6－1－3　温排水拡散

— 現況再現性の確認

温排水拡散計算結果は，環境水温に対する上昇水温を示している。1981年の水温観測結果によると，Jurong 川，Pandan 川河口で，海域水温に比べ0.5℃程度高い水温がみられたことを除き，海域の各観点での水温は28.0～28.4℃の範囲にある。

現時点で温排水の排水がある Jurong Stage Power Station（5.6℃up：33.4m^3/sec）の近傍の水温は28.1～28.2℃であり，周辺海域の水温に比べても差はみられない。

計算結果の上昇水温の平面分布図を図Ⅱ6－18に示すが，計算結果によると，Jurong Stage Power Station からの温排水による水温上昇は最大0.1℃であり，Pasir Panjung Power Station 近傍でも最大0.04℃の水温上昇にとどまる。

このように，両Power Stationからの温排水による周辺海域の水温に及ぼす影響はきわめて小さい。

観測値，計算値とも温排水が周辺海水温に大きな影響を与えていたことから，計算結果は現況を再現していると考える。

— 将来の上昇水温

現況の温排水拡散計算と同様に，将来地形，将来負荷を入力し，将来予測計算を実施した。

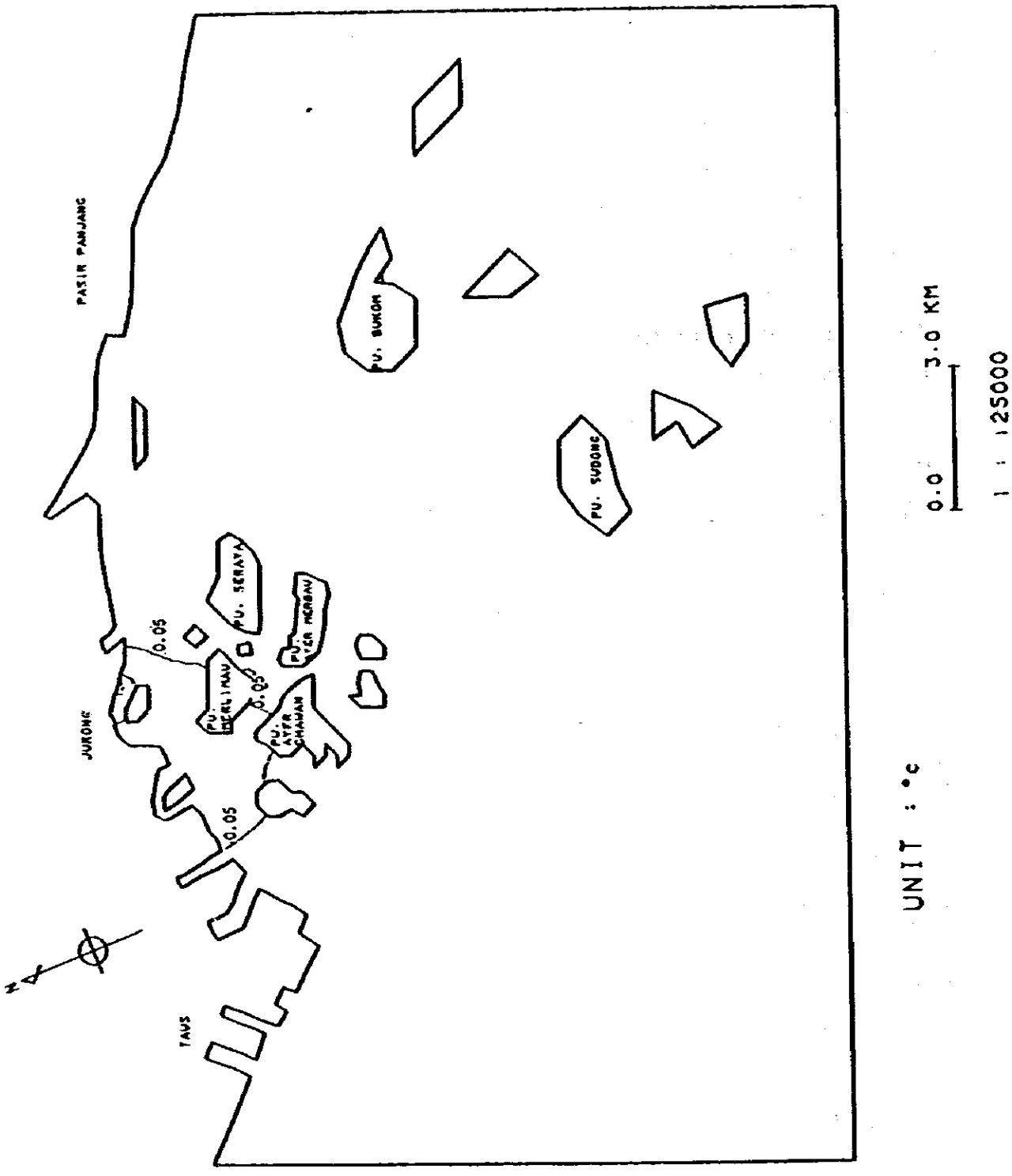
計算結果の上昇水温の平面分布を図Ⅱ6－19，Ⅱ6－20に示す。また，代表地点での上昇水温を表Ⅱ6－7に示す。

これらから将来の上昇水温について要約すると次のとおりである。

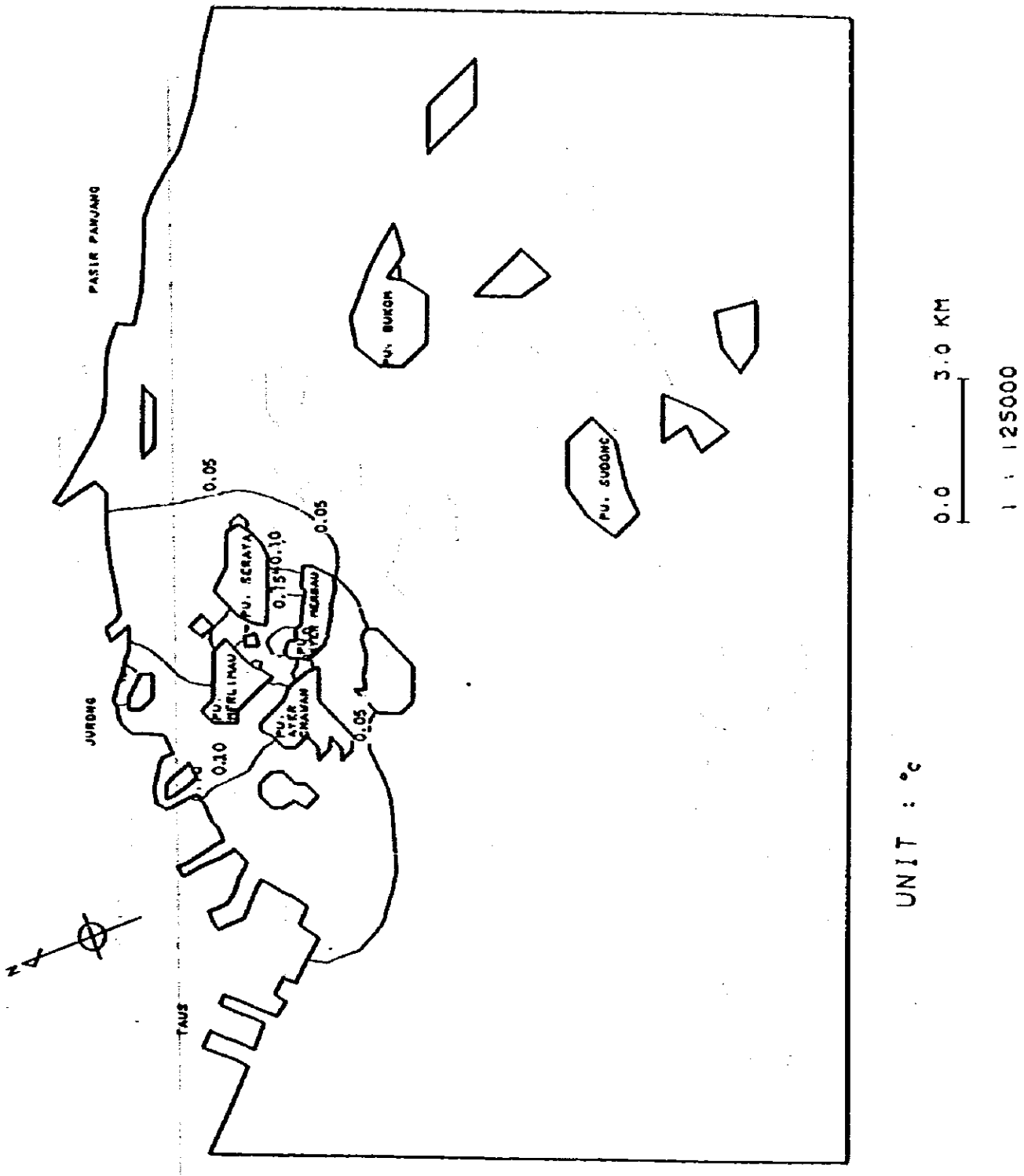
① 現況の上昇水温と直接比較できる西流による上昇水温とを比較すると，将来では，現況に比べ，Merlimau 島，Merbau 島，Seraya 島で囲まれる海域で0.1℃の温度上昇がみられる程度で，他の海域では0.05℃程度の変化にとどまる。水質観測点（S1～S49）の21点での上昇水温の平均値は，現況の0.03℃に比べ，将来では0.06℃であり，温排水の増加に伴ない0.03℃の上昇となる。

② 将来の西流による水温上昇と，東流による水温上昇とを比較すると，東流による水温上昇は全体的に小さくなる。水質観測点（S1～S49）21点での水温上昇の平均値は，西流の0.06℃に対し，東流では0.03℃である。

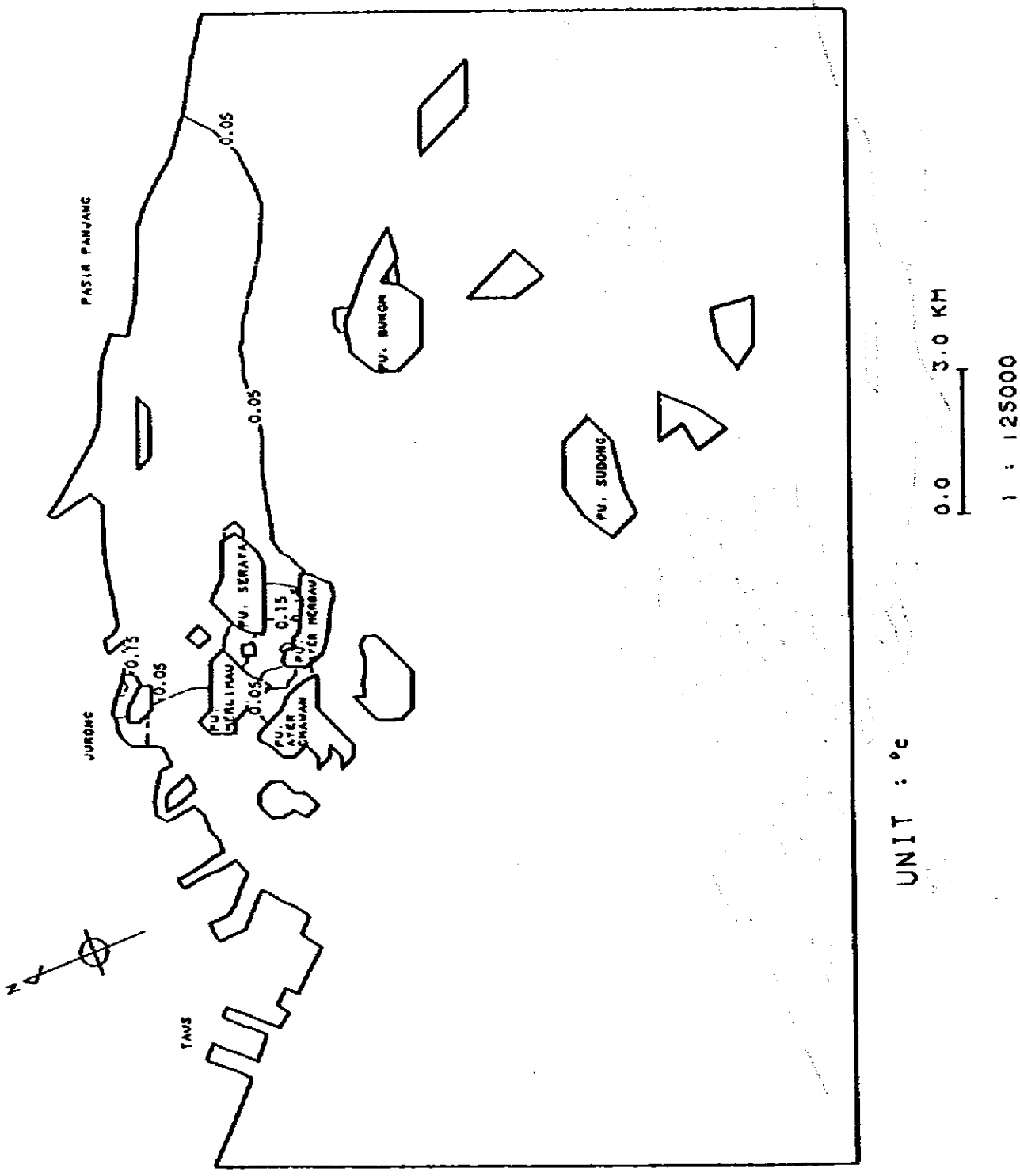
上昇水温の変化の最大が0.1℃程度であり，平均的にみても0.05℃未満の変化にとどまることから，将来の温排水負荷が海域水温に及ぼす影響は小さいと考える。



図Ⅱ　6－18　上昇水温の平面分布・現況



図Ⅱ　6－19 上昇水温の平面分布・将来（東流）



図Ⅲ　6 － 20　上昇温度の平面分布・将来（西流）

表 6－7　上昇水温の比較（現況と将来）

(UNIT : PPM)

POINT	PRESENT STAGE (現況)	FUTURE STAGE(将来)	
		E-W	W-E
S 1	0.016	0.038	0.066
S 3	0.014	0.035	0.062
S 5	0.012	0.026	0.042
S 6	0.012	0.025	0.032
S 12	0.016	0.060	0.076
S 13	0.014	0.053	0.050
S 16	0.044	0.090	0.082
S 21	0.012	0.038	0.015
S 24	0.057	0.101	0.041
S 25	0.040	0.158	0.104
S 28	0.053	0.108	0.029
S 29	0.015	0.057	0.014
S 30	0.011	0.036	0.004
S 31	0.052	0.099	0.013
S 36	0.023	0.053	0.003
S 38	0.013	0.034	0.001
S 39	0.049	0.092	0.006
S 45	0.029	0.059	0.001
S 47	0.019	0.044	0.001
S 48	0.014	0.036	0.001
S 49	0.019	0.043	0.001
A	0.012	0.018	0.053
B	0.012	0.018	0.048
C	0.006	0.011	0.027
D	0.001	0.002	0.010
E	0.029	0.068	0.073
F	0.010	0.033	0.005
G	0.006	0.019	0.001
H	0.008	0.021	0.000
I	0.014	0.032	0.000

6－2　Tekong海域の結果

6－2－1　流　　況

― 現況再現性の確認

Seraya海域の計算結果に実施したと同様に，流況の観測値と計算値とを比較し，現況の流況モデルを再現しているかを検討する。

なお，潮汐流計算は，3潮汐（36時間）分，恒流計算は1,000step（4.2時間）のそれぞれ計算を実施し，充分安定した結果であることを確認した。

検証項目と方法はSeraya海域と同様に潮流楕円と恒流ベクトルについて比較する。

表Ⅲ6－8には，潮流楕円の大きさ，傾きについて比較したものを，図Ⅲ6－21には観測値による潮流楕円と計算値による潮流楕円とを比較したものを示す。また，表Ⅲ6－9には，恒流ベクトルによる観測値と計算値との比較を示す。これらから潮汐流と恒流の現況再現性について要約すると以下のとおりである。

① 潮流楕円の比較によると，最大流速を示す楕円の長軸の長さについて，計算値は観測値に対し－0.2～－5cm/secの差がみられた。TC2，TC3，TC4での流速の差は0.2～1.4cm/secで非常によい整合性がみられたが，Tekong島とUbin島の間のTC1では計算値の方が観測値より5cm/sec大きな値となっている。

全体的な最大流速の分布のバランスといった観点によると，観測値と計算値との流速比率の平均は1.0506で（TC1：1.1603，TC2：1.0044，TC3：1.0329，TC4：1.0050）計算値の方が観測値より若干大きな値となるが1：1の関係に近い。また，最大流速時の流向を示す長軸の傾きについて観測値と計算値との差は1～－16°の範囲にあり，ほぼ観測値の流向を再現している。

楕円の形状も観測値と相似で偏平であることから明確な往復流の様相を再現している。

② 恒流ベクトルの比較によると，観測値と計算値の流速の差は－0.6～2.6cm/secの範囲にある。TC1，TC2，TC4では1cm/sec未満の差であるのに対し，TC3では2.6cmの差となっている。

Tekong島東側水路のTC2の恒流観測値は南下する流向を示しているのに対し，TC3では北上するような流向を示し，相反する流向の流れが水路内でぶつかり，潮目を形成していると考えられる。

数値計算でこのような比較的狭い水路で180°流向の異なる流れを求めることは非常に困難である。このため，TC3の観測値と計算値の比較は行なわない。

3観測点の観測値と計算値の流速比率の平均は1.0027である（ちなみにTC3を加え

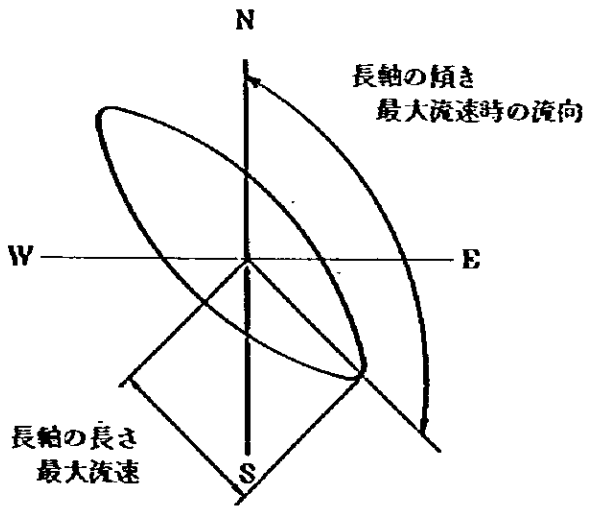
た値は0.8787である）。

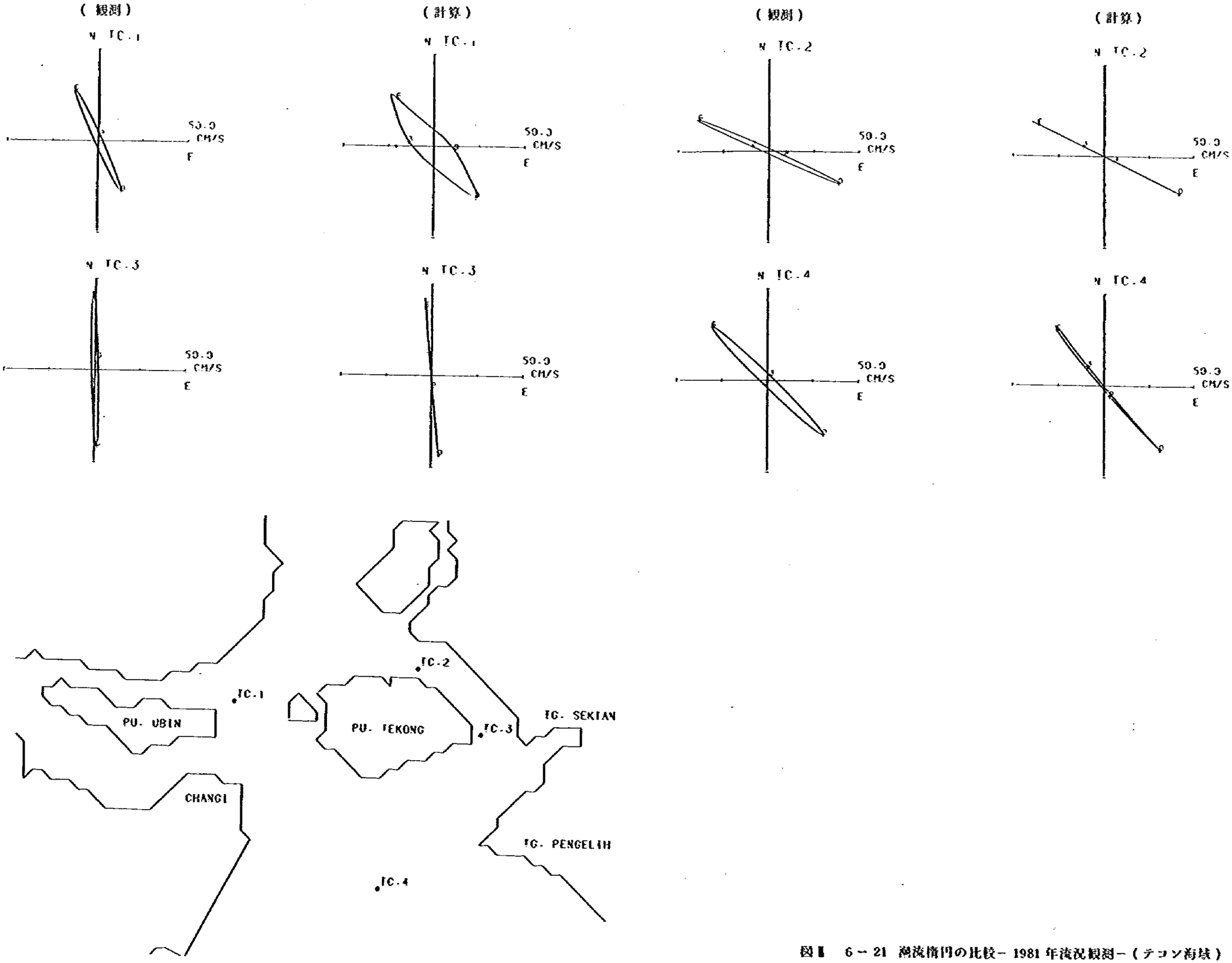
また，流向について比較すると観測値と計算値の差はTC3を除くと10.0～68°である。TC1，TC2で比較的流向の差が大きいが，観測値，計算値ともTC1では，Ubin島北側水路から流出する向きにあり，TC2ではTekong島東側水路を南下する向きである。①～②で述べたように潮汐流，恒流とも場所により若干の不整合がみられることを除き，流速・流向によい整合がみられた。これらのことから判断して，現況再現性は充分確認されたと考える。

