WASC 2202

FOLDERS ON SHELF

VARIOUS RGPF
ANNUAL REPORTS

1931-1932 Annual Report

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MINUTES SHOULD BE NUMBERED CONSECUTIVELY.

Supplied 5 442

SUBJECT: Supply 5 (F.P. W32/10)

Annual Report RCPF 1931-32

W.O. Etc. NUMBERS

NO.

Separate Sub-numbered sections are provided where there are two or more distinguishable sections or interests in the correspondence. "Action Here" Slips will be inserted by the Registry as a guide in minut[redacted]y Departmental Minute Sheets (Form 98) for internal correspondence.

REFERRED TO	DATE	REFERRED TO	DATE	REFERRED TO	DATE
C.G.P.F.	9.6.32				

442

(2877—030) 5000 4/26 H. St. (E. 4702)

MINUTES SHOULD BE NUMBERED CONSECUTIVELY.

Supplies 5 440 442a

SUBJECT: Annual Report RCPF 1931-32

No. Supply 5

(F.P. W324/10)

W.O. Etc. NUMBERS	

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C.G.P.F.	9.6.32				

442

(40) Wt. P2877—530 5000 4/28 H. St. (E. 4702)

W 324/11

D.O.F.

Herewith Annual Report on the Royal Gunpowder Factory for the Year 1931/32.

(sd) P. H. Evans.
Supt. R.G.P.F.

8.6.32.

R.G.P.F. ANNUAL REPORT

for the

YEAR 1931/32.

Directing Staff. No change has occurred during the year.

Technical Staff. Mr. G. Bennett-Powell took over the joint "Services" section as manager on 1.6.31 vice Capt. T.Denness, promoted, and Mr. T.Griffiths has been promoted from Technical Assistant to Shop Manager in the Machinery Section as foreshadowed in last year's report.

In the Building Works Department it has been arranged with Supt. R.S.A.F. that the allocation of the time of the staff between the two Factories shall be more elastic than has been the case in the past and Mr. Asprey the new Clerk of Works who replaced Mr. W. Reid has put in a considerable amount of time at R.G.P.F.

Mr. Browne, Foreman of the Electrical Section retired during the year as mentioned elsewhere in this report.

Industrial Staff. The number of employees on 31.3.32 was 274 as compared with 272 on 31.3.31. Tables A1, A.2.and A.3., shew these classified according to ages and categories.

PRODUCTION.

GUNCOTTON SECTION.

Acids. I. Plant.

One nitric acid collector and two coolers were renewed during the year, one steel egg was re-lined with lead and the cover of one still has been replaced. Five of the piers supporting the fume condensing Towers have been rebuilt and finished with an asphalte top. It is thought that this will prevent acid from soaking into the brickwork and so confer a longer life on the pier.

In the sulphuric acid concentrating house three Evans-Bowden Towers are completed, apart from the one in use, and two Kesslers are still unused. The joint between the

dome and tower has been changed to the Kessler type owing to the difficulty of sealing which occurs when some form of binding is not used. Two coke condensers have been completely rebuilt and filled with coke. A test of output was carried out on the E.D.Tower for a week of three shifts and its superiority over the Kessler clearly demonstrated. The output is greater in a given time, and the small quantity of acid held in the tower makes the apparatus more sensitive to changes of feed. It is thus possible rapidly to regulate the flow of acid to suit a change in the producer and to take full advantage of optimum conditions. Similarly the feed can be reduced when necessary and the output responds more quickly than from a Kessler.

During the week's work the limiting factors were the producer, and to a lesser extent, the fan speed. A summary of the performance is appended and if a constant supply of gas were available there seems to be no reason why the maximum output should not be maintained over a long period.

The fans in the nitrating house continue to provide insufficient ventilation, the vanes of each needing renewal twice during the year, earthenware impellors are being fitted which it is hoped will effect an improvement.

As the wooden trucks fall into disrepair they are being replaced with aluminium; the truck is consequently lighter and more manageable, reducing the accidental breakages of stoneware pipes. For a similar reason, fibre wheels are being fitted to the cotton waste platform trucks.

Mechanical stirring has been fitted to two mixed acid tanks.

Guncotton.

A small door has been fitted to the cotton waste drying machine, at the back of the bottom shelf, through which a blockage can be removed with a minimum of difficulty.

Pulped guncotton flows over a new pattern baffle

in the grit run, having the down stream edge undercut; it appears to be somewhat more effective in trapping grit than a plain bar. All moulding machines have now been fitted with safety valves, two presses have still to be altered.

Following the decision to dispense with the use of phenol in the drilling house the opportunity was taken to remodel the arrangements for removing waste from the machines. Water from the jets now washes drillings down an aluminium gutter to a labyrinth emptying into the main drain.

For transporting slabs and primers, spiral springs have been fitted to a truck to lessen the damage caused by jolting.

Fuze Powder. R.D.202.

A new runner suspension has been fitted to the mill, embodying both the support and guide in a single phosphor-bronze forging hung on the crosshead. Unfortunately manufacture ceased before another milling could be carried out.

Output of the Evans-Bowden Tower. Week ending 5.3.32.

Acid charged to concentrator.

	Bulk.	% H_2SO_4	H_2SO_4
D/N.	77.25	77.96%	60.22
Condensate	9.59	56.28%	5.40
Total.	86.84		65.62
Acid obtained from Concentrator.			
C.O.V.	63.36	93.5%	59.24
Condensate	9.59	56.28%	5.40
Total.	72.95		64.64

Efficiency of Concentration = $\frac{\text{C.O.V.}}{\text{D/N + Condensate}} = \frac{59.24}{65.62} = 90.28\%$

Loss of Acid. = $\frac{.98}{65.62} = 1.50\%$

Yield of condensate = $\frac{\text{Condensate}}{\text{D/N + Condensate}} = \frac{5.40}{65.62} = 8.22\%$

Coke used = 6.565 = .1109/C.O.V or .1015/C.O.V + Condensate.

Output for three Periods of 24 Hours each.

Feed tank average.		C.O.V. average.		Average Rate of flow of 100% acid.	Max. obtained in one hour.	
Sp.G.	% H_2SO_4	Sp.G.	% H_2SO_4		Sp.G.	lbs. C.O.V.
1.677	74.57%	1.844	94.33%	1056-lb/hr.	1.842	1480
1.671	73.93%	1.8425	93.84%	1150 ,,	1.840	1580
1.683	75.28%	1.840	93.00%	1290 ,,	1.840	1700

(All quantities in short tons unless otherwise stated.)

II. MANUFACTURE.

Nitric Acid.

One retort has been used during the whole year, the charges of soda nitrate being :-

38 @ 2 Tons.

38 @ 1 Ton.

24 @ 1½ Tons.

Total nitrate of soda charged = 131.03 S/Tons crude.

= 128.41 ,, pure.

Equivalent HNO_3 = 95.14 S/Tons.

Nitric acid produced. = 104.62 S/Tons @ 89.6%

= 93.63 S/Tons HNO_3

Loss. = 1.51 S/Tons.

Efficiency. = 98.4%

Strong sulphuric acid used = 125.72 S/Tons @ 94.7%

= 119.06 S/Tons H_2SO_4.

Two stills have been used for the redistillation of weak waste acid:-

No.8 - 52 distillations.

No.5 - 54 ,,

The charge in each was in all runs 16,500-lbs.

Acid charged = 877.94 S/Tons containing 552.35 S/Tons H_2SO_4

165.16 ,, HNO_3

160.43 ,, H_2O

Strong nitric acid recovered = 180.2 S/Tons @ 89.4%

= 161.11 ,, HNO_3

Loss = 4.05 S/Tons.

Efficiency = 97.5%

Weak sulphuric acid recov'd = 699.79 S/Tons @ 77.2%

= 540.44 ,, H_2SO_4

Loss = 11.91 S/Tons.

Efficiency = 97.8%

Concentration of Weak Sulphuric Acid.

Acid charged to concentrator = 713.95 S/Tons @ 77.8%

= 555.67 ,, H_2SO_4

Strong sulphuric acid produced 573.33 ,, @ 94.7%

= 542.64 ,, H_2SO_4

Loss = 13.03 S/Tons.

Efficiency = 97.6%

~~Concentration~~

NITRATION.

