Report of the Technical Cooperation of Construction Equipment in Kanchanaburi Equipment Training Center, Department of Highways. Gorvernment of Thailand

June. 1984

Japanes Expert of Japan International

Cooperation Agency (JICA)

Jinichi YAMADA

June 15th 1984

Mr.MANUS KORWANICH
Director General
Department of Highways
Menistry of Commumcation
Kingdom of Thailand

Dear Mr.MANUS:

I have the pleasure in presenting the Repert of the Technical Cooperation for Construction Equipment in Kanchanaburi Equipment Training Center, Department of Highways, Government of Thailand.

This report contens subjects in relation to construction equipment which should be studied and scrutinized more intensly plus the executive summary of its utility in the past two years.

While in Kanchanaburi Equipment Training Center for two years, I have had several useful experiences which were rather difficult to obtain in my native country Japan. When I get back to Japan, I shall make good use of this experience which you have selflessly extended to me. I am deeply grateful to you and your staff for all the assistance and cooperation in this our mutually beneficial efforts.

I wish, you and the Department of Highways, also the Kanchanaburi Equipment Training Center, all the luck and prosperity in the years to come.

Sincerely Yours,

Jinichi Yamada

Jinichi YAMADA

Japanese Expert
Japan International
Cooperation Agency

INTRODUCTION

We four Japanese mechanical Experts (Kazuo WATANABE, Hiroshi FUKUMOTO, Kazushige MUTOH, Jinichi YAMADA), were sent to Kanchanaburi Equipment Training Center, Department of Highways, Government of Thailand from Japan International Cooperation Agency (JICA) for alternately four years (1. July. 1980 to 21. June. 1984) for the primary purpose of intence the DUTIES OF CONSTRUCTION EQUIPMENTS.

All four US served in turns:

Mr. Kazuo WATANABE - 1. July 1980 to 30, June 1981

Mr. Hiroshi FUKUMOTO } 1. July 1980 to 30. June 1982
Mr. Kazushige MUTOH }

Mr. Jinichi YAMADA - 22. June 1982 to 21. June 1984

My duties coverd organization and supervision of training program for Thai mechanical engineers and technicians in equipment maintenance and overhauling. (See reference)

I have executed below the systems and procedures for the proper management of equipment in cooperation with the CHIEF of Workshop and HIS ASSISTANTS.

Reference:

1. Background Information

The Department of Highways has established a Construction and Training Center in Kanchanaburi. Initially the purpose is to construct a highway between Kanchanaburi - Thongphaphum using equipment financed by OECF. The JICA has also supported by sending a team of 3 mechanical engineers to train Thai counterparts in equipment management and maintenance. The team of mechanical engineers will expire in June 1982. It is envisage that one mechanical engineer is still needed to fulfil the original plan.

2. Specification for the post.

(a) Post title

Mechanical Engineer (Heavy Equipment)

(b) Duties for which the expert will be responsible

These should preferably be listed, and it is inportant to give as much detail as possible.

He will organinze and supervise the training of Thai mechanical engineer and technicians in equipment maintenance and overhauling.

(c) Authority under whom expert will be responsible.

Department of Highways Thailand.

(d) Number of personel required.

One.

TABLE OF CONTENTS

Duties

DUTIES

1. DATA COLLECTION and ANALYSIS.

I have analyzed productinity repair cost and fuel consumption from actual data. It was difficult to collect actual data from daily record and monthly record because these data are not listed under individual equirpment. And this was not enough for analysis.

In order to analyse the above it is required rationally to collect data on construction equipment. Therefore I wrote these down (see attached appendix-1).

2. VALUATION OF OLD EQUIPMENT IN JAPAN.

Kanchanaburi Equipment Training Center was established to evaluate utility of old equipments but it was not a unified evaluation system.

In order to evaluate old equipment, D.O.H have set up evaluation system of old equipment suitable to the conditions of Thailand for future planning.

For reference, I have introduced evaluation system of old equipment from Ministry of Construction in JAPAN. (See attached appendix-2)

3. COSTING OF CONSTRUCTION WORK.

D.O.H have listed down the unit price of each kind or type of construction work, but, there are no details covering fuel comsumption, working days or working hour of equipment, equipment ownership cost, fleet of equipments, arrengement of operator etc.

For reference, refer to appendix-3 where I have delivered a lecture for Thai engineers in Kanchanaburi Equipment Training Center last year 1983.

4. BUDGING REPAIR-EXPENDITURES.

Budget of repair expenses has been estimated be means of percentage in construction cost in Kanchanaburi Equipment Training Center.

However, only the CIVIL ENGINEER can decide on the parcentage of repair expenses. The mechanical engineers can likewise recommend on these since they are also able to understand equipment use plan, equipment pause plan, equipment reinfoce plan, repair plan, equipment disposal plan, etc.

Therefor it is required to forecast next fiscal year's construction plan (earth volume, used equipment, construction period, condition of job site, etc, See attached appendix-4).

5. PROGRAMING PROCEDURE.

(See attached appendix-5)

6. HAND BOOK FOR MECHANICAL ENGINEER.

In order to manage equipment efficiency, D.O.H. published the hand book for Mechanical Engineer.

(Example of contens shows attached appendix-6)

7. THAI ENGINEERS HAVE RECEIVED THE TRAINNING

OF JICA IN JAPAN AS COUNTER PARTS OF JAPANE SE EXPART.

a. "Maintenance of construction machinery" course.
Mr. Thaveesak, Mechanical engineer (May to Aug 1983)

b. "Highway construction" course.
Mr. Somkual, Civil engineer (Sep to Nov 1983)

8. SUPPLY OF INSTRUMENTS AND GOODS TO Kanchanaburi Equipment Training Center.

(See attached appendix-7),

9. PREPARATION OF TEXT BOOKS.

These Text Books were made by Mr.Thaveesak, mechanical engineer and Mr.Peerapal, mechanical engineer, and were translated into Thai-language. (See attached text Books).

a. Selection of equipment for Road Construction Work.
(Section 1: Properties of Soil & Method for Selection of Equipment).

b. Procedure and Estimate of Equipment Management suggested by Japanese Expert.

c. Selection of Equipment for Road Construction Work.
(Section 2: Calculation of Operating Capacity and Equipment Fleet Design).

10. AUDIO-VISUAL EQUIPMENT.

Slides and video tapes were bought from Japan and movies borrowed from JETRO were shown by engineers of the Kanchanaburi Equipment Training Center for all the staff.

11. DIAGRAM SCHEDULE and PLANNING EQUIPMENT USE.

These introduce the Diagram Schedule and Planning equipment use for civil/mechanical engineer in Kanchanaburi Equipment Training Center's

future construction planning. (See attached appendix-8).

12. FUNDAMENTAL KNOWLEDGE OF MAINTENANCE.

(See attached appendix-9)

13. OTHERS

(See attached appendix-10)

I wish to thank Mr.Vicha, Project Director, Mr.Thaveesak, Chief of workshop, Mr.Peerapol, Mechanical Engineer, Mr.Weerawat, Mechanical Engineer and their staff who have assisted and cooperated with me in the performance of my duties.

Finally, I wish the Department of Highways and Kanchanaburi Equipment Center more prosperity in the future.

appendix-1

DATA COLLECTION and ANALYSIS

December 8, 1983.

Kanchanaburi Equipment Training Center

Jinichi YAMADA

For collecting data on equipment and analysis, DOH should fill in the Equipment's Record (Form-1) when purchasing some equipments, and, in order to collect data and analyze statistically, DOH has on hand individual equipments.

All operator of D.O.H. should write down the Daily Record (Form-2) for each kind of equipments every day.

And then D.O.H. should post to the Monthly Record (Form-3) from Daily Record every 10th of each month.

Average Fuel Comsumption, Production Rate and other items should be computed.

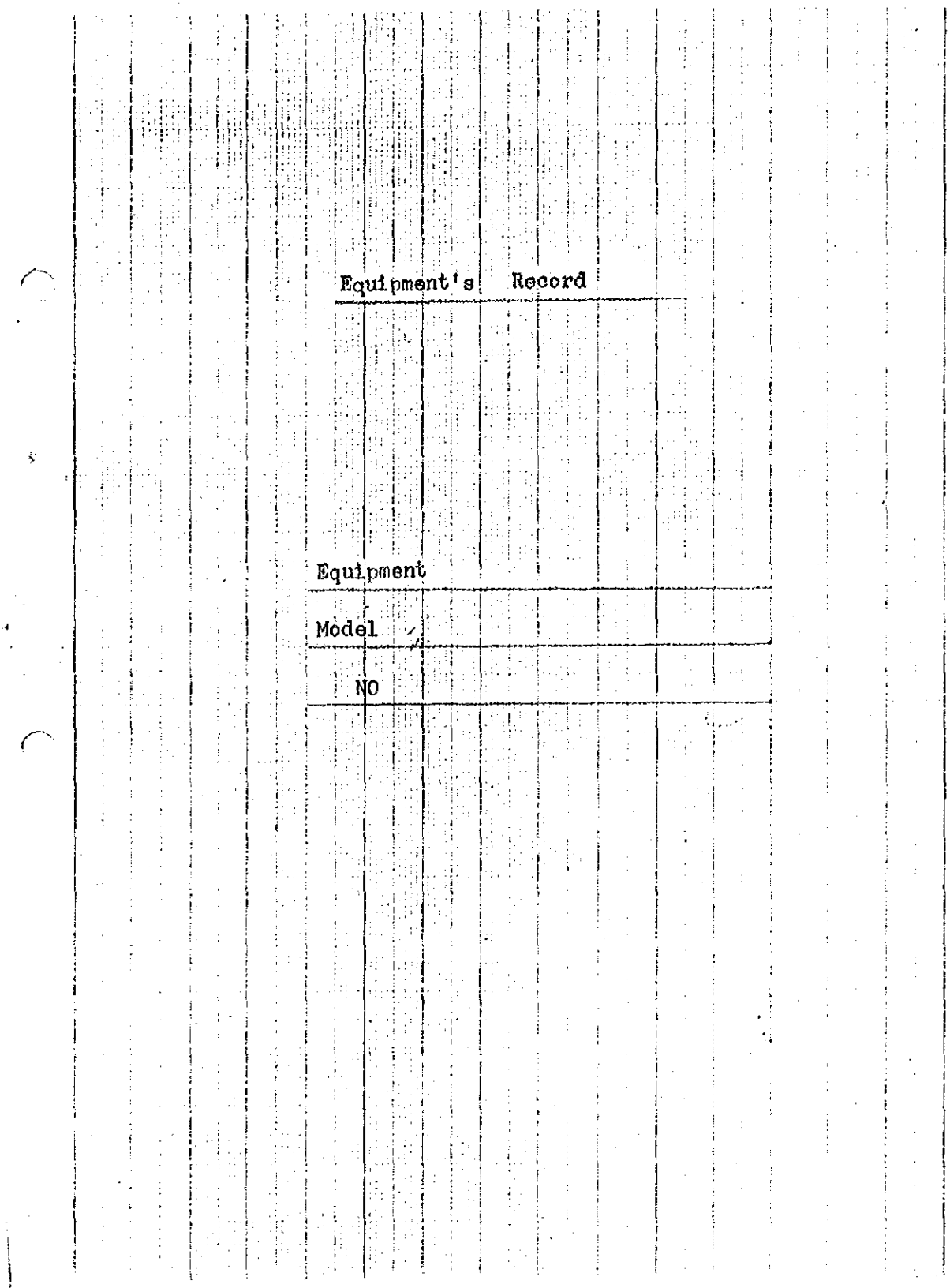
Also, post the Annual Working, Maintenance Record in the Equipment's Record (Form-1) from the Monthly Record within the 15 th of the ending month every new fiscal year and calculate Annual Average Operating Hour, Annual Operating Day and other items.

Then further check each data from the computed result of each item.

D.O.H. should collect all these data and analyze statistically Economic Lifetime, Average Fuel Comsumption, Average Annual Operating Hour, Repairing Cost/hour and other itemes till November in accordance with the Analysis System Flow Chart about Control of Equipment (Form-4).

D.O.H. should declare to each Equipment Center and other Divisions the results of the analysis statistically after due consideration.

D.O.H. should perform above-mentioned procces and system every year periodically.


Equipment's Record
Equipment
Model
NO

Equipments Record is very important for the proper management of equipments, planning of the maintenance procces, and decision for period of disposal and evaluation of old equipments. It is necessary to record data factually and accurately.

Points of Out Line:

1. To enter each items in detail as per equipment epecifications.
2. To enter with modified record, the cost and capacity ofter modification.
3. To record working content of repair and repair cost; Enter every month from daily record as follows:

3.a To enter working volume and Km which foremen or operater have measured.

3.b To enter contents of rapair point and change of parts (which is in corporated in Maintenance Repair and Equipment Modification).

3.c Overall operating time is the actual working hour of each equipment and the time consumed when transfer operater whithin 10 minutes.

3.d Operating day is the sum total of operating time when added up equivalent to days

3.e Modified record contents modification of functions and capacity of equipments.

Make & Model		Purchase Office		
Type		Contractor		
Make Chassis		Purchase Date		
Make Engine		Purchase Price		
Chassis No		Detail	Substance Price	
Engine No			Stationary expenses	
Inspector			Other expenses	
Detail of Accessory				
Description	Model or Type	Q'ty	Remark	

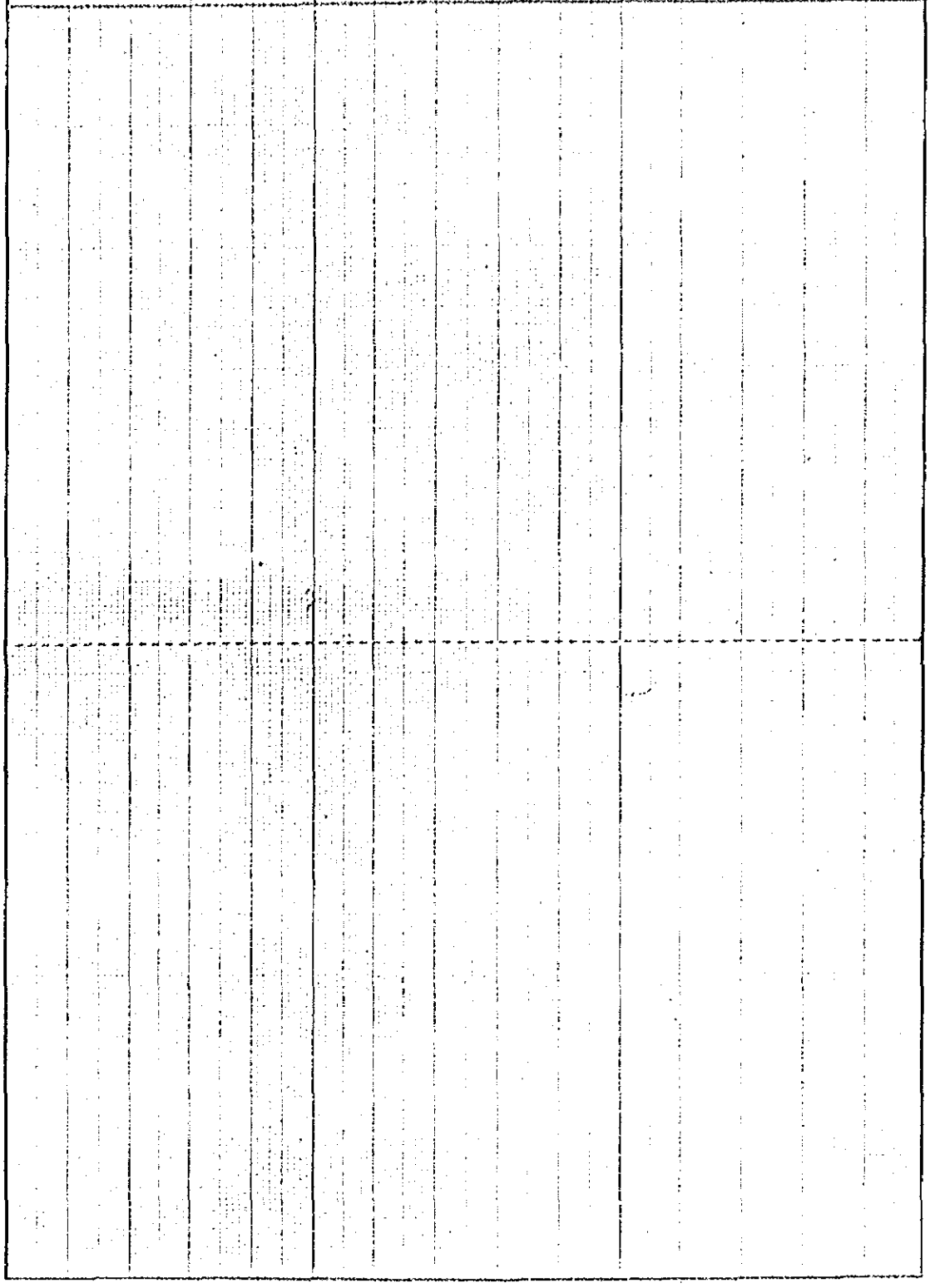
Detail of Tool					
Description	Model	Q'ty	Description	Model	Q'ty