再現性の確認が得られた恒流を 図Ⅲ 6－22，に恒流と潮汐流とを合成した1時間毎の流況を図Ⅲ6－23にそれぞれ示す。

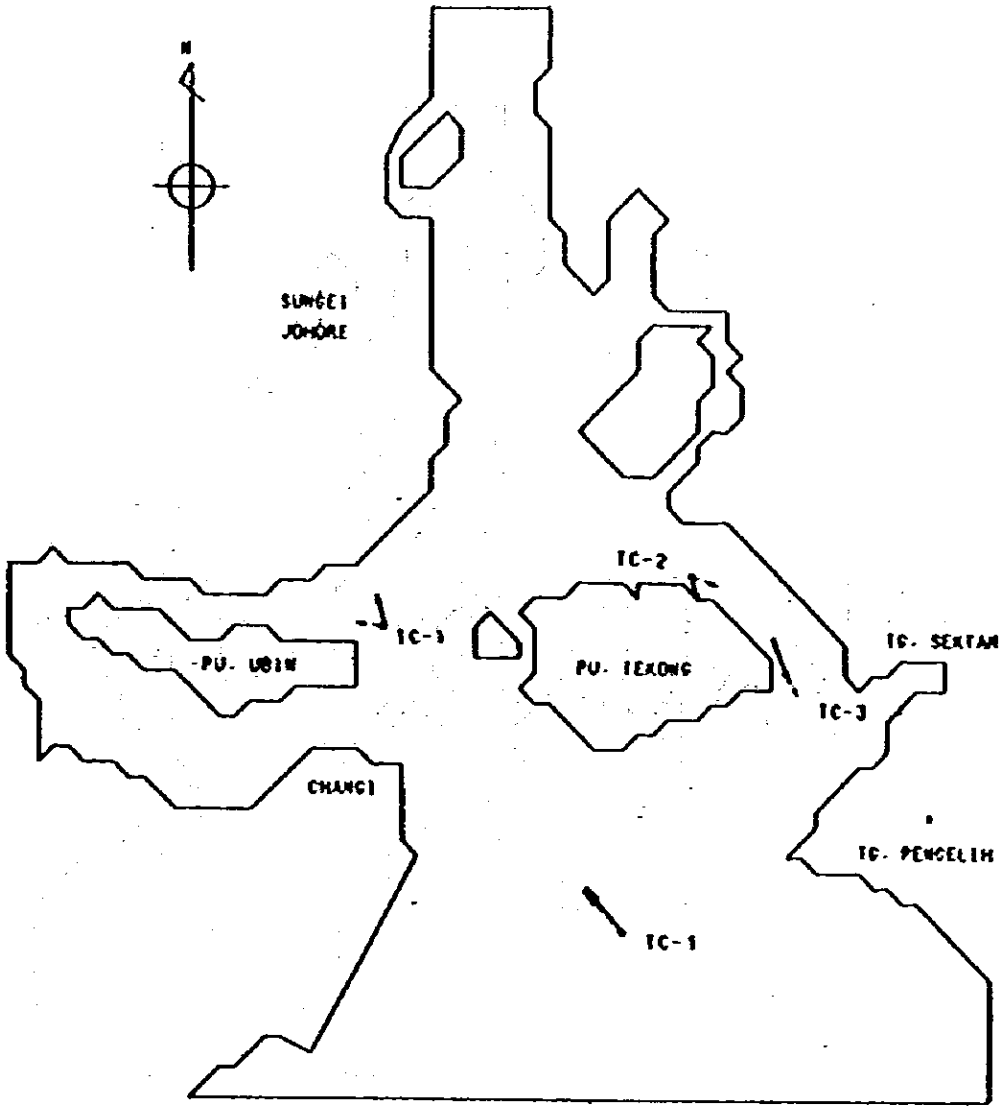
表Ⅲ　6－8　潮流楕円の比較（観測値と計算値）

地点		長軸の長さ：最大流速値 （cm/s）				長軸の傾き：最大流速時の流向 (°)		
		a 観測値	b 計算値	c=a−b 差	d=b/a 比	e 観測値	f 計算値	g=e−f 差
1981年 流況調査	TC1	31.20	36.20	−5.00	1.1603	155	139	16
	TC2	43.41	43.60	−0.19	1.0044	115	116	−1
	TC3	41.05	42.40	−1.35	1.0329	178	175	3
	TC4	42.41	42.62	−0.21	1.0050	134	139	−5





図Ⅱ　6 ～ 21　潮流楕円の比較－ 1981 年流況観測－（テコン海域）



10.0 cm/s

OBSERVATION 観測

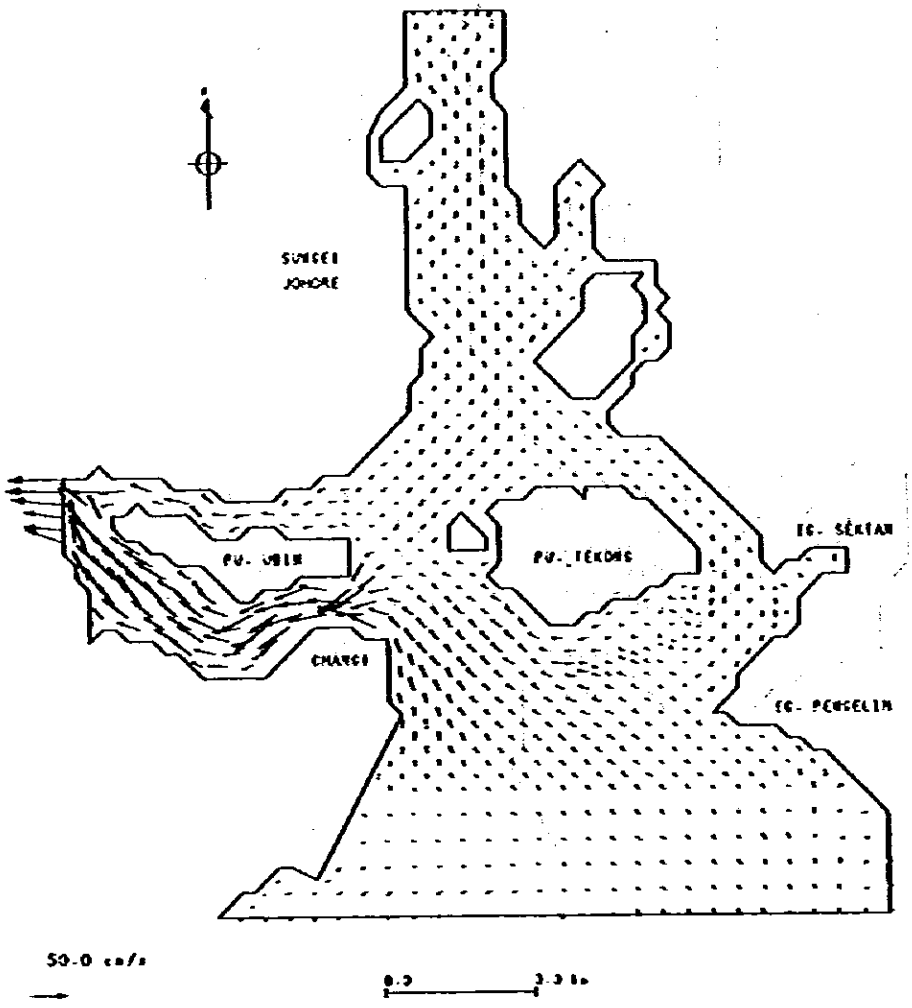
CALCULATION 計算

0.0 3.0 km

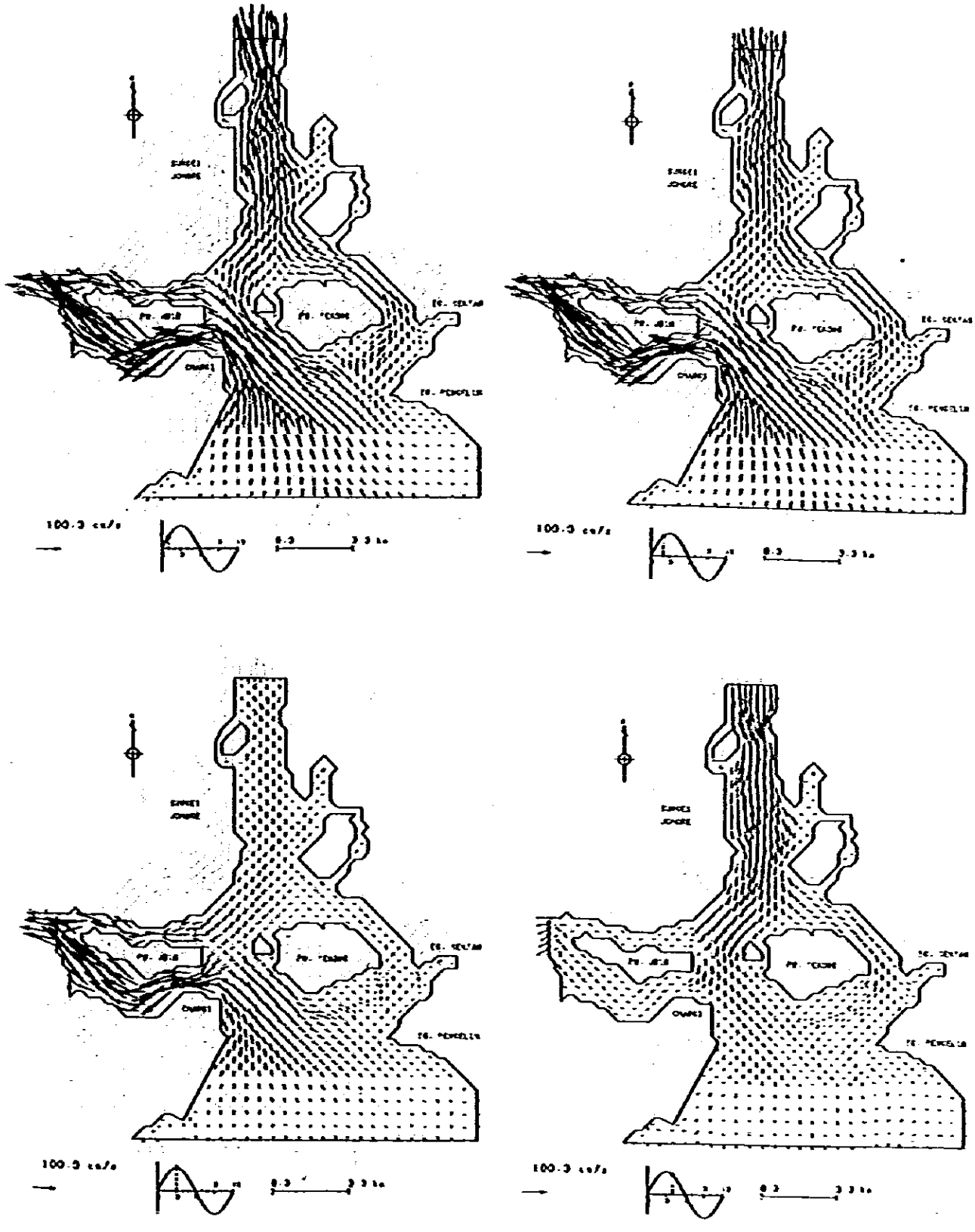
表 Ⅲ 6－9 恒流ベクトルの比較－1981年流況観測－

POINT	OBSERVATION		CALCULATION		DIFFERENCE		
	a VELOCITY (cm/s)	b DIRECTION (°)	c VELOCITY (cm/s)	d DIRECTION (°)	a-c VELOCITY (cm/s)	b-d DIRECTION (°)	a/c VELOCITY RATIO
TC-1	4.49	336.68	4.85	275.64	-0.38	61.04	1.0851
TC-2	3.24	160.69	2.93	114.31	0.41	46.38	0.8729
TC-3	5.17	339.25	2.62	170.28	2.55	168.97	0.5062
TC-4	7.66	319.92	7.65	309.90	0.00	10.02	0.9994

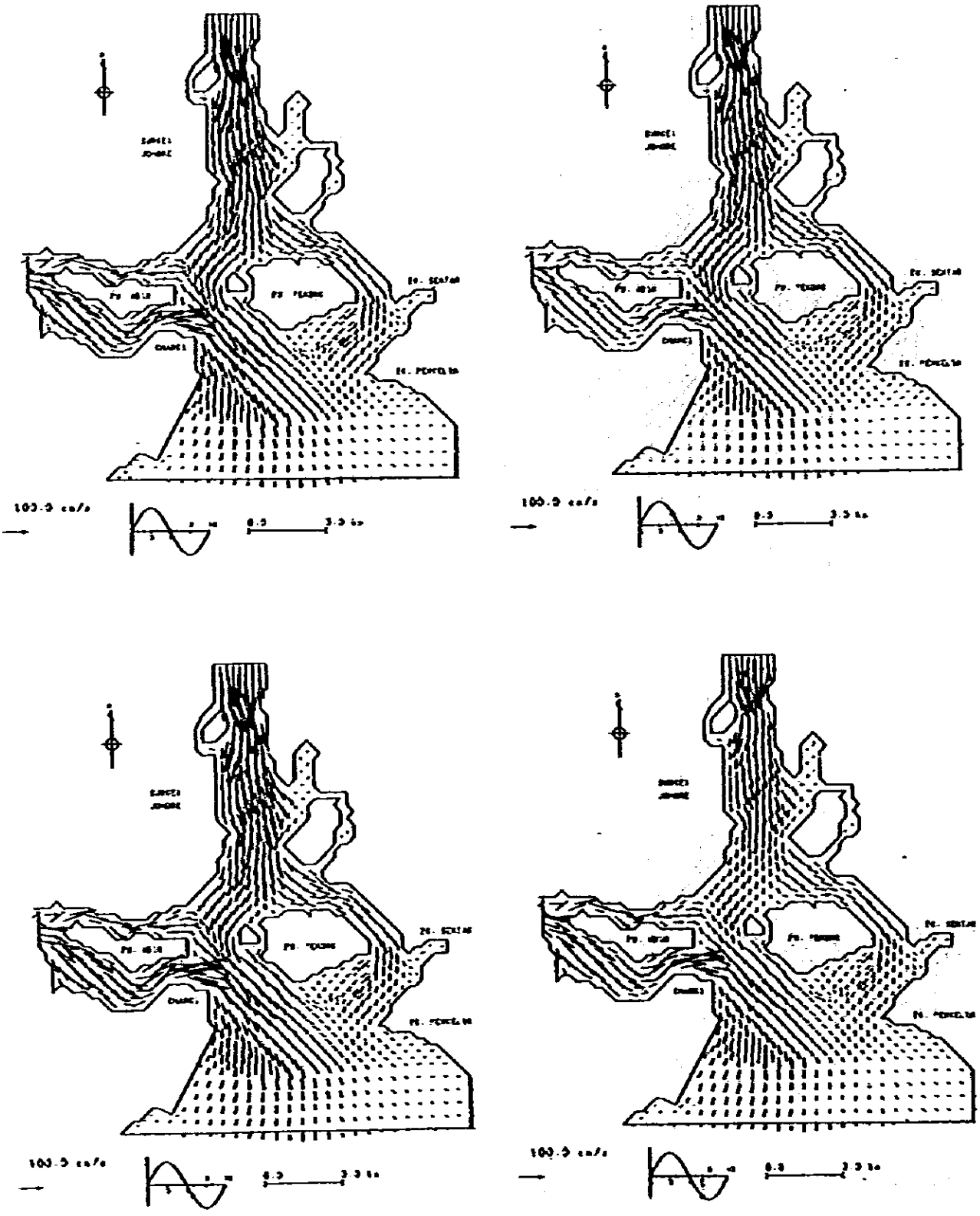
N DIRECTION S


SUNGEI
JOHORE
PU. UBIN
PU. TEKONG
TG. SEKIAN
CHANGI
TG. PENGELIH

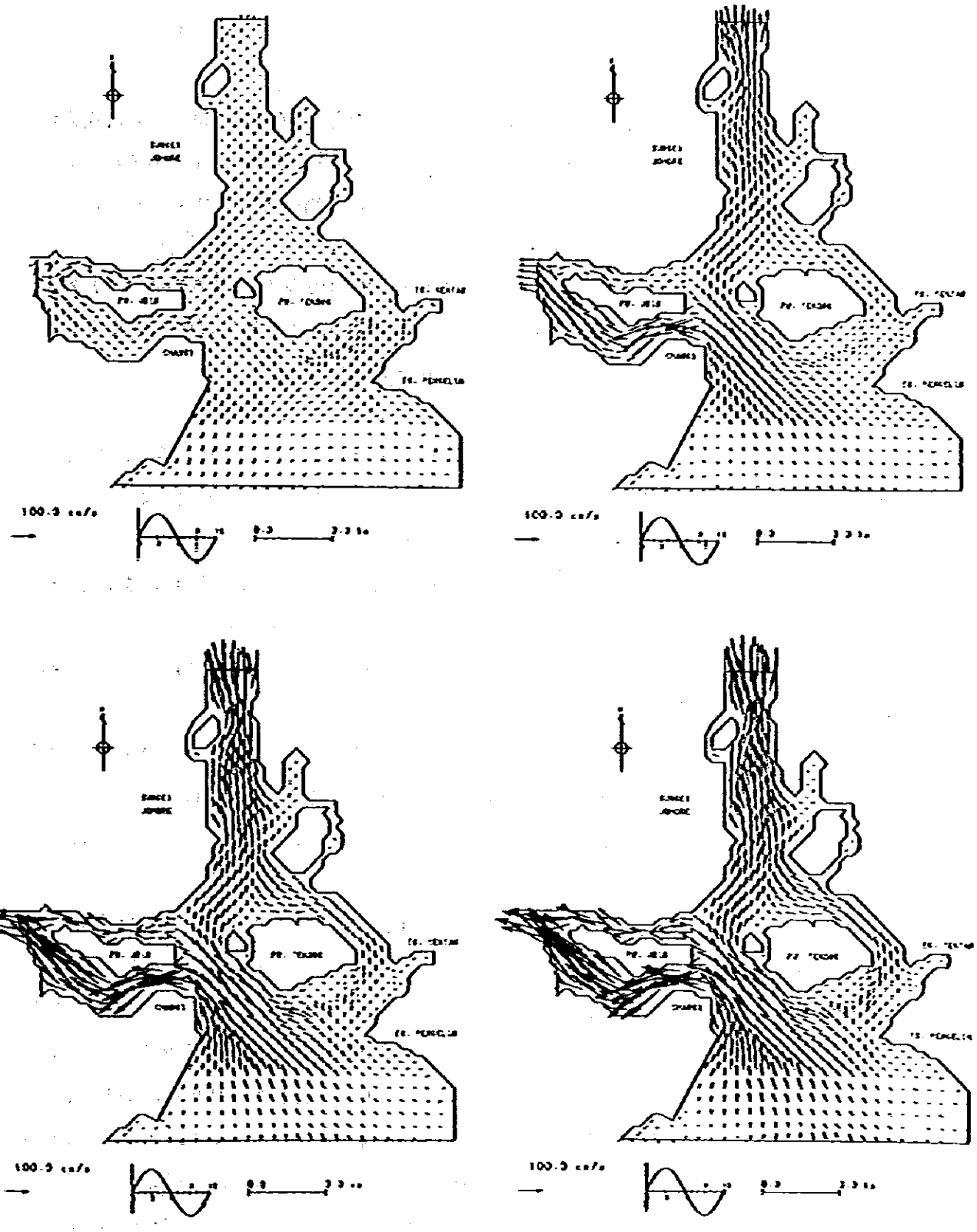
図■ 6－22 恒流・現況



図Ⅱ　6－23(1) 流況・将来（恒流＋潮汐流）



図Ⅱ　6－23(2) 流況・将来（恒流＋潮汐流）



図Ⅱ　6－23(3) 流況・将来（恒流＋潮汐流）

— 将来流況

現況計算と同一の境界条件を用い，地形の変更，排水流量の変更を加えて将来予測計算を実施した。

将来の恒流を図Ⅲ6－24，Ⅲ6－25に，恒流と潮汐流とを合成した1時間毎の流況で，火力発電所のみの場合を図Ⅲ6－26に，火力発電所と一貫製鉄所の場合を図Ⅲ6－27にそれぞれ示す。

現況流況との比較は後述するとして，火力発電所のみの場合と火力発電所と一貫製鉄所の場合の流れの差について述べておく。

① これらの流れの差は，製鉄所からの排水の有無（9,300㎥/日：0.107㎥/sec）だけであることから排水口周辺で若干の変化がみられるだけで，周辺海域の流況に及ぼす影響はきわめて小さい（ 図Ⅲ 6－24，Ⅲ 6－25参照）。

— 将来流況の変化

将来流況と現況流況とを比較する。なお，石炭火力発電所のみとした場合と，石炭火力発電所と製鉄所とした場合の流況の変化がきわめて小さいので，現況流況との比較は，石炭火力発電所と製鉄所の場合の流況について行なう。

図Ⅲ6－28に代表点における1時間毎の流速，流向を比較したものを，図Ⅲ6－29には下げ最強時と上げ最強時の流速の変化とその範囲を示す。

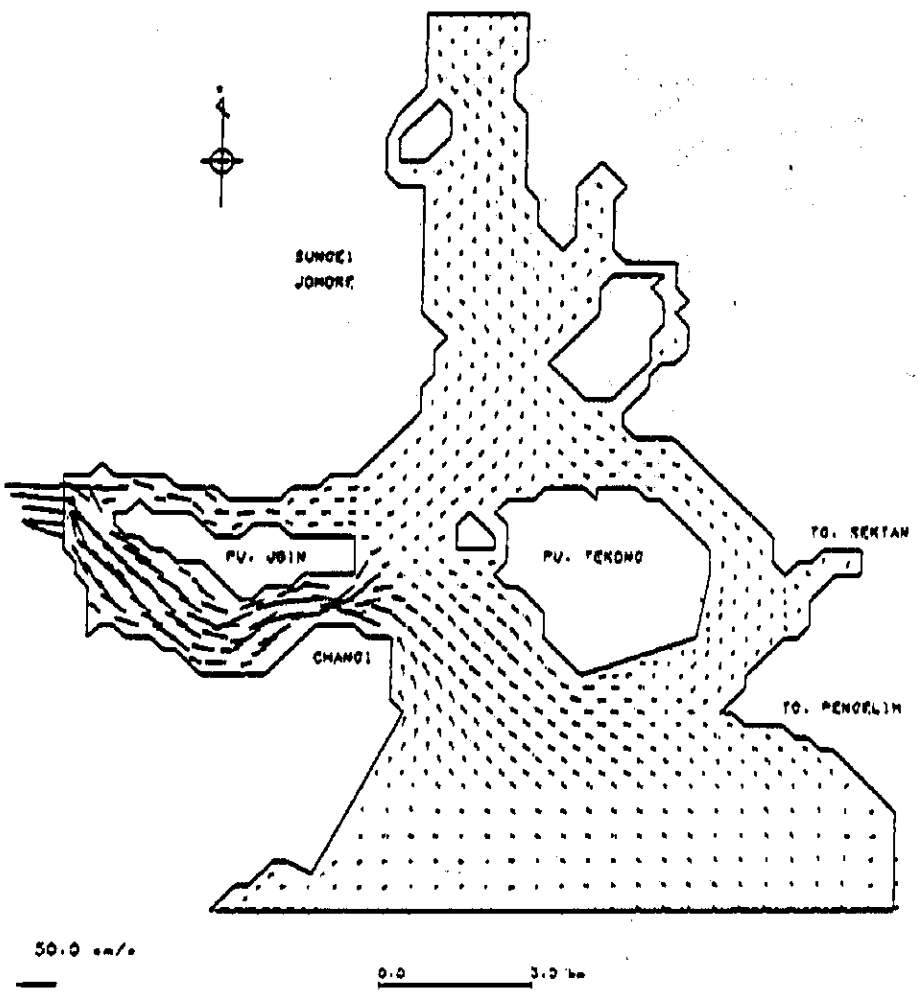
これらから将来流況の変化を要約すると以下のとおりである（潮時に関する記述はTekong島の西海岸での状況である）。

① 高潮時には，外洋側からJohore水道へ向う流れが弱くなり，転流直前であり流速は全体的に小さい。現況流況に比べ1cm/sec以上の変化がみられる地点は，Tekong島埋立地の南側E地点（1.4cm/sec）のみであり，他の比較点では1cm/sec未満の変化にとどまる。

