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TECHNICAL COORDINATION AND PROGRESS MEETINGS
ON ROCKET MOTOR RESEARCH AND DEVELOPMENT

The Minutes of the 53rd Coordination Meeting held at E.R.D.E.
Waltham Abbey, on Thursday, January 12th, 1961.

Present

Mr. J.E. Serby (Chairman)	D.G./G.W.
Dr. W.B. Littler	D.C.S./A. W.O.
Mr. M.B. Morgan	D.C.A.(R.D.)
Mr. A.N. Christmas	D.G.W. Tech.
Mr. J.E.P. Dunning	D/R.P.E.
Dr. C.H. Johnson	D/E.R.D.E.
Mr. T.M. Wilson	A.S/L.G.W.1.
Mr. P.G. Elias	A.D.O.F/X/P.
Dr. K.D. Errington	A.D/G.W.(P. & W.)
Mr. J.R. Forshaw	A.D/Eng. R.D.6.
Mr. A. Brewin (Part time)	A.D./M.X.R.D.
Dr. W.R. Maxwell	R.P.E.
Mr. I.W. Broughton	"
Dr. D. Bunting	"
Dr. G.H. Young	E.R.D.E.
Mr. G.K. Adams	"
Dr. W.G. Williams	"
Lt. Cdr. W.E.D. Hull	R.P.E.)
Mr. P.D. Verschoyle	E.R.D.E.) Joint Secretaries

Mr. Serby apologised for his unavoidable absence from the Progress Meeting in the morning. He thanked Dr. Littler for taking his place in the chair and welcomed Mr. Morgan and Mr. Wilson who were attending the meetings for the first time.

AGENDA ITEM (V) Other Business

The Chairman said that the Controller had asked for a discussion of the slurry casting process as a means of reducing the cost of the C.D.B. process. He was taking this item first because Mr. Brewin wished to leave early.

Mr. Brewin said that the costs of casting powders were approximately:

Single base	8/-	per lb.
Double base	12/-	" "
Experimental	15/- to 20/-	" "

In the conventional C.D.B. process the "high energy" ingredients had to be incorporated in the casting powder, and this involved a processing cost. In the slurry process these ingredients were simply stirred into the mix. It appeared from calculations by Dr. Williams, which were not yet complete, that the saving could probably not amount to more than 10 per cent of the total cost.

There were two processes used in U.S. for producing the very fine ball powder used in the Nitrosol process. In the first, N.C., nitromethane and water were treated in a colloid mill and the liquids then removed by steam distillation. The nitromethane could not be reused because of some rather obscure chemical reaction possibly with aldehydic substances in the N.C.

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This was not a good process and there was no real U.S. Government project using it. The second process was associated with Olins. The N.C., in a solvent, was injected into super-heated water and emulsified in a "turbuliser". Flash evaporation produced balls 0.001 to 0.003" in diameter. We had no detailed information on the process and presumably we should have to pay heavily for the details. He suggested that there would be a danger of decomposition in the super-heated water. In this country the original Olin ball powder process was in operation, producing about 50 per cent of the 0.030 to 0.035" size required for small-arms propellant, the balance being smaller, but capable of being reworked. There was capacity for this process at Bishopton and at E.R.D.E., and the small-arm size range was in production, so that the finer material was in the nature of a by-product. It was suggested that a size fraction passing 0.008" might be investigated in a slurry-casting process. A laboratory scale investigation was already under way. In reply to Mr. Christmas, Mr. Brewin said that it was possible that the T.E.G.N. advocated by Dr. Shuey might be found to give a lower S.I. than D.E.G.N. He thought that Dr. Shuey's recommendations should not be accepted without examination. Dr. Johnson said that he would deprecate any substantial diversion of effort to work on the slurry casting process, particularly because it entailed a new method of treating N.C., and a great deal of detailed re-investigation of the new product might be entailed. The Chairman asked that Dr. Williams should report at the next meeting.

AGENDA ITEM (ii) "Plastic Propellant Development, An Unsatisfactory Situation"

Dr. Young said that this subject had already been discussed in part at the morning meeting. Plastic propellant was a very versatile and useful system. Using aluminium, a wide range of properties were available, with high energy. Nevertheless, there were a number of difficulties in the way of the practical application of the plastic propellants - he feared that it might be wrongly assumed that the position was satisfactory. He thought that the design and production of motors of one to four tons all-up weight ought to be pushed in order to find out what the possibilities really were. This had been talked about for years. The full utilisation of high energy propellants of all types required more work on nozzles and on insulation. A number of propellants could not be used because of nozzles or motor ends burning out. He suggested that trials should be made in 17" and 24" motors, which he was sure would be successful at temperatures experienced in this country, using as high a loading density as possible. Plastic propellants possessed high chemical stability, and manufacturing capacity was available.

Dr. Young continued that the investigation of the rheology of plastic and other propellants was very important, and although it was done at E.R.D.E. the effort was regrettably small, the mathematical side in particular being neglected.