Record of Equipment Control		
Office	Date of Change	Reason of Change

Equipment Specifications

	Record of Modify	

Photo of Equipment



Annual WorKing, Maintenance Record

No

	Repairing				Operating			Pause				WorKing	Fuel		Oil				Road	Reproducing
	Daily Check	Sched. Check	Repair	Days	Operating Time	Other Time	Days	Rest Time	Trouble Time	Waiting Time	Days	Volume & Km	Gasoline	Light oil	Engine oil	Gear oil	Grease	Other	hour meter	Cost
					Total															
10																				
11																				
12																				
11																				
2																				
3																				
4																				
5																				
6																				
7																				
8																				
9																				
Total																				
Accumulate Total						②						③	④	④						⑤

① Annual Average Operating Hour = ①/Y

Annual Average Operating Day = ②/Y

Average Operating hour Per Operating Day = ①/2

Average Repairing Cost Per Operating Day or hour = ⑤/①②

Average Fuel Consumption = ④/①

Average Production Per Operating Day or hour = ③/①②

Remark

Y ; Progress Year

Daily Record

Office																			
Equipment		Model															Equipment No		
Holiday	Date				Weather								Job Name						
Operator		Foreman				Full Name								Position					
		6	7	8	9	10	11	12	13	14	15	16	17	18	19	Total			
Repairing time	Daily Check																		
	Schedule Repair																		
	Repair																		
Operating time	Operating time (A)																		
	(B)																		
	(C)																		
	Other Operating time																		
Pause time	Rest time																		
	Trouble time																		
	Waiting time																		

Trouble part Condition	Reason	Correction

Remarks

Read hour meter		Sum total	
		Working time	
Gasoline	l	Working Volume	(A)
Light oil	l	Working Volume	(B)
Engine oil	l	Working Volume	(C)
Gear oil	l		
Grease	Kg		
Other			

Month Year No

Monthly Record

				Days	This Month	Accom late
Equipment		Model & Type		OP, Days		
Equipment No		Job Name		Rep, Days		
				Pavse Days		

Day	Wea ther	Repairing			Operating		Pause			Working Volume & Km	Fuel		Oil				Read Hr.M	Rep' Cost	Remarks
		Day C.K	Sche' C.K	Rep' C.K	OP' T	Oth' T	R't T	Tr' T	Wa' T		Gas'	L.θ	E.O	G.O	Gr'	Oth'			
					Total														
L.M																			
Acc																			
1																			
2																			
3																			
4																			
5																			
6																			
7																			
8																			
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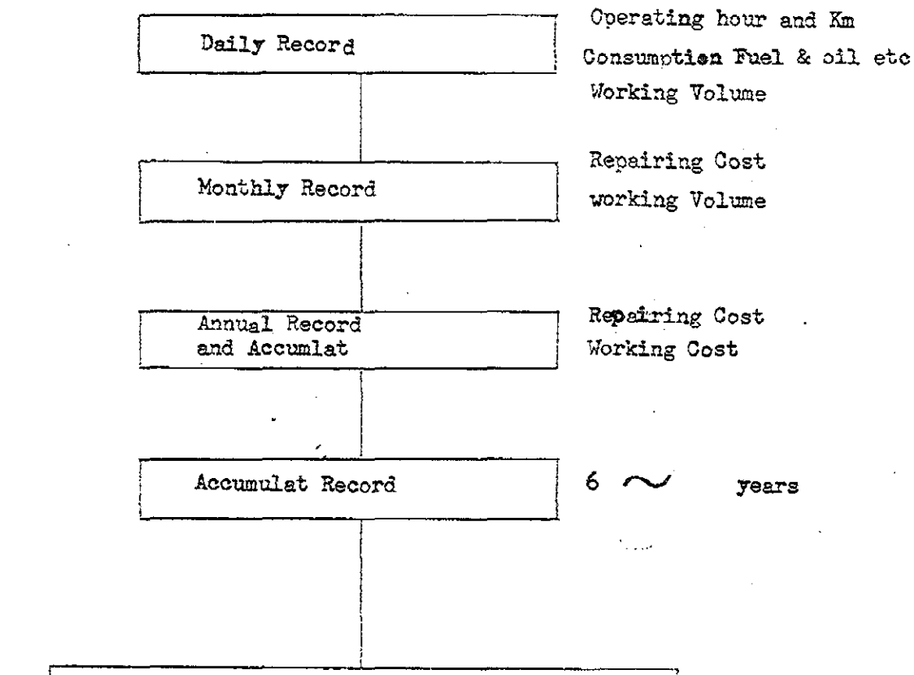
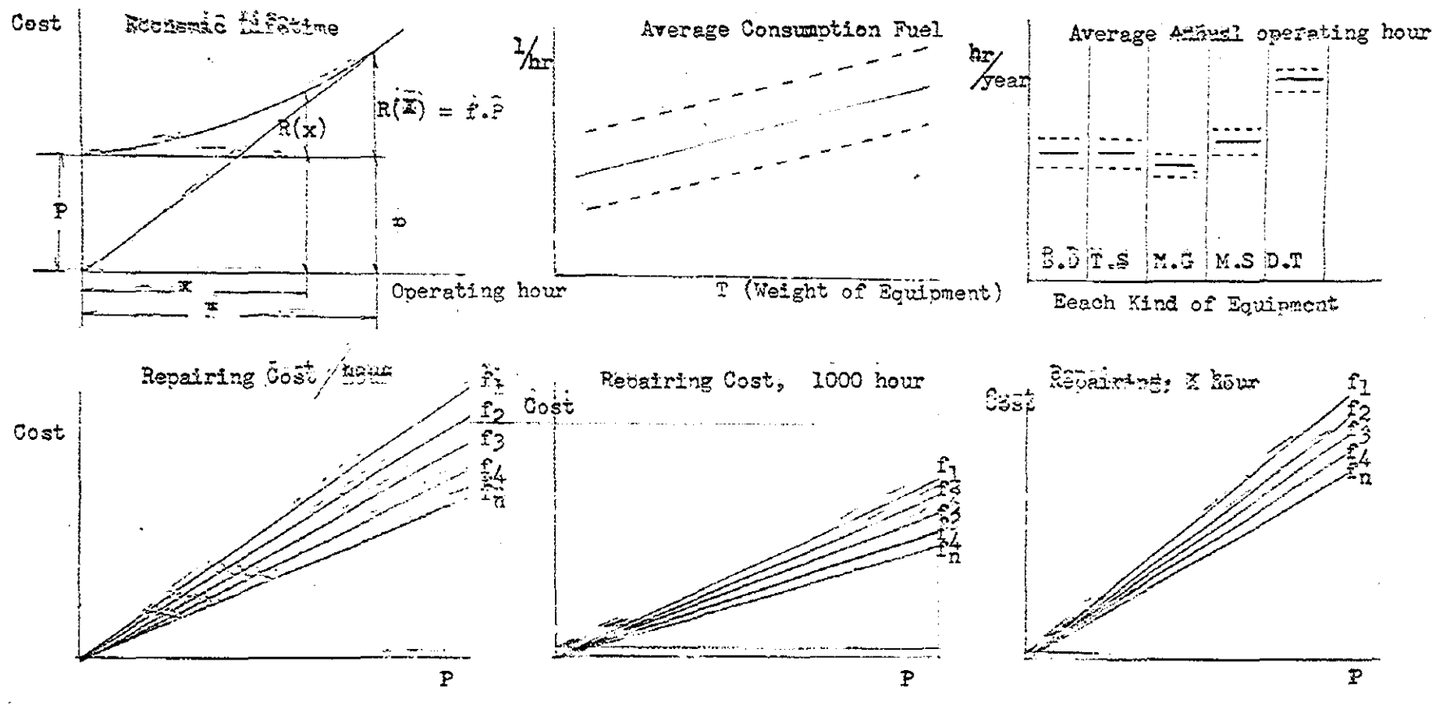
29																			
30																			
31																			
Sum																			
Acc Sum																			

Average Fuel Consumption L/H

Production Rate M³/H M³/H

Analysis System Flow Chart about Control of Equipment





appendix-2

VALUATION OF OLD EQUIPMENT IN JAPAN

October 5, 1983.

Kanchanaburi Equipment Training Center

Jinichi YAMADA

No.

Date

How to Valuate Old Equipment in JAPAN

Fundamental Formula of Valuation of Old Equipment

$$V = \left\{ (P - a) S^{\overset{a}{\overset{\times}{\times}}} - b \right\} E$$

Where V : Valuation

P : Purchase Price

a : Cost of Lost and Unrepairable Units

$S^{\overset{a}{\overset{\times}{\times}}}$: Remain Cost Rate

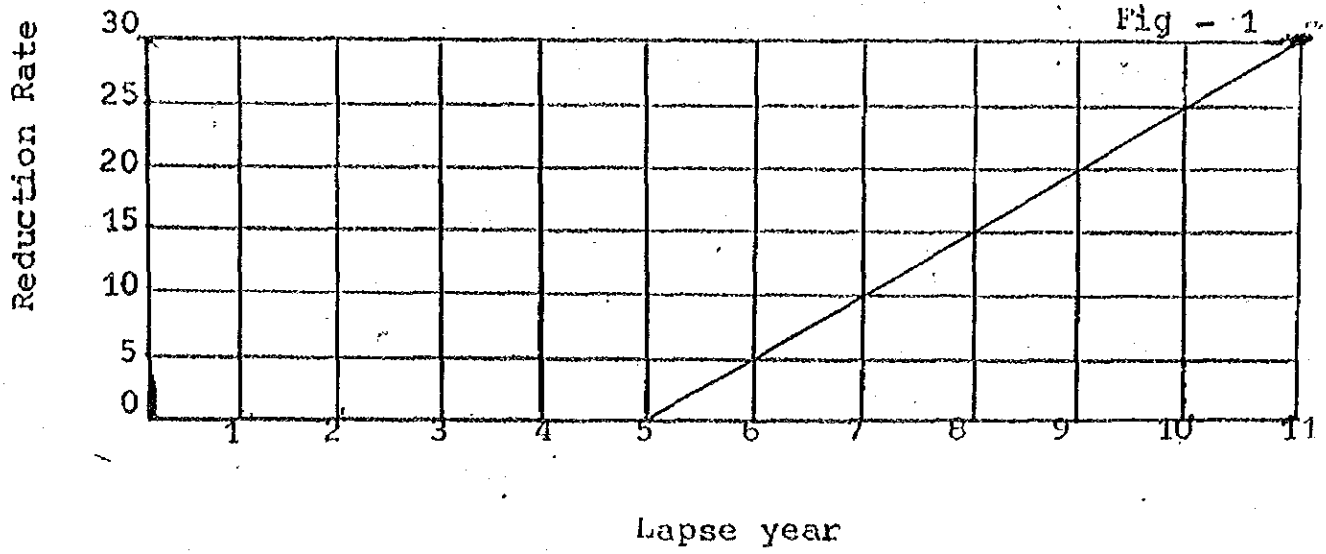
b : Estimated Repair Cost

E : Utilization Efficiency

(1) Purchase Price (P) can be reduced up to 30% depend on weakness of the equipment.

(See Figure - 1)

Fig - 1



No.

Date /

(2) $S^{\frac{x}{X}}$ is Remain Cost Rate

Where S : Remain Rate = 0.1

X : Useful Life

x : Working Hours

x/X : Working Hours Rate

If X = 4,000 x = 3,500

x/X = 3500/4000 = 0.875 ≅ 0.88

therefore

$S^{x/X}$ = 1.32

But when x/X is over 1.3 $S^{\frac{x}{X}}$ is maximum 0.0501. See the table - 1

(3) Y is corrected Usefule Life

Where the Fomula

$Y = y \times \frac{Ar}{Wr}$ (Use integer Value)

y : Economic Life year See the Table -5

Ar : Average annual operating hours.

Wr : Average actual annual operating hours from purchasing day.

Table - 2

Y	≤6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	≥21
Equipment Life 5 years and below	93	88	84	82	80	78	77	75	74	73	73	72	72	71	71	70
Equipment Life 6 year and over	86	77	70	67	62	61	58	56	55	55	53	52	52	50	50	49

No.

Date

Table - 1

$\frac{x}{X}$	$S\frac{x}{X}$	$\frac{x}{X}$	$S\frac{x}{X}$	$\frac{x}{X}$	$S\frac{x}{X}$	$\frac{x}{X}$	$S\frac{x}{X}$	$\frac{x}{X}$	$S\frac{x}{X}$
0.01	0.978	0.27	0.537	0.53	0.296	0.79	0.162	1.05	0.0891
0.02	0.955	0.28	0.525	0.54	0.288	0.80	0.158	1.06	0.0871
0.03	0.933	0.29	0.513	0.55	0.282	0.81	0.155	1.07	0.0851
0.04	0.912	0.30	0.501	0.56	0.275	0.82	0.151	1.08	0.0832
0.05	0.891	0.31	0.490	0.57	0.269	0.83	0.148	1.09	0.0813
0.06	0.871	0.32	0.479	0.58	0.263	0.84	0.145	1.10	0.0794
0.07	0.851	0.33	0.468	0.59	0.257	0.85	0.141	1.11	0.0776
0.08	0.832	0.34	0.457	0.60	0.251	0.86	0.138	1.12	0.0759
0.09	0.813	0.35	0.447	0.61	0.245	0.87	0.135	1.13	0.0741
0.10	0.794	0.36	0.437	0.62	0.240	0.88	0.132	1.14	0.0725
0.11	0.776	0.37	0.427	0.63	0.234	0.89	0.129	1.15	0.0708
0.12	0.759	0.38	0.417	0.64	0.229	0.90	0.126	1.16	0.0692
0.13	0.741	0.39	0.407	0.65	0.224	0.91	0.123	1.17	0.0676
0.14	0.725	0.40	0.398	0.66	0.219	0.92	0.120	1.18	0.0661
0.15	0.708	0.41	0.389	0.67	0.214	0.93	0.117	1.19	0.0646
0.16	0.692	0.42	0.380	0.68	0.209	0.94	0.115	1.20	0.0631
0.17	0.676	0.43	0.372	0.69	0.204	0.95	0.112	1.21	0.0617
0.18	0.661	0.44	0.363	0.70	0.200	0.96	0.110	1.22	0.0617
0.19	0.646	0.45	0.355	0.71	0.195	0.97	0.107	1.23	0.0589
0.20	0.631	0.46	0.347	0.72	0.191	0.98	0.105	1.24	0.0575
0.21	0.617	0.47	0.339	0.73	0.186	0.99	0.102	1.25	0.0562
0.22	0.603	0.48	0.331	0.74	0.182	1.00	0.100	1.26	0.0550
0.23	0.589	0.49	0.324	0.75	0.178	1.01	0.0978	1.27	0.0537
0.24	0.575	0.50	0.316	0.76	0.174	1.02	0.0955	1.28	0.0525
0.25	0.562	0.51	0.309	0.77	0.170	1.03	0.0933	1.29	0.0513
0.26	0.550	0.52	0.302	0.78	0.166	1.04	0.0912	1.30	0.0501

Method of using the table - 1

When $X = 8000$, $x = 5600$

$\frac{x}{X} = 0.70$

There fore $S\frac{x}{X}$ is 0.200.