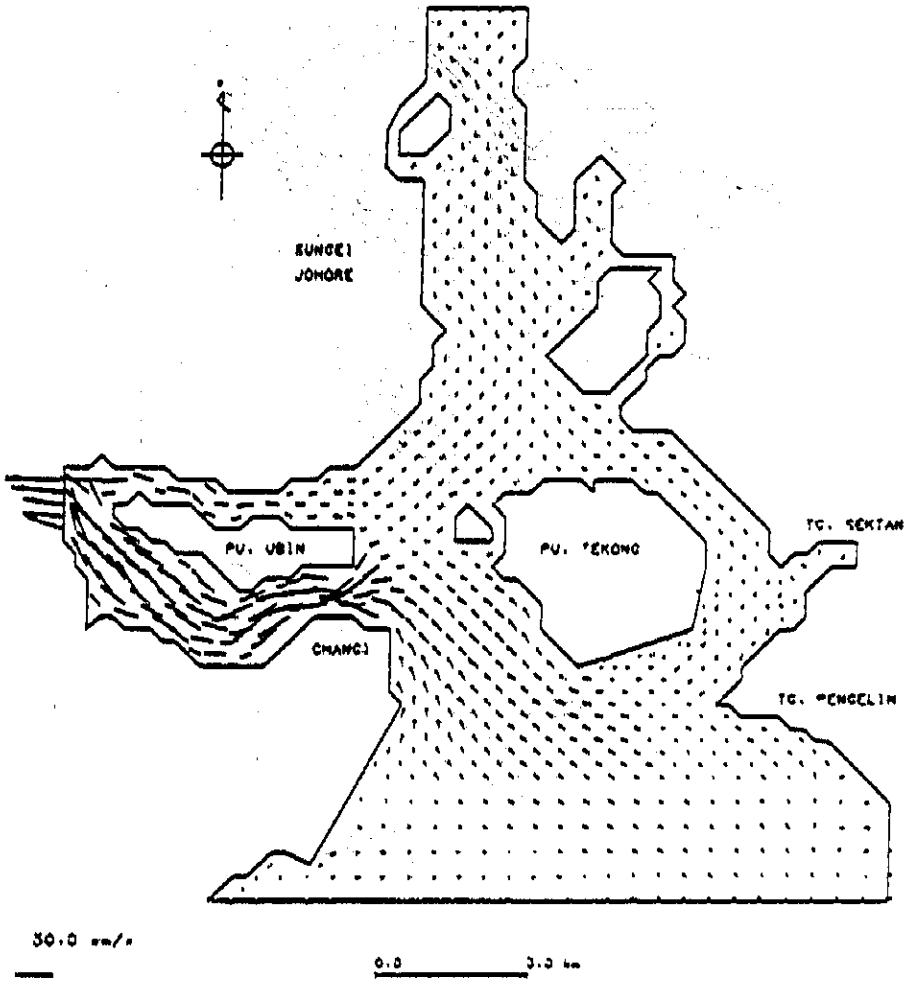
流向の変化は，Tekong島埋立地の南側とTg Pengelih間の水路で最大14°程度の変化がみられる。

② 高潮＋3時（下げ最強時）には，Juhore水道側から外洋に向う流れが最も強くなるが，恒流の流向とぶつかるため流速は相殺し，上げ最強時よりは小さくなる。現況流況に比べ1cm/sec以上の流速変化がみられる地点は，Changi東南のH地点，Tekong島埋立地南および東側のTC−3，D，E地点である。図Ⅲ6－29に示されるようTekong島埋立地とTg Pengelih間の水路（1Km×3Kmの範囲）で最大8cm/sec程度の流速増加があり，埋立地南側（1Km×1Kmの範囲）で最大8cm/sec程度の流速減少がみられる。

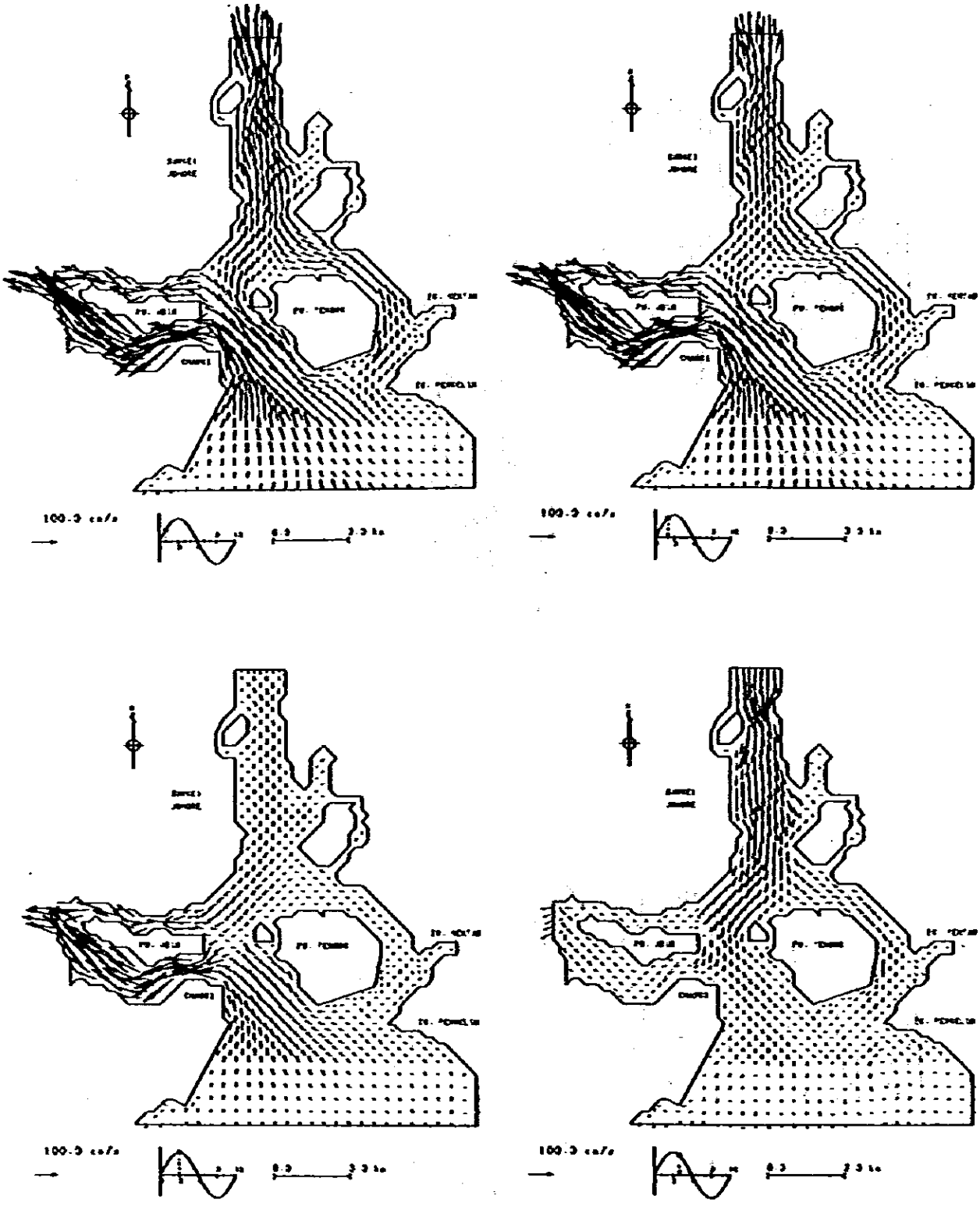
流向の変化は，Tekong島埋立地とTg Pengelih間の水路で最大5°程度である。



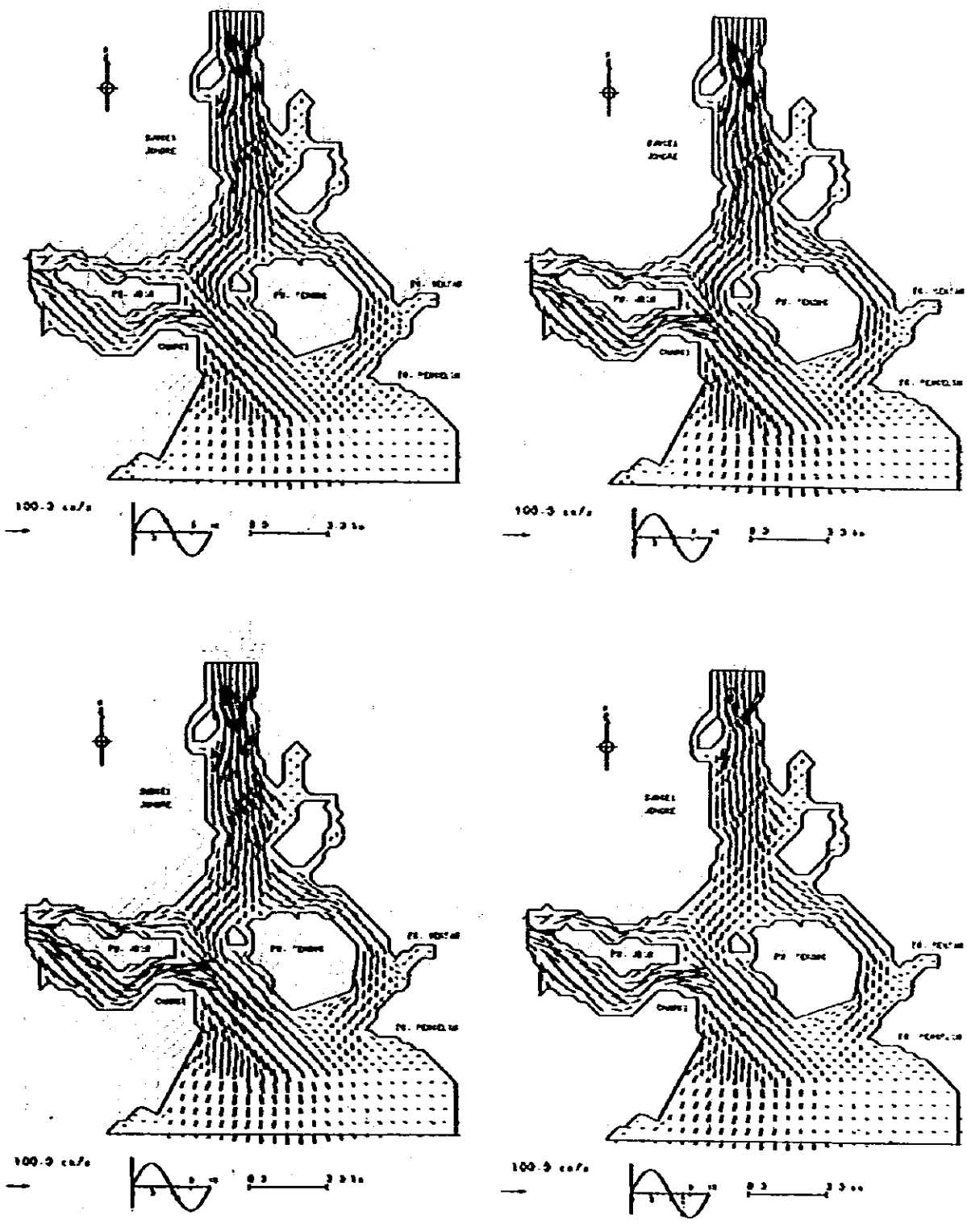
図Ⅲ　6－24　恒流・将来（石炭火力発電所のみ）



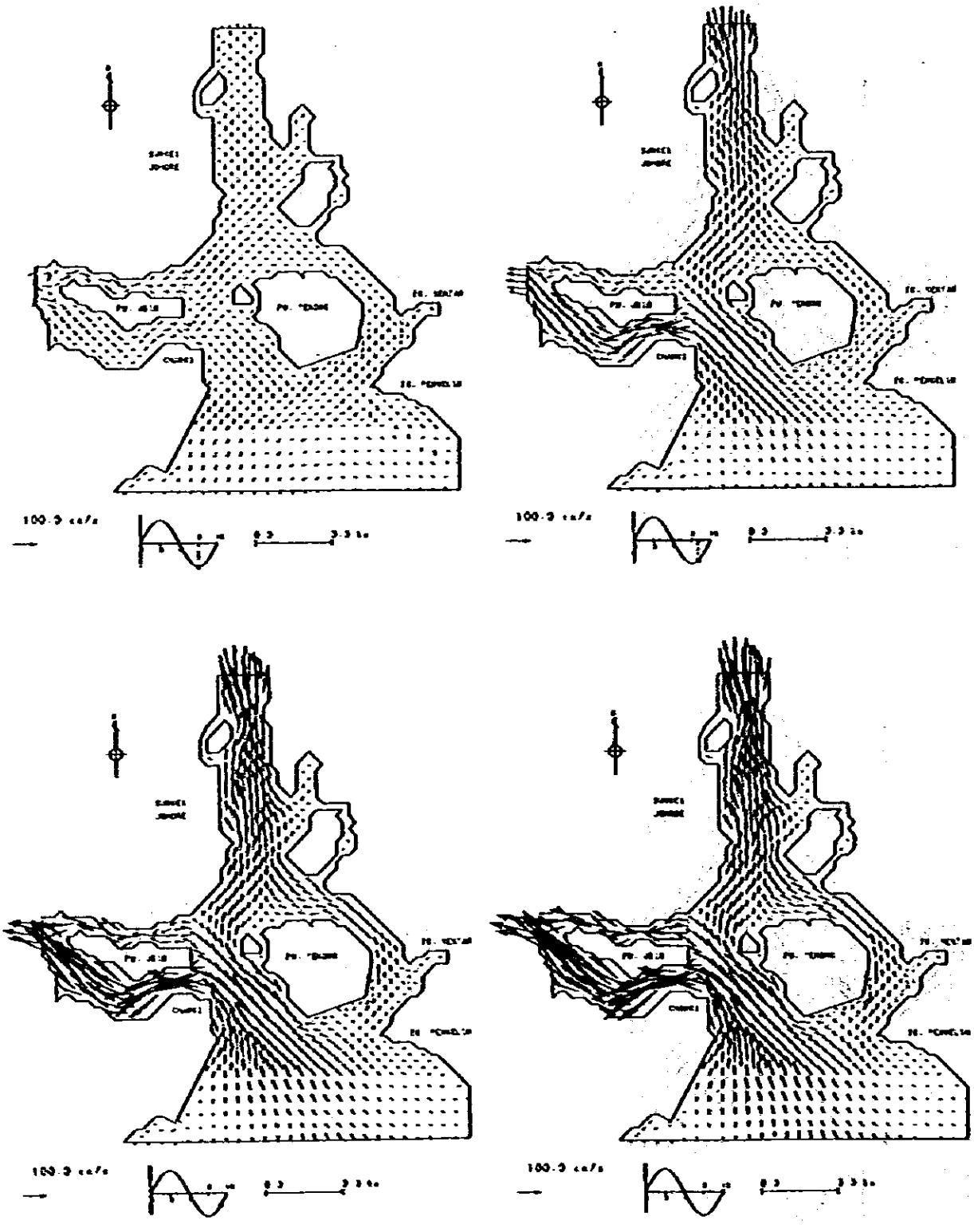
図Ⅲ　6－25　恒流・将来（石炭火力発電所と製鉄所）



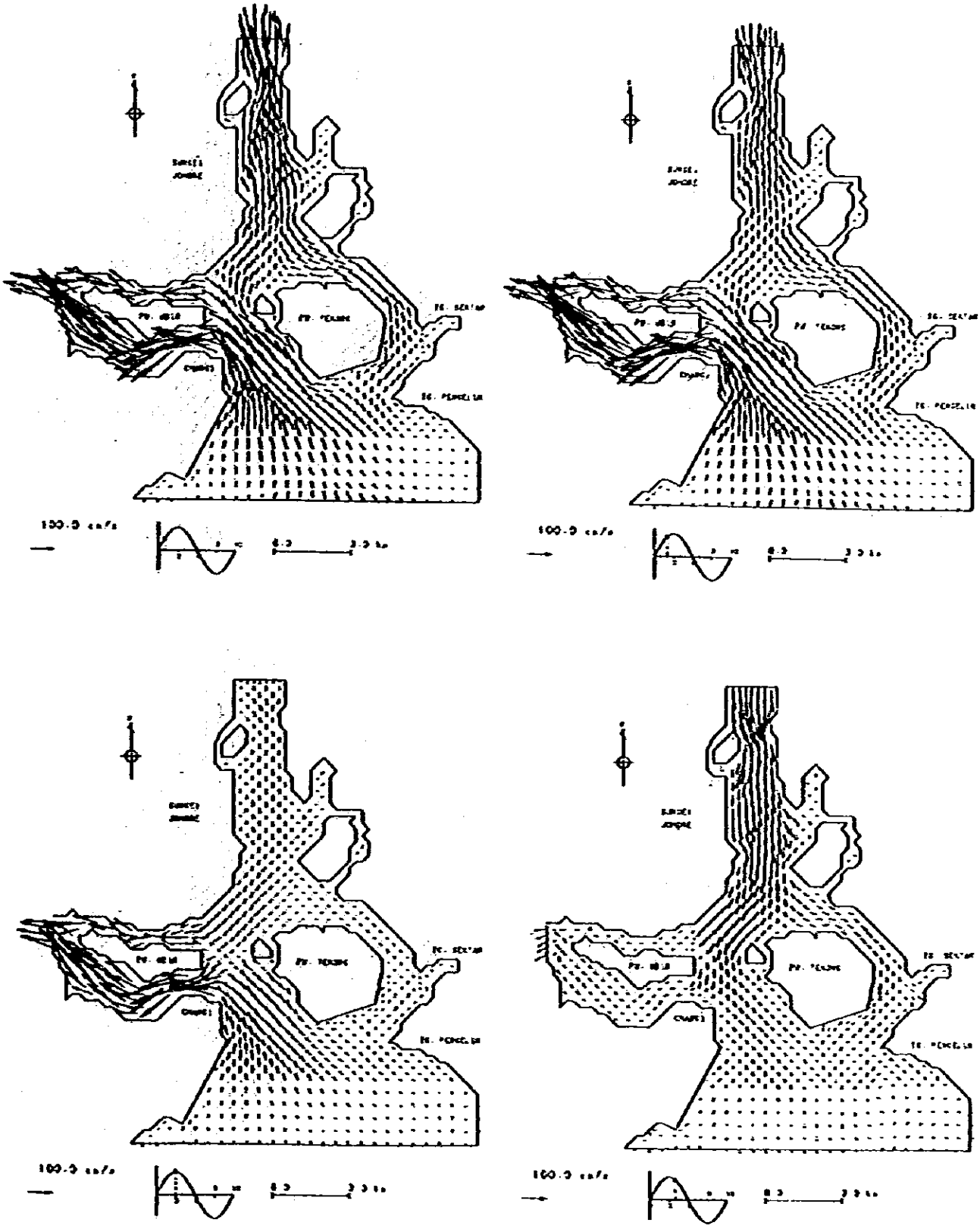
図Ⅱ　6－26(1)　流況・将来（石炭火力発電所のみ）



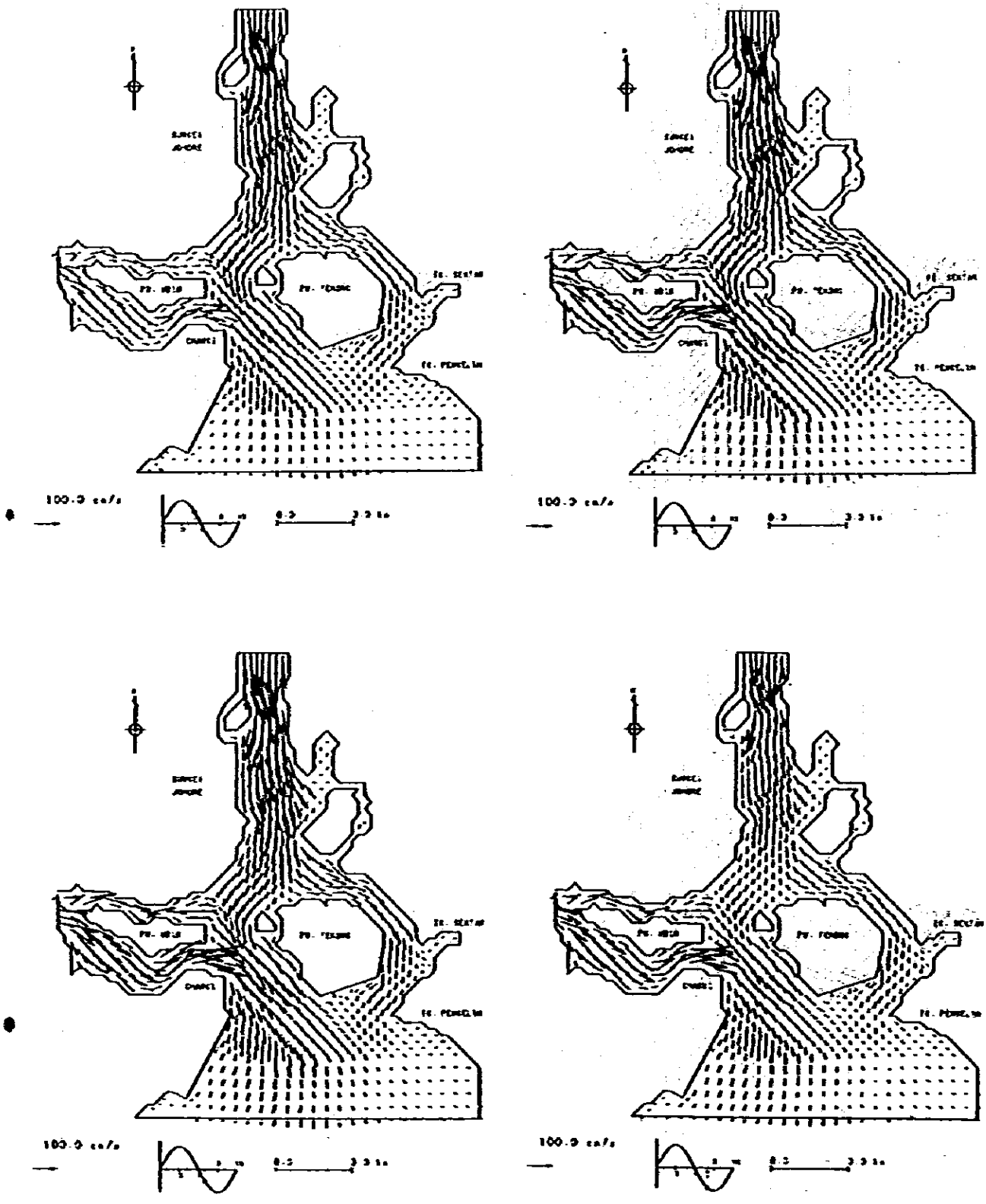
図Ⅱ　6－26(2) 流況・将来（石炭火力発電所のみ）



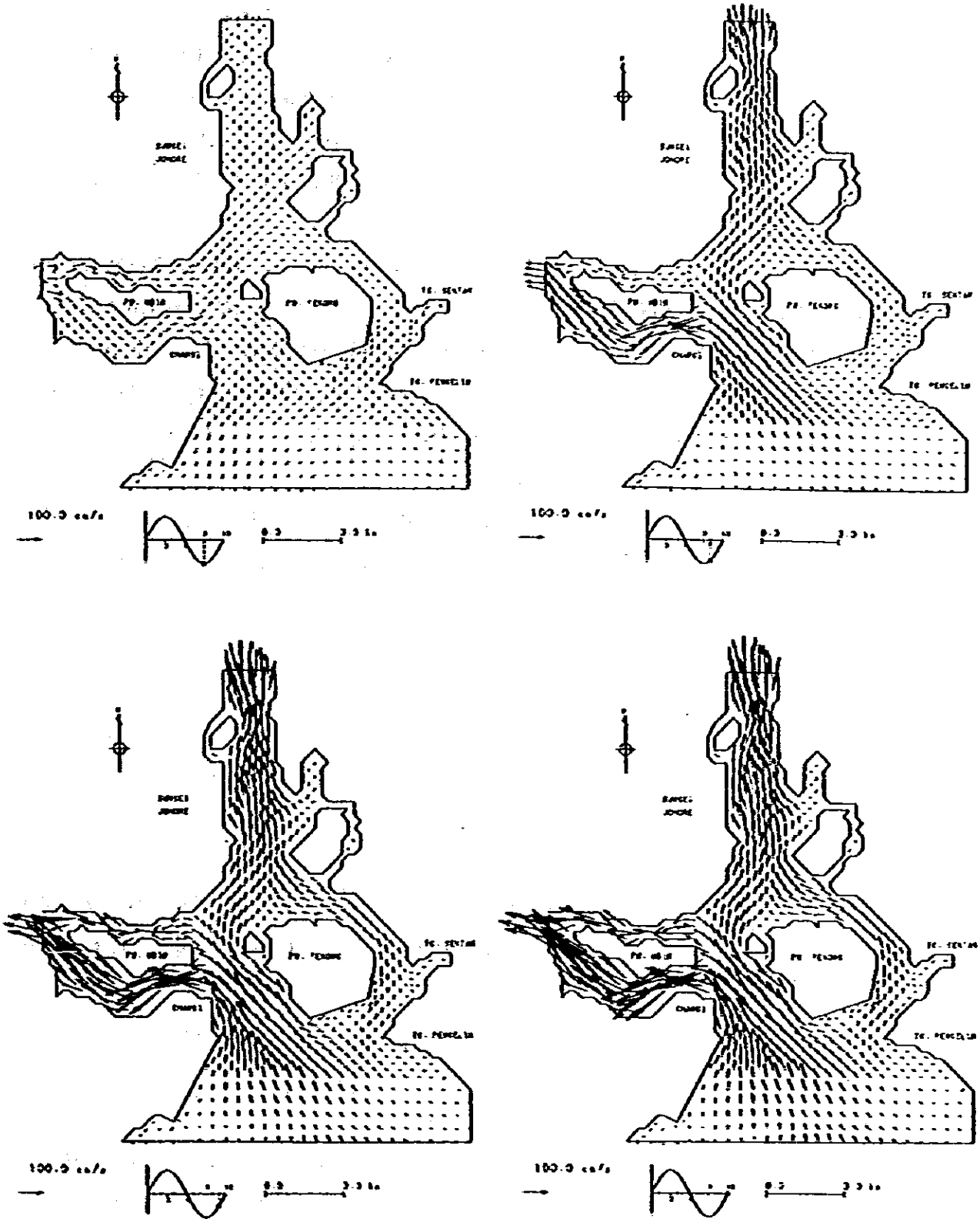
図Ⅱ　6－26(3)　流況・将来（石炭火力発電所のみ）



図Ⅱ　6－27(1)　現況・将来（石炭火力発電所と製鉄所）



図Ⅱ　6－27(2) 浚況・将来（石炭火力発電所と製鉄所）



図Ⅱ　6－27(3) 流況・将来（石炭火力発電所と製鉄所）

③ 低潮時には，潮汐流と恒流が相殺し，流速値は最も小さくなる。各代表点とも流速の変化は1cm/sec未満にとどまる。流向の変化はTekong島埋立地とTg pengelih間の水路で10°程度生じているが，流速が小さいことから大きな変化とはいえない。