No. of Sets of Guncotton = 1379

,, Nitrocotton = 40

,, Gunwood. = 4

Mixed acid used = 2567.97 S/Tons.

Cotton waste) used = 85.706 S/Tons.

,, linters = 77.677 ,, nett(See Raw Materials)

Guncotton produced = 130.332 (including N/C)S/Tons.

Guncotton in eaveall = 3.305 S/Tons.

Yield = 167.8%. Available for Cordite = 163.6%

Ratio: Mixed Acid/Cotton waste = 33.45/ 1

Mixed acid/Guncotton = 19.94/ 1

Service C/C. Particulars of Primers & Slabs.

9,000 1-oz.C/C Dry Primers. Service of C.O.O Bramley.

Fuze Powder - R.D.202.

Ammonium Perchlorate refined	crude	4 cwts.
	pure	380-lbs.
,, ,, used.		425-lbs.
Starch used.		21-½bs
Charcoal used.		111-lbs.
Powder produced.		519-lb 6-oz.
Powder reconditioned.		54-lb. 14-oz.

III. RAW MATERIALS.

	T.	c.	lb.	
Oleum drawn from Store	144.	12.	95	= 162 S/Tons.
add difference in stocks				13.87
Oleum consumed.				175.87 S/Tons.

= 1.349 per lb.C/C.

Nitrate of Soda	T.	c.	lb.	
drawn from Store.	117.	-	-	= 131.04 S/Tons
add diff: in stocks.				12.67
				143.71

= 1.103 per lb. C/C.

Cotton waste and linters.

	T.	c.	lb.	
C/W	52.	17.	106	
C/L	23.	12.	59	= 85.706 S/Tons.

Deduct oil and moisture 5.459

Pickings & Fly. 2.580

Nett Cotton waste and Linters used for nitration = 77.677 S/Tons

~~Foreign matter removed in picking:- lbs. %~~

Summary of Consumption and Losses. S/Tons.

	H_2SO_4		HNO_3	
	Actual.	Per Ton G/C.	Actual.	Per Ton G/C.
Manufacture of Nitric Acid	119.06	.9136	1.51	.0116
Redistillation.	11.91	.0914	4.04	.0310
Concentration.	13.08	.1035	-	-
Nitration.	33.45	.2566	97.77	.751
Washing out plant.	7.22	.0554	1.00	.007
	184.72	1.4205	104.32	.8006

Foreign matter removed in picking:-

	lbs.	%
Wood, string & metal.	162	.1095
Grit.	32	.0199
Fly.	4909	3.0600

Cotton used per lb. of Guncotton = 0.6580 Gross.
= 0.5960 Nett.

Nitroglycerine Section.

In the manufacture of nitroglycerine and its subsidiary processes the year has run its normal course. As a consequence of the Holton Heath Explosion a large amount of consideration has been given to the possibility of improving the plant and the method of working from the point of view of safety. It was found however that little could be done from this point of view, with the exception that the already partially dismantled No.3 Nitrator has been removed, thus restoring the Nitrating House practically to its pre-war state.

The fact that under present conditions only one nitrator-separator is in use minimises the danger of mistakes.

A scheme for the reinforcement of the earth traverses has been submitted for approval.

The personnel has remained the same, but some of the younger men from other sections have received training in nitroglycerine work in view of anticipated casualties.

Three men from R.N.C.F. also received a short training in N/G manufacture.

In the manufacture of Picrite there have been many changes, usually connected with the development of a new industry. The chief and a very important change has been the substitution of water extraction for Carbon-dioxide extraction. This has resulted in economies in power, labour and materials, and is largely accountable for the decrease in the incidence of dermatitis. Several difficulties have been encountered chiefly from the purity of product aspect, all of which were overcome and for some time an exceedingly pure product has been manufactured.

A record of the year's work in the various processes is appended.-

A. MANUFACTURE OF NITRIC ACID.

Retorts used were No.10 26 runs.

No.11 26 runs.

All charges were 30-cwt of Nitrate of Soda. Average time of distillation was 11 hours.

Materials and results.

Nitrate of soda used	87.36 S/Tons	at	98.26% $NaNO_3$
O.O.V used	79.20 ,,	@	92.10% H_2SO_4
Oleum used	8.25 ,,	@	20% SO_3
Coke ,,	14.73 ,,		
Strong nitric acid made	82.32 ,,	@	91.40% HNO_3
Weak ,, ,, ,,	6.72 ,,	@	53.60% HNO_3
Nitre cake produced	107.3 ,,	@	32.0% H_2SO_4

Efficiency Strong acid 90.3%

Total 95.43%

Plant and Buildings.

All ironwork and supports and roof was tarred.

Condensing towers were dismantled, piers rebuilt and towers overhauled and re-erected.

B. DENITRATION OF WASTE ACID.

37 charges of waste acid were denitrated in No.1 Tower.

Tower was run for 444 hours at an average Temp of 158°C.

Output. Waste acid denitrated 114.9 short tons.

Denitrated Sulphuric acid made 115.7 S/Tons @ 69.8% H_2SO_4.

Nitric acid recovered 18.7 S/Tons 58.9% HNO_3.

Efficiencies. Sulphuric acid 98.64%

Nitric acid 86.44% (Considering all Nitrogen as recoverable.)

Repairs. Lead draining tank and egg from waste acid boiler renewed. Air connections to all eggs renewed and rearranged for better and safer manipulation.

C. CONCENTRATION OF WEAK SULPHURIC ACID.

The concentrator continues to give complete satisfaction and shows no signs of deterioration in spite of its erratic usage.

No. of hours run 949. Average Dome Temperature 114°C.

Output

Weak acid concentrated	187.69 S/Tons	@ 65.0%	H_2SO_4
Strong Acid made	114.42 ,,	@ 91.8%	,,
Weak ,, ,,	28.50 ,,	@ 43.6%	,,

Coke used 29.06 S/Tons.

Efficiency strong acid 87.64%

Total. 95.04%

D. REDISTILLATION OF WEAK NITRIC ACID.

12 distillations were carried out in No.3 Still, average time being 15½ hours.

Output.

Weak nitric acid redistilled	24.52 S/Tons	@ 58.32%	HNO_3
Strong sulphuric acid used	38.72 ,,	@ 93.13%	H_2SO_4
Strong nitric acid made	13.50 ,,	@ 89.4%	HNO_3
Weak ,, ,, ,,	2.76 ,,	@ 60.4%	,,
Weak sulphuric acid recovered	51.72 ,,	@ 69.4%	H_2SO_4
Coke used	4.70 ,,		

Efficiencies.

Nitric acid, strong	84.37%
Total.	96.03%
Sulphuric acid.	99.5%

Repairs etc.

Ironwork of roof of building was tarred.

Nitric acid egg was relined.

E. ACID MIXING.

One mixer was used for 360 hours.

Output.

Nitric acid (new)Mixed	62.02 S/Tons	@ 91.56%	HNO_3
,, (recovered),,	13.38 ,,	@ 89.37%	,,
Oleum 20% mixed.	32.25 ,,	@ 20%	SO_3

E.ACID MIXING Contd.

Output.

Oleum 65% mixed 39.75 S/Tons @ 65% SO_3

Total mixed 147 .40 S/Tons.

Repairs etc.

No.2 Acid Mixer renewed (new pattern in place of old).

Nitric acid gauge tank relined.

F. MANUFACTURE OF N/G.

37 charges were nitrated, all in No.2 Nitrator.

Average time of nitration was 67 minutes, and of separation 213 minutes.

Average temperature of brine was -10°C. All charges were nitrated at 10°C, and washed in No.1 Washing House.

Materials and Output.

Glycerine used	27.195	S/Tons.
Mixed acid used	152.625	,,
Waste acid made	112.85	,,
Soda ash used	2.07	,,
N/G made.	63.364	,,
Yield.	232.99%	

Summary of Tests of N/G.

	Max.	Min.	Avge.
Moisture.	.37%	.17%	.26%
Heat Test.	13	10	11.35 minutes.
Alkalinity.	All under .0005%		

N/G was used as follows:-

For M.D	57.13	S/Tons.
Mk.I	.74	,,
R.D.N.	3.46	,,
Dynamite.	.45	,,
Various experiments.	.47	,,

BUILDINGS & PLANT.

