

~~CONFIDENTIAL~~

SEPARATED FROM INCLOSURES, HANDLE THIS DOCUMENT AS Unclassified

September 28, 1965

*Mailed 10/1/65
CPC 65-1015*

OFFICE OF THE MANAGER
SAN FRANCISCO OPERATIONS OFFICE

SUBJECT: REQUEST FOR APPROVAL PROCUREMENT ACTION IN ACCORDANCE WITH CONTRACT 48, MODIFICATION 20, ARTICLE XI MONSANTO RESEARCH CORPORATION PROPOSED PURCHASE ORDER 4714003 - CPFF

Major Funding Program: Weapons
Sub-Program: B Program
Project: High Explosives R & D

Attached for Commission review and approval is proposed Purchase Order 4714003 in the CPFF amount of \$49,913.00, including fixed fee of \$3,910 which covers research and development of high energy binders for high explosives as described in APPENDIX B (classified CBI) to this order.

This requirement has Director's Office approval as to funds and program. Dr. R. E. Batsal of the Chemistry Department has authorized this action under Account 5055-12 as necessary for the Weapons Program.

The effective term of this agreement is twelve (12) months commencing upon receipt of an authorized order by Monsanto.

The Chemistry Department selected Monsanto Research Corporation to perform this work as this is a continuation of a program conducted under Subcontract 212. Other sources were investigated but Monsanto Res. is the only firm possessing the experience and knowledge in performing this work. We have attached a memorandum dated June 28, 1965, by R. E. Batsal/M. Finger to Mr. W. B. Harford in support of the selection of Monsanto Research Corporation.

The nature of this work involves considerable uncertainties and, therefore, can best be accomplished under a cost reimbursement type order. Monsanto has indicated unwillingness to perform this work on a fixed price basis.

Monsanto Research Corporation is considered financially responsible to undertake this work.

The Monsanto proposal and the Scope of Work in APPENDIX B have been reviewed and approved by Dr. R. E. Sigwell as a satisfactory statement of the work to be performed. The separate elements of the estimated costs have been carefully reviewed by both Chemistry and Procurement Department personnel and are considered reasonable for this procurement.

Fixed fee at \$3,910 or approximately 8.5% is in line with fee normally paid by the University for this type of work.

In a letter dated September 14, 1965, copy attached, MRC proposed an overhead rate of 103% for cost estimating and provisional billing at this time. If the current ABC/SAN study of the FY-1964 audit proves this rate to be incorrect, MRC will agree to accept a contract modification reducing estimated cost and fee to reflect overhead rates approved by the Commission.

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This document is classified here with the information contained herein is unclassified

Note: Attached to this copy of the contract is a copy of the contract for...

September 28, 1965

A General and Administrative (G&A) rate of 9% and payroll benefit rate of 19% were previously approved by the Commission in a letter dated July 28, 1965.

Terms and Conditions are standard Laboratory CPFF forms and are consistent with contracts awarded to MRC in the past. We have included Type C Patent provisions with background rights and the usual data and copyrights provisions.

The vendor's personnel and procurement policies are acceptable to the University to the extent they are acceptable to the cognizant Government audit agency.

Monsanto Research Corporation is not a small business concern. Notice of Intent to award this work has previously been submitted to the Commission in our letter of July 9, 1965.

Work under this order is classified according to Mr. W. K. House of the Laboratory Classification Office. Documents and information may be classified up to Confidential - Defense Information, Group III. Classification guidance will be submitted by the Classification Office. Security facility and personnel clearance arrangements will be coordinated by Mr. J. W. Tanner of the Procurement Department.

Attached for your assistance in the review of this purchase order are four copies each of the following documents:

1. Proposed Purchase Order 4714003 including Appendices A & B
2. Vendor's proposal
3. Vendor's cost breakdown
4. MRC letter of 9/14/65 by T. L. Gossage

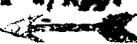
Should you request additional information, please contact F. G. Heras, Extension 7911.

ORIGINAL SIGNED BY G. V. BRIM PROCUREMENT DEPT.

