WAS< 1955

Mr R. Treadgold
Laboratory Notebook

Ron Treadgold - Working papers on propellant manufacture and experiments at RGM.

Original retained by Ron Treadgold.

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MEMORANDUM

Tel. No. 309

From MINISTRY OF SUPPLY,

(Branch) Housing

(Room No. & Bldg.)

Our Ref.:

8th January 195 4

To: A R Treadgold Esq

Your Ref.:

Subject: allocation - housing
Monkswood Estate

Thank you for your minute - The procedure is for you to write to Mr A. Brewin - Chairman of the Housing Committee at this Establishment. Your memo should include details of (1) No. in family & ages and sexes of any children; (2) How you are at present housed & your daily journey; (3) Grade you grade and details of Changes of posting.

P K Wards
Housing Manager.

L.H. 446

ANY REPLY SHOULD BE GIVEN OVERLEAF.

Cordite. — A Solvent. — Gun Props. 1
Casting Powders. 2

B Semi-Solvent — Gun propellants 1
Seat Ejector Cartridge 2
Casting Powders. } (by aid of dispersion of additives).

C Ball Powder.

A1 Solvent Mfr.

Incorporation — dough — 13·4 % N_2/NC, 13·1 } Acetone or acetone/water 90 10.
12·6, 12·2 } Ether/Alcohol 60/40.

Paste (NC + Plasticiser: NG, TEGN, DEG) — gelat with solvent then fillers added (picrite, ROB moderants TiO_2, Pb Stannate, CuO. incorp. casting liquids Plasticiser TA TNG up to 5 hours.

A2. Casting Powder — Av. size .035" + .035" long.
Standard 12·6 NC + 60 %. Pb Salicylate 3·0 %, Stannate 3·0, phthalate 3·0
NG levels 9 - 30 %.

High Impulse — Standard composition { 12·6 % NC, NG 20 %, 20 %. Al. 35, AP 23.

~~Ether~~ 60 % fillers — v. highly filled — ~~ether~~ acetone/alcohol 65/35 solvent.

25 % solvent mix on dry wt of chg.

A1. Pressing: 3" - 8" Press.
As cords — up to 0·25" diameter
MT 7·19 35 holes Normally
MT 7. $\frac{D}{d} \simeq 10$. $\frac{L}{D} \simeq 2{\cdot}6$.
MT19 10 5mm Tank Gun TiO_2 as erosion reducer

Mortars: Pin sizes as small as .008" (Tubular)
030 - 010 / 010 ann.

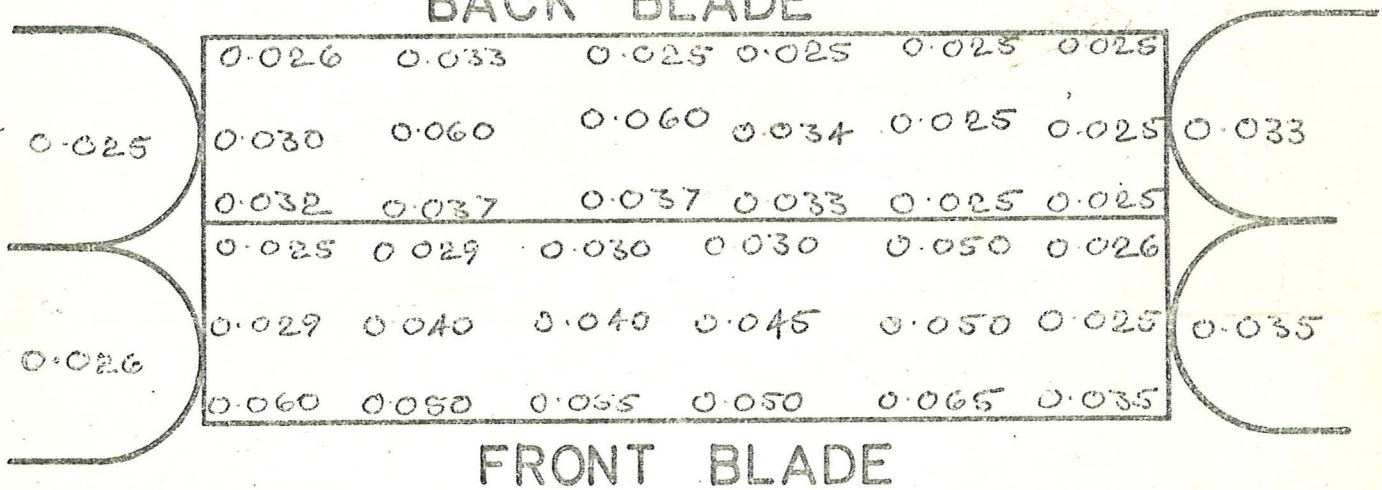
X Reproducibility of ROB of Solvent v. Semi solvent propellants

'N' solvent 55 % picrite ≃ 19 NG 19 13·1/NC 7·3 % Carbamite.
MNF semi-solvent 55 picrite — 12·2 % NC.
In general - Semi-solvent comps give more consistent Rs of B. than solvent.

Naval (Cafpwent)

MIXER. BEATER & TROUGH. CLEARANCE DIM: RECORD

BACK BLADE



FRONT BLADE

DRG. N° 693979

AOA AOA

AOI

SIZE 101B. INCORPORATOR

CLIENT MIN. OF TECHNOLOGY

M/C. Nº

REMARKS

SIGNED

DATE

to be encurred as a result of this treatment.

Processing times, from ¼ to ¾ hrs, have no detectable effect on the bond strength.

Effect of reduced temp on drop tests:

The apparatus (as designed by K T B Stott) was fitted with a cold jacket, supplied with chilled air from an adjacent solid CO_2 cabinet, which enabled the standard 1 in² circular drop test specimens to be tested at temps down to -40°C It was observed that the resistance of all types of bonds with & without adhesive, was greatly enhanced by low temperatures; at -40°C the eventual break has almost always been found to take place within the core of the plastic propellant specimen, remote from the metal interface. The following results will indicate the order of these effects:

		No. of 7in drops.	
Adhesive	RT.	-20	-40
1261	4	25	94
NONE	2	4	45
1330/21R	10	46	97

It is proposed to utilise a rapid strain plastometer (pneumatically operated type) in order to emulate more exactly the intensity and time scale of the stresses presumed to operate on actual rocket motor. It is thus hoped to produce the A/H type fracture often observed in motors which have exploded during low temperature firing trials. Conversions necessary to modify the apparatus for such work are complete and experimental tests will be conducted immediately.

Contribution to Quarterly Tech. Rep. 1/3/57.

~~Adhesion of plastic propellant to~~

Use of Rhobond 20 as an adhesive for plastic propellant.

Rhobond is a hycar based adhesive recommended by its makers (Goodyear Ltd) as a bonding agent for rubber to metal. It is at present used by ICI Summerfield for securing the rubber linings of motor tubes for use with pressed charges. Since it has been found that one coat of Rhobond acts as an excellent ~~sealer~~ sealer for a phosphate film ~~sheet~~ it was decided to examine its properties with a view to its replacing Bostik 1261 as a propellant adhesive. It adoption would moreover assist in standardisation of manufacturing processes for both plastic propellant + pressed charge designated motor tubes.

The experimental procedure adopted was as follows. Metal cylinders (as used for all previous adhesion tests) were coated, by brushing, with Rhobond 20 and were then cured for 15 mins at 60°C. After cooling they were recoated and allowed to air dry for a further 60 mins. The plastic bond was then formed up at 1000 psi and the assemblies then ~~out~~ subjected to prolonged storage at 60°C. At the expiration of various ~~but~~ times, extending to 32 days, samples were withdrawn, cooled to -40°C, and tensile strengths determined at a rate of strain of 2in/min. Low temp trials were adopted to investigate and tendency to high brittle point suspected to occur ~~th~~ in this hycar based adhesive.

~~The~~ Concurrent control tests using Bostik 1261 only and Bostik 1261 on a Rhobond "primer" were also carried out. Since experience has shown that the breaking stress of these bonds is little or no criteria with respect to quality a systemmatic examination of the fracture was recorded using a colour coding scheme to present a pictorial record of the progress of the hot storage condition of the bonds. The following conclusions were formed

1). Bostik 1261.

The initial bond, before being subjected to 60°C, was poor, about 40% by area of the adhesive surface being exposed at break. This condition improved somewhat after one days hot storage but adhesive/metal failure became more notable over the test period

2) Bostik 1261 + Rhobond 20 (primer).

Initial bonds were again poor followed by a ~~rapid~~ marked improvement at 1~2 days at 60°C. Slow deterioration ensued

but at all times was better than B1261 only and in no case was any base metal exposed. Such deterioration as did occur was mainly confined to a breakdown between the two adhesives but this never exceeded 25% by area compared with a metal exposure with B.1261 amounting to about 50%.

3). Rhobond 20

Again the initial bond was poor (approx 30% propellant/adhesive breakdown) but this rapidly improved and after 16 days was down to about 10%, with a graphical indication that this improvement would continue.