In addition to many small repairs, resulting from the weekly and other periodical inspections, there were many larger replacements and alterations carried out during the year.

In the Nitrating House the following were carried out:-

The bi-ennial examination of No.2 Nitrator, when the top was completely renewed, the coils being found in excellent condition. New inlet cocks were fitted into the brine pipes for Nos.1 & 2 Nitrators.

As a result of finding the outer jacket of the thermometer in the Nitrator broken and containing various solids and liquids, while the mercury column was intact, a new solid stem thermometer was fitted. Some difficulty was experienced in getting this thermometer supplied, but eventually Messrs. Cossors were persuaded to experiment, and were successful in supplying a satisfactory one.

The Prewash was replaced by a new one. The life of the Prewash under present working conditions, and without the ebonite jets, is about 2 years, which is quite satisfactory.

New pattern non-ferrous metal air reducing valves were put in. The plant in the N/G houses is now quite free from iron.

No.3 Nitrator and all its accessories were completely removed, and also the surrounding platform. As a result the house has been slightly rearranged, making it more convenient to carry out operations.

The small experimental nitrator was removed and placed in store.

The gutter from the Nitrating House to the Wash Water Settling House was completely renewed. This gutter had been in use without repair since 1916.

The protruding part of the brick retaining wall at top of the traverse was removed.

In No.1 Washing House, the three washing tanks were renewed. These tanks have now no ebonite jets. All the fume pipes were renewed. The shape has been altered giving better

draining,

draining, and the pipes are now of the drawn type and not jointed decreasing the possibility of the lodgment of N/G. The lead covering of all platforms and stools was renewed, and the Labyrinth was repaired. The gutter to the Wash Water Settling House was renewed.

In the Wash Water Settling House the lead covering of the iron bands of the tank was renewed.

In both Washing Houses and Mixing Houses, the roof lights aren now made of "Windolite". This has greatly improved the lighting of the houses and will give much less repair and renewal work.

Summary of Consumption and Losses of Acids.

	H_2SO_4.		HNO_3	
	Actual S/Tons	Per Ton N/G.	Actual	Per Ton N/G.
M'fr of Nitric Acid	87.400	1.382		
Denitration.	1.099	0.017	1.730	0.027
Redistillation.	0.178	0.003	0.791	0.012
Concentration.	5.041	0.079		
Acid Mixing.	2.663	0.042	8.744	0.138
Nitration.	2.352	0.037	53.795	0.849
Total.	98.733	1.560	65.060	1.025

Raw Materials used.

	Per Ton N/G.
Nitrate of Soda.	1.460
Oleum 20%	0.736
,, 65%	0.682
Glycerine.	0.4292
Soda Ash.	0.0327

G. DRYING AND WEIGHING GUNCOTTON & NITROCOTTON.

Stoves, 7, 8, 9, 10 & 11 were used.

52 Stovings of Guncotton and 5 dryings of different quantities of Nitrocotton were carried out.

Average time of the stovings was 65 hours.

Moistures at the end of drying were Max 0.76% Min 0.26% Average 0.49%.

Total amount dried was,

Guncotton 120.018 S/Tons.

N/C..... 2.485 ,,

Guncotton was used for	M/D.	119.505	S/Tons.
	Mk.1	0.467	,,
	Exptl.	0.046	,,
Nitrocotton was used for	R.D.N.	2.725	S/Tons.
	Exptl.	0.484	,,

No.14 Stove is now used as N/C Store instead of No.5 which is undergoing repair.

The lead floor and zinc lining of No.8 Stove were repaired.

H. PASTE MIXING.

Mixing Houses Nos.2 & 3 were used, No.2 for all pouring of N/C and Mixing M.D & Mk.1, and No.3 for R.D.N., Dynamite and all experiments. The wet mixing plant in No.2 Washing House was used for mixing paste for an experimental lot of about 700-lbs of Cordite S.C. The plant was also used for washing paste bags.

R.D.N. Paste is now put through 1/4 mesh sieve. Double mixing through such a small sieve makes the operation about four times as costly as the mixing of M.D. or Mk.1 paste.

Paste Mixed.

M.D.	176.64	S/Tons.
Mk.1	1.21	,,
R.D.N/A	14.80	,,
Dynamite made.....	0.70	,,

Repairs.

Roof of No.3 and No.5 Mixing Houses repaired. In this design of building, the joists near the centre posts rot, and it is likely that this trouble will occur in other buildings of this description. The repair has been carried out so as to do away with the cause of this rotting.

I. TETRYL.

The only manufacture carried out during the year was the conversion of two lots of Grade Ia to Grade I Crystals for the Air Ministry.

Output.

	lbs.	
Crude purified	6769	Gd. Ia. Corned.
Pure made.	6157	Gd.I Crystal.
Primary Acetone used.	13440-lbs.	

Apart from minor repairs to buildings, no alterations or repairs were necessary during the year.

J. NITRITE MANUFACTURE.

During the early part of the year, experimental work only was carried out. In the middle part, when regular manufacture was sanctioned, following changes in method and increase in size of plant, an extremely difficult time was experienced on account of various deficiencies in the purity of product. In the last part, all these difficulties had been overcome, and a steady output of pure product, at decreasing costs was turned out.

Following is a bried summary of the work.

Extractions	1	(carbon dioxide)
	454	(water)
Autoclave runs.	176	
Nitrations.	74	
Purifications (dissolvings)	809	

Raw materials used.	S/Tons.
Calcium cyanamide	50.760
Carbon-dioxide.	0.266
Ammonium Nitrate.	15.306
Sulphuric Acid 98%	33.000
Ammonium Hydrate	0.005
Nitric Acid.	0.646

Product made.	S/Tons.	
	8.926	Picrite.
	1.676	95% finished.
	0.306	50% ,,
	0.572	25% ,,

Owing to the many changes, reworking etc, it would serve no useful purpose to give the raw materials per lb., Picrite for the whole year, but the following are the figures for the last three months.

	Per ton Picrite.
Calcium cyanamide	3.20
Ammonium nitrate.	1.11
Sulphuric acid.	2.55
Nitric acid.	0.012

The Picrite was used as follows:-

for R.D N/A	8.631	S/Tons.
to C.S.R.D.	1.323	,,
Experimental.	.155	,,

CORDITE SECTION.

The amount of Cordite manufactured during the year has been approximately 207 tons, and as a large part of this has been on the hydraulic press, the number of men employed is somewhat lower than last year, although the output is slightly more, and has varied from 50 - 56 including supervision.

There has been a remarkable freedom from sickness this year, at no time has the number been more than three and for a considerable part of the year there has been complete freedom from absence from this cause.

The following remarks on alterations and other details in connection with plant may be of interest.

Paste Stores.

No.4 Paste Store is now connected on the same steam main as No.3 as was suggested in last year's Annual Report. A very large amount of steam main is thereby eliminated: and incidentally the main is very much more easily accessible for repairs.

Incorporation.

It is satisfactory to report that no accident has occurred during incorporation.

Two additional Medium Machines (charge of 120-lbs) have been installed in No.8 Incorporating House so that the incorporation of R.D.N. is now carried out in 120-lb. machines only.

Pressing.

No accident has occurred either on the screw or the hydraulic presses.

Considerable repairs have been necessary on the small Screw Presses. A large number of thrust bearings have been replaced and Bay 2, No.10 Press House has been put into thorough repair. It is to be feared however that replacement of the main thrust bushes will be necessary on many of the presses at an early date as they show signs of considerable wear.

MANUFACTURE.

Some difficulty has been experienced towards the end of the year in the manufacture of MD.T 5-2. Irregular expansion of the cord on extrusion from the die has resulted in an enlarged cord being sometimes obtained and since the expansion has not always been the same, irregularity in size of cord has resulted. This occurred on the change over from 50/50 linters/cotton waste, to 100% cotton waste and was undoubtedly due to better gelatinisation of the latter. We have now, by varying certain conditions in the manufacture, apparently overcome this difficulty since the weight per 100" has returned to normal, and the irregularity has disappeared.