C. L. BLUE

GLE:FGH:cm

Att: as indicated

cc: R. Batsel/E. Biscell/M. Finger w/App. B.
R. P. Connell w/all atts. 
D. S. Gibbs
W.B. Harford/W.E. Humphrey w/cy. F. O. only
J. A. Jensen
J. W. Tanner

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LIVERMORE LAWRENCE RADIATION LABORATORY
ROOM: 109 BLDG.: T-103

MEMORANDUM

June 28, 1965

TO: W. B. Harford
FROM: M. Finger
SUBJECT: Request for Exceptional Procurement
Monsanto Research Corporation

For the past two years LRL has sponsored research on "High Energy Binders for High Explosives" with Monsanto Research Corporation. This work was carried out on Project Agreement No. 5, Subcontract 212. This capably conducted research effort has yielded some very promising explosive binders.

One of the new binders is a highly extensible rubber that is also an explosive; and it is composed of readily available commercial chemicals. Additional research and development must be done if we are to benefit by the work done to date and bring this and other developments into the range of practicality.

Attached is a proposal from Monsanto Research Corp. - Dayton Laboratory. This proposal presents a program that extends and refines the research on "High Energy Binders for High Explosives", which MRC - Boston has been conducting. This proposal was submitted after a series of discussions between technical representatives of MRC (Boston & Dayton Lbs) and members of the High Explosive Section at LRL.

The technical scope of this new proposal encompasses work that could lead to substantial improvements in the explosive binder systems previously developed. It also allows the exploration of new binder systems of potential value to our explosives research and development effort. The program of work as outlined in the attached proposal meets with our technical approval.

The object of this research is to provide binders that have excellent elastomeric characteristics and possess explosive energy. These binders when combined with high energy crystalline explosive would yield high energy PBX's with substantially improved physical and chemical properties. In addition, the new binders, in a prepolymer state, would be combined with solid explosive to give a paste-like material that could be injection molded at relatively low pressures. The material then would be cured in the mold to give a rigid, but somewhat rubbery, explosive part.

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This material contains information affecting the National Defense of the United States within the meaning of the Espionage Laws, Title 18, U.S.C. Secs. 793 and 794, the transmission or revelation of which in any manner to an unauthorized person is prohibited by law.

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June 28, 1965

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Memo Re: Request for Exceptional Procurement
Monsanto Research Corporation

To: W. B. Harford
From: M. Finger

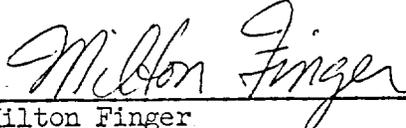
Because of the unique nature of the binder system and because it is a continuing program, the project must be negotiated on a sole-source basis.

In addition, we have investigated the possibility of contractual research with Mound Laboratory, Rohm and Haas, and Reaction Motors. It is our belief that these firms are not working in fields of chemistry closely aligned to our immediate interest. A review of the classified and unclassified literature shows that the LiClO_4 solid-solution binder is unique to MRC. The program involves work with small amounts of explosives. The work will not involve restricted data. However, it will be conducted at the Confidential, Defense Information security level. MRC - Dayton has the facilities and necessary clearances for this work.

The cost estimate of \$49,913, for the proposed level of effort, is commensurate with the amount of money we have budgeted for this type of research procurement.

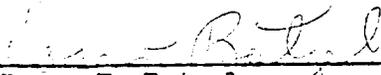
The technical coordinator for LRL will be Milton Finger with Eugene Bissell as alternate. Technical progress reports shall be in the form of a brief monthly letter; and a detailed Final Report at the conclusion of work.

Would you, therefore, initiate appropriate contractual negotiations with Monsanto Research Corporation. This should be charged to account number 5281-12.



Milton Finger
General Chemistry Division

Approved:



Roger E. Batzel
Assoc. Director for Chemistry

MF:law

cc - C. L. Blue w/2 attach., Ltr and CDI Rpt.
R. E. Batzel w/1 attach., Ltr.
G. Dorough w/1 attach., Ltr.
H. E. File w/2 attach., Ltr and CDI Rpt.

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ud. JH/Hay

MONSANTO RESEARCH CORPORATION

DAYTON LABORATORY

DAYTON, OHIO 45407

11 June 1965

Mr. J. Harris
Lawrence Radiation Laboratory
University of California
P.O. Box 808
Livermore, California

~~GROUP 4
Downgraded at 3 year intervals;
declassified after 12 years~~

Subject: Project Agreement No. 5, Subcontract 212

Gentlemen:

Attached are three (3) copies of our planning statement submitted as a continuation of work performed under Project Agreement No. 5, Subcontract 212.