A ~~and~~ large programme of work is in hand to extend the examination of this promising material, especially with regard to the effect of ethyl oleate containing plasticiser (high peel strengths of Rhobond after long immersion in ethyl oleate have already indicated a good resistance to this ester) and also tests to ascertain the shelf life of coated tubes, ready for filling, are being carried out. If these latter tests prove satisfactory it is hoped to apply the adhesive to the motors, put them into store in this prepared and inhibited condition, and withdraw and fill as required, although some surface reactivation may be found necessary after long storage.

Contribution to Quarterly Report (to 29/2/56). 13/3/56.

Igniter Development.

(a) Pelletised powder.

4 oz of pelletised SR371C has been prepared (pellet size 0·125" diam x 0·150" lg, 4). and sent to Dr Newman for firing trials.

(b) Jelly Roll type

Attempts have been made to prepare igniters based on information from American sources but it has been found difficult to emulate the recommended procedure. A supply of polystrene sheet is on order – meanwhile ~~cellophane~~ cellophane sheet has been tried without much success.

(c) Small scale rocket charge igniters.

The present system of firing pressed charges and composite rounds is somewhat unsatisfactory owing to the necessity of loading igniter leads through the ~~gun~~ carbon choke aperture with consequent reduction in effective area especially when small sizes are involved.

~~A redesigned firing tube fitted with a~~ An sealed igniter assembly which can be inserted into the base of the firing tube has been prepared, utilising a modified I/C engine sparking plug as a gas seal to permit entry of the igniter firing current. Although satisfactory in principle ~~of~~ occasional open-circuits were encountered during igniter continuity tests owing to ~~the~~ fouling of internal contact points by combustion debris. A thermo-setting plastic type with moulded-in conductors is now ~~in~~ proposed and can be manufactured with equipment available in ERDE.

Adhesion of plastic propellant to steel surfaces.

(a) Effect of ~~Waltersing~~ of steel on strength of the bond.

Test specimens were treated by Messrs. Robert Stuart Ltd under identical conditions to those to which standard rocket tubes are subjected.

No evidence ~~was~~ of A/P fracture was observed in any tests conducted at high or low rates of stress so in can safely be [illegible]

Contribution to Quarterly Report. 21/8/57.

Polyurethane Propellants.

Density determination of cured material

A large beam balance has been modified for use in hydrostatic density determination; one pan and cradle was removed and replaced by a hook with lead counterpoise and a 30 swg steel wire suspension. Below this was fitted a water jacketed glass cylinder, which could be easily maintained at 20°C and filled with Kerosine. This liquid was found to be compatible with P.U. propellants and of course, was readily available. Its density was accurately determined using a sample of pure electrolytic copper as a standard of known density. The apparatus was found to accommodate comfortably masses over the range 50 – 750 gms and a normal ~~size~~ sample of propellant used was about 100gms. The density of the setting material of completed K rounds can be ascertained provided the mass of the steel tube is previously determined and stamped on the tube prior to filling with propellant. This procedure indicates the presence of any occluded air pockets within the composition — ~~this~~ it is anticipated that these ~~rounds~~ checks should be carried out on each round before being sent for firing. The maximum error on any determinations carried out to date has ~~not~~ been found not to exceed a scatter of 0.4%. The following results were obtained on samples submitted by the small scale plant —

	Composition				Density		
No.	A/P	A/Pic	Polyester	TDI.	Determined.	Calculated.	Voids.
U42/1	55	20	22.94	2.06.	1.651	1.650	Nil.
/2	"	"	"	"	1.646	"	0.25%
/3	"	"	"	"	1.649	"	Nil.
/4	"	"	"	"	1.650	"	Nil.
Y3B/1	70	–	27.53	2.47. (Vac)	1.645	1.645	Nil
Y3B/1.	"	–	"	" (Air)	1.635	"	0.6%
Y3B/2	"	–	"	" (Vac)	1.640	"	0.3%
Y3B/2.	"	–	"	" (Air).	1.638	"	0.4%
Y5/1	75	–	23.15	1.85	1.695 (Checked).	1.689	Nil
U38	60	20	18.02	1.98.	1.681	1.696	1.0%

Adhesion of Plastic propellant to motor walls.

Rapidly applied stress

Trials have been carried out using a Hounsfield impact tester which had been loaded to increase the bob weight to 6¼ lbs, thus giving a total of 12½ foot/lbs for the normal 2ft fall. The velocity of impact is 11 ft/sec which ensures that all specimens are subjected to a standard rate of strain when fractured. A simple jig was devised consisting of a T-shaped cross head which was screwed to a normal adhesion test piece assembly; the other half being secured to a rigid bracket bolted to the bench top. Lugs were fitted to each side of the bob such that they engaged, on falling, with the cross head and thus fractured the specimen, the energy absorbed being indicated by the friction loaded pointer. A blank determination to find the energy required to displace the crosshead and fractured test piece only gave a constant which was subtracted from all readings.

A mean of ten readings was determined in each batch and the average energy required to break the bond was transferred into the equivalent single drop that would be required when using the usual drop test apparatus; this figure being considered as more readily comparable with existing data. Considerable scatter was observed in the results, but it was made up largely of occasional "rogue" values, rather than general erratic trends.

Composition	Bond.	Hounsfield Impact.	Drop Test.
E3354.	Wall unsized only.	28in, 33in.	—
E3354	Bostic 1261.	30in 37in.	—
E3300	Wall unsized only.	—	23in
E3300	Bostic 1261.	—	40in
E3354	Plobond 20.	4·3in.	—

A program of work is now under way to give a systematic comparison of each method of test.

2) Slowly applied stress, after hot storage. Test temp -40°C.

The present program of work is now almost completed, and the results obtained are summarised in the table below.

Comparisons								Plioband 20			Bos. 1261.		
No.	A/Rc	A/Pic	TiO_2	SiOt	Lect.	Vistanex	Blk.						
RD2307.	65·5	20	1	-	1	12·5	-	50H	40L	10 A/P.	40H	15L	45 A/M
RD2307A	65·5	20	1	-	1	-	12·5	50H	40L	10 A/P.	98H		
B	65·5	20	1	1	-	-	12·5			98 A/P	Work in progress.		
C	65·5	20	1	1	-	12·5	-			95 A/P	40H	50L	10 A/P.
E3298	77	7	0·5 TiO_2 0·5 TiO_2	1	-	14	14			98 A/P	80H		20 A/P.
E3300	76	8	1	1	-	-	14			98 A/P	80H	5L	15 A/P
E3354	76	8	1	1	-	14	-			98 A/P	20H	75L	5 A/P.

In addition, the following results were obtained using (a) Plain waltensed steel (b) Plioband 20, followed by Bos. 1261.

	P20/B1261			Metal only.
RD2307	50H	30L	20 A/P.	—
E3300	60H	20L	20 A/P	50H 50L

(NB a progressive improvement of the bond on hot storage was observed).

The normal preparation of Plioband specimens is a two coat procedure; the first being cured at 60°C/30 min and the second dried at 20°C/1 hr. This is considered impracticable on production, since all motors are filled hot. A comparison was made between the 60°/20° procedure and a 60°/60° double curing cycle (using two coats as before) but no difference was observed in the nature of the bonds obtained (These tests were carried out using RD2307A stored at 60°C for 6 days) In each set the fracture take presented an 80H/20 A/P break.

A. R. Treadgold 21/8/57

Contribution to Quaterly Report. 29/11/16.

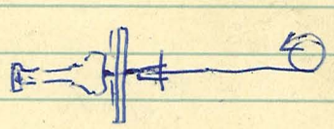
Application of rapid strain to plastic propellant at low temperatures

It has been postulated that if plastic propellant is subjected to a strain of 150% elongation per sec for about 20 milliseconds (equivalent to an extension of 3%) at temperatures in the region of -30°C, fracture will result. Efforts have been made to ~~~~ obtain these conditions as follows —

1) Permanent elongation of material after low temperature tensile fracture.

A low geared electric motor rated at 350 lb/ft torque was fitted with a pulley and bowden cable such that the latter traversed a stout wooden base at about ~~100~~ 100 in/sec which will thus apply an initial elongation of 150%/sec to a standard 3cm dumbell specimen. The latter was held by a fixed and a movable jaw, the latter being pulled towards the motor pulley by the bowden cable. The specimen was cooled by a CO_2 cold box and after attaining the required temperature it was extended to break, the halves then being replaced and ~~~~ any extension measured

Temp.	Ref. lines.	Extn.	Permanent Set. To Increase in final length.
-5°c	2.95cm	.55cm.	18.7%
-10	2.95	.45	15.0
-15	2.90	.12	4.2
~~-20~~	~~3.00~~	~~.20~~	~~6.8~~
-25	2.95	.05	1.7
-30	2.93	.02	0.7
-35	2.95	.02	0.7
-40	2.95	0	0



A graphical examination of these results indicated that fracture would occur, for a 3% extension, at temperatures in the region of -20°C. However observation of the specimens during test showed plainly that some elasticity was present at these temperatures and some other experimental approach was required. The apparatus was then modified such that the specimen could be extended by a known amount, ~~and the~~ suddenly released, and any elastic recovery or fracture observed. The method used was to ~~pull~~ pull the movable jaw up against a rigidly fixed stop, the overide of the motor being ~~released~~ permitted by a shear-pin system. By ~~varying~~ insertion of plates the gap and consequent extension of the specimen could be varied at will.