No.

Date

Example When Y = 6 year Ar = 1,100 hr , Wr = 850

$$y = 6 \times \frac{1,100}{850} = 7.7647 \fallingdotseq 7 \text{ year}$$

Therefore corrected useful life is 77% when above 6 year used

(4) E : Utilization Efficiency

(1) C (Hackneyed Correction Rate) = A x B and always 50% or more. If A x B is less than 50% Use the 50% rate (A reduction within 50%)

In case the equipment life is over the Useful life year and Working hours rate(※) is within 0.4 the minimum rate of C can be reduced from 50% to 30% (If A x B is less than 30% use the 30% rate.) (A reduction is within 70%)

(2) D (Correction Rate of Machine Type) are shown in table - 3

Table - 3

Classifl Equipment	Correction Rate of Machine Type
Vehicle	100%
Versatility equipment	70% ~ 90%
Not versatility equipment	60% ~ 70%

No.

Date

2. The old equipment is value of scrap when can not valuate as equipment.

In this case use the table - 4

Eeach kind of equipment material component (%)

Table - 4

Equipment	Specification	Scrap iron		Pig-iron(Cast iron, Cast steel)	Copper	Lead	Gun metal	Brass	Aluminium	Miscellaneous
		Grade 1	Grade 2							
Truck	1 ~ 3.5 t	50.0	14.9	22.0	0.1	0.3	2.4	0.4	0.3	9.6
Light vehicle	4 x 2	33.2	49.4	9.4	1.0	0.7	0.1	0.1	1.6	4.5
,	4 x 4	31.2	46.4	17.0	0.5	0.7	0.1	0.6	0.4	3.1
Tractor shovel	Crawler type	73.8	–	24.7	–	0.1	0.3	0.5	0.2	0.4
,	Wheel type	65.1	–	25.1	0.1	0.1	0.4	0.8	0.2	8.2
Motor grader		65.4	2.4	23.4	0.1	0.2	0.2	0.1	0.1	8.5
Wheel dozer	18 t class	55.7	0.4	20.2	0.4	0.1	0.1	–	–	23.1

No _____

Office | | Old Equipment Valuation | Date

Machine No					
Type					
Make & Model					
Purchase Date					
Price					
Salvage Value Rate	(S)				
Usefull Life	(X)				
Working Hours	(x)				
Remain Cost Rate	$(S^{\frac{x}{X}})$				
Cost of Lost and Unrepairable Units	(a)				
Estimated Repair Cost	(b)				
Valuation	$H = (p - a)S^{\frac{x}{X}} - b$				
Utilization Efficiency (E) — Reckoned Correction Rate (c) — Correction Rate of Corrected Useful Life	(A)				
Decrease Rate of Utilization Efficency	(B)				
$C = A \times B$					
Correction Rate of Machine Type	(D)				
$E = C \times D$					
Final Valuation (H x E)					
Cost of Lost & Unrepairable (a) — 1					
2					
3					
4					
Total					
Estimated Repair Cost (b) — 000	Chassis				
010	Power Train				
020	Engine				
030	Electrical System				
040	Fuel System				
050	Steering System				
060	Braking System				
070	Cab and Body				
080	Hydraulic System				
090	Undercarriage				
110	Attach Equipment				
130	Miscellaneous				
	Total				

Classification / Code No.	Specification: Capacity (t) * indicates the type widely used in Japan	Specification: Rated Output (p.s.) (PS)	Specification: Weight (t)	(1) Original Purchasing Price (thousand yen)	(2) Economic Life (year)	Average Annual: (3) Operating Hours	Average Annual: (4) Operating Days	Average Annual: (5) Use Days	(6) Repair & Maintenance Cost Rate (%)	(7) Annual Administration Cost Rate (%)	Equipment Ownership Cost: per operating hour: (8) Cost Rate/hr (×10⁻⁶)	Equipment Ownership Cost: per operating hour: (9) Cost/hr (yen)	Equipment Ownership Cost: per use day: (10) Cost Rate/diem (×10⁻⁶)	Equipment Ownership Cost: per use day: (11) Cost/diem (yen)	Reference: Conversion per operating hour: (12) Conversion per Operating Hour Cost Rate/hr (×10⁻⁶)	Reference: Conversion per operating hour: (13) Conversion per Operating Hour Cost/hour (yen)
01 Bulldozer & Scraper																
0101 Bulldozer																
11 [Standard]																
010 — 1	1 t	8	0.9	1,090	5	600	120	165	80	7.0	313	341	970	1,00	513	559
030 — 1	3	39	3.6	4,120	"	"	"	"	"	"	"	1,290	"	4,00	"	2,110
060 — 1	6	64	6.3	6,020	"	1,000	150	210	95	"	280	1,69	762	4,90	440	2,650
080 — 1	8	76	8.7	8,260	"	"	"	"	"	"	"	2,310	"	6,90	"	3,630
110 — 1	11	108	11.9	10,900	6	1,100	165	230	100	"	220	2,40	630	6,90	352	3,840
150 — 1	15	141	14.6	14,400	"	"	"	"	"	"	"	3,17	"	9,70	"	5,070
210 — 1	21	211	22.1	22,000	"	"	"	"	"	"	"	4,80	"	13,00	"	7,740
320 — 1	32	319	33.5	33,500	"	1,200	180	250	005	"	208	6,97	580	19,00	329	11,000
440 — 1	44	410	44.1	53,600	"	"	"	"	"	"	"	11,10	"	31,00	"	17,600
21 [Swamp]																
035 — 1	3.5 t	39	3.8	4,640	5	900	135	185	100	7.0	322	1,490	865	4,010	500	2,320
070 — 1	7	64	6.9	6,720	"	1,000	150	210	105	"	300	2020	762	5,120	430	3,090
090 — 1	9	79	10.1	9,270	"	1,100	165	230	"	"	273	2,530	696	6,450	418	3,870
130 — 1	13	108	13.7	12,500	6	"	"	"	"	"	227	2,840	630	7,880	359	4,490
160 — 1	16	141	16.7	15,700	"	"	"	"	"	"	"	3,560	"	9,890	"	5,640
31 [Ultra Swamp]																
040 — 1	4	39	3.9	4,990	5	900	135	185	105	7.0	333	1,660	865	4,320	511	2,550
100 — 1	10	77	10.7	10,400	"	1,100	165	230	"	"	273	2,840	696	7,240	418	4,350
130 — 1	13	110	13.1	12,200	6	"	"	"	110	"	235	2,870	630	7,690	367	4,480
160 — 1	16	140	16.2	16,000	"	"	"	"	"	"	"	3,760	"	10,100	"	5,870
41																
1 — 1	15	141	13.7	15,900	6	1,1	1	230	105	7.0	22	3,0		10	3	

appendix-3

COSTING OF CONSTRUCTION WORKS

September 28, 1983.

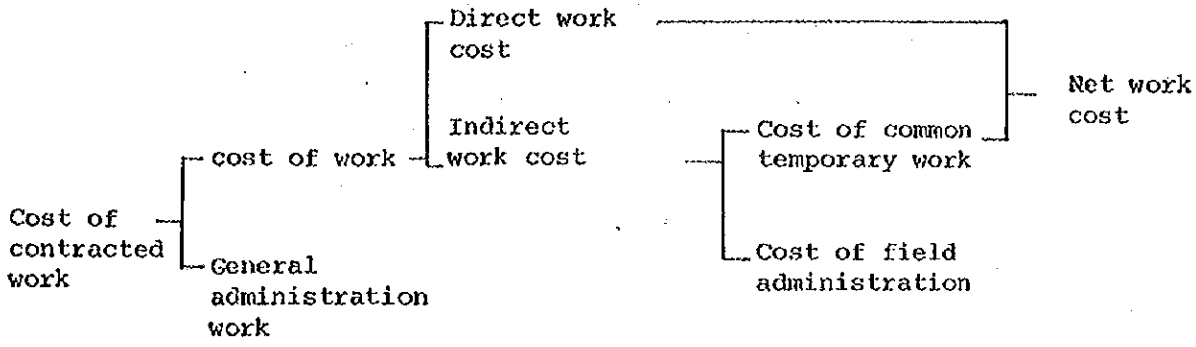
Kanchanaburi Equipment Training Center

Jinichi YAMADA

Contents (Page)

1. Cost of Contracted Construction Work

When calculating the cost of construction work the Ministry of Construction gives a contractor, the cost of the contracted work which is broken down as follows.



(Items of Contracted work Cost)

The items for costing costruction work on contract shall be as follows.

(1) Direct work Cost

As for the direct work cost, each division of work shall be further divided into type, kind, detail and name according to the place and type of work, and, calculations shall be made for the three elements of cost materials, labor, and direct expenses.

(2) Indirect Work Cost

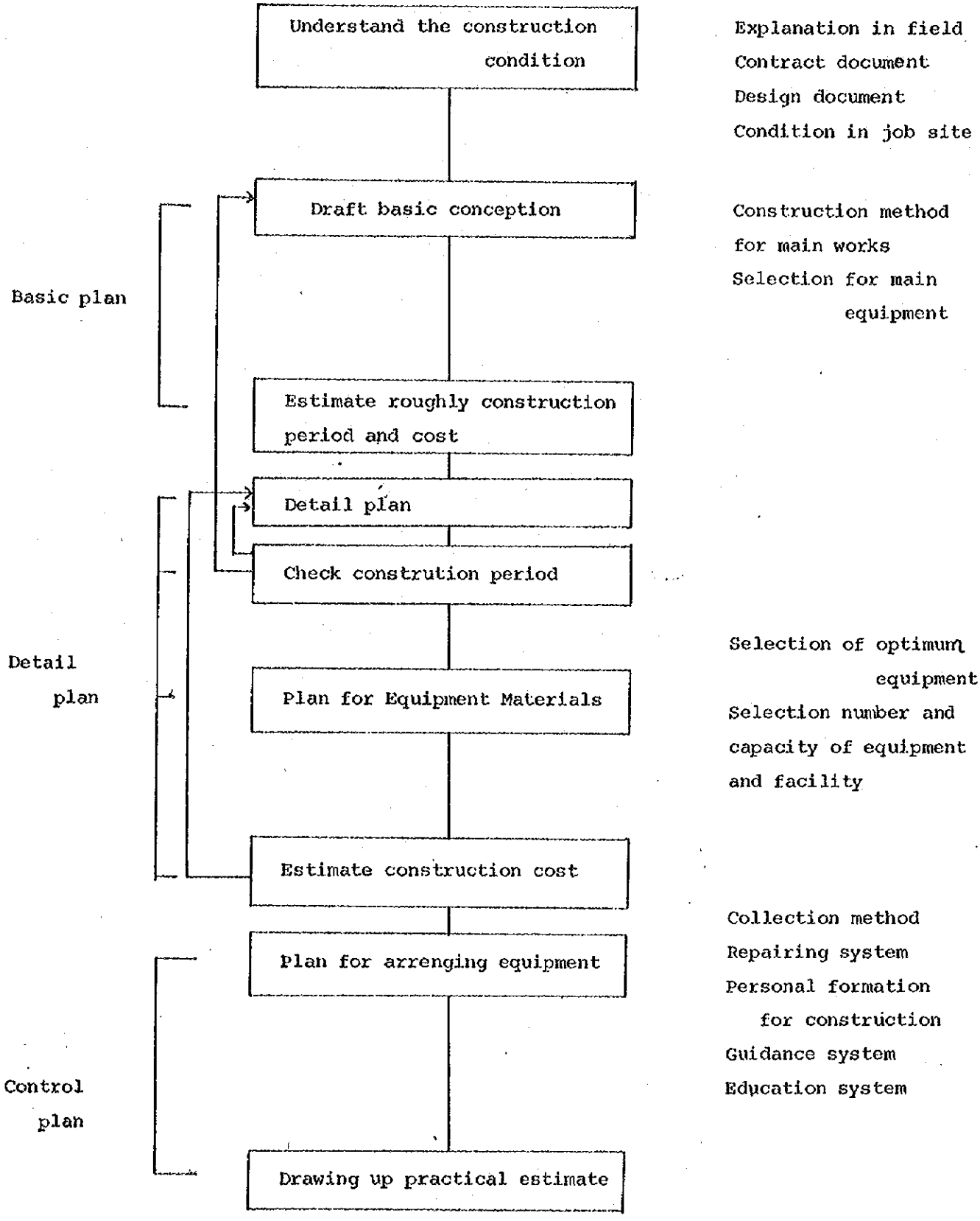
The indirect work cost shall be the cost of work and expenses other than the cost mentioned above in all the divisions of work and shall be divided into the common temporary work cost and field administration cost.

