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ENCLOSURE (H)

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REPORT ON
NISSAN EKITAI NENRYO CO., LTD.
WAKAMATSU PLANT

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ENCLOSURE (B)I. INTRODUCTION

The Wakamatsu low-temperature coal carbonization plant, of the NISSAN EKITAI NENRYO K. K., was inspected by the Petroleum Section of the U. S. Naval Technical Mission to Japan, during the period 24-25 October, 1945. This report records and summarizes the technical information obtained during this visit. Japanese personnel connected with the plant, who assisted in supplying this information, were as follows:

Mr. N. YAMADA	Director of Plant.
Mr. S. KUNII	Head of Carbonization and Refining Departments.
Mr. T. FUJIO	Head of Mechanical Dept.
Mr. T. MONDEN	Office Manager.

II. HISTORY AND ORGANIZATION

The company was founded on 25 February 1939, with an initial capitalization of 10,000,000 Yen, and construction was started on a plant at WAKAMATSU, to produce oil from coal mined nearby in the Orio district of NORTH KYUSHU. The design of the low-temperature carbonization plant was based on the patents of the Lurgi-Gesellschaft, Frankfurt-am-Main. Complete licensing rights for this process had been purchased by the Teikoku Nenryo Co., Ltd., who in turn, sub-licensed to the Nissan Ekitai Nenryo Company. The first units of the Wakamatsu plant were completed in March 1941, and consisted of a Lurgi low-temperature retort of 300 tons/day coal charge capacity plus tar separating and light oil distilling equipment. Production of gasoline, fuel oil and semi-coke was started. Additional refining equipment, including tar distillation, light oil treating, and de-waxing units, were completed by the middle of 1942, and from that time on, the plant produced motor gasoline, diesel oil, fuel oil, pitch, semi-coke (coalite) and raw wax.

Three German engineers from Lurgi-Gesellschaft assisted in the construction and acceptance tests of the first units. Mr. Finkbeiner arrived in September, 1940, Mr. Erb in December, 1940 and Mr. Bruggeman in March, 1941. All three departed in June, 1941.

In September, 1941, the Japanese Government ordered an extension of the plant, and work was started on the construction of three additional low-temperature retorts plus auxiliary equipment. For this extension, the capitalization of the company was increased to 15,000,000 Yen on 22 December 1941, and a special "accommodation" loan of 15,000,000 Yen additional was obtained from the Teikoku Nenryo Company. The first additional unit was completed in May, 1943, the second in May, 1944, and the third in November, 1944. In connection with this extension, the company also undertook installation of additional tar distilling and dewaxing units, also gasoline and phenol distillation equipment. This equipment was still in the process of construction in October, 1945. To finance this construction, the capitalization was increased, on 15 November 1944, to 25,000,000 Yen.

The plant maintained steady production with two or three units continuously on stream until the fire-bomb raid of 8 August 1945. Although damage was relatively light, destruction of the central tar oil pumping room necessitated a shut down of the entire plant. It was anticipated that production would be started again in November, although the supply of coal was becoming critical due to labor difficulties at the mines.

In the initial establishment of the company, it was planned to install a pilot plant for the hydrogenation of tar oils, and reaction vessels had been ordered from the Krupp Corp. in Germany. These vessels were not delivered and other

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items required were never ordered, due to increasing difficulties in procuring construction materials.

The main offices of the company are located in TOKYO, and at present, of the total capitalization of 25,000,000 Yen (20,000,000 paid up), the Teikoku Nenryo Company owns 50 per cent and the balance is largely held by the Nippon Kogyo Co., Ltd. (Nippon Mining Co.) The top management of Nissan Ekitai Nenryo Co. is as follows:

President:	Mr. M. FURUKAWA
Directors:	Mr. J. TANAKA Mr. N. YAMADA Mr. E. SUZUKI Mr. T. YAMADA Mr. S. UCHIDA
Inspectors:	Mr. S. NATSUBORI Mr. R. KUMADA
Counsellors:	Mr. M. FUJITA Mr. M. TAKASHIMA

The management of the Wakamatsu plant is as follows:

Mr. H. YAMADA	Plant Director
Mr. S. KUNII	Head of Low-Temp. Carb. and Tar Oil Refining Depts.
Mr. T. FUJII	Head of Mechanical Dept.
Mr. T. MONDEN	Office Manager

Before the end of the war, the plant had a total of about 700 employees.