Materials RD2307 & K3298 ~~not~~ have been tested at -30 & -40 respectively - Results

RD 2307

Temp	Ext^{n} applied	Permanent Set	Effect on Specimen
-30	20%		Break.
"	"		Break
-30	10%	Top small for Appreciable movement.	Break.
"	"		Break
-30	6·6%	Negligible.	Break
"	"		Unbroken.
"	"		Unbroken
-30	3·3%		Unbroken
"	"		Unbroken.

E 3298.

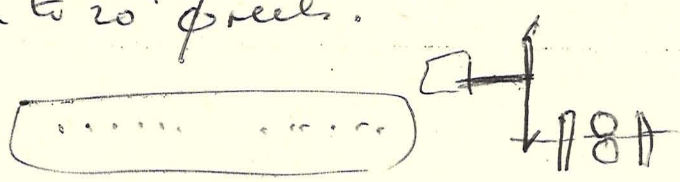
-40	20%		Break.
"	"		Break
-40	10%	Negligible	Break.
"	"		Break
"	"		Unbroken.
-40	6·6%		Break
	"		Unbroken
	"		Unbroken.
-40	3·3%		Unbroken.

From these results it can be stated that with RD2307 fracture is probable when subjected to 150%/sec strain for periods in excess of 40 milliseconds and the same conditions obtain with E3298 at temperatures of below -30°C and the same conditions obtain with E3298 at about -40°C and lower.

Other composition not using EC. developed (US) DBP (2)
as alt. coolant. – graphite & carbon black.
(: Picrite carbamite complex formed with ~~EC~~ EC as high as 7·3%.
↑ this gives variable ROB ≃ incorporation technique)
(solvent level → different xtal size).

Pressing of blasting Powders.

3" – 8" presses. die sizes 030 – 040" (cord) – extrude
Π up to 5000 psi on dough – cut on Melvin cutter – stoved on to 20" φ reels.
to VMS ≃ ½%. graphited sieved – cast.



At low temp firings with same pic/cord propellants v. high Π developed – thought to be due to charge shattering (primer blast). ∴ Use of DBP to soften as well as being alt. coolant

B **Semi-solvent**. For large φ charges solvent level to be as low as poss.

MNF. Normal solvent incorp (21% acetone) and pressing. then pre press ($\frac{3}{16}$" cord) – air dry overnight VM drops to ≃ 5%. Then cold rolling to form sheet. Cut out discs 3" or depends on press cylinder φ. Press with heated cylinder (70°C). 2-3%
as cord etc etc. ie 2" charges (rockets) Stove.

Solventless

Same as solvent. with paste etc (wet) except with water sol. cap'd ("spraying on" or sol^d coat). For large rocket charges

Paste → gelatinised on rolls – pressed hot ~~20~~ 1.5 ton/psi.
10½", 15", 21"

↑
10 NC
1 H_2O — Stirred — Slurry Sheeting over Vac. — 30% 50% H_2O — Add soluble additives — dry.
Sprayon
NG.

Mr. Threadgold

ARMAMENT RESEARCH AND
DEVELOPMENT ESTABLISHMENT,
FORT HALSTEAD.

Our Ref.: R.6/6D/

Your Ref.: SKR.42.09. 25th February, 1959.

To: S./P.AE.E.,
SHOEBURYNESS.
Essex.

For the attention of Capt. Ketley-Jackson. (2 Copies)

TRIAL PS/12/J/2, SCHEDULED FOR 1100 HRS. ON 9.3.59.

1. Please note the new time for the above trial.

2. It is expected that the following visitors will attend:-

* Dr. B. H. Newman, E.R.D.E., Waltham Abbey.

* Mr. A. R. Threadgold, E.R.D.E., Waltham Abbey.

Mr. R. Harris, P.2/A.R.D.E.

Mr. D. Kingdon, P.2/A.R.D.E.

Mr. Brown, P.2/A.R.D.E.

Mr. G. F. Blighton, P.1/A.R.D.E.

Mr. L. A. Wareham, P.1/A.R.D.E.

Mr. J. W. Simpson, P.1/A.R.D.E.

Mr. P. B. Shilstone, P.1/A.R.D.E.

Mr. A. V. Feist, S.1/A.R.D.E.

* Lt.-Col. J. F. May, P.6/A.R.D.E.

* Major A. G. Symonds, P.6/A.R.D.E. (W.R.)

* Mr. J. Congdon, P.6/A.R.D.E.

* Mr. J. Taylor, P.6/A.R.D.E.

* Lunch will not be required for these people.

People requiring lunch at P.AE.E. should contact Capt. Ketley-Jackson not later than 6.3.59.

J. Taylor

P.6/W.H.,
A.R.D.E.

Copies to: Each visitor.
File R.6/6D.

JT/HMF

Contribution to Quarterly Report. 24/5/57.

Polyurethane-bonded propellants.

Incorporation of constituents

The most frequently occurring fault with these mixtures has been the occlusion of gas pockets within the body of the cured grain and outgassing of the constituents was carried out to alleviate this trouble. The earlier procedure was to outgas the polyester at 90°C for 2 hrs., followed by addition of salts and a further 2 hrs under vacuum and finally the addition of TDI to the cooled mixture.

This has now been somewhat simplified and it is generally possible to obtain a bubble free material by merely outgassing the polyester at room temp for 2 hrs and then adding TDI, with a further 10 minutes mixing. No heating of the mixture at any stage is necessary.

This process can be carried out most conveniently in a single vertical stem type paddle mixer fitted with a vacuum sealed lid and a small (70g) mixer of this type is in use in the laboratory. Larger batches are still prepared in a twin Z blade incorporator but this type involve sealing and cleaning problems.

Mouldings.

In order to prepare rounds for ballistic assessment the propellant is cast into the standard 2" tube fitted with a polythene central rod and cone-shaped end pieces. After curing the rod can be readily extracted and the cones withdrawn from the ends of the charge. Work is now in hand to manufacture cones by injection moulding methods owing to the difficulty of the present method using sheet and welding apparatus.

Filling

The tendency to occlude air whilst filling is of course most noticeable with highly loaded mixes containing less than 20% rubber, whereas 30% content induces relatively free flowing material. Various schemes have been tried including vibration & vacuum assistance, but so far the method best applicable to all

types seems to be a transfer mould system. The material is loaded into a cylindrical container fitted with a plunger. A nozzle on the base of the tube is inserted into a hole in the side of the empty round. This is now filled with rod + cones and ~~flanged~~ air tight end pieces. Vacuum is applied and then the ram is depressed, thus transferring propellant from the cylinder to the evacuated round case. Complete filling is indicated by slight ejection of the end caps, which are then removed and ~~corrected~~ the alignment of the rod + cones within the tube is corrected if necessary.

Density checks have been carried out and it appears that voids can be reduced to about 0.5% by this method. (a satisfactory hydrostatic medium is ethyl alcohol).

Hard vacuum, less than the vapour pressure of TDI at ambient temp ~~to~~ must be ~~to~~ avoided since foaming is evident under these conditions.

Adhesion

Prior to filling, all cases are subjected to the following

a) Vapour degrease in trichlorethylene
b) 5 min pickle in 20% HCl
c) Rinse, cold water
d) Waltenise (RC bath 10 min)
e) Rinse, hot water, dry in air blast.

This surface was found to give a ~~bet~~ firm bond to with all types of polyurethane propellant and work is now in hand to determine the actual strength of the bond under varying conditions of storage and test temperature.

Contribution to Quarterly Report (to 29/2/56) 13/3/56.

Igniter Development

(a) Pelletised powder

4oz of pelletised SR371C has been prepared (pellet size 0·125" diam x 0·150" long) and sent to Dr. Newman for firing trials.

(b) Jelly Roll type

Attempts have been made to prepare igniters based on information from American sources but it has been found difficult to emulate the recommended procedure. A supply of polystiene sheet is on order – meanwhile ~~cellophane~~ cellophane sheet has been tried without much success.

(c) Small scale rocket charge igniters

The present system of firing pressed charges and composite rounds is somewhat unsatisfactory owing to the necessity of leading igniter leads through the ~~gas~~ carbon choke aperture with consequent reduction in effective area especially when small sizes are involved.