④ 低潮＋3時（上げ最強時）には，潮汐流，恒流とも外洋側からJohore水道側に同方向に流れることから流速値は最大になりTekong島，Changi間では50～70cm/secの流速が生じる。

現況流況に比べ1cm/sec以上の流速変化がみられる地点は，Tekong島埋立地とTg Pengelih間の水路のTC−3，C，D地点，埋立地南側のE地点，Changi東南のG，H地点である。I図■ 6－29に示されるようにTekong島埋立地とTg Pengelih間の水路（2Km×3Kmの範囲）で最大6cm/secの流速増加があり，埋立地南側（2Km×2Kmの範囲）で最大8cm/sec程度の流速減少があり，Chongi東南海域（3Km×3Kmの範囲）で最大4cm/sec程度の流速増加がみられる。

流向の変化は，Tekong島埋立地とTg Pengelih間の水路で10°程度である。

①～④に述べたように下げ最強時，上げ最強時等，流速が大きい時期に比較的広い範囲に流速の変化がみられる。

6－2－2 COD拡散

— 現況再現性の確認

COD拡散計算を実施し，得られた結果と水質モデルとを比較し，水質の現況再現性について検証する。

なお，Tekong海域での水質観測時の流れは，微弱であったことから，定常拡散計算を実施し，平均的な水質を求めた。

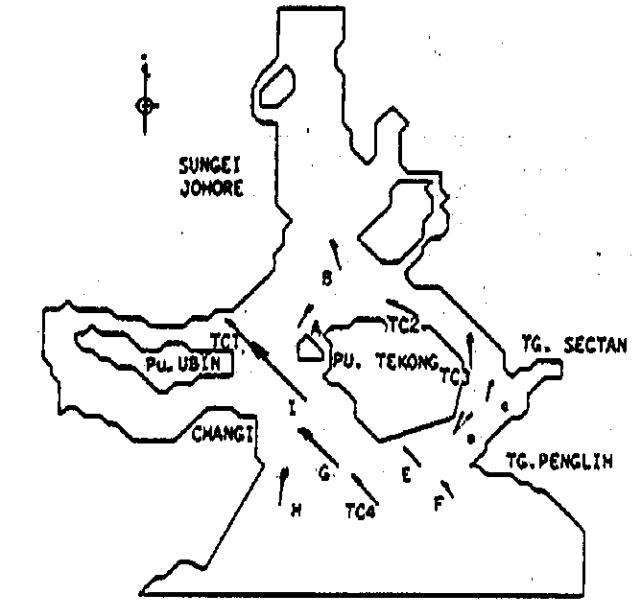
図■ 6－30に計算結果のCOD濃度平面分布を，表■ 6－10，図■ 6－31に観測値と計算値とを比較したものを示す。また，図■ 6－32には代表断面における観測値と計算値の比較を行なったものを示す。

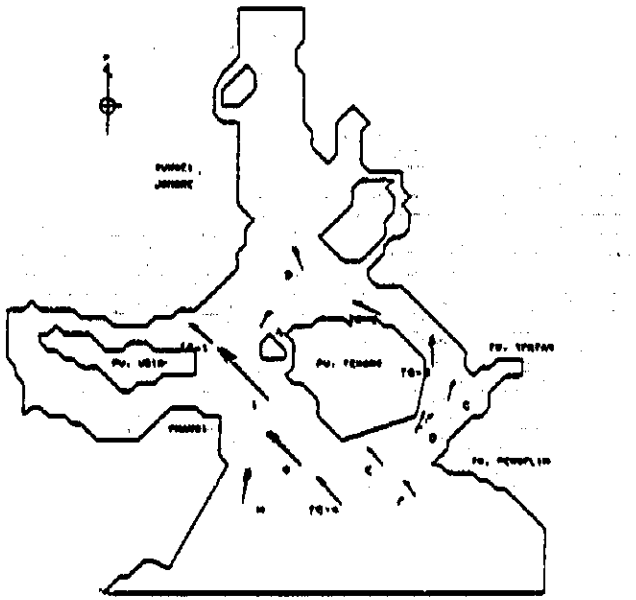
これらから計算結果の現況再現性について要約すると次のとおりである。

① 計算値のCOD濃度の平面分布は，CODの観測値の分布状況と同様に，Tekong島北側で濃度は高く，南側で低い傾向を再現している。

② 水質観測点（T1～T32）11点の観測値と計算値とを比較すると，観測値と計算値との差は最大で1.1ppm程度である。全点の平均値によると，観測値の1.56ppmに対し，計算値は1.49ppmでその差は小さい。

③ 観測値と計算値との関係を求めると，相関係数0.71，回帰直線式y＝0.722x＋0.481

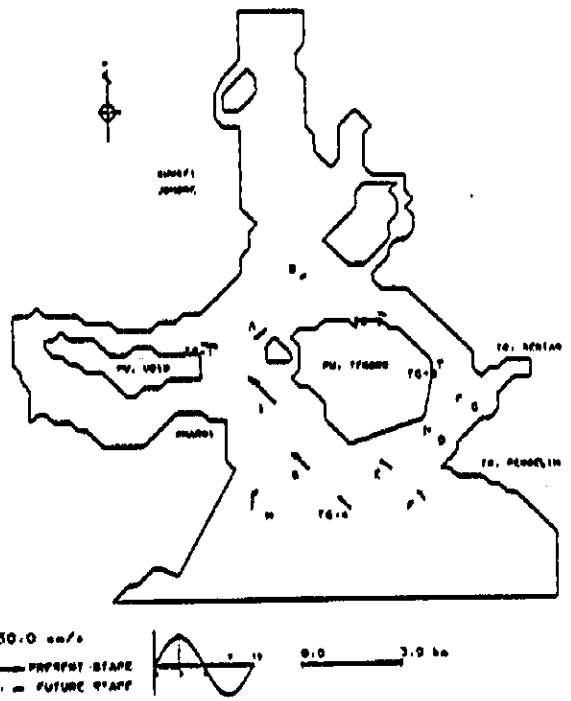


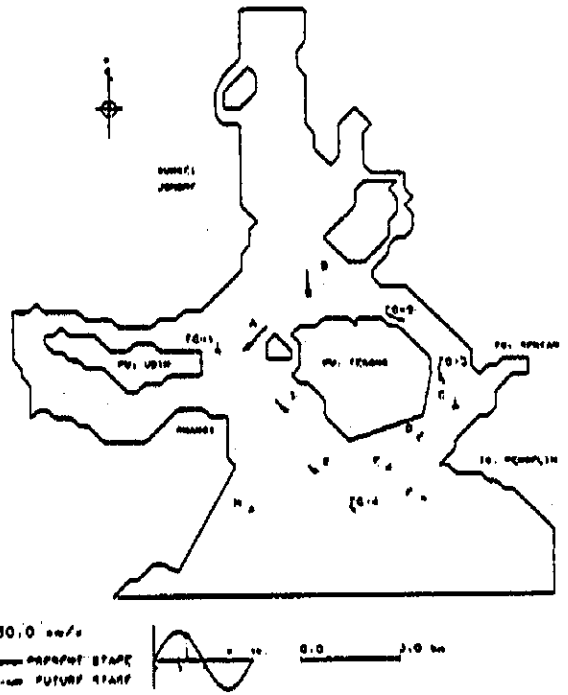


POINT	PRESENT STAGE		FUTURE STAGE		DIFFERENCE		a/b VELOCITY RATIO
	a VELOCITY (cm/s)	b DIRECTION (°)	a VELOCITY (cm/s)	d DIRECTION (°)	a-c VELOCITY (cm/s)	b-d DIRECTION (°)	
TC-1	30.79	318.91	30.59	318.92	0.19	0.18	0.9994
TC-2	40.17	295.41	40.72	295.41	-0.55	0.00	1.0138
TC-3	38.42	353.29	42.00	354.13	-3.58	1.14	1.0932
TC-4	30.13	323.30	32.11	321.83	-0.98	1.47	1.0273
A	31.45	27.91	31.04	27.66	0.41	0.25	0.9871
B	38.08	342.83	38.20	342.34	-0.11	0.49	1.0030
C	22.75	9.72	25.52	9.02	-2.77	3.70	1.1219
D	25.55	25.00	29.16	35.74	-3.61	10.74	1.1411
E	21.29	327.55	17.34	329.98	3.96	1.67	0.8142
F	16.33	332.60	15.99	331.60	0.33	1.00	0.9795
G	49.49	313.08	51.18	315.13	-1.67	1.98	1.0338
H	39.27	10.64	41.05	10.31	-1.78	0.07	1.0453
I	78.03	314.79	78.48	315.92	0.15	0.73	0.9981

POINT	PRESENT STAGE		FUTURE STAGE		DIFFERENCE		a/b VELOCITY RATIO
	a VELOCITY (cm/s)	b DIRECTION (°)	a VELOCITY (cm/s)	d DIRECTION (°)	a-c VELOCITY (cm/s)	b-d DIRECTION (°)	
TC-1	29.24	312.40	29.05	312.17	0.19	0.23	0.9935
TC-2	35.90	295.22	35.98	295.22	-0.26	0.00	1.0073
TC-3	34.83	353.38	37.64	356.03	-2.81	1.33	1.0807
TC-4	30.08	324.33	30.90	322.53	-0.83	1.79	1.0277
A	21.93	28.98	21.18	28.01	0.37	0.49	0.9658
B	28.61	338.23	29.49	337.81	0.01	0.43	0.9969
C	21.33	10.70	23.73	6.89	-2.40	3.81	1.1125
D	25.06	24.18	27.85	35.21	-2.79	11.03	1.1114
E	19.39	330.37	13.42	328.29	5.97	2.08	0.7852
F	16.01	333.22	15.47	333.08	0.54	0.47	0.9663
G	41.37	314.03	42.87	315.47	-1.50	1.34	1.0363
H	37.55	11.12	38.43	11.05	-1.38	0.06	1.0366
I	87.74	315.03	87.30	315.87	0.45	0.84	0.9956

図 III　6 － 28(1)　流況の変化（石炭火力発電所と製鉄所）

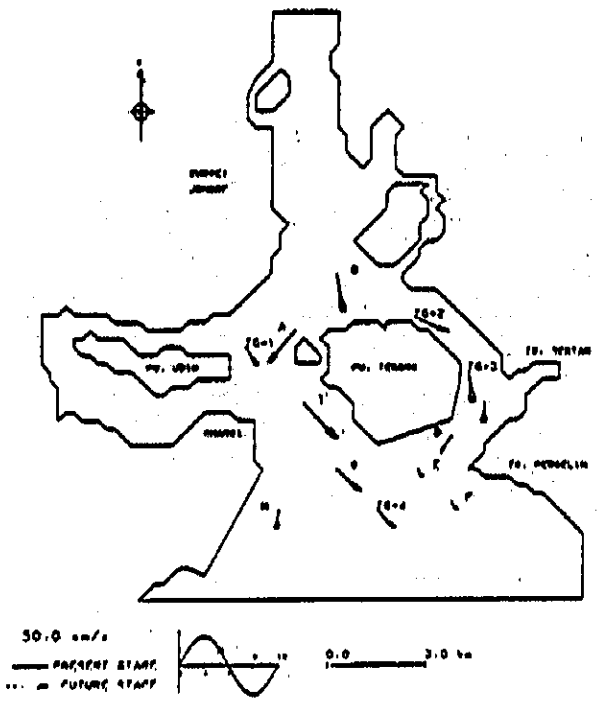




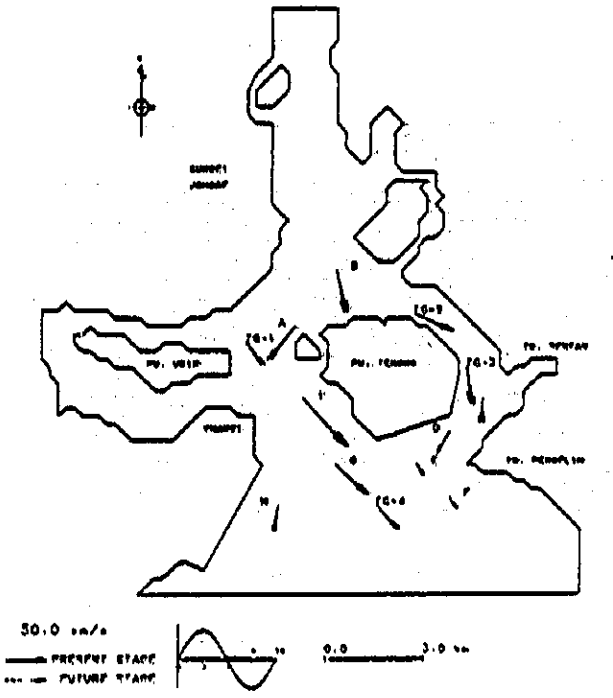
POINT	PRESENT STAGE		FUTURE STAGE		DIFFERENCE		VELOCITY RATIO
	VELOCITY (cm/s)	DIRECTION (°)	VELOCITY (cm/s)	DIRECTION (°)	VELOCITY (cm/s)	DIRECTION (°)	
TC-1	13.12	270.68	13.04	270.19	0.08	0.49	0.9938
TC-2	8.45	289.45	8.40	289.46	0.05	0.01	0.9944
TC-3	8.44	355.26	8.42	353.51	-0.18	1.75	1.0212
TC-4	7.44	331.04	8.04	326.78	-0.60	4.85	1.0815
A	18.48	251.37	18.07	251.26	-0.18	0.11	1.0111
B	9.54	229.19	9.83	228.74	-0.09	0.45	1.0099
C	3.24	12.00	3.78	9.62	-0.54	2.44	1.0884
D	7.85	14.75	8.91	28.49	0.93	13.67	0.8812
E	7.06	318.74	8.61	305.97	1.40	12.77	0.8091
F	6.15	334.45	5.95	330.98	0.58	3.47	0.9050
G	11.98	317.28	12.74	318.45	-0.76	1.17	1.0637
H	18.85	18.91	19.22	18.41	-0.37	0.50	1.0198
I	23.09	313.78	22.58	313.30	0.51	1.52	0.9779

POINT	PRESENT STAGE		FUTURE STAGE		DIFFERENCE		VELOCITY RATIO
	VELOCITY (cm/s)	DIRECTION (°)	VELOCITY (cm/s)	DIRECTION (°)	VELOCITY (cm/s)	DIRECTION (°)	
TC-1	17.00	184.42	16.94	184.39	0.06	0.03	0.9967
TC-2	22.34	114.73	22.06	114.73	-0.33	0.00	1.0146
TC-3	20.45	174.68	23.03	174.24	-2.20	0.24	1.1057
TC-4	22.84	135.85	22.73	135.92	0.11	0.09	0.9950
A	39.43	222.52	39.47	222.47	0.16	0.05	0.9990
B	33.40	178.57	33.44	178.31	-0.04	0.25	1.0011
C	14.10	183.14	14.09	186.06	-0.59	3.09	1.0418
D	12.98	214.90	16.02	218.45	-3.04	3.55	1.2403
E	9.39	152.20	8.07	159.07	1.31	5.87	0.8601
F	8.83	146.27	9.09	151.15	-0.26	4.88	1.0293
G	27.07	130.97	27.23	134.64	-0.16	0.67	1.0067
H	12.72	173.10	13.34	174.53	-0.59	1.43	1.0487
I	39.19	137.39	39.01	137.77	0.19	0.38	0.9952

図 III　6 － 28 (2)　流況の変化（石炭火力発電所と製鉄所）

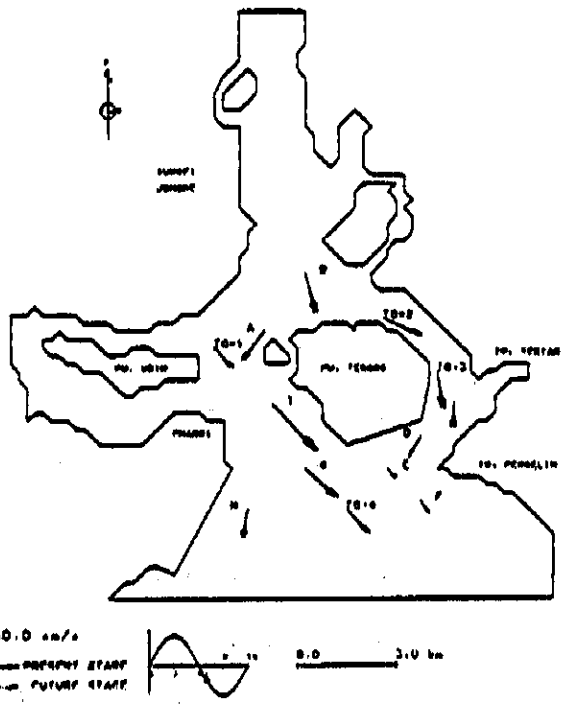


POINT	PRESENT STAGE		FUTURE STAGE		DIFFERENCE		VELOCITY RATIO
	a VELOCITY (cm/s)	b DIRECTION (°)	a VELOCITY (cm/s)	d DIRECTION (°)	a-c VELOCITY (cm/s)	d-b DIRECTION (°)	c/a VELOCITY RATIO
TC-1	31.52	149.43	31.49	149.20	0.13	0.05	0.9990
TC-2	42.07	113.01	42.44	113.01	-0.37	0.00	1.0088
TC-3	39.34	174.30	42.37	174.07	-3.03	0.23	1.0770
TC-4	43.16	136.90	43.14	136.14	-0.38	0.16	1.0088
A	50.41	220.10	49.88	220.02	0.52	0.08	0.9896
B	49.35	171.95	49.34	171.72	0.02	0.23	0.9997
C	25.99	188.96	26.86	185.97	-0.87	2.99	1.0335
D	29.92	211.91	29.99	216.93	-5.07	5.03	1.2034
E	18.73	143.07	15.87	145.32	2.86	1.25	0.8472
F	18.67	147.06	18.77	149.87	-0.21	2.82	1.0111
G	53.46	134.01	54.17	134.93	-0.69	0.94	1.0128
H	30.10	181.92	31.08	182.35	-0.98	0.42	1.0326
I	79.81	137.28	79.23	137.81	0.58	0.52	0.9927

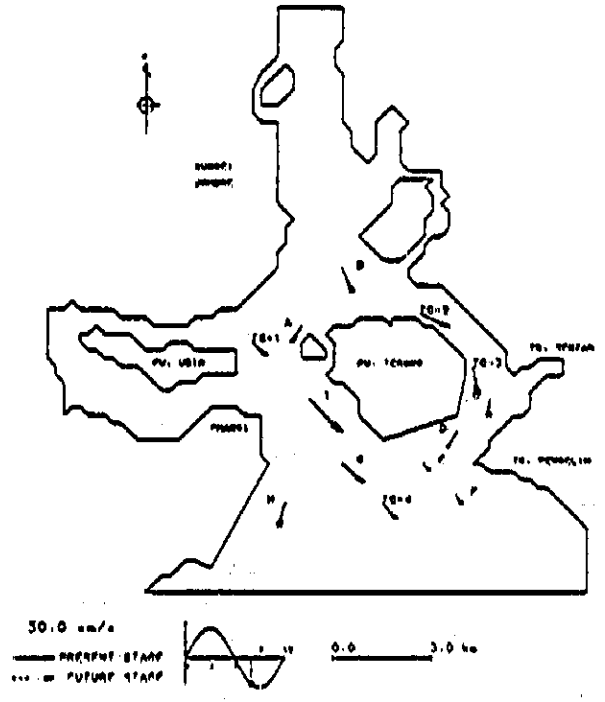


POINT	PRESENT STAGE		FUTURE STAGE		DIFFERENCE		VELOCITY RATIO
	a VELOCITY (cm/s)	b DIRECTION (°)	a VELOCITY (cm/s)	d DIRECTION (°)	a-c VELOCITY (cm/s)	d-b DIRECTION (°)	c/a VELOCITY RATIO
TC-1	38.49	141.20	38.34	141.14	0.15	0.06	0.9961
TC-2	50.34	113.23	50.70	113.26	-0.36	0.00	1.0072
TC-3	47.36	174.24	50.91	174.07	-3.15	0.17	1.0665
TC-4	52.86	136.38	53.91	136.25	-1.06	0.13	1.0124
A	51.92	218.97	51.13	218.97	0.79	0.00	0.9924
B	56.64	169.23	56.60	168.99	0.04	0.23	0.9992
C	30.99	187.92	31.80	185.64	-0.83	2.28	1.0275
D	30.24	210.96	35.43	215.08	-5.19	5.12	1.1715
E	22.99	139.36	19.84	139.43	3.15	0.07	0.8593
F	23.19	147.00	23.31	149.20	-0.12	2.20	1.0050
G	66.48	133.73	67.31	134.21	-0.83	0.48	1.0125
H	38.34	183.98	39.43	184.22	-1.08	0.23	1.0283
I	99.07	137.36	98.38	137.85	0.70	0.48	0.9929