The Nissan Ekitai Nenryo Company has no other plants in or outside of Japan.

III. DESCRIPTION OF PROCESS

A layout map for the Wakamatsu Plant is given by Plate I(H), and an over-all flow diagram is given by Plate II(H).

The coal charged to the low-temperature carbonization units is obtained from mines in the Orio district, and was stated to be a coal with low sulphur content (0.5%), poor coking qualities, and well suited for gasification. A flow sheet of the Lurgi-design low temperature-carbonization plant is given by Plate III(H). Coal is conveyed to the coal bunkers at the top of the retort and passes downward through the drying zone at about 250°C and the carbonization zone at 600°C. The coke (coalite) is cooled by cold circulated fuel gas, introduced at the bottom of the retort. Heat for carbonization and drying is supplied by circulating gas from each of these zones through external "verbrennungsöfen's". Hot carbonization gas, withdrawn from the top of the carbonization zone, is passed successively through the pre-cooler, Cottrell precipitator, coolers, and gasoline absorber. A flow diagram for the latter unit is given by Plate IV(H).

Tar from the pre-cooler and Cottrell is sent to batch tar stills (total charge capacity 10 tons oil per 24 hours) and fractionated into pitch and heavy oil. The heavy oil is dewaxed by cooling to -5°C and filtering. The dewaxed oil is used either in bunker or semi-diesel fuels, and the raw wax is sold for use in lubricating oil manufacture.

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Both the crude middle oil from the coolers and gasoline from the absorption plant are washed with 10% caustic, to remove phenols and cresols, which are recovered and sold. The neutral middle oil can be used in diesel oil or fractionated for production of solvent naphthas. The caustic washed gasoline is treated with 60° Be. sulphuric acid, then with 4% caustic, and finally washed with water.

IV. PRODUCTION

Capacity of each of the four Lurgi retorts is 300 tons of coal per 24 hours. Table I(H) summarizes actual quantities of coal charged during the period from the start of operations on 16 April 1941, to 8 August 1945, when production was stopped as the result of a fire-bomb raid on that date. The consumption of NaOH and H₂SO₄ is given by Table II(H). Actual output of products is given by Table III(H). The yield of oil obtained is about 90% of that shown by the Fischer-Hempel carbonization test. No major operating difficulties were encountered, although actual retort throughputs varied with the coking properties of the coal.

Typical inspections on the several products are given in Table IV(H). No significant difference existed between design and actual product yields and quality.

In general, the plant appeared to be well-managed, and the maintenance of equipment was good.

V. RESEARCH AND DEVELOPMENT

The research department was very small, consisting of only three chemists plus assistants, and it was primarily concerned with tests necessary in controlling plant operations. The following Japanese patents regarding low-temperature carbonization are held by the company:

<u>Patent No.</u>	<u>Date of Patent</u>	<u>Inventor</u>	<u>Title of Patent</u>
No. 67614	25 Feb., 1926	O. Hubman	Process of drying fuels and its equipment.
No. 73611	28 Sept., 1927	G. Munschel	Process of drying fuels and its equipment.
No. 82931	4 Nov., 1929	O. Hubman	Equipment for low-temperature carbonization of fuels by internal heating.

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Table I(H)
ACTUAL COAL CHARGED TO WAKAMATSU PLANT

	1941	Metric Tons			
		1942	1943	1944	1945
Jan.		7,162	10,230	15,245	20,794
Feb.		7,015	3,630	16,002	14,801
Mar.		7,669	7,797	16,120	19,602
Apr.	2,978	6,656	11,109	15,417	20,149
May	7,781	108	8,017	19,063	13,427
June	5,906	8,219	13,690	16,693	18,441
July	7,662	10,602	18,612	17,956	11,308
Aug.	6,815	8,957	17,817	18,388	2,136
Sept.	7,457	9,539	15,390	17,536	0
Oct.	6,849	8,145	10,831	18,454	0
Nov.	6,740	5,404	10,468	19,102	
Dec.	7,221	9,073	12,019	22,010	
Total	59,409	88,579	139,610	211,976	120,444

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Table II(H)
ACTUAL CONSUMPTION OF
SODIUM HYDROXIDE AND SULPHURIC ACID
(Metric tons)