~~A redesigned firing tube fitted with a~~ A gas sealed igniter assembly which can be inserted into the base of the firing tube has been prepared, utilising a modified I/C engine sparking plug as a gas seal to permit entry of the igniter firing current. Although satisfactory in principle ~~it~~ occasional open-circuits were encountered during igniter continuity tests owing to ~~the~~ fouling of internal contact points by combustion debris. A thermo-setting plastic type with moulded-in conductors is now ~~in the~~ proposed and can be manufactured with equipment available in ERDE.

Adhesion of plastic propellant to steel surfaces.

(a) Effect of Wallerising of steel on strength of the bond.

Test specimens were treated by Messrs. Robert Stuart Ltd under identical conditions to those to which standard rocket tubes are subjected.

No evidence ~~was~~ of A/M fracture was observed in any tests conducted at high or low rates of stress so it can safely be implied that no deleterious results are likely

to be incurred as a result of this treatment.

Processing times, from ¼ to ¾ hrs, have no detectable effect on the bond strength.

Effect of reduced temp on drop tests

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C. R. Treadgold

13/3/56.

Contribution to Quarterly Report June – August 1956. 13/9/56.

Igniters for 2" Air to Air.

A large number of compositions have been prepared based on metallic fuels and potassium perchlorate, or other nitrate, oxidants. An ignitability test has been devised in which a small sample of mixture (about 0.2 gms) is subjected to contact with an electrically heated filament of 30 s.w.g. nichrome. The temperature is incrementally raised by a variac transformer and the point of ignition recorded against an empirical scale. It was then possible to ~~record~~ indicate the ease of ignition with temperature and to visually note the apparent rate of burning. With semi-qualitative results were used to agree a short list of compositions to be submitted to S.S.S. proof stands for ballistic assessment; exhaustive trials on all compositions, though desirable, were impractical with staff & equipment available.

Most compositions prepared were assembled into shellacked paper containers with F.S.3 matches and fired at atmospheric pressure on open waste ground at a point approved by the Safety officer, near the New Weir. A visual estimation of the usefulness of the igniter was attempted, taking particular note of the ~~…~~ of any scattering of unburnt material, sporadic burning, misfires and hangfires.

By these tests it was decided to postpone for the time being the following types for reasons of difficulty of initiating and sustaining ignition until the charge was consumed.

1) Titanium – Potassium nitrate 4 (erratic).
2) Atomised Aluminium – >6.
3) perchlorate.
4) Magnesium, Teflon, potassium nitrate 3 (erratic).
5) Flake Aluminium – potassium nitrate >6.
6) Titanium – teflon 3 (v. erratic

All these groups either misfired completely or gave slow erratic burning with considerable residues of unburnt material.

Initially igniters submitted to S.S.S. consisted only of a paper case and match (waterproofed with shellac varnish) with no retaining fibre board disc. Results were very erratic and it was decided to fit all with collars to ~~…~~ restrain any tendency to self-ejection from the rocket motor.

Several compositions including Benzofurane, A.I.K., & SR371C have been pelleted and fired successfully provided the charge was retained within a copper gauze sheath. However

it has been found possible to avoid the slow and hazardous pressing pelleting operation by adopting a coarse powder in which about 30% of gun arabic is incorporated with the mixture, dried crushed & sieved 5-44 mesh to give a granular product, similar in properties to its pelleted equivalent. Upon some form of tube cage is necessary to avoid scattering of unburnt material.

At present igniters charged with Magnesium/Teflon and Aluminium/PTFE pyrotechnics are being prepared for ballistic assessment. Work on the former mixture leads delivery of the new type of T-53 match from TCI Ltd and a loose charge of 2gm of Aluminium/PTFE pyrotechnic shows promising results. Pressure rise rates will be measured at -40°C - +60°C. Typical results for a 3½ gm Mag/Teflon are in the order of 29×10^3 psi/sec at 63°F mean temperature. This is approximately the same as for SR371C, and gives ignition delay times of 17-20 milliseconds, which will probably be reduced by use of an improved match.

Ignitability test (heated filament).

The ambient scale was devised over the range 1-7, ascending temperatures of ignition. The following results were obtained -

		Scale
Boron 17%	$KClO_4$ 83%	1
Boron 15%	KNO_3 85%	2
SR371C		2
Aluminium 27%	Teflon 73%	2
Titanium 41%	$KClO_4$ 59%	2
Magnesium 33%	Teflon 67%	3
Fluke Aluminium 33%	$KClO_4$ 67%	6
Alternate		7 ignition.

Physical testing of polyether urethane rubbers, etc.

Apparatus is now available for the determination of certain physical properties on rubbery materials. To facilitate the preparation and investigation of small scale batches of rubber it was decided that the following tests would suffice.

1) Density
2) Hardness
3) Tensile strength
4) Torsion set (Permanent set)
5) Clash & Berg flex test.

Several samples of polyether urethane rubber have been submitted by Combustion Section for test, but unfortunately the method of curing of the sheet is at present highly unsatisfactory

and preparation of dumbbells is a particularly difficult operation owing to the irregular cross-section, presence of air bubbles, and tenacious adhesion of a wax paper backing used to permit removal of the cured sample from the ~~tray~~ oven tray. However teflon covered trays are in course of manufacture and these should effect considerable improvement. The following results obtained must therefore be regarded as highly approximate and may be discredited in the light of future determinations on accurately cast specimens.

Composition	Tensile properties				
	Mod. 100%	300%	500%	UTS	Ext'n/break
R5	39 psi	73 psi	—	115 psi	420%
R9	63 psi	113 psi	33 psi	55 psi	700%

Hardness figures have varied from <30 to about 60 B.S.S. degrees. A Clash-Berg determination of cold flex ~~at~~ gave a rotation of 200° at -43°C; other materials gave the following results—

Black rubber sheet	-65.5°C
PIB	-51°C
Thiokol	-41°C

Use of Pliobond 20 as rocket wall adhesive

The rubber sheet liners applied to the interior of motors by ICI Ltd are bonded with Pliobond 20, a butadiene/acrylonitrile based material. Since it has been shown that a phosphate finish sealed with one coat of Pliobond offers excellent storage properties it was suggested by Bristol Aircraft that we might investigate the desirability of adopting this as a universal pretreatment prior to normal Bostik [illegible] application for charge bonding, or even the substitution of [illegible] by Pliobond throughout. A visit to Bristols was arranged ~~at~~ ERDE being represented by A R Tredgold and CWD by Dr G R Smith & T Wilkinson [illegible]. ~~He~~ explained the problem on behalf of BAC and conducted a tour of the shops pointing out the salient features of tube design etc relevant to adhesion problems. It was agreed to carry out laboratory tests at ERDE to examine Pliobond 20 as a plastic propellant adhesive.

As a result of tests performed to date it appears

that although there is no reduction in adhesion when used as an undercoat to Bostik 1261, some stripping of propellant was observed when applied directly to Thiokol. Ambient temps of 20°C were used for these preliminary trials and further work is planned for low temperature tests at -40°C, and owing to the high brittle point of these mixtures some breakdown is anticipated (Bostik [illegible] — -42°C).

Quarterly Report (Dec Jan Feb - 1953/54) 1. 3. 54.

1) Density Gradient Tube

One column has been prepared (Barium iodide solution; 1·5 – 1·7) and graphs plotted of change of gradient / time, over a period of 30 days. Reasonable stability was observed provided excessive & and sudden changes of room temperature were avoided. Some system of control of temperature is anticipated. Glass floats are being prepared to standardise the columns at desired ranges.

2) Karl Fischer Moisture Determination.

Reports of previous workers have been studied and several modifications made to the suggested techniques. A large number of titrations conducted with the modified arrangement indicate that application of the method to plastic ~~propp~~ propellants and their ingredients should be practicable and investigation is now being carried out. A "cleaned up" version of the apparatus is in course of construction.

3) Ammonium nitrate (caking, etc.)

Nothing to report; pending completion of item (2).

A. R. Treadgold.
1. 3. 54.

Quarterly Report

15/12/55.

Pressed Charges

Mechanical Properties.

Suitable equipment has now been developed to enable tensile, compressive and shear tests to be carried out with a reasonable degree of reproducibility — order of ±5% in most cases. Occasional anomalous results are inevitable owing to the essentially heterogeneous nature of pressed compositions. Thus, in addition to obtaining comparative data for different compositions, the optimum consolidation conditions can be ascertained prior to small scale plant work. Shock resistance is determined somewhat empirically by observing the number of falls from ~~four feet~~ a height of four feet which will just cause fragmentation of a three inch round conduit charge as used for small scale ballistic assessment.

The mechanical properties have been thus determined for a number of compositions including pitch & polythene based (ERDE) GIN ~~and~~ wax bonded (ICI) materials. The greatest tensile, shear & compressive strengths are observed with pitch propellant, whilst much improved shock resistance is obtained from polythene based mixtures. ICI mixtures tend to be intermediate in nature between pitch & polythene but have a generally much lower shock resistance than polythene.