図 III　6 － 28(3)　流況の変化（石炭火力発電所と製鉄所）

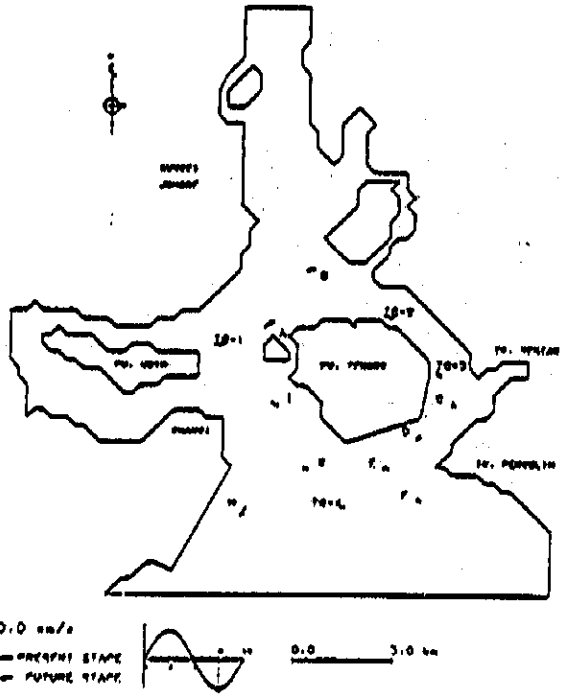


POINT	PRESENT STAGE a VELOCITY (cm/s)	PRESENT STAGE b DIRECTION (°)	FUTURE STAGE a VELOCITY (cm/s)	FUTURE STAGE d DIRECTION (°)	DIFFERENCE a-c VELOCITY (cm/s)	DIFFERENCE f-e DIRECTION (°)	a-c/a VELOCITY RATIO
TC-1	37.04	138.31	37.08	138.23	0.13	0.08	0.9959
TC-2	48.43	115.40	48.99	115.49	-0.37	0.00	1.0076
TC-3	43.43	174.45	48.77	174.13	-2.94	0.12	1.0641
TC-4	31.03	136.43	32.22	136.63	-0.77	0.10	1.0150
A	43.40	218.40	43.09	218.55	0.41	0.14	0.9905
B	48.40	166.78	48.17	166.51	0.03	0.27	0.9994
C	28.47	187.49	30.98	185.47	-0.72	2.02	1.0240
D	30.13	209.62	34.38	214.98	-4.25	5.36	1.1410
E	23.47	130.07	19.97	125.93	3.38	0.14	0.8562
F	23.40	149.30	23.97	149.00	0.13	1.70	0.9942
G	64.63	133.47	66.38	133.97	-0.74	0.90	1.0112
H	39.98	185.85	41.02	186.03	-1.04	0.18	1.0259
I	98.30	137.46	97.82	137.89	0.09	0.43	0.9931

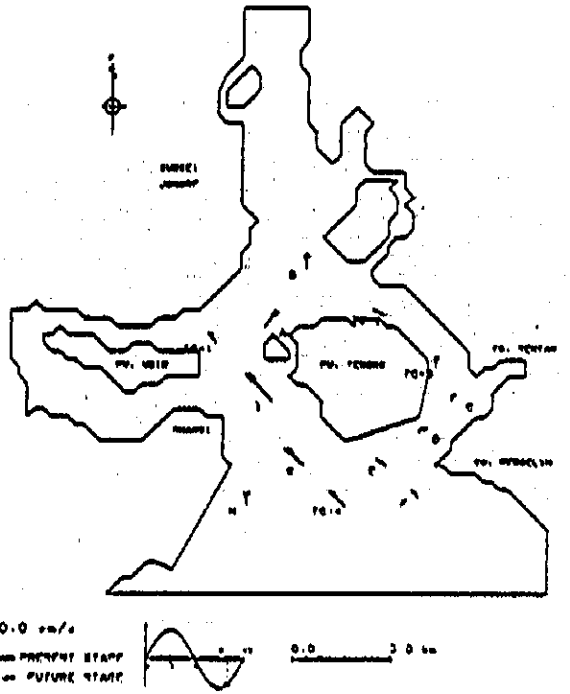


POINT	PRESENT STAGE a VELOCITY (cm/s)	PRESENT STAGE b DIRECTION (°)	FUTURE STAGE a VELOCITY (cm/s)	FUTURE STAGE d DIRECTION (°)	DIFFERENCE a-c VELOCITY (cm/s)	DIFFERENCE f-e DIRECTION (°)	a-c/a VELOCITY RATIO
TC-1	28.78	133.97	28.65	133.84	0.13	0.13	0.9954
TC-2	36.41	115.69	37.06	115.68	-0.26	0.00	1.0070
TC-3	36.00	174.37	38.32	174.19	-2.32	0.18	1.0643
TC-4	34.13	137.60	34.92	137.23	-0.77	0.37	1.0205
A	43.77	211.45	43.40	211.20	0.37	0.24	0.9945
B	31.79	139.74	31.76	139.37	0.03	0.37	0.9990
C	23.04	188.40	24.31	186.28	-0.69	2.11	1.0294
D	25.72	207.78	28.22	214.18	-2.50	6.42	1.0973
E	19.65	135.87	18.47	134.30	1.18	1.57	0.9382
F	19.20	148.21	18.79	149.10	0.41	0.89	0.9786
G	48.58	133.46	50.20	134.13	-0.61	0.67	1.0124
H	33.88	188.53	34.76	188.64	-0.88	0.11	1.0260
I	76.36	137.39	75.79	137.80	0.55	0.41	0.9928

図 III　6 — 28 (4)　流況の変化（石炭火力発電所と製鉄所）

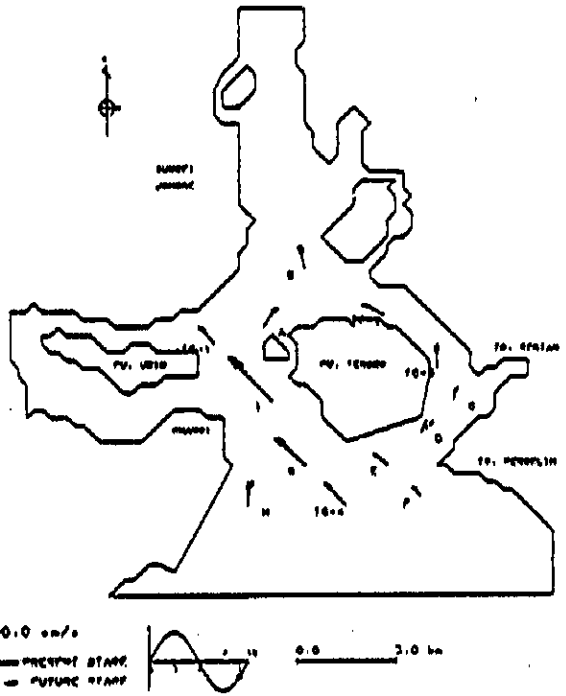


POINT	PRESENT STAGE a VELOCITY (cm/s)	PRESENT STAGE b DIRECTION (°)	FUTURE STAGE a VELOCITY (cm/s)	FUTURE STAGE a DIRECTION (°)	DIFFERENCE (future−present) VELOCITY (cm/s)	DIFFERENCE (future−present) DIRECTION (°)	cm/s VELOCITY RATIO
TC-1	12.84	107.96	12.79	107.36	-0.05	-0.60	0.9960
TC-2	10.23	113.91	10.21	113.92	-0.03	-0.01	0.9975
TC-3	10.56	174.63	11.03	174.01	+0.47	-0.62	1.0442
TC-4	12.85	136.09	13.34	136.94	+0.52	1.85	1.0403
A	12.37	46.84	12.40	46.75	+0.14	-0.08	1.0104
B	7.90	80.35	7.92	79.82	+0.03	-0.53	1.0036
C	6.90	181.43	7.22	188.90	+0.31	7.47	1.0453
D	9.21	200.91	8.98	209.91	-0.38	9.10	0.9744
E	8.88	129.11	7.91	120.56	-0.97	-8.55	0.8907
F	8.49	144.11	8.24	144.66	-0.25	1.45	0.9704
G	18.97	133.88	17.68	134.51	-0.48	0.63	1.0285
H	18.27	190.61	18.47	190.30	+0.20	-0.31	1.0108
I	27.77	135.26	27.41	135.97	-0.36	0.71	0.9870

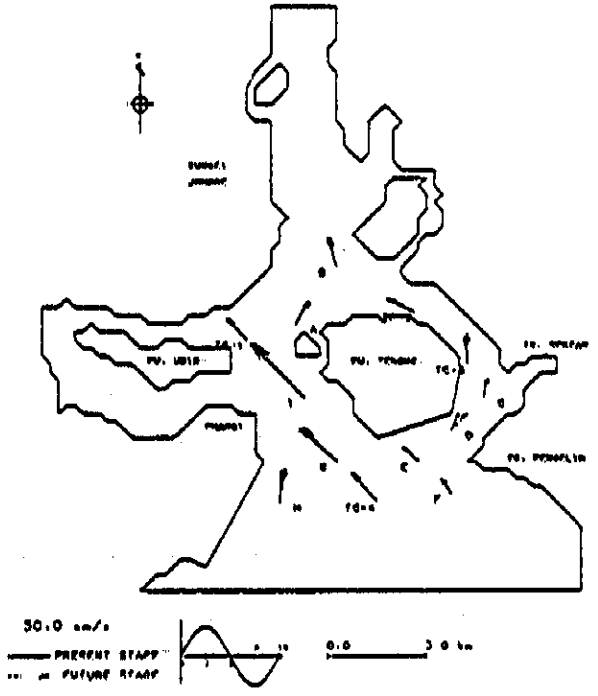


POINT	PRESENT STAGE a VELOCITY (cm/s)	PRESENT STAGE b DIRECTION (°)	FUTURE STAGE a VELOCITY (cm/s)	FUTURE STAGE a DIRECTION (°)	DIFFERENCE (future−present) VELOCITY (cm/s)	DIFFERENCE (future−present) DIRECTION (°)	cm/s VELOCITY RATIO
TC-1	10.42	343.76	10.17	343.66	-0.25	-0.10	0.9757
TC-2	13.33	269.78	13.34	269.78	+0.01	0.00	1.0290
TC-3	12.43	334.83	13.43	334.04	+1.00	-0.79	1.1312
TC-4	12.15	320.64	12.43	320.37	+0.27	-0.34	1.0225
A	24.84	35.46	24.68	35.38	-0.16	-0.08	0.9936
B	19.04	357.68	19.70	357.08	+0.66	-0.60	1.0034
C	7.21	3.78	7.80	0.79	+0.59	-3.02	1.0820
D	8.55	32.15	8.33	30.05	-1.78	-2.10	1.2711
E	9.43	322.95	9.28	331.19	-1.17	8.24	0.7862
F	5.32	333.98	5.30	341.12	-0.02	7.13	0.9926
G	16.51	312.82	16.67	314.74	+0.17	1.92	1.0101
H	10.37	10.27	11.22	11.19	+0.85	0.92	1.0817
I	23.28	316.17	23.42	316.31	+0.14	0.14	1.0059

図 III　6 − 28 (5)　流況の変化（石炭火力発電所と製鉄所）



POINT	PRESENT STAGE		FUTURE STAGE		DIFFERENCE		RATIO
	a VELOCITY (cm/s)	b DIRECTION (°)	c VELOCITY (cm/s)	d DIRECTION (°)	c-a VELOCITY (cm/s)	(c-a)-b DIRECTION (°)	c/a VELOCITY RATIO
TC-1	22.48	323.07	22.37	323.82	0.11	0.15	0.9950
TC-2	28.47	295.42	27.39	295.82	-0.56	0.09	1.0182
TC-3	24.07	334.96	27.27	334.60	-2.09	0.54	1.1016
TC-4	25.47	321.11	26.01	320.18	-0.74	0.93	1.0281
A	29.07	31.17	29.77	31.01	0.30	0.16	0.9987
B	30.19	347.42	30.32	347.07	-0.12	0.59	1.0040
C	14.26	4.83	15.62	1.81	-1.36	3.01	1.0947
D	14.26	27.44	16.48	30.02	-2.01	8.58	1.1831
E	13.03	318.44	10.77	318.73	2.26	0.10	0.8783
F	9.19	331.13	9.10	333.18	0.09	2.04	0.9907
G	34.78	312.83	33.52	314.44	-0.78	1.61	1.0918
H	24.87	10.70	28.31	11.04	-1.34	0.34	1.0537
I	34.04	313.48	34.14	313.67	-0.19	0.39	1.0018



POINT	PRESENT STAGE		FUTURE STAGE		DIFFERENCE		RATIO
	a VELOCITY (cm/s)	b DIRECTION (°)	c VELOCITY (cm/s)	d DIRECTION (°)	c-a VELOCITY (cm/s)	(c-a)-b DIRECTION (°)	c/a VELOCITY RATIO
TC-1	30.48	320.43	30.72	320.26	0.16	0.17	0.9948
TC-2	35.96	295.63	36.44	295.63	-0.58	0.00	1.0162
TC-3	33.51	358.13	36.80	354.70	-3.29	0.86	1.0982
TC-4	34.09	322.19	34.04	320.96	-0.96	1.22	1.0290
A	31.80	29.03	31.44	28.81	0.37	0.21	0.9884
B	36.59	344.41	36.73	344.00	-0.14	0.41	1.0037
C	19.68	6.07	21.66	3.93	-2.18	3.32	1.1113
D	20.75	25.42	24.03	33.40	-3.48	8.48	1.1579
E	18.21	320.03	15.05	321.66	3.14	1.37	0.8263
F	13.41	331.70	13.23	333.08	0.17	1.37	0.9871
G	45.91	313.15	46.42	314.06	-1.31	1.53	1.0268
H	34.15	10.40	33.80	10.96	-1.04	0.18	1.0491
I	71.38	314.42	71.42	313.48	-0.03	0.47	1.0005

図 III　6－28(6)　流況の変化（石炭火力発電所と製鉄所）

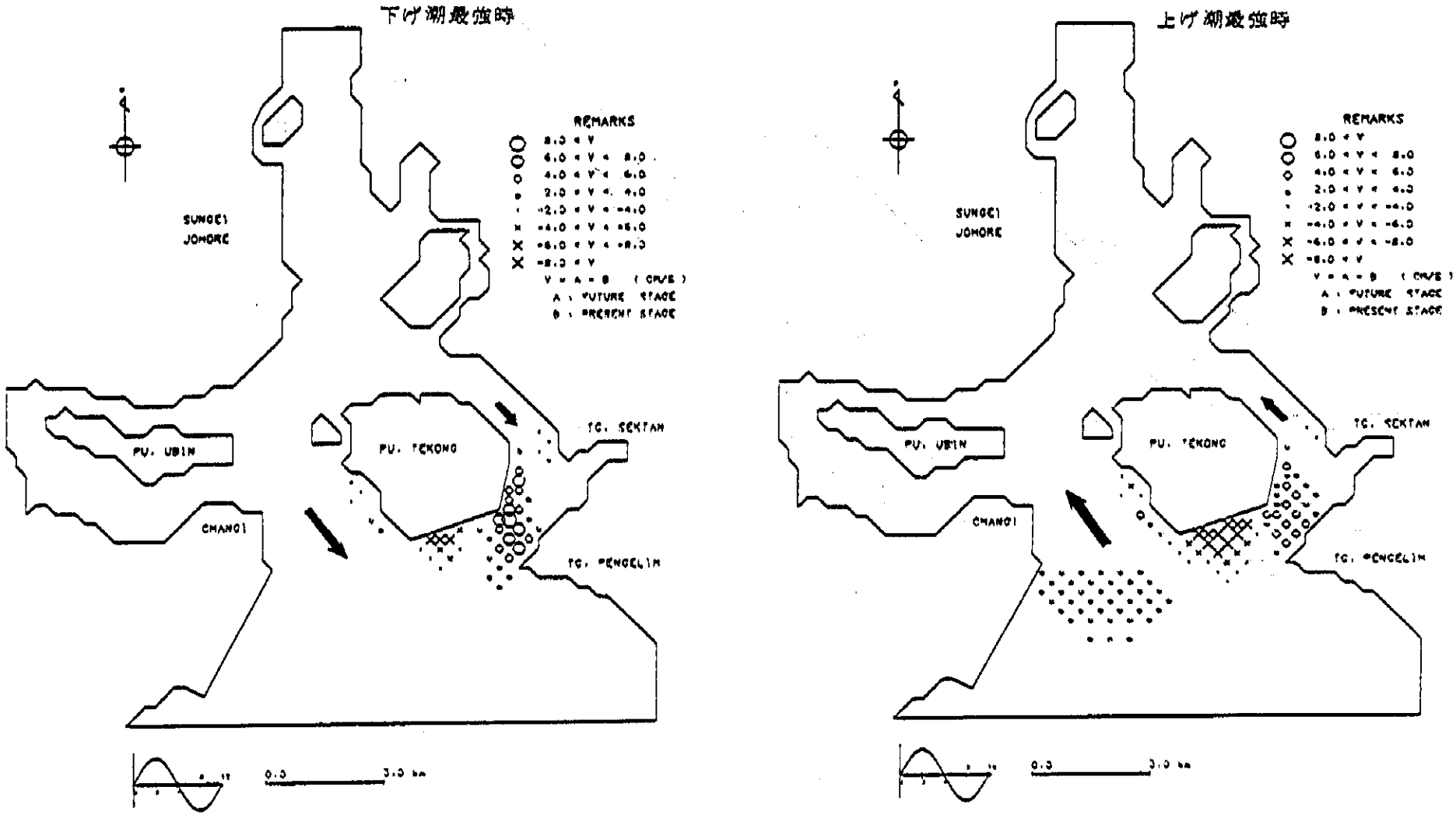


図 III　6 — 29　流速の変化とその範囲

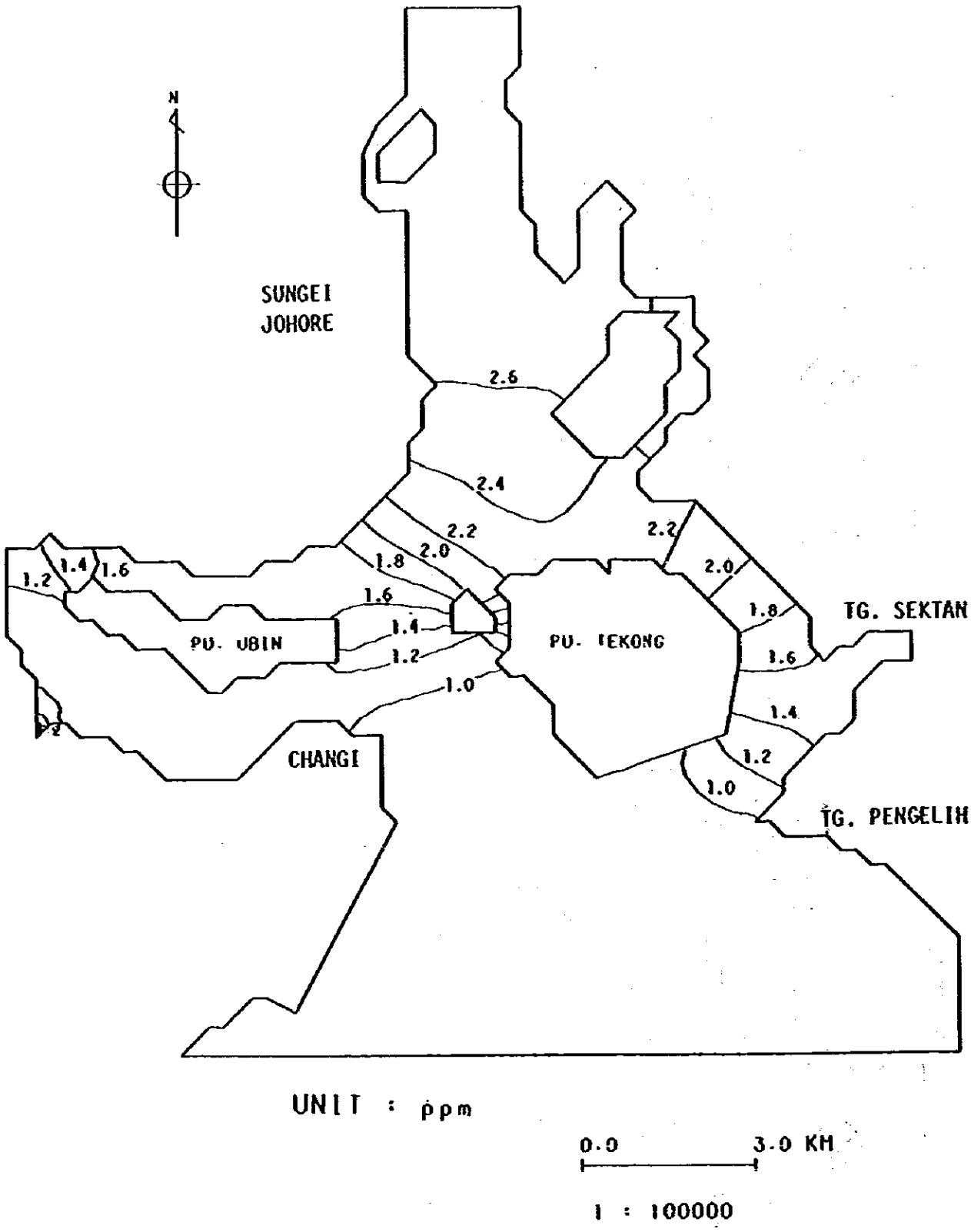
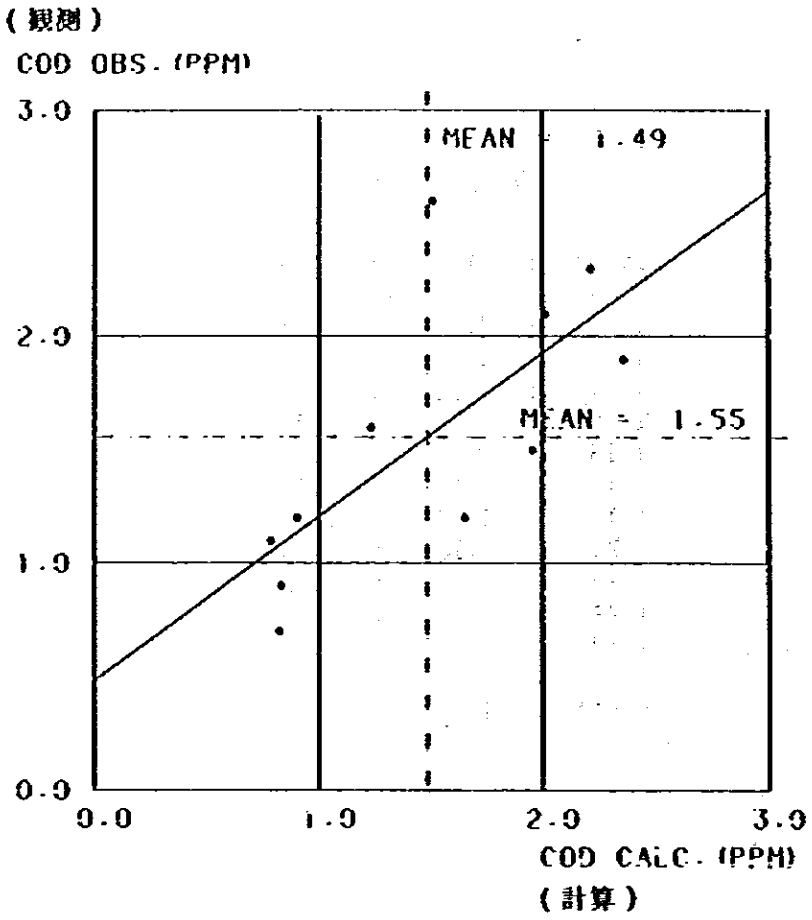