In supporting Dr. Young's proposal, Dr. Johnson said that in working on projects, of which Linnet was an example, many practical difficulties had to be dealt with without much gain in the way of useful information. He would like to see an effort to find out specifically what was the limit of performance of the plastic propellants. There was a real need to select one or two propellants and to test them thoroughly until their properties were as well known as those of S.C. cordite. An effort should be made to spend less time on dubious projects. An important point was that plastic propellant was entirely British, and in exploiting it we should be entirely independent of the U.S.A.

Mr. Dunning said that Dr. Young's theme was not new to him, and he agreed that the good points of plastic propellant should be exploited, but

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it was already in use in a considerable number of motors. The Raven had been a research effort, and a very big step forward. The next step should be the 36" motor. He agreed that hardware also was involved. Work was in progress on nozzles on a small scale and an attempt was being made to devise a method of testing them without actually conducting rocket firings. It was necessary to use projects as research tools because of lack of staff for independent research.

Dr. Errington remarked that there was at present no weapon requirement for any motor containing more than a ton of propellant. Any exploration of what plastic propellant would do in larger sizes we must do ourselves, whereas on other propellents it would be done in U.S.A.

Dr. Maxwell supported Dr. Young on the need for more work on rheology of propellents and on stress relief by means of liners. There was a vacancy for a suitable man on the staff at Westcott. Mr. Brewin said that there were apparently no physicists nor mathematicians in this country who were interested in the design of plastic components. The Chairman suggested that Mr. Thornhill of A.R.D.E. might be approached, but Dr. Johnson replied that this had been gone into. He was doubtful whether a mathematician would solve the problem. Prof. Oldroyd was sending a man to E.R.D.E. Dr. Maxwell suggested that some help might be obtained from the stress laboratory at Brunel College of Technology.

Mr. Christmas said that the subject of Dr. Young's introductory remarks was a very controversial one. A major review had been carried out by the working party. Only a limited effort was available and on this effort projects to which we were already committed must have first charge. The Chairman said that it was necessary to weigh up how much effort should go on projects and how much on research, and Mr. Morgan said that if too much was put onto projects research would dry up. Mr. Christmas agreed that there must be a satisfactory level of research for the future. Any sensible engineer in industry would not undertake a project until the technological background was clear, but since a guided missile took five years to develop one wished to take advantage of improvements in technology which occurred during this time. Mr. Dunning said that it was this which upset the balance of effort. Optimism about the time scale of projects caused necessary research to be put off because it was argued that results would not be ready in time to be utilised in the current projects. Dr. Johnson said that Blue Water was the project which overshadowed all else at present. Mr. Dunning agreed, saying that the project officer for Blue Water had had to be taken from Dr. Maxwell's research team. Before that, research items had been shut down in favour of the underground launcher for Blue Streak. Mr. Christmas said that one could only arrive at a balance over a comparatively long term. Blue Water, if successful, would be the first of a family of polyurethane motors, and it was important that Bristol Aerojets should eventually be capable of taking over as design authority for further developments in this field. Mr. Dunning was doubtful whether this would ever be possible. He thought that the number of projects embarked upon should be very carefully scrutinised. Dr. Young was confident that in the next five to ten years motors containing one to four tons of propellant would be needed and he felt sure that it would be a good thing to go ahead with plastic propellant. Mr. Christmas said that Dr. Young was speaking generally; there were two areas in which his proposals might be taken up, firstly in a study of engineering applicability, investigating specific engineering features to determine whether it was possible to make a motor of a given size. Secondly, one should try to consider all the possible requirements. A range of propellents was available, with a range of properties, but it was necessary to see how

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individual propellents could be suited to individual requirements. The engineering approach was well illustrated by the I.C.I. study of case bonding of C.D.B. It was necessary to translate general requirements into specific activities, and he thought in certain directions this was being done. In reply to Dr. Johnson, who suggested that insufficient work was being done on nozzles, Dr. Maxwell said that progress was being made, for example on Gosling IV. Mr. Dunning said that a year ago the nozzle for this motor had been a problem, but the immediate requirement had now been met. It would still be difficult to provide for a duration of a minute. Mr. Christmas said that on Blue Water a conscious decision had been made that Phase II would best be done with polyurethane propellant, and nothing short of technical disaster should be allowed to stop it. If the Blue Water hardware was suitable for plastic propellant and if money was available the suitability of plastic propellant might be investigated, without proposing it as an alternative. Dr. Maxwell said there was no doubt of the need for rubbery propellents in larger-diameter motors. Mr. Christmas thought there should be an intermediate size, probably 24", between the 17" and 36" plastic propellant motors.

