canal and introduction of the multi-track system. The reason behind the phenomenon of significantly high risk levels in vessels in the southbound convoy in the vicinity of El Ballah is explained by the frequent occurrence of groundings and contracts to the banks during the mooring operations of the second southbound convoy.

Regarding the risk levels classified in Fig. IV-1-(1)-12 by daytime and nighttime, there is not much difference between the pre-widening/deepening period and post-widening/deepening period, but if the difference in service frequency that lies between daytime and nighttime is considered, it may sound natural that the higher risk level is seen in the nighttime.

5) Comparison of Risk Levels in the Suez Canal with levels in Other Canals

Table IV-1-(1)-3 compares the risk level of the Suez Canal with those of other canals.

Note, however, that statistical procedures employed differ from place to place, and thus comparison of these statistical data on a compatible basis involves considerable difficulties.

Table IV-1-(1)-3 Comparison of Risk Levels with Other Canals

Name of Canal	Number of Transit Vessels	Number of Accidents	Length of Canal (Km)	Risk Level per Kilometer
Sueze Canal (1982)	22,545	174	162	4.76×10^{-5}
North Sea Canal (1980)	18,672	1	33	0.16×10^{-5}
Kiel Canal (1982)	64,782	265	99	4.13×10^{-5}
Panama Canal (1982)	14,009	71	82	6.18×10^{-5}
Average	30,002	128	94	4.54×10^{-5}

Note: These data were compiled under various systems.
Statistical comparison of these data on a compatible basis involves considerable difficulties.

6) Importance of Accident Records

The data appearing on the SCA's accident records are insufficient, and the statistics obtained from these data through statistical procedures are of limited value.

It is suggested that the extreme importance of correct recording of the details of accidents, their proper processing, analytical studies on the processed data and fair evaluations of the results be recognized.

(2) Discussions on Accident Records in the Preliminary Study Team Format

1) Causes of Accidents

Of the 56 causes of collision, 17 causes of unskilled ship manoeuvering techniques and 15 causes of erroneous engine operation attract attention.

The causes of grounding accidents are much the same where, 17 out of the total 112 causes of grounding are attributable to unskilled ship manoeuvering techniques and the same number of grounding accidents were caused by erroneous engine operation. The remaining causes, however, in descending order, are 11 causes of abnormal weather, 10 causes of poor lookout, 7 causes of improper hull and equipment maintenance, 7 causes of improper machinery maintenance, and 6 causes of negligent observation of weather and sea conditions.

The five major causes of accidents may be broken down as below:

Unskilled ship manoeuvering techniques'	49
Erroneous engine operation	45
Poor machinery maintenance	35
Poor lookout	28
Poor maintenance of hull and equipment	23

The most distinct features of the causes of accidents in perspective are that 269 cases out of the total 325 cases were attributable to such causes arising from human factors as unskilled ship manoeuvering techniques, poor machinery maintenance and erroneous engine operation, poor lookout, etc., accounting for as high as 82.8% of the accidents, and those cases attributable to causes other than human factors were 56 or 17.2%.

It goes without saying that a considerable number of cases of groundings were attributable to causes related to weather conditions.

It is considered essential that the SCA reduce occurrences of such frequent human-caused marine casualties through greater efforts in the education and training of Canal pilots.

2) Relationship between the Position of Vessels in a Convoy and Risk Level

Fig. IV-1-(2)-1 shows the risk levels as correlated to the position of vessels in convoys.

In collision cases, risk levels are high for the first 40% of vessels in a convoy, whereas those in the rear 60% of the convoy suffer most from grounding accidents.

When the total accidents are considered, those vessels in the middle part of the convoy from 20 to 60% comprise a majority, but the frequency of accidents is lower in vessels in the foremost part of the convoy. This may be attributable to the fact that those vessels in the forward part of the convoy can readily increase their speed when required for their manoeuvres, whereas vessels running in the middle have no such freedom in manoeuvres due to the obligation to observe the established ship-to-ship distance and other restrictions. In this connection, it is believed essential to have controls over transit vessels to observe their assigned ship-to-ship distance in a better way and to encourage better formation of the convoy in motion.

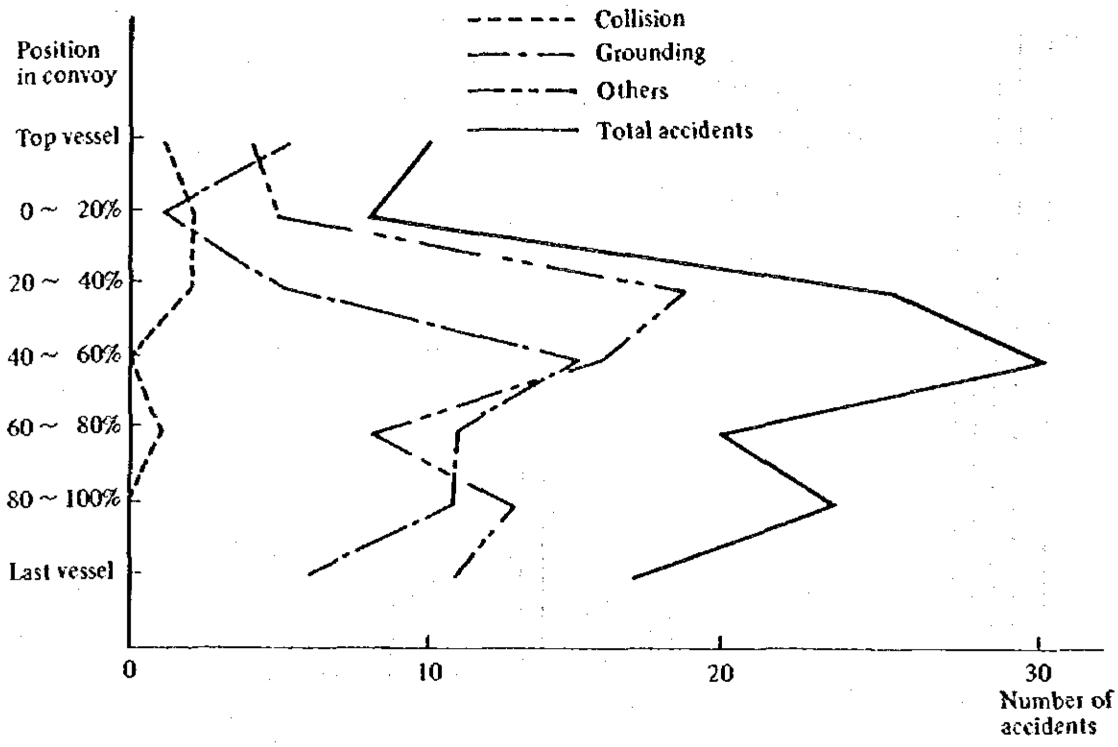


Fig. IV-1-(2)-1 Number of Accidents by Vessel's Position in Convoy

3) Relationship between Risk Levels and Number of Vessels per Convoy

In the case of grounding, a convoy consisting of 21 to 25 vessels and another of 6 to 10 vessels suffer most from marine casualties. As a whole, the 21 to 25 vessels group accounts for 62 out of the total 180 incidents marking the highest rate followed by the 6 to 10 vessels group with 29 cases.

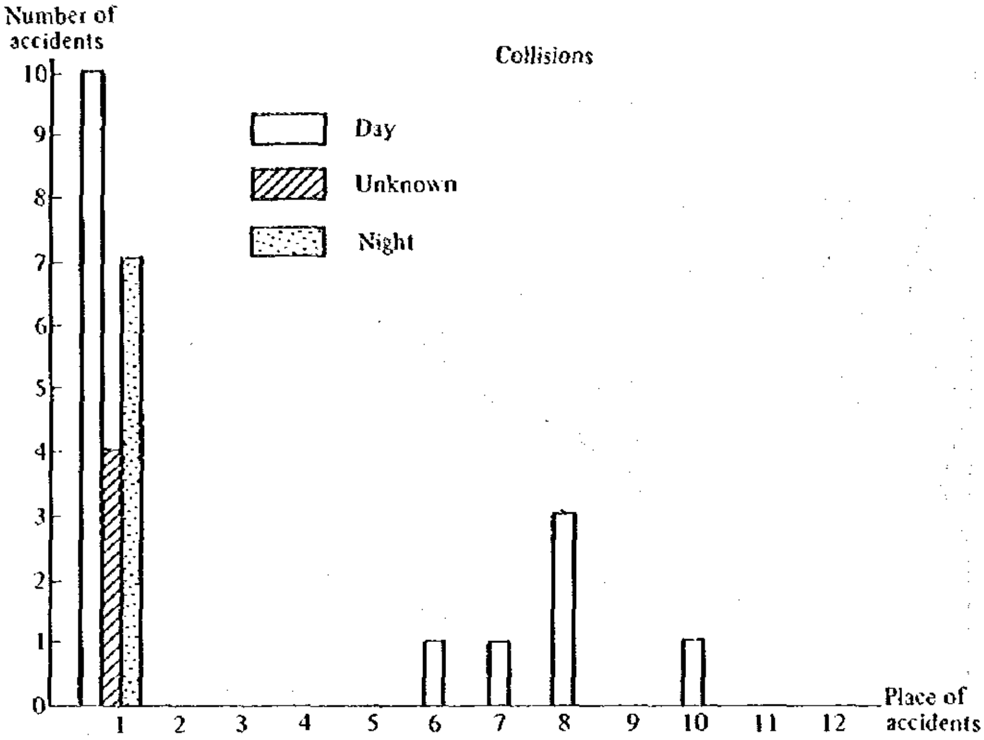
The fact that most convoys consist of 21 to 25 vessels is the cause of the distinct peak in the statistical data, but the reason why the second highest peak is displayed by the 6 to 10 vessels group could be the large number of accidents experienced in the tie up operation of the No. 2 southbound convoy vessels at the West Branch of El Ballah.

4) Relationship between Place of Accident and Time of the Day Whether it is Daytime or Nighttime

Fig. IV-1-(2)-2 shows the numbers of collision and gorunding accidents classified by place of accident, and time of the day whether it is daytime or nighttime.

The frequency of collision accidents is highest in Port Said where the frequency ratio of accidents in daytime to those in nighttime is 10:7.

The frequency of grounding accidents is highest in El Ballah where the frequency ratio of accidents in daytime to those in nighttime is 14:7. The same ratio of the total grounding cases is 33:24.



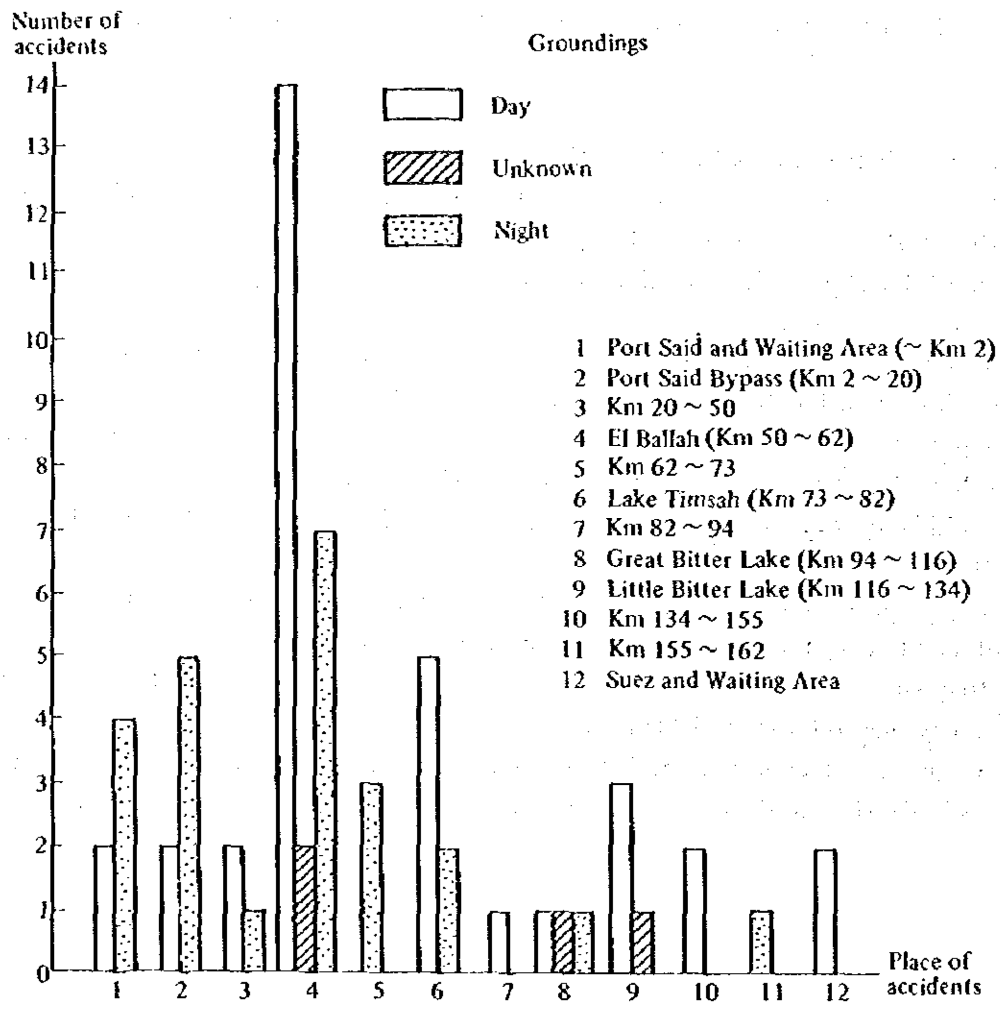


Fig. IV-1-(2)-2 Number of Accidents by Day/Night and Position

Generally, the frequency of grounding accidents is higher in daytime than in nighttime, but in the cases of Port Said and its waiting area, and Port Said Bypass, the frequency in nightime assumes twice or more of that in daytime, and this is considered to be one of the features inherent to this region of the Canal. In this connection, the improvement and reinforcement of aids to navigation covering the water of this region is strongly impressed.

Although it is statistically shown that the ratio of accidents in daytime to nighttime is approximately 2:1 if all accidents are considered, if the amount of traffic in daytime and nighttime are taken into account, it may be fair to comment that the difference in accident frequency by time of the day whether it is daytime or nighttime does not suggest any trend of appreciable significance.

5) Relationship between Place of Accidents and Direction of Transit

As mentioned above, collision accidents are heavily concentrated in Port Said and its associated waters where the ratio of such accidents northbound to southbound is 9:4.

When the subject comes to grounding accidents, the ratio is heavily biassed by southbound vessels as can be seen in the data of 13:46. Such a heavy concentration of grounding accidents in the southbound passage is caused by the frequent groundings or contacting the Canal banks in the Ballah West Branch at the time of the mooring operations of the No. 2 southbound convoy. This is exactly what we observed when we discussed the accident record of the SCA.

Leaving the discussions in detail to be given later, it should be noted that considerations must be taken for the reinforcements of tugs as well as the improvement in ship manoeuvring procedure for due reduction of risk levels in this area of the Canal.

6) Relationship between Gross Tonnage and Frequency of Accidents

Fig. IV-1-(2)-3 shows the gross tonnage distribution of vessels involved in accidents classified by major types of accident.

In each accident group, vessels with gross tonnage in a range from 10,000 to 20,000 tons exhibit closely analogous distribution patterns. However, this is nearly identical with the gross tonnage distribution of vessels transiting the Canal, and thus it may be concluded that ship size and risk level have no meaningful relationship.

It is generally said that larger vessels have higher risk levels, but in the case of the Suez Canal, the risk levels of large vessels transiting the Canal might have been mitigated due to the arrangement of escort boats and pilotage services by the Chief Pilot for large vessels and the special arrangement of extra pilots.

7) Relationship between Ship Type and Frequency of Accidents

Fig. IV-1-(2)-4 shows the relationship between ship type and frequency of accidents with associated data showing the number of vessels which transited the Canal during the one-year period in 1983.

These curves are in extremely good agreement with each other suggesting that there is no appreciable difference in risk levels by ship type.

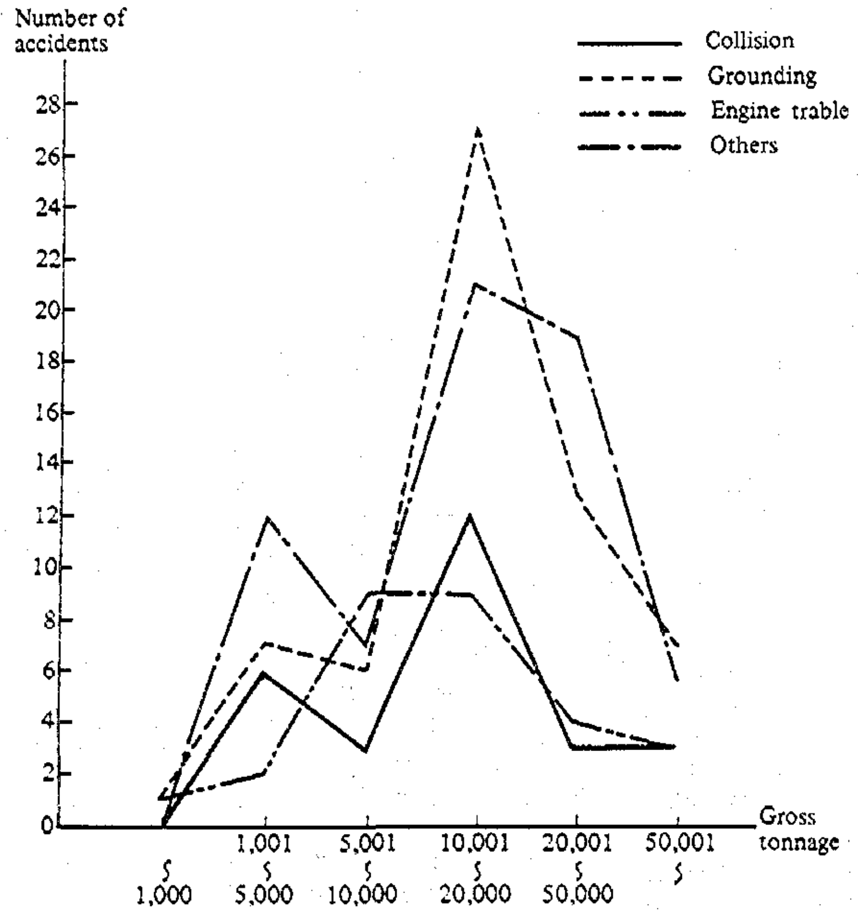


Fig. IV-1-(2)-3 Number of Accidents by Size of Vessel

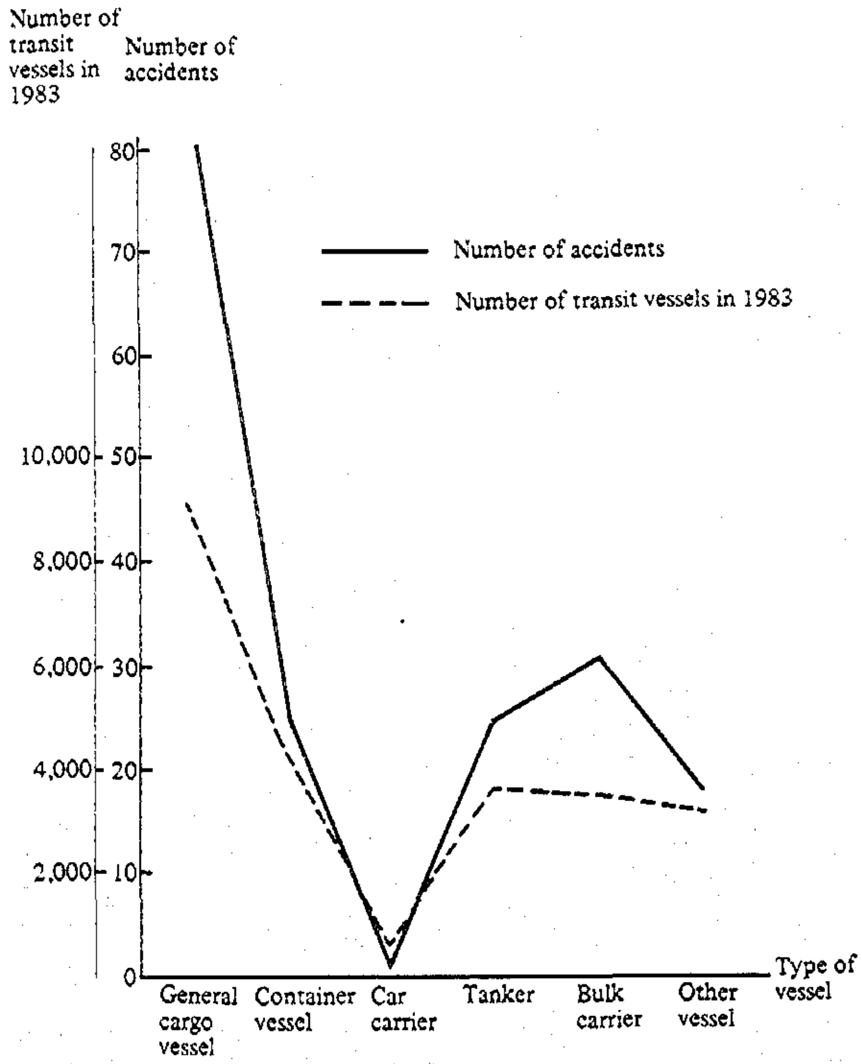


Fig. IV-1-(2)-4 Number of Accidents and Transit Vessels by Kind of Vessel

8) Relationship between Vessel Movements and Frequency of Accidents

Of 27 total cases of collision, 20 occurred either in mooring operations or in anchoring/heaving up anchor operations.

Of 61 total cases of grounding, 38 occurred during passage, and 20 either in berthing operations or in anchoring/heaving up anchor operations. The frequency of accidents at anchor or moorage is very low: only 3.

As a whole, 102 cases occurred whilst in passage, 59 in berthing/anchoring/heaving-up anchor operations, and the number of accidents which occurred at anchor or moorage was 20.

For the prevention of accidents, it is desirous to realize improvements in ship manoeuvring techniques, reinforcements in tug assistance for mooring operation and upgrading of assisting procedures.

9) Summary of Accidents Analyses

The following may be pointed out on the basis of the results of accidents analyses:

(i) Influence of Other Vessels

49 out of 55 cases of grounding occurred without the influence of other vessels. Such a trend well corresponds to the fact that most of the causes for grounding accidents are attributable to unskilled ship manoeuvering techniques, poor lookout, erroneous engine operation, etc.

(ii) Use of Radar

On the use of radars, it is noted that 3 vessels were using radars while 19 vessels were not using when collision accidents occurred; 29 were using but 26 were not using radars when grounding accidents took place.

As a whole, in 45 cases out of 79 cases, no radars were in use when accidents occurred.

In view of the fact that radars are now installed in almost all merchant vessels, use of radars must be ensured without fail particularly when vessels are in the Suez Canal and its associated waters where extreme care is required for safe operation of vessels.

(iii) Use of Remote Control Mode of Engine Operation

In our assessments on the mode of engine operation whether it was manual or remote control, it was revealed that 54 cases out of the 79 accidents were under the manual mode of operation, and such a statistical trend can easily be justified in view of the special areas of water in the Suez Canal.

In 12 cases, engines were operated under the remote control mode, but these were considered to be inherent with those vessels with engines which are always designed to run under remote control.

(iv) Speed of Vessels Involved in Accidents Immediately before Occurrence

Various engine motions involving stopping and reversing of the engines are normally used at time of occurrence as one of the preventive means. We have investigated the vessels' "collision speed" and "grounding speed" at the occurrence of accidents, and the data shown here are the results of our investigation.