	1943		1944		1945	
	NaOH	H ₂ SO ₄	NaOH	H ₂ SO ₄	NaOH	H ₂ SO ₄
Jan.	-	-	3	4	15	38
Feb.	-	-	56	83	9	19
Mar.	-	-	76	100	24	29
Apr.	-	-	41	52	29	29
May	-	-	27	44	28	44
June	-	-	40	72	28	51
July	-	-	33	57	44	54
Aug.	-	-	39	71	6	13
Sept.	-	-	41	75	0	0
Oct.	37	64	43	72	0	0
Nov.	40	66	20	32	-	-
Dec.	30	44	21	35	-	-
Total	107	174	440	697	183	277

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Table III(H)
ACTUAL PRODUCTION AT WAKAMATSU PLANT

		Semi-cokes (tons)	Gasoline (kl)	Fuel oil (kl)
1941	Apr.	1,856	0	286
	May	4,740	0	717
	June	3,721	31	636
	July	4,814	139	700
	Aug.	4,496	145	758
	Sept.	4,792	151	769
	Oct.	4,518	115	607
	Nov.	4,246	107	566
	Dec.	4,549	168	734
		Total	37,532	856
1942	Jan.	4,513	132	645
	Feb.	4,420	132	934
	Mar.	4,832	148	701
	Apr.	3,919	141	626
	May	68	0	68
	June	5,178	148	753
	July	6,892	157	992
	Aug.	5,822	161	824
	Sept.	6,220	168	862
	Oct.	5,294	134	738
	Nov.	3,518	85	505
	Dec.	5,898	125	909
		Total	56,574	1,531

Note: Semi-diesel, pitch, and crude wax were not produced.

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Table III(H) (cont'd)
ACTUAL PRODUCTION AT WAKAMATSU PLANT

		Semi-coke (tons)	Gasoline (kl)	Semi-diesel (kl)	Fuel oil (kl)	Pitch (tons)	Crude wax (tons)	
1943	Jan.	6,419	126	-	968	-	-	
	Feb.	2,285	42	-	327	-	-	
	Mar.	4,859	86	-	736	-	-	
	Apr.	7,030	137	-	1,173	-	-	
	May	6,938	154	-	1,076	-	-	
	June	9,326	161	-	1,385	-	-	
	July	11,997	150	-	1,749	-	-	
	Aug.	11,458	157	-	1,708	-	-	
	Sept.	10,556	341	-	1,529	-	-	
	Oct.	7,268	191	507	1,010	147	-	
	Nov.	6,721	143	172	657	101	16	
	Dec.	7,711	209	76	560	28	8	
Total		92,566	1,897	755	12,878	276	24	
		Semi-coke (tons)	Gasoline (kl)	Semi-Diesel (kl)	Fuel Oil (kl)	Pitch (tons)	Cresol (tons)	Crude wax (tons)
1944	Jan.	9,486	73	83	1,152	40	75	7
	Feb.	10,307	81	0	1,059	35	25	0
	Mar.	10,378	160	187	1,076	10	23	0
	Apr.	9,923	0	182	983	0	14	0
	May	12,290	89	170	1,607	0	18	0
	June	10,753	152	170	1,307	0	17	0
	July	11,617	553	259	1,378	0	25	0
	Aug.	11,867	272	200	1,429	0	37	0
	Sept.	11,301	372	69	1,610	0	56	0
	Oct.	10,985	272	281	1,471	0	69	0
	Nov.	11,371	75	78	1,490	57	0	0
	Dec.	15,850	150	180	1,717	60	0	0
Total		135,728	2,249	1,859	16,279	202	359	7
1945	Jan.	12,798	131	61	1,847	43	0	0
	Feb.	9,090	123	56	1,246	8	7	0
	Mar.	12,037	176	413	1,301	20	0	12
	Apr.	12,399	124	466	1,433	70	22	24
	May	8,229	0	414	679	8	0	0
	June	11,340	104	266	1,195	102	0	0
	July	6,915	204	350	410	95	0	0
	Aug.	1,303	87	62	79	33	0	0
	Sept.	0	0	0	0	0	0	0
	Oct.	0	0	0	0	0	0	0
Total		74,129	949	2,000	8,190	396	29	36

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Table IV(H)
PROPERTIES OF PRODUCTS