We have the necessary personnel and facilities to initiate this program immediately. Our cost for such a program is \$49,913 including a fixed fee of \$3,910. This estimate is broken down as follows:

Direct Labor		
Research Manager	.180 hours	\$ 1,791
Sr. Res. Group Leader	95 hours	822
Sr. Research Chemist	1500 hours	9,090
Research Technician	1500 hours	5,085
	<u>3275</u>	<u>16,788</u>
Salary Related Costs @19%		<u>3,190</u>
Total Direct Labor		19,978
Overhead		
Materials		1,000
Travel		<u>650</u>
Subtotal		42,205
General and Administrative Expense @9%		<u>3,798</u>
Total Estimated Cost		46,003
Fee		<u>3,910</u>
Total Estimated Cost and Fee		<u>\$49,913</u>

COPY

*709985
Copy 14 of 15
10/10/85
NE Swolchick HOS signed*

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~~Document transmitted
herewith contains
Classified Defense Information~~

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Separated From Enclosures, Handle
this Document As Unclassified

A SUBSIDIARY OF MONSANTO COMPANY

Mr. J. Harris

2

11 June 1965

We hope that our proposal will receive your favorable consideration. Should you have any questions or need additional information, please let me know.

Very truly yours,

T. L. Gossage
Assistant Director
Government Relations

mfc

cc: M. Finger

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PROPOSED PROGRAM
for
CONTINUATION OF RESEARCH
on
HIGH ENERGY BINDERS FOR HIGH EXPLOSIVES

Declassified on [redacted] of [redacted]

787685

*Group 4 Sched. 1, 2, 3, 4
NEB/Perick ADD
10/10/95
12 years*

I. INTRODUCTION

The work proposed is based on an extension and refinement of the systems and approaches used in our prior work. The systems employ lithium perchlorate (LiClO₄) in solid solution and dinitrofluoroethyl derivatives as the energetic components in the binders. The program is directed to improvements and optimization of the following characteristics in the plastic bonded cast explosives:

- Physical properties
- Stability
- Energetics
- Fabrication

The program consists of three phases: (1) refinement of the present acrylonitrile/methacrylonitrile lithium perchlorate/ethylene glycol (AN/MAN/LP/EG) system; (2) further definition and development of the 2,2-dinitro-2-fluoroethyl acrylate (DNFEA) system and (3) investigation of improved binder systems. These phases are discussed briefly below.

II. DISCUSSION

GROUP 4
Downgraded at 9 year intervals;
declassified after 12 years

A. AN/MAN/LP/EG Solid Solution System

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This binder system has been developed to the point where castings of bonded HMX explosives can be made. However, problems in control and reproducibility can be encountered and there is need for further information on the polymerization reaction. It is believed that many of these problems are associated with purity of the lithium perchlorate. Much of the work on this system was

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done prior to the development of the recrystallization technique for purification of the LiClO_4 . It is quite possible that the inhibitor (hydroquinone) used in the formulation is required to neutralize some catalyzing impurity in the LiClO_4 . Thus, with LiClO_4 of varying purity, selection of the correct catalyst-inhibitor system becomes difficult. It is also felt that more detailed information on the effect of oxygen and trace metals would be desirable for more reliable control of the polymerization reaction.

It is suggested that these studies be carried out at this time only if difficulties with the system as presently defined preclude preparation of suitable samples for the planned safety and energetics studies.

If results are favorable and the decision is made to further develop this solid solution system, optimization of the mechanical properties of the bonded explosive would be required. This would be accomplished by determination of physical properties as a function of binder content, plasticizer/polymer ratio, type of plasticizer and extent of cross-linking.

B. DNFEA System

From recent work under the present contract, we believe we now have a procedure for the preparation of laboratory quantities of 2,2-dinitro-2-fluoroethyl acrylate (DNFEA) of sufficient and reproducible purity to consistently yield soluble high molecular weight polymer. Additional polymerization studies and replicated preparations of monomer are required to confirm this.

With good quality monomer available, catalyst systems, polymerization conditions, polymerization rates, cross-linking, polymerization exotherm, pot life and related studies can be initiated. Concurrently, a more detailed characterization of the polymer could be conducted, including definition of the thermal and mechanical properties. Subsequently the preparation of slurry cast samples of bonded HMX explosive could be carried out and the products characterized. If preliminary evaluations prove favorable more detail studies on optimization of properties of the bonded explosive would be desired.