For collision cases, 12 out of 22 occurred at 0 knots and 0 to 2 knots of speed displaying the highest peak which was followed by the speed in a range from 6 to 8 knots representing 5 cases. In the collision record for the speed range of 0 knots and 0 to 2 knots, many collision cases occurred during the mooring anchoring/heaving-up anchor operations, whereas in the case of the speed range from 6 to 8 knots, almost all the accidents took place during passage.

As for grounding accidents, those accidents which occurred in the speed range of 6 to 8 knots represent the highest frequency – 20 out of 56 cases – which was followed by 14 cases in the speed range of 0 to 20 knots. It is noted that the grounding cases involving the speed range of 6 to 8 knots occurred, in many cases, during the passage of vessels proceeding at their transit speed, whereas the groundings at the speed range of 0 to 2 knots frequently occurred during mooring operation.

As a whole, accidents at the speed range of 0, and of 0 to 2 knots represent 30 out of 78 cases, and 6 to 8 knots, 25, thus it suggests that one third of the total accidents occurred within the speed range of 6 to 8 knots which involves a possibility of developing into major marine accidents. Extreme care must therefore be taken in this regard.

(v) Measures Taken for Preventing Accidents

The steps taken for collision avoidance were speed reduction in 8 out 19 cases, and steering attempts in 6.

In the case of grounding accidents, speed reduction in 34 out of 55 cases, and steering attempts in 9 were identified as the steps taken for preventing such accidents.

As a whole in 42 out of 74 cases speed was reduced, and in 15 steering attempts were made. In 2 cases, no preventive steps were reportedly taken whatsoever.

From the above observation, we realize that considerable efforts were made on the part of the vessels to prevent accidents.

(vi) Location of Grounding Accidents

In 41 out of 56 cases, grounding accidents occurred at the Canal banks, whereas 15 cases took place in shallow waters.

As will be shown later, training by means of ship manoeuvring simulation on ship manoeuvres under strong wind, stopping and mooring operations may be considered to be an appropriate countermeasure for controlling these types of accidents.

(vii) Status at Time of Collision

As for collision accidents between vessels, most collisions took place in meeting situations. This suggests the need for sufficient lookout.

The number of cases in crossing situations and overtaking situations were almost equal.

As for the objects of collisions, the number of collisions with tugs was 9 out of 27 cases representing the highest frequency followed by 6 cases with cargo vessels and 6 with vessels of other types. There were 2 cases of collision with dredgers and one case with a ferry. There were no collisions with tankers.

In light of the above, greater efforts in the education and training of those crewmembers serving on board tugs is strongly desired.

(viii) Detailed Records of Accidents

As was mentioned earlier when we discussed the SCA's accident records, the importance attached to the detailed recording of accidents and their analysis must be fully understood, and at the same time, it is hoped that the records in the Preliminary Study Team Format should be continued to facilitate better utilization of these materials for the prevention of future accidents.

IV-2 Canal Conditions

(1) Topographical Conditions

Though international standards on canal topography do not exist, recommendations on general approaches (approach channels to ports and harbours and the like) and maneuvering areas have been presented by PIANC (the Permanent International Association of Navigation Congress), and some standards on canal topography have been established in many of the world's countries including Japan.

1) Evaluation of Canal Cross Sections Based on the Recommendations by PIANC.

The IInd International Oil Tanker Commission (chairman: J.G. Leite) which was active from 1970 through 1974 under PIANC, published its final report on "Big Tankers and Their Reception" in the PIANC Bulltin, 1974.

In the report, working group No.2 presented the results of its study on the subject of "Optimal dimensions and layouts of approaches (channels and maneuvering areas) for large tankers, considering among other things the influence of winds, currents and waves, and means offered by modern technology for the ease and the control of navigation."

This working group consisted of four members, Mr. Paul Bastard (France) as the group leader, Mr. Anders Bohlin (Sweden), Dr. Ing. Naumann (Germany) and Mr. Van der Burgt (Netherlands). Three members from the above mentioned commission, Mr. J. Perrin (France), Mr. J.H. Potter (United Kingdom) and Mr. J. Dubois (France) co-operated with the working group.

Based on their recommendations, the depth and width of canals which are necessary for the navigation of large ships, for the Suez Canal as an example, were calculated for 150,000 DWT-class tankers (with vessel length L = 270 ~ 290 m, full load draught D = 53 feet = 16.2 m and vessel width B = 44 m).

(i) Design Depth of the Canal

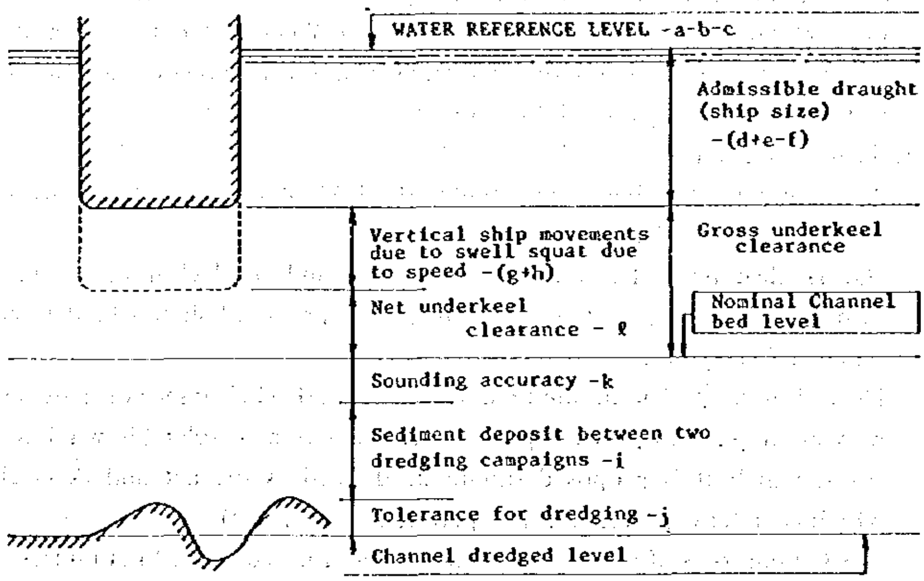


Fig. IV-2-(1)-1 Model of Depth Compositions

The design depth of the Canal is calculated as follows: (Refer to Fig. IV-2-(1)-1).

- water reference level (–a–b–c)
  - a: the average minimum level of the sea at every point of the channel during the planned approach manoeuvre for the chosen lowest tidal conditions (including modifications of water level due to meteorological conditions, pressure, wind) for which passage is desired (taken from statistical records) and reduced by:
  - b: the variation of this level in the event of a maximum allowable security margin for manoeuvre time or duration being taken up and;
  - c: an allowance for the lack of precision in water level measurement.
- ship size (d+e–f)
  - d: the design draft according to the International Load Line Certificate and corresponding to the fully bunkered deadweight capacity of the ship to be planned for, full or partly laden, consideration should be given to a normal allowance for hogging, sagging, list and trim.
  - e: an allowance for decreased salinity in the port approach, and decreased by:
  - f: an allowance for the water and fuel used up by the ship on its way to the port from its last bunkering station.
- vertical ship movement (g+h)
  - g: the increase in design draught due to the squatting of the ship approapriate to the speeds allowed for in the planned passage.
  - h: the increase in design draught due to the maximum swell conditions for which port access is planned.
- difference between nominal channel bed level and channel dredged level (i+j+k)
  - i: the highest theoretically allowable sediment deposit levels in the channel between dredging operations, corrected to allow for:
  - j: the tolerance of execution of dredging work and,
  - k: confidence we have in the sounding.

    This confidence depends especially on the space between sounding points or profiles, and on the precision with which the position of the apparatus and the depth of the tide are known at the time of the sounding. When sonar is used on muddy bottoms the precision depends on the frequency and the progressive variation of the density of the mud covering the solid bottom.
- underkeel clearance (ℓ)
  - ℓ: A minimum allowable margin under the keel of the ship. There are two particular definitions of "underkeel clearance".

    [Gross clearance] The minimum allowable underkeel clearance or margin with the ship at rest in quiescent waters, which it is proposed should be defined as the gross underkeel clearance.

    [Net clearance] The minimum allowable underkeel clearance or margine with the ship moving at planned passage speed under the action of tolerable wind and swell conditions, which it is proposed should be defined as the net underkeel clearance (that which is under expected normal operational conditons).

    For the purposes of this report (ℓ) will be interpreted as the "net underkeel clearance".

The required channel dredged level may be described as:

Required channel dredged level = water reference level – ship size – vertical ship movement – difference between nominal channel bed level and channel dredged level – net underkeel clearance.

or.

Required channel dredged level = (–a–b–c) – (d+e–f) – (g+h) – (i+j+k) – ℓ

In operational use, consideration will have to be given on each occasion to the appropriateness of the design factors especially in regard to:

- actual water level;
- actual ship's draughts including effects of hogging, sagging, list and trim;
- anticipated vertical movement of the ship under the action of currents, wind and wave forces prevailing at the actual time of passage;
- and, actual bed levels derived from the latest surveys as amended for sedimentation occurring after the survey and sounding precision.

The design factors which must be determined, once the desired size of ship and the frequency of regularity of its passage have been chosen, are:

- security margin for manoeuvre time;
- squatting due to the speeds chosen for the approach, whilst maintaining manoeuvrability of the ship;
- vessel movements due to the influence of swell for which an approach will be permitted;
- the net underkeel clearance of margin.

The value of certain of the other factors necessitates a statistical study (for example: tide levels, wind and wave strengths and frequencies).

Here, if CDL (datum level) is taken as the water reference level, –a–b–c = 0 because CDL is almost equal to LWL (mean spring low water level) and the probability of the water level dropping below this level is very small.

Then for ship size, if d = 16.2 m, as assumed before, and e and f are taken as zero, d + e – f = 16.2 m. Vertical ship movement depends on the speeds of navigating ships and the characteristics of swell (period, amplitude, etc.). In the case of the Suez Canal it is also necessary to consider the influences of the so-called Area Ratio (the ratio of a ship's below waterline sectional area to the sectional area under sea level of the canal) and h/d (ratio of depth of the canal to the draught of a ship). The relation between squatting and ship speed is as shown in Figs. IV-2-(1)-2(1) and IV-2-(1)-2(2).

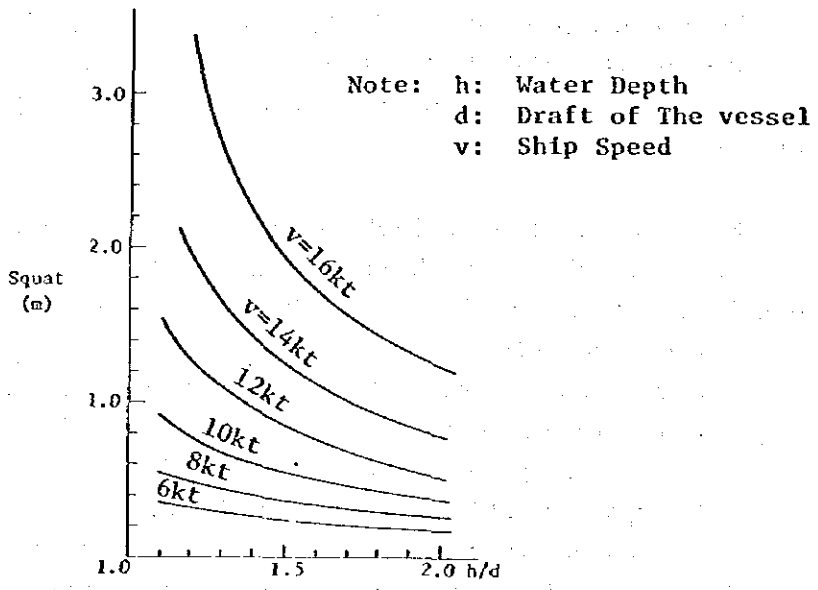


Fig. IV-2-(1)-2(1) Squat and Ship Speed (150,000 DWT Tanker)

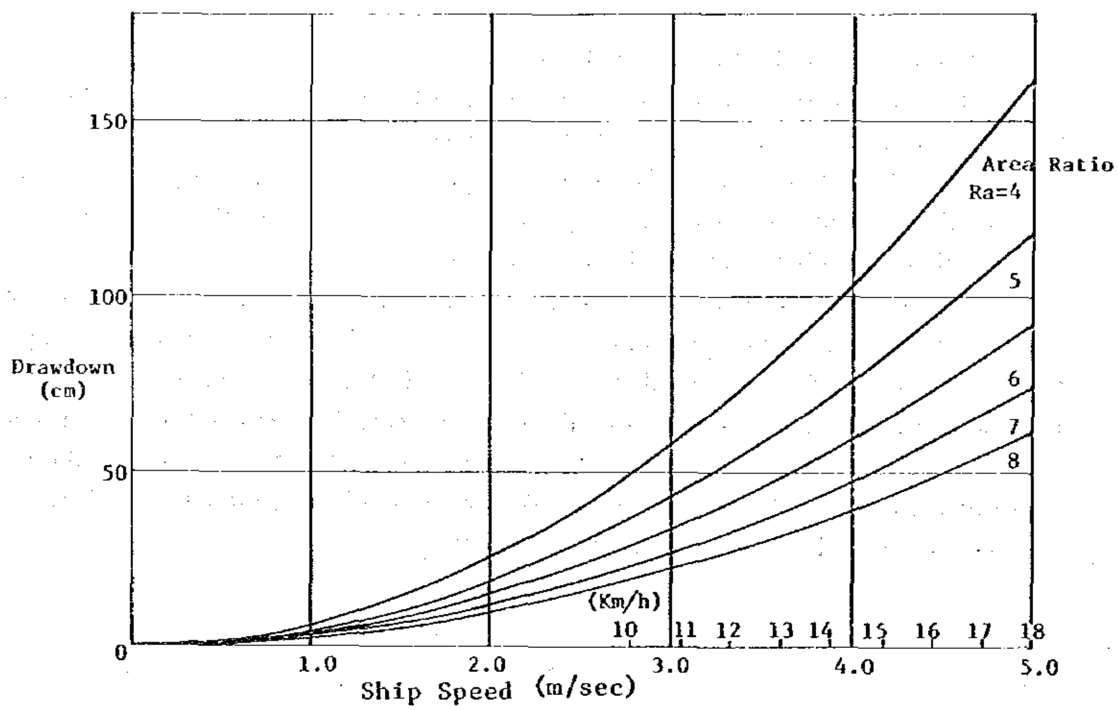


Fig. IV-2-(1)-2(2) Drawdown and Ship Speed

Ship speed is limited to 14 km/h = 7.56 Knots according to the Navigation Rules, so a squat g of about 0.5 m is expected for an h/d (ratio of depth to draught) of about 1.2 and the squat g can be about 0.7 m if the Area Ratio is about 5.0, depending on navigation speeds. Concerning the navigation waterway in the Canal, excluding both ends (Port Said and Suez), it is not necessary to consider swell because swell can be assumed to be zero, h = 0. Then g + h = 0.5 to 0.7 m.

For vertical ship movement, the results in Chapters 6 and 8 of the "Feasibility Study Report on the Second Stage Development Project of the Suez Canal (July 1980: JICA)" are utilized.

Then, for the difference between nominal channel bed level and channel dredged level, i, j and k are not available as confirmed figures as stated in the study, so i is assumed to be a layer of maximum sediment thickness 1.9 m at the center line of the Canal and other variables are considered to be absorbed within the depth allowance, so that i + j + k = 1.9 m.

This depth allowance (specified, here, as the pure depth allowance) is assumed to be one meter, ℓ = 1 m, based on the Commentary of the Recommendation, and assuming this is a case of a rocky bottom. Thus, the required dredged channel level is calculated as $(-a-b-c) - (d+e-f) - (g+h) - (i+j+k) - \ell = -19.6$ m to 19.8 m.

From the calculations described above, the present Suez Canal design depth of –19.5 m (under the conditions for navigation of 150,000 DWT-class tankers) is seen, from this evaluation based on the PIANC Recommendation, to be reasonable.

(ii) Width of the Canal

The PIANC Recommendation was worked out referring to the analytical results from a survey on the reception waterways for large tankers (VLCC-class) of the ports of Gothenburg (Sweden), Le Havre (France), Marseille-Fos (France), Milford-Haven (United Kingdom), Point Tapper (Canada), Rotterdam (Netherlands) and Wilhelmhaven (West Germany). The outlines of each of these navigation waterways are as shown in Table IV-2-(1)-1.

In the commentary of the Recommendation, it is stated that the minimum width of the reception waterway for 200,000 DWT-class tankers, in the case of one way traffic, should be 180 m ~ 250 m where there i no cross current and 300 m where cross current exists.

These figures correspond to 0.55L ~ 0.77L, 3.8B ~ 5.3B and 0.92L, 6.4B, respectively, if vessel length (L) and vessel width are taken as 325 m and 47 m, respectively.

Based on this, PIANC recommends 5B in the case of no cross current and 5B ~ 7B in the case of existing cross current, depending on the strength of the current.

5B = 220 m was obtained as the required width of the navigation way of the Suez Canal, from calculations based on the Recommendation and using the above mentioned dimensions of the navigating ships for the case of no cross current. This corresponds to 0.81L ~ 1.07L.

$L^2/8R$ is recommended as the necessary extra width at the channel's bends and L/32 = 8.4 m to 9.1 m is obtained if R = 4L, shown as an example of curvature (minimum R) in the study, is used.

Table IV-2-(1)-1 Widths of Channels

Name of Port	Width (m)	Service	Conditions
Gothenburg	210 250 ~ 300	one way reserved reserved	straight cross current 1/2 knot curve
Le Havre	300	priority	cross current 1.5 ~ 2 knots
Marseille-Fos	250		no current
Milford-Haven	outer 375 inner 180	priority	
Point Tupper	5 times the width of VLCC	300,000 DWT	
Rotterdam	entrance 1200 inner 400 ~ 600	two way	cross current 2 ~ 3 knots
Wilhermshaven	300 more than this at curves	priority for laden VLCC	cross current 1 knot

From this, 230 m (0.82L, 5.2B) is thought to be the minimum required width for the navigation way of the Suez Canal. From evaluation based on these studies, the present width of the greater part of the navigation way of the Suez Canal which was reviewed in the study, can be concluded as being insufficient, excepting the navigation way at the Port Said Entrance and at Great Bitter Lake.

(iii) Plane layout of the Canal

The choice of rectilinear lay-out seems preferable to any other. The ships' captains and pilots agree that the navigation difficulties are then reduced to a minimum. Moreover, the creation of such a lay-out permits the bringing into use by day as by night, of a luminous alignment which forms a valuable aid to navigation.

In cases where it is not possible on account in particular of the presence of a rocky bottom to bring a straight channel into being, the axis of the channel should be made up of several segments of straight lines linked together by arcs of a circle. It is advisable to define the minimum radius of these days.

This question entails consideration of the minimum turning radius of big ships. Trials carried out in prototype as well as in reduced model show the minimum diameter of the circle in which the trajectory of turning around is inscribed as four times the length (L) of the ship.

The report presented by the Soviet delegation during the 7th meeting of the preceding Commission recommended that the radius should not be less than 5L.

The American report presented during the 5th meeting of the preceding Commission recommended a much larger radius (8, 10 or 12L).

The Working Group of PIANC has judged finally, that it is advisable to recommend that the sweep radius of a channel be at least equal to five times the length (5L) but observes that a greater radius ought to be chosen where the ship is subject to cross winds or currents liable to bring about a significant leeway.

To reach the minimum values shown above, a broadening of the channel is necessary.

The choice between the various solutions to be considered for the lay-out of the channel depends not only on technical nautical and economic considerations, but also on the relative importance of the introductions of aids to navigation (luminous alignment, radar, etc.).

A ship sailing along an axis does not in general follow a straight course. Her trajectory bears off alternatively in one direction or the other from the theoretical axis. The deviations so noted are all the more important when the ratio between the transverse component of the current's speed and the ship's speed is high. It appears desirable to limit the value of this ratio to 0.25, otherwise the manoeuvering of the ship becomes delicate. The lay-out of the channel must take this data into consideration.

If the evaluation of the plane layout of the present Suez Canal is made based on this way of thinking, some problems can be found at the junctures of the East Channel and West Channel. These portions are greatly affected by lack of width and by being junctures of two navigation ways. For instance, both ends of the Ballah Bypass and the portion going from Great Bitter Lake to Little Bitter Lake (the so-called Kabrit Loop) can be pointed out as portions where the Canal's plane layout needs to be improved.

2) Evaluation of the Cross Section of the Canal by Japanese Standards

In Japan, the Port and Harbour Law which has been established as the fundamental law of port and harbour management states the following:

Article 56-2. Construction, improvement or maintenance of water facilities, protective facilities, mooring facilities and other port facilities specified by Government Ordinance shall be in conformity with technical standards set by the Ministry of Transport Ordinance in addition to the provisions of applicable laws or regulations, if any.

The Ministry of Transport laid down the circular notice of the Director General of Bureau of Ports and Harbours, Ministry of Transport, which provides concrete interpretation and application of the ministerial ordinance, for proper enforcement of the ordinance. The enforcement of the technical standards for port and harbour facilities in Japan is as shown in Fig. IV-2-(1)-3

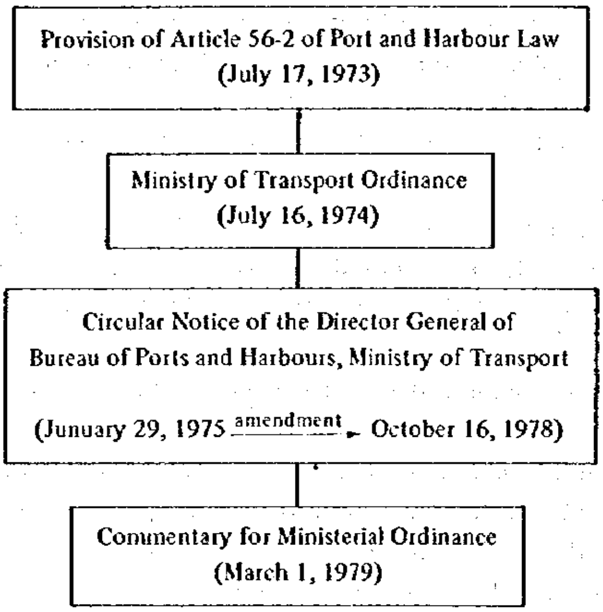
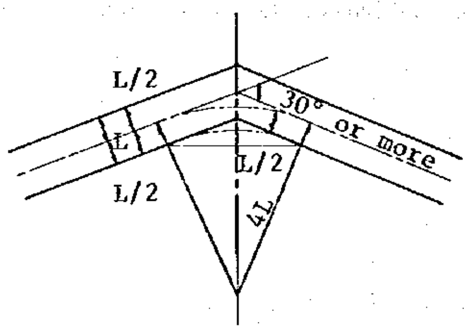


Fig. IV-2-(1)-3 Enactment of Technical Standards for Port and Harbour Facilities in Japan.

In the section on waterways in the "Technical Standards", the following standards are shown:

- Principle of Planning
  Safe navigation, ease of ship operation, topography, weather and marine phenomena, and coordination with other facilities shall be taken into consideration for the planning of waterways.
- Layout of Waterways
  The intersection angle of center lines of a waterway at a curve should not exceed 30 degrees. When it does exceed 30 degrees, the center line at a curve of a waterway shall be a circular arc with the radius of curvature about 4 times or more of the overall length of the ship, and width of the waterway shall be wide enough for the navigation of the ship (see Fig. IV-2-(1)-4).



L: Overall length of the ship

Fig. IV-2-(1)-4 Layout of Waterway at Curves

However, this may not apply when the waterway is exclusively for ships of high turning capability such as yachts and motorboats or when safe and smooth operation of ships can be made by traffic control such as marks and signals.

- Width of Waterways

The width of waterways shall be determined in accordance with the following:

[Standard waterway] A double way waterway shall be in accordance with Table IV-2-(1)-2, depending on the length of the waterway and the navigational conditions.