		Liquid Fuels (°C)		
		Semi-diesel Oil	Fuel Oil	Motor Gasoline
Distillation	Dew point	76	98	72
	5%	222	238	108
	10%	233	256	114
	20%	248	293	126
	30%	257	332	135
	40%	270	349	142
	50%	282	370	151
	60%		372	160
	70%	318		168
	80%	350		179
	90%			194
	97%			216
Composition	Acidic oil (%)	19.0	36.5	
	Basic oil (%)	2.0	0.5	
	Neutral oil (%)	79.0	63.0	
Red. Visc. (50°C secs)		36	174	
Flash Point (°C)		67	118	
Specific Gravity		0.941 (15°C)	0.967 (50°C)	795 (15°C)
Solidifying Point (°C)		13	31	
Spont. Ign. Point (°C)		285		

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Table IV(H) (Cont.)
PROPERTIES OF PRODUCTSPitch

Solidifying point.....	above 150°C
Volatile matter.....	54.86%
Fixed carbon.....	44.88%
Ash.....	0.26%

Cresols

Distillation

Dew point	76°C	
5%	199	(H ₂ O 3.8%)
10%	205	
20%	207	
30%	209	
40%	211	
50%	215	
70%	225	
90%	268	

Coke

Volatile matter.....	9.4%
Fixed carbon.....	67.5%
Ash.....	22.5%
Sulfur.....	0.4%
Calorific value.....	6,000 Cal
Melting point of Ash.....	1,500°C

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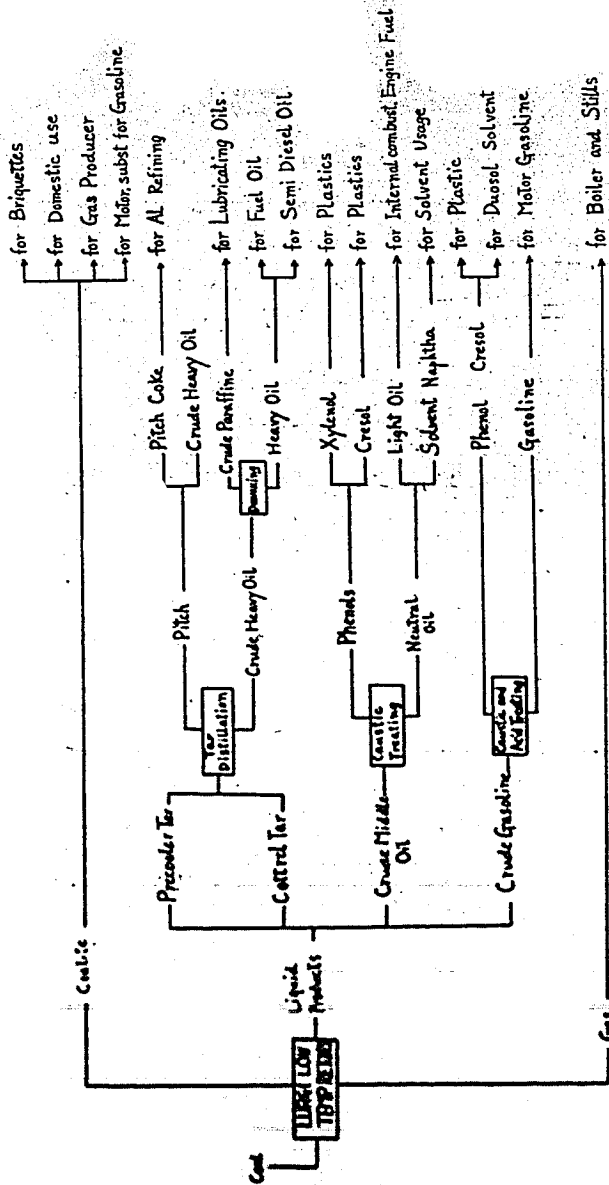
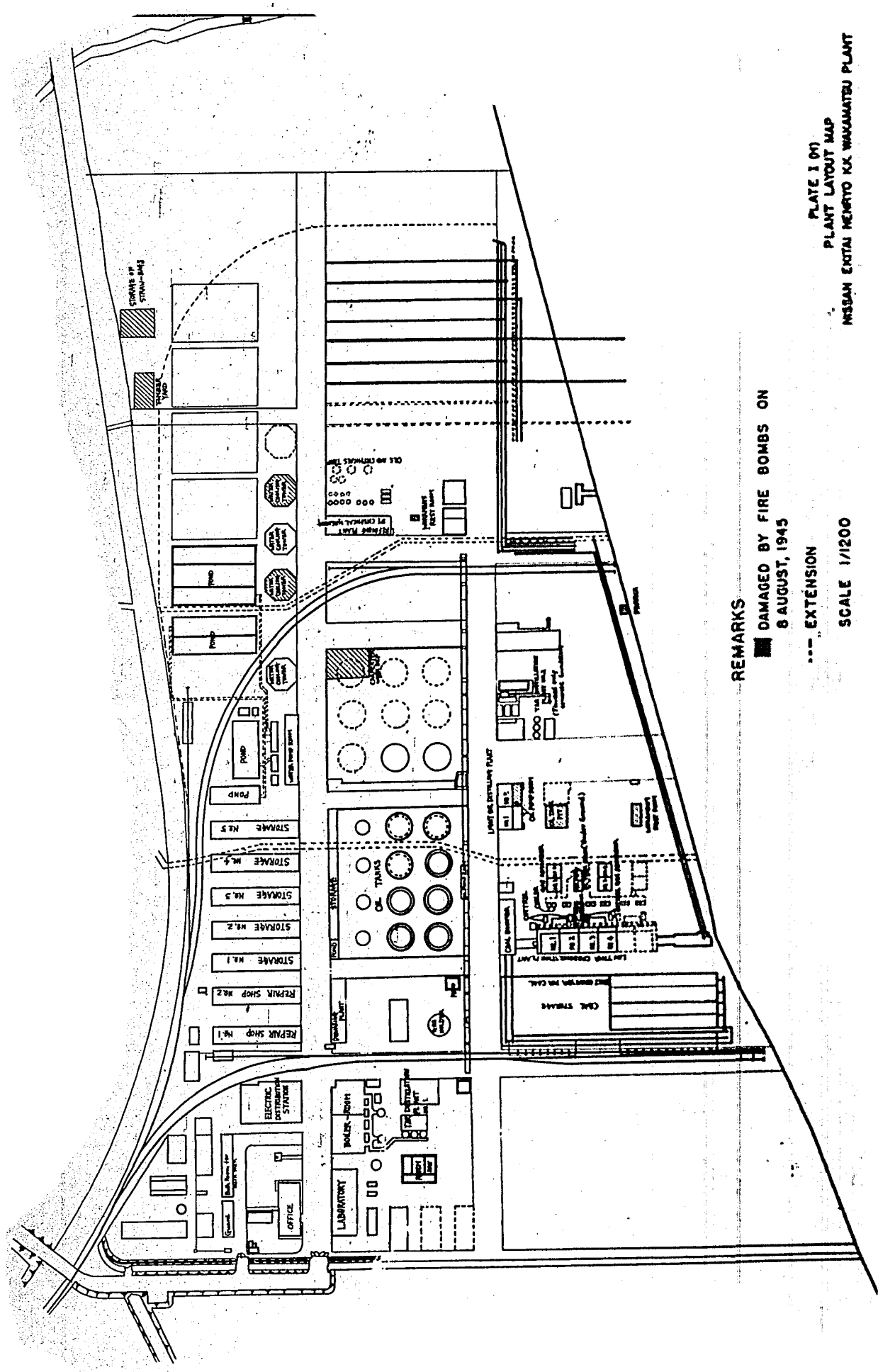