図 ■ 6－30 COD濃度平面分布・現況

表 Ⅲ　6－10　観測値と計算値との比較

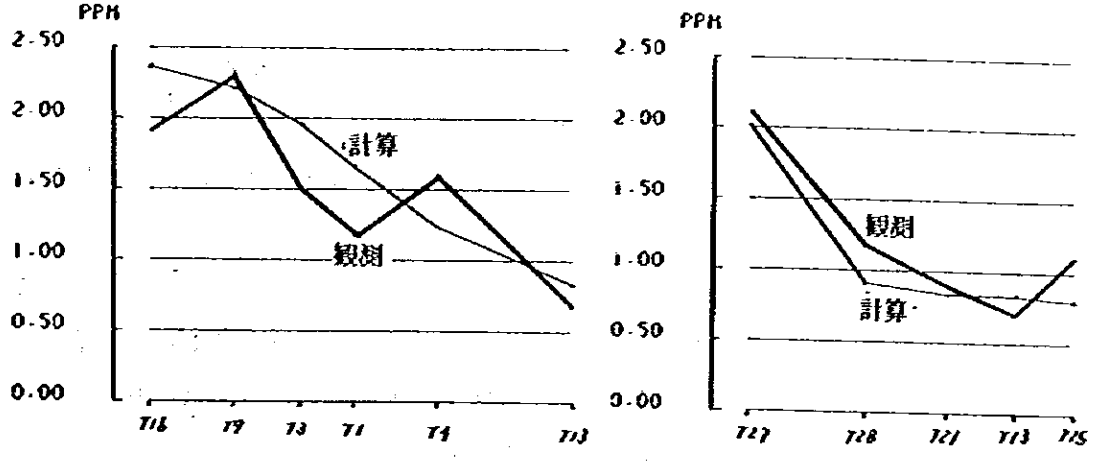
(UNIT : PPM)

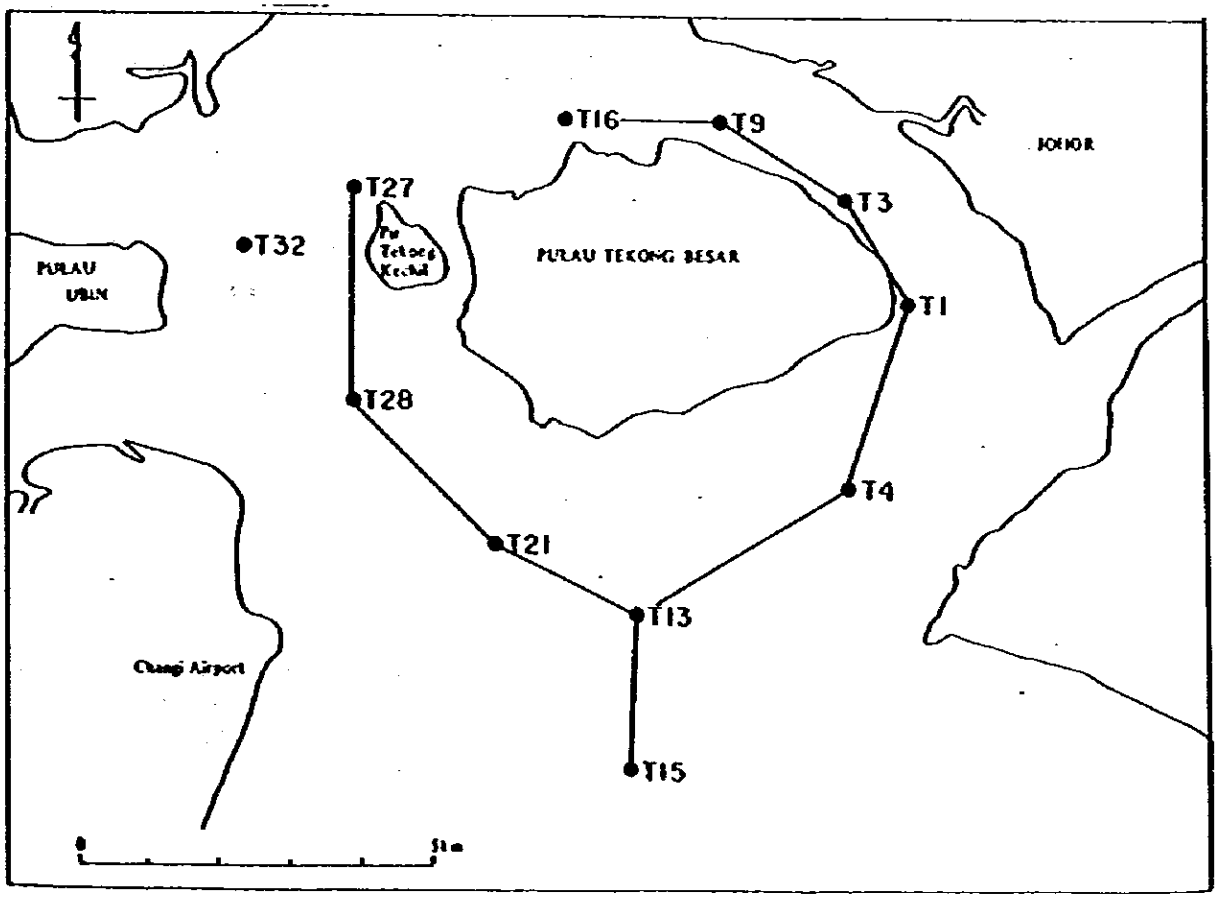
POINT	:	OBS (観測)	:	CALC. (計算)
T 1	:	1.20	:	1.66
T 3	:	1.50	:	1.96
T 4	:	1.60	:	1.24
T 9	:	2.30	:	2.22
T 13	:	0.70	:	0.83
T 15	:	1.10	:	0.80
T 16	:	1.90	:	2.36
T 21	:	0.90	:	0.84
T 27	:	2.10	:	2.02
T 28	:	1.20	:	0.91
T 32	:	2.60	:	1.52
MEAN	:	1.56	:	1.49



$Y = 0.72X + 0.48$　　$R = 0.71$　　$\begin{pmatrix} t\ \text{Test} \\ t_R > t\ 0.05 \\ 2.67 > 1.83 \end{pmatrix}$

図 6－31　観測値と計算値との関係





図■ 6 -- 32 代表断面でのCOD濃度（観測値と計算値）

が得られる。

比較的差が大きいT32のデータを除くと

相関係数0.85　回帰直線式はy=7.12x=0.393となる。

ここにy：観測値　x：計算値

①～③から，計算結果は，観測時のTekong海域の水質を再現していると考えられる。

－ 将来水質

現況の拡散計算と同様に将来地形，将来負荷量を入力し，将来予測計算を実施した。

将来拡散計算結果のCOD濃度平面分布を図Ⅲ6－33，Ⅲ6－24に，代表点でのCOD濃度を表Ⅲ6－11に，代表断面でのCOD濃度を図Ⅲ6－35にそれぞれ示す。これらから将来の水質について要約すると次のとおりである。

① 現況と将来（負荷元を石炭火力発電所と製鉄所）とを比較すると，現況と将来とのCOD濃度の差は，最大で0.03ppm程度である。水質観測点（T1～T32）11点での平均値は，現況の1.49ppmに対し，将来1.50ppmと0.01ppmの濃度の増加がみられる。

② 将来を石炭火力発電所のみとした場合と，これに製鉄所を加えた場合の水質を比べると，最大0.01ppm未満の差がある程度で，製鉄所からの負荷の有無による海域水質への影響はほとんどない。

6－2－3　温排水拡散

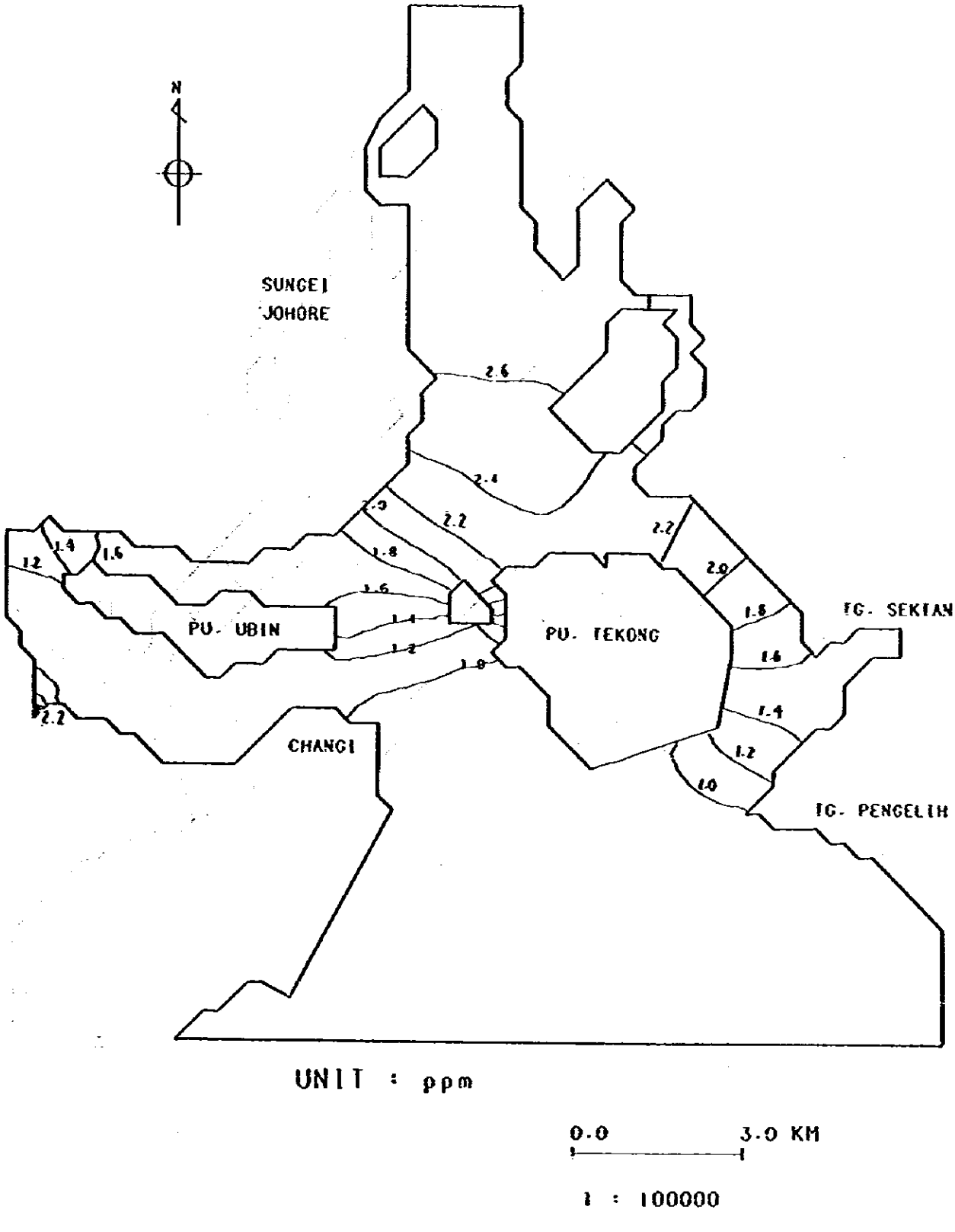
現況時点では，温排水の排出がないことから，温排水拡散の現況再現は実施していない。

将来時点での温排水拡散計算結果を図Ⅲ6－36に代表点における上昇水温を表Ⅲ6－12に示す。

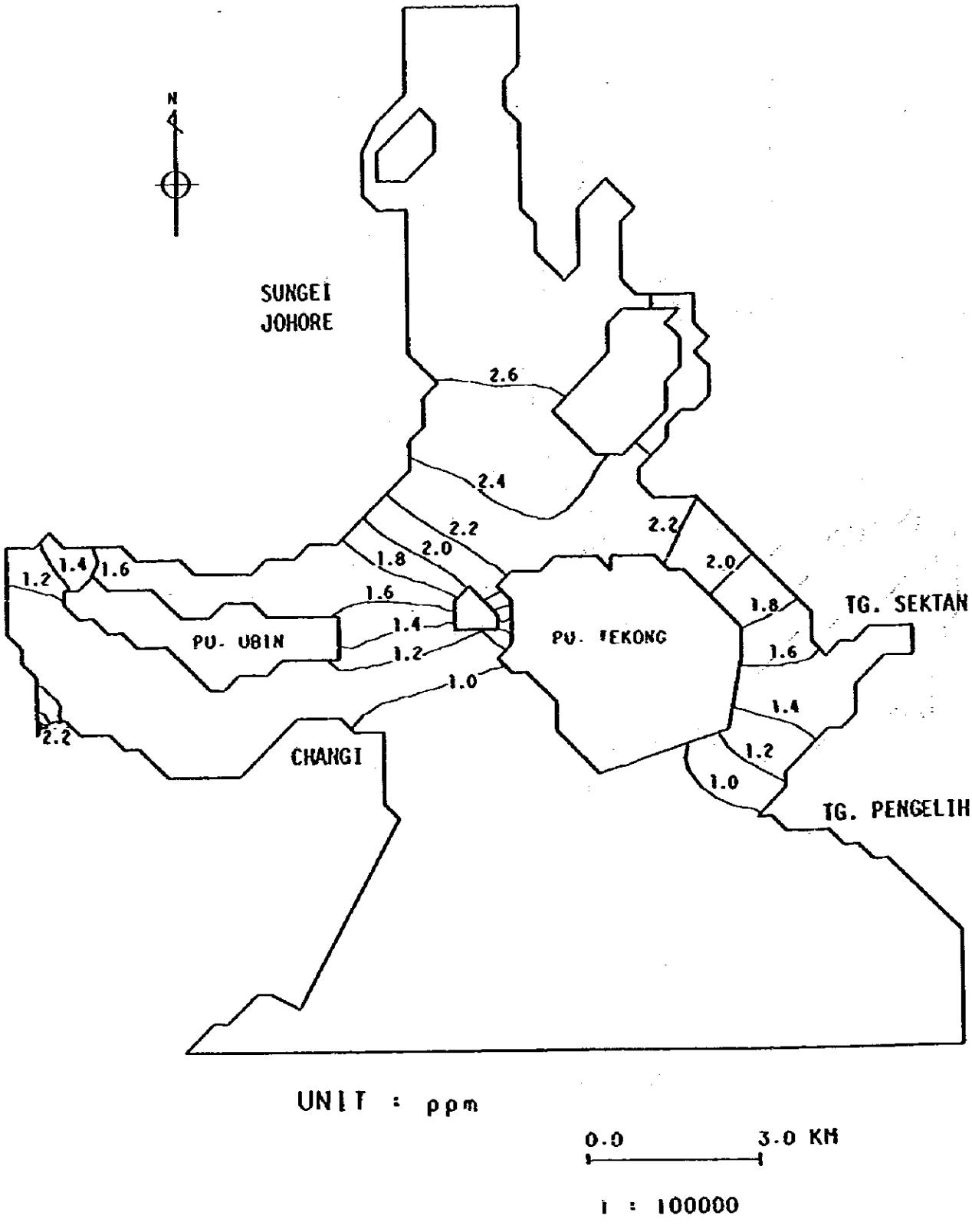
将来時点での温排水は，石炭火力発電所から生じる（8.3℃，27.8㎥/sec）。この温排水による周辺海域の水温上昇は最大0.5℃程度である

0.1℃の水温上昇は，排水口を中心にTekong島埋立地とTg Pongelih間の水路（3㎞×3㎞）の範囲である。0.2～0.5℃の水温上昇は，排水口付近（1㎞×0.5㎞）の範囲でみられる。

水温観測値の最大（28.9℃）と最小（28.3℃）との差（0.6℃）より上昇水温の最大値（0.5℃）の方が小さく，温排水が周辺海域の水温に及ぼす影響は少ない。



図■ 6－33 COD濃度平面分布・将来（石炭火力発電所のみ）

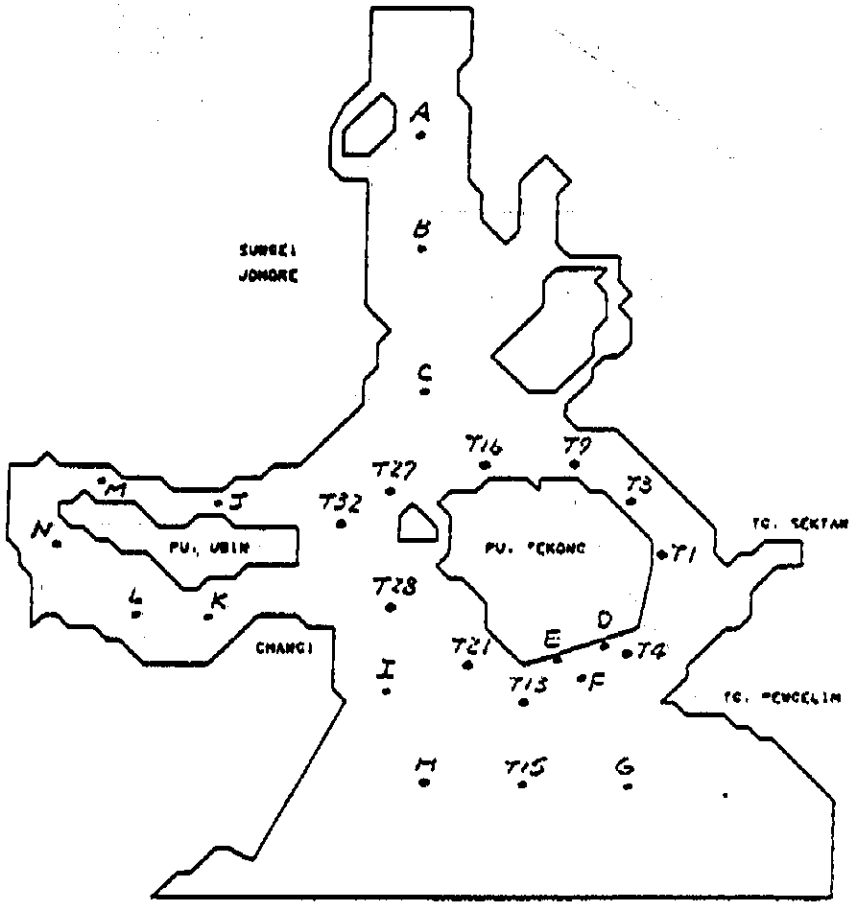


図Ⅲ 6－34 COD濃度平面分布・将来（石炭火力発電所と製鉄所）

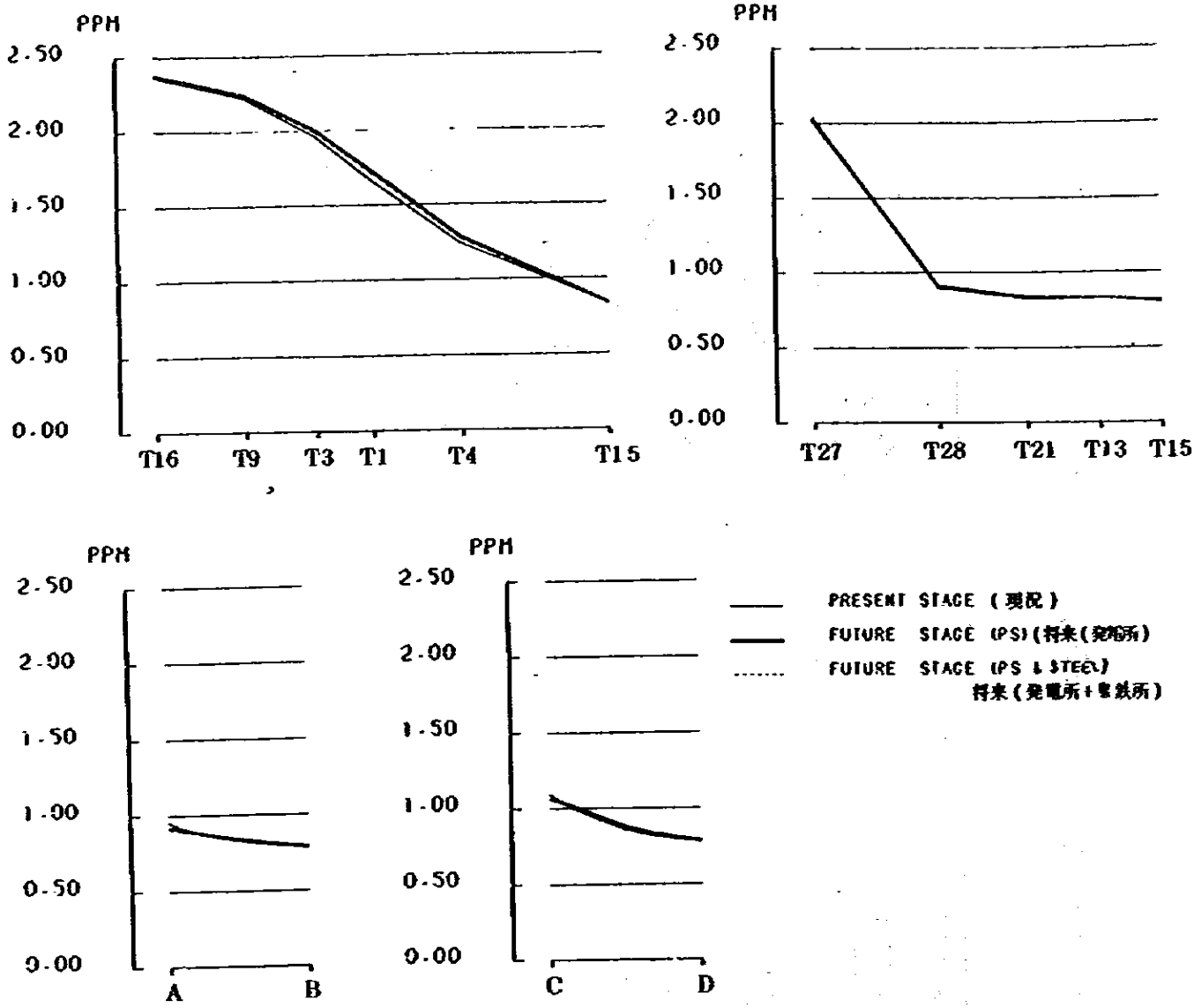
表Ⅲ　6－11　COD濃度の比較（現況と将来）

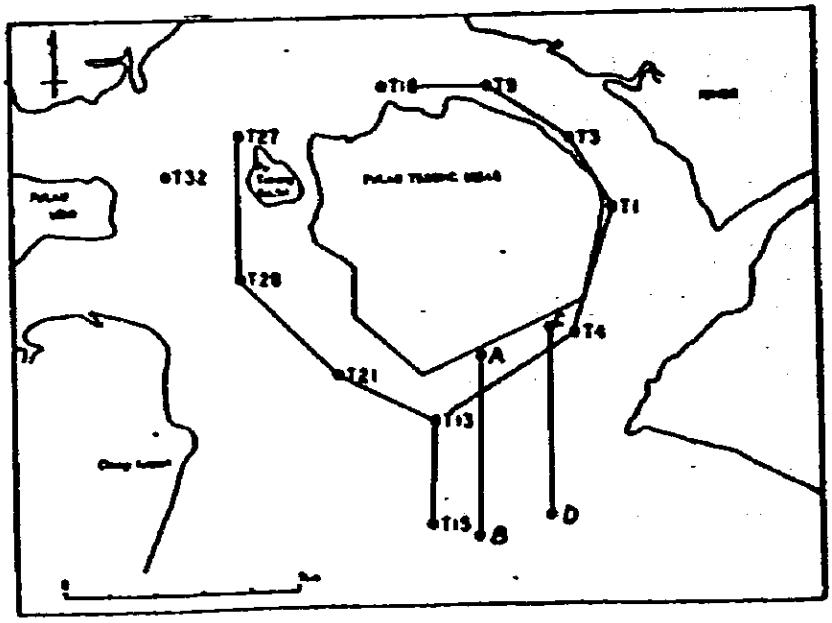
(UNIT : PPM)