[Special waterway] A special waterway such as a waterway with remarkably large traffic volume, a waterway crossed by sailing ships or a waterway for VLCC shall have a width which adds an allowance to the value in Table IV-2-(1)-2.

[Waterways for fishing boats or ships of less than 500 gross ton] The width shall be decided according to actual conditions.

Table IV-2-(1)-2 Widths of Waterways

(L is the overall length of the ship)

Length of Waterways	Conditions of Navigation	Width
Relatively long waterways	Ships pass by each other frequently	2 L
	Other than the above	1.5 L
Waterways other than the above	Ships pass by each other frequently	1.5 L
	Other than the above	L

- Depth of Waterways

The depth of waterways shall be an appropriate value of no less than the full load draft of the ships in consideration of the extent of oscillatory motions of the ships due to the natural conditions such as waves, winds, and tidal currents, and the trim. In this case, "a proper depth" means a depth obtained by an allowance added to the depth specified in Table IV-2-(1)-3.

The allowance varies with such conditions as rolling, pitching and squat of ships and the conditions of sea bed materials. However, this provision may not apply to special waterways where the draft of ships using this waterway is always smaller than the full draft, such as an approaching waterway to the dock of a shipyard, or a waterway exclusively for partially loaded ships.

- Stopping Distance

The length of waterways at harbour entrances and the area of continuous mooring basins shall be determined by considering the stopping distance of ships.

- Calmness of Waterways

The calmness of waterways shall be determined by considering conditions such as the safety of ships, embarkation of pilots and use of tugboats. Particularly in water areas from harbour entrances to basins, necessary measures shall be taken to secure calmness in accordance with the size and kind of ships, and the size of tugboats when they are used.

Furthermore, in addition to incident waves, the influence of longshore waves and reflected waves from breakwaters or quaywalls shall be considered.

- Waterway Maintenance

The depth and width of waterways shall be maintained properly for the smooth use of the harbour and the safe navigation of ships.

When a waterway is planned on a river mouth or a beach where a large amount of littoral drift is expected, the degree of maintenance dredging required in the future should be forecast by estimating the rate of sediment transport by flood or the rate of littoral drift by waves and tidal currents.

Table IV-2-(1)-3 Standard Depths of Basins (In Japan)

Kind of Ships	Depth (m)	Size of Ships	Kind of Ships	Depth (m)	Size of Ships	Kind of Ships	Depth (m)	Size of Ships
		Gross Tons			Dead weight Tons			Dead weight Tons
Passenger Ships	5.0	1,000	Oil Tankers	4.5	700	Ore Carriers	9.0	10,000
	6.0	3,000		5.0	1,000		10.0	15,000
	7.5	5,000		5.5	2,000		11.0	20,000
	9.0	10,000		6.5	3,000		12.0	30,000
	10.0	20,000		7.5	5,000		13.0	50,000
	11.0	30,000		9.0	10,000		15.0	70,000
General Cargo Ships		Dead weight Tons		10.0	15,000		16.0	90,000
	4.5	700		11.0	20,000		18.0	100,000
	5.0	1,000		12.0	30,000		20.0	150,000
	5.5	2,000		13.0	40,000	Ferry-boats		Gross Tons
	6.5	3,000		14.0	50,000		5.0	1,000
	7.5	5,000		15.0	70,000		5.5	2,000
	9.0	10,000		16.0	100,000		6.0	3,000
	10.0	15,000		20.0	150,000		6.5	4,000
	11.0	20,000		21.0	200,000		7.5	6,000
	12.0	30,000		22.0	250,000		8.0	13,000
	13.0	40,000						
	14.0	50,000						

Note: 1. The depth of basins should be 1.1 times the full load draft of the ship below the datum level, considering the extent of oscillatory motion of the ship due to the natural conditions such as waves, winds and tidal currents. However, this provision shall not apply to a basin for outfit of ships and a basin used for special anchorage or mooring of ships. In the case of basins for ferryboats, the draft difference between stern and bow during cargo handling should be considered to determine the depth of the basin. Furthermore, where the sea level of a basin may be below the datum level because the seasonal change of mean sea level is larger than the tidal level change due to astronomical tide, or where the basin may be attacked by high waves and swells, these influences should be considered.

2. The depth of a basin can be determined in reference to the values of the Table IV-2-(1)-3, when the full draft of the ship is not known.

(i) Design Depth of the Canal

The present design depth of the Suez Canal of −19.5 m seems to be a reasonable value based on evaluation by this Japanese standard.

(ii) Width of the Canal

The present width of the Suez Canal, which was reviewed in the study, is, for the most part, judged as too small based on evaluation by the Japanese standard, even when compared with the minimum widths presented in Table IV-2-(1)-2.

It is necessary to take notice, however, that this standard was established for sea navigation lanes in the open sea.

(iii) Plane Layout of the Canal

The conclusion here is exactly the same as the result of the PIANC Recommendation.

3) Canals in Foreign Countries

In this survey, case studies have been carried out for canals in foreign countries other than the Suez Canal. These studies include the studies of several canals, such as the Kiel Canal and the Essen Canal (West Germany), the Eems Canal and the Amsterdam Canal (Netherlands) and and the Panama Canal (Panama) which are described in the Appendix. These canals and navigation ways differ from the Suez Canal concerning the conditions of location, object of construction, size, controlling or managing method, etc., and some of them may be inappropriate for evaluation of canal topography. For instance, some canals are completely inland canals (river canals), and naturally have different characteristics from the Suez Canal which must accommodate 150,000 DWT-class tankers. It is considered useful to seek general tendencies in the relations between ships and canals and to compare them from this general viewpoint.

Outlines more detailed of each canal are compiled in the appendix of this report.

(i) Canals in West Germany

The Kiel Canal is an open-and-shut type international canal crossing the base of the Jutland Peninsula at the northern end of West Germany. This canal has a depth of –11.0 m, and the width of its navigation way (bottom width) is 90 m at this depth. Transiting vessels are limited by the regulations to maximum draughts of –9.5 m. Ships having the maximum draughts of –9.5 m are permitted to be up to L = 160 m and B = 27 m, and up to L = 193 m and B = 20 m and ships having draughts of –7.0 m can be up to L = 235 m and B = 32.5 m.

So, it can be said that the underkeel clearance is 1.5 m and width of the navigation way is between the values of 0.47 L ~ 0.56 L and 3.3B ~ 4.5B (refer to Fig. IV-2-(1)-5).

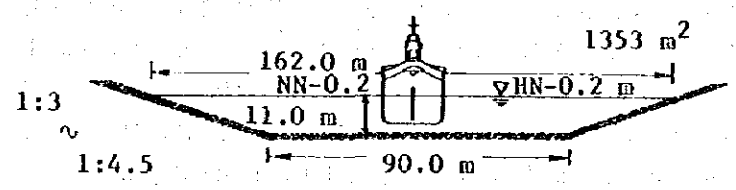


Fig. IV-2-(1)-5 Cross Section of the Kiel Canal

The Elbe River (Waterway) is the access route to the Port of Hamburg and has a width of from 750 m ~ 1,000 m (at Cuxhaven at the mouth of the Elbe River) to 250 m (inside the Port of Hamburg) and a depth of –13.5 m. The height difference between ebb and flow tide in the Elbe River is 3.3 m and the depth based on the mean high tide there is said to be –16.5 m. It is said to be possible to receive fully loaded 110,000 DWT-class tankers. The port authority of the Port of Hamburg uses about 10% of the draught of passing ships as underkeel clearance. If the dimensions of 110,000 DWT-class ships are assumed to be L = 280 m, B = 42 m the width of the waterway in the Port of Hamburg becomes 0.89L and 6.0B. A compulsory pilotage system is applied to all ships of more than 1,000 GT and all tankers of more than 300 GT.

The Essen Canal (officially known as the Rhine-Herve Canal) is a lockgate type inland canal and serves as the core of transportation in the Ruhr industrial area. This canal is used mainly for traffic of so-called barges as well as of small ships, and has a depth of −4.0 m and width of 42 m at the bottom (portions of the canal are currently being expanded). It is a small sized canal (refer to Fig. IV-2-(1)-6). The design area ratio of the Essen Canal is 7.0.

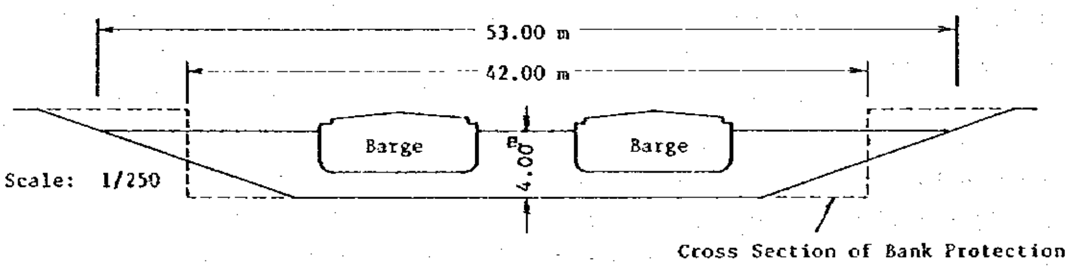


Fig. IV-2-(1)-6 New Profile of the Essen Canal

(ii) Canals in the Netherlands

The width and depth of the Amsterdam Canal (officially called the North Sea Canal) are 170 m and −15 m, respectively, and 250,000 DWT-class tankers with no load and 80,000 DWT-class tankers of fully loaded are said to be able to navigate through the canal.

If 80,000 DWT-class ships have the dimensions of L = 250 m and B = 37 m, the width of the waterway is evaluated as 0.68L and 4.6B. Its depth allowance seems to be comparatively smaller than general waterways. The width and depth of the mouth of the Mass River which is the access route to the Port of Rotterdam, are 600 m and −20.7 m, respectively, and 275,000 DWT-class tankers are said to be able to go through.

The width and depth of the Amsterdam Canal are 250 m and −13.4 m, respectively, in the neighbourhood of Botlek Berth upstream of Rotterdam, 250 m and −13.4 m further upstream at Waal Haven, and 200 m and −10.3 m at Rijn Haven.

At the mouth of the river where the river enters the North Sea, the allowed ship type (size) seems to be a little too large, and from the depth of −20.7 m, the width of 600 m and the typical dimensions of a 250,000 DWT-class tanker of L = 350 m, B = 52 m, the cross section is evaluated as 1.7L and 11.5B.

Concerning the Eems Canal, there are channels at the mouth of the Eems River and these channels are being used as approach ways to ports and harbours in their neighbourhood. The channel to the Port of Eems has a depth of −11 m and is used by 410,000 DWT tankers, and the channel to the Port of Delfzijc has a depth of −8.7 m and is said to be able to receive fully loaded 35,000 DWT-class ships. The widths of these channels are not clear.

(iii) Panama Canal

The Panama Canal is a lock-gate type international canal and the dimensions of its narrowest waterway, which determine the ship types (sizes) able to pass through the Canal, are a width of 33 m and a depth of −12 m. Due to these dimensions, 65,000 DWT-class ships, the so-called Panamax, are the present upper limit. A plan to expand its waterway to make the navigation of 300,000 DWT-class tankers possible, is under study in response to the enlargement of ship size.

4) Natural Conditions

(i) Visibility

Fig. IV-2-(1)-7 shows the number of ships which were forced to stop in the Canal owing to bad weather from 1975 to 1982. In this figure, bad weather means mostly poor visibility.

The average number of ships is 345/year.

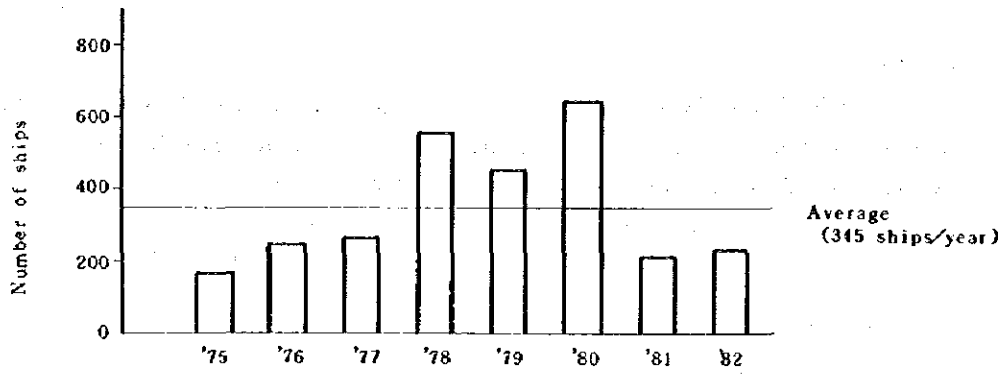


Fig. IV-2-(1)-7 Average Number of Ships Suffering Compulsory Stoppage in the Canal owing to Bad Weather (1975 ~ 1982)

Fig. IV-2-(1)-8 shows visibility conditions on the days when the ship accidents actually occurred and yearly average visibility conditions. This figure indicates that visibility under one kilometer clearly affects the number of accidents. Visibility is one of the most important factors affecting navigation.

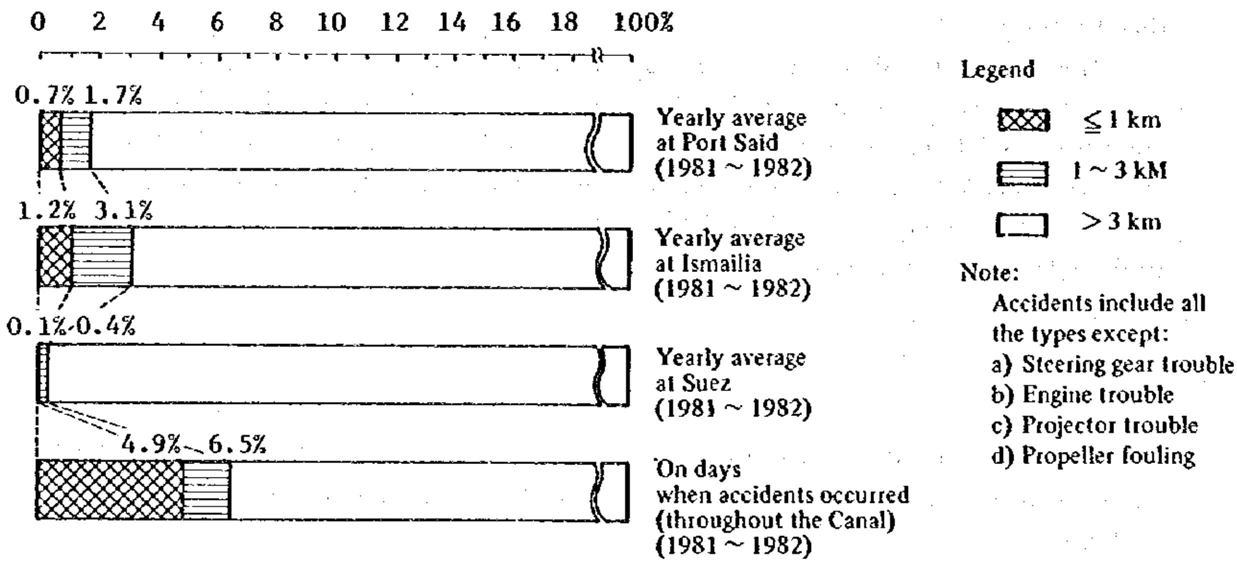


Fig. IV-2-(1)-8 Comparison of Visibility

(ii) Wind

Fig. IV-2-(1)-9 shows the occurrence frequency of velocity on the days when ship accidents actually occurred and the yearly average velocities. This figure indicates that wind velocities over 22 knots are related to ship accidents.

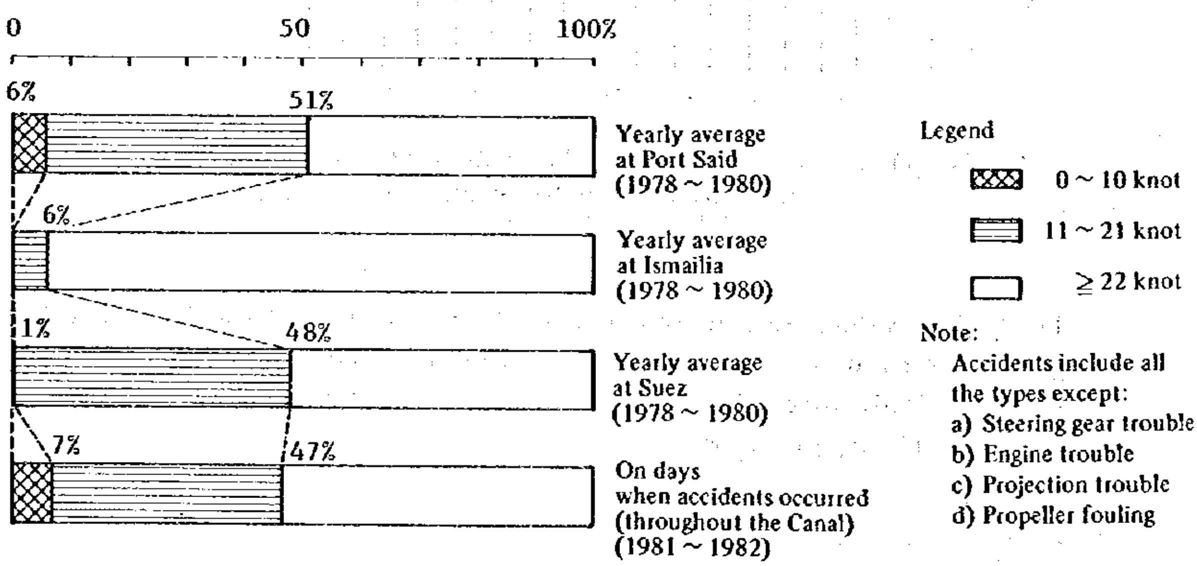


Fig. IV-2-(1)-9 Comparison of Wind Velocity

The most frequent wind direction of strong winds in northwest to north in this region (See II-2-(5)). This means that the occurrence frequency of strong winds which run across the waterway in high near El Kabrit. In fact, many ship accidents have occurred in the El Kabrit area.

(iii) Tidal Current

According to the results of observations and simulations, the current runs across the waterway at the points near the junction of the bypasses, El Kabrit and the Port Said approach channel. Such cross-currents produce strong fluid pressure on ships. In fact, many ship accidents have occurred near these points.

(iv) Waves

In the Port Said sea area, the occurrence of wave heights over 2 meters is about 20%, with a maximum height of 6 ~ 7.5 meters. The direction of high waves is almost always 270 ~ 0° degrees from north.

Although the water area in the west branch of the Port Said approach channel is protected from high waves by breakwaters, the water area in the east branch of the Port Said approach channel is rarely affected by high waves.

(v) Sedimentation

At Port Said, the volume of sediment in and around the east and west channels is estimated at about $4 \sim 5 \times 10^6$ m^3/year. The results of our simulation indicate that a large volume of sediment is deposited, particularly at the entrance of the east branch and at the point 10 kilometers offshore in the approach channel of the east branch.

On the other hand, at Suez, sedimentation has not become an issue in the Canal and its approach channel.

(2) Traffic and Anchorage Conditions

1) Traffic Conditions

(i) Transit System

The transit system presently employed with one Northbound convoy and two Southbound convoys is considered to be the optimum traffic system well matching the current conditions of the Suez Canal, completed on the basis of years of operational experience.

(ii) Transit Speed and Ship to Ship Distance

Fig. IV-2-(2)-1 shows the records of stopping distance when full astern is applied in vessels proceeding at speeds of 8 knots and 6 knots. When the above results are compared with the results of the stopping trial in the Canal carried out by the SCA on a 70,000 DWT tanker "DAPHNE", the stopping distance on the trial vessel proceeding at a speed of 7 knots can be read as approximately 650 meters as shown in Fig. IV-2-(2)-1, but the actual stopping distance of the same vessel proceeding at an initial speed of 7.01 knots in the trial by using a tug was 1,225 meters, because the astern of engine cause the swinging of the vessel and impossible to make it, whereby it was proved that the stopping distance in the Canal was nearly twice as much as the stopping distance in open sea.

If we consider the emergency stopping distance of a vessel actually proceeding through the Canal, more distance than the trials results may possibly be required; and further, if we take some degree of safety allowance into account, a stopping distance 1.5 times as much as that in the trials may be necessary. If such is the case, the following ship-to-ship distances of three times the values given in Fig. IV-2-(2)-1 are considered necessary for safe operation.

DWT	Displacement	Initial Speed (s)	Crash Astern Stropping Distance (d)	d x 3	dx 3/s
30,000	37,000	14 km/h	580 m	1,740 m	7.5 min
60,000	75,000	14 km/h	740 m	2,220 m	9.5 min
140,000	174,000	13 km/h	1,100 m	3,300 m	15.2 min
250,000	310,000	13 km/h	1,200 m	3,750 m	17.3 min

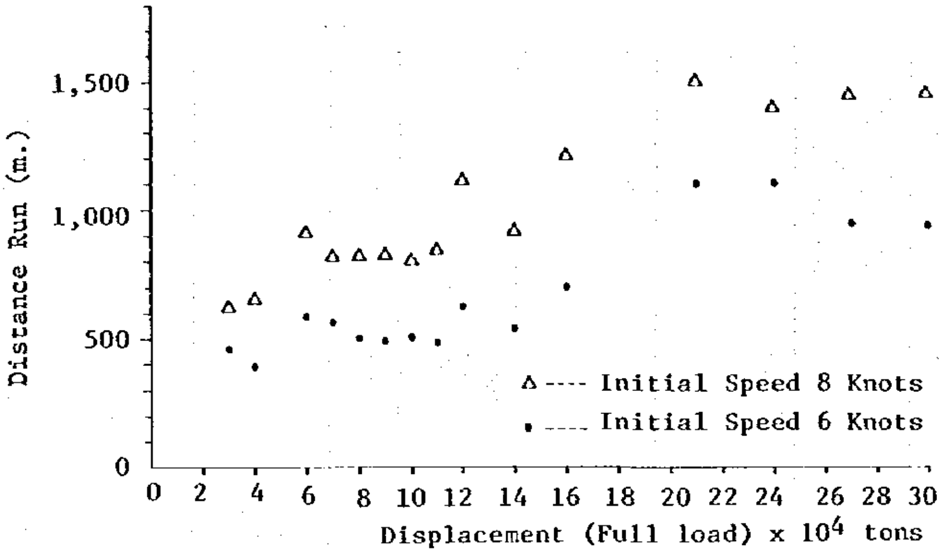


Fig. IV-2-(2)-1 Reverse Stopping Distance
(Source: Japan Dockmasters' Association)

These values are in pretty good agreement with the ship-to-ship distance established by the SCA as the reference values, and thus the SCA's standards are considered to be reasonable.

On the other hand, the results of analysis on the Traffic Diagram for the month of August, 1983 show that the actual transit speed for both northbound and southbound vessels, ranges from 8.0 to 9.4 knots (14.8 to 17.4 km/h) which exceeds the speed of 13 to 14 km/h prescribed in the Rules of Navigation by a considerable extent.

For preventing secondary accidents such as head-to-stern collisions and groundings, the transiting speed prescribed in the Rules of Navigation should be observed.

(iii) Qualifications, Education and Training of Canal Pilots

Table IV-2-(2)-1 compares the required qualifications, training and examinations to become Suez Canal pilots and those required to be licensed pilots in foreign countries. There are countries where age limits are imposed for becoming pilots and others where no such age limits are provided, and in the case of the Suez Canal, no age limits are prescribed. However, it is considered preferable to provide age limits for pilots such as the age limit of 35 years of age for encouraging active employment of young and talented pilots in the U.K., the Netherlands and France.

Generally, sea-going experience as required in other countries is not required in the case of the Suez Canal pilots, but the SCA demands the qualification of master for ocean-going vessels, thus the former requirement is considered to be automatically satisfied.