Figure 1(H)
OVER-ALL FLOW SHEET



REMARKS

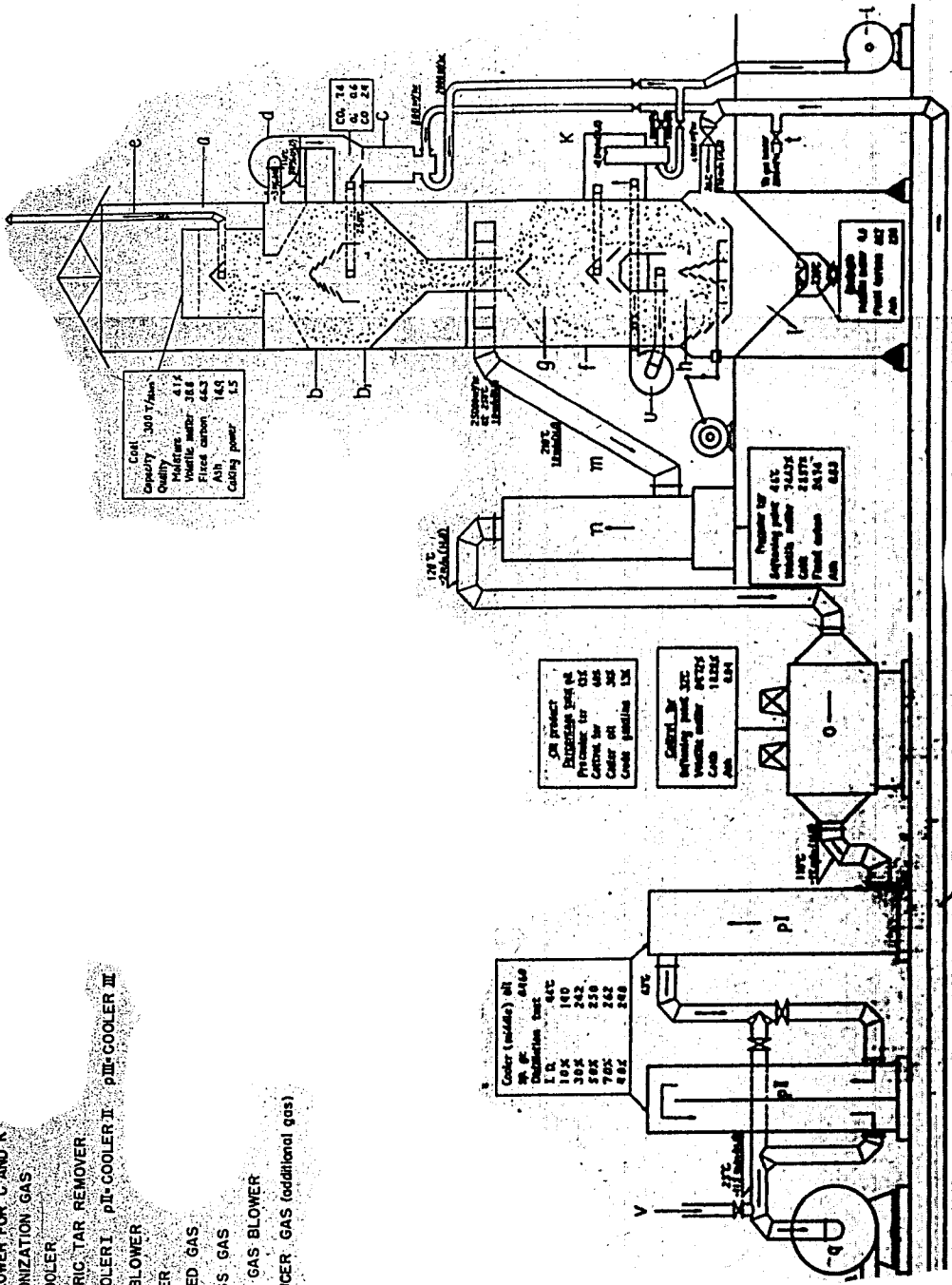
■ DAMAGED BY FIRE BOMBS ON
8 AUGUST, 1945

--- EXTENSION

SCALE 1/1200

PLATE I (M)
PLANT LAYOUT MAP
NISSAN EHTAI MEMPHO KK WAKAMATSU PLANT

- L. AIR BLOWER FOR "C" AND "K"
- M. CARBONIZATION GAS
- N. PRECOOLER
- O. ELECTRIC TAR REMOVER
- P. P1-COOLER I, P1I-COOLER II, P1II-COOLER III
- Q. GAS BLOWER
- R. WASHER
- S. PURIFIED GAS
- T. EXCESS GAS
- U. COLD GAS BLOWER
- V. PRODUCER GAS (additional gas)



Coal	3007/Ann
Capacity	415
Moisture	38.8
Fixed carbon	44.3
Ash	14.9
Caking power	1.5

200°C	120000
120°C	21000 (G.D.)

CO PRODUCT	8150
PRODUCER GAS	100
PRODUCER GAS	242
COAL	505
COAL	705
COAL	242
COAL	242

COAL	8150
PRODUCER GAS	100
PRODUCER GAS	242
COAL	505
COAL	705
COAL	242
COAL	242

COAL	8150
PRODUCER GAS	100
PRODUCER GAS	242
COAL	505
COAL	705
COAL	242
COAL	242

PRODUCER GAS	415
PRODUCER GAS	38.8
PRODUCER GAS	44.3
PRODUCER GAS	14.9
PRODUCER GAS	1.5

PLATE 10 (P)
 FLOW SHEET OF LOW-TEMPERATURE
 CARBONIZATION PLANT
 SRIHARI COLLEGE OF ENGINEERING
 SRIHARI COLLEGE OF ENGINEERING