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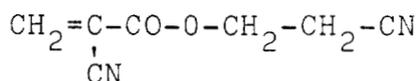
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C. New Binder Systems

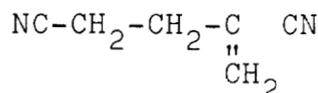
This more exploratory phase of the proposed work can be subdivided into four general areas: (1) improved vinyl polymer solid solution systems; (2) systems incorporating both the LiClO₄ solid solution principle and derivatives of the high energy dinitrofluoroethyl ethanol; (3) improved systems based on dinitrofluoroethyl derivatives only; and (4) exploratory systems.

1. Improved Solid Solution Systems

One of the deficiencies of the AN/MAN/LP/EG system is the high volatility of the nitrile monomers. A system free of monomeric plasticizer (ethylene glycol) would also be desirable as there is always the possibility of plasticizer migration with loss in properties and/or contamination of adjacent media. It may be possible to obtain improvement in both of these areas by use of other appropriate monomers. For this we propose two primary candidates, namely, β-cyanoethyl α-cyanoacrylate (I) and methyleneglutaronitrile (II).



(I)



(II)

Monomer (I) would be significantly higher boiling than acrylonitrile or methacrylonitrile and should give a polymer with lower glass transition temperature than polyacrylonitrile, thus requiring less, or no, plasticizer. This ester (I) should be preparable by the method reported by McKeener (Ref. 1) and later used by Kinsinger (Ref. 2,3) for the preparation of the methyl and butyl esters of α-cyanoacrylate. Kinsinger (Ref. 2) has also reported free radical polymerization studies of ester of this acid. The two CN groups and the ester group in (I) should provide sites for coordination of sufficient LiClO₄ to give solid solutions with a favorable oxygen balance.

1251950 Monomer (II) recently announced in pilot plant quantities by U.S.I. Chemicals (Ref. 4), is the dimer of acrylonitrile. Little information is available on the polymerization of this monomer although it is inferred that it will homopolymerize as well as copolymerize. Its structure can be viewed as α-cyanoethylacrylonitrile. In general, α-substituted acrylics with hydrocarbon

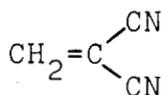
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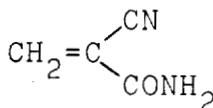
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substituents larger than methyl do not homopolymerize. However, with the polar cyanoethyl group the reactivity might be considerably different. Copolymerization should offer little difficulty. The volatility of (II) is relatively low (b.pt. 103°C/5mm.) and the high CN content should give high LiClO₄ solubility. Other systems which might be considered are copolymers of the following:



(IV)



(V)

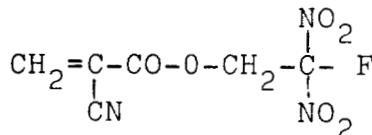


(VI)

Syntheses for vinylidene cyanide (IV) are known and α -cyanoacrylamide (V) and fumaronitrile (VI) are available commercially in laboratory quantities. All three monomers are higher boiling than acrylonitrile. They also have higher potential coordination capacity for LiClO₄ and thus might permit use of a comonomer that does not associate with LiClO₄. Thus comonomers, for example ethylacrylate, could be used to give internal plasticization and still permit solution of sufficient LiClO₄ to give an operable oxygen balance.

2. Combination Solid Solution/Dinitrofluoroethyl Systems

The availability of a binder system incorporating energy sources from both LiClO₄ solid solution and the dinitrofluoroethyl group would give greater flexibility in optimizing energetics and physical properties. Monomers on which such a system might be developed are the previously mentioned compounds vinylidene cyanide (IV), α -cyanoacrylamide (V), fumaronitrile (VI) and dinitrofluoroethyl α -cyanoacrylate (VII).



(VII)

Monomers IV, V, and VI would be used in copolymers with acrylic, fumaric, methylene malonic, and itaconic esters of dinitro-

4.

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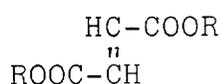
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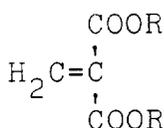
fluoroethanol. In these systems the component promoting dissolution of LiClO_4 would come from one monomer and the dinitrofluoroethyl component from the other comonomer. In compound VII both functions are incorporated in the same monomer.

