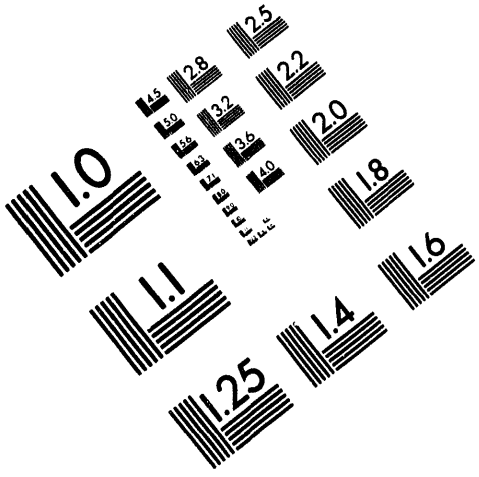

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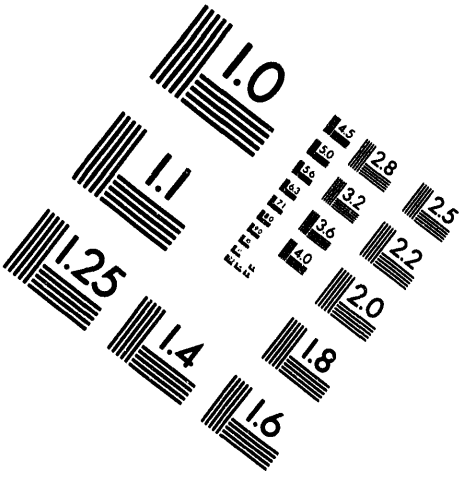

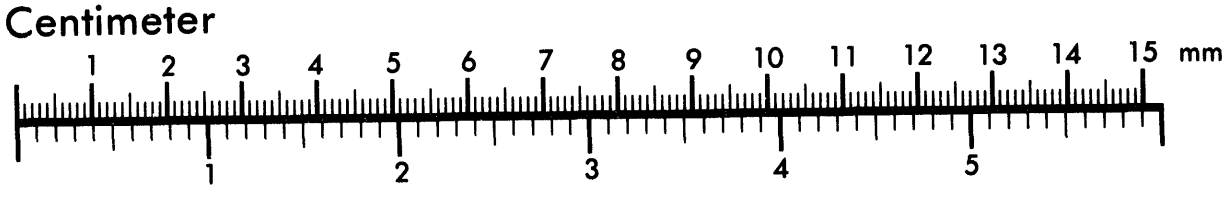

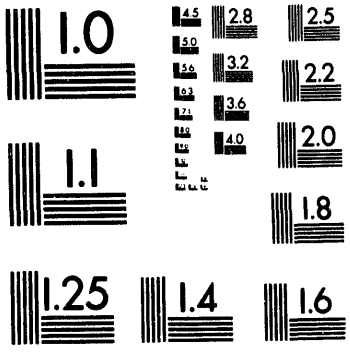

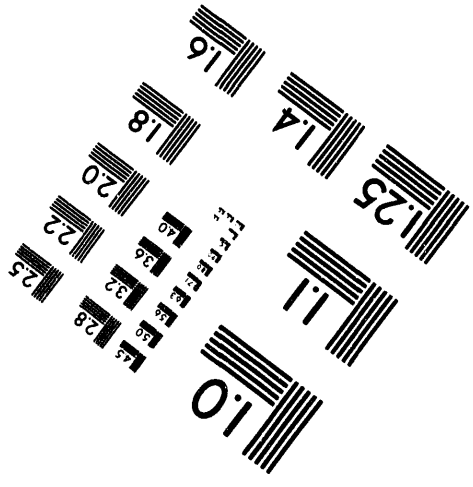

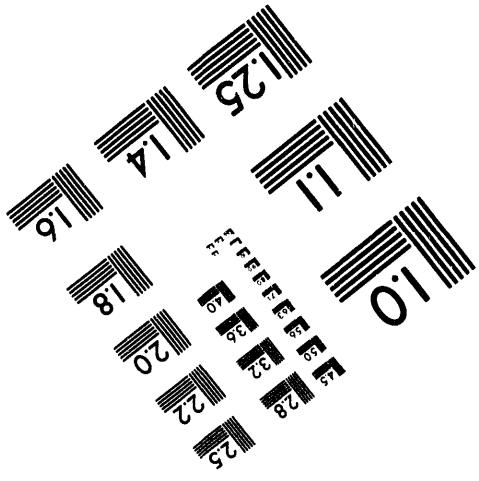

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RICHLAND, WASHINGTON

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TITLE AND AUTHOR

Letter to Mr. Frank Rom, Lewis Research Center

F. W. Albaugh

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54-1100-026 (1 -65)
AEC-RLOO RICHLAND, WASH

May 20, 1965

[redacted]

National Aeronautics and Space Administration
Lewis Research Center
21000 Brookpark Road
Cleveland 35, Ohio 44135

Attention: Mr. Frank Rom

Gentlemen:

References: 1. Conversation between F. Rom, P. Finnegan, and K. Drumheller, May 19, 1965.

2. Notes provided on May 19, 1965 by P. Finnegan.

The following proposal and information are submitted as requested in the referenced conversation and notes.

It is proposed that development work be performed which is directed towards the provision of fuel elements in accordance with the following specifications, at costs estimated as shown. Cost estimates are based on full cost recovery principles, including general overhead, under our Contract AT (45-1)-1830 with the Atomic Energy Commission. They should not be considered as fixed-price quotations.

Fuel elements will be 1-1/2" long and made with round holes spaced on the pattern of 1/8" hexagonal hole with a .030" web. The outside holes will be .125" diameter. Hole size will decrease to .108", .092", and .075" in respective internal rings with a corresponding increase in web thickness. The element cross section will be hexagonal with a dimension of approximately 1-1/4" across the flats.

Fuel will be natural or depleted UO_2, spheroidized by agglomeration to provide an initial low density. Fuel particle size will be a nominal 60 to 100 microns. Fuel loading will be a nominal 20 volume percent. Fabrication will be by pneumatic impaction.

[redacted]

[redacted]

AUTHOR: K. Drumheller			FOR SIGNATURE OF: FW Albaugh		
OPERATION	Finance	R&MT Dept	CR&D Section		
FOR APPROVAL OF			DR de Halas		
APPROVED					
DATE			5-20-65		

Item	Quantity	Description	Estimated Cost
1	4	Niobium matrix, flat surfaces on outside edges