On the matter of training, the SCA's established requirements for training involving a total of 36 vessels in two months are considered to be too short to become a Suez Canal pilot, which requires extremely high levels of technique and rich experience even for those qualified harbour pilots, and it is rather suggested that more substantial experience over a

Table IV-2-(2)-1 Comparison of Qualifications, Training and Other Requirements to become Pilots

Waterway or Port (Country)	Age Limit for Certification	Certificate of Competency Necessary to Become a Pilot	Sea-going Experience	Training and Examination	Rank	Renewal	Age Limit for Service
Suez Canal (Egypt)		Master of ocean-going vessel		2-month long training with the qualification of harbour pilot, thence examination is to be taken.	4		60 (Extended service beyond the age limit is possible under special contract.)
Thames River (UK)	35 years of age or below	Master of ocean-going vessel	Sea-going experience in a capacity as ship officer for navigational watch for a period exceeding 8 years	Boarding with a licensed pilot for a period of 3 to 6 months, thence oral examition is to be taken.	2	1-year	60
Elbe River (West Germany)		Big Master	Sea-going experience in a Capacity as ship officer holding a Master's license for a period exceeding 6 years	6-month long training, thence examination held by the Minister for Transport is to be taken.	1		65
Maas River (The Netherlands)	Master's license must be obtained before 30 years of age	Master	Sea-going experience in a capacity as deck officer for a period exceeding 4 years	4-week long special training, one-year long ship-board training, thence examination is to be taken.	3	Valid till retirement	55
(Norway)	23 ~ 45	Chief Mate		One-year long shipboard training, examination	1	2-year	65
Le Havre (France)	35 years of age or below	Master of the First Grade	Sea-going experience for a period exceeding 6 years	Examination	1 Restrictions are imposed for the first five years		57
Barcelona (Spain)	25 ~ 53	Master	Sea-going experience for a period exceeding 18 years, or commanding experience in a capacity as Master for a period exceeding 5 years		1		nil
St. Lawrence River (Canada)	23 years of age or below	Master or Chief Mate of ships of 350 gross tons or more		Three-year long shipboard training		Valid till retirement	65 (Extended service up to 69)

Waterway or Port (Country)	Age Limit for Certification	Certificate of Competency Necessary to Become a Pilot	Sea-going Experience	Training and Examination	Rank	Renewal	Age Limit for Service
San Francisco (USA)	18 years of age or more	Master of the highest Grade	Sea-going experience in a capacity as Master of ocean-going vessel	Examination for certification/examination for qualification of radar operator	1	1-year	65
Brisbane (Australia)		Master of ocean-going vessel	Recent sea-going experience	Physical examination including eyesight check	1	2-year	65
Hong Kong (Hong Kong)	24 years of age or more	2nd Mate and upwards		18-month long shipboard training Examination for certification Physical examination including eyesight check	plural	1-year	nil
Lisbon (Portugal)	25 ~ 35	Mate and Master		Examination for certification		nil	65
Genoa (Italy)	28 years of age or more	Master of ocean-going vessel	Sea-going experience in ships of 3,000 tons or more for a period of 6 years of which 4 years in a capacity as deck officer and one year as Chief Mate		1	Valid till retirement	65
Rio de Janeiro (Brazil)	21 ~ 36	Not required	Not required	One-year long training after successful passing of paper examination, oral examination and examination for practical knowledge and experience	1	Valid till retirement	nil
Tokyo Bay (Japan)		Third Grade Maritime Officer (navigation)	Sea-going experience in ships of 3,000 tons or more for a period exceeding 3 years in a capacity as Master	Oral examination after 3-month long shipboard training following the successful passing of physical examination and paper examination	1	5-year	nis

longer period be required. In the light of the lengths of training, e.g., 6 months for Elbe River pilots, one year for Maas River pilots, and 3 years for St. Lawrence River, at least a 6-month long training should be considered necessary for becoming a Suez Canal pilot, and further introduction of simulator-aided training should also be considered.

In addition to the above, periodical physical checks, special drills and training for emergency stoppings within the Canal area, general emergency procedures, and liaisons and communications work with the traffic control center may be considered necessary.

(iv) Escort Boat Arrangements

In the event of failure in the leading vessel while transiting the Canal with the inevitable necessity of emergency stopping, it is extremely difficult to stop such a vessel without running ashore in the absence of tug assistance, because the astern of the engine causes the swinging of the vessel normally, and in the case of a very large vessel, this situation is quite serious. Also, in the case of a very large vessel, tug assistance is considered indispensable for supporting the vessel under intense beam wind. Therefore, it is necessary to thoroughly study the criteria for arranging escort tugs.

(v) Importance of Recording Various Items of Data

As mentioned in the evaluation of the accident record kept by the SCA, various data on the movements of transiting vessels, e.g., time of arrival in waiting area, anchoring position, time of heaving in anchor, time of passing major points, times of embarkation/disembarkation of pilots, times of tying up in bypasses, times of casting off/heaving up anchor in lakes, etc. should be recorded for subsequent processing for statistical analysis.

The importance of recording these data for the forementioned purposes should be fully recognized.

(vi) Summary of Survey of Canal Users

i) Answers from Masters of Transiting Vessels

(a) Cause of Feared Dangers and Location

Although a wide variety is seen in the answers to the question on the causes of collision accidents stating improper aids to navigation, narrow area of passage and others, a heavy concentration is seen in response to the question on the cause of grounding, where 60 answers out of 85 were related to improper aids to navigation.

In locational assessment, considerable concentrations were seen in Port Said and Suez, and many navigators feared the danger of running aground due to improper aids to navigation especially in Port Said where such answers reached as high as 36 out of 60.

Since strong complaints are directed to the improper aids to navigation in Port Said, the improvement of aids in this area is considered necessary.

As a whole, responses stating fear of running aground were a majority – 85 out of 121 – whereas those stating fear of collision totaled 36.

(b) Assessment of Answers by Direction of Transit, Type of Vessel and Size

On these items, no specific trend was seen.

(c) Comments

Among the comments, the largest number of answers, 27 out of 63, were on the need for racon, followed next by lack of information and communications counted 15.

ii) Answers from Canal Pilots

The number of answers from Canal pilots was few and it was difficult to grasp any clear-cut trend, but the answers stating fear of grounding due to improper aids to navigation and bank irregularities, and comments characterized by wishes for the better maintenance of buoys, additional installation of aids to navigation and increase in transit speed were found dominant among others.

iii) Answers from Japanese Captains

(a) Dangers Feared by Ship Type and the Reasons Behind

On containerships, 24 answers out of 96 identified narrow water as the cause of collisions, 24, complexity of meeting, and 15, improper aids to navigation. On the causes for collision with objects other than vessels, no appreciable trend was seen. On grounding, a significantly large number of 28 answers out of 77 were found related to strong current followed by 11, narrow water, 9, shallow effect, and 8, improper aids to navigation.

Of a total of 230 answers on containerships, the answers stating fear of collisions with other vessels were 96, representing the largest number followed by 77, fear of running aground, but the number of answers stating fear of collision with objects other than vessels was small, only 33.

As for the causes of accidents, the largest number of 44 was narrow water, 37, strong current, 34, improper aids to navigation, and 32, complexity of meeting.

On tankers, we have only a few answers and thus trend evaluation seems a bit difficult. However, those answers stating fear of collisions with other vessels due to complexity of meeting, and fear of grounding on account of the shallow effect may be mentioned to be significant. Among the 41 answers from tankers, 17 were related to the fear of grounding, and 18, the fear of collisions with other vessels. Causes specified were narrow water 9, complexity of meeting 6, and shallow effect, 5.

On general cargo vessels, 9 answers out of 45 were stated complexity of meeting as the cause of collisions, 8, narrow water, followed by 4, improper aids to navigation, and 4, strong current. As for the causes of collisions with objects other than vessels, the total number of answers was only 20, of which 4 mentioned strong current, and 3, narrow water. On grounding, the largest number of 13 answers out of 48 cited narrow water followed by 11, improper aids to navigation, and 7, strong current.

Of a total of 119 answers on general cargo vessels, the answers stating fear of running aground were 48 representing the largest number followed by 45, the fear of collisions with other vessels, and the number of answers stating fear of collision with objects other than vessels was 20. On the causes of grounding, 25 answers were related to narrow water, 21, strong current, 17, improper aids to navigation, and 12, complexity of meeting.

(b) Places Where Dangers were Feared

In our overall assessments on the places where dangers were feared, 68 answers out of 169 cited the fear of collisions with other vessels in Port Said followed by 43 in Suez inner anchorage. For others, 23 and 19 were found related to the approach and waiting area in Port Said and Suez respectively.

On dangers of collision with objects other than vessels, a majority of 47 out of 67 were in Port Said.

On the locations where grounding is feared, 62 answers out of 164 cited Port Said, followed by 25 in El Kabrit, and 18 and 17, in Suez inner anchorage and Port Said bypass respectively.

Of the total 400 answers, the answers stating fear of collisions were 169, and those of grounding were 164, whereas the number of answers stating fear of collision with objects other than vessels was 67.

(c) Comments

Of the total number of 438 comments received, 61 answers requested improved communications in the waiting areas, 55 requested embarkation of pilots in the waiting areas, 54 widening of anchorage, 41 simplification of booking notice, 37 strict enforcement of anchoring instructions, and 35 doubling the track of the Canal.

iv) Summary of the Three Questionnaire Surveys

The results of the three questionnaire surveys may be summarized as below:

(a) The major dangers feared in transiting the Canal are collisions and grounding, and other items are almost negligible.

(b) The causes of collisions, in many cases, are considered to be improper aids to navigation, narrow water and complexity of meeting.

(c) The causes of grounding, in many cases, are considered to be improper aids to navigation, narrow water and strong current.

(d) The places where high levels of danger are perceived are Port Said 45% and Suez 18%.

(e) As a whole, 517 comments were received, and the top ten items may be enumerated as below:

Improved communications	129
Increased and improved maintenance of aids to navigation (including comments requesting racon)	63
Canal pilot should board at waiting area	62
Widening of anchorage	54
Simplification of booking notice	41
Clearer anchoring instructions	37
Doubling of the Canal	35
Widening of the Canal	19
Improved operation of tugs and escort boats	18
Improved transit system	15

(f) As a conclusion, the following three measures are strongly recommended:

a) Modernization of aids to navigation

b) Establishment of safety measures in Port Said and Suez, especially in Port Said

c) Improved communications

2) Anchorage Conditions

(i) Status of the Use of Anchorages

i) Great Bitter Lake

According to Figs. II-4-(2)-1~4 showing vessels at anchor in Great Bitter Lake, anchorage is more or less evenly used in the Eastern Anchorage, but in the Western Anchorage, those anchorages in sections W1 and W4 on the North side are not utilized very much.

In Fig. II-4-(2)-11, four northbound vessels are found at anchor within the traffic route.

400 to 500 m or more of ship-to-ship distance at anchor is maintained by vessels in this area except for some small craft.

In Figs. II-4-(2)-10 and 12 showing the anchoring density, the densities at both of the southern and northern extremities of the Eastern Anchorage, and at the middle area and the northern extremities of the Western Anchorage are relatively high, but these are not generally siginificant, and it may be fair to comment that the anchorages are used in a relatively uniform manner.

Figs. II-4-(2)-25 and 26 show the status of anchoring by time of day. In the Eastern Anchorage, the number of vessels at anchor hits the peak at about noon, and such a status continues for one hour.

Likewise, in the Western Anchorage, the peak condition also appears at about noon. However, the anchoring density of 20 vessels or more continues for about four hours.

ii) Port Said Waiting Anchorage

According to Figs. II-4-(2)-5~8 showing vessels at anchor in the Port Said Anchorage, it is evident that only the East half of the anchorage is used, while the West half remains almost completely unused.

Off the designated anchorage, a noticeable number of vessels at anchor in the prohibited zone can be seen.

The nearest ship-to-ship distance of vessels at anchor is about 350 meters.

In the anchorage vessels supposedly waiting for berths in Port Said for cargo work not for transiting the Canal, are seen.

Considering the density charts, no specific features are seen in Fig. II-4-(2)-14, but in Fig. II-4-(2)-16, high density values are seen in areas on the East side of the anchorage for shallow draught vessels showing that this portion of the anchorage is in frequent use.

In Fig. II-4-(2)-27 showing the status of anchoring by time of day, it is demonstrated that the peak number of vessels at anchor appears in the time belts from 1500 to 1700 hours and from 0900 to 1200 hours, but this trend is not so significant, where 10 to 15 vessels are generally at anchor all the time.

The anchoring period, in many cases, ranges from 1 to 2 hours.

(ii) Discussions on Tracks

i) Great Bitter Lake

In track charts showing the vessels' tracks up to the anchoring stage, most of the northbound vessels enter the anchorage after passing the South Light taking a detour from the designated traffic route and head to their anchorage making ways through the anchorage waters.

The same trend can be seen also in the case of the southbound vessels. They pass through the anchorage after clearing the North Light, in most of the cases, and head straight to the points of anchorage proceeding through the anchorage waters.

Also, they follow the same tracks after heaving up anchors.

Almost all the northbound vessels proceed into the channel at the northern point of the North Light after passing through the anchorage, and in the case of the southbound vessels, they pass through the anchorage and then proceed into the channel at the southern point of the South Light in most of the cases.

ii) Port Said Waiting Anchorage

In track charts showing the vessels' tracks up to the anchoring stage, specifically those coming from the north, vessels with a draught exceeding 38 ft, of course, proceed directly to the anchorage, while vessels with a draught below 38 ft either proceed directly to the anchorage passing through the deep water anchorage or proceed south on the east side of the anchorage by making a detour to the points of anchorage.

Vessels coming from the west make way directly to the points of anchorage in most of the cases.

In tracks after heaving up anchors, vessels with a draught exceeding 38 ft enter the East Channel either at the point of Hm 135 or at Hm 165. Those with a draught below 38 ft head to the Fairway Buoy after clearing the vessels at anchor making various sheltering manoeuvres.

It was noted that several vessels were found heading from the anchorage for deep draught vessels to the West Channel, thus service distinction between the anchorages for shallow draught vessels and deep draught vessels was not necessarily observed in a strict manner.

(iii) Capacity of Anchorage

i) Great Bitter Lake

On the 15th March, 1984, 37 northbound vessels transitted the Canal, 16 of which anchored in Great Bitter Lake. On the same day, the same number, 37 southbound vessels, transitted 26 of which anchored in Great Bitter Lake.

On the 24th October, 1984, 34 northbound vessels transitted 27 of which anchored, whereas 29 southbound vessels transitted 23 of which anchored in Great Bitter Lake.

When the numbers of vessels at anchor shown in Figs. II-4-(2)-25, 26 and the anchoring capacities of the Eastern Anchorage and Western Anchorage, namely 26 and

34 respectively, are compared, it may be seen that there are still considerable capacity allowances.

ii) Port Said Waiting Anchorage

The total number of vessels anchored in the Port Said Waiting Anchorage from 1400 on 17th March, 1984 to 1400 hours on the subsequent day was 43.

According to Fig. II-4-(2)-27, the time when the largest number of vessels at anchor was recorded is the period from 1600 to 1700 hours on the 17th, and the number was 17 vessels. If this figure is compared with the 23 vessels of anchoring capacity, it is evident that there is a considerable allowance in anchoring capacity.

However, the fact that the west half of the anchorage was not in use suggests that there is a greater possibility of coming into contact with other vessels, even if the anchorage has an allowance. Control of the anchorage should therefore be made so that all the area of anchorage is used evenly as mucb as possible.

In the possible event of an increase in the number of vessels waiting for berths in Port Said for cargo work, provision of some other suitable anchorage would be required to accommodate them.

(3) Aids to Navigation

1) Rate of Completion of Aids to Navigation

Table IV-2-(3)-1 compares the numbers of aids to navigation provided in the Suez Canal and in other canals, channels, rivers and narrow traffic routes. The term "mean distance between aids to navigation" signifies the value obtained by dividing the total linear length of a waterway by half the number of aids to navigation on the assumption that these aids are evenly provided on the banks of both sides.

If we take into account the greater geographical complexities in canals, and channels other than the Suez Canal, the rate of completion of aids to navigation in the Suez Canal is considered to be fairly high, and as far as the water within the Canal is concerned, the installation of the aids to navigation in this area is considered to be sufficient.

However, the story is different with respect to the approaches and waiting areas. Specifically, both Port Said and Suez incorporate very little reference objects for navigation, and when the subject comes to lighthouses, only the Port Said High Light barely measures up to acceptable standards. Hence, it is necessary to provide an adequate number of lighthouses, racons and other aids to navigation for helping incoming vessels to fix their positions.

Table IV-2-(3)-1 Comparison of Number per Kilometer and Interval of Aids to Navigation

Name of Waterway	Number of Aids to Navigation	Length of Waterway (Km)	Number of Aids to Navigation per Km	Mean Distance between Aids to Navigation (m)
Suez Canal	439	162	2.71	738
Maas River (Hook of Holland to Waal Haven)	102	30	3.40	588
North Sea Canal	109	33	3.30	606
Elbe River (Cuxhaven to Volhaven)	219	102	2.15	932
Kiel Canal	108	99	1.09	1,833
Kanmon Strait (Hesaki to Mutsure Island)	68	25	2.72	735
Panama Canal	279	82	3.40	588
Average	189	76	2.48	805

2) Quality of Aids to Navigation

Although the Canal buoys provided within the water of the Canal are considered satisfactory in both function and structure, it is considered necessary to provide them with identification numbers.

Concerning the buoys in the approaches of Port Said and Suez, an adequate number of larger buoys and racons must be provided.

Specific recommendations will be made later in the urgently needed countermeasures section, but it goes without saying that negligent or erroneous identifications of buoys often develops into serious marine casualties.

3) Maintenance

As mentioned above, many comments requesting improved maintenance of the aids to navigation were received from the Canal pilots, masters of transiting vessels and Japanese captains having the experience of transiting the Suez Canal, and in particular maintenance of those buoys provided in areas outside Port Said and Suez seems unsatisfactory.

The importance of maintaining those buoys in the approaches in a satisfactory condition must be fully recognized.

Table IV-2-(3)-2 compares several maintenance-related items of the aids to navigation provided by the SCA and by the Aids to Navigation Department of the Maritime Safety Agency of Japan.

Table IV-2-(3)-2 Comparison of Maintenance of Aids to Navigation between the SCA and the Aids to Navigation Department of Japan Maritime Agency

	SCA	Japan
Confirmation of Lightening		O
Regular Maintenance		
15 days		O
30 days		
45 days	O	
2 months		O
3 months (Underwater)	O	
6 months		O
1 year	O	
Lift up maintenance of buoys Canal buoys (every 2 years) Approach buoys (every 1 year)	 O O	
Automatic extinguishment alarm		O
Marking for collided vessels		O

Broadly speaking, the aids to navigation of the SCA are considered to be maintained satisfactorily if the maintenance standards prescribed by the SCA are closely observed. However, introduction of the practices established by the Aids to Navigation Department of Japan, in which obligatory daily lighting condition checks are performed and in case of lighting failure, defective parts are immediately replaced with new ones irrespective whether it is in night time or on holiday; and the fixing of automatic lighting failure alarms on the important buoys in approaches and fairways is made obligatory, may be considered necessary.

As for those buoys provided within the Canal, they seem to be maintained relatively well thanks to timely notices from the pilots of transiting vessels and signal stations coupled with better accessibility than for those buoys provided outside the ports. However, those buoys provided in the approaches, waiting areas and fairways seemed to be poorly maintained.

Further, it is extremely important that the installed positions of those Canal buoys are subjected to frequent checks to ensure their correct positioning since the manoeuvring of transiting vessels in the waters of the Canal requires extremely high accuracy.

For checking the position of buoys within the Canal, the following procedures and equipments are considered:

i) If the required position fixing accuracy is available by SCVTMS, use of such equipment is the easiest and most economical procedures.

ii) Use of a portable radar unit. It must be noted, however, that a position fixing error of a few percent is unavoidable with radar observation.

iii) Following are examples of position fixing equipment:

(a)	Hyper-Fix	Racal Positioning Systems Ltd., England
(b)	Artemis	International Navigatie Apparaten B.V., Netherlands
(c)	Auto Carta II	Racal-Decca Survey Inc., USA
(d)	Auto Carta/3	Racal Positioning Systems Ltd., England
(e)	NS-2 Buoy Tender Guidance System	Sena Co., Ltd., Japan

(4) Traffic Control and Regulations

1) Present Status of Traffic Control

(i) Traffic Control System

The traffic control system presently in operation is such that liaisons and communications among each harbour office, signal station, transiting vessel and the pilot on board the vessel and the head office are carried out mainly by VHF and UHF radiotelephony and ordinary telephone, and centralized control of the entire transiting conditions of the Canal is effected by recording the respective moves of transiting vessels on the Traffic Diagram as stated before. This traffic control system seems to be outdated considering modern sophisticated traffic control techniques, but in effect it is a good control system established on the wealth of years of operational experience, well matching the needs of the Canal.

However, in light of the on-going situation dominant in the traffic control systems employed in the canals, channels, rivers and other similar waterways in foreign countries, upgrading of the system by the introduction of a computer-aided radar system, the SCVTMS, may be considered as a reasonable choice.

When the SCVTMS becomes fully functional for the scientific and efficient control and management of the Canal and transiting vessels, the safety of vessels transiting the Canal will be further enhanced. In this connection, full operation of the SCVTMS as soon as possible is strongly desired.

(ii) Meeting with Other Transiting Vessels at Deversoir

In cases where vessels of the northbound convoy proceed to the north starting from the anchorage in the Great Bitter Lake, traffic control is carried out in such a way that the leading vessel passes the North junction of both branches of Deversoir immediately after the last vessel of the southbound convoy has passed the junction, with the starting time of the leading vessel of the northbound convoy set accordingly. However, in case of a possible failure of vessels of the southbound convoy, it is likely, as a matter of possibility, that collision or grounding accidents may result from collision avoidance manoeuvres, and thus extremely careful traffic control with reasonable allowances is desired. The same suggestion may equally be directed to the junctions of El Balah and El Kabrit.

(iii) Anchorage Controls

When transiting vessels anchor at the anchorages within each waiting area of Port Said, Suez, Great Bitter Lake, and Lake Timsah, or depart from the assigned ancorage, it seems that traffic controls are not observed in a strict manner.

2) SCVTMS

(i) System Evaluation

As mentioned before, the SCVTMS is a system capable of graphically displaying on the the CRT of the control centre various items of computer-processed information on vessels' movements including positions, courses, speeds, etc., together with identification symbols based on data obtained through radars and Loran-C. If the measured off-track, ship-to-ship distance and speed deviate from the preset allowable values, alarms are automatically issued and all the operational data are recorded on magnetic tapes. If the system is operated in such a way that its multiple functions are fully utilized as originally designed, it will be extremely useful for the efficient control and management of the Canal and for the enhancement of the safety of vessels transiting the Canal.

(ii) Present Status of SCVTMS

The SCVTMS has problems in that the Loran-C system which is one of the vital parts of this system can not achieve the required level of position fixing accuracy at present, and a variety of investigations are now under way. The SCVTMS is now not in operation, and it is estimated to take a fairly long period of time before the Canal can be practically controlled and managed by this system.

(iii) Position Fixing Accuracy of Loran-C

Distribution of Number of Vessels Passed Gate Line, Distribution of Vessels Breadths Occupying Water at Gate Line, and Track Chart shown in Part II, II-4 Traffic and Anchorage Conditions, are the figures represented by computer process of the off-track and positional data of vessels stowed in the magnetic tapes of the SCVTMS. However, on the figures representing distribution of vessels passed gate line and distribution of vessels' breadths occupying water, it is evident that the transitable Canal breadth is considerably exceeded by the data shown, and on the track chart, many tracks are found deviated from the transitable area of water. Further, at the computer process, a fairly large volume of data, which were considered to be useless or unusable, were discarded. From these observations, we can realize that the position-fixing accuracy of the Loran-C system has degraded to a significant extent.