Typical Properties

	Tens.	Comp.	Shear	Drop.
ICI Wax.	210 psi	1930 psi	696 psi	1 drop/4 ft
Pitch bonded.	736	5170	1452	1 drop/18 ins.
Polythene bonded	180	1980	950	10 drop/4 ft.
ICI RC6	212	2420	640	5 drop/4 ft.

Moisture Sealing.

The moisture resistance and general susceptability to handling have been much improved by a single dip in a nitro cellulose base lacquer. No detectable effect on ballistics or other properties has been noted and adhesion of inhibitor coatings is satisfactory.

Effect of constituents on rate of burning.

The composition of polythene bonded Catalyst (A/D) has been studied with special reference to the effect of binder, ammonium perchlorate, & ammonium picrate on RD normal composition (E1176) containing 90% AN/PN, 5% polythene 5%

Quarterly Report (cont).

catalyst has a R_b of 0·16 in/sec/1000 psi at a n value of about 0·8. Increase of R_b up to 0·33 in/sec/1000 psi has been obtained by ammon. perchlorate additions of 50% w/w but with subsequent heavy smoke evolution. Pressure exponents tend to be rather high (ca 0·8) with polythene bonded compositions but in the light of recent work it is hoped to effect some reduction in this value.

Rapid method for determination of viscosity of P.I.B.

~~This method is based on~~

Basically the method consists of allowing a ordinary billiard ball, dusted with talc, to rest on the undisturbed surface of the binder for a standard time and the subsequent measurement of the diameter of the image of the impression obtained on the ball. The method is suitable for viscosities over the range 30,000 – 5,000,000 poises. A fuller description and mathematical approach is given in ERDE Tech. Note 17/TN/55

Use of quinhydrone as catalyst in propellants.

Plastic propellant containing 1% Q/H has been prepared and it has been found that prolonged hot storage at 60°C gives rise to an abnormal loss of volatile material when compared with a control containing none of this additive. The results are as follows.

With Q/H, steady loss 5·5 mgm/dm²/day.
Without " " 1·5 mgm/dm²/day.

Pressed charges have also been prepared using Q/H as a suspected catalyst in place of ammon. dichromate in pitch and polythene bonded material (E998, E1176). Firing results were disappointing, however, showing ~~little difference~~ no apparent difference from the uncatalysed composition.

Recent Work on Pressed charges. 12/12/53.

Moulding

All moulds are now fitted with tufnol plungers in place of the original mild/cast steel system which was extremely prone to seizure and subsequent damage to walls; often resulting in total loss of the mould + drift. With the tufnol/mild steel arrangement not one case of mould damage has resulted in about 9 months use. In the rare event of damage occurring through non-axial application of pressure, to the tufnol former, this can readily be replaced and avoids elaborate turning and rewinding of heaters involved as is the case when a mould has to be badly scored. Tufnol is quite satisfactory for pressures up to about 15000 psi, the rated compressive strength being of the order of 25000 psi.

The use of polythene as a binding agent has revealed the existence of considerable temperature gradients in the heated powder prior to application of forming pressure. This was traced to the method of measuring the powder temp, by insertion of a thermometer into the loose powder contained in the mould. Owing the large proportion of occluded air the loose powder became virtually an insulator resulting in local excessive build up of temperature in the vicinity of the mould walls. The following procedure has now been adopted as standard — Holes have been bored vertically downwards from the top face adjacent to the wall and through the axis of the central conduit former such that thermometers can be inserted therein. The external shell is then maintained at about 10°C higher than that required for the powder and heating continued until the central core is at the required temperature. The transfer of heat is facilitated by pre-consolidating the loose powder (prior to the heating cycle) at 5000 psi — thus excluding much entrapped air.

A segmented mould with tapered retaining shell has been prepared by 7/E shop and is now being fitted with a heating element by the electricians. No work has yet been carried out with this device.

Moisture sealing

The moisture resistance and general susceptability to handling have been much improved by subjecting the charges, after forming and cooling, to a single dip in a nitrocellulose base lacquer. No detectable effect on ballistics

has been noted, and adhesion of inhibitor coatings is satisfactory.

Effect of constituents on rate/burning.

1) Catalyst.

Additions of Ammonium dichromate up to 10% w/w caused no marked change in R_b, the overall range being 0·12 — 0·16 ins/sec/1000 psi with the max. value at 5%, with a corresponding pressure exponent of 0·5. Restriction ratios varied from 940 — 1150.

2) Binder

Rounds prepared with varying polythene contents 5·4% (O₂ balance) — 15% showed a max. R_b of 0·17 ins/sec/1000 psi at 5·4% down to 0·09 in/sec/1000 at 15%; press. exps. from 0·43 — 0·85.

3) Am. perchlorate.

Up to 50% of NH_4ClO_4 was added in place of the corresponding mixed crystal content and rates of burning up to 0·33 in/sec/1000 were obtained over the range 10% — 50% NH_4ClO_4. The higher concentrations of perchlorate however gave rise to the usual heavy smoke output.

4) Amm. Picrate

Increments of 10% am. picrate substituted for mixed crystals in the composition were found to give rise to an R_b increase of about 0·05 in/sec, yielding 0·28 in/sec/1000 psi at 20% addition. Pressure exponents were rather high — of the order of 0·85.

General conclusions concerning use of polythene as binder.

Although rather more accurate temperature control is required than is the case with pitch bonded charges, the preparation of polythene rounds is a much easier operation, mainly for the following reasons.

1) Very little tendency to adhere to mould or former.
2) Less cracking on contraction — via increased "toughness"
3) Less damage suffered by drifts, often caused by (1).
4) Clean working, as compared with milling, etc, of pitch.

General service aspects.

Polythene bonded charges are reasonably shock resistant, being capable of withstanding about 10 drops onto a solid steel anvil from four feet. Thermal stresses applied by cycling between -40°C and +60°C are without visible effect after 16 cycles. Efforts to control R_t have met with limited success however except by the addition of ammonium perchlorate, which is somewhat undesirable owing to its smoke, safety, and supply problems.

Proposed future work

~~It is proposed to p~~ Star conduit charges to fit a 2" motor will be prepared and thrust measurements taken. Resistance to ignition shock, which gave rise to some failures with pitch bonded materials, will be noted and efforts made to improve the present rather "makeshift" pitch/asbestos inhibitors.

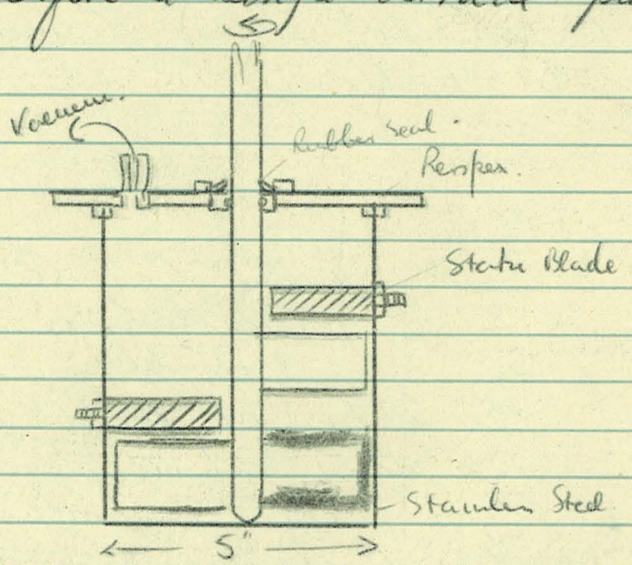
The segmented mould is almost ready for use and work will be carried out on it in the very near future; it is thus hoped to remedy insidious cracking of charges during withdrawl from moulds.

A. R. Bradwell
13/12/55

Work of Polyurethane Propellants up to date. 5/6/57.

1). Mixing and preparation of compositions.

It has been found that the use of twin blade Werner-Pfleiderer type incorporator with applied vacuum leaves much to be desired. Any gland leaks induce a flow of air through the mixture being "outgassed" and the cleaning of the equipment is a long & tedious owing to inaccessibility. Therefore a single vertical paddle type was devised, viz:



The static blades can be removed to facilitate cleaning of the pot and the perspex lid is located concentrically and secured merely by the application of the vacuum. The paddle revolves at about one rev/sec and the function of the static blades is to avoid the tendancy of the stiff mixture to "knot" around the paddle and revolve ineffectually with it. A steam heating jacket surrounds the pot which can also be cooled by water circulation.

This set up has been well tried and has proved to be very satisfactory and a large (10 lb) model is being designed for pilot scale work. Lab work has shown that the heating & cooling jacket can be dispensed with.

Initially the following procedure was adopted for incorporation of constituents

a). Polyester (Daltocel S.F.) with mixes at 90-95°C and outgassed for 2 hrs.

(b) ~~Cooled to 40-50°C~~ Salts added and mixed for 1½ hrs. (in vacuo.)

(c) Cooled to 40-50°C. The TDI (Vulcafor SF) added and mixed 5 min (air pressure), then 20 min in vacuo.

d) Mixture now ready.