The difficulty of reducing the V/M mentioned in last year's report resulted in the Specification limits of V/M in M.D.T 5-2 being raised to .6%. It is now easily possible to work within the limit, and it is very seldom found that the V/M exceeds .5%.

Stoving Reeled Cordite.

The drying of reeled cordite in two stages remains quite sarisfactory.

As was mentioned last year, No.1 Reel Stove has been compartmented, but unfortunately it is impossible to make a comparison of the cost of drying cordite between the two years.

The output of M.D.T 5-2 for 1931-32 was only 60% of that of the previous year and part of No.1 Stove has been used for drying cannon cordite. However one portion only of this stove has been used for drying reeled cordite so that it is evident that considerable economy in steam consumption has resulted over the former method which would have needed double the accommodation.

The amount of dry waste from M.D.T 5-2 has again been very low, amounting to only .69% of the cordite reeled. When it is remembered that in 1924/5 it was as high as 5.64% it will be appreciated what a remarkable reduction has been

affected. The amount of waste made this year was only 1300-lbs whereas on the 1924/25 figures it would have been nearly 11,000-lbs. Since it costs over 1s. per lb. to rework cordite it will be seen that considerable saving has resulted.

R.D.N/A.

Since the change over from R.D.N to R.D.N/A an increase of 3½% of acetone is required for the incorporation.

As mentioned above all R.D.N/A is at present incorporated in 120-lb machines in the endeavour to obtain a uniform product.

Considerable difficulty has been experienced during pressing owing to the strainers becoming choked with aggregates of crystals, and it has been found necessary to increase the time of incorporation, and as long a period as possible is given. About 7 - 8 hours is the normal time allowed, but the longer it can be incorporated the easier will be the pressing as the aggregates of crystals break up on prolonged incorporation. The increased time now required for incorporation has however greatly reduced the output capacity of our plant and it is now considerably less than half our original estimate when the time of incorporation was only three hours.

Further the increase in solvent and the use of picrite have unfortunately decreased the output from the press and we now obtain only 1.35-lb per pressing compared with 1.6-lb, a decrease of over 15%.

Apart from the trouble in pressing, the manufacture of R.D.N/A offers no special difficulties, and there is now almost complete absence of adhesion of the cords on drying. This is probably attributable to the fact that the N_2% in the N.C. is 12.3. It may be remembered that similar absence of sticking was found with R.D.B. when the N_2% was on the high limit of the Specification.

Solventless Cordite.

An impurity experiment was required by the Navy and about 700-lbs were manufactured. The extruded cord was inclined to

be rough. The rolling and pressing proceeded without any trouble except for one slight ignition on the rolls which remained quite local in its effect.

A hood has been erected over the rolls to carry away the fumes.

Experimental Batches.

19 experimental batches have been made during the year. These include experiments on R.D.N/A, M.D., chopping of H.S.C.T and the manufacture of Small Arms Ammunition of composition containing a higher percentage of G/C than M.D.

Ballistics.

No cordite has been rejected this year for Ballictics. There has been a marked tendency however for both the velocities and pressures to rise and two lots, one of M.D. 11/15 and one of 4¼ show pressures and velocities above specification. These increases appear to be due to the use of linters and should disappear now we are on cotton waste again, although of course we shall have to re-establish the correct size of cord to give specification ballistics. The 4¼ M.D. mentioned above was also slightly high in M.D.

Below will be found the various quantities of materials etc. used and made during the year.

I. Raw Materials and Paste.

	M.D.	Mk.1	R.D.N.	Exptl	Total
Acetone (Cons 2415-2417)	144,291	535	5646	210	150,682
Mineral Jelly. (Cons 184-5).	19,181	128	-	-	19,309
Carbamits. (Cons 2-4).	-	-	2400	144	2,544
Paste.- N/G Ch.Nos.556-593) G/C Batches 1092 -) 1202. N/C Batches) 16,17,20,21.)	361,722	2422½	29692½	1860	395,697
	525,194	3085½	37738½	2214	568,232

II. Material Incorporated.

M.D. Dough.	380,760	
,, rework.	5,750	
,, Experiments.	30	386,540
Mk.I dough	2,550	
rework	485	3,035
R.D.N/A	32,100	
,, Experiments.	1,960	34,060
Various experiments.		200
		423,835

Material Pressed and Issued.

III. Pressed.			IV. Issued.		
Small screw presses.					
M.D.T 5-2	191,480		M.D.T.5-2	193,980	
M.D.2¼	15,670		2¼	15,670	
4¼ cut	835		4¼ cut	835	
4¼ reeled	8,720		4¼ reeled	8,720	
Experiments	295	217,000	8	57,800	
Mk.1 1/.05	1,780		11	80,900	
3	150		15	9,200	
3¾	875	2,805	Experiments.	311	367,396
RDN/A	30,880		Mk.I 1/.05	1,575	
,, Expt.	1,700	32,580	3	150	
Total small screw	=	252,385	3¾	875	2,600
			RDN..042"	18,931	
Hydraulic Press.					
M.D.8	92,500		Expmts.	2,128	21,059
M.D.11	64,000		S.C.		683
M.D.15	9,200				391,738
Expmts.	116	165,816			
No.3 Large Press S/C.		683			
Total Pressed		418,884			

V.

Below is given details of loss of Cordite due to burnings etc and also the percentage of Acetone and mineral jelly used.

	M.D.		Mk.I	
Paste used.	361,722		2,422½	
M.J ,,	19,181		128	
Stock of rework 31.3.31	4,500	385,403	420	2,970½
Cordite produced.	382,816		2,805	
Stock rework 31.3.32	1,875	384,691	13	2,818
Loss		712		152½
% Loss.		.18		5.4
% Acetone used.		37.7		-
% M/J used.		5.08		-

MAIN LABORATORY.

Investigations during the year have been confined to the manufacture of Petrolite and R.D.N/A and the annexed report on Petrolite Manufacture (D) and notes on the manufacture of R.D.N/A (E) have been prepared for the information of the Ordnance Committee.

Investigation of the various processes involved in the manufacture of Petrolite and Picrite continues to absorb the full resources of the Laboratory and it is hoped to submit a comprehensive report on these activities in the course of the next few months.

Inspection of Raw Materials, intermediate and finished products.

1931-32.

The following raw materials supplied by outside Contractors have been inspected.

	Tons.
Cotton Waste	44
Acetone.	50
Mineral Jelly.	20
Nitrate of Soda.	100
N.O.V.	200
C.O.V.	32
Soda Ash.	4
Chemical Lead.	34
Ammonium nitrate.	1½
Diethyldiphenylurea.	1
Coke.	161
Petrol.	110 galls.

Intermediate products inspected included.

N/G 37 nitrations = 111 washings = 12,677-lbs.

G/C 116 Batches) 126 Tons.
56 Stovings)

N/C 4 Batches) 3.5 Tons N/C
4 Works) .75 tons Gunwood.
Expmts)

Picrite = 17,851-lbs.

Finished products inspected included -

340 samples representing - Cordite M.D. 98 Lots) 191.4 Tons.
,, ,, 5 Batches)
,, Mk.1 14 Lots.).... 1.4 tons.

30 samples representing - R.D.N/A 16 Batches) 16.25 tons.
,, 2 Lots)

770 Batch samples.

85 Blend ,,

140 RDN/A ,,

36 R.D.202 ,,

Routine inspections for the purpose of process control included the following:-

C.O.V from N/G manufacture.			40 samples.
,,	G/C	,,	190 ,,
Denitrated acid for N/G manufacture			120 ,,
,, ,,	G/C	,,	186 ,,
Nitric acid "	N/G	,,	120 ,,
,, ,,	G/C	,,	52 ,,
Mixed acid	N/G	,,	16 ,,
,, ,,	G/C	,,	30 ,,
Waste ,,	N/G	,,	30 ,,
,, ,,	G/C	,,	36 ,,
Nitre cake ,,	N/G	,,	12 ,,
,, ,, ,,	G/C	,,	26 ,,
Soda Nitrate,,	N/G	,,	12 ,,
,, ,,	G/C	,,	26 ,,
Cotton waste.			260 ,,
Acetone.			100 ,,
Mineral Jelly.			50 ,,
Glycerine.			28 ,,
Ammonium perchlorate. Charcoal. Starch.			40 ,,
Coke.			16 ,,
Filter-bed waters.			290 ,,
Vat Boiling.			800 ,,
G/C from weighing house.			60 ,,
,, ,, stove.			35 ,,
R.D.N/A from Incorporators.			150 ,,

Product 'A'	200 samples.
,, 'B'	80 ,,
,, 'C'	177 ,,
Picrite.	215 ,,
Ammonium Nitrate liquor	170 ,,
Cyanamide sludge.	155 ,,
Dicyandiamide.	26 ,,
Picrite from spray crystalliser.	90 ,,

MACHINERY SECTION.