On the foregoing grounds, it is considered meaningless to assess the Canal topography by the estimation of the risk levels and frequencies of collisions and groundings of transiting vessels by analyzing the track charts, distribution of number of vessels passed gate line, distribution of vessels' breadths occupying water, etc., using the data given by the SCVTMS.

(iv) Hydraulic Centreline

The hydraulic centreline represents a reference line established for taking measurements of the off-track distance and for automatic issuance of off-track alarms, which is input into the computer. This is one of the versatile functions of the SCVTMS. This hydraulic centreline was intrinsically identical with the centreline of the waterway of the Canal which should also align with the centreline noted on the relevant chart. However, because of the inaccuracy of the Canal maps, the hydraulic centreline was postulated using a number of actual tracks recorded by large vessels which transited the Canal after obtaining data through the use of Loran-C before the question of whether such a hydraulic centreline does in fact align with the actual centreline to be indicated on the chart was resolved.

Figs. IV-2-(4)-1~6 are maps noted with the hydraulic centreline which were drawn based on microfilm photos of the maps marked with the data of hydraulic centreline that were forwarded from the SCA in July, 1984.

The system of coordinates used in position fixing by Loran-C, namely the system of coordinates of the hydraulic centreline and that used in this map have been left uncorrelated.

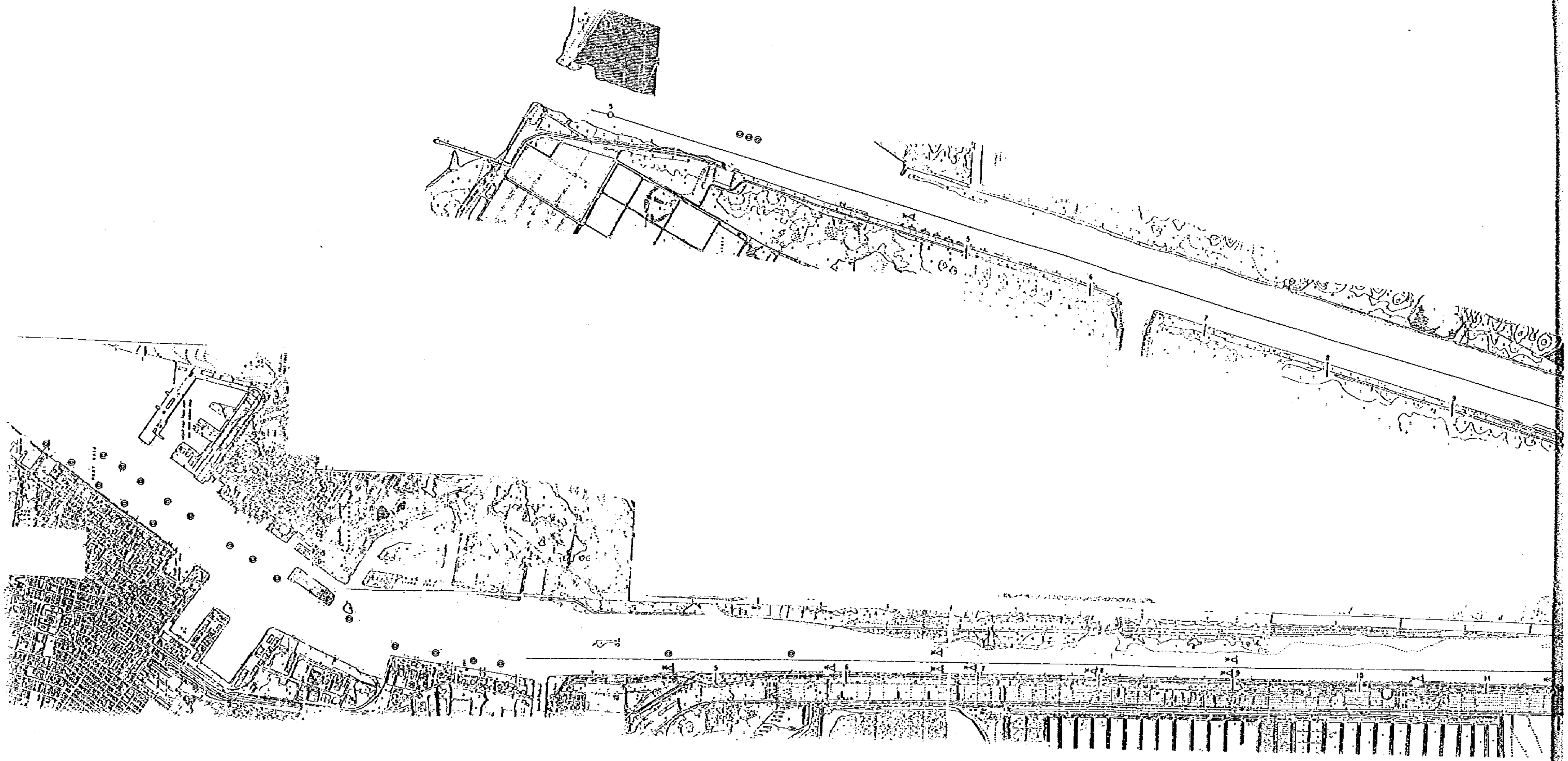


Fig. IV-2-(4)-1 Hydraulic Center Line (1)

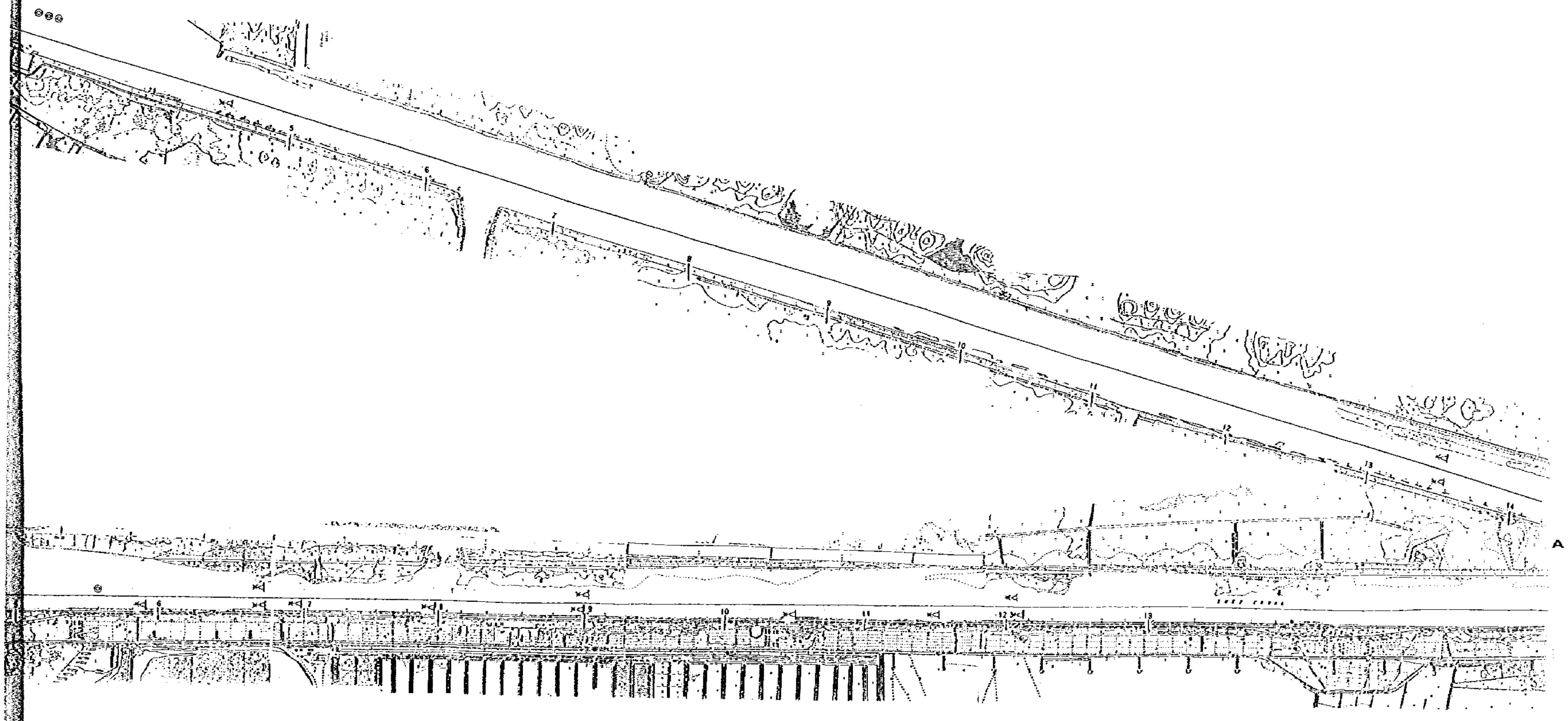


Fig. IV-2-(4)-1 Hydraulic Center Line (1)

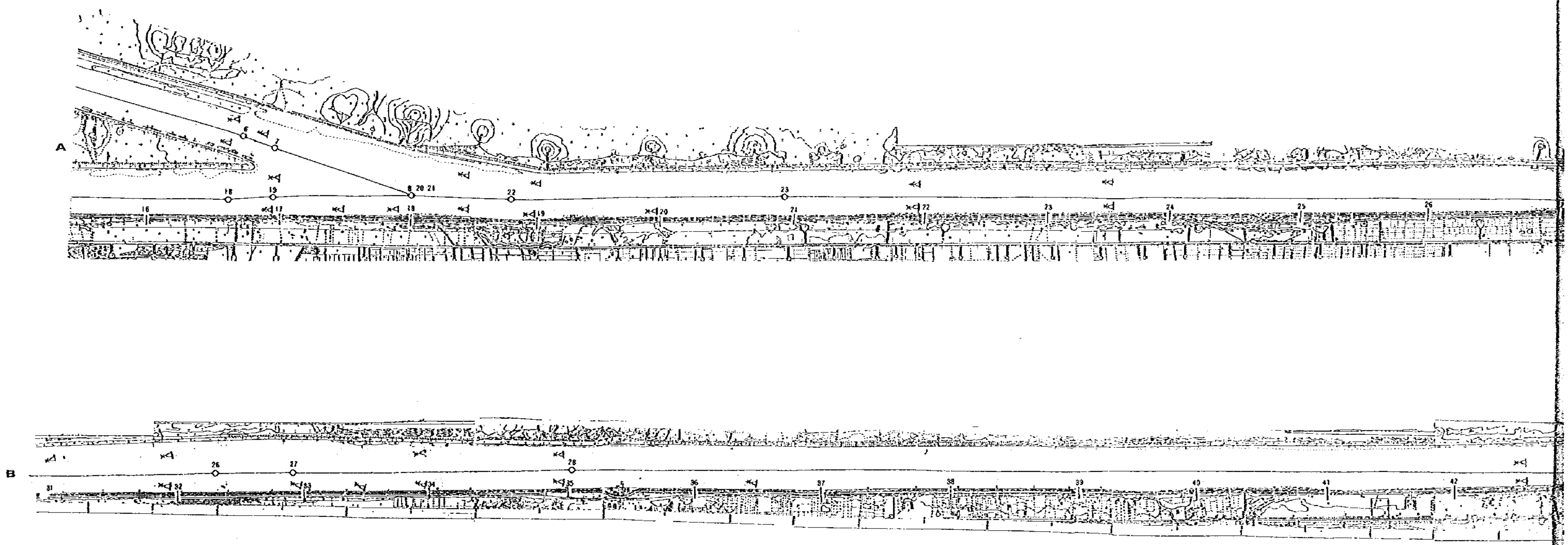


Fig. IV-2-(4)-2 Hydraulic Center Line (2)

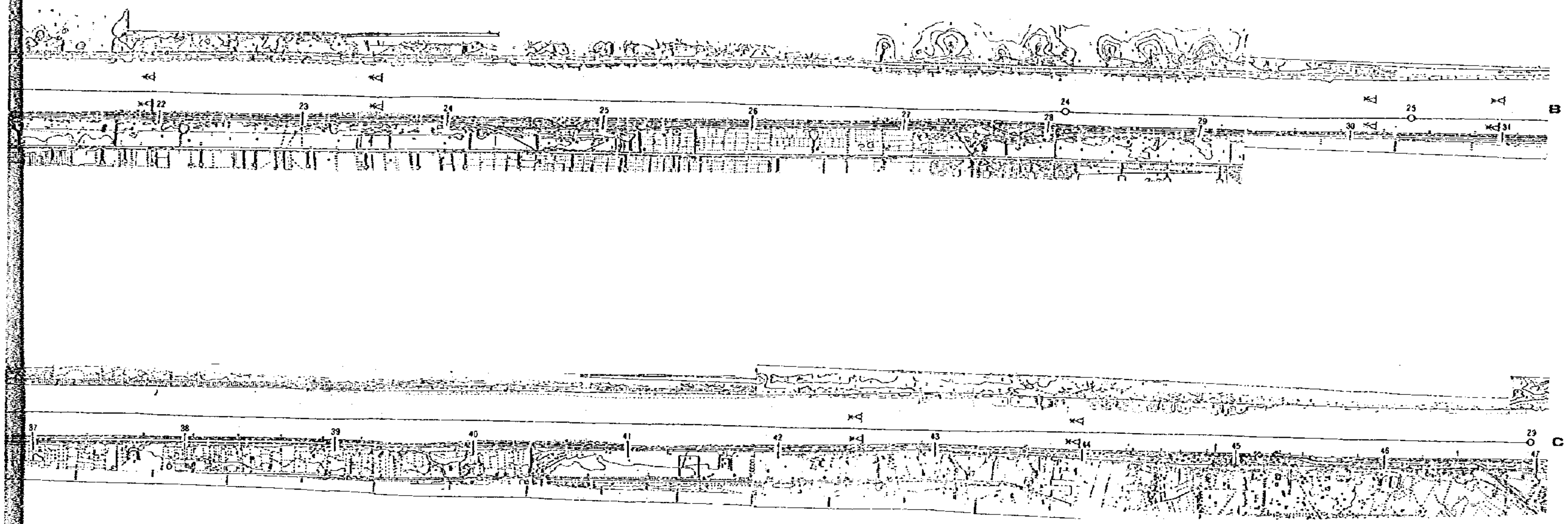


Fig. IV-2-(4)-2 Hydraulic Center Line (2)

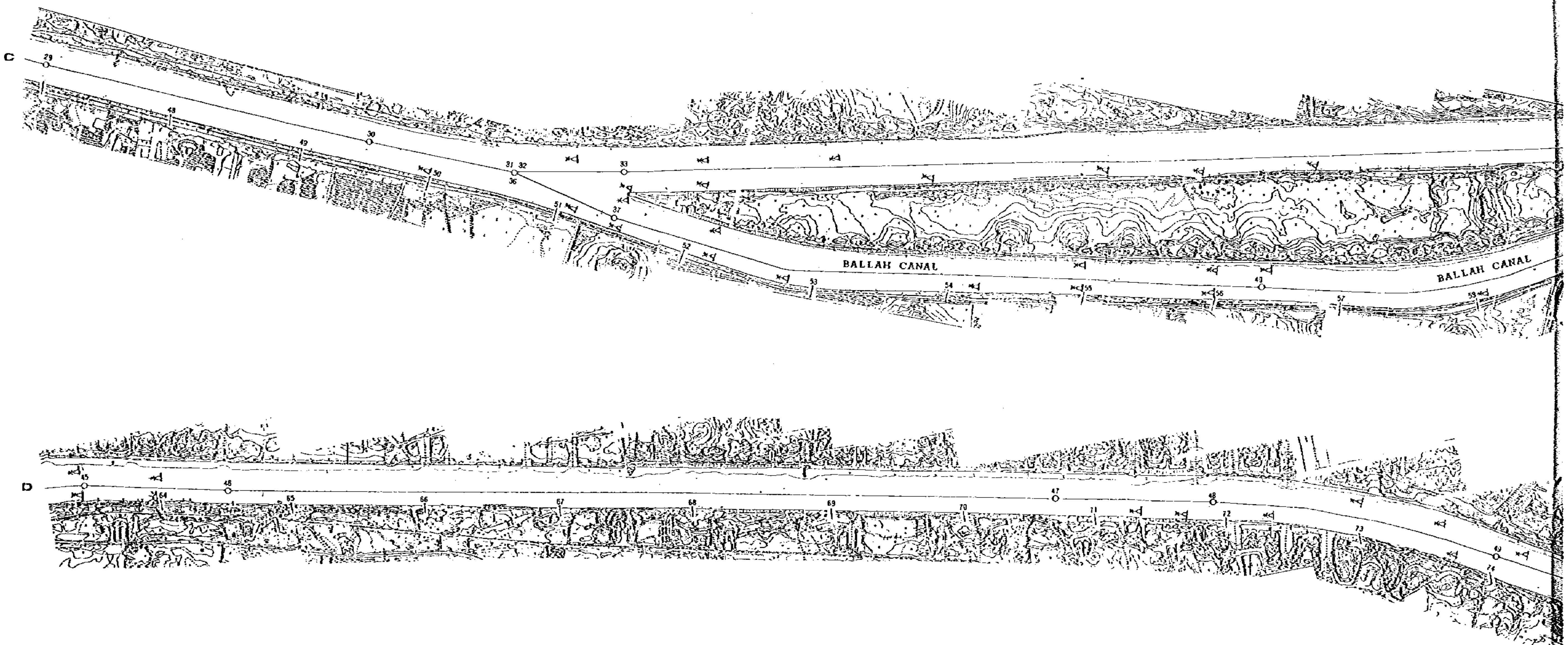


Fig. IV-2-(4)-3 Hydraulic Center Line (3)

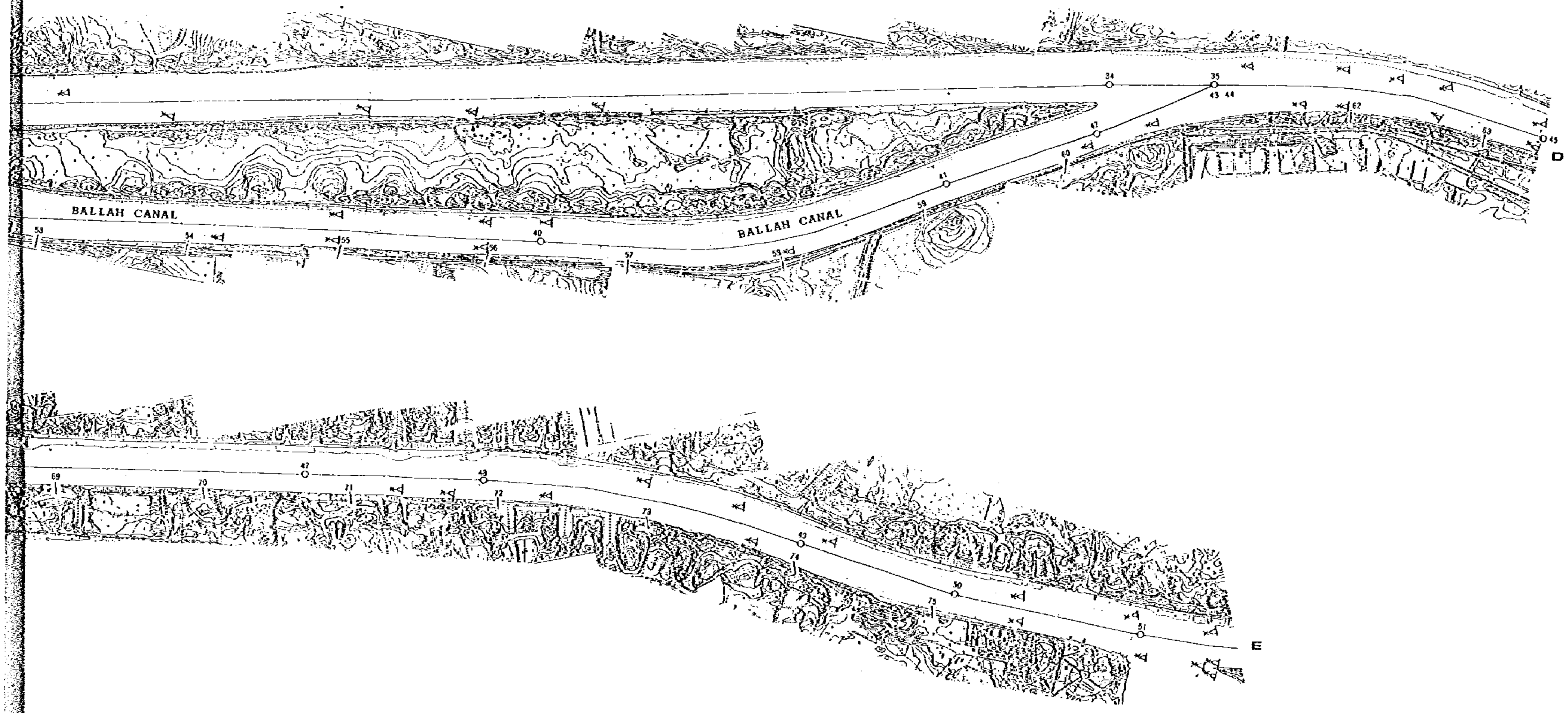


Fig. IV-2-(4)-3 Hydraulic Center Line (3)

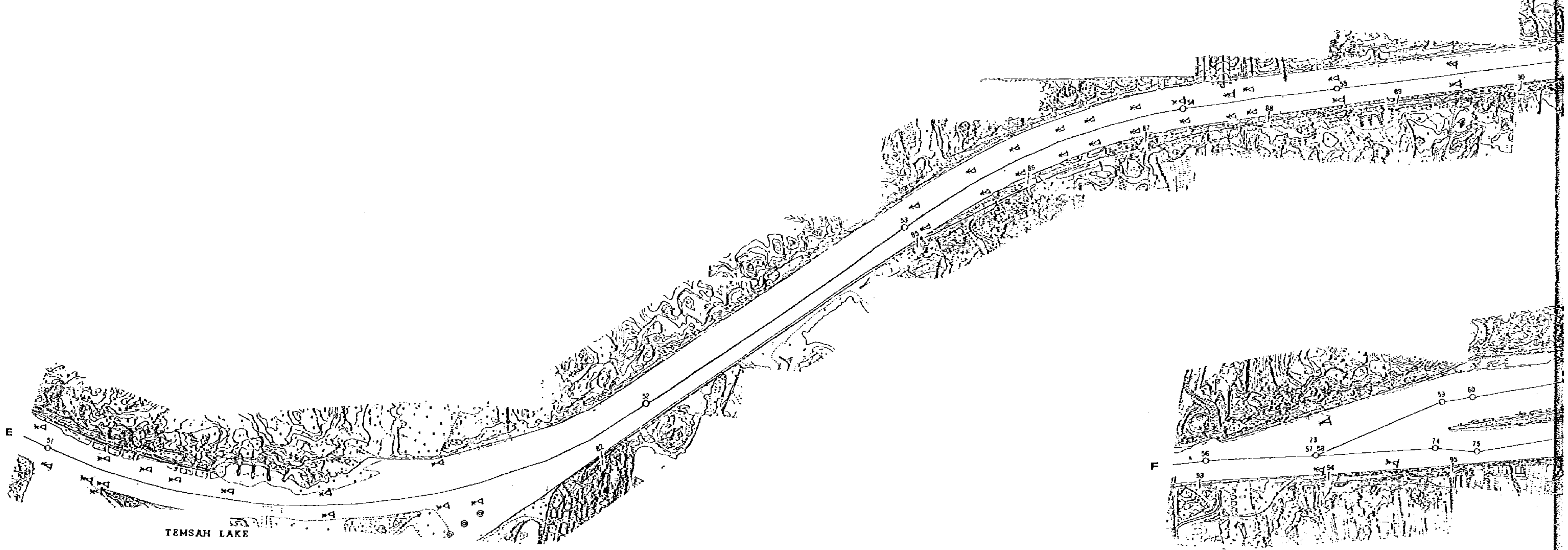


Fig. IV-2-(4)-4 Hydraulic Center Line (4)

