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ADVANCED SHAPE CHARGE PROJECT (U)

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The following work was performed on the ASC Program during the month of August.

Project Planning

Some options available for the final two stage design have included an LX-07 explosive as a back-up to the primary design explosive - a new formulation under development designated "HE 6.5." During August, preliminary information on the explosive energies of four different experimental HE 6.5 formulations indicated that none of the formulations were sufficiently energetic. It was therefore concluded that within the time frame remaining on this project we must continue our efforts on the LX-07 physics design for the two-stage shape charge.

A new milestone planning guide is shown in Figure 1. The tasks listed reflect the LX-07 two stage design approach, an electroformed liner study (Task 3.3), the flat plate studies Mod II (Task 3.1A), and a two stage design incorporating 42° copper and nickel liners with Octol and LX-07 explosives (Task 3.4). Task 3.1A is scheduled for completion in September while tasks 3.2, 3.3, and 3.4 will be completed during October. Delivery of the LX-07 liner studies to BRL, three each, are scheduled for early November predicated upon a successful test of the electroformed 14.5° Ni liner, i.e., the liners to be delivered will be electroformed nickel.

Project Costs

The following table lists the total costs in K\$ through the month of August.

	<u>April-June</u>	<u>July-August</u>	<u>Total</u>
LLL Manpower	87.2	93.3	180.5
Expenses ¹	50.8	15.1	65.9
LLL Facility	-	35.3	35.3
Total Cost ²	137.9	143.7	281.6

1 Fiscal year-end estimates for June were greater than actual expenditures which were balanced by a reduction in July and August expenses; totals are correct.

2 Totals not exact due to rounding-off errors.

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FIGURE 1

ASC Project Milestones

Physics Design

Hardware and Schedules:

The flat plate study Mod II (Task 3.1A) were in fabrication during August; tests are scheduled for September.

The copper liners (Task 3.2) fabricated at LLL were ready for testing early August, however, a break down in the 1 MeV unit at the Physics International test site and poor performance of the ring initiator design delayed testing. The tests were rescheduled for early September pending solution of these two problems. The nickel and steel liners were not delivered as scheduled during August and have been rescheduled for delivery by the end of September. This represents over a two month delay beyond the originally scheduled delivery of July 16. During August a concerted effort to locate other potential liner fabricators was undertaken; fabrication sources capable of machining precision shape charge liners in 5 to 6 weeks have been identified and will be used in the future. Electroformed liners were also considered as a means of reducing costs and delivery time (Task 3.3).

Metallurgical analysis of the copper billet used to fabricate liners in Task 3.2 was completed in August. No evidence of cracks, porosity, or gross inclusions were found. The largest inclusion measured was 0.060 mm diameter; the average grain diameter was 0.190 mm diameter and the longest grain observed was 1.8 mm at the billet center.

Task 3.4 has been redefined as the 42° two-stage design. This design was completed as a consequence of iterative computational code debugging. Although not originally scheduled as an experimental task, the availability of a completed two stage design permits an earlier test of the two stage design concept than would be possible via task 3.5----the 100 mm two stage LX-07 design. This latter design is scheduled for completion during October.

Computational Effort:

HEMP calculations on the first stage have been started using the preliminary 100 mm o.d. design calculations performed over the period July-August. Preliminary calculations on the second stage configuration were

continued. An approximate HEMP grid for the second stage was also zoned to predetermine computational problems with this type of configuration.

Two separate calculations were performed for a first stage designed to initiate the second stage with a slapper plate and a first stage designed to initiate the second stage via an explosives initiator. In addition, several apex designs were tried in these calculations. Results so far indicate that (β) collapse angles are somewhat larger near the apex than originally anticipated.

A design of a larger two stage system also was completed for a preliminary two stage test. The first stage is a 21° (α) half angle cone with a slapper base and simple 21° apex. The second stage was designed using a combination of double slide plane HEMP calculations and an Eulerian-particle code of P.I.

H.E. Development

All four formulations aimed at a 6.5 km/s detonation velocity have been fired in the three diameters of the cylinder tests: 0.75, 1.0, and 2.0 in. These critical tests of detonation energy confirmed the indication of low energy found in the first test reported last month. None of the formulations were close to Octol in energy, and at this time none of them are useable for improving or developing the advanced shaped charge. Cylinder wall energy decreased in a regular pattern with decreased HMX content (and increased KClO_4), with increased particle size of KClO_4 (KP) and with decreasing charge diameter. Wall velocity increased relative to Octol with increased tube expansion (i.e., increasing time after initiation). Test energies ranged from 60 to 85% of Octol. All of these effects are consistent with the rationale that the KP combustion is diffusion limited, and that the combustion is progressing but is incomplete during the time of the measurements.

Particle size analysis on the various batches of KP were completed and appreciable progress was made on determining the dispersion or intimacy of mixing of the KP in the pressed formulation. Microscopic analysis showed that

the KP powder ground at LLL in a jar mill for ~ eight hours to a Fisher average particle size of 2.7 to 3.0 μm actually had 50% of the weight above 11 to 19 μm . The purchased KP, used in one of the formulations, had a Fisher size of 10 μm but a 50% size on a weight basis of 14 μm . The dispersion of the KP in the pressed formulation is much more difficult to determine. Both scanning electron microscope (SEM) and x-ray fluorescence micro probe observations have been tried in addition to microscopic methods. Specimens were lapped to a few μm finish and etched in various ways. SEM seems to be most informative. Thus far, results indicate good dispersion without agglomeration of the KP, but work continues in order to obtain more conclusive evidence.

Hardware and specimens are nearing completion for the hollow tube tests. These will be fired on the four explosives in order to establish a complete set of reference data and to get an understanding of this new test, even though these explosives fail to meet requirements.

A final effort is being made to achieve higher energy with this HMX-KP-Estane system. KP has been sent to Pantex, Amarillo, TX, to be ground to one μm (50% size on a weight basis). This will be one tenth the size of the KP used in the current formulations, and it should markedly increase the energy and reduce the time and size dependence in the cylinder test.

Initiator Design

Experiments were performed to evaluate the feasibility of using a disc of 0.64 mm thick DuPont Detasheet-C explosive to detonate a hollow cylinder of LX-07 explosive in support of the liner studies (Task 3.2). Although the LX-07 detonation went high order, the simultaneity of breakout at the end of the cylinder was very poor ($\sim 0.3 \mu\text{sec}$). The reasons for the poor performance can be attributed to the following: Surface irregularities of the Detasheet resulted in only point contacts at the interface and the thickness of the Detasheet is approximately equal to the failure diameter of the LX-07. A thin layer of XTX explosive

"battered" between the Detasheet disc and the LX-07 cylinder improved the simultaneity. Work is underway to fabricate 1.27 mm thick XTX sheets to be used in future initiators.

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