It has since been observed that a good, gas free, mix can be obtained by the following simplified procedure

a). Polyester + oxidants into mixer at room temp and mixed (in vacuo) for 2hrs.
b). TDI added and further mixing (in vacuo) for 15 min at room temp

This yields a material which has a longer life in the viscous condition – about 3–6 hrs in a workable state (or longer if stored at ~0°) compared with about one hour for the material incorporated at the higher temperature. This is presumably due to the addition of TDI to the warm (40–50°C) polyester/salt mixture.

Curing of the composition

This process has been checked by curing the composition at various temperatures ranging from 25°C to 95°C and it has been shown that a good rubbery mix is formed after 15 hrs at 40–60°C; lower temperatures are too long (>2days) while temps in excess of 70°C give rise to local gas pockets and darkening of the material

least risk of gas evolution seems to occur at around 40°C

Casting, moulding etc.

Various techniques have been tried in order to obtain a void free material. It has been found that wax paper containers, as used commercially for packing cream, honey etc are very suitable for such tests since the cured specimens can be bisected and examined for voids. The attached photo shows an example where material E1825 (now designated U4) was loaded into these cups under various conditions. It is seen that vacuum filling gives least occlusions, but it must be borne in mind that E1825 (30% binder) is a very comparatively fluid material and the tendancy to coalesce under gravitation stresses only is much less marked in lower binder content mixtures. These often display mainly plastic properties and some form of pressure assisted consolidation in vacuo is desirable.

				Theo ρ.
Density	1·511	1·535	1·590	1604
% voids	~~[illegible]~~ 5·5%	3·1%	0·6% ~~[illegible]~~	

It must be noted that an excessively hard vacuum, below the vapour pressure of RDX at that temperature prevailing, will cause vapour cavities and foaming which ~~[illegible]~~ tend to occlude air when the pressure is again increased. All these tests are therefore conducted at pressure not less than 1~2 cm Hg at room temperature.

Filling of K Rounds for ballistic assessment.

Early work involved merely filling containers by spoon or palette knife, sometimes with vibration table or vacuum assistance. This procedure was far from ~~[illegible]~~ perfect owing to trapping of air pockets. It was found that polythene formers were suitable as there was very easy parting of the cured material from the polythene surface. Shaped rods and end pieces (see photo) were therefore made and inserted into the empty tube. This was then attached (as in photo) such that the nozzle of the piston assembly (a 3" deaerator ram) was located in a hole in the side of the tube. After clamping, pressure was applied to the ram (about 50~100 psi, depending on the viscosity of the mix), and composition thus transferred until a stream was extruded from a hole ($\frac{1}{16}$") bored diametrically in the nozzle orifice. The assembly was then removed

from the p
The contents
former about
indicating li
and ensuring
tube . The ro

lassoed off
the of interior
& and
filled cavity
within the

Density checks have been carried out and it appears that voids can be ~~x~~ reduced to about 0.5% by this method (Ethyl alcohol is a very satisfactory medium for density determinations

Adhesion

Prior to filling all case are given the following treatment.

1) Vapour degrease in trichloroethylene
2) 5 min pickle in 20% HCl
3) Rinse, cold water.
4) Wallerising (HCl Bath, 10 min).
5) Rinse, hot water, dry in air blast.

This surface was found to be as good, or superior to all other treatments, including ~~[illegible]~~ enamel stoving, unheated steel, and Vulcaforce (Tri phenyl methane 4 4' diisocyanate) coatings. Work is now in hand to ascertain the strength of the bond under varying conditions of storage + test temperature.

Strand burning specimens.

The following method was devised for the filling of ~~[illegible]~~ paper wound drinking straws for strand burning assessment. The apparatus consists of a cylinder with a ½" bore and close fitting ~~[illegible]~~ piston. A T-piece union is screwed into lower end and a cap fitted into the base. A stainless

steel tube alleyches to the T piece, the other outlet being blanked off by an acorn-nut with finger-bar (this nut is removable for cleaning purposes. A drinking straw, the top end being sealed by a screw clip, is slid over the vertical tube and pressure applied to the ram (about 6000 psi normal) Material within the cylinder is thus injected into the straw which moves upwards of its own accord as filling takes place. When full, it falls off the end of the tube and the next empty one can be slid over. The whole of this filling operation is carried out under safety conditions, using a 5 ton electrically operated press.

1. WITH EFFECT FROM 01/11/75, YOUR SALARY WILL BE CALCULATED ON A NEW COMPUTER SYSTEM OPERATED BY THE CIVILIAN PAY AND RECORDS OFFICE(BATH). YOU HAVE BEEN ALLOCATED A NEW STAFF NUMBER - 275671H WHICH MUST BE QUOTED ON ALL CORRESPONDENCE FORMS ETC FORWARDED TO CPRO(BATH).

2. RELEVANT INFORMATION CONCERNING THE NEW SYSTEM IS AVAILABLE LOCALLY. OVERTIME CLAIMS SHOULD BE SUBMITTED ON THE APPROPRIATE FORM WITH EFFECT FROM THE ATTENDANCE PERIOD COMMENCING 05/10/75 IN ACCORDANCE WITH LOCAL MANAGEMENT INSTRUCTIONS.

/ 3. CLAIMS

MR. A.R. TREADGOLD,
ERDE
WALTHAM ABBEY
ESSEX

3. CLAIMS IN RESPECT OF ANY OVERTIME WORKED BEFORE THIS DATE SHOULD BE SUBMITTED UNDER THE EXISTING ARRANGEMENTS TO REACH CHESSINGTON COMPUTER CENTRE NOT LATER THAN 10/10/75.

4. YOUR CO-OPERATION IN ACHIEVING THIS DATE WILL BE APPRECIATED.

CHESSINGTON COMPUTER CENTRE

SPECIMEN PAY SLIP AND EXPLANATIONS

	1	2	3	4	5	6	7	8	9	10	11
A		EARNINGS	TOTAL ASSESS-ABLE PAY TO DATE	TAXABLE PAY TO DATE	TAX REFUND	UNTAXED ADDITIONS	TOTAL GROSS	NET PAY	REMARKS EXPLANATION OF CHANGES ETC.	PAY NO.	NAME
B		TAXABLE ADDITIONS	FREE PAY	TAX DUE TO DATE	TAX DEDUCTION	N.I. AND OTHER DEDUCTIONS	TOTAL DEDUCTIONS			(SIGNATURE)	
		80. 0. 0.	600. 0. 0. 150. 0. 0.	450. 0. 0. 60. 0. 0.	8. 0. 0.	1. 6. 0.	80. 0. 0. 9. 6. 0.	70.14. 0.		1234	PAY, A.Y.E.
	Number of hours of authorised overtime for which payment is made.	A = 1/12th of annual basic salary plus P.A. & E.D.A. where applicable. B = Overtime Transfer Grants, Special Lodging Allowance etc. will be shown here.	A = Accumulative total of amounts shown in Col. 2 of your pay slips from commencement of financial year. B. Represents the non-taxable pay as shown in the Tax Tables for the month against your Code No.	A. This figure is arrived at by deducting 3B from 3A. B. Tax due on the above figure.	A. If the amount shown in Col. 4B is less than that shown for the previous month, the tax refund will be shown here. B. Diffce. between the amount shown in Col. 4B for the previous month and the present one.	A. Unabated sick pay would be entered here and this amount deducted from the earnings (Col. 2A). B. Consolidated deductions i.e. N.I. F.S.S.U. Superannuation C.S.B.F. C.S.S.A. etc.	A. Total of 2A & B, 5A & 6A. B. Total of 5B & 6B.	Subtract 7B from 7A - the resultant amount is entered here.	All variations in pay and deductions are shown here.		

JWS.

L.H. 114 B.

Telephone: Waltham Cross 3688
Ext. 301.
Any further communication on the subject of this letter should be addressed to:—
THE DIRECTOR
and the following reference quoted:—

.....

Your Ref.....

MINISTRY OF SUPPLY
EXPLOSIVES RESEARCH AND DEVELOPMENT ESTABLISHMENT,
WALTHAM ABBEY,
ESSEX

January 14th 1958.

Mr. D.A.R. Treadgold,
C.P.R.

Dear Mr. Treadgold,

Transfer to other duties.

It has been necessary for me to make some transfers of staff because of the changes in emphasis of our work and also to give members of the staff wider experience.

It has now been agreed that you will be transferred to the Composite Propellant Development Section on the South Site, under the direction of Dr. Newman, for duties connected with plant operation and development concerning plastic and polyurethane propellants.

Would you please report to Dr. Newman on Monday January 20th? You will be attached to his section until further notice.

I am sure you will find this job most interesting, and I am confident that you will be able to make useful contributions to this important work.

I wish you every success in your new appointment.

Yours sincerely,

G.H. Young,
S.P.R.I.

Copies to: Mr. Freeman,)
Dr. Newman) For information.