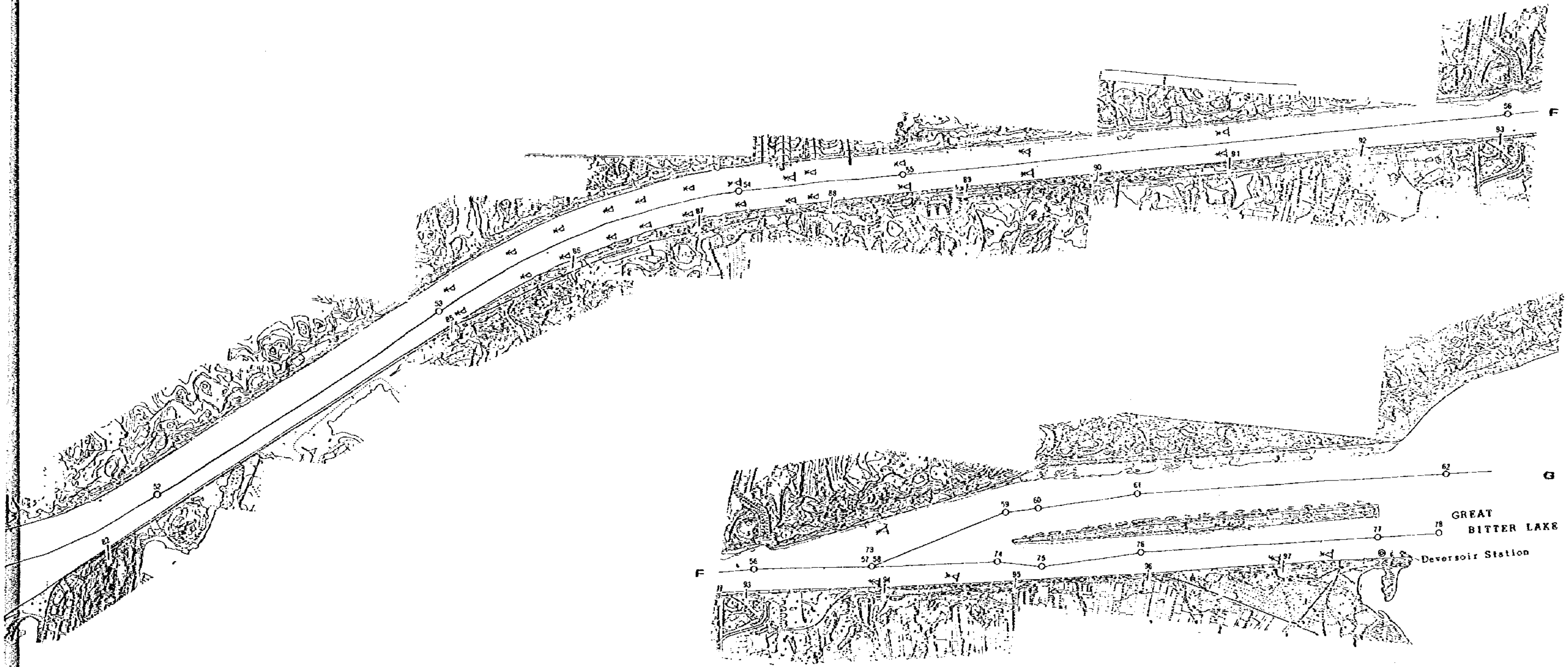


Fig. IV-2-(4)-4 Hydraulic Center Line (4)

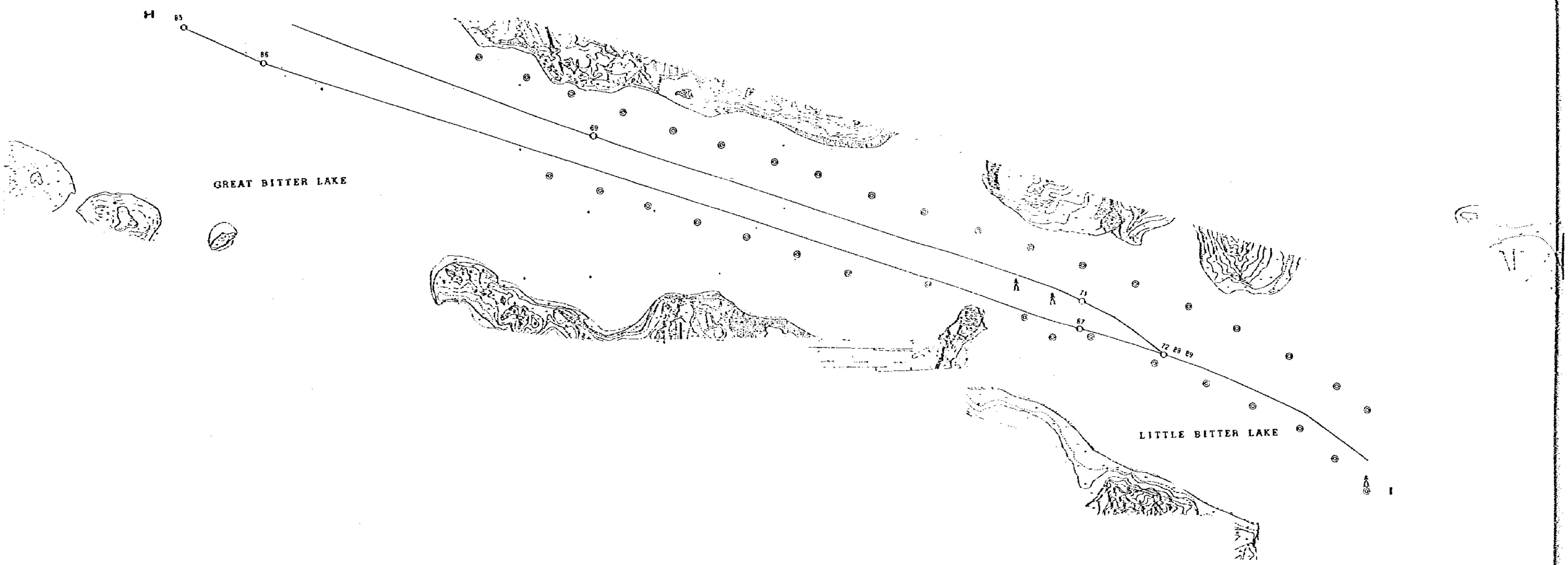


Fig. IV-2-(4)-5 Hydraulic Center Line (5)

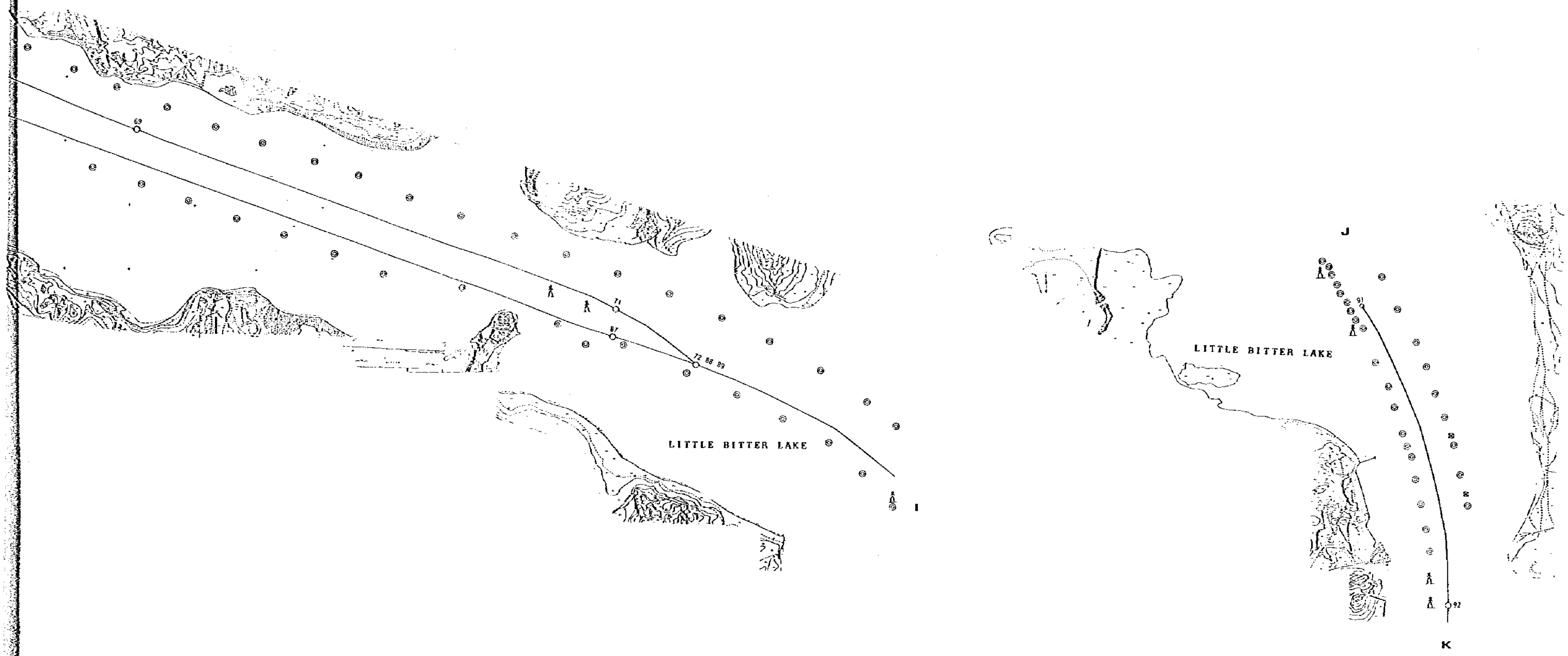


Fig. IV-2-(4)-5 Hydraulic Center Line (5)

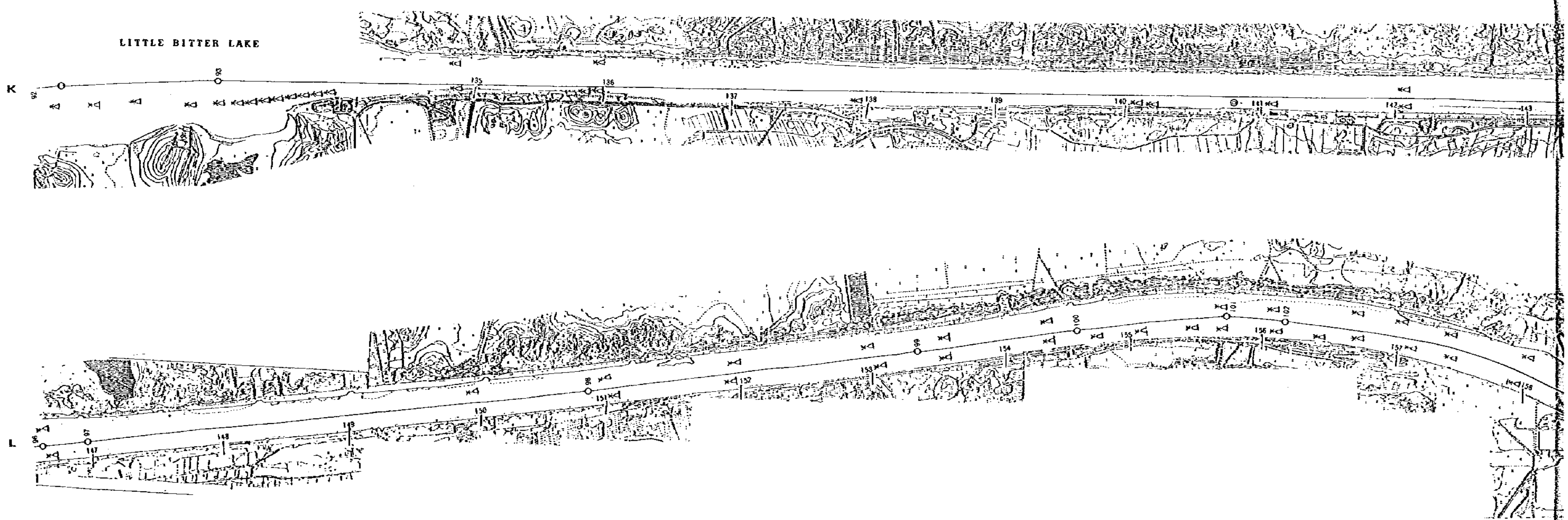


Fig. IV-2-(4)-6 Hydraulic Center Line (6)

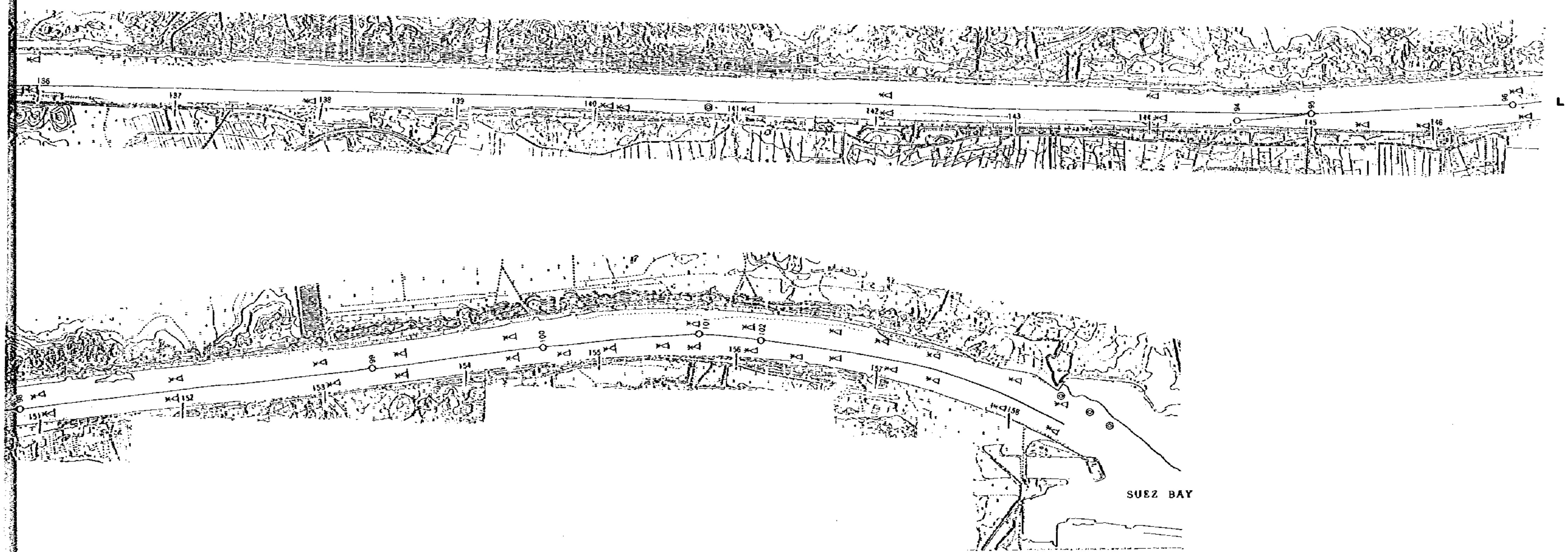


Fig. IV-2-(4)-6 Hydraulic Center Line (6)

(v) Comparison of the SCVTMS with the System of Tokyo Bay Traffic Advisory Service Centre

Table IV-2-(4)-1 compares the Uraga Traffic Route of Tokyo Bay with the Suez Canal, and Table IV-2-(4)-2 compares the SCVTMS with the system of the Tokyo Bay Traffic Advisory Service Centre.

Although we admit that the direct comparison of the Canal with the channel may be not adequate in consideration of the large differences involved in the length of the waterways, width and geometrical shapes, the SCVTMS and the VTMS system of Tokyo Bay closely resemble each other, and hence we rather like to make comparative assessments on these systems.

These two systems have the following common features:

i) Radars are used for tracking transiting vessels.

ii) Vessels' data obtained by radars are computer-processed.

iii) Computer-processed operational data such as vessel's position, course and speed are graphically displayed on the CRT.

iv) Identification numbers can be allotted to each vessel.

v) Information on the movement of own vessel and other vessels as well as sea and weather conditions necessary for the passage can be given.

vi) These systems carry out booking of transit and give necessary instructions for traffic control.

vii) Vessels data for 20,000 vessels can be input into the computer storage of the system of the Suez Canal, whereas those for 10,000 vessels can be input into the Tokyo Bay system's computer storage.

viii) Both systems have a control voice recording system.

These two systems have the following differences:

i) The Tokyo Bay system carries out tracking of transiting vessels using only radars, whereas the Suez Canal system tracks using radars and Loran-C.

ii) The Suez system automatically issues alarms for abnormal off-track, speed and ship-to-ship distance. The Tokyo Bay system automatically issues alarms for the dangers of collision and grounding.

iii) The Tokyo Bay system offers periodical broadcasting and telephone services.

iv) The Tokyo Bay system can make character displays of the contents of the regular broadcasting, traffic route information, sea and weather conditions and various other items of information aside from vessels' details.

v) The SCVTMS requires vessels to carry the CORT units for the operation of the Loran-C.

vi) Tracking of vessels by radars is done manually in the SCVTMS, whereas it is carried out automatically in the Tokyo Bay system.

vii) In the SCVTMS, the computer-processed vessel data are recorded on magnetic tapes.

viii) In the Tokyo Bay system, radar PPIs are recorded on 8 mm film.

As shown above, the SCVTMS and Tokyo Bay system have various points of difference in details, yet they are basically similar, and if the SCVTMS exerts its designed func-

Table IV-2-(4)-1 Comparison between Suez Canal and Uraga Traffic Route

	Suez Canal	Uraga Traffic Route
Length	162 Km	15(+11) Km
Width	160 m at 11 m depth	700 ~ 800 m
Depth	19.5 m at center	20 ~ 80 m
Traffic system	1 way convoy system	2 way separated
Pilot	300 tons or more	10,000 tons or more
Fishing	Not permitted	Permitted
Average number of transit vessels per day	about 60	about 750

Table IV-2-(4)-2 Comparison between SCVTMS and System of Tokyo Bay Traffic Advisory Service Center

	SCVTMS	Tokyo Bay Traffic Advisory Service Center
Service hours	24	24
Tracking of Vessels	3 Radars and Loran-C	3 Radars
Data process	Computer process	Computer process
Type of display	Graphic display	Graphic display
Number of staff	53	63
Kind of service		
Periodical broadcast	No	Yes
Emergency broadcast	Yes	Yes
Telephone service	No	Yes
Individual information service	Yes	Yes
Traffic control	Yes	Yes
Recording to magnetic tape	Yes	No
Voice recorder	Yes	Yes
Control vessels	All transitting vessels	All transitting vessels
Escort board	100,000 tons or more	250 m in length or over, and 200 m in length or over carrying dangerous cargo
Carrying of CORT	Yes	No
Communication	VHF, UHF Radio communication	VHF, SSB Radio communication
Information display	No	Yes
Data capacity	20,000 vessels	10,000 vessles

tions and performance, its contribution to the enhancement of the safety of transiting vessels can be great in light of the excellent record marked by the Tokyo Bay system in which the risk level in the Uraga Traffic Route of Tokyo Bay in the period before the introduction of the Tokyo Bay Traffic Advisory Service Centre was reduced by half after the completion of the centre.

(vi) Comparison of SCVTMS with VTMS Employed in Other Similar Canals and Channels

Table IV-2-(4)-3 is an outline of the Vessel Traffic Management Systems provided in other similar canals and channels.

When they are compared with the SCTVMS, the following may be pointed out:

i) In almost all systems, traffic management is carried out by grasping vessels' movements with the aid of radars and by giving the information necessary for passage by VHF radiotelephony, except for several cases where traffic management is done solely by communications through VHF radiotelephony or TV pictures of vessels' movements alone.

ii) Use of Loran-C for grasping vessels' movements is practiced only in the Suez Canal.

iii) It is only the vessel traffic and management system of Tokyo Bay where vessels' movement information obtained by radars is computer-processed (as far as those contained in Table IV-2-(4)-3 are concerned).

iv) It can be said that the SCVTMS is one of the most sophisticated vessel traffic management systems.