POINT	PRESENT STAGE（現況）	FUTURE STAGE（将来） P.S.	FUTURE STAGE（将来） P.S. & ST.MIL
T 1	1.662	1.722	1.711
T 3	1.963	1.997	1.987
T 4	1.239	1.272	1.265
T 9	2.219	2.235	2.230
T 13	0.831	0.829	0.826
T 15	0.795	0.798	0.798
T 16	2.363	2.370	2.370
T 21	0.838	0.822	0.820
T 27	2.021	2.022	2.028
T 28	0.910	0.893	0.892
T 32	1.518	1.514	1.519
A	2.738	2.739	2.739
B	2.685	2.686	2.687
C	2.484	2.487	2.490
D	1.089	1.063	1.056
E	0.933	0.894	0.885
F	0.948	0.942	0.938
G	0.792	0.798	0.800
H	0.790	0.786	0.785
I	0.831	0.819	0.816
J	1.640	1.637	1.643
K	1.102	1.091	1.092
L	1.102	1.091	1.092
M	1.620	1.617	1.622
N	1.113	1.102	1.104

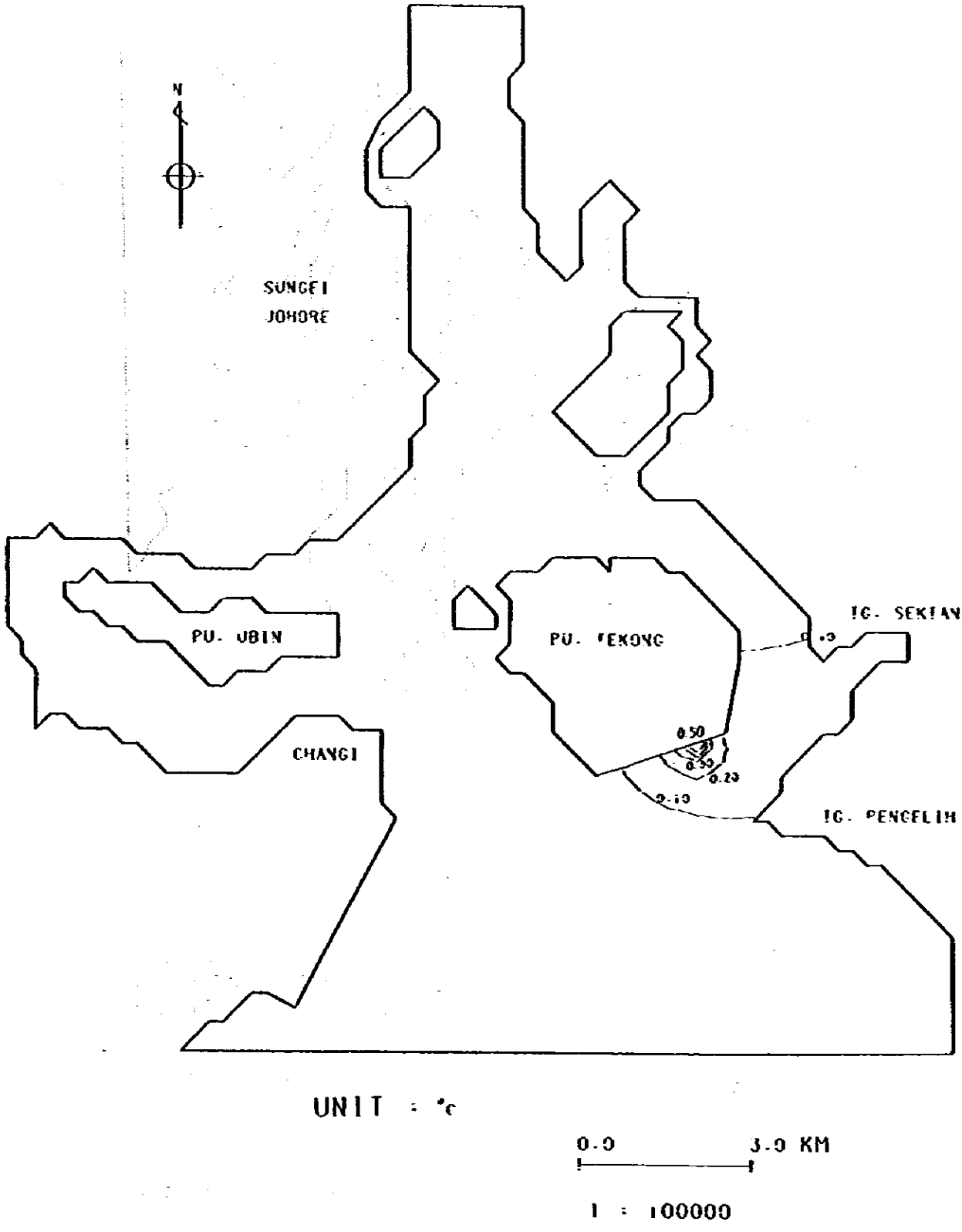


P.S. ：発電所　P.S. & ST. MIL：発電所＋製鉄所





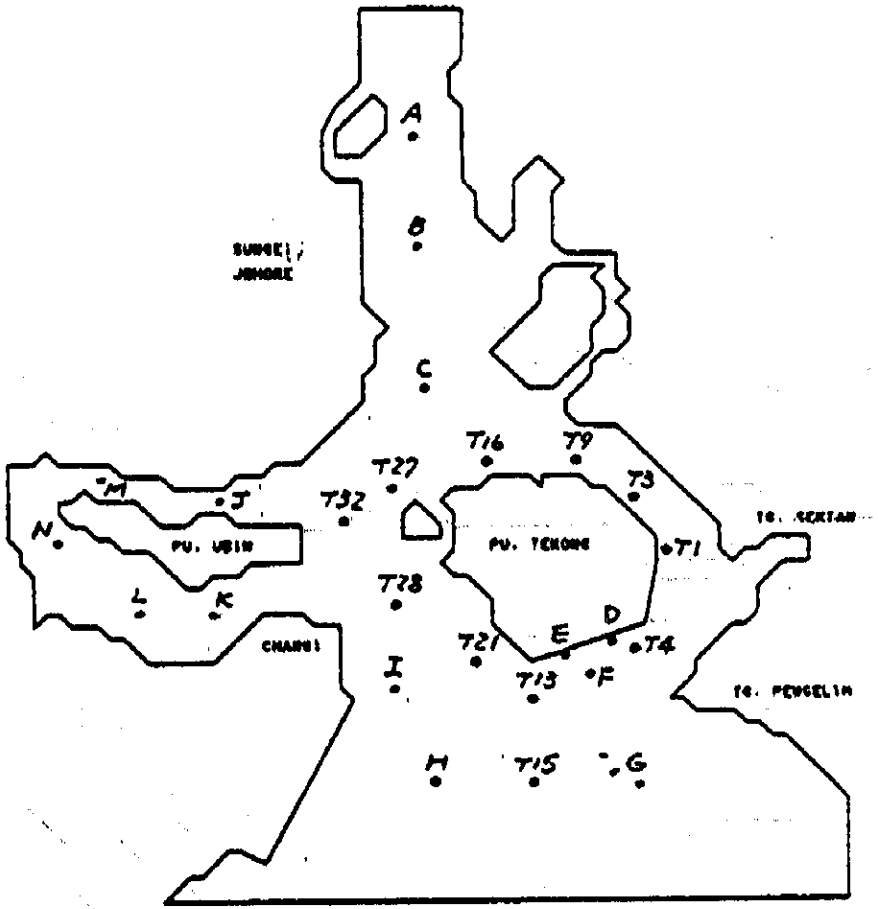
図表　6－35　代表断面でのCOD濃度(現況と将来)



図■ 6－36 上昇水温の平面分布・将来

表Ⅲ　6－12　代表点での上昇水温

POINT	:	T (°C)
T 1	:	0.098
T 3	:	0.062
T 4	:	0.169
T 9	:	0.033
T 13	:	0.042
T 15	:	0.024
T 16	:	0.015
T 21	:	0.035
T 27	:	0.014
T 28	:	0.030
T 32	:	0.021
A	:	0.000
B	:	0.002
C	:	0.006
D	:	0.281
E	:	0.098
F	:	0.127
G	:	0.022
H	:	0.018
I	:	0.029
J	:	0.019
K	:	0.026
L	:	0.026
M	:	0.018
N	:	0.026



ANNEX

SCOPE OF WORK

FOR

THE STUDY OF ENVIRONMENTAL EFFECTS

OF COAL FIRING POWER STATIONS

AND INTEGRATED STEEL MILL

DECEMBER 1980

This Scope of Work is agreed by the following two authorities concerned;

The Jurong Town Corporation,
Government of the Republic of Singapore.

Japan International Cooperation Agency,
the Official Agency responsible for the implementation
of technical cooperation programmes of
the Government of Japan.

To confirm the aforementioned, the Scope of Work is herewith attached and signed by the responsible personnel of the said authorities concerned.

Date: 19th December 1980
Issued at: Singapore

For the Jurong Town Corporation,
Government of the Republic of
Singapore.

YING YOK HANG
PRINCIPAL DIRECTOR (TECHNICAL)
JURONG TOWN CORPORATION
GOVERNMENT OF THE REPUBLIC OF
SINGAPORE

For Japan International
Cooperation Agency,
the Government of Japan.

菊島一郎

ICHIRO KIKUSHIMA
LEADER OF THE JAPANESE
PRELIMINARY SURVEY TEAM
DEPUTY DIRECTOR
ENVIRONMENTAL PROTECTION GUIDANCE
DIVISION
INDUSTRIAL LOCATION & ENVIRONMENTAL
PROTECTION BUREAU
MINISTRY OF INTERNATIONAL TRADE AND
INDUSTRY

IN THE PRESENCE OF:-

LIM SAK LAN
SENIOR DIRECTOR, ENGINEERING
JURONG TOWN CORPORATION

御手洗章弘

AKIHIRO MITARI
HEAD, INDUSTRY DIVISION
MINING & INDUSTRIAL PLANNING
AND SURVEY DEPARTMENT
JAPAN INTERNATIONAL COOPERATION
AGENCY

1. Introduction

In response to the request of the Government of the Republic of Singapore, the Government of Japan has agreed to extend the technical assistance to conduct the study on the environmental effects of coal firing power stations and the integrated steel mill which will be sited in the new industrial estates of the Republic of Singapore, which assistance is given in accordance with the laws and regulations in force in Japan.

The study will be carried out through The Japan International Cooperation Agency (hereinafter referred to as JICA), which is the official agency responsible for the implementation of technical cooperation programmes of the Government of Japan, in close cooperation with the Government of the Republic of Singapore and authorities concerned.

2. Objectives

The objectives of the study are:-

(1) To conduct the field survey in terms of air and water qualities within and at surrounding areas of Pulau Seraya, Jurong, Pulau Tekong, where the proposed coal firing power stations and the integrated steel mill are to be sited.

(2) To conduct the simulation study by computers based on the data obtained from the above said field survey and to assess the estimated pollution loads when these plants are in operation.

3. Scope of the study

3-1 Survey Areas

(A) Pulau Seraya, the proposed site of the coal firing power station and its surrounding areas.

(B) Pulau Tekong, the proposed site of the coal firing power stetion and the integrated steel mill, and its surrounding areas.

(C) Other areas mutually agreed to be surveyed.

3-2 Survey Plan

(A) Air Quality Survey

i) Long Term Measurement

a) Sulphur dioxide (SO_2) concentration

b) Wind directions and velocity at ground surface

c) Net radiation

d) Temperature

Notes: Period of measurement - 1 year

ii) Short Term Measurement

a) Vertical profile of wind directions and velocity

Notes: Period of measurement - two days each at two stations.

iii) Simulation - Simulation of sulfur dioxide (SO_2)

(B) Water Quality Survey

i) Measurement

a) Current directions and velocity

b) Chemical Oxygen Demand (COD)

c) Water temperature and salinity

Notes: Period of measurement - 2 weeks per measuring point for the above (a), once per measuring point for the above (b) and (c), and 1.5 months in total including preparation works.

ii) Simulation - Simulation of COD and temperature

4. Time Schedule

As shown in ANNEX I (Subject to change)

5. Report

5-1 Interim Report

i) 30 copies

ii) The interim report will be submitted in English to the Government of the Republic of Singapore within 5 months after the completion of the simulation for water quality survey.

iii) The interim report will contain the results of the water quality survey and refer to the progress of air quality survey.

iv) The Government of the Republic of Singapore will provide the comments to JICA through the Embassy of Japan within 1 month after receipt of the interim report.

5-2 Draft Final Report

i) 30 copies

ii) The draft final report will be submitted in English within 4 months after the completion of the simulation for air quality survey.

iii) The Government of the Republic of Singapore will provide the comments to JICA through the Embassy of Japan within 1 month after receipt of the draft final report.

5-3 Final Report

i) 50 copies together with 50 copies of abstracts.

ii) The final report will be submitted in English within 2 months after receipt of the comments of the draft final report.

6. Contribution of the Government of the Republic of Singapore

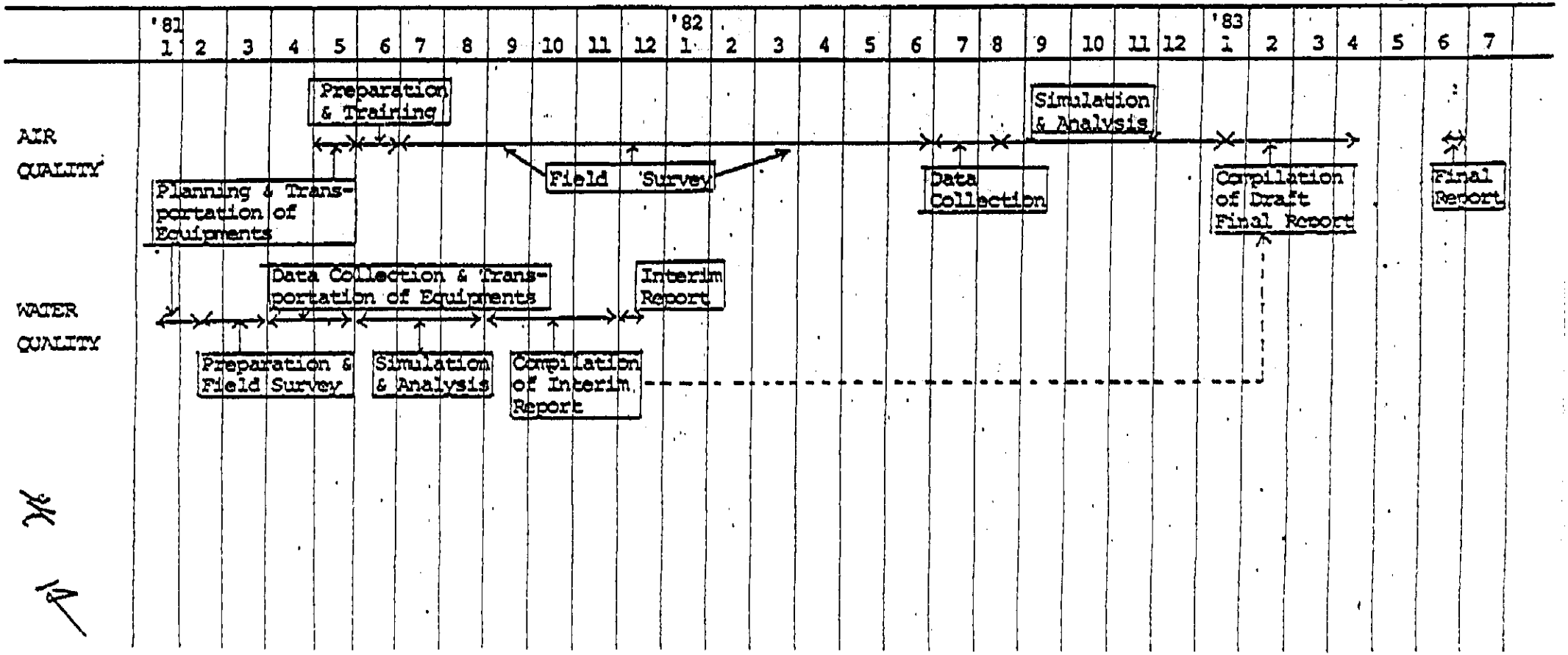
1. The Government of the Republic of Singapore will assign a qualified counterpart to be responsible for liaison and cooperation with the team conducting the survey. (hereinafter referred to as Survey Team)
2. The Government of the Republic of Singapore will provide the Survey Team with the necessary and available information and data.
3. The Government of the Republic of Singapore will make arrangements for the Survey Team to visit the authorities concerned.
4. The Government of the Republic of Singapore will provide the Survey Team with an office, sites for monitoring stations, laboratory testing facilities, storage space, temporary site office, transportation and boats as are necessary for the survey (ANNEX II)
5. The Government of the Republic of Singapore will exempt the Survey Team from taxes and duties on machinery, equipments and materials brought in Singapore by the Survey Team.
6. The Government of the Republic of Singapore will exempt the members of the Survey Team from any tax, including import and export duties imposed on the members' personal effects.
7. The Government of the Republic of Singapore will make an effort to ensure the securities of machinery, equipments and materials brought in Singapore by the Survey Team.

7. Contribution of the Government of Japan

1. The Government of Japan, through JICA, will provide a Survey Team who will conduct the field survey and simulation according to the Time Schedule (ANNEX I)
2. The Government of Japan will conduct during the stay of the Survey Team in the Republic of Singapore the training course for the Singapore counterparts to further their skills in operating and maintaining the necessary measuring machinery and equipments for the period of the field survey.

ANNEX I

TIME SCHEDULE FOR THE STUDY OF ENVIRONMENTAL EFFECTS OF COAL FIRING POWER STATION AND INTEGRATED STEEL MILL IN THE REPUBLIC OF SINGAPORE



The Detailed Information on Provision of Facilities by the Government of The Republic of Singapore

[1] Air Quality Survey

1. Monitoring Stations
   About 7 monitoring stations are to be established in the surrounding areas of the proposed sites. The land or places for these monitoring stations should be provided.
2. Electricity Supply
   The electricity connection and supply for monitoring stations at mutually agreed sites should be provided by the Government of the Republic of Singapore.
3. The Facilities to Accomodate the Chemical Reagents
   The facilities for storage, preparation of chemical reagents and distilled water should be provided at Jurong Town Corporation's Laboratory or National University of Singapore's Laboratory.
4. The Government of the Republic of Singapore will provide necessary personnel for the daily operation and maintenance of the monitoring stations.

[2] Water Quality Survey

1. The Laboratory Testing Facilities for Chemical Analysis
   The laboratory testing facilities for chemical analysis of aqueous samples shall be provided at Jurong Town Corporation's Laboratory or National University of Singapore's Laboratory.
2. The Storage Space for the Measuring Equipments and Materials
   The storage space to be provided for the measuring equipments and materials shall be big enough for opening of the packages and adjusting the equipments.
3. The Small Boats for Survey
   The Survey Team will require 3 small boats for about 20 days in total. The Government of the Republic of Singapore will provide the Survey Team with such number of boats as are necessary for the survey.

9/C

[3] Handling of Measuring Equipments

All the measuring equipments necessary to conduct the field survey will be, in principle, brought in and out by the Survey Team. The Government of the Republic of Singapore is requested to provide facilities and arrangement on the followings:-

(a) Custom clearance including loading and unloading

(b) Inland transportation

(c) Packing and unpacking

MINUTES OF MEETINGS

FOR

THE STUDY OF ENVIRONMENTAL EFFECTS

OF COAL FIRING POWER STATIONS

AND INTEGRATED STEEL MILL

DECEMBER 1980

MINUTES OF MEETINGS

FOR

THE STUDY OF ENVIRONMENTAL EFFECTS

OF COAL FIRING POWER STATIONS

AND INTEGRATED STEEL MILL

19TH DECEMBER 1980

CONFIRMED BY:

YING YOK HANG
PRINCIPAL DIRECTOR (TECHNICAL)
JURONG TOWN CORPORATION
GOVERNMENT OF THE REPUBLIC OF
SINGAPORE

菊島一郎

ICHIRO KIKUSHIMA
LEADER OF THE JAPANESE
PRELIMINARY SURVEY TEAM
DEPUTY DIRECTOR
ENVIRONMENTAL PROTECTION
GUIDANCE DIVISION
INDUSTRIAL LOCATION & ENVIRONMENTAL
PROTECTION BUREAU
MINISTRY OF INTERNATIONAL TRADE AND
INDUSTRY

MINUTES OF MEETINGS

The Japanese Preliminary Survey Team and the Singapore Counterpart had discussion on the Environment Effects of the Coal Firing Power Stations and Integrated Steel Mill and the following were mutually agreed upon.

Data of the Proposed Coal Firing Power Stations and the Integrated Steel Mill

(A) Coal Firing Power Station

i) The Japanese side requested for information on the proposed coal firing power station.

ii) After discussion with the Singapore side which included P.U.B., the assumptions given in Appendix A were agreed upon.

iii) It was indicated that one coal firing power station will be on Pulau Seraya and one on Pulau Tekong. (See Appendix D)

(B) Integrated Steel Mill

i) The Singapore side indicated that the proposed steel mill will use about eight million tons of iron ore per year and producing about one million tons of steel product by the direct reduction process using coal.

ii) The Japanese side requested for technical information similar to those in Appendix A.

iii) The Singapore side replied that it is not in a position to provide, except that the location will be in Pulau Tekong (See Appendix D). However, it will try to obtain the information requested by the Japanese side at the earliest possible date.

iv) It was mutually agreed that this matter will be further discussed and resolved when the next water quality survey team visits Singapore.

(C) Data on Emission Sources (Present & Future 1990)

(a) Air Quality

i) The Japanese side requested for emission data both present and future and suggested that if such data is not available then a survey be carried out to obtain the same.

ii) The Singapore side agreed to carry out such survey.

iii) The Japanese side indicated that these data should be made available by June 1982.

iv) The Singapore side agreed to the above.

(b) Water Quality

i) The Japanese side requested for effluent data present and future including industries located on the southern islands and suggested if such data is not available then a survey be carried out to obtain the same.

ii) The Singapore side agreed to carry out such survey.

iii) The Japanese side indicated that these data should be made available by May 1981.

iv) The Singapore side agreed to the above.

(c) Malaysian Development Plan (North of Straits of Johore)

i) The Japanese side requested information regarding industrial development plan immediately north of the Straits of Johore.

ii) The Singapore side replied that it is not in a position to do so.

iii) It was mutually agreed that effects of the Malaysian developments shall not be considered.

(D) Monitoring Points

Based on survey carried out by Japanese Preliminary Survey Team, the following monitoring points were agreed upon.

(a) Air Quality

i) SO_2, wind direction, wind velocity - 7 points

ii) Net radiation - 1 point

iii) Vertical distribution of temperature - 1 point

iv) Pilot balloon observation - 2 points

(b) Water Quality

i) Current direction, current velocity - 10 points (around the two proposed sites

ii) Water temperature, salinity, COD observation. - 30 points (around the two proposed sites

(c) Clearance from Competent Authorities

The Singapore side will arrange and obtain necessary clearance from the competent authorities to conduct the above surveys.

(E) Simulation Methods

i) The Japanese side stated that for SO_2 diffusion calculation, Plume Puff model will be adopted and predict a yearly concentration of SO_2.

ii) As for water temperature and COD diffusion calculation, FEM (Finite Element Method) will be adopted.

iii) The Singapore side agreed to the above methods.