- L: AIR BLOWER FOR 'C AND 'K'
- M: CARBONIZATION GAS
- N: PRECOOLER
- O: ELECTRIC TAR REMOVER
- P: pI-COOLERS I, pII-COOLER II, pIII-COOLER III
- Q: GAS BLOWER
- R: WASHER
- S: PURIFIED GAS
- T: EXCESS GAS
- U: COLD GAS BLOWER
- V: PRODUCER GAS (additional gas)

- A: COAL BUNKER
- B: PREDRIER (drying zone) (1)
- C: COMBUSTION FURNACE FOR (b)
- D: BLOWER
- E: EXHAUST
- F: CARBONIZATION PIT
- G: CARBONIZATION ZONE
- H: COOLING ZONE
- I: COKE DISCHARGE
- K: COMBUSTION FURNACE FOR (g)

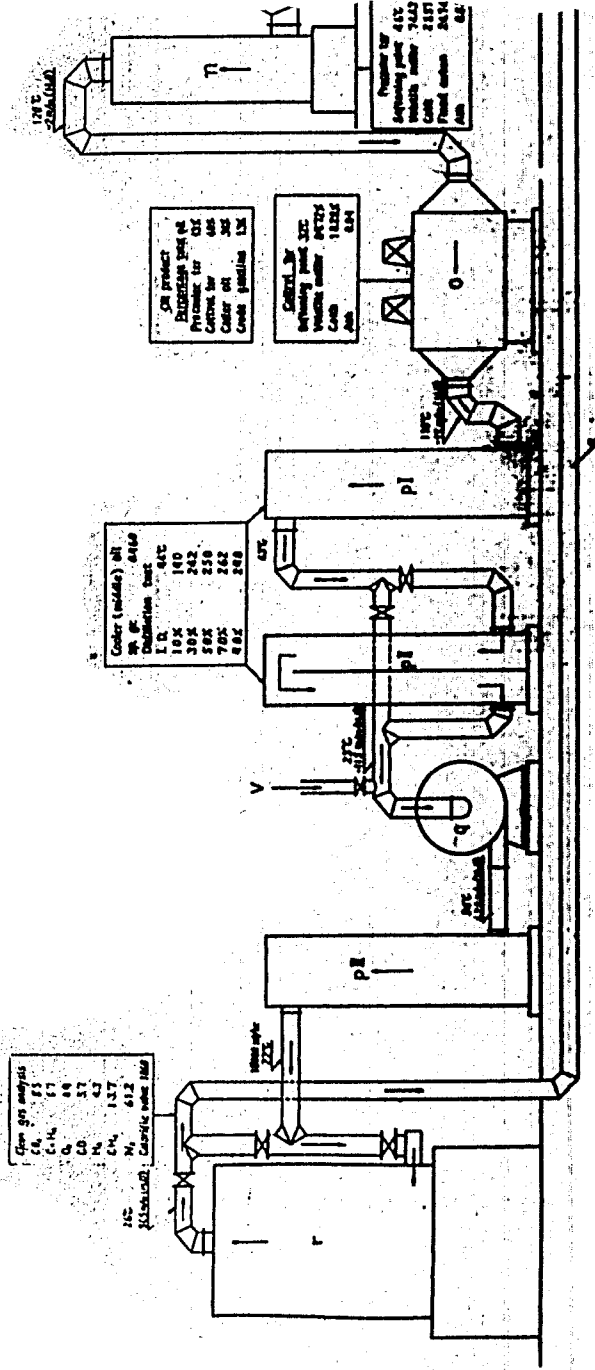
Gas gas analysis	
C ₁	6.1
C ₂	5.1
C ₃	4.8
C ₄	4.8
C ₅	3.7
C ₆	4.7
H ₂	1.37
N ₂	61.2
O ₂	61.2

Coke (update) wt	
wt. %	64.6
wt. %	64.6
L.O.	100
10%	242
30%	258
50%	262
70%	268
80%	268

In product	
Recovery yield %	64.6
Recovery yield %	64.6
Recovery yield %	64.6
Recovery yield %	64.6
Recovery yield %	64.6

Control by	
Recovery yield %	64.6
Recovery yield %	64.6
Recovery yield %	64.6
Recovery yield %	64.6
Recovery yield %	64.6