Organisation.

Mr. Griffiths who had been technical assistant was appointed Shop Manager on 25.8.31 in the place of Mr. Williams who retired on February 15th. Mr. Browne, Foreman of the Electrical Section retired on the 15th June 1931 and it was decided to combine the Electrical and Machinery Sections under one Foreman and one Assistant Foreman. Mr. Threadgold, Asst. Foreman in the Machinery Section was promoted to Foreman and Mr. Goodhind appointed Assistant Foreman.

Services.

The running of the crystallising plant and Hydro-extractors at the Picrite Factory has given us a good deal of anxiety. The very heavy revolving parts of the former together with overflow of brine have been very detrimental to the running of the ball bearings on which the parts revolve and numerous renewals have had to be made. An alteration in the method of carrying away the brine solution has improved the position. Breakages of the steam engine parts of the hydro-extractors have also been numerous due to the onerous duty they are called upon to perform. Alternative methods of driving these hydro-extractors have been considered but were too costly for a plant in an experimental stage.

A larger super-centrifugal has been purchased for the final operation of the product in the first stage and is expected shortly to be put into service. This machine is arranged for electric drive, in place of steam engine.

Many renewals and repairs have been carried out to Guncotton and Cordite plant and it may be mentioned that motor driven agitators are now installed in two of the mixed acid tanks at the Guncotton Factory.

Electric Supply.

The cost of electricity per unit for the two power houses combined has for the past three years been as follows:-

1929/30	341,079 units	@	3.610 d. per unit.
1930/31	317,807 ,,	@	4.027 d. per unit.
1931/32	317,532 ,,	@	3.596 d. per unit.

The decrease in cost as compared with last year is due to a decrease in the cost of fuel and other boiler house expenses.

The decision to manufacture T.N.T. in new buildings towards the northern end of the factory rendered it essential to have a supply of electricity at 220 volts at this point. Hitherto this end of the factory has had facilities for lighting only at 110 volts. Interconnecting overhead mains have now been erected and a supply is available at 220 volts, and the 110 volt supply will be shortly discontinued. It is probable that electric motors will largely supersede the steam engines which are driving plant at this end of the Factory and a saving in cost of manufacture should be derived therefrom.

The running plant has been maintained in very fair condition but it is to be expected that the plant at the Lower Works Power House will require some renewals in the near future.

An investigation has been made regarding the possibilities of taking electric power from the North Met.Electric Power Supply Co. These investigations indicate that no great advantage is to be derived from this course at the Upper Works, but that at the Lower Works it would be advantageous both in peace time and

in an emergency and would save the expenditure of a considerable sum of money on idle boiler plant which would otherwise have to be kept in working order. The negotiations are proceeding and it is hoped to submit a definite proposal at an early date.

Boiler Houses.

Three boiler houses have been in commission during the whole year and the average cost of steam for the three houses as compared with the two previous years is as follows:-

1929/30	80.257 million pounds	@	42.63 d.	per 1,000
1930/31	74.450 ,,	,,	@ 46.21 d.	,, ,,
1931/32	83.728 ,,	,,	@ 39.5 d.	,, ,,

The cost cannot be considered altogether satisfactory even when the high cost of fuel is taken into consideration, and a trial is being made of closing down No.3 Boiler House and supplying steam to the northern end of the Factory from No.5 Boiler House through the 5" main which was erected during the War. It is hoped that by throwing the additional demand on to No.5 Boiler House where mechanical stoking and cheaper coal are employed and economisers are installed that a reduction in cost will result. A steam meter and reducing valve costing altogether about £200 have been installed for this service.

The softening of the boiler feed water was considered but there did not appear to be an adequate return for the expenditure involved.

Cranes for Coal and Acid Drum Handling.

The boilers of three of the four steam cranes in use have needed repairs due to extensive corrosion. An entirely new uptake tube has been fitted in one while the other two have been repaired by welding.

Lorries for conveyance of Guncotton.

The older of the two Straker Squire Lorries was found to be incapable of further useful work and was sold. In order to provide a means of conveyance of guncotton in the event of breakdown of the remaining lorry, a removable covered body has been made for the Du Cros lorry employed at the R.S.A.F. This is kept at the Guncotton Factory.

AR 31-32

Fuze Powder Plant.

An estimate was prepared and submitted for the supply and erection of plant for the manufacture of Fuze Powder.

BUILDING WORKS DEPARTMENT.

Property.

The gross returns from property attached to this Factory for the past five years are as follows:-

27/28	28/29	29/30	30/31	31/32
£1020	£994	£996	£1529	£1537.

The loss on possible rental from Cottages amounted to less than £2. for the year. Some detailed figures of expenses in maintenance may be of interest.

Ordinary Rentals.

	Assessed Value C. of L.	Rentals received.	Maintenance cost per annum for last 3 years.
	£530.	£525.	£312.
1/7 Basic Rentals.	£443.	£292.	£327.
Free Quarters.	£195.	Nil.	£175.

Following the order in the High Court dated July 30th, 1931, we were asked by both the defendant bodies in the recent L.V.D. dispute to carry out clearance works on main rivers external to the two Factories, to the value of £380, and internally to the two scheduled streams to the value of £79.

The Controller of Lands is proposing to negotiate an entirely new agreement defining liabilities in these waterways as between ourselves and the Lee Catchment Board and agreeing to the repeal of all existing Acts of Parliament and agreements

We have, in the meantime, surveyed the whole of the waterways in the two Factories in company with the Lee Catchment Board Engineer and submitted to that body an agreed schedule of desirable works of maintenance of wharfing, weed clearance. and dredging.

Although we have again escaped flooding the condition of the rivers and streams is such that any heavy snowfall followed by a sudden thaw and rainfall occurring, these factories will, we fear, be under water in a few hours.

Our risk in this respect is indicated by the fact that we have had many high runs of water for days on end while the comparative maximum and minimum daily averages for the last two years have been-

February 19113 cu.ft. per min: against April 16805.

October 3619 ,, ,, ,, July 5881.

the maximum call on our waterways shewing a drop of more than 10% with an increasing tendency to high water, while the all over yearly figure has remained constant.

The average daily readings of Fields Weir Gaugings have been:-

27/28.	28/29.	29/30.	30/31.	31/32.	
17.731	8.293	9.974	9.987	9.973	cu. ft per min.

The Department has, since July last, had part time services from the newly appointed Clerk of Works and the Asst.Foreman here has had 2 periods of service at R.S.A.F. arising out of sickness.

Works carried out during the year included the remaining 2 pairs of new lock gates at the Lower Island, the lock itself being dredged of many years accumulation of mud and debris. A further stretch of concrete wharfing was also driven to the Lower Island Canal.

In the Guncotton Works a coke condenser was rebuilt and a commencement made with the repair of the overhead acid runs stretches of 100 feet being taken up and renewed at a time.

The internal wooden valley gutters of 2 Reeling stoves were found to be decayed, and were removed and replaced with cast iron gutters and the roof covered with asbestos tiles.

In the Nitro Glycerine Factory the Brine Run from Nitrating House was remodelled and renewed, and in the Cordite works the paths of the Accumulator House Cut were laid with tarred limestone.

During the last 3 months of the year the three Experimental T.N.T. buildings were erected and practically completed, together with a gantry across the Mill Head Stream for supplies and a 3" water main and hydrants for fire purposes.

Following the resignation of the late A.F.B.O. we secured, after considerable trouble on the part of the Chief Officer of the London Fire Brigade, the services of a retired ex-Station Officer who joined at the end of January. He has interested himself very largely in the various appliances and the ring main extensions, the second portion of which scheme was just being completed on his arrival. For this work a 6" main in lieu of the old 3", running from the Refinery Bridge to the Main Office block was installed and the M.W.B. consented to the intake for this supply being constructed in an entirely new position under the terms of the 1887 Agreement without detriment to us of the cheap rate of supply, but from our needs in a much more advantageous position.