Mr A R Treadgold, D2 Branch

WAA 229/07

Dear Colleague

ERDE CAREER STATEMENTS

The Director, in a letter dated July 1973 to all staff up to and including SSO or equivalent grades, referred to the setting up of Career Development Panels at ERDE for each grade. The panels **consider** annually whether an officer's career would benefit from training and/or a change of job: it is stressed that there is no intention to move staff around every year. Since the Director's letter we have heard from DPSM (Mr K W Jones) and his colleague Mr Rogerson at the ERDE Colloquium on 29 3 74 that these reviews can be of value up to the end of an officer's career.

The Director asked all staff to complete a form outlining his or her career. Although the information could be extracted from personal files, it will assist the Director's staff materially if officers provide it themselves. I would be grateful therefore if you would help by taking the action ticked below, using the imaginary completed form overleaf as an example of the detail sought.

(✓) complete and return to me the form previously sent to you but not so far received (if you have mislaid the form, please telephone me for another)

( ) update the form enclosed ( ) complete the blank form enclosed

( ) expand the information already given to match the guidance form overleaf.

Yours sincerely

D Gordon

D Gordon
for Director

A.200 (North Site, opposite Library) ext 233

CAREER STATEMENT

Name John James SMITH*

Date of birth 25 12 30

Qaulifications (with dates)

School Cert (1947)
Inter BSc (1950)
BSc Chemistry (1953)
MSc (1956)
PhD (1960)

Grade	Date
AEO	1 8 53
EO	1 1 57
SEO	1 1 64
SSO	1 1 73
PSO	1 7 73

Experience before Civil Service appointment

1947-51 Laboratory assistant with Unilever Ltd - analysis of oils and fats
1951-3 Shift chemist with British Paints Ltd in charge of 3 assistants in control lab

Experience in Civil Service

1953-7 Analytical development in Paints Division, CI Woolwich
1957-64 Development of high temperature surface coatings at CPM Dept RAE Farnborough
1964-73 Development of case-bonding adhesive systems in Propellants 2 Branch ERDE
1973- Section Leader, case-bonding P2/ERDE in charge of SSO, 3 HSOs, SO and 3 EWs

Courses attended

1968 Middle Management (Eastbourne and T & E Branch)
1972 Project Management (T & E Branch)
1973 Statistics for Quality Control (Brunel University)
1974 Reading Efficiency (ERDE)

*Women enter Miss or Mrs as appropriate

ACR. 1.1.67. - 31.12.67.

Inter BSc. 1965?
HNC (Chem) 1956.

1. ~~Investigation stability~~ Stability and ballistic investigation of plastic propellants suitable for high ambient storage temperatures (~~area~~ up to 200°C). ~~2 months~~

2. Study of plastic propellants for Bantam solid cord motors to improve resistance to thermal cycling and aging. ~~6 months~~

3. Photographic documentation of section plant, projects and facilities for ~~use~~ ~~and~~ reports, visual aid, and archives.

4. General supervisory duties of strand burning and small scale propellant manufacture.

ACR 2.1.68 - 1.6.68
Inter Sc 57, HNC (Chem) 56.

4 Above
2. Investigation of Bantam propellant systems and development of equipment for accelerated fatigue cycling tests on candidate propellants.

AER 17. 11. 69.

2 - 12 - 68 / 1 · 12. 69.

Date entry			Service		
C.S.	1 - 1 - 54		Pres. Br.	15 -	9.
P. Grade	1 1	67	Pres. Sat.	15	9
			R. Off.	-	5
			CS off	15	9.

Inter BSc 1951
HNC (Chem) 1956

A
1. Investigation of propellant stress problems in Bantam motors
2. Study of analytical method used for determination of particle size and water content of ammo-perchlorate
3. Development and supervision of large scale remote controlled plant for manufacture of rubbery propellants

---

B.
1. Physics, light engineering
2. Design of propellant processing and test equipment
3. Interest in photography and electronics
4. Design and development.
5. Not at present
6. —
7. Problems and projects with which I am currently involved would appear to present ample scope for reliable and occasional stressing of any alloy

Entered SSO 1.1.67

1973-4

30. 11. 73.

Started present job. Apl 73.

Courses French one year W.A.E. Centre.

Management of physical testing laboratory for record data and qual. control of rubber prop.s:
Surveillance of test equipment, especially with regard to improvement of existing techniques and des. and dev. of novel apparatus for rubber curing studies

Des. preparation, testing and performance assessment of special test rotors employing change stress relieving rubber liners

Design of new plant items, Tensile T.P. preparation and resolution of plant eng. problems

Photog. recording of test phenomena.

1974-5.

24. 10. 74.

Management of Physics testing laboratory engaged on process control of rubber propellants. Maintenance and design improvement of test equipment. Photog. record of special tests and development of apparatus for the cutting of dumb-bell test pieces.

P.T.O

1975-76

1. Supervision of laboratory engaged in phys. testing and process control of rubbery propellants
2. Investigation of possible causes, and effects of, age hardening of propellants during storage at elevated temp (60-80°C)
3. Effect of temp cycling on stress relaxation
4. Design of lab. equipment for novel test schemes
5. Cooperation with small scale facility when plant design problems arise
6. Photographic recording

---

4. 10. 76.

1. Supervision of lab. carrying out physical testing + process control of Rub. props.
2. Investigation of extrusion method for preparing fast burning charge forms for Lab. Devel. of formulation of plastic nature with can be subsequently cured to a rub. prop.
3. Devel. of test scheme to investigate stress relaxation of rubbery propellant.
4. General photographic recording of testing programmes + equipment etc.

MINISTRY OF AVIATION MEMORANDUM

From: (Branch and Address)	To: .....19.....
Telephone No. Extn.	
Our ref:	Your ref:

1. Physics, chemical engineering
2. Processing equipment and cable gear.
3. Photography, simple electronics
4. Design and development.
5. No.
6. —
7. The present scope of my duties amply occupy my time and provide much food for thought.

L.H. 1s

Use the reverse for continuation or reply as necessary.

(1420) M727020 999 12,000 Pads TS&Co.Ltd. Gp.815

10'70

Date entry:

to C.S 1. 1. 57.

P. Grade 1. 1. 67.

Servi		
Pres. for.	16.	10
Prec Sect.	16.	10
R. offr	1.	6.
CS offr.	16.	10.

1. ~~Investigation of rubbery propellant burning rate capability theory etc~~
1. Assessment of maximum burning rates ~~obtainable~~ of modified ~~rubbery~~ CTPB propellants and their processibility on conventional equipment.
2. Development of ~~rubbery prop CTPB certain~~ CTPB propellants as candidate compositions for certain rocket motors.
3. Supervision and operation of a large scale (350 kg) remotely controlled CTPB ~~plant~~ propellant plant and associated maintenance and development.
4. Organisation of visits to ERDE of student parties from local ~~schools etc~~ colleges etc

P.T.O.

ACR 1958.

Design & Construction of ~~homogenisers~~ a for laboratory scale homogenisers for polyurethane propellants or 4 months. manufacture.

Development of apparatus for ~~determ~~ detecting ~~of~~ ultrasonic ~~determination~~ detection of voids in P.V. filled 2" ballistic assessment ~~motors~~ motors. 2 months.

Suitability of ~~fillers~~ dispersions of Fullers earth ~~f~~ with hydrocarbons or esters ~~etc~~ as ~~fillers~~ ~~for~~ in plastic propellant compositions 1 month.

Modifications to ~~the~~ ~~full scale~~ or pilot ~~plant~~ scale deaerator with view to improving through-put of propellant 2 months

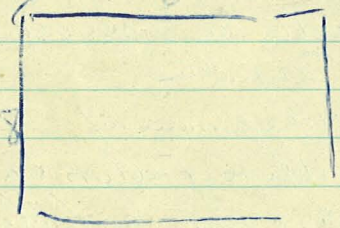
Construction of a miniature deaerator of a new pattern ~~designed~~ based on a single shaft with co-axial scrolls ~~to~~ to demonstrate ~~the efficiency and~~ 2 months

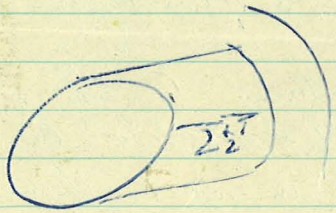
Filling of large diameter ~~motor~~ section to investigate size limitations on ~~of~~ plastic ~~filled~~ motor design 1 month.

~~Red~~ Modification of small scale motor filling ~~technique~~ to reduce explosion hazards.

provide
and ~~[illegible]~~ interchangeability of assemblies.

General supervisory duties associated with propellant manufacture and missile filling.





11.71.

Date Entry
C.S 1.1.54
Res. Grade 1.1.67.

Length Service
Pres. Branch 17. 11
" Office. 17. 11

Rep. offered. – 8

Contr. Office – 17. 11

Inter BSc (1951)
HNC Chem (1956).