Producer gas	
Recovery yield %	64.6
Recovery yield %	64.6
Recovery yield %	64.6
Recovery yield %	64.6
Recovery yield %	64.6



CHAMBER WASHER

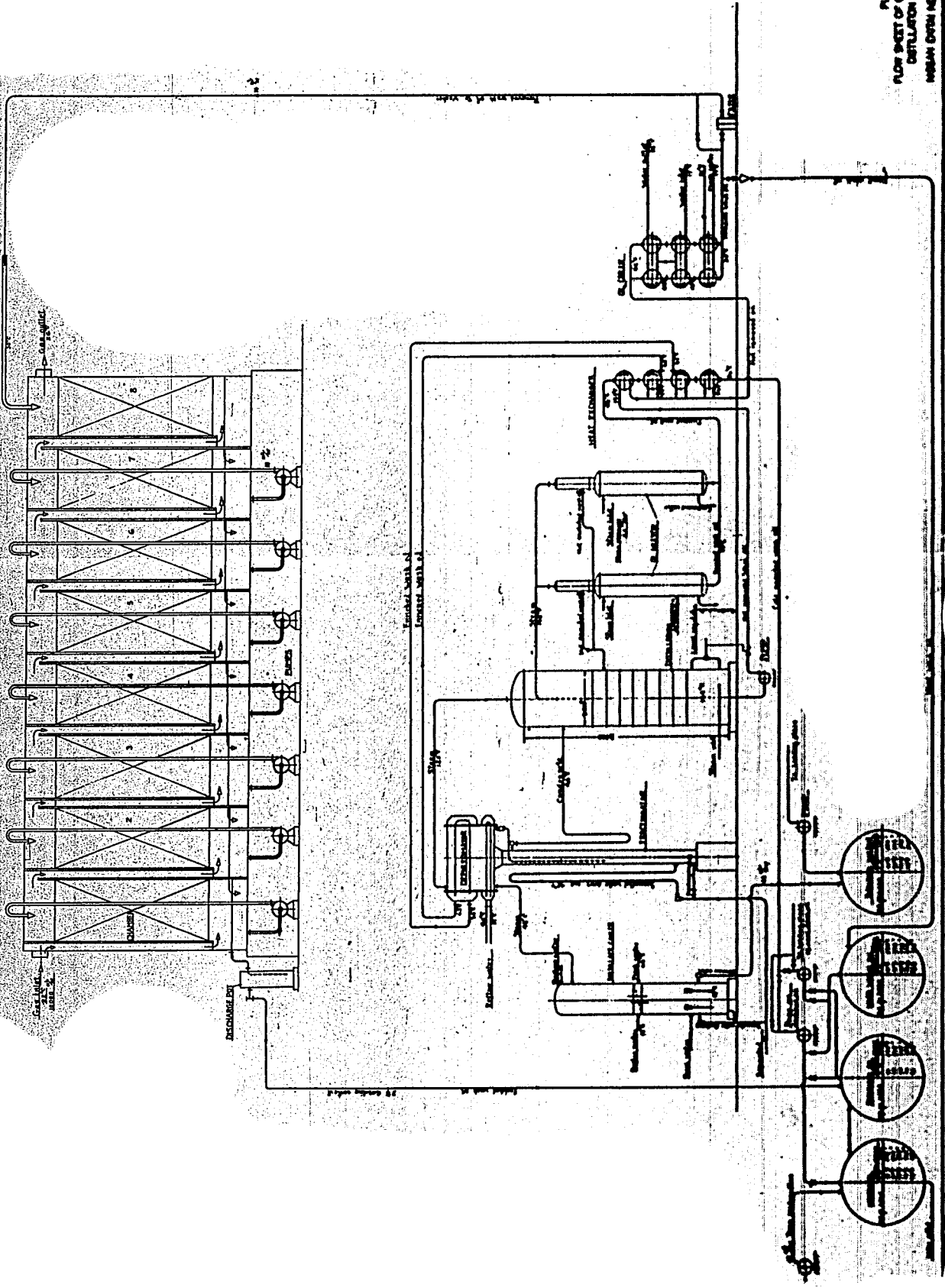


PLATE 214
FLOW SHEET OF GAS AMMONIA AND LIQUID
DISTILLATION PLANT FOR CARBON
NORMAN OSTERHOLM U.S. BUREAU OF MINES