(3) General Administration Cost

The general administration cost is necessary for the contractor to carry on its corporate operations and it shall comprise the general administrative expenses and profit added and shall be developed by the use of the following the general administation cost rate.

$$\text{General administration Cost rate} = \frac{\text{General administration cost}}{\text{Cost of work}}$$

2. Procesure of Construction plan



3. Exemple Earth volume of accounts

Earth volume of accounts

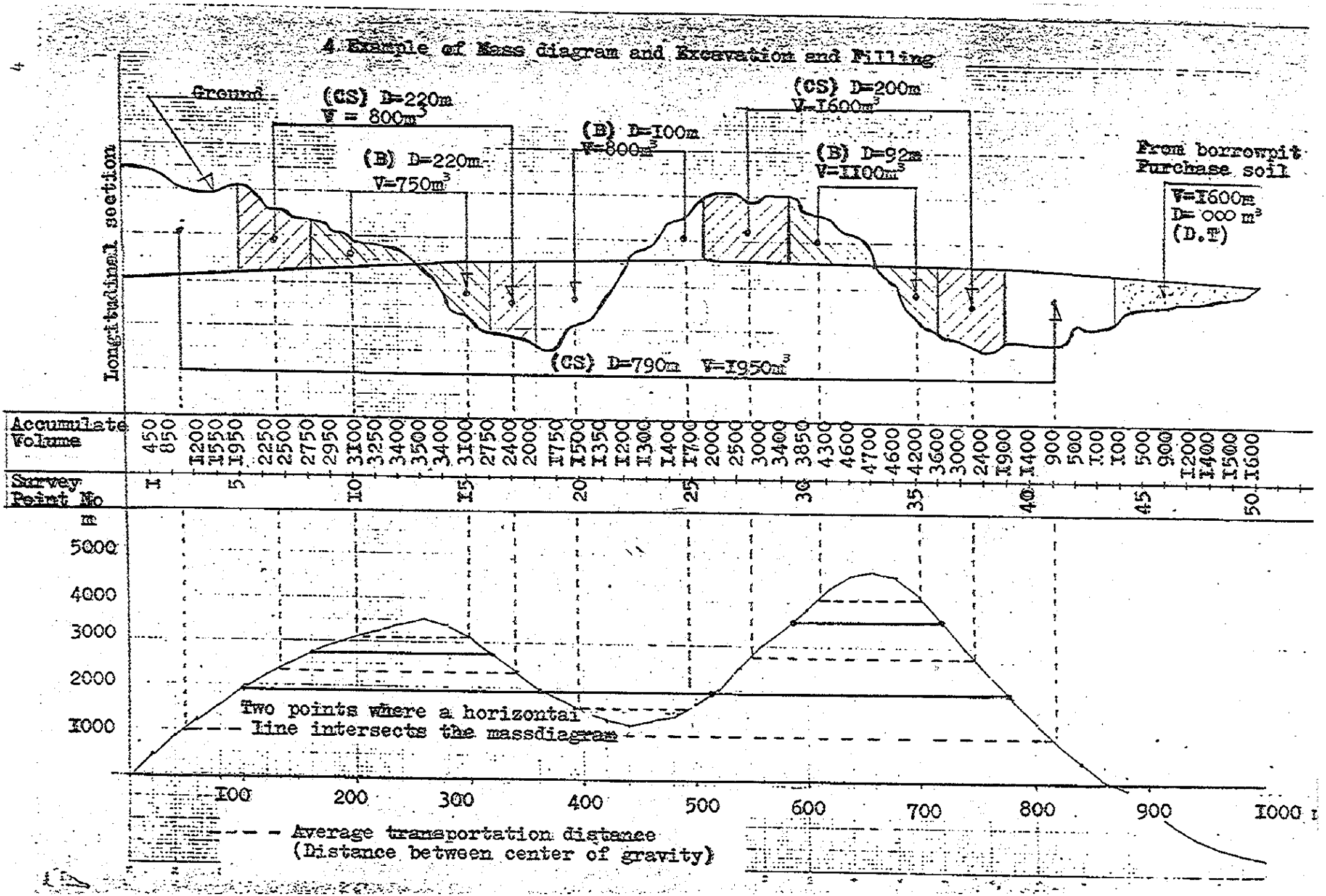
Survey point No	Distance (m)	Excavation: Section area (m^2)	Excavation: Mean Section area (m^2)	Excavation: Earth volume (m^3)	Filling: Section area (m^2)	Filling: Mean section (m^2)	Filling: Earth volume (m^3)	Filling: Percent swell and shrinkage (C)	Filling: Compensation volume (m^3)	Deduct volume (m^3)	Takeoff volume (m^3)	Accumulate volume (m^3)	Direction of side volume (m^3)
11		23.6			8.3							+ 963.6	
12	20.00	29.4	26.5	530.0	1.3	4.8	96.0	0.9	106.7		+ 423.3	+1386.9	106.7
12+12.5	12.50	5.5	17.5	218.8	6.5	3.9	48.8	"	54.2	(Culvert)	+ 164.6	+1.551.5	54.2
13	7.50	4.2	4.9	36.8	12.6	9.6	72.0	"	80.0	+ 100.0	+ 58.8	+1.608.3	36.8
14	20.00	2.6	3.4	68.0	18.5	15.6	312.0	"	346.7		- 278.7	+1.329.6	68.0
15	20.00	0	1.3	26.0	21.3	19.9	398.0	"	442.2		- 416.2	+ 913.4	26.0
Total													

Compensating volume = Earth volume/C

\+ : Excavation

\- : Filling

4. Example of Mass diagram and Excavation and Filling



5 Estimation Form

Estimation Form

Item	Type	Kind	Detail	Size	Unit	Q'ty	Unit Price	Amount	Remark
	Earth work				set				
		Cutting			m^3				
			Sediment		〃				
			Soft rock		〃				
		Filling			〃				
			Soil Field		〃				
			Soil from borrw pit		〃				
			Purchase soil						
		Slope protection							
			Sodding		〃				
	Subbase course								
		Lower subbase		Uncrushed, gravel max 00 m m	〃				
		Upper subbase		Crushed stone max 00 m m	〃				
				Thick 00 m m	〃				
	Drainage				m				

Item	Type	Kind	Detail	Size	Unit	Q'ty	Unit price	Amount	Remark
		Concrete gutter	U-type		m				
		"	L - type		"				
	Miscellaneous				set				
		Shoulder			"				
		Access road			place				
		Guard rail			m				
		Site marker			Pcs				
	Provisional expence		"		set				
	Preparatory expence				"				
	Transportation cost				"				
	Technical control cost				"				
	Housing cost				"				
	Cost for safety				"				
	Field [illegible] tion								

Item	Type	Kind	Detail	Size	Unit	Q'ty	Unit price	Amount	Remark
Net construction cost									
	General administration cost				set				
Total construction cost									

6. Unit - price form & Method of discription

Unit - price form & Method of discription

Item	Description	Size	Unit	Q'ty	Unit price	Amount	Remark
Material exoence							
	Light oil		l				
	Miscellaneous		set				
Labor expence							
	Driver		P				
	Assistant driver		n				
	Labor personnel		n				
Exoence of equipment							
	Equipment ownership cost		hr				
Total							

7. Example Unit - price Digging and Pushing of Motor scraper

Unit - price Digging and pushing of Motorscraper

Capacity : 11^{m^3} (335PS)
Soil : Sandy soil
Earthmoving distance : 500^{m}
Working Efficency : 0.65

Item	Description	Size	Unit	Q'ty	Unit price	Amount	Remark
Material expence							
	Light oil		l	42.6			
	Miscellaneous		set	1			
Labor expence							
	Driver		person	0.20			
	Assistant driver		"	0.10			
	Laber personal		"	0.04			
Expence of equip ment							
	Equipment ownership cost		hr	1			

$$V = \frac{60 \times q \times E}{1.7 + 0.0068\ L} = \frac{60 \times 9.7 \times 0.65}{1.7 + (0.0068 \times 500)} = 74.2^{m^3}/hr$$

$$q = \frac{qo \times k}{L} = \frac{11 \times 1.1}{1.25} = 9.7^{m^3}$$

qo : Struck capacity = 11^{m^3}
k : Load coefficient = 1.1
L : Percent swelland shrinkage = 1.25

appendix-4

BUDGETING PERAIR - EXPENDITURES

January 23, 1984.

Kanchanaburi Equipment Training Center

Jinichi YAMADA

The present Budget System for repair expenses is the rate of construction cost at Kanchanaburi Equipment Center. But I think every mechanical engineer may not understand content of repair cost rate. In my concept every mechanical engineer needs inquiry concerning the following in order to provide reasonable system of demand budget for repair expenses:

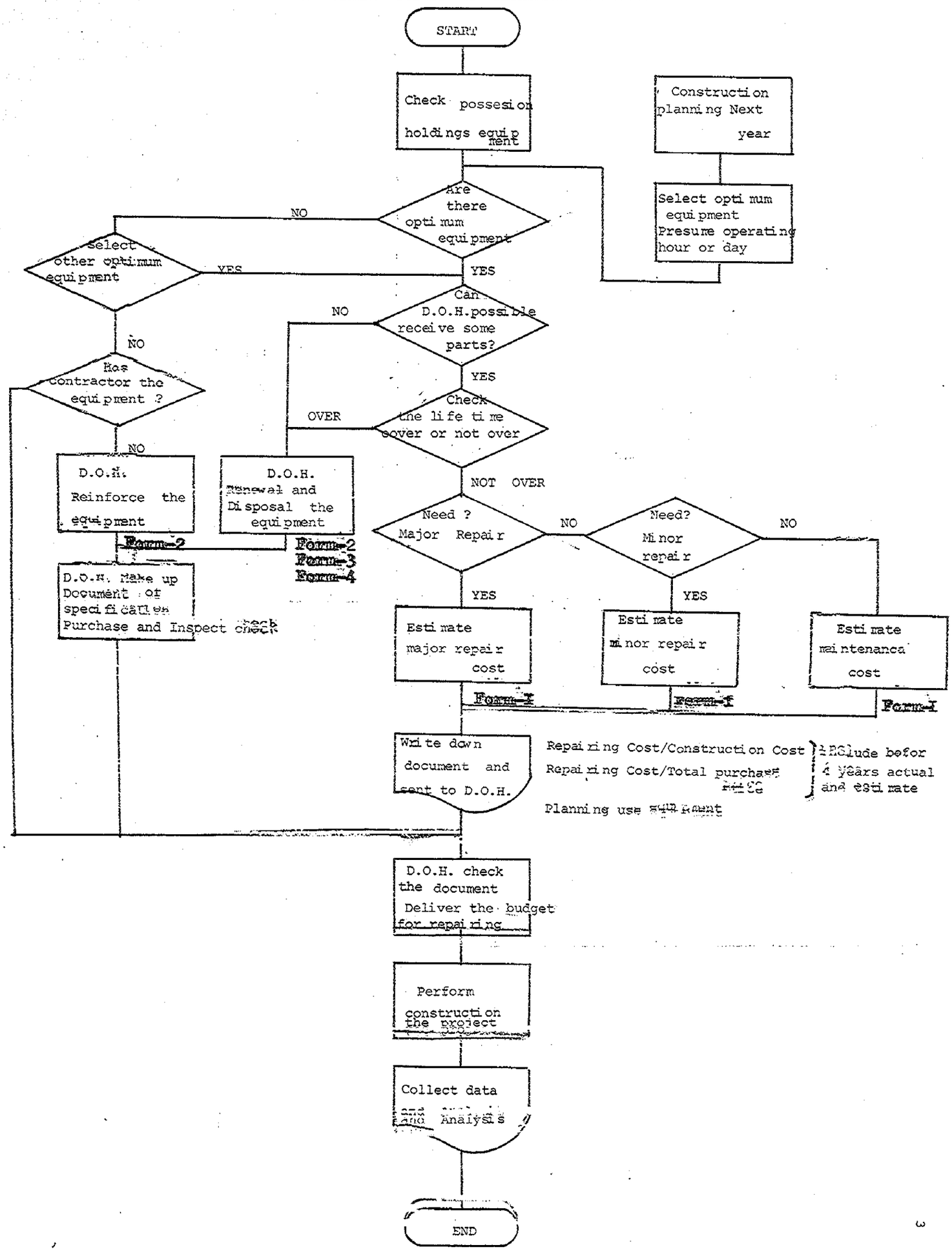
1. Compare the repair expenses rate from actual construction cost and the repair cost in the past.
2. Calculate the rate between actual repairing cost and equipments cost.
3. Calculate the ratio between the number of repair units and the total units of equipment.
4. Analyze economic life-time of equipment from actual operating hours and actual repairing cost.
5. Understand the next year planning construction and estimated operating hours of indevidual equipments.
6. Investigate and analyze production rate per hour of individual equipments for each condition of soil and each condition of job site.
7. Estimate operating hour of individual equipments as mentioned above 5,6 and estimate repair expense from 3.

Then D.O.H. should rearrange same equipment or same brand of equipment to same area because D.O.H. has many kinds of equipments and many old equipments. It is better to dispse old equipments or take rest period for machine equipment to recuperate.

Otherwhich, D.O.H. should purchase same equipments of same specifications.

I think that D.O.H. can manage equipments and can control spare parts easily.

FOR DEMAND BUDGET OF REPAIRING EXPENSES



(19) Plan of Maintenace Equipment

Form-I

No

Equipment	Model	No	Last Fiscal year Operating houres Days	Last Fiscal year Repairing Cost	Accumulate Operating houres, Days	Accumulate Repairing Cost	This Fiscal year Operating houres, Days	This Fiscal year Estimate Repairing Cost	Remarks

(I9)Plan of Purchase Equipment

Form-2
No

Equipment	Model	Unit Price	Q'ty	Amount	Reinforce Equipment		Renewal Equipment				
					Q'ty	Amount	Q'ty	Amount	Object Renewal Equipment		
									Model	No	Sum Operating Houres/Days

Form-3

(19)Plan of Pause Equipment

No

Equipment	Model	No	Disposition Place	Present Condition of Equipment	Pause Period	Reasan of Pause	Remove Disposition Goodor Bad	Accumulate Operating Hour or Km	Remarks

(19) PLAN OF DISPOSAL EQUIPMENT

Form-4

No

EQUIPMENT	MODEL	NO	DISPOSITION PLASE	REASON OF DISUSE	METHOD OF DISPOSAL	ACCUMULATE OPERATING HOUR OR KM	REMARKS

appendix - 5

PROGRAMMING PROCEDURE

February 27, 1984.

Kanchanaburi Equipment Training Center

Jinichi YAMADA

Procedure of Programming

1. System Analysis

To grasp precisely and clearly the present process of management which is to be converted into EDP system.

This will be accomplished by utilizing the work flow chart that has been used by DOH in handling the work manually.

2. System Design

System design aims at forming a system being easily computerized by examining the present system in parallel with system analysis.

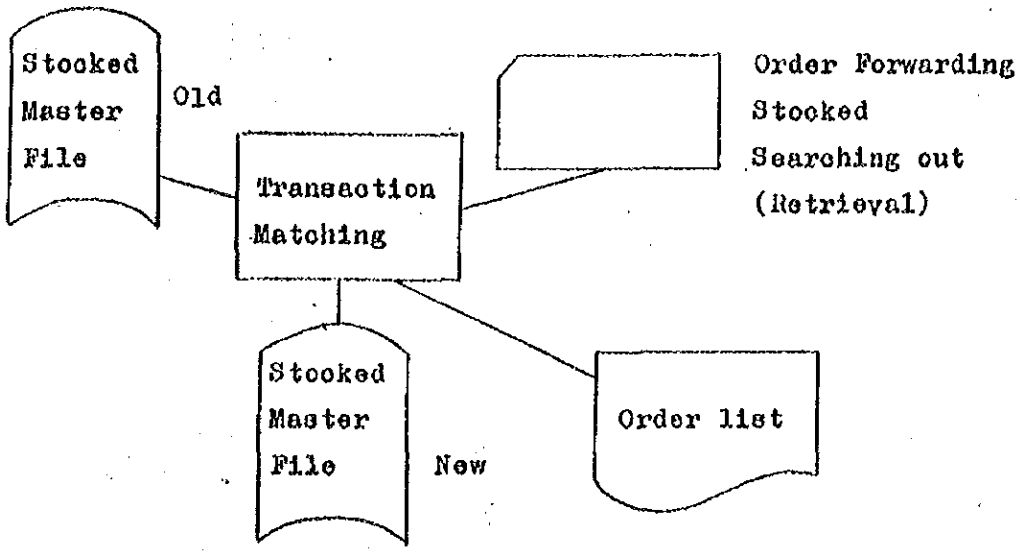
This will require not being seized by conventional systems with an assistance of staff who understand present conditions very well. That is, the followings should be clarified.

① System target ---------- Purposes of the EDP System
② Input/Out put Format
③ Process chart ---------- System management procedure
④ Dominant logic chart
⑤ Master file ---------- Tape, Disc-pac, etc.,

3. Process Chart

To draw the management process of the system designed.

(An example)



4. Logic Chart

Logic chart shows logically the management process by computer. An example is shown in the attached sheet.