Table IV-2-(4)-3 Vessel Traffic Management Systems of Similar Canals and Waterways

	Name of the system	Traffic Regulation Kiel Canal	VTS Elbe	Rotterdam Vessel Traffic Management System
OUTLINE	Organization operating the system	Waterway and Shipping Administration Navigation Offices Brunsbuttel and Kiel	Waterway and Shipping Administration Navigation Office Cuxhaven and Hamburg	Pilot Center, Ministry of Defence
	Address of the organization			
	Brief description of its history	In operation since 1895, improvement in 1950	Construction 1960-65, in operation since 1960	In operation since 1957
MANAGEMENT	Category of the traffic management	Vessel management system	Information service and pilotage	Vessel movement reporting system with radar surveillance
	Other comments on management	Traffic Regulation by bight signals: speed limit 15 km/h and 12 km/h	Speed regulation by general advice	Semaphore with lamp matrix
	Operation time (service time)	24 hour operation	24 hour operation	24 hour operation
	Waterway (ship route)	Canal	Eble Route determined	Separated lanes
	Vessels under management	All vessels under management	Reports mandatory for vessels with dangerous cargo	Voluntary
	Pilotage mandatory for:	Nearly all vessels	Vessels over 1,000 g.t. and all vessels with dangerous cargo	Obligatory for vessels over 500 g.t.
WATER	Category of area covered by the VTMS	Canal	River and approach	Harbour and approaches
	Approximate size of water	100 km long canal: 162 m (bottom 90 m) wide	150 km long channel, 0.2 – 4.6 km wide	Channel, 50 km in total length, 0.5 – 2 km wide
	Approximate amount of cargo handled	93 million tons in 1981	Outer Elbe – 118 million tons in 1980 Lower Elbe – 75 million tons in 1980	320 million tons in 1975
	Special navigation aids			Decca navigation system

	Name of the system	Traffic Regulation Kiel Canal	VTS Elbe	Rotterdam Vessel Traffic Management System
COMMUNICATION	Number of VHF stations/number of VHF zones/number of channels/language	2 stations/2 zones/4 channels/German	2 manned stations/10 zones/7 channels/ German and English	7 manned stations/7 zones/11 channels/ Dutch. German and English
	Installation of VHF on board	Mandatory for tankers, portable sets used by pilots	Not compulsory but portable sets are provided	Not compulsory but all pilots have VHF sets
	Number of MF and HF stations/ frequency			
	Visual signal system and its description	Light signal system		
	Automatic traffic data processing Other visual/radio communication device			
SURVEILLANCE	Number of radars/num. of manned ra. stations/num. of unmanned ra. sta. and type of radar	5 radars; Decca RR12 19A	9 radars/3 manned stations/6 unmanned st. Philips 8GR275/01 antenna S34, S37 and SP34	7 radars manned; Philips
	Radar frequency/horizontal beam width/vertical beam width/minimum pulse length	9.3 GHz/0.8°/20°/50 ns	9 GHz/0.25°, 0.35°, 0.6°/16°/80 ns	
	Type of radar antenna and its size	Slotted wave guide/2.7 m	Slotted wave guide/4.36 m, 4.4 m and 6.3 m	Processing
	Automatic radar processing			
	Number of surveillance TVs/number of TV stations			
	Ship identification system (e.g., VHF DF)	Ship reporting system at locks		
	Other device for surveillance	TV converted bright display		
REMARKS				

	Name of the system	Traffic Regulation Kiel Canal	VTS Elbe	Rotterdam Vessel Traffic Management System
OUTLINE	Thames Navigation Service "Gravesend Radio"	Marine Traffic Control and Information Systems Saint Lawrence Seaway	New Orleans Vessel Traffic Service includes Mississippi River Gulf Outlet	Tokyo Bay Traffic Advisory Service Center
OUTLINE	Port of London Authority	The Saint Lawrence Seaway Authority	U.S. Coast Guard	Maritime Safety Agency
OUTLINE		202 Pitt Street Cornwall, Ontario K6J 3P7	Washington, D.C. 20590	100 2-1-3 Kasumigaseki, Chiyoda-ku, Tokyo
OUTLINE	VHF radio in 1959, radar extention planned in 1978/79, NDP/RDP being investigated	Tra. control early 50s, VHF became mandatory & computerized system in 1963, TV used 1966	Operation since 1977	In operation since 1977, added a new radar station in 1983
MANAGEMENT	Vessel movement reporting system with radar surveillance and tidal passage surveillance	Vessel movement reporting system requiring traffic clearance	Vessel movement reporting system traffic light at high water	Vessel traffic regulation system with radar surveillance
MANAGEMENT	Tra. con. procedures regulated by p. General Directions Signal at dock & jetties		No regulations. Voluntary procedures contained in operating manual	Maximum speed 12 knots in channel
MANAGEMENT	24 hour operation	24 hour operation	24 hour operation	24 hour operation
MANAGEMENT	Channels marked with buoys	Designated	Buoyed channels	Separated traffic lanes (750 x 2 m) marked by buoys
MANAGEMENT	Vessels over 50 g.t.	Vessels over 6.1 m	Vessels over 300 g.t. passenger v. over 100 g.t. and towing v. over 26 ft. when tow. & dredg.	Separation scheme for vessels over 50 m, VMRS for vessels*
MANAGEMENT	All sea-going passenger vessels and vessels over 3,500 g.t.	Compulsory for all deep-sea vessels and inland vessels without pilot certificates	Compulsory for sea-going vessels	Mandatory for vessels over 10,000 g.t.
WATER	Docks, river Thames and esturial approaches	Rivers, canals and lakes	River and dredged channels	Bay and its approach
WATER	94 km long channel, 0.3 – 3.6 km wide	700 km long	560 km long river and channels	60 km x 20 km
WATER	47.5 million tons in 1977		622 million tons in 1980	411 million tons in 1981
WATER	Special navigation aids			Remark beacon and Radar beacon

* Vessels over 10,000 g.t., vessels and towing vessels over 200 m

	Name of the system	Traffic Regulation Kiel Canal	VTS Elbe	Rotterdam Vessel Traffic Management System
COMMUNICATION	4 stations/2 zones/7 channels English	3 manned stations/7 zones/5 channels/ English and French	5 stations (1 manned, 4 unmanned)/ 4 zones/3 channels/English	1 manned station/1 zone/3 channels/ Japanese and English
	Not mandatory yet but non-equipped vessels must not proceed without permission	Mandatory for vessels over 19.81 m	Compulsory for vessels under management	Not compulsory but recommended
				1 station/A3H 1665 kHz (for broadcasting)
		Signal lights	3 traffic lights	
			Computer-assisted vessel data system with computer tracking display	Processing of vessel data Status of harbor traffic signals
	Telex link into national system	Channel markers		Automatic telephone announcement
SURVEILLANCE	7 radars/4 manned stations/3 unmanned st. Decca HR25, HR09 and Decca SPOTS			3 radars/2 manned stations/1 unmanned st. Oki
	A-9.1 GHz/0.3°/4°/50 ns P-9.4 GHz/1.0°/15°/50 ns A-Parabolic reflector/7.5 m P-Slotted waveguide/2.7 m			14 GHz/0.25°/15°/100 ns Double slotted waveguide/6 m
			4 TV sites linked to traffic center	Processing for traffic and digitize
		Closed circuit TV		
		Microwave point detector		
		Semi-automated ship position indicating system		Electric indicating board
REMARKS	1. Speed recommendation – 10 knots above Gravesend and 8 knots above Wandsworth 2. Special procedures for VLCCs on planned passages 3. Special procedures for other designated vessels such as LNG carriers		Operating Manual available with charge from: Commanding Officer U.S. Coast Guard Vessel Traffic Service 4400 Dauphine Street Bldg. 601-6-C, New Orleans, LA 70146 Radar and LLTV surveillance planned by 1986	

3) Rules and Regulations

All the requirements necessary for transiting the Canal are provided for in the Rules of Navigation laid down by the SCA.

The SCA, on the basis of the requirements of the Rules of Navigation, executes all controls and management over transiting vessels, and those vessels transiting the Canal must be guided by the requirements of the Rules of Navigation for their operation and behaviour in the Canal and its associated waters.

The Rules of Navigation have been formed on the basis of the long service experience of the SCA in the control and management of the Canal since the first opening in 1869, and the present rules prescribed in the Rules of Navigation are considered to well match the present day needs of the Canal.

4) Results of the Study concerning the Hydraulic Center Line

A field survey has been conducted to reconfirm the correlation between the canal cross-sections and the hydraulic center line.

(i) The surveyed areas were Km 14.5 ~ 19, Km 50 ~ 53, Km 59 ~ 62, Km 93 ~ 96, Km 118 ~ 122 and Km 145 ~ 148.

(ii) The items of the survey were the canal cross-sections, and the positions of bollards and navigation buoys.

The results of the field survey concerning the correlation between the canal cross-sections, the hydraulic center lines, and the distribution of vessels track chart which was drawn from data provided by SCA are shown in Figs. IV-2-(4)-7 ~ VI-2-(4)-12.

(iii) The following matters are found for each area:

i) Area Km 14.5 ~ 19

The correlation between the canal cross-sections, the hydraulic center lines and the distribution of vessels track chart is reasonable.

ii) Area Km 50 ~ 53

The correlation between these items is almost all reasonable except for part of west channel.

The western hydraulic center line of the area from Km 51.5 to 52.5 is too close to the west bank.

iii) Area Km 59 ~ 62

The correlation is reasonable.

iv) Area Km 93 ~ 96

The correlation is reasonable.

v) Area Km 118 ~ 122

As for the east channel, the correlation between the canal cross-sections and the hydraulic center line is reasonable, but the distribution of vessels track chart reaches the east side of the center line.

As for the west channel, the hydraulic center line reaches the center bank and the distribution of vessels track chart reaches the west side of the west bank.

vi) Area Km 145 ~ 148

The correlation between the canal cross-sections and the hydraulic center line is almost all reasonable except around Km 147.5. Near this point, the line is too close to the west bank.

The distribution of vessels track chart is not always reasonable, because the distribution is too extensive on the east side.

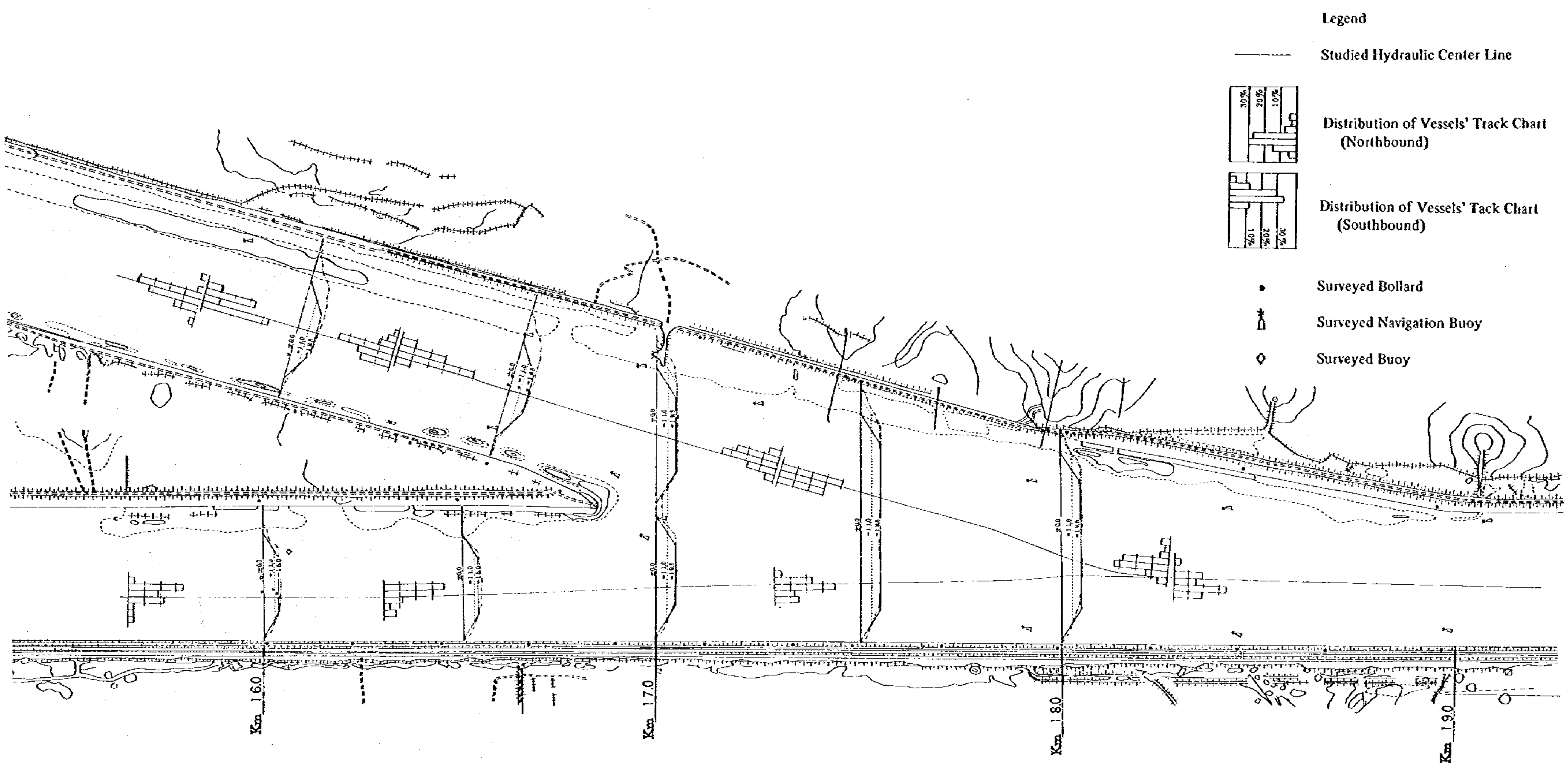


Fig. IV-2-(4)-7 Correlation between the Canal Cross-sections, the Hydraulic Center Lines and the Distributions of Vessels' Track Chart (Km 14.5 ~ 19)

Legend

Studied Hydraulic Center Line

Distribution of Vessels' Track Chart (Northbound)

Distribution of Vessels' Track Chart (Southbound)

Surveyed Bollard

Surveyed Navigation Buoy

Surveyed Buoy

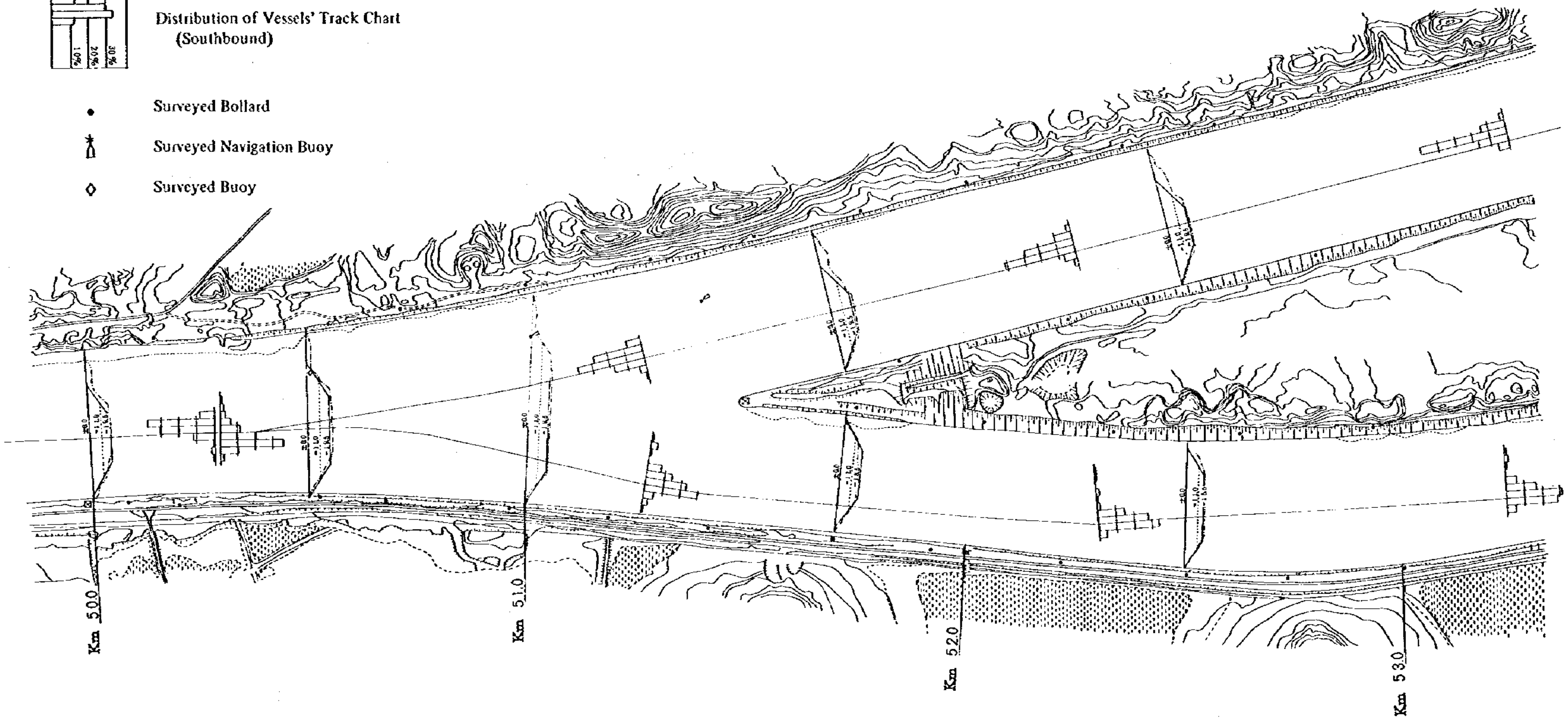


Fig. IV-2-(4)-8 Correlation between the Canal Cross-sections, the Hydraulic Center Lines and the Distributions of Vessels' Track Chart (Km 50 ~ 53)

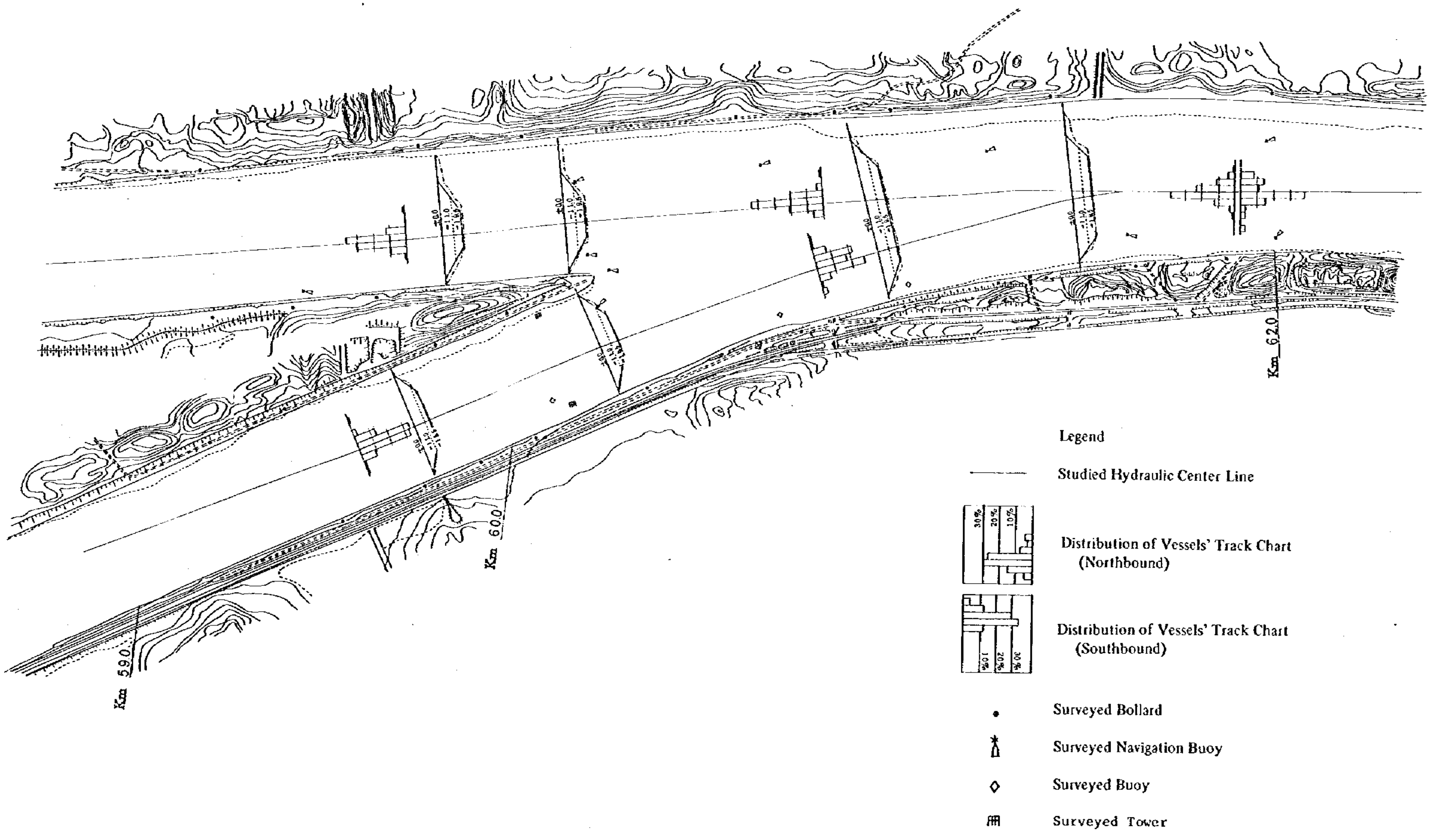


Fig. IV-2-(4)-9 Correlation between the Canal Cross-sections, the Hydraulic Center Lines and the Distributions of Vessels' Track Chart (Km 59 ~ 62)

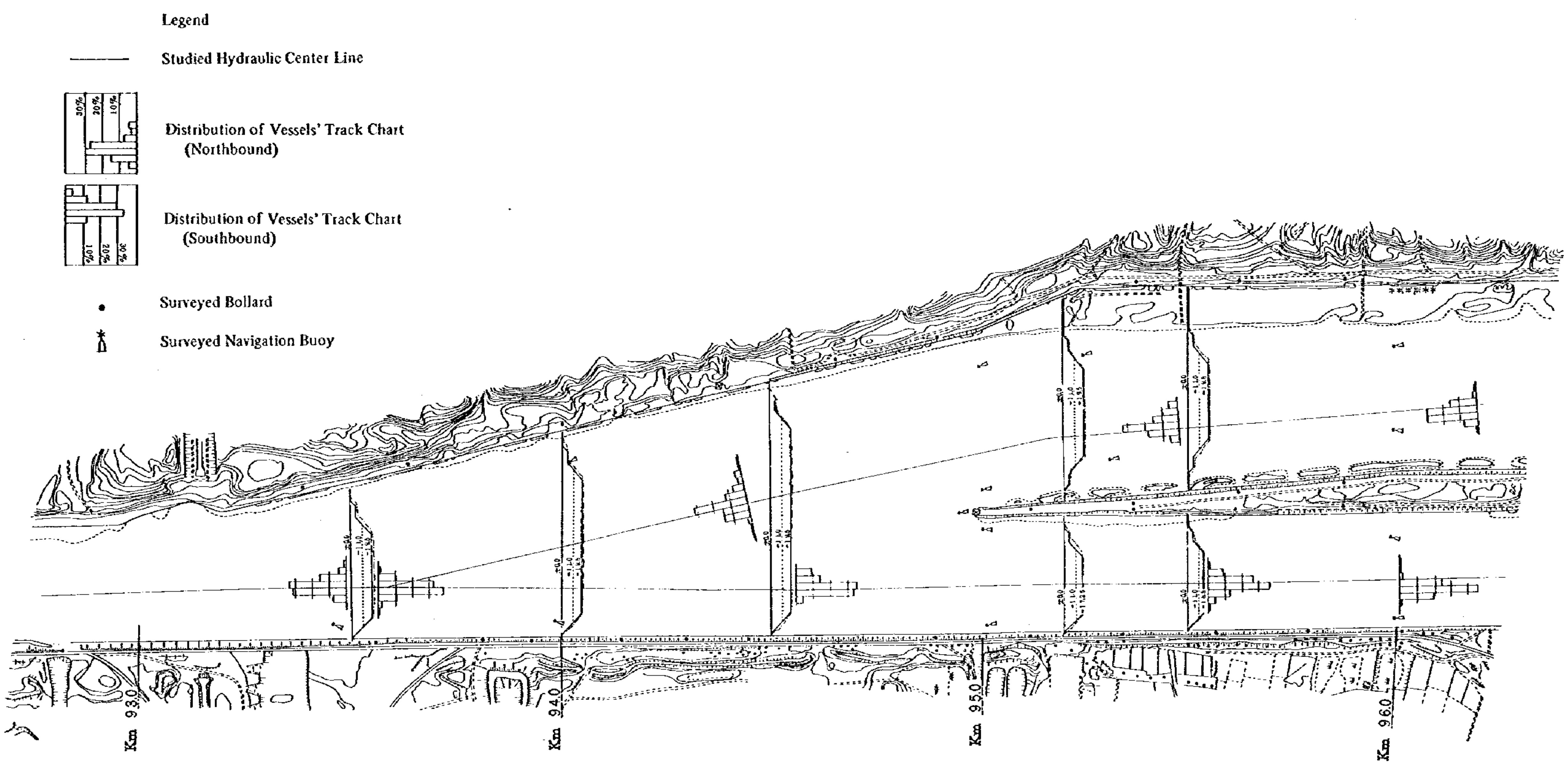


Fig. IV-2-(4)-10 Correlation between the Canal Cross-sections, the Hydraulic Center Lines and the Distributions of Vessels' Track Chart (Km 93 ~ 96)