(F) Evaluation on the Environmental Effects and Impacts

i) The Japanese side enquired about the environmental ambient standards of SO_2 and COD.

ii) The Singapore side replied that it has only the emission standard but not the ambient standard.

iii) The Japanese side stated that it will predict the levels of SO_2 and COD from the coal firing power stations and integrated steel mill.

iv) The Japanese side stated that it will also be able to predict the total levels of SO_2 and COD in the year 1990 if adequate datas on the emission are collected from the survey referred in para C.

v) It was mutually agreed that if no ambient standard is indicated by the Singapore side, the Japanese side will not be in a position to comment on the levels of SO_2 and COD and in any case further evaluation will have to be carried by the Singapore side.

(G) Maintenance of monitoring stations

i) The Japanese side requested the Singapore side to provide the necessary personnel for the daily operation and maintenance of the monitoring stations as indicated in Appendix 'B'.

ii) Singapore side agreed to provide the personnel required.

(H) Survey Schedule

i) The Japanese side mentioned that the schedule may need to be altered. Such alteration will be mutually discussed and agreed upon.

ii) The Singapore side agreed to the above.

5(I) Contributions

i) The Japanese side requested that land and sea transport for future survey team and equipments and their local counterparts be provided in accordance with schedule in Appendix 'C'.

ii) The Singapore side agreed to provide the same.

iii) At the commencement of the survey, the Japanese side will arrange for all the equipments to be delivered to Jurong Town Hall. The Singapore side will arrange for the transportation of the equipments from the Jurong Town Hall to the various monitoring stations and will be responsible for the setting up of the stations.

iv) On completion of survey, the Singapore side will arrange for transportation of all equipments from the monitoring stations back to Jurong Town Hall and the Japanese side will arrange to collect the same from Jurong Town Hall.

(J) Datas/Reports

i) The Singapore side requested that information supplied to the Japanese side shall be treated as confidential materials. Similarly the results and report of the study are to be treated also as confidential.

ii) The Japanese side agreed to the above.

APPENDIX A

Assumption on Coal Firing Power Station

Generated Output	350 MW x 2
Fuel	Coal Calorific Value 7,000 Kcal/kg Sulpher 1% (wt%) Consumption 154 x 10^4 t/year (operation rate 70%)
Stack	Gas Volume 182 x 10^4 Nm^3/h Gas Temperature 150°C (without desulfurization of flue gas) Gas Discharge Velocity 30 m/s Height 200m
Cooling Sea Water	Amount 29.4 m^3/s Temperature difference 7°C
Effulent	Volume 1,200 m^3/d COD 160 mg/l

NOTE:
The sites of stacks and outlets are as shown in Appendix D

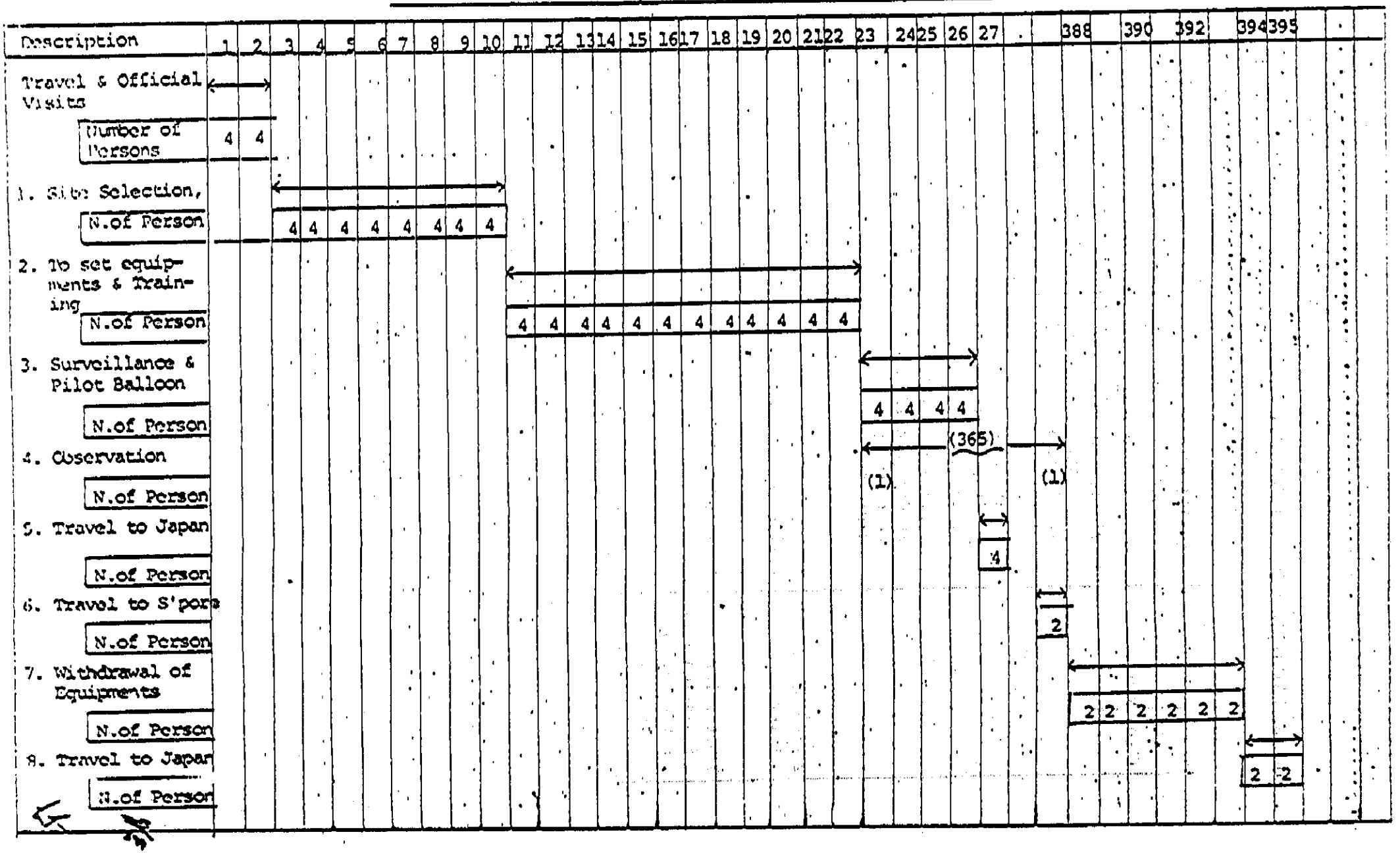
APPENDIX B

ON THE MAINTENANCE OF MONITORING STATIONS

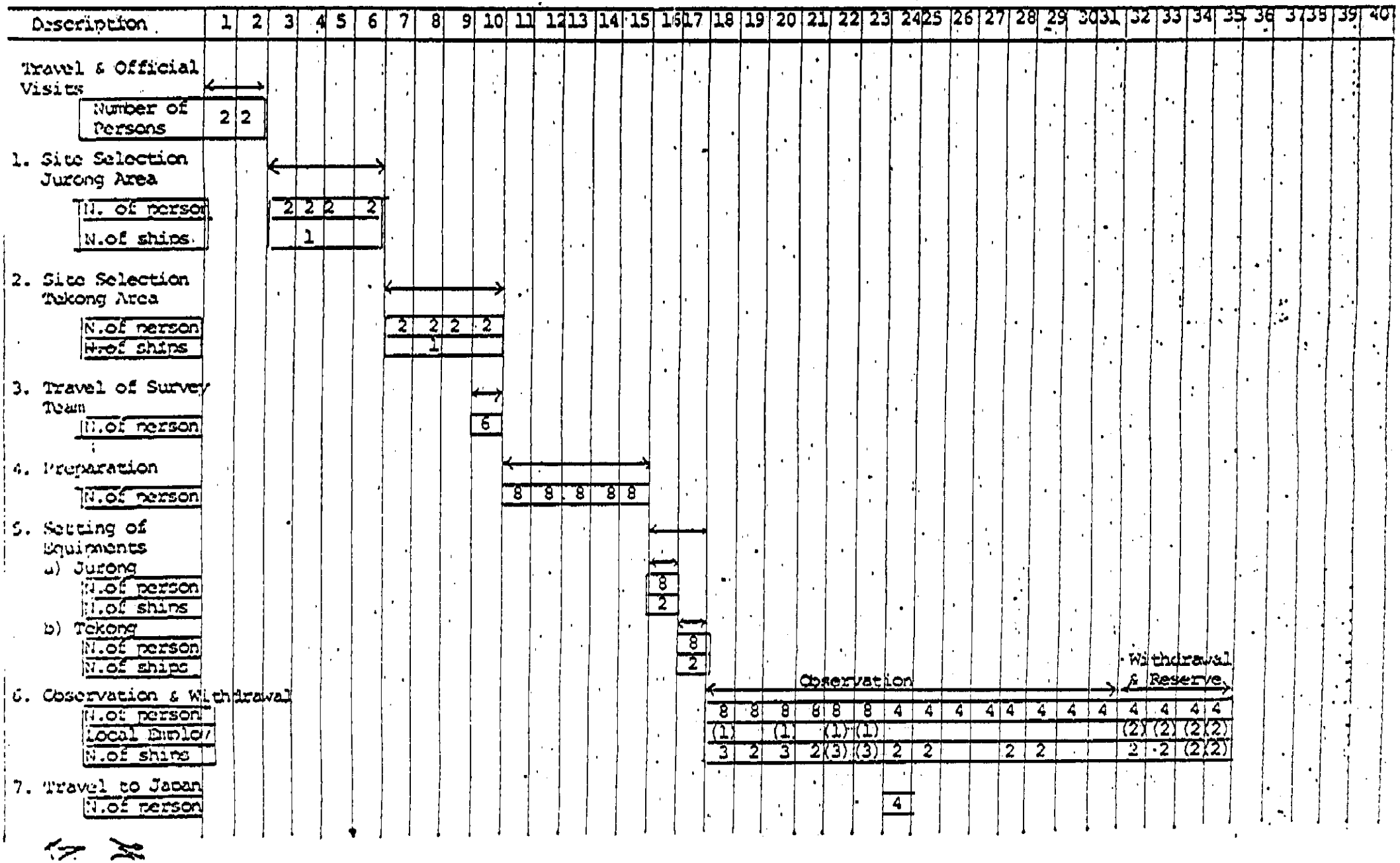
	Qualified Persons	Regular Persons
1 SO_2 Monitor	Once every 20 days:- a Absorption solution and chart sheet, ink should be refilled or replaced b Calibration of monitor should be conducted c Chart data for last 20 days should be sent to Japan through JICA, Singapore	Once per everyday he should check the monitoring station whether it is operating properly without any trouble or not
2 Wind Speed Meter	Same as above but no calibration required	Same as above
3 Net Solar Radiation Flux Meter and Air Thermometer	Same as No (2) above	Same as No (1) and (2) above

APPENDIX C

TIME SCHEDULE FOR FIELD SURVEY IN SINGAPORE (AIR QUALITY)



TENTATIVE TIME SCHEDULE FOR FIELD SURVEY IN SINGAPORE (WATER QUALITY)



TENTATIVE TIME SCHEDULE FOR FIELD SURVEY IN SINGAPORE (WATER QUALITY)

Description	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
8. Packing of Equipments																																				4	4	4	4	
N.of person																																								
9. Travel to Japan																																								4
N.of person																																								

MINUTES OF MEETINGS

FOR

THE STUDY OF ENVIRONMENTAL EFFECTS

OF COAL FIRING POWER STATIONS

AND INTEGRATED STEEL MILL

FEBRUARY 1981

MINUTES OF MEETINGS

FOR

THE STUDY OF ENVIRONMENTAL EFFECTS

OF COAL FIRING POWER STATIONS

AND INTEGRATED STEEL MILL

21ST FEBRUARY 1981

Confirmed by:

YING YOK HANG
PRINCIPAL DIRECTOR (TECHNICAL)
JURONG TOWN CORPORATION
GOVERNMENT OF THE REPULIC OF SINGAPORE

友田正敏

MASATOSHI TOMODA
ENVIRONMENTAL PROTECTION GUIDANCE DIVISION
INDUSTRIAL LOCATION & ENVIRONMENTAL PROTECTION BUREAU
MINISTRY OF INTERNATIONAL TRADE AND INDUSTRY
FOR JAPAN INTERNATIONAL COOPERATION AGENCY

Minutes of Meeting

The Japanese Survey Team and the Singapore Counterpart had discussion on the Environmental Effect of the Coal Firing Power Stations and Integrated Steel Mill and the following were mutually agreed upon.

Data of the Proposed Coal Firing Power Stations and the Integrated Steel Mill

(A) Coal Firing Power Station

(i) The Japanese Side worked out a revised set of assumptions on the proposed coal firing power stations.

(ii) After discussion with the Singapore Side which included the P.U.B., the assumptions given in Appendix 'A' were agreed upon.

(iii) These assumptions will supercede those contained in Appendix 'A' of Minutes of Meetings dated 19th December 1980.

(B) Intergrated Steel Mill

(i) The Japanese Side showed a set of draft assumptions on the proposed integrated steel mill, studied and calculated based on the data provided by the Singapore side.

(ii) After discussion with the Singapore Side, which included E.D.B., the assumptions given in Appendix 'B' were agreed upon.

(iii) These assumptions will be adopted for the purpose of the study.

(iv) The location of the stacks and effluent points are as indicated on the plan (Appendix 'C') attached.

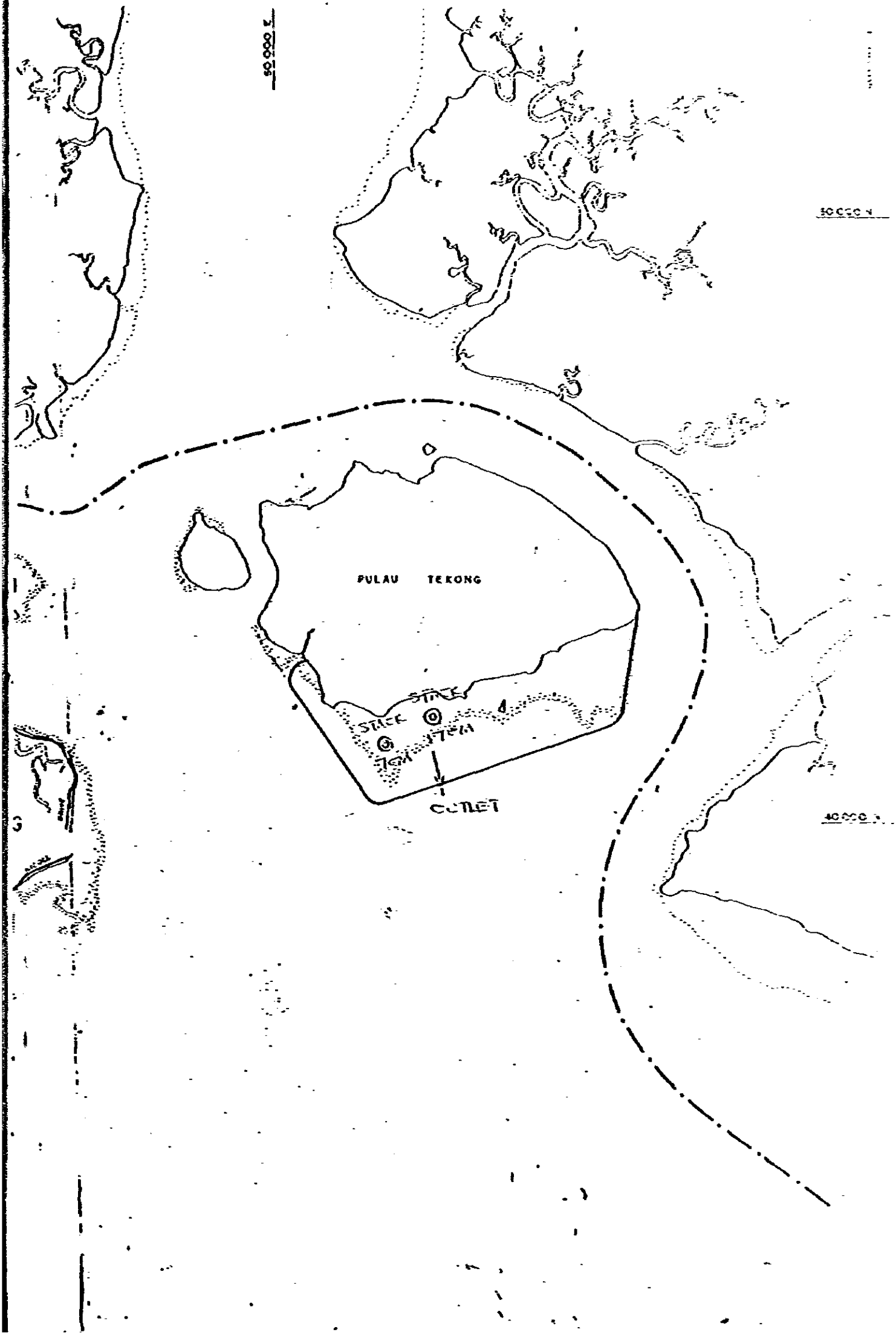
eeeee

Assumption on Coal Firing Power Stations

Location	P. Seraya	P. Tekong
General Capacity	750 MW (250 MW x 3)	700 MW (350 MW x 2)
Fuel Calorific value Sulfur Consumption	Coal 27 MJ/kg 1% (wt) 1.7 Mt/year	Coal 27 MJ/kg 1% (wt) 1.6 Mt/year
Stack Height Gas Temperature Gas Volume Gas Discharge Velocity	183 m 150°c 2,650,000 Nm^3/h 25 m/s (without flue gas desulfurization)	183 m 150 °c 2,470,000 Nm^3/h 25 m/s (without flue gas desulfurization)
Cooling Sea Water Volume Temperature Difference	110,000 m^3/h 8.3°c	100,000 m^3/h 8.3°c
Effluent Volume (COD) Mn	1,500 m^3/d 50 mg/l	1,500 m^3/d 50 mg/l
	(Boiler air heater washing effluent, after neutralisation & mixing with water treatment plant effluent)	

Assumption on Integrated Steel Mill

Location	Pulau Tekong
Production Process	Grate Kiln and Electric Arc Furnace Steelmaking
Ore Feed	Lump Ore (Fe 62.6%, S 0.018%) 800 x 10^4t/year
Product	Bar and Wire Rod 100 x 10^4t/year Balance (reduced iron) for Export
Reductant	Coal (S 1%wt) Calorific Value 30 MJ/kg Consumption 336 x 10^4t/year (Operation rate 83%)
Fuel	Heavy Oil (S 3%wt) Consumption 431 x 10^3kl/year(Grate Kiln) 357 x 10^2kl/year(Reheating Furnace)
Stack	Grate Kiln Process Gas Volume 5 x 10^6 Nm^3/h Gas Temperature 100°c (without desulfurization of flue gas) SO_2 Volume 3,500 Nm^3/h Gas Discharge Velocity 30 m/s Height 170 m Reheating Furnace Gas Volume 6.3 x 10^4 Nm^3/h Gas Temperature 500°c SO_2 Volume 100 Nm^3/h Gas Discharge Velocity 30 m/s Height 70 m
Effluent	Volume 9,300 m^3/day (10% of total used water) (COD) Mn 7 ppm


50 000 E
50 000 N
PULAU TEKONG
STILT
STILT
STILT
OUTLET
40 000 N

THE STUDY OF ENVIRONMENTAL EFFECTS OF COAL FIRING POWER STATIONS AND INTEGRATED STEEL MILL

MINUTES OF MEETING OF THE PRESENTATION OF DRAFT REPORT VOLUME 1 - WATER QUALITY

FEBRUARY 1982

MINUTES OF MEETING

The Japanese study team for the Water Quality Survey of the Study of Environmental Effects of Coal Firing Power Stations and Integrated Steel Mill in the Republic of Singapore (Hereinafter referred to as "The Team"), sent by the Japan International Cooperation Agency (Hereinafter referred to as "JICA"), presented to the Singapore authorities a report entitled "DRAFT REPORT ON ENVIRONMENTAL EFFECTS OF COAL FIRING POWER STATIONS AND INTEGRATED STEEL MILL IN THE REPUBLIC OF SINGAPORE VOLUME 1 - WATER QUALITY".

The following is a summary of the meetings and discussions:

1 Schedule of Meetings and Participants

The schedule of meetings and participants are listed in Annexes 1 & 2.

2 Presentation of the Draft Report

2.1 The Team presented the Draft Report which has been prepared based on the objectives, the scope of work, and information described in the following record of discussions:

- Scope of Work dated 19 December 1980
- Minutes of Meeting dated 21 February 1981

The presentation was made by highlighting the features of the study and results.

2.2 The Singapore authorities and the Team exchanged views on the Draft Report.

1 The Singapore authorities expressed satisfaction and appreciation for the dedication, efforts and hard work put in to complete the study.

2 A preliminary review of the Draft Report indicates that the contents of the Report are objective.

4 The Singapore authorities expressed the intention of making questions in order to clarify the contents of the Draft Report, if necessary

- The Team replied to the Singapore authorities that such questions should be made to JICA's office in Singapore by 28 February 1982. The answers will be made in written form outside the final report.

3 Final Report of Volume 1 - Water Quality

The Draft Report of Volume 1 - Water Quality will be considered as final.

The Final Report of Volume 1 - Water Quality will be submitted to the Singapore authorities by the end of April 1982.

YING YOK HANG
PRINCIPAL DIRECTOR (TECHNICAL)
JURONG TOWN CORPORATION
FOR GOVERNMENT OF REPUBLIC OF SINGAPORE

鈴木洋一

YOICHI SUZUKI
LEADER OF THE JAPANESE
WATER QUALITY SURVEY TEAM
FOR JAPAN INTERNATIONAL
CO-OPERATION AGENCY

Id 5300a

ENVIRONMENTAL STUDY
WATER QUALITY SURVEY

Presentation of Draft Report

Venue: VIP Lounge, Jurong Town Hall, Singapore

Time: 9.00 am - 10.00 am

Date: 4 February 1982

Member Lists

Japanese Report Team

Mr Yoichi Suzuki	-	IPCAJ, Leader, Water Quality Survey Team
Mr Kihachi Inagaki	-	IPCAJ, Co-ordinator
Mr Kisaburo Nakata	-	MITI
Mr Masaya Konno	-	MITI

Singapore Counterpart (JTC)

Mr Tang I Fang	-	Chairman
Mr Francis Mak	-	General Manager
Mr Ying Yok Hang	-	Principal Director (Technical)
Mr Lim Sak Lan	-	Senior Director (SME)
Mr Tan Suan Yong	-	Senior Principal Civil Engineer
Mr Hee Ah Mui	-	Senior Civil Engineer

ENVIRONMENTAL STUDY
WATER QUALITY SURVEY

Technical Session for The Discussion on
The Draft Water Quality Survey Report

Venue: Jurong Town Hall, Singapore

Time: 9.30 am - 12.00 noon

Date: 5 February 1982

Member Lists

Japanese Report Team

Mr Yoichi Suzuki	-	IPCAJ, Leader, Water Quality Survey Team
Mr Kihachi Inagaki	-	IPCAJ, Co-ordinator
Mr Kisaburo Nakata	-	MITI
Mr Masaya Konno	-	MITI

Japanese Embassy

Mr Tokio Katayama	-	1st Secretary, Commercial Attache

Singapore Team

Mr Liu Sak Lan	-	Jurong Town Corporation
Mr Tan Suan Yong	-	Jurong Town Corporation
Mr Hee Ah Hui	-	Jurong Town Corporation
Mr Ng Hwee Choon	-	Jurong Town Corporation
Mr Chiang Kok Meng	-	Ministry of the Environment
Mr Foong Chee Leong	-	Ministry of the Environment
Mr Jasbir Singh	-	Port of Singapore Authority
Mr Yang Keng Nua	-	Port of Singapore Authority
Mr Wong Seng Chee	-	Port of Singapore Authority
Mr Joseph Hui	-	Anti-Pollution Unit
Dr Tay Joo Hwa	-	National University of Singapore
Dr Ng Wun Jern	-	National University of Singapore