5. Coding

6. Debug (Programme test)

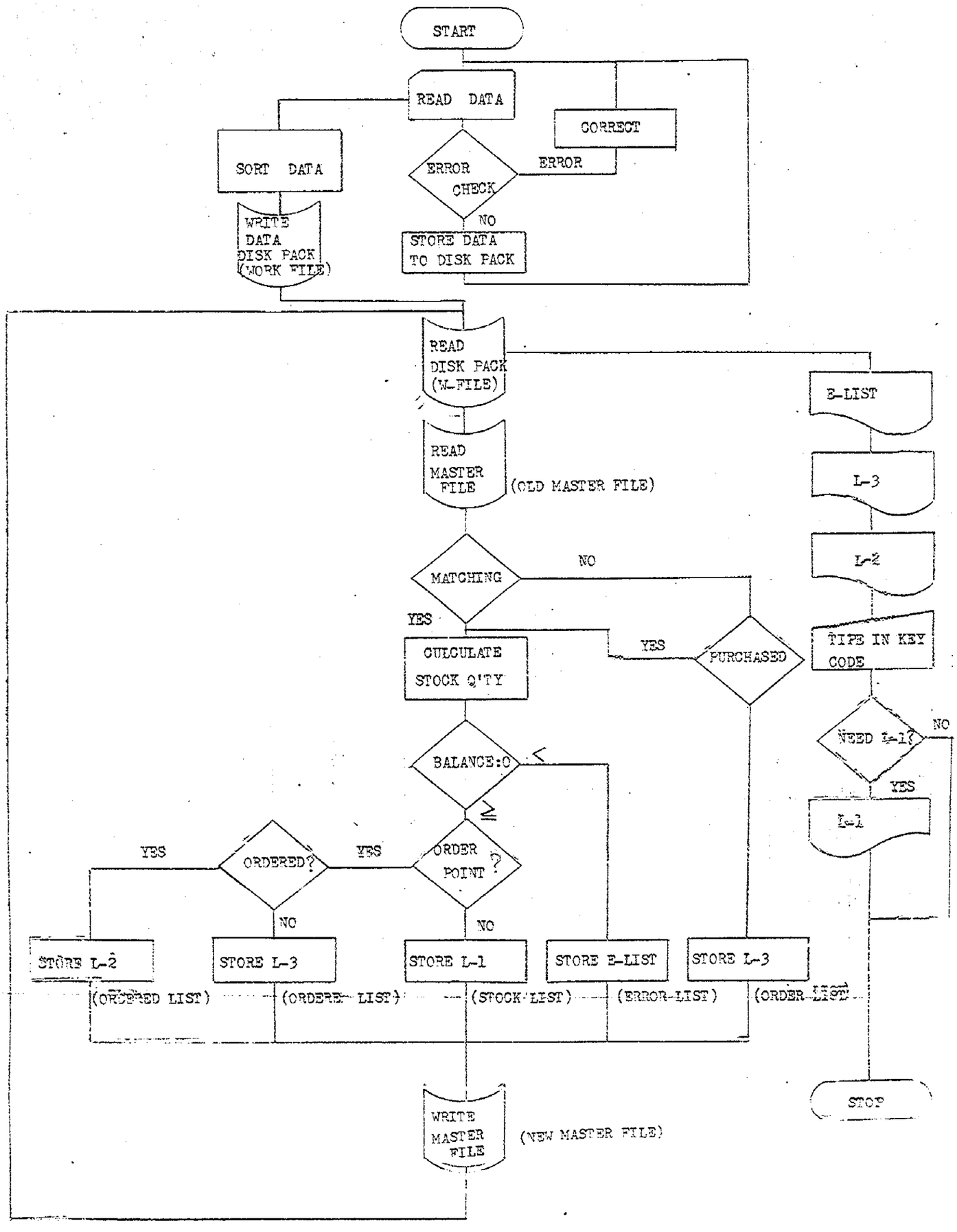
To accomplish the above,

* EDP system is to be designed mainly by the staff of a certain division that deals with the system.
* Staff in computer section assist the above staff by training them the EDP system design.
* A better EDP system will be obtained by collecting conceptions of staff in the relating sections and compling them into an integrated one.
* To unify the organization and the work flow among DOH.
* Disposal of unnecessary equipments and parts and re-formation of the arrangement. (According to the construction volume)
* Uniform management system of the parts.
* Record of equipment

  Purchase -> Arrangement -> Disposal (Standardization)
* Establishment of an instant delivery of goods system with an appropriate stock.

  Amount of stock and demand projection. Collection and analysis of actual data by statistical method.
* Stock --- Ledger by item of goods

PARTS CONTROL SYSTEM EXAMPLE



appendix-6

HAND BOOK FOR MECHANICAL ENGINEER

1. Regulations concerning Equipments
   - Administer regulations concerning Equipments
   - Definition of Operating hour
   - Planning for Budget of repairing for Equipments
2. Concerning Equipments and Vehicles
   - Concerning Standerd with paint of equipments
   - Concerning Communication Low
   - Concerning Cord-number of Equipments
3. Purchasing (Contract) and Inspection Concerning equipments
   - Standerd of purchasing for vehicles and equipments
   - Outline of Inspection for equipments
4. Concerning Valuate Old equipments
   - Outline Valuate Old equipments
5. Aggregation (Estimate) concerning Machinery cost
   - Cost of Construction Equipments (An Estimation table of the construction equipments ownership cost)
   - Outline of Estimation construction works
6. Other
   - Outline of draw up the Record concerning equipments
   - Outline Handle for unnecessary equipments (Concerning disposal old equipments)
   - Management of equipments by the computer system

appendix-7

Technical Equipment of JICA

(Goods of Supply)

No	Discription of Goods	Type & Model	Q'Ty	Remark
1.	Video TV	Sony KV-2024 E	I Set	
2.	Video Recorder	JVC HR -A100	I Set	
3.	Video Camera	7I - T	I Set	
4.	Slide Projector	Super Cabin III	I set	Magazine & ZooM Lens F2.8
5.	Recopy Machine	SHARP SF-880	I Set	
6.	Steam Cleaner	MARUMA NO.800	I Set	220 V 50 HZ
7.	Movie Projector	ELMO I6m/m16CLMO	I Set	220 V 50 HZ
8.	Overhead Projector	ELMO HP-3000	I set	W/Trans
9.	Cassete Tape Recorder	SONY CFS-F5S	I Set	

Mar. 30, 1983

We recieved each goods of the list.

Reciever signature

V. Suppamthum

Supplier signature

Shichi Yamada

Technical Books of JICA,

(Goods of Supply)

NO	Description of Goods	Q'ty	Remark
1.	Highway Engneering	1 Copy	T = Thai
2.	Route Location & Design	1 "	T
3.	Soil Mechanics	1 "	T
4.	Reinforced Concrte Design	1 "	T
5.	Concrete Technology	1 "	T
6.	Engineering Economics	1 "	T
7.	Tractors	1 "	T
8.	Microcomputer	1 "	T
9.	Engineering Quality Control	1 "	T
10.	Automotive Air Conditioning	1 "	T
11.	Timber & Steel Design	1 "	T
12.	Small Internal Combustion Engine	1 "	T
13.	Basic Flow Chart	1 "	T
14.	Refrigerator Standard Specification	1 "	T
15.	Fiber Glass	1 "	T
16.	Plastic Coating	1 "	T
17.	Building Safety Standard	1 "	T
18.	Applied COBOL	1 "	T
19.	Fandamental of Compvter	1 "	T
20.	Pile Bearing Load	1 "	T
21.	Concrete Testing Handbook	1 "	T
22.	Steel-Structure Building Standard	1 "	T
23.	Mortar Building Standard	1 "	T
24.	Timber Building Standard	1 "	T
25.	Nbrde's Architectural Catalog File	2 vol	T
26.	Z-80 Microproecessor	1 copy	T
27.	Computer & Accounting	1 "	T
28.	Reinforce Concrete Building Construction Inspection	1 "	T

NO	Description of Goods	Q'ty	Remark
29.	Structure Detail	1 copy	T
30.	Human Relations in Industry	1 "	T
31.	Workshop Administration Ploblem	1 "	T
32.	Fortran ⅣW	1 "	T
33.	Joke on Workshop Sefety	1 "	T
34.	Surveying Fundamentals	1 "	E = English
35.	Advanced Surveying	1 "	E
36.	Remote Sensing and Image Interpretation	1 "	E
37.	Matrix Structur 1 Analysis	1 "	E
38.	Statically Indeterminate Structures	1 "	E
39.	Soil Mechanics in Engineering Practice	1 "	E
40.	Soil Mechanics	1 "	E
41.	Automotive Ency Clopedia	1 "	E
42.	Mechanical Engineer's H/B Vol 1	1 "	E
43.	Mechanical Engineer's H/B Vol 2	1 "	E
44.	Modern Personel Management	1 "	T
45.	Conference Arrangement Technique	1 "	T
46.	Car Using and Maintenance	1 "	T
47.	Astronomy Practice	1 "	T
48.	Electrical Constructing Standard	1 "	T
49.	Constructing Data	1 "	T
50.	Mortar Technique	1 "	T
51.	Basic Sheet-Metal Work	1 "	T
52.	Metal Work Data	1 "	T
53.	Machining Theory	1 "	T
54.	Metallurgy 1	1 "	T
55.	Metallurgy 2	1 "	T
56.	Basic Intergrated Circuit	1 "	T

NO	Description of Goods	Q'ty	Remark
57.	Highway Engineering H/B	1 copy	E
58.	Engineering Measurement & Instrumentation	1 "	E
59.	A Course in Workshop Technology	1 "	E
60.	Element of Hydraulics & Hydraulic Machinery	1 "	E
61.	Elementary Workshop Calculations	1 "	E
62.	Factory Plant & Works Services	1 "	E
63.	Hydraulics & Hydaulic Machinery	1 "	E
64.	Mechanical Estimating & Costing	1 "	E
65.	Mechanical Costing Estimation	1 "	E
66.	Mechine Design Fheory & Practice	1 "	E
67.	Basic Heat Transfer	1 "	E
58.	Engineering Thermadynamics With Applications	1 "	E
59.	Electrical Wiring	1 "	T
60.	Geology for Engineer	1 "	T
61.	Constructing Data	1 "	T
62.	Art of Leadership	1 "	T
63.	Flowering Plant Growing	1 "	T
64.	A Plant Improving	1 "	T
65.	Workshop Fundamental	1 "	T
66.	The Failure of Building Case Study	1 "	T
67.	Blasting Dperation	1 "	E
68.	Civil Engineering	1 "	T
69.	Construction Work Management	1 "	T
70.	Drafting	1 "	T
71.	Basic Q.C.	1 "	T
72.	Q.C. Technic	1 "	T

30 Mar 1983

We recieved each goods of the list

Reciever signature

V. Sypundam

Supplier signature

Shinichi Yamada

Technical Equipment of JICA

(Goods of Supply)

No	Description of Goods	Type & Model	Q'ty	Remarks
1.	Floating Seal Tester	MARUMA, E-1305	1 Pce	
2.	Sound Scope	ANZEN, SS -1	3 Pcs	
3.	Portable Spot Welder	ANZEN, WEL - 151	1 Pce	AC 220 V
4.	Wheel Alignment Gauge	ANZEN, S - 430	1 Pce	
5.	Cutting Engine	ZM 396 CC	1 Set	Presented by ISUZU

May. 2, 1983

We received each goods of the list

Receiver signature

V. Egunbe

Supplier signature

Junichi Yamada

Technical Goods of JICA

(Goods of Supply)

No	Description Of Goods	Quantity	Remark
I.	Education Slide (SS - 903)		
	Planning Organizing Controlling	I Pcs	
2.	Education Slide (SS - 90I)		
	Effective Communication	I Pcs	
3.	Education VTR (TSEZAE 490I - 0)		
	D I55 - 4 Diesel Engine Series		
	Replacing Valve Seat	I Pcs.	
4.	Education VTR (TSEZAE 4902 - 0)		
	D I55 - 4 Diesel Engine Series		
	Replacing Nozzle Holder Sleeve	I Pcs	
5.	Education VTR (TSEZTE 490I - 0)		
	D I55-4 Diesel Engine Series		
	Adjustment of Injection Nozzles	I Pcs	
6.	Education VTR (TSEZTU 0600 - 0)		
	Trouble Shooting of Electrical System	I Pcs	
7.	Education VTR (TSEZTU 0600 - 0)		
	Inspection & Adjustment of Electrical System	I Pcs	
8.	T/P Film For O.H.P	I Set	
	TP - T x 4 Pcs TP-G x 46 Pcs		
	TP - K x 75 Pcs TP - G x 46 Pcs		
	TP - P x 52 Pcs TP - E x 56 Pcs		
	TP - H x 36 Pcs TP - A x 43 Pcs		
9.	Plastic Model (IIM - 07)		
	Torque Converter	I Set	

NO	Description of Goods	Quantity	Remark
IO.	Unit Instruction Manual		
	Basic Electricity (SEULU 060I - 0)	3 Vols	
	Electrical System (SEULU 0602 - 0)	3 "	
	Weld Rebuilding of Under-carriage Parts (SEULU 3004-0)	3 Vols	
	Total	7 Pcs	
		2 Sets	
		& 9 Vols	

Sep I, 1983

We received each goods of the list

Reciever Signature
: V. Sayyamtrai

Supplier Signature
Junichi Yamada

Technical Books of JICA

(Goods or Supply)

No.	Description of Goods	Quantity	Remark
1	Construction Equipment Service Manual (Control)	30	E
2	Text Book (Machine Selection - 1)	200	T
3	Text Book (Machine Selection - 2)	200	T
4	Text Book (Management of Equipment)	200	T
5	Technical Movies	2	E

June 6, 1984

We recieved each goods of the list

Reciver signature

Supplier signature

Jiuichi Yamada

appendix-8

DIAGRAM SCHEDULE and PLANNING EQUIPMENT USE

May 9, 1984.

Kanchanaburi Equipment Training Center

Jinichi YAMADA

Contents

Schedule diagram and Planning equipment use

Usually the stage work planning is used by show a diagram and represe-ntative of them are Bar chart type progress schedule, Diagram of stage work control, Coordinated type progress schedule and Net work etc.

Schedule diagram have to easy-to-use for stage work control but too much complicated schedule diagram is atheoretical, its not practical use. However its too much simplicity,its can not perform stage work control scientifically. And also these are used generally combined Planning equipment use. Then describe about Coordinated type progress schedule (Figure-1) and the importance of planning equipment use (Figure-2~5).

(About Bar chast type progress schedule, Diagram of stage work contral and Net work omitted.)

Coordinated Type Progress Schedule (CTPS)

1. Out line

The CTPS is modified by element of the construction point or survey point contained in the bar-chart. It is therfore possible to comprehend and calulate the state of progress of each division accurately. This projects the cause of delayed constructions as against the related structures construction schedule and also the diversity of construction equipments parallel with each division work equipment. It is possible to examine the cause of late construction such as for speedy construction to fit structures and arrange/assign construction equepments into which section.

The CTPS is made by a combination working section which devides each kind of work while calculating needed working days with the work volume per day and the construction volume. Therefor, it is possible to determine the appropriate and inappropriate elements, to estimate construction cost (i,e. proper investigtion of construction period and part, combined number of equipments to be used, method of combining construction equipments, etc. from the CTPS). Also allow for investigation of construction method.

2. Procedure in the CTPS.

(1) The mass diagram is seen in the upper part of the drawing while the CTPS is found on the lower part in symmetry with the mass diagram.

(2) The vertical axis shows calender months and the horizontal axis shows the survey point on the CTPS.

(3) At the right side of the same schedule is found the graph of earthmoving volume and the number list of main construction equipments needed (symmetry months of the CTPS).

3. Items to enter in the CTPS.

The barious functions in each kind/type of work are entered in the CTPS which manifest the relationship between the working days and the

work points (These will have to consider calender days in the working day's rate). Entry items as follow:

(1) Preparatory works : Preparatory drainage works, Engineering survey, Job site inspection prior to construction works.

(2) Temporary works : Construction works of the temporary office, the werehousing and the temporary housing for the workers, etc.

(3) Construction road : Approach of job site, the temporary bridge,

(4) Clearing and grabbing : These can be accomplished process of cutting and filling which also include stripping.

(5) Various earthwork : The cutting work devides the bedrock into some working blocks and estimate working days of each kind of construction equipments from earth volume of the blocks

(6) Bridge construction : Superstructure works, Substructure works, Foundation works.

(7) Retaining-wall works : Concrete retaining-wall, Block retaining-wall, etc.