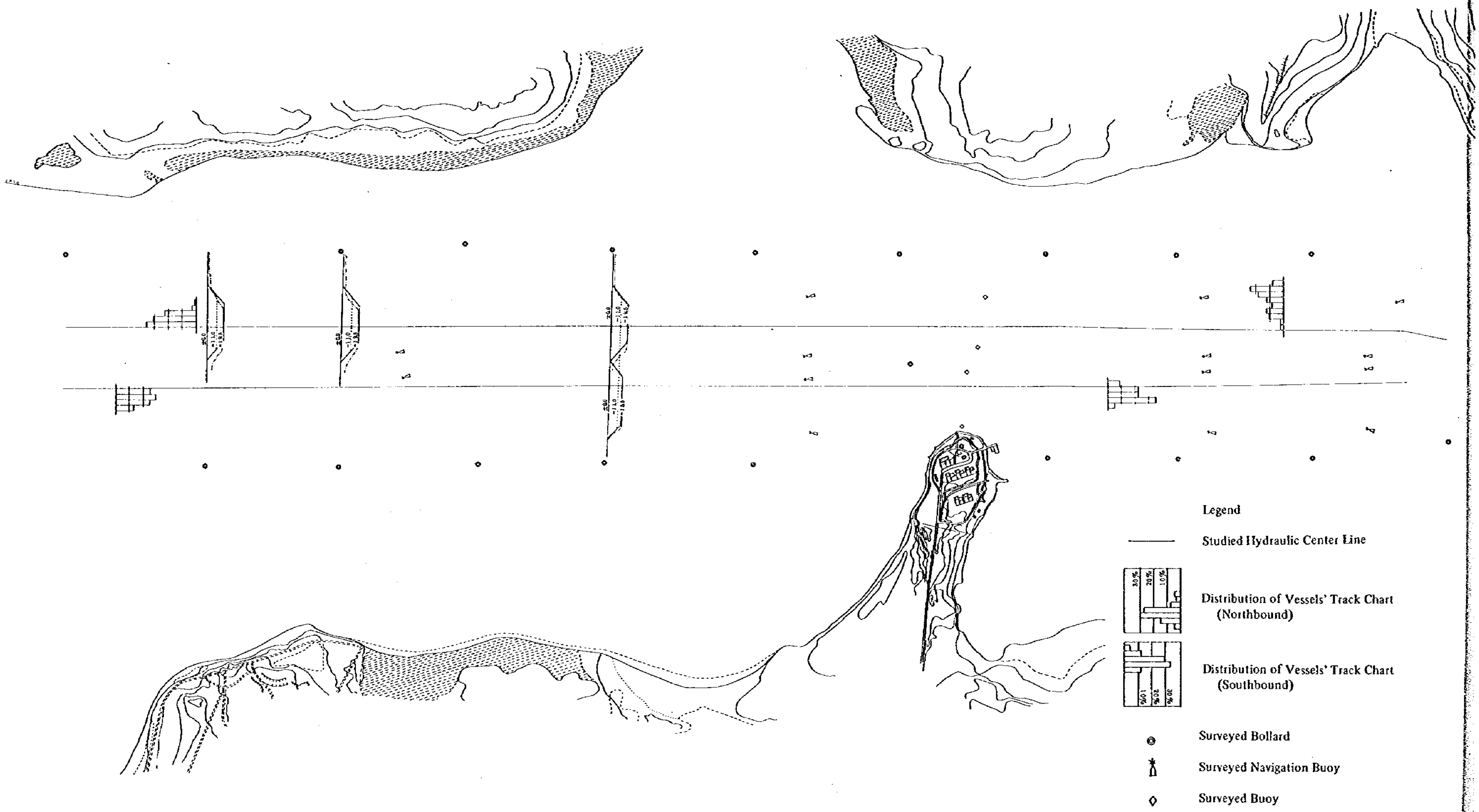


Fig. IV-2-(4)-11 Correlation between the Canal Cross-sections, the Hydraulic Center Lines and the Distributions of Vessels' Track Chart (Km 118 ~ 122)

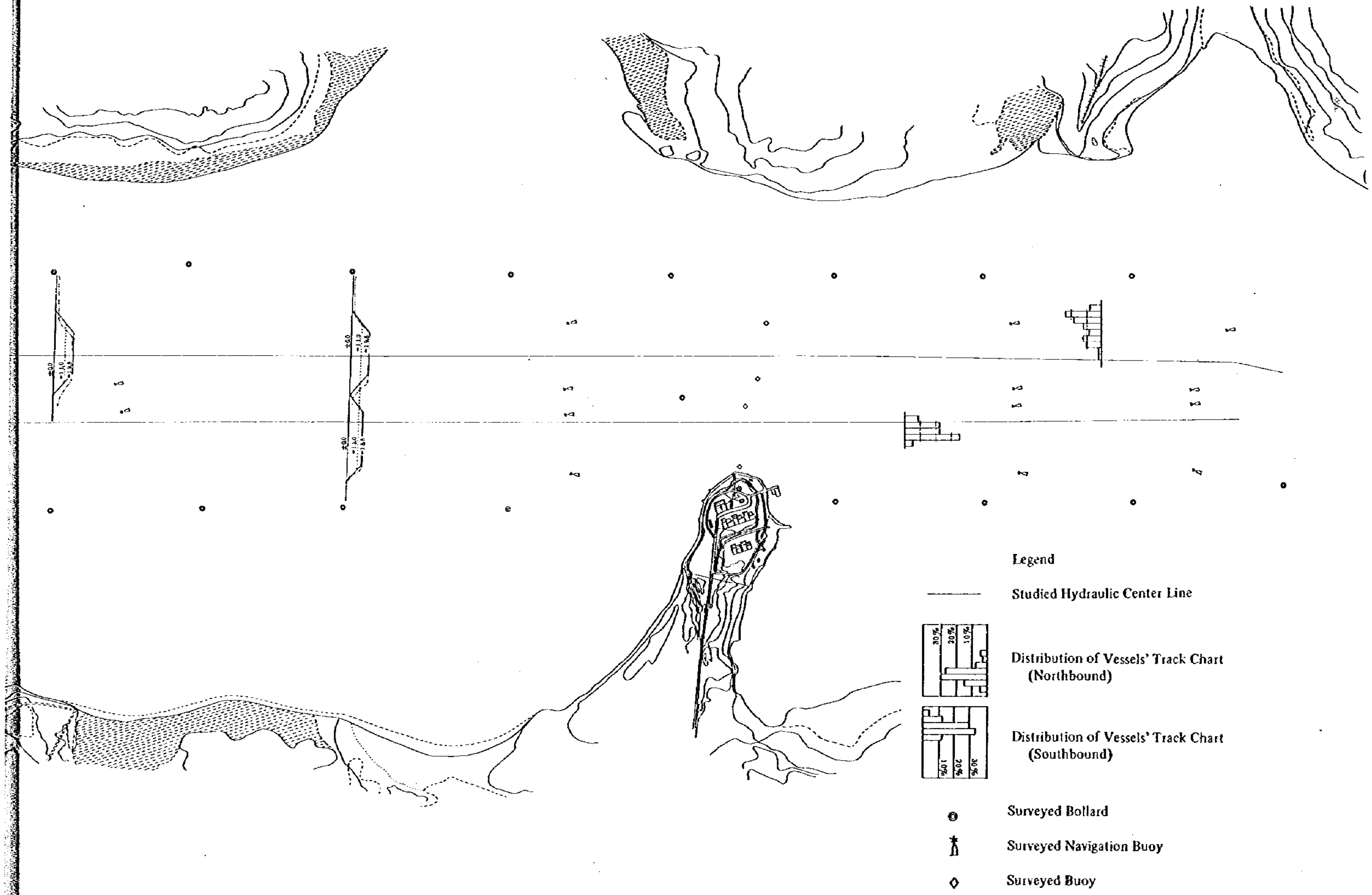


Fig. IV-2-(4)-11 Correlation between the Canal Cross-sections, the Hydraulic Center Lines and the Distributions of Vessels' Track Chart (Km 118 ~ 122)

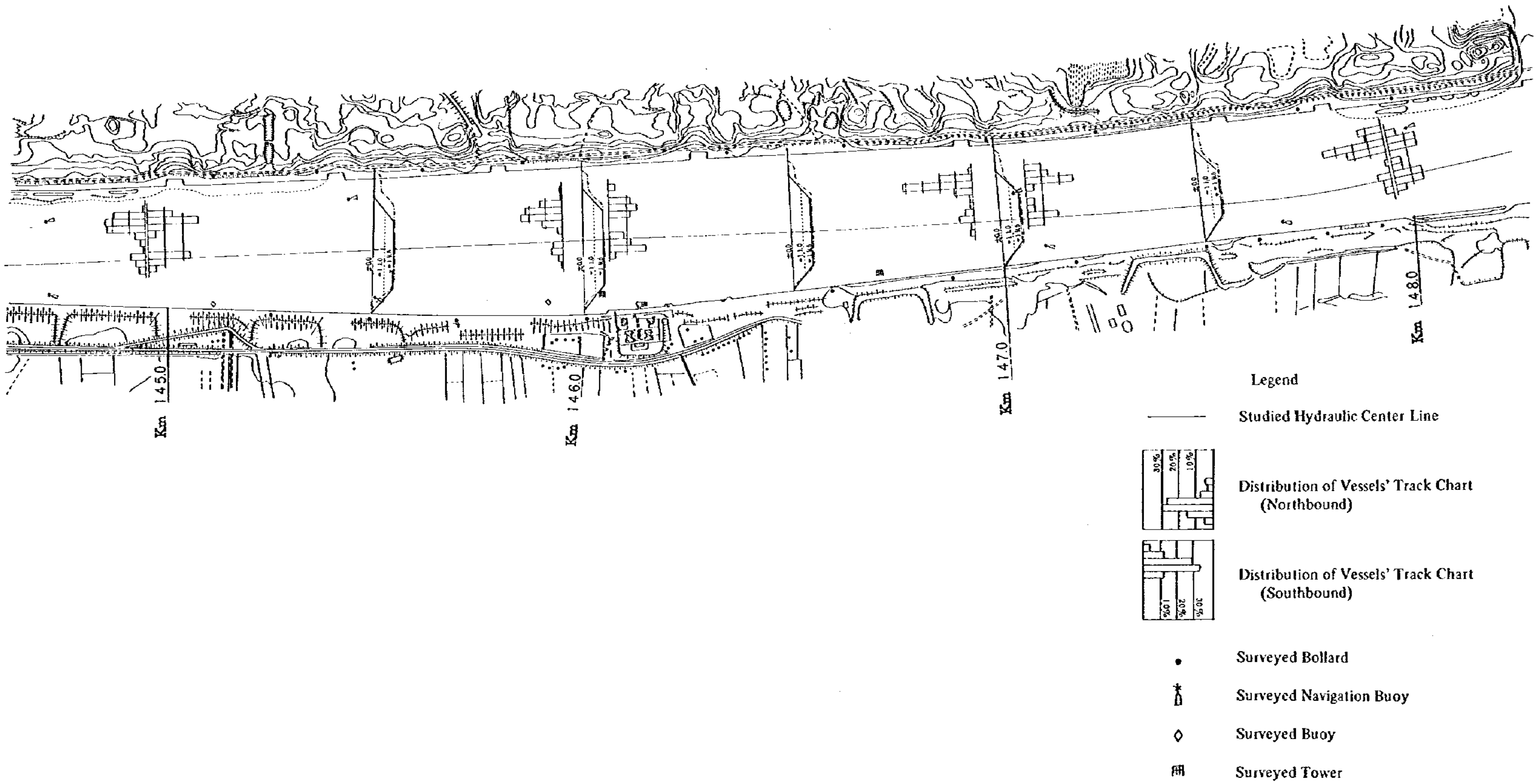


Fig. IV-2-(4)-12 Correlation between the Canal Cross-sections, the Hydraulic Center Lines and the Distributions of Vessels' Track Chart (Km 145 ~ 148)

(5) Construction and Maintenance Works

1) Accident Conditions in the Canal

In this paper, construction and maintenance works means dredging; accidents mean collisions.

We speak here not only of collisions and grounding accidents of transit vessels, but also of accidents between work ships (executing improvements and functional preservation of the Canal) and transit vessels, which could block the Canal with the sinking of a dredger or a transit vessel, or block the Canal with soil spilling from a damaged floating pipeline.

Table IV-2-(5)-1 lists accidents which occurred in the Canal between work ships doing dredging work and transit vessels.

(i) Number of Accidents

Table IV-2-(5)-2 shows the number and the location of accidents. In the 6 years from Jan., 1977 (after the start of the First Stage Development Project) to Dec., 1982, a total of 40 accidents occurred, beginning with the floating pipeline mishap at Km 156.00 on Feb. 8, 1977, and ending with the dredger accident at Km 9.20 on Nov. 20, 1982.

After completion of the First Stage Development Project, the number of all accidents decreased for the years 1981 and 1982, but, considering the number of dredgers involved the First Stage Development Project and the reduced number in subsequent operation, the accident rate per dredger is not necessarily decreasing.

(ii) Location of Accidents

The number and the location of accidents were 2 (5%) in the Port Said approach channel; 1 (2.5%) at Port Said; 35 (87.5%) in the Canal; and 2 (5%) at undetermined sites.

As for frequent accident sites, there were 29 accidents during the First Stage Development Project (excepting the 2 at undetermined sites), and a breakdown shows there were 4 (13.8%) between Km 0.00 and 20.00; 12 (41.4%) between Km 20.00 and 50.00; 5 (17.2%) between Km 50.00 and 63.00; thus a total of 21 (72.4%) occurring between Km 0.00 and 63.00.

Since completion of the First Stage Development Project, 4 (44.4%) of a total of 9 accidents have occurred between Km 0.00 and 20.00 with none occurring between Km 20.00 and 50.00 where accidents occurred most frequently during the First STage Development Project.

The dredging in this section was not all of the same type. There was deepening dredging between Km 0.00 and 20.00, and there was widening dredging between Km 20.00 and 50.00.

Table IV-2-(5)-1 Accidents between Transit Vessels and Dredgers or other Equipment concerned with Dredging Work

No.	Date	Dredger's Name	Direction	Location	Description
1	8. 2.'77	Suruga Maru	N.B.	Km 156.000	A ship touched the dreger's floating pipelines.
2	1. 3.'77	Khafrah	-	Port Said	When leaving port, sailing from berth No.3 heading to sea, a ship had rudder failure and the ship's bow collided with the dredger and floating units moored on both sides of the dredger in front of island No.1
3	25. 7.'77	26th July	N.B.	-	Due to a ship's high speed, the mooring wires of the floating units were cut.
4	10. 8.' 7	Khaled	N.B.	Km 29.500	Due to a ship's high speed, the dredger's floating pipelines were broken.
5	25.11.'77	Khaled	S.B.	Km 27.500	- ditto -
6	17.10.'77	El Fateh	N.B.	Km 5.455	Due to a ship's high speed, the mooring ropes of the barge of the dredger were cut which caused a hole in the barge.
7	2. 5.'78	Khaled	N.B.	Km 25.995	Due to a ship's high speed, the mooring wires of the floating units and floating pipelines were cut which put the dredger out of operation for one hour.
8	18. 5.'78	Suez 2	-	Km 123.300	Due to engine trouble and bad weather, a ship collided with the dredger and sank it.
9	10. 6.'78	Tarek Ibn Ziad	N.B.	Km 21.600	A ship collided with the dredger's floating pipelines.
10	16. 7.'78	Tarek Ibn Ziad	S.B.	Km 21.000	Due to engine trouble, a ship collided with the dredger's floating pipelines.
11	28. 7.'78	Khaled	-	Km 25.200	Due to steering gear trouble, a ship collided with the dredger and sank it.
12	18.11.'78	Alameda 2	-	Km 51.450	Due to sheer, a ship collided with the dredger's pipelines.
13	14. 3.'79	10th Ramadan	S.B.	Ballah	Due to a ship's high speed, the dredging wires and mooring ropes of auxiliary units were cut.
14	15. 3.'79	Tarek Ibn Ziad	S.B.	Km 44.300	A ship was adrift and touched the dredger hull causing no damage.
15	14. 5.'79	-	S.B.	Km 122.500	Due to rudder failure, a ship touched the dredger's floating pipelines.

No.	Date	Dredger's Name	Direction	Location	Description
16	16. 5.'79	Khofo	S.B.	Km 42.460	While passing alongside the dredger, a ship broke the dredger's pipeline and the mooring ropes of auxiliary units thus putting the dredger out of operation.
17	24. 5.'79	Suez 5	-	Km 63.000	A ship collided with the dredger and sunk its motor launch.
18	27. 6.'79	Ramsis	-	Hm 85	A ship collided with a dredger
19	28. 6.'79	Khofo	S.B.	Km 42.500	Due to a ship's high speed, the dredger's floating pipelines were broken.
20	29. 8.'79	10th Ramadan	S.B.	Km 58.000	Due to a ship's high speed, the dredger's floating pipelines were broken and the mooring ropes of auxiliary units were cut.
21	31. 8.'79	Khofo	S.B.	-	While passing alongside the dredger, a ship broke the dredger's dredging wire.
22	9.10.'79	Khofo	S.B.	Km 49.850	Due to a ship's high speed, the mooring ropes of auxiliary units were cut and the dredger listed.
23	25.11.'79	Zenobia	N.B.	Km 5.858	Due to a ship's high speed, the dredger's floating pipelines and auxiliary units were damaged.
24	7.12.'79	-	S.B.	Km 61.000	A ship was adrift and touched the dredger's floating pipelines.
25	15. 2.'80	Tarek Ibn Ziad	S.B.	Km 44.600	Due to a ship's high speed, the spud wire of the dredger broke before mooring the dredger with the assistance of the tug.
26	10. 3.'80	Zenobia	S.B.	Km 4.000	Due to a ship's high speed, the spud wire broke causing denting
27	11. 3.'80	26th July	S.B.	Km 45.400	A ship cut the mooring ropes of the dredger barge
28	18. 3.'80	26th July	S.B.	Km 45.000	Due to a ship's high speed, the mooring ropes of the floating crane and other floating units moored alongside the dredger were cut resulting in heavy listing of the dredger.
29	2. 4.'80	Tarek Ibn Ziad	S.B.	Km 45.820	Due to a ship's high speed, the floating pipelines broke and put the dredger out of operation.
30	10. 7.'80	Maria Carolina	-	Km 162.000	After heaving anchor and starting to the center of the Canal, steering wheel failure occurred which caused swinging of the ship and resulted in rubbing against the dredger.
31	6.12.'80	Al Seddiek	-	Km 17.000	A barge collided with the dredger's floating pipelines.
32	10. 1.'81	Zenobia	S.B.	Km 5.000	A ship touched the dredger's floating pipelines.

No.	Date	Dredger's Name	Direction	Location	Description
33	18. 2.'81	Khofo	N.B.	Km 141.600	Due to steering gear trouble, a ship was adrift and came alongside the dredger.
34	24. 3.'81	26th July	S.B.	Km 5.200	Due to sheer, a ship was adrift and came alongside the dredger causing damage to it and to the floating pipelines.
35	1. 4.'81	Salah E. Din El Ayoubi	-	Hm 85	A ship collided with the dredger before the pilot came aboard.
36	16. 1.'82	Tarek Ibn Ziad	S.B.	Km 10.725	Due to a ship's high speed, one mooring wire of the spare floating pipeline was cut and three auxiliary units were set adrift.
37	21. 2.'82	Al Khattab	N.B.	Km 114.000	A ship's high speed caused the dredger and floating crane to swing and break a crane boom as a result.
38	25. 2.'82	Nefertiti	S.B.	Km 91.450	Due to a ship's high speed, the main engine room was flooded
39	9. 4.'82	Mahmoud Younes	N.B.	Km 71.000	Due to a ship's high speed, damage was caused to the starboard spud, and the mooring ropes of the service barge and auxiliary units were cut.
40	20.11.'82	Tarek Ibn Ziad	S.B.	Km 9.200	A ship collided with the dredger causing damage.

Table IV-2-(5)-2 Number of Accidents concerning Dreding Work, by Year and Position by Year and Position, from 1977 to 1982

Kind / Year / Position	Collision with Dredger							Collision with Other Equipment							Total						
	1977	1978	1979	1980	1981	1982	Total	1977	1978	1979	1980	1981	1982	Total	1977	1978	1979	1980	1981	1982	Total
Port Said	1		(Hm) 1		(Hm) 1		3								1		1		1		3
Km 0 ~ 20				1	1	1	3	1		1	1	1	1	5	1		1	2	2	2	8
20 ~ 50		1	2	1			4	2	3	2	3			10	2	4	4	4			14
50 ~ 63			1				1		1	3				4		1	4				5
63 ~ 75																					
75 ~ 81						1	1													1	1
81 ~ 93						1	1													1	1
93 ~ 116						1	1													1	1
116 ~ 135		1					1			1				1		1	1				2
135 ~ 162				1	1		2	1						1	1			1	1		3
Suez																					
Unknown								1		1				2	1		1				2
Total	1	2	4	3	3	4	17	4	4	8	2	1	1	23	6	6	12	7	4	5	40

(iii) Objects Damaged in Accidents

Table IV-2-(5)-3 shows the number of accidents according to objects.

Objects damaged in accidents are classified as dredgers, floating pipelines, other floating units (such as anchor barges), and other (such as dredging wires).

The breakdown of damage to objects involved is 17 (42.5%) dredgers; 17 (42.5%) floating pipelines; 4 (10%) other floating units; and 2 (5%) others.

Two dredgers have been sunk in accidents with transit vessels. They are the Suez 2, sunk on May 18, 1978, and the Khaled Ibn El Walid, sunk on July 28, 1978.

No accidents involving sinking have occurred since completion of the First Stage Development Project, but the ratio of accidents with dredgers is very high and the resulting serious damage is considerable.

Table IV-2-(5)-3 Objects Damaged in Accidents (1977 ~ 1982)

Objects \ Year	1977	1978	1979	1980	1981	1982	Total
Dredgers	1	2	4	3	3	4	17
Floating Pipelines	3	4	6	2	1	1	17
Other Floating Units, such as Floating Cranes	2			2			4
Others, such as Dredging Wires			2				2
Total	6	6	12	7	4	5	40

(iv) Causes of Accidents

Table IV-2-(5)-4 shows the number of accidents by cause.

Causes may be roughly classified into human, mechanical and other factors.

Accidents due to human factors, such as high speed and steering failure of transit vessels, have occurred 18 times (45%) and 5 times (12.5%) respectively, amounting to a total of 23 accidents (57.5%).

Accidents due to mechanical factors on the transit vessels, such as engine trouble and steering gear trouble, have occurred 2 times (5%) each, thus amounting to a total of 4 accidents (10%).

Accidents due to other factors have occurred 13 times (32.5%). In particular, accidents due to the high speed of transit vessels occurred 4 times (of a total of 5) in 1982.

Table IV-2-(5)-4 Causes and Number of Accidents between Transit Vessels and Dredgers or other Equipment (1977 ~ 1982)

Cause \ Year		1977	1978	1979	1980	1981	1982	Total
Human Factor	High Speed	4	1	5	4	0	4	18
	Steering Wheel Failure	1	1	1	1	1	0	5
Mechanical Factor	Engine Trouble	0	2	0	0	0	0	2
	Steering Gear Trouble	0	1	0	0	1	0	2
Others	Unknown	1	1	6	2	2	1	13
Total		6	6	12	7	4	5	40

2) Closing Remarks

The following can be concluded regarding the accidents which have occurred in the Canal between work ships involved in dredging work and transit vessels.

(i) The number of accidents has not varied during or after the completion of the First Stage Development Project, except for the year 1979.

(ii) As for the objects of accidents, 85% of these involved dredgers and floating pipelines.

After the completion of the First Stage Development Project, the ratio of accidents with floating pipelines has decreased whereas the ratio of accidents with dredgers has increased.

(iii) The causes lie not with the dredgers, though their location has not been clear, but rather with the human factor of the transit vessels, especially their high speed.

(6) Resources Against Fire and Pollution

The evaluation shall include the equipment delivered until 1984. As a whole, tug boats, submersible pumps, foams, foam concentrate, dry chemical powder and dispersant are sufficient in quantity to meet minimum requirement, while equipment such as oil boom tender boats, protective apparatus, and recovered oil disposal facilities do not exist. Oil skimmers and oil booms are insufficient.

Oil skimmers are far differ from each other in handling, and there is no standardized evaluation of their performance. Thus, we are forced to rely on the performance described in their catalogs.

As for oil booms, they should be standardized in design specifications so that those oil booms brought to the site from various sources can be jointed together.

Performance of dry chemical powder depends very much on humidity. The dry chemical powder performance was not tested assuming it is satisfactory because of the low humidity in Egypt.

The result of performance tests for dispersant and foam concentrate conducted in accordance with Japanese standards showed that the dispersant has normal emulsification rate, high toxicity and low flash point and the foaming rate of the foam concentrate was 4.2 times.