The consumption of M.W.B. water for the past 5 years has cost :-

27/28.	28/29.	29/30.	30/31.	31/32.
£117	£156	£173	£131	£168.

The anticipated L.C.C. inspection for the beginning of the year was somewhat disappointing in that the visiting officers were considerably delayed at R.S.A.F. and only able to stay a very short time here. The Chief Officer, in his report, proposed a separate inspection of this Factory again this year and we are hoping this will take place.

OFFICE & STORES.

The modification of the Morris award and amendment of O.T and Nightshift conditions were carried through without incident, but the rate of pay for the sixth night making up a normal night-shift week of 47 hours - a condition of affairs peculiar to Waltham - has only recently been finally settled.

We have put into service a new sailing barge, in place of one which had seen many years of service for conveyance of explosives to Woolwich. The construction of the vessel which cost us £1174 was carefully watched over on our behalf by S.E & C.S at Woolwich and the service rendered by that Officer is much appreciated.

Following upon a decision to drop the use of linters in the manufacture of Guncotton for Cordite, we negotiated for the exchange of our stock of linters for an equivalent stock of Cotton Waste. This exchange has been carried out at some ~~expense~~ cost to us but at an appreciably lower figure than if we had sold Linters and bought waste in the open market.

	Value of Stock.		Value of stock taken.		+ or -	
	This year. £	Last year. £	This year. £	Last year. £	This year.	Last year.
Glycerine.	42048	44251	42048	44251	-	- 1
Other Explosive Materials.	15210	22473	2365	6828	-	-26
General Stores.	15104	17661	7577	11179	-	-
	72362	84385	51990	62258	-	-27

Production Statistics.	This year.	Last year.
Approx. total value of productions.	£80,000	£85,000
M.D. 5-2. Quantity produced -	lb. 192,780	lb. 278,669
Cost per lb.	s. d. 3/5	s. d 3/5

ACCOUNTS.

Schedules B & C attached show turnover and a comparison of F.E. with the figures for last year. The differences in the items marked 'X' in the latter statement are mainly accounted for by the diversion of expense from the Picrite plant to general maintenance which has fallen somewhat in arrears on account of pressure of work in the former plant.

A.1.

Total Strength on 31/3/32.

	Waltham. No.	Waltham. %	31/3/33
Over 60 and under 65	44	16.06	46
" 50 " " 60	132	48.18	134
" 40 " " 50	48	17.52	41
" 30 " " 40	25	9.12	33
" 21 " " 30	19	6.93	17
Under 21.	6	2.19	7
	274	100.00	275

A2.

R.G.P.F.

Personnel. 31.3.32.

	Total this year.	Total last year.
Supervisory &c.	38	38
Skilled.	41	39
Semi Skilled.	83	80
Unskilled.	108	113
Women & Girls.	-	-
Boys.	4	2
	274	272
Highest.	277	279
Lowest.	272	272
Average.	274	277
Entries during the year.	4	4
Discharges " " "	8	6
Transfers " " "	20	27

A3.

Nos. and Average of R.G.P.F. Employees on 1.4.31 and 31.3.32.

Age.	Nos. on 1.4.31.	Nos. on 31.3.32.
65	-	-
64	2	12 — 1 Foreman from prod.
63	12	2 — Tosd 1933/34. (1 production)
62	2	12 — 6 prod
61	12	10
60	11	8
59	10	12
58	11	14
57	14	13
56	13	13
55	13	12
54	12	21
53	20	15
52	15	9
51	9	14
50	13	9
49	9	10
48	10	5
47	5	7
46	7	4
45	4	3
44	2	3
43	3	6
42	6	5
41	5	3
40	3	2
39	3	1
38	1	1
37	1	4

A3. Cab

Age.	Nos. on 1.4.31.	Nos. on 31.3.32.
36	4	4
35	5	5
34	4	4
33	4	1
32	1	1
31	2	1
30	1	3
29	2	7
28	7	3
27	3	1
26	1	1
25	1	2
24	2	1
23	1	1
22	1	2
21	2	1
20	-	1
19	1	1
18	1	-
17	-	2
16	-	1
15	-	-
14	1	1
	272	274
	Average age = 49.27	Average age = 49.59

B

1951 - 52.

Annual Turnover.

Royal Gunpowder Factory, Waltham Abbey.

	Parliamentary Estimate. £	Latest Forecast £
A. Establishments.	4,100	3,955
B. Wages.	48,360	45,693
C. Materials.	26,883	16,673
D. Machinery, Contract.	4,000	2,766
E. Works, Contract.	524	129
F. Miscellaneous.	6,175	6,413
G. Non-effective.	6,650	6,651
	96,692	82,280
Add - Net effect of Materials on I.D.Ds.	5,770	3,395
	102,462	85,675
H. Productions for Army, Navy, etc.	108,000	102,083
Misc. Receipts.	1,850	2,091
Sale of Scrap, old stores and stores issued on repayment.	2,530	586
	112,380	104,730
Deduct - Net effect of I.D. Services.	5,033	5,124
	107,347	99,556
Balance as shown below.	4,885	13,861

Incomings.	Parl'y Estimate £	Latest Forecast £
Estimated amounts recoverable in respect of :-		
Depreciation of Buildings and Mains.	2,700	2,633
Depreciation of Machinery.	1,300	1,462
Buildings, Machinery and Mains written off.	-	25
First Equipment of Shops written off :-		
Petrolite Plant.	4,000	2,470
T.N.T. Pilot Plant.	-	1,852
Decrease of Stores in Stock.	5,000	12,291
	13,000	20,733

Outgoings.	Parl'y Estimate £	Latest Forecast £
Estimated expenditure on New Capital :-		
Land.	-	-
Buildings & Mains -		
(a) Contract.	50	57
(b) Departmental.	1,750	1,484
Machinery -		
(a) Contract.	2,850	1,209
(b) Departmental.	465	657
Adjustment of Refrigerator charges.	-	283
First Equipment :-		
Petrolite.	3,000	1,530
T.N.T.	-	1,852
To be transferred to Supplies Suspense A/c.	4,885	13,861
	13,000	20,733

R.G.P.F. WALTHAM ABBEY.

FACTORY EXPENSE.

COMPARISON BETWEEN 1931/32 & 1930/31.

C.

Description.	1931/32	1930/31
Process Expenses.	£	£
Foremen, Asst. Foremen, etc.	1920	2136
Miscellaneous Labour.	732	745
Consumable Stores.	426	420
Gas.	48	30
Water.	21	14
Steam.	4554	4877
Power.	3172	3434
Refrigeration.	2388	3019
Compressed Air.	2134	2286
Maintenance of Plant.	X 11328	X 9513
Maintenance of Buildings.	1550	2491
Depreciation.	816	803
Rates.	200	166
Internal Transport.	809	793
Balance of Process Expenses.	X 4273	X 7617
Sectional Expenses.		
Chemists.	2283	2339
Electric Light.	252	302
Gas.	89	88
Steam for Heating.	1539	2614
Maintenance of Services.	1394	1256
Miscellaneous Labour.	268	276
Laboratory Testing.	3078	3084
Care & Custody of Deptl. Stores.	184	183
Allowances.	1359	1455
O.T. & N.S. Bonus.	137	165
Balance of Sectional Expenses.	778	968
Credit for Materials returned to Store.	424	747
General Expenses.		
Superintendence.	526	626
Registry Pay & Order Branches.	252	275
Worktakers Wages & Accounts.	763	797
Central Stores.	1986	2019
Police, Fire Brigade & Warders.	3056	3258
Maintenance of Grounds, Mains, Canal, Permanent Way, etc.	3823	4025
Non-effective Charges.	3437	3599
Balance of General Expenses.	7502	6826
TOTAL.	67666	71502
Less Subsidy.	13555	13555
Net Factory Expense.	54111	57947
Percentage to Direct Labour.	606.35	615.02
Direct Labour.	8924	9422

D

PETROLITE MANUFACTURE at R.G.P.F. WALTHAM ABBEY.