AGENDA ITEM (iv) Ravensburg Lathe

Mr. Dunning said that the study of the dilation of lightweight rocket tubes was part and parcel of the art of rocketry. The Ravensburg lathe was required in the production of helical welded tubes up to 50" in diameter for Bristol Aerojet. Mr. Christmas said that the proposal seemed reasonable, but the cost was £40,000 to £50,000, and it did not appear that the present requirements would provide enough work for it. It had appeared that we could do the 36" motor without it. The Chairman said that a decision had already been taken elsewhere, and he suggested that the discussion should not be reopened. Mr. Dunning said that earlier in the meeting the Chairman had said that money was not the limiting factor, but Mr. Christmas had put the proposal back on financial grounds. The lathe would be wanted eventually, it was an essential tool, and delivery was 12 to 18 months. Mr. Christmas said that the proposal had been put back because the case was too weak. Dr. Maxwell said that the development of techniques for making lightweight hardware for ballistic missiles had started some years ago. Mr. Serby's working party had recommended that a 36" motor should be developed up to flight testing at a cost of about £1,000,000. The D.R.P.C. had agreed and staff increases had been authorised. No suitable lathe had been found in government agencies. The lack of a proper lathe could be overcome with difficulty but would cause delay. There was a lathe at Woolwich which might be used; one would have to make a 3' length oversize and send it to Woolwich for the ends to be trimmed, return to Banwell for the end closures to be welded on and return again to Woolwich for turning for correct alignment. He had been to France, where they were already making 32" diameter motors and were going to make 60", buying the "knowhow" on welding from Bristol Aerojets. Mr. Christmas asked what delivery could be obtained on the lathe, and for what percentage of the time it would be in use for 36" motors in 1962? Dr. Maxwell replied that it could be installed within a year, and that it would be in use for perhaps 20 per cent of the time in 1962. Mr. Christmas asked whether it would have a large effect on the programme if the lathe was not available for the first half of 1962? Dr. Maxwell replied that the programme was already lagging. The Chairman closed the discussion by saying that he did not think that approval could be obtained for the purchase of the lathe at a time when we were being asked to review the whole of the solid propellant programme. The same applied to Dr. Young's proposal on plastic propellents.

AGENDA ITEM (iii) Distribution to U.K. Reports to S.P.I.A.

Dr. Johnson said that he had asked to have this item put on the agenda of this meeting because it was probably the only one where all the people concerned met together. It had appeared from a letter from Mr. L.T.D. Williams of B.J.S.M. that there had been a very serious drop in the number of reports received by S.P.I.A. from E.R.D.E. and other Establishments in 1960 as compared with 1959. Investigation of the figures given for 1959 for E.R.D.E. Reports and Technical Memos. had shown them to be wrong, and grossly inflated, although the 1959 total was in fact greater than that for 1960. It was agreed that Dr. Johnson would let Mr. Dunning know his methods of checking the numbers of reports received by S.P.I.A.

AGENDA ITEM (i) Arrangements for J.A.N.A.F. Meetings

Dr. Johnson said that the J.A.N.A.F. meeting was one at which it was important that the U.K. should be represented. Up to about two years ago we used to be represented and submit papers. The emphasis in the agenda for the meeting in May, 1961, was on exotic solid propellents and on the U.S. large motor programme. There was only one paper from Westcott and one from I.C.I. Dr. Williams of E.R.D.E. would be attending. Dr. Young had been asked last year what motors we were producing. Dr. Johnson suggested that a joint R.P.E./E.R.D.E. paper might be put forward for 1962.

Dr. Maxwell said that they now emphasised only certain projects or aspects of rocketry each year and unless a paper was on one of these it was rejected. Dr. Young thought that they would be glad to receive papers from U.K., and he suggested that if papers were sent before the agenda was drawn up, then the agenda might be arranged to accommodate them. A joint paper on Blue Water might be acceptable. Dr. Errington was sceptical of this; he thought the U.S. were not very interested in our motor projects. He was afraid that the liaison built up over the years might dry up. It was agreed that Dr. Johnson would consult Mr. L.T.D. Williams on the best course of action.

AGENDA ITEM (v) Other Business

The Chairman said that he had asked Dr. Sillitoe of I.C.I. how much information he received from the U.S.A. on case bonding of C.D.B. Dr. Sillitoe had replied that there was not much, and the state of the art in the U.S. was apparently not particularly healthy. Mr. Christmas said that he had not been told this, but the lack of a solution in the U.S. agreed with his view of the position in the U.K. He thought the exercise at I.C.I. was well directed. Dr. Williams said that the U.S. work was predominantly in aid of strategic or space motors so that the problems of storage were less important. The Americans considered that their case bonding systems were adequate for the present usage. Consideration was being given by the U.S. Navy to a 26-inch diameter case-bonded C.D.B. tactical motor and A.B.L. was due to conduct environmental testing in a year or so. Work on adhesive systems had been re-started. Dr. Littler said that the longer range Blue Water had the support of the War Office. The U.S. were trying to impose Sergeant on N.A.T.O. Mr. Wilson said that he had it from the War Office that Phase I was dead but that Phase II was authorised to the end of this financial year, with a very small overlap. Mr. Christmas said that a minimum programme had been worked out at Westcott on technical problems six months ago, but it had been delayed by six months.

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