3. Improved Dinitrofluoroethyl Systems

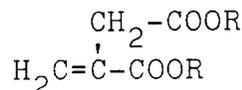
If monomers can be made which have higher available oxygen contact than the DNFEA, a higher energy binder system could be developed or other comonomers or additives could be added to give improved physical properties with equivalent energy to the DNFEA system. Potential monomers for this are the previously mentioned esters of fumaric (VIII), methylene malonic (IX), and itaconic (X) acids.



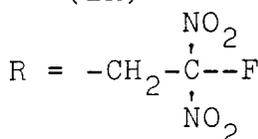
(VIII)



(IX)



(X)



In all of the improved systems initial work would be directed at understanding and controlling the polymerization reaction and development of conditions to yield compositions with good mechanical and thermal properties. Development and evaluation of the bonded explosive systems would follow.

4. Exploratory Systems

Practically all of the work with LiClO_4 solid solution polymer systems have used vinyl polymers. From the standpoint of fabrication and in some cases physical and chemical properties, various non-vinyl addition and condensation polymers could offer distinct advantages. Consideration and exploratory experimentation will be conducted in this area. The types of most probable utility are isocyanate derived polymers and polymers based on ring-opening polymerization.

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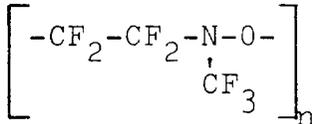
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"Nitroso rubber,"



the copolymer of tetrafluoroethylene and nitrosotrifluoromethane may have utility as a high energy elastomeric binder or as an ingredient in compounded binders. This material is available in only very limited quantities and good curing systems are not yet available. We, through other contracts, are active in this area and will follow closely the results of further characterization, development of cures, and availability. This information will be used in the explosives binder problem where applicable.

D. References

1. C. H. McKeener, U.S. Patent 2,912,454(1959).
2. A. J. Canale, W. E. Goode, J. B. Kinsinger et al, J. Applied Polymer Sci., 4,231-6(1960).
3. J. B. Kinsinger et al, J. Applied Polymer Sci., 9, 429-37 (1965).
4. Anon. C and EN, Feb. 22, 1965, page 37.

III. PROGRAM SUMMARY

It is obvious that all of the aspects discussed above cannot be researched in detail with the proposed level of effort. The following outline summarizes that portion of the work that we believe could be accomplished. Sufficient flexibility in the program would be maintained so that shifts in emphasis could be made as the research results or other factors might dictate.

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A. AN/MAN/LP/EG System

No further work until current experiments on safety and energetics are completed, unless further polymerization information is required to allow preparation of samples for these experiments.

B. DNFEA System

Prepare monomer as required for polymerization studies, unless an alternate source is developed.

Conduct polymerization studies and define conditions for controlled, reproducible polymerization to both soluble and crosslinked polymers.

Determine thermal and mechanical properties of the polymers.

Prepare bonded HMX castings and determine properties. Investigate variables in casting process.

C. New Binder Systems

1. Solid Solutions

Prepare β -cyanoethyl α -cyanoacrylate (I) and study its polymerization in a LiClO_4 solid solution system and characterize the products therefrom.

Study the polymerization and copolymerization of acrylonitrile dimer (II) in a LiClO_4 solid solution system and characterize the products therefrom.

2. Combined Solid Solution DNFE Systems

Prepare and investigate polymerization of dinitrofluoroethyl α -cyanoacrylate (VII) in a LiClO_4 system and characterize the products.

Attempt copolymerization of DNFEA with α -cyanoacrylamide (V) and with fumaronitrile (VI) in LiClO_4 systems and characterize the products.

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3. Improved DNFE Systems

Prepare, polymerize and copolymerize the DNFE ester of itaconic acid (X) in attempts to lower the glass transition temperature of an all-DNFE system.

4. Exploratory Systems

Explore the possibilities of isocyanate derived polyurethanes, and polyureas; epoxy and other ring-opening polymerization systems for LiClO_4 solid solution binder systems.

Follow developments in "nitroso rubber" field and apply as indicated by information obtained.

From the one or two best systems from A, B, and C above, investigate casting of bonded HMX and further optimize the systems.