(8) Culvert construction : Box culvert, Pipe culvert,etc.

(9) Irrigation and drainage works : Main works related to these.

(10) Shifted coustruction works : Shifted channel, Shifted road,etc.

(11) Other construction works : Enter in the schedule other construction which have influence on above.

Example :

Earthworking volume (cutting) : $40.000 m^3$

Working days rate : 0.7

Operating hour per day : 6.5 H/D

Production rate

Tractor shouel : $50 m^3/H$

Dump Truck : $13 m^3/H$

$$\text{Working days} = \frac{40.000}{50 \times 6.5} = 123 \text{ days}$$

Calender days = $123 \times \frac{1}{0.7} \fallingdotseq 176$ days

If calender days should be assumed obout 90 days neccesary number of Tractor shovel = $\frac{176}{90} \fallingdotseq 2$.

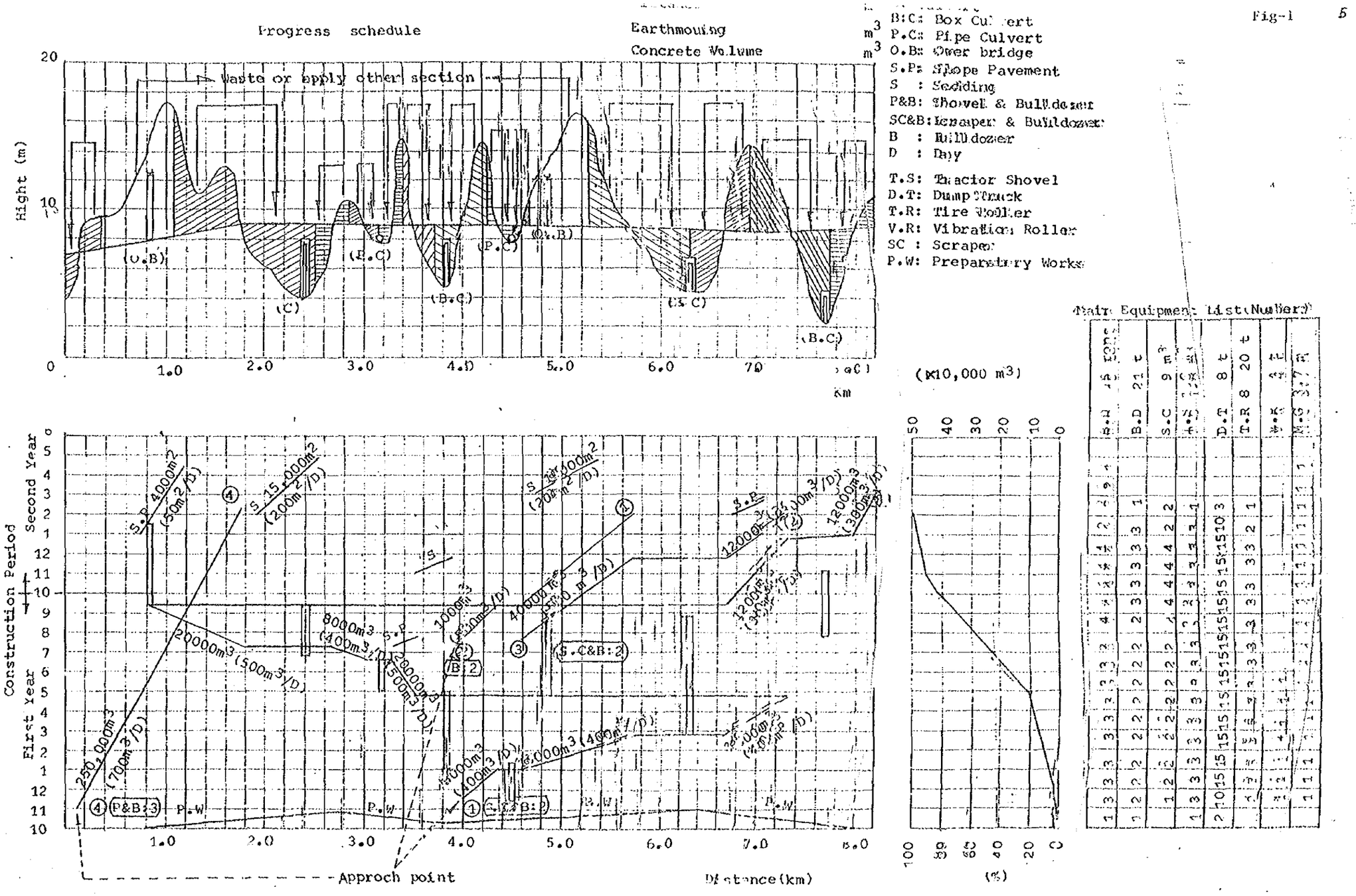
Neccesary number of Dump truck = $\frac{50 \times 2}{13} \fallingdotseq 8$

It is equally nessesary to investigate the arrangement of equipments at job site when increase equipments to be used.

(Explanation of Figure 1)

1. Vertical line in the drawing shows schedule of culvert and over bridge, therefor the Culvert near 2.4 Km point shows that construction period is neccesary July of the first year to September of the same year.
2. Slanting line shows the Slope Pavement, etc. The slope Pavement ($15.000m^2$) near 2 Km point shows that construction period is neccesary from February to May of second year.
3. Zigzag line shows schedule of earthwork.
4. Number of slanting line of earthwork and slope pavement shows working volume of the section and a plan of working volume per day.
5. Therefor in Jun of the first year the party 1 of earthwork is engaged to construct earthvolume ($20.000m^3$) at 3.4 Km point and the party 4 of earthwork is engaged to big volume construct earthwork. But the parties of 2 and 3 will not yet work and they will wait untill after construction of culvert and over bridge is accomplished.

Fig-1



B:C: Box Culvert
P.C: Pipe Culvert
O.B: Ower bridge
S.P: Slope Pavement
S : Seeding
P&B: Shovel & Bulldozer
SC&B: Scraper & Bulldozer
B : Bulldozer
D : Day

T.S: Tractor Shovel
D.T: Dump Truck
T.R: Tire Roller
V.R: Vibration Roller
SC : Scraper
P.W: Preparatory Works

Main Equipment List(Number)

	B.H 15 tons	B.D 21 t	S.C 9 m3	M.C	D.T 8 t	T.R 8 20 t	V.R 4 t	M.C
1	3	3	3	3	3	3	1	1
2	2	2	2	2	2	2	1	1
3	2	2	2	2	2	2	1	1
4	2	2	2	2	2	2	1	1
5	3	3	3	3	3	3	1	1
6	3	3	3	3	3	3	1	1
7	3	3	3	3	3	3	1	1
8	3	3	3	3	3	3	1	1
9	3	3	3	3	3	3	1	1
10	3	3	3	3	3	3	1	1
11	3	3	3	3	3	3	1	1
12	3	3	3	3	3	3	1	1
1	3	3	3	3	3	3	1	1
2	3	3	3	3	3	3	1	1
3	3	3	3	3	3	3	1	1
4	3	3	3	3	3	3	1	1
5	3	3	3	3	3	3	1	1
6	3	3	3	3	3	3	1	1
7	3	3	3	3	3	3	1	1
8	3	3	3	3	3	3	1	1
9	3	3	3	3	3	3	1	1
10	3	3	3	3	3	3	1	1
11	3	3	3	3	3	3	1	1
12	3	3	3	3	3	3	1	1
1	2	2	2	2	2	2	1	1
2	2	2	2	2	2	2	1	1
3	2	2	2	2	2	2	1	1
4	2	2	2	2	2	2	1	1
5	2	2	2	2	2	2	1	1
6	2	2	2	2	2	2	1	1
7	2	2	2	2	2	2	1	1
8	2	2	2	2	2	2	1	1
9	2	2	2	2	2	2	1	1
10	2	2	2	2	2	2	1	1
11	2	2	2	2	2	2	1	1
12	2	2	2	2	2	2	1	1
1	1	1	1	1	1	1	1	1
2	1	1	1	1	1	1	1	1
3	1	1	1	1	1	1	1	1
4	1	1	1	1	1	1	1	1
5	1	1	1	1	1	1	1	1
6	1	1	1	1	1	1	1	1
7	1	1	1	1	1	1	1	1
8	1	1	1	1	1	1	1	1
9	1	1	1	1	1	1	1	1
10	1	1	1	1	1	1	1	1
11	1	1	1	1	1	1	1	1
12	1	1	1	1	1	1	1	1

The importance of planning equipment use.

Some equipments may require an increase or decrease in the number of units used in the work process. Planning is therefor necessary in order to decrease vicissitude (i.e. that the number/units of equipments used per unit hour should be in proportion with number/units of equipments)

The Planning Process:

1. Design Work Schedule (Figure-2) considering, the number of units of each type of equipment required for daily use, and the projected construction period.
2. As shown in Figure-3 consolidate all schedules, for each type of equipment used in all stages of work process, into a MODIFIED SCHEDULE OF EQUIPMENTS USED (Figure-4). The series of steps/stages in the work process can be made flexible (where each steps/stage can be inter changed or re-arranged) to obtain optimum performance at economical cost as shown in Figure-5.

To design a specific Schedule of Use for each Kind of equipment refer to the MODIFIED SCHEDULE OF EQUIPMENTS USED. Spare-equipment supply listing in combination with plan of construction and condition of job site will point out trouble equipments, and thereby dispose of the same.

A very convenient PROGRESS CHART is then drawn /and plotted out, based on work PLAN and EQUIPMENT-USED PLAN, which should contain:

1. staff plan/schedule (i.e. drivers and assistants assigned to operate each groups type of equipments)
2. equipment-supplies plan/schedule
3. maintenance and repair plan/schedule (at job site)
4. spare-parts replenishment and disposal plan/schedule
5. fuelling and lubrication plan/schedule.

Construction Schedule
แผนงานก่อสร้าง

Fig-2

Type of work	Summary	Q,ty	2527	2528	2529
Preparatory Work	Survey, temporary facitities, Preparatory, drainage	1 Set			
Clearing and Grubbing		28,000 m^2			
Excavating & Banking	Sediment Soft rock	411,300m^3			
Slope pavement	Sodding Seeding	34,300m^2			
Culvert	Pipe Cancrete 6 Box Concrete 2	8			
Bridge	P.C beam	1			
Foundation	Sand pile Sand compaction	56,000M			
Tunnel	Excavation, Concrete	365m			
Other		1 Set			

Schedule of equipments used of each kind of work
แผนการใช้เครื่องจักรสำหรับงานแต่ละชนิด

Fig-3

Type of work	Machine	Specification	No of machine	2527	2528	2529
Clearing and Grubbing Excavating and Banking	Bulldozer	27 t Ripper	1			
	Bulldozer	19t,	3			
	Bulldozer	14t Semp	4			
	Tractor Shovel	1.8 m	3			
	Tractor Shovel	1.1m^3				
	Hydraulic Shovel	Back hoe 0.3 m^3	1			
	Dump truck	11t				
	Tire Roller	10 15 t	1			
	Motor Grader	3.7 m	1			
Culvert	Tractor shovel	1.1 m^3	1			
	Hydraulic Shovel	Back hoe 0.3 m^3	1			
	Dump truck	11t	1			
Bridge	Tractor shovel	1.1 m^3	1			
	Hydraulic Shovel	Back hoe 0.3 m^3	1			
	Concrete pump	40 m^3	1			
Foundation	Sand pile	U106ASL	2			
	Sand compactor		1			
	Tractor Shovel	1.1 m^3	1			
	Compressor	150 PS	1			
	Generator	200 KVA	1			
Tunnel	Tractor Shovel	1.6 m^3	1			
	Tractor Shovel	1.1 m^3	1			
	Dump Truck	11 t	4			
	Compressor	150 PS	1			
	Concrete Pump	40 m^3	1			
	Generator	200 KVA	1			
	Generator	100 KVA	1			

Schedule of equipments used of each kind equipment

แผนการใช้เครื่องจักรแต่ละชนิด

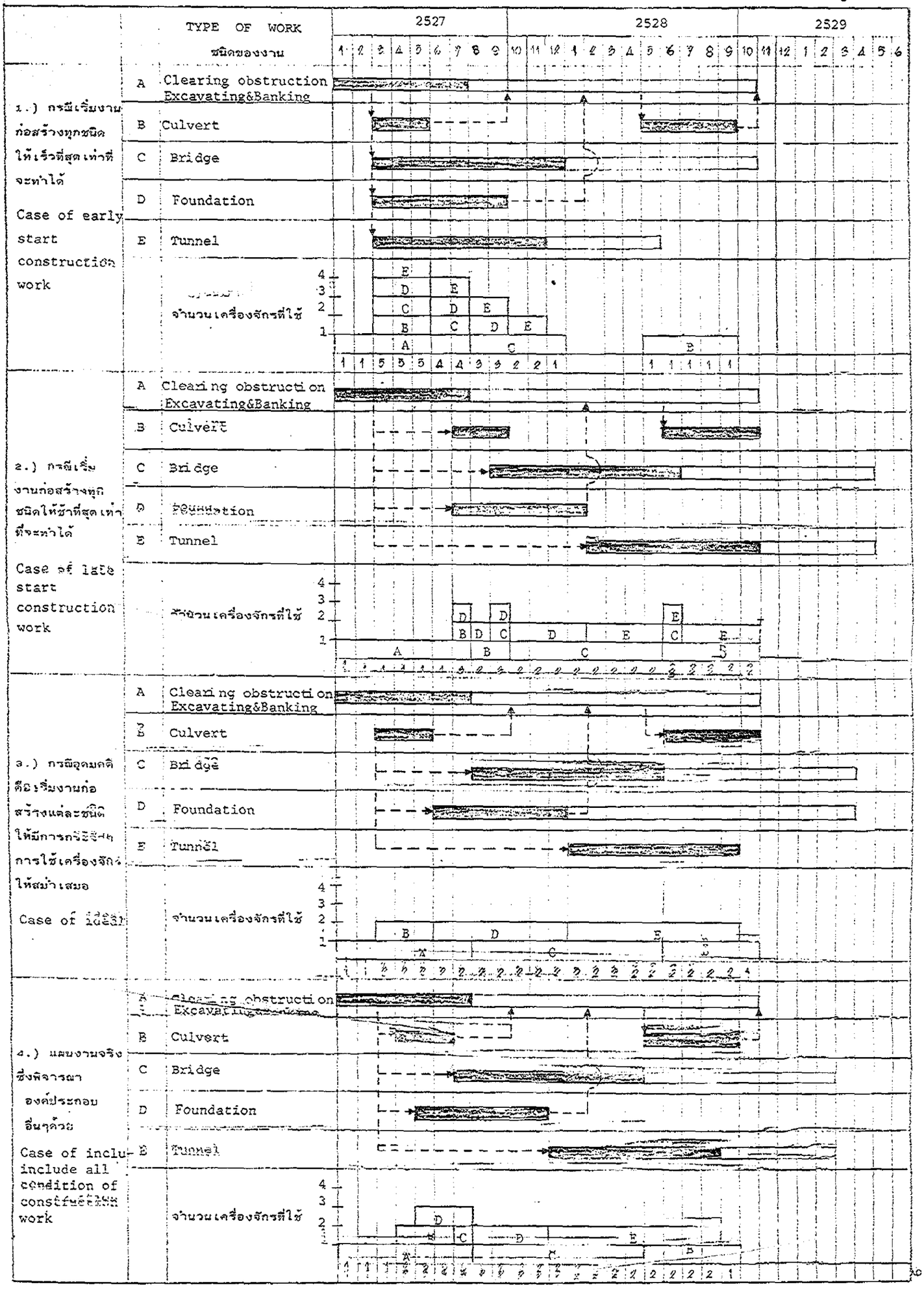
Fig-4

Machine	Capacity	2527									2528												2529								
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6
Bulldozer	27 t; Ripper			1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1												
Bulldozer	19t			1	1	2	2	2	2	3	3	3	3	3	3	3	3	3	3	2	2	1	1	1							
Bulldozer	14t, Swamp			2	2	2	2	3	3	4	4	4	4	4	4	4	4	4	4	3	3	2	2	2	2						
Tractor Shovel	1 8 m^3			1	1	1	1	3	3	3	3	3	4	4	4	4	4	4	4	4	4	2	2	1	1	1	1				
Tractor Shovel	1.1 m^3	1	1	1	2	4	4	3	2	2	2	2	2	2	2	2	2	3	3	3	3	2	1								
Hydraulic shovel	Backhoe 0.3 m^3	1	1	1	1	1	1	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1									
Dump truck	11 t	2	2	5	6	9	9	10	10	10	10	10	10	10	10	10	10	10	10	10	10	11	11	5	5	5	5				
Tyre Roller	10-15 t	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1						
Motor Grader	3.7 m	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1							
Sand Pile	U 106ASE					2	2	2	2	2	2	2																			
Sand Compactor						1	1	1	1	1	1	1																			
Concrete Pump	40 m^3					1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1				
Compressor	150 ps					1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1										
Generator	200					1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1						
Generator	100												1	1	1	1	1	1	1	1	1										

Example : Schedule of Equipments used (T.S 1.1 m^3 from Figure-3)

ตัวอย่างการวางแผนงานก่อสร้างโดยพิจารณาการใช้เครื่องจักร

Fig-5



appendix-9

FUNDAMENTAL KNOWLEDGE OF MAINTENANCE

March 23, 1984.