3rd. REPORT.

The starting point in the manufacture, originally, was the production of an aqueous solution of cyanamide by treatment of calcium cyanamide fertiliser with carbon dioxide and water in a pressure vessel and subsequent separation of the precipitated chalk sludge from the solution. The cyanamide solution then paased to an autoclave for reaction with ammonium nitrate.

As dicyandiamide is equally satisfactory as a starting point for the manufacture of guanidine nitrate C.S.R.D. advised later that polymerisation of the cyanamide to dicyandiamide by evaporation of the solution in presence of ammonia was beneficial in that it permitted the use of more concentrated solutions in the autoclave with a consequently greater output. Thus the starting point has now become the production of dicyandiamide.

The capacity of the first cyanamide extraction vessel was 60 gallons and in this the carbon dioxide process gave fairly satisfactory results. This first vessel has been replaced by one of 360 gallons capacity with a view to studying the reaction under conditions more suitable for large scale production. In this larger vessel the carbon dioxide process has not been so satisfactory, difficulty being experienced in completing the reaction. In view of this difficulty and as the starting point is now dicyandiamide alternative methods for the production of this body from calcium cyanamide fertiliser have been investigated.

It seems to be generally known that pure dicyandiamide is obtained when calcium cyanamide fertiliser is extracted with hot water and the equation $2\ CaCN_2 + 4\ H_2O = 2Ca(OH)_2 + (CN.NH_2)_2$ is given as representing the reaction. This apparently simple method appeared worth investigation. The reaction appears to proceed in two stages. The action of water on calcium cyanamide is first to produce the acid salt calcium bicyanamide which further reacts with hot water to produce cyanamide which polymerises to dicyandiamide. These reactions may be expressed by the following equations:-

$2\ Ca\ CN_2 + 2\ H_2O = Ca(CN.NH)_2 + Ca(OH)_2$.

$Ca(CN.NH)_2 + 2\ H_2O = CN.NH_2 + Ca(OH)_2$.

Time is necessary to complete the reactions but, on the other hand, if the heating is unduly prolonged, decomposition of the cyanamide will occur with subsequent loss in yield.

In the same way increase in temperature facilitates the reaction but boiling increases the rate of decomposition of the cyanamide considerably. It was necessary, therefore to ascertain the optimum conditions and in the laboratory these were found to be a 30 minute extraction at a temperature of 90 - 95°C. Under these conditions a satisfactory yield of dicyandiamide was obtained. The product was of high standard of purity with a satisfactory melting point of 203-209°C. It contained 0.25 per cent of lime. After one recrystallisation the nitrogen content was 66.60 per cent. (theoretical 66.67%). Recrystallisation is unnecessary in manufacture. Under factory conditions it was difficult to imitate exactly the laboratory conditions. With the knowledge that in the laboratory the method was in every way satisfactory it was now necessary to find large scale conditions equally satisfactory. This has been done and the process is now working smoothly.

There are many advantages in adopting this process.

Carbon dioxide is no longer required. This was purchased from the Trade and accounted for 4.157d in a total of 10.707d. cost of materials consumed per pound of Petrolite manufactured. This amounts to a saving of £37 per ton of Petrolite.

The plant required for the water extraction process is much more simple than that required for the carbon dioxide extraction under pressure.

After hot water extraction the sludge is easily filterable and quite different from the difficultly filterable slime produced in the carbon dioxide process. This does away with the most troublesome process in the manufacture and means that expenditure on centrifugal and other filtering machines will be curtailed considerably.

This improvement in the condition of the sludge effects also a saving in labour. At the present rate of output, 750-lbs petrolite per week on a single shift, one man only is required on extraction instead of 2½ men by the carbon dioxide process.

In the carbon dioxide process it was necessary at some stage to evaporate a considerable amount of water because of the low concentration of the fertiliser extract. The water to be evaporated amounted to at least 70 gallons per shift on the present output and it was anticipated that on full scale production a multi-effect evaporator would be necessary. In the water extract method, however, the dicyandiamide crystallises when the extract is cooled and is then separated from the mother liquor which is returned to the extractor for a fresh charge. Evaporation is thus eliminated.

The production of dicyandiamide is now a definite stage in the process. The material is produced in the dry state and can be checked for purity before being used for the next stage.

In the previous report it was mentioned that a 1.6 metre centrifugal machine, horizontally mounted, was on order from Super Centrifugal Engineers Ltd. This machine, required originally for the separation of the sludge resulting from the carbon dioxide extraction method, has been found quite suitable for this purpose and suitable also for dealing with the improved sludge from the water extract process, a very considerable increase in output being obtained with the latter.

TREATMENT OF DICYANDIAMIDE WITH AMMONIUM NITRATE.

Experience has shewn that this process corrodes the steel autoclave considerably. A new vessel can be used for some time without perceptible corrosion then a few small pittings are observable and after this the deterioration is rapid.

From the position of the corrosion there were some grounds for thinking that the localised direct gas heating might be responsible to some extent. The autoclave was,therefore,

oil jacketed but without beneficial effect. Samples of various acid resisting steels have been subjected to tests but none has been found satisfactory for the purpose. The success of aluminium evaporating pans for the concentration of similar liquor suggested the use of this metal as a lining for the autoclave. An autogenously welded aluminium lining was fitted and has been used intermittently for over a year. It has recently been cut out for examination which shows that, except for one spot which has been abraded by contact with the dip pipe, the aluminium generally has suffered no loss in thickness. There are traces of minute pits at the bottom but apart from the abraded spot mentioned the lining was quite serviceable for a much longer period.

In view of this it should now be possible to design a suitable large scale autoclave. In working the present vessel it has been found that the rate of heating has been retarded considerably by the oil jacket and still further by the aluminium lining not being in the closest contact with the steel of the autoclave. In addition to the decrease in output caused by this there is reason to believe that a slow rate of heating tends to increase the amount of undesirable by-product. It is not considered advisable to revert to direct gas heating because of the risk of dangerous local overheating of the steel due to poor thermal contact between the steel and aluminium. The heating would be better carried out by an aluminium steam coil in the vessel supplied, if necessary, with superheated steam.

The use of the concentrated solutions already referred to has more than trebled the autoclave output.

TREATMENT OF GUANIDINE NITRATE WITH SULPHURIC ACID.

A nitrator suitable in size for large scale production has been installed and taken into use. It has a capacity of 300 gallons and has been worked with a charge of 1,000-lbs. of guanidine nitrate. Both cooling and stirring are efficient and no difficulty has been experienced in controlling the

reaction but the product has not been quite so uniform in quality as that obtained with the small nitrator. In particular the nitrogen content is sometimes slightly low. This is, no doubt, a direct result of the disturbance of the nitration conditions consequent to the sevenfold increase in the charge. It is expected that the investigation, which is proceeding, will indicate the steps necessary to restore uniformity.

RECRYSTALLISATION OF NITROGUANIDINE.

In order to obtain a product in a very fine state of division this operation is now carried out in a spray crystalliser designed by C.S.R.D. 35-lbs of Nitroguanidine are dissolved in 75 gallons of boiling water and the hot solution, after filtration, is sprayed on to a revolving metal cylinder cooled by refrigerated brine. The crystals are separated from the mother liquor by means of a centrifugal machine. After drying the very fine crystals are separated by passing through a Schutz O'Neill disintegrator. The spray crystalliser is capable of an output of 5 charges i.e. 175-lbs per shift.

The product is satisfactory in quality but a larger output is very desirable. Alteration of the design of the crystalliser is indicated. It would seem preferable, if possible, to revolve the spraying jets rather than the very heavy metal cylinder and to use a thin walled sheet metal vessel in place of the latter.

The ADAPTABILITY OF THE VARIOUS PROCESSES TO AN OUTPUT OF 2,000-lbs. OF PETROLITE per SHIFT.

Production of Dicyandiamide.

It would be necessary to extract, per shift, 5,000-lbs of fertiliser with 1,450 gallons of water.

Four extractors of 120-150 gallons capacity would be required. Each extractor would deal with six 225-lb. charges of fertiliser, per shift. Four large centrifugals would be necessary to filter the extract. There would also be required a tank for cooling

the extract and a centrifugal for separating the dicyandiamide.

Production of Guanidine Nitrate.