IV. PERSONNEL

To staff this project we propose the following approximate level of effort.

Project Leader	180 hours
Organic Polymer Chemist	1500 hours
Explosives Consultant	95 hours
Research Technician	1500 hours

1251963 As Project Leader we would name Dr. J. M. Butler, Manager of Polymer Research at the Dayton Laboratory of MRC. He would have direct technical and administrative supervision of the project. He has had over 20 years experience in industrial and contract research in the area of polymer chemistry. This experience includes monomer synthesis, polymerization, polymer applications, polymer characterization and research administration. It was in

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his research group at Dayton that the solid solution concept was conceived and first reduced to practice.

For the synthesis and polymerization work we would assign an experienced organic researcher with background in polymer chemistry.

We are extremely fortunate in having Dr. R. A. Cooley available for consultation and advice on the explosives aspects of the program. Dr. Cooley has been associated with research and development in the rocket, explosives, pyrotechnics and related fields since 1942. This includes responsible positions in these fields with the U.S. Navy, University of Missouri, California Institute of Technology, Olin Mathieson Chemical Corporation and Propellax Chemical Division of Chromalloy Corp.

An experienced technician would assist in the synthesis and polymerization work and, under proper supervision, carry out most of the testing and characterization measurements.

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7 June 1965

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MONSANTO RESEARCH CORPORATION

DAYTON LABORATORY • DAYTON, OHIO 45407

AREA CODE 513 • PHONE 268-3411

14 September 1965

Mr. George Brim
Lawrence Radiation Laboratory
University of California
P.O. Box 808
Livermore, California

Subject: Monsanto Research Corporation Overhead Rate

Dear Mr. Brim:

As you know, there are several contracts between LRL and MRC which are being held up because of a disagreement on the Dayton Laboratory proposed overhead rate. These contracts include Castable Explosives, Polyurethane Foams, Injection Molding, and Personal Services. Mr. D. G. Comerford, MRC's Controller, has been in frequent communication with the San Francisco AEC Office. Likewise, I have discussed the situation with our cognizant Air Force Audit Office. It is my understanding that a letter has been sent from the Dayton Audit Office to the San Francisco AEC Office. This letter contains all of the information necessary for the AEC to make a determination on the Dayton Laboratory overhead rate.

Rather than delay these important programs any longer, I suggest for your consideration, that they now be executed with an overhead ceiling of 103%. If, after the San Francisco office completes their study of the FY-64 audit, it is determined that in accord with the AEC cost principles, the Dayton Laboratory overhead rate is less than 103%, say 92-95%, we will accept a modification to the contracts reflecting this lower rate.

I do believe that these programs should not be further delayed. The solution which I propose, I hope is acceptable both to LRL and the AEC Office.

Very truly yours,



T. L. Gossage
Assistant Director
Government Relations

TLG/mfc

1257965

A copy of this Representation must be completed and returned with your Proposal.

INVITATION FOR PROPOSAL

REPRESENTATION:

The bidder represents that he has, has not, participated in a previous contract or subcontract subject to either the Equal Opportunity Clause herein or the clause originally contained in Section 301 of Executive Order No. 10925; that he has, has not, filed all required compliance reports; and that representations indicating submission of required compliance reports, signed by proposed subcontractors, will be obtained prior to subcontract awards.

Monsanto Research Corporation

Organization

BY: E. N. Rosenquist

E. N. Rosenquist

TITLE: Laboratory Director

DATE: 21 July 1965

1257966

CERTIFICATE OF CURRENT COST OR PRICING DATA

Purchase Request No. _____

This is to certify that, to the best of my knowledge and belief:

- (i) complete=~~(pricing data)~~=(and) (cost data) current as of
10 June 1965 have been considered in pre-
paring the cost estimate for continuation of subcontract
212, Project Agreement No. 5
and submitted to the Contracting Officer or his repre-
sentative;
- (ii) all significant changes in the above data which occurred
since the aforementioned date through 10 June 1965
(date)
have been similarly submitted; and no more recent
significant change in such data was known to the under-
signed at the time of executing this certificate; and
- (iii) all of the data submitted are accurate.

10 June 1965
(date of execution)

NAME *D. H. Rufner*
D. H. Rufner
TITLE Chief Accountant
FIRM Monsanto Research Corp.

1257967