Kanchanaburi Equipment Training Center

Jinichi YAMADA

Contents

Fundamental Knowledge of Maintenance

1. Management of Maintenance

The present. D.O.H. has many kinds of equipments (about 15.000 - units in all).

D.O.H should perform the succeding in order to use many kinds of equipments effectively. The msintenamce of these equipment must be carried out so that it's utility can be fully displayed. Maintenance should cover careful inspection and servicing through the use it testers and measuring instruments in accordance with specified standards so that the utility of equipments can be fully demonstrated. Maintenance work must be performed accurately and efficiently. For this purpose, there are many precautions which all formen and servicemen should fully understand in the performance of their maintenance work, such as :

(1) Comprehension of fundamental work techniques

(2) Planning and implementation of work method and procedures

(3) Records Maintenance

(4) Accurate judgment and improvement of technigue

(5) Control of tools and parts

(6) Orderliness of work shop

1 - 1 Comprehension of fundamental work techniques

Inorder to perform the accurate maintenance of equipments, the fundamental work movements of maintenance workers must be accurate and precise. For the correct performance of maintenance work, all mechanices should fully undesstand all fundamental work procedures for maintenance of equipments (i.e.the use of machine tools, the use of measuring instruments, washing method,the removal and installation of mechanical parts,etc.),and they should faithfully carry out such procedures. Inaccurately repaired and maintained equipments will not be able to withstand actual construction work these will have to be sent back to the work shop for repair even if it appeared to in

perfect condition at the time of delivery. It is therefore necessary to perform reinspection of equipments after maintenance work has been completed. It is equally necessary to confirm that equipments are thoroughly repaired and serviced by using testers and measuring instruments.

1 - 2 Planning and implementation of work method and work procedures

Duplication of functions decreases the efficeincy of mainténance work on equipments. In order to avoid this maintenance of equipments must be systematically carried out in accordance with a well devised plan. Since there are many kinds of maintenance work, these is not one single case where same kind of maintenance job is performed repeatedly, but there may be cases where there is a similarity in equipment by model and there is no big difference between the conditions of equipments when they are sent to the work shop. Therefor, it is possible to devise maintenance methods and work procedures which for use as maintenance standord for each type of equipment. It is necessary to prepare a standard manual for work procedures for each model of equipment and to have all mechanics fully understand and implement such procedures. It is also desirable that other reference materials (i.e. color classified drawings and photographs suitable each type of equipment) be prepared.

1 - 3 Records Maintenance

Management records are useful for selecting proper methods of work execution and calculating the cost of construction by means of checking the actual operation record of necessary equipments, and the amount of various expenses sequired for the operation of these equipments. It is also necessary to continuously record the result of measuring of equipment parts to find out the degree of wear and tear of parts not replaced at the time of maintenance. As a method of recording, all operators are required to write down the day's work in a daily record sheet which are then consolidated into a monthly record of equipments. The of monthly

record is then entered in the history book of equipments. The contents of maintenance work are incorporated in the maintenance record of equipment, while the outline and cost of maintenance work are recorded in the history book of equipment. At the work shop, efforts should be made to establish a preventive maintenance system applicable to the maintenance of all equipments after the date of its purchase.

1 - 4 Accurate judgement and improvement of techniques

Mechanecs are required to have both theoretical knowlege and actual, on-the-job experiance to be able to comprehend the condition of equipments accurately and make a correct judgement in the proper repair and maintenance of the same. This can prevent, minimize if not anticipate future problems corvering maintenance of such complicated equipments. Knowlege of equipment condition can be down with accuracy. The responsible mechanic must first ask the operator of the equipment also the condition of the equipment, (how it has been functioning) and second he must operate and imspect the equipment by himself. Review of past maintenance records is equally important and, to make an objective judement of the equipment conduct proper inspection by using testers and measuring instruments. Therefore D.O.H. will have to train and develop qualified/skilled mechanics. After which, send these skilled mechanics for work shops to improve level of general technolagy including facility tools, and reinforcement of inspection and testing functions.

1 - 5 Control of tools and parts

To perform maintenance of equipments efficently, D.O.H must pay attention to the proper management of tools and parts, and procure required spare parts and tools. The kinds, quantity and quality of tools must be selected by studying the requirements of maintenance. Effective utility of special tools and machines and regular tools can improve the efficiency of maintenance. Mechanics must be able to judge the condition and cause of faulty equipment by utilizing measuring instruments in the inspection of same.

Poor tools and inadequate facilities can not aid mechanics at work shop in excuting repair and maintenence of equipments in perfect condition. Time is wasted in the repair of equipments and availability of equipments is decreased. Poorly maintained machines pose as hazard for operators and mechanics. D.O.H have to give due consideration in the procurement and maintenance of tools and repair facilities. Necessary parts must be stocked as per economical standard. Proper stock and prompt delivery system is most important for the function of parts control. Also full attention is necessary for dustproofing and moistureproofing.

1 - 6 Orderliness and cleanliness of work shop

It is important to keep tools and other devices in order, and the work shop clean at all time to preserve the safety of mechanics, improve efficiency and perform accurate maintenance. Parts of each section of equipments must be separately stored as to similar parts; location must be accurately comfirmed and memorized when equipments are disassembled and reassembled. Otherwise,it would become impossible to judge each piece of parts whether it is good or poor after disassembly. Also time and motion is wasted in locating proper parts thereby decreasing work efficiency to reassemble. It is desirable that shelves with door be provided for storing parts and tools (three-dimensional) to protect it from dust. Since dust is harmful to equipments especially when they are disassembled and reassembled,the work shop must be kept clean at all times.

2 Normality and Abnormality

(Function ,heat treatment of material,points of rapair)

2 - 1 Elements of machine

The elements of a machine are individual parts which composes a machine like for a instance a key, a shaft and a gear,etc. Since a machine is composed of the combination of these individual elements, if a weak element is mixed in the combination of a machine,it may problem and malfuntion all

the time and it creates a weak point in the machine. Consequently, a perfect machine can be composed on condition that all individual machine elements used in it are in perfect working condition. Since machine elements are required to perform respective functions, they are most rationally designed and manufactured in shape, accuracy, suitability, material and heat treatment to perform such functions. In maintaining a machine, at first all madhine elements must be inspected in accordance with a standard for maintenance, as to each element:

A. You should check it whether it is normal or not.

B. If it is not normal, you should determine whether it should be simply repaired or improved after reviewing the causes of its abnormality.

C. Then, you should determine whether it is to be replaced with a new part, or it should be internally repaired (restoration or improvement), then perform the work.

D. Lastly, you should make inspection of the element.

2 - 2 Normality

The normal condition of an element means that it has no abnormality such as damaged portion and excessive wear, etc. When it is in it's normal condition, it should be properly serviced by cleaning, and chainging oil or grease as required and then restored back in the machine.

2 - 3 Restoration and improvement of element when it is abnormal

Due to its nature, an equipment, even though it is a perfect product, may generate abnormalities such as partial damage or excessive wear of certain parts, etc. Depend on sever working conditions erroneous operation, improper maintenance or other cases. In this case, it is enough to simply restore the faulty part and improve one of the above item which caused the trouble. Onthe contrary , there is a possibility that a certain product partially has potential weak points.

In such a case,it is desirable than you should consult with the equipment's producer/manufacture. Such weak points must then be improved,these measures can be considered: the change of material and the reinforcement of the part for damaged part,and the change of the material,face hardening,installation of hardened bush,etc. for wear of part,and improvement of hardness of part by heat treatment for the collapse of part,and it is necessary to take countermeasures suitable to the phonomena.

2 - 4 Precautions for repairing equipments

(1) Elements must be carefully stored and protected from rust and damage .

(2) The accuracy and fitting allowance of elements must be well recognized.

(3) As methods of heat treatment, there are quenching and tempering methods which must be aimed at giving toughness to a part and induction hardening and carburizing to harden the surface of a part.

(4) In repairing a part by welding, the influence of thermal stress must be avoided as much as possible.

2 - 5 Abnormality

A. Damage

The damage of a part is generally composed of breakage, yielding (elongation,collapse) and crack.

B. Breakage

The breakage of a part is such a phenomenon that it is torn or broken and it begins with the generation of cracks in many cases. Is is important to deted the condition of crack earlier and repair it ealier as well. In order words, preventive maintenance is very important.

C. Yielding

This is such a phenomenon that a bolt elongates or neck of a

spline twists being yielded by repetitive impacts and excessive load. And such a phenomenon where a key collapses being struck is a kind of impact yielding. This phenomenon can be easily detected by external inspection.

D. Crack

Welded beads portions, the foot of tooth of a gear and notched portions such as the bottom of key and spline may generate cracks as they are repeatedly applied with impact loads. These portions must be inspected by color check, magnetic method and supersonic wave flaw detction method at the time of overhauling.

E. Abnormal abrasion

(a) Nibbling abrasion, seizure

This is caused by poor lubrication or dust entered the machine by the breakage of seal.

(b) Abrupt abrasion

A machine element wears out quickly and faster than estimation.

(c) Pitching

Such a phenomenon that small holes are generated on the tooth surface of a gear or rotating surface of a roller bearing is called as speckled abrasion phenomenon and it is generally called pitching. As this abrasion is seen, the abrasion of the machine element progresses rapidly,but some pitching phenomenon stops at certain degree.

(d) Fretting corrosion

This is a kind of corrosive abrasion and this appears in the race of a roller bearing, in the joint of axis and a housing in some cases. The progressing condition of abrasion of a machine element can be classified as follows from the relation between the speed of abrasion and the

lapse of time.

(1) Initial abrasion

The abrasion of a machine element takes place from the beginning of its use to the time when it becomes fit.

(2) Constant abrasion

Constant abrasion means such abrasion after a machine element was once properly fitted into its position, and the abration of some elements gradually and linearly increasing, that of other's ones increasing sharply from a certain point, and that of another gradually saturating. (This abrasion includes pitching abrasion stated above.) The characteristics of progressing condition of these kinds of abrasion will be usefull in determining the limit of use of machine elements at the time of overhauling of equipments based on the limit of use for old parts provided in the standard for maintenance.

F Excessive play

The term means,such a phenomenon in a gap between machine elements becames larger than its designed value and is caused by the callapse of a material or the abrasion of an element, for instance. The excessive play of the major parts of a machine such as swing rollers of a shovel,upper and lower rollers links and rollers of a bulldozer,quickly increases and it in turn gives adverse influence on the overall impact and vibration of the machine unless it is quickly repaired.

Consequently,it is important to quickly repair an excessive play between machine elements in the early stage of its generation. In the case of a play between ordinary machine parts,for instance, when a key becomes loose, it generates an excessive play and eventually breaks its counterpart (for instance, a boss). These excessive plays may be caused by

such a reason that a key was installed loose at the time of its initial assembly or by loose bolts for which periodical tightening was neglected in many cases. Therefore, case should be exercised to perform periodical tightening of bolts and machine elements.

G Fitting of machine elements

If the fitting between a key and a key groove, a shaft and the inner race of a roller bearing is not appropriate, those excessive plays between elements are generated and they become the cause of a serious trouble or malfunction of a machine. In short, as to the maintenance of machine elements, like that of a whole machine, it is important to carry out preventive maintenance of those elements for the purpose of preventing troubles and abrasion of those elements, and then it is necessary to inspect them for abnormality, make judgement and take necessary actions to correct or repair those abnormalities thus detected.

3 Procedure for lubrication control

If you know the fact that 25 to 30 % of the machine failures are directly or indirectly caused by lubrication, you will understand that lubrication control is very important in the system of preventive maintenance. And lubrication gives not only a direct merit of decreasing lubrication accidents but also another merit to see, that the lives of pasts are elongated, allowing repair expenses to be saved. Lubrication control is not limited to supply of lubricating oil. It includes many technical problems such as oil leak and selection of proper lubrication oil and the problem of organization.

3 -1 Selection of lubricating oil

(1) Ask the opinions of the machine maker and oil dealers and

examine the manual.

(2) Select the kinds of oil which can over as wide ranges as possible(a small number of kinds of oil allows the control to be simplified).

(4) Investigate the performance and prices of lubricants thoroughly. It should not occur that low - priced lubricating oil aften causes failures and deteriorates parts fast.

(5) The propriety of afterservice is also important point.

3 - 2 General lubricarion instructions

There are many kind of equipments in D.O.H, lubrication is a highly essential part of daily maintenance, determine to a great extent the life of parts and equipments. When having recieved a equipment, be sure tocheck water and oil levels and make sure that the equipment is ready for operation.

(1) Service intervals are based on service meter readings.

(2) Always place the equipment in a level position when checking the oil level.

(3) Thoroughly wipe clean all lubricating points with wire brush, rag, etc., before applying lubricants.

(4) Draining the oil must be done while the engine is warm immediately after the engine stops.

(5) Lubricate those miscellaneous points,not equipped with fittings, like pins and yokes, with engine oil.

3 - 3 Storage of lubricating oil

The storage of lubricating oil and grease requires careful control.

A Storage

(1) Indoor storing is best .

(2) For inevitable outdoor storing,the drums should not be

placed directly on the ground,but on wood,etc. If the temperature changes suddenly, more water is liable to be gathered. The reason is that the container expands and contracts due to temperature defference between day and night, to allow open air to enter through the clearances of the container, causing the moisture in air to be absorbed in oil and condensed. If oil is exposed to derect rays of the sum, the oxidation of oil is promoted, to deteriorated the oil. In case of outdoor storage, covering is requied to avoid direct rays of the sun.

(3) A drum stored in outdoor open sir should be placed on its side to allow easy recognition of the brand.

(4) When the drum is placed upright, it had better be kept a little inclining with the mouth piece above,not to a allow water to be collected.

(5) The cover of a container should be closed tightly.

(6) Oil of the same item should be placed at the same location. Arrangement should be planned to facilitate the use of the oldest product remaining there.

B Opening and closing

The container should be slowly opened without giving impact. Especially Thailand is very hot, oil expands due to high temperature, and an unexpected accident may be caused, The loosened air plug should be tightened without fail.

c Washing of the container

(1) The container should be used after removing water, dust, metal powder,etc, perfectly.