1. Large scale (350 kg) CTPB propellant plant — supervision, ~~and~~ maintenance and operation ~~[illegible]~~. Assessment of capability, ~~of [illegible]~~ with spec. reference to ~~the~~ manufacture hazards and safety precautions.

2. Development of test equipment ~~for~~ to ~~estimation~~ ~~[illegible]~~ observation of ~~certain~~ physical ~~characteristics~~ behaviour of ~~[illegible]~~ CTPB cure ~~Systems~~ ~~[illegible]~~ during curing of rubbery ~~binder~~ propellant systems.

3. ~~Special equipment for~~

Over

DEMAND UPON THE ENGINEERING BRANCH

for the provision of new equipment or facilities or the improvement or extension of existing facilities.

Branch or Section

Section Ref. No.

Cost Code or General Expense

1. Description of work required

B.1. Physics Chemistry.

2. Utilisation of physical & chemical principles & the design ~~and devel~~ p. of operation of specialized plant & instruments

3. Photg, electronics, light machining.

4. Des. & Dev. 5. No.

This demand is for:

*(a) items having a life of over 5 years
*(b) items which will have a life of less than 5 years or will be consumable
*(c) modifications to existing facilities

Degree of urgency ....

Date ..... Head of Section

*Delete as appropriate.

2. To: _____

The approximate cost of this work will be £ ..... including £ ..... for items to be supplied or obtained by the Engineering Branch.

The approximate time of commencement from receipt of instructions to proceed will be .....

The approximate time for completion will be ..... weeks from commencement.

Do you confirm that the work should be put in hand?

Date ....

ACR. 2/7/60 1.7.61.

1) Cardboard charges. ✓
2) L.B.P trials ✓
3) Slug Tests.
4) Strand burners. ✓
5) R & H charges ✓
6). Lab. vacuities.
7) Small pygmill

1). ~~Desig~~ Filling of various ~~sized~~ cardboard and steel tubes with plastic propellant for detonation trials, including design of ~~any~~ necessary equipment. (2 months)

2). Trials on large mixing machinery ~~working~~ using inert + live materials ~~and~~ 1

3). Extension of strand burner facilities and ~~design + manufacture of~~ development of ~~the~~ (double strand freeing blocks) by modification of standard bomb ~~cap~~ lids for double strand firing arrangement. 2.

4). Filling of special motors for ballistic assessment to Rohm & Haas pattern. 1

6) General duties, including safety and ~~reliability~~ design recommendations, associated with propellant manufacture

6) Development of small scale ~~pa~~ detonator capable of throughput of ~~a~~ 400 lb/hr and trials using inert material 2

AER 2/7/59 - 1/7/60.

Slump tests + Star shells
PIB pump
Sensitiveness trials - filling
14/07/59.

1). Size limitation of C.P. filled rounds - on - filling of vessels for slump trials and obtaining data therefrom: Star shell filling for acceleration trials (2 months).

2). Bass Ko-Kneader cartridge mixer - devising suitable loading arrangements and running of M/C using inert composition (6 months).

3). Filling of detonator velocity assessment charges (1 month)

4) Issue of 14/07/59. (1 month)

5) General supervisory duties associated with C.P. manufacture + processing.

ACR 2/7/58 - 1/7/59.

Pugmill Designs.

Comet Pumps.

K. Rounds; carbon cup burners, star shells, 3" gas pipe for densitometer

Adhesion of P.P.

Investigation of factors affecting pugmill ~~design~~ operation and ~~production of~~ design for pilot scale (~~c~~ 30 lb/hr) vertical scroll pattern mill (2 months)

~~Cup~~ Study of ~~Cold~~ adhesives for ~~use with~~ bonding of plastic propellant to motor ~~tube~~ tube (1 month)

Modifications to ~~C~~ ~~H~~ polyurethane feed pump to Ko-Kreader continuous mixer for plastic propellant (3 months)

~~Research~~ investigation of problems associated with ~~charge~~ special filling requirements re, ~~of~~ thrust motors assessment (8" type), ~~and~~ ~~corrosion~~ constant pressure Stand Burner charges, sensitiveness & acceleration trials of plastic propellant 2 months

General supervisory duties ~~associated with regarding~~ associated with propellant manufacture + motor filling

A.C.R. 2.7.64 – 1.1.66. 15. 12. 65.

1. H.R Propellants.
2. Small pugmill
3. K.E.K. mill
4. Explosion enquiry.
5. Sec. Safety Meetings
6. Sec. P.P. Work. Party.
7. S/Burner Sub-committee.

1. Investigation of stability and performance of composite propellants and under high ambient temperature, up to 150°C. – Apparatus for this
2. Preparation of reports on ~~a~~ an ammonium perchlorate mill (11/TN/65) and a small scale plastic propellant de-aerator (in process).
3. Secretarial duties (i) ~~local safety~~ Section safety meetings (ii) Plastic propellant working party ERDE/B.G W/R.P.E. (iii) Sub-committee on stand ~~burning~~ burner problems.
4. Photographic record of an accident involving a plastic propellant incorporator
5. Processing of plastic propellant ~~for~~ ~~to be~~ supplied to a commercial organisation for use in signal rockets.

A.C.R. 2.1.66 – 1.1.67

1. H.R. propellant
2. Strand Burner.
3. Sec. P.P. W.P.
4. Reports

1. As for 2.7.64 – 1.1.66 (but raise temp to 200°C).

2. Supervision of strand burning facility and liaison with other establishments to maintain standards.

3. Secretariat duties to P.P. Working Party.

4. ~~Publish~~ "Resistance of Plas.-Prop. to Grav.-Stresses 3/R/65 and preparation of 'A Modification to the present S.S. Eqn.' in/OW/66.

ACR 27.61 to 1.7.62.

1) KEK mill
2) L.B.P trials and drencher trials
3) Slump tests.
4) Stress relaxation.
5) Co-ax pugmill
6) Cardboard tubes for centrifuges

1) Trials on mixing machinery and investigation of 'rocket assested' drencher incidents ~~as~~ which occurred during the series. 2 months

2) Filling of ~~large motor sections~~ vessels to simulate large motor charge sections ~~for~~ and recording of ~~slumps~~ creep under normal gravitional stress. 3 months

3) Design and construction of ~~the~~ apparatus to determine stress ~~relation~~ relaxation ~~characteristics~~ on ~~the~~ small samples of plastic and ~~rubbery~~ elastic propellants. 3 months.

4) Trials on small scale deaerator using live propellant and filling of small motors from this ~~plant~~ device.
3 months.

5) Filling of various cardboard and steel tubes with plastic propellant for detonation trials 1 month

6) Examination and trials of various machines for milling of ammonium perchlorate 1 month.

ROA from.

ACR. 2-7-62 → 1.7.63.

1) Supervision of large scale propellant production ~~RSP223~~.
2). Formulation ~~adj~~ adjustment and modification for ballistic + rheological.
3) ~~Development of~~ Trials and development of ~~new~~ alternative milling systems for A.P.
4) Investigation of effect of ballistics of ~~impurities~~ certain impurities eg, chromium in A.P. and classification of ~~natural~~ natural characteristic of different sources.
5). Modification of ~~standard~~ burners (ex ROF) for simultaneous determination on sample + ~~control~~ standard ~~batch~~ control batch.
6).

1.) Investigation of effect on ballistics of certain impurities in ammonium perchlorate ~~and~~ ~~cause~~ nature of this material from different sources and examination of properties of plastic propellant prepared from perchlorate ~~of~~ ~~to~~ supplies ~~of~~ various sources. 2

2) Supervision of large scale propellant production.
3) 2.
3) Formulation, adjustment and modification of propellants to obtain required ballistic + rheological properties

4) Modification of standard burners in ROF BGW for simultaneous determination of sample and standard control batch. 1

5) Trials and development of alternative milling system for A.P. 4

6) Modifications to plant and equipment to improve safety and ~~simplify procedure~~. operating techniques.

7) S_TV.

AER. 24/63 - 1/7/64.

1). Manufacture - Dev. of Compositions
2). Remarks of data for new H/C mixes and approval trials of same.
3) Safety — improvements in method, sec. duties.
4) KEK mill
5) Compression of supply of A.P.
6) Attendance at WP
7)

1). Supervision of manufact. of P.P. up to 150 Kg.

2. Dev. and formula mod. of p.p to RPE specs.

3. Operating data of new m/cs. 2

4. Comp. of AP of diff sources. 1

5. Gen improvements to plant and techniques to safety 2
Sec. duties to periodical safety meeting.

6. Treat on K.E.K. 4.

A.S.T.M. STANDARDS

on

ADHESIVES

Sponsored by

A.S.T.M. COMMITTEE D-14

on Adhesives

CONTENTS

JANUARY, 1950

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1916 Race St., Philadelphia 3, Pa.

SILICONES

AN INTRODUCTION TO THEIR CHEMISTRY AND APPLICATIONS

By

G. G. FREEMAN

D.Sc., F.R.I.C.

PLASTICS MONOGRAPH No. C.9