Three autoclaves of 120 gallons capacity would be required. Each would deal with 2 charges per shift. One or two centrifugals, according to type, would be necessary for separating the guanidine nitrate.

Treatment of Guanidine Nitrate with Sulphuric Acid.

Three 350-gallons nitrators would be required. This is the size of the nitrator already in use which takes a charge of 1,000-lbs. of guanidine nitrate. Each nitrator would operate once per shift. One or two centrifugals would be required for separating the product.

No difficulty is foreseen, as far as the above processes are concerned in planning a factory for this output, but it is considered that some improvement in spray crystallising is necessary before proceeding to large scale output. It would be advisable, also, to obtain experience, as soon as possible, with the internally heated type of autoclave suggested.

1/10/31

"E".

The MANUFACTURE OF R.D.N/A.

The manufacture of R.D.N/A may be divided into the following stages which will be considered separately:-

1. Mixing of the paste.
2. Storage of the paste.
3. Incorporation.
4. Pressing.
5. Drying.
6. Blending.

1. Mixing.

In the method of mixing now in use, the picrite and nitrocelluloses are intimately mixed by hand and then passed through a ½" mesh brass sieve. The nitroglycerine is then poured on and the whole remixed by hand and again passed through the sieve.

There is no doubt that the ease and success of incorporation depends to a very great extent on the efficiency of the mixing. An improvement on our present method would be the use of ¼" mesh sieve in place of the ½". (It will be remembered that a great improvement in the incorporation of R.D.B. resulted when the ¼" mesh sieve was taken into use.)

2. Storage.

Owing to the gelatinising action of nitroglycerine on nitrocellulose, storage of paste for any considerable period of time is very undesirable. This action which appears to be only slight with a nitrocellulose having a nitrogen content on the high limit of the specification (12.3%) becomes considerable with a nitrocellulose having a nitrogen content on the low limit (12.1%).

The effect of this gelatinising action is to produce hard lumps of N/C- N/G mixture free from Picrite, resulting in a patchy incorporated material containing these lumps which disappear only very slowly and prolonged incorporation is necessary to cause them to disappear entirely.

3.INCORPORATION.

The following method of incorporation is at present in use. The N/C - N/G - Picrite mixture is loaded into the machine with the addition of acetone as for M.D. Cordite. The blades of the machine are cleaned after 15 minutes and after a further 15 minutes the Carbamite and Chalk are added. The incorporation then proceeds for 4 hours making a total time of 4½ hours.

The amount of acetone used is 17 per cent of the total dry weight of all the ingredients. The use of picrite in place of petrolite has not only caused the material to bulk more in the incorporating machine but has also necessitated the use of more solvent. It is found that some time elapses before the material properly kneads together, which is presumably due both to the small amount of gelatinisable ingredients and also to the small percentage of solvent.

The time as stated above has been laid down as 4½ hours for incorporation, but owing to the slowness with which the material works up it is found that after 4½ hours considerable numbers of small nodules of N/C - N/G free from Picrite are present and it requires at least 6 hours to eliminate these. There is no doubt that the more efficiently the preliminary mixing of the ingredients is done, the less will be the time required for incorporation, but the elimination of these nodules is always a slow process, and it does not seem sound to reduce the time of incorporation to less than 6 hours. (The original time laid down for R.D.N. was 3 hours, so it will be seen that the output of the incorporating machines will be halved if 6 hours is required.)

It has been found that R.D.N/A dough, once it is removed from the incorporating machine, shews a great tendency to form a dry skin on the outside of the lumps of dough, and, as this skin would choke the strainer and therefore raise the extrusion pressure excessively, it is not deemed advisable to unload more dough than sufficient to keep the presses at work for a short time (1 to 2 hours), the rest being left in the machine which is kept running until the last of the dough is removed. It will be seen that with a small output this reduces the output of the incorporator, but with larger output this difficulty would be overcome.

4.PRESSING.

In pressing R.D.N/A it is essential that the dough should be as fresh as possible, since on standing, as stated above, a skin is formed on the surface of the dough due to loss of acetone, and this would choke not only the strainer but also the dies of very small sizes.

The dough is pressed through a 50 mesh strainer before extrusion from the die. This strainer eliminates most of the foreign matter and also holds up any nodules of N/C - N/G material. Straining through a fine mesh has a very beneficial influence on the dough giving a resultant cord infinitely superior to one which is obtained from dough that has not been so strained.

In order to obtain a cord of the correct density it is necessary to design the dies so that the pressure required for extrusion shall be sufficient to consolidate the dough completely before the cord emerges from the die, and also it is desirable that the extrusion pressure shall be greater than the pressure required for straining so that the maximum pressure will be on the die and not on the strainer. To ensure obtaining the required pressure it is necessary to have the parallel portion of the die of the correct length to set up sufficient resistance

to extrusion, but our manufacturing experience with R.D.N/A is limited to one size, .042, other sizes having been made in small quantities only.

Most of the R.D.N/A so far made has been pressed on the small screw presses, and the material obtained from these is very much superior not only in uniformity but in general appearance to that made on the hydraulic presses, and on small sizes such as .042 the output per man is greater on the Small Press and the amount of waste needing to be re-incorporated is very much less. After extrusion, the cord, when pressed on a small press, is reeled automatically in the reeling gear on to a reel of a diameter to give the length required with as little waste as possible. The cords are cut off the reel, shaken out, and cut to the required length. It is very necessary for the cords to be properly separated at the ends after cutting, otherwise much waste will be made after drying, since if not separated, the ends stick together and it is impossible when dry to part them without breaking the cord, and for this reason also great care must be exercised when holding the wet cords in the hand, since if too much pressure is exerted, the cords will matt together and it will be impossible to separate them.

5. DRYING.

With ordinary R.D.N, it was possible to dry down to a V/M of .2% without the application of heat, but since the introduction of R.D.N/A with the necessary increase of solvent used in incorporation, it is found that even after 2 days at 110°F. the V/M is reduced to only about .3% and if a limit of .2% is required longer stoving will be necessary.

6. BLENDING.

Blending is carried out in exactly the same way as for M.D. Some difficulty is usually experienced in separating the cords, owing to sticking and this is especially so if insufficient care has been used in packing the wet material.

1.10.31.

Statement
re
Maintenance
of Plant &
Buildings

H.324/11/1

S.R.G.P.F.

The attached statement with regard to the maintenance of plant and buildings is a limited statement only.

What I require from you is a statement that plant and buildings were maintained as at 31st.March last, as it is not clear from your present communication that such was the case, but rather that you are now getting in arrears.

I must remind you that I have received no communication from you to indicate that you are getting in arrears with maintenance, or that you are carrying out capital services which interfere with maintenance.

Please give a clean certificate or indicate precisely in what way current or emergency output is limited by the state of your Factory as at 31st. March last and oblige.

(sd) R.Townsend.

8th July 1932. D.O.F.

D.O.F.

Clean certificate herewith.

As explained to you on the telephone, the second para of the previous statement was only intended to indicate for your information that, it may be necessary to ask for some additional staff to enable clean certificates to be rendered in future.

(sd) P. H. Evans.

9.7.32 Supt. R.G.P.F.

are Puddling 1024 man weeks
Charging 156

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(sd) R.Townsend.
D.O.F.

8th July 1932.

Stokes D.O.F. 27/10 He would rather ... have to qualify the arrears in any way. Asked P.C. to look into the money side & see what we can do

D.O.F.

Clean certificate herewith.

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(sd) P. H. Evans.
Supt. R.G.P.F.

9.7.32

[illegible]

W.324/11/1

MAINTENANCE.

During the year 1931/32 the plant and buildings have been maintained in a condition to meet the programme of expansion in time of emergency.

(sd) P.H.Evans.

Superintendent.
R.G.P.F.

9/7/32

W 3224/11/1

MAINTENANCE.

The plant and buildings have been maintained in a condition to meet the programme of expansion in time of emergency. A substantial portion of the maintenance staff has however been employed on Capital work during the last few years mainly in connection with the development of Petrolite production and T.N.T and there are now definite signs that this diversion from maintenance cannot be permitted to continue without an increase of staff.

(sd) P.H.Evans.

Superintendent.
R.G.P.F

7.7.32