(2) When washing oil used, additional washing should be done, using the same oil as contained in it.

(3) After the end of washing, the cover should be closed without fail.

appendix-10

ตารางกำหนดบริการ

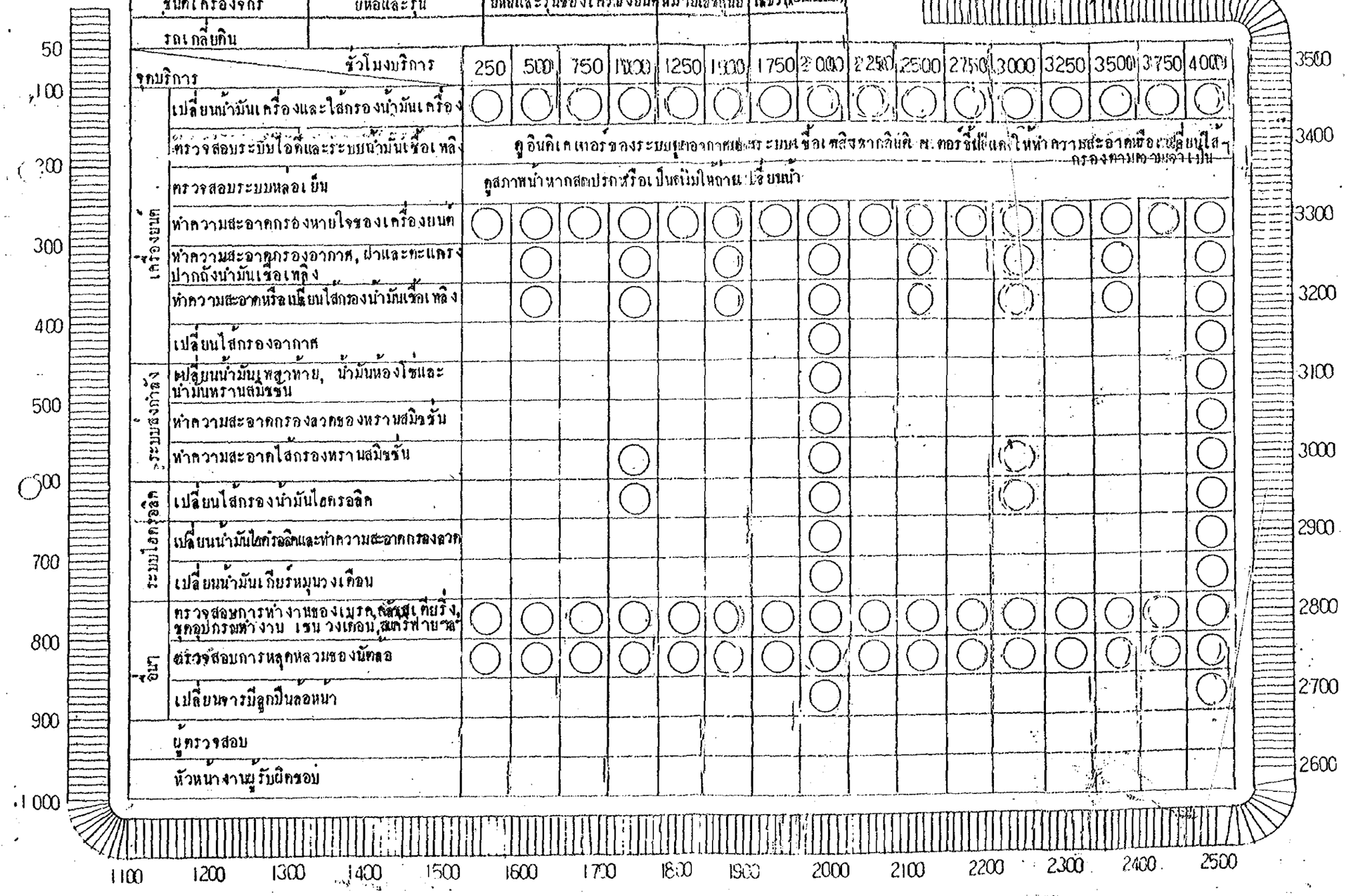
ชนิดเครื่องจักร	ยี่ห้อและรุ่น	ยี่ห้อและรุ่นของเครื่องยนต์	หมายเลขหน่วย	ผู้ขาย (ตัวแทนจำหน่าย)
รถแทรกเตอร์หรือรถตักตีนตะขาบ				

จุดบริการ \ ชั่วโมงบริการ	250	500	750	1000	1250	1500	1750	2000	2250	2500	2750	3000	3250	3500	3750	4000
เครื่องยนต์ เปลี่ยนน้ำมันเครื่องและไส้กรองน้ำมันเครื่อง	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
เครื่องยนต์ ตรวจสอบระบบไอดีและระบบน้ำมันเชื้อเพลิง	ดูอินดิเคเตอร์ของระบบดูดอากาศและระบบเชื้อเพลิงหากอินดิเคเตอร์ขึ้นสีแดงให้ทำความสะอาดหรือเปลี่ยนไส้กรองตามความจำเป็น															
เครื่องยนต์ ตรวจสอบระบบหล่อเย็น	ดูสภาพน้ำหากสกปรกหรือเป็นสนิมให้ถ่ายเปลี่ยนน้ำ															
เครื่องยนต์ ทำความสะอาดกรองหายใจของเครื่องยนต์	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
เครื่องยนต์ ทำความสะอาดกรองอากาศ, ฝาปิดถังน้ำมันเชื้อเพลิงและตะแกรงปากถังน้ำมันเชื้อเพลิง		○		○		○		○		○		○		○		○
เครื่องยนต์ ทำความสะอาดหรือเปลี่ยนไส้กรองน้ำมันเชื้อเพลิง		○		○		○		○		○		○		○		○
เครื่องยนต์ เปลี่ยนไส้กรองอากาศ								○								○
ระบบส่งกำลัง เปลี่ยนน้ำมันทรานสมิชชั่น				○				○				○				○
ระบบส่งกำลัง ทำความสะอาดกรองแม่เหล็กและกรองหายใจของระบบทรานสมิชชั่น	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
ระบบส่งกำลัง เปลี่ยนไส้กรองน้ำมันทรานสมิชชั่น	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
ระบบส่งกำลัง เปลี่ยนน้ำมันไฟนัลไดรฟ์				○				○				○				○
ระบบไฮดรอลิค เปลี่ยนไส้กรองน้ำมันไฮดรอลิค		○		○		○		○		○		○		○		○
ระบบไฮดรอลิค เปลี่ยนน้ำมันไฮดรอลิค ทำความสะอาดกรองดูด								○								○
อื่นๆ ตรวจการทำงานของเบรคและสเตียริ่ง	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
อื่นๆ ปรับความตึงของโซ่ตีนตะขาบ	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
อื่นๆ ตรวจการทำงานของอุปกรณ์ทำงาน เช่น ใบมีด, รีปเปอร์	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
ผู้ตรวจสอบ																
หัวหน้างานผู้รับผิดชอบ																

ตารางกำหนดการบริการ

ชนิดเครื่องจักร	ยี่ห้อและรุ่น	ยี่ห้อและรุ่นของเครื่องยนต์	หมายเลขรุ่นย่อย	เลขรหัส(SERIAL)
รถเกลี่ยดิน				

รายการ \ ชั่วโมงบริการ	250	500	750	1000	1250	1500	1750	2000	2250	2500	2750	3000	3250	3500	3750	4000
เครื่องยนต์ เปลี่ยนน้ำมันเครื่องและไส้กรองน้ำมันเครื่อง	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
ตรวจสอบระบบไอดีและระบบน้ำมันเชื้อเพลิง	ดูอินดิเคเตอร์ของระบบดูดอากาศและระบบเชื้อเพลิงหากสกปรกให้ทำความสะอาดหรือเปลี่ยนไส้กรองตามความจำเป็น															
ตรวจสอบระบบหล่อเย็น	ดูสภาพน้ำหากสกปรกหรือเป็นตะกรันให้ถ่ายและเปลี่ยนน้ำ															
ทำความสะอาดกรองหายใจของเครื่องยนต์	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
ทำความสะอาดกรองอากาศ, ฝาและทะแกรงปากถังน้ำมันเชื้อเพลิง		○		○		○		○		○		○		○		○
ทำความสะอาดหรือเปลี่ยนไส้กรองน้ำมันเชื้อเพลิง		○		○		○		○		○		○		○		○
เปลี่ยนไส้กรองอากาศ								○								○
ระบบส่งกำลัง เปลี่ยนน้ำมันเฟืองท้าย, น้ำมันห้องโซ่และน้ำมันทรานสมิชชัน								○								○
ทำความสะอาดกรองลวดของทรานสมิชชัน								○								○
ทำความสะอาดไส้กรองทรานสมิชชัน				○				○				○				○
ระบบไฮดรอลิค เปลี่ยนไส้กรองน้ำมันไฮดรอลิค				○				○				○				○
เปลี่ยนน้ำมันไฮดรอลิคและทำความสะอาดกรองลวด								○								○
เปลี่ยนน้ำมันเกียร์หมุนวงเดือน								○								○
อื่นๆ ตรวจสอบการทำงานของเมาร์, คลัทช์เทียริ่ง, ชุดอุปกรณ์ทำงาน เช่น วงเดือน, สกรีฟายร์	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
ตรวจสอบการหลุดหลวมของนัทลอ	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
เปลี่ยนจารบีลูกปืนล้อหน้า								○								○
ผู้ตรวจสอบ																
หัวหน้างานผู้รับผิดชอบ																



ตารางกำหนดบริการ

ชนิดเครื่องจักร	ยี่ห้อและรุ่น	ยี่ห้อและรุ่นเครื่องยนต์	หมายเลขเครื่องยนต์	เลขรถ(ถ้ามี)
รถตักล้อยาง				

จุดบริการ \ ชั่วโมงบริการ	250	500	750	1000	1250	1500	1750	2000	2250	2500	2750	3000	3250	3500	3750	4000
เครื่องยนต์ เปลี่ยนน้ำมันเครื่องและไส้กรองน้ำมันเครื่อง	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
เครื่องยนต์ ตรวจสอบระบบไอดีและระบบน้ำมันเชื้อเพลิง	ดูอินดิเคเตอร์ของระบบดูดอากาศและระบบเชื้อเพลิงหากมีสิ่งอุดตันให้ทำความสะอาดหรือเปลี่ยนไส้กรองตามความจำเป็น															
เครื่องยนต์ ตรวจสอบระบบหล่อเย็น	ดูสภาพน้ำหากสกปรกหรือเป็นสนิมให้ถ่ายเปลี่ยนน้ำ															
เครื่องยนต์ ทำความสะอาดกรองหายใจของเครื่องยนต์	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
เครื่องยนต์ ทำความสะอาดกรองอากาศ,ปั๊มน้ำมันเชื้อเพลิงและหัวฉีดน้ำมันเชื้อเพลิง		○		○		○		○		○		○		○		○
เครื่องยนต์ ทำความสะอาดหรือเปลี่ยนไส้กรองน้ำมันเชื้อเพลิง		○		○		○		○		○		○		○		○
เครื่องยนต์ เปลี่ยนไส้กรองอากาศ								○								○
ระบบส่งกำลัง เปลี่ยนไส้กรองน้ำมันทรานสมิชชัน		○		○		○		○		○		○		○		○
ระบบส่งกำลัง เปลี่ยนน้ำมันทรานสมิชชัน				○				○				○				○
ระบบส่งกำลัง ทำความสะอาดกรองลวด, กรองแม่เหล็กและกรองหายใจของระบบทรานสมิชชัน				○				○				○				○
ระบบส่งกำลัง เปลี่ยนน้ำมันเฟืองท้ายและน้ำมันไฟนัลไดรฟ์								○								○
ระบบไฮดรอลิค เปลี่ยนไส้กรองน้ำมันไฮดรอลิค		○		○		○		○		○		○		○		○
ระบบไฮดรอลิค เปลี่ยนน้ำมันไฮดรอลิค,ทำความสะอาดกรองลวด								○								○
อื่นๆ ตรวจสอบการทำงานของเบรค	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
อื่นๆ ตรวจสอบข้อบกพร่องของระบบสเตียริ่ง	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
อื่นๆ ตรวจการทำงานของอุปกรณ์การทำงาน เช่น การยกและควบคุมงานบูม	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
ผู้ตรวจสอบ																
หัวหน้างานผู้รับผิดชอบ																

TYPE	MAKE & MODEL	ENGINE MAKE&MODEL	SERIAL NO	UNIT NO	DATE	HOURMETER READIN	INSPECTER

			D R	D L	M R	M L
Track	1	Idler oil leaks,wear,crack				
	2	Idler plate wear,bolt loose				
	3	Track link tension				
	4	Carrier roller,oil leaks,wear,bolt loose				
	5	Track roller,oil leaks,wear,bolt loose				
	6	Track guard,damage,bolt loose				
	7	Sprocket oil leak				
	8	Sprocket teeth,wear,bolt loose				
	9	Track link,pin,bushing wear,damage				
	10	Track shoe,lug wear,damage				
	11	Shoe bolt loose				
	12					
	13					
Frame	14	Track frame crack				
	15	Main Frame crack				
	16	Equalizer bar setting pad damage				
	17	Final drive oil level,dirty				
	18	Final drive element change				
	19	Engine,T/M,under guard deformation				
	20					
	21					
Work Equipment	22	Arm wear crack				
	23	Trunnion,wear,bolt loose				
	24	Blade,wear,crack,pin damage				
	25	Edge,Bit wear,bolt loose				
	26	Blade cylinder oil leaks				
	27					
	28					
	29	Ripper shank,protector,point wear				
	30	Ripper drawbar bolt loose				
	31	Ripper cylinder oil leaks				
	32	Ripper shank beam crack				

			D	M
Engine,radiator,Electrical ect.	33	Fuel tank water trap drain		
	34	Radiator water level,rust deposits,scale		
	35	Radiator leaks		
	36	Water pump		
	37	Fan belt adjustment		
	38	Engine oil level,oil deterioration		
	39	Engine breather clean,element change		
	40	Engine oil leaks,water,gas leaks		
	41	Air cleaner,clean		
	42	Engine,sound & exhaust gas,burn		
	43	Engine,support,bolt loose		
	44	Manifolds		
	45	Engine controls		
	46	Governer		
	47	Fuel Filters,change		
	48	Lubrication points		
	49	Oil cooler		
	50	Batteries check,clean		
	51	Generator		
	52	Starter		
	53	Switches		
	54	Wiring		
	55	Fuel pump or B&F pump		
	56			
	57			
Transmission	58	T/M oil level,oil leaks,oil deterioration		
	59	T/M element change		
	60	T/M magnetic strainer clean		
	61			
	62			
	63			
	64			

			D	M
Torque Converter Hydraulic System	65	Hydraulic oil level,oil deterioration		
	66	Hydraulics element change		
	67	Links & connections oil leaks		
	68	General operation		
	69	Lubrication points		
	70			
	71			
	72			
	73	Torque converter,clutch operation adjust		
	74	Steering clutch operation adjustment		
	75	Steering brake operation adjustment		
	76	Brake and locks		
	77	Lubrication points		
	78			
	79			
Gauges	80	Hourmeter		
	81	Ammeter		
	82	Voltmeter		
	83	Fuel meter		
	84	Oil pressure		
	85	Water temperature		
	86	Air pressure		
	87			
	88			
	89			
	90			
Miscellaneous	91	Blade operation		
	92	Ripper operation		
	93			
	94			
	95			
	96			

Detail of defect action required

Remarks

×	need adjustment	S	Service
××	need exchange	C	Clean
×××	need repair	A	Adjustment
T	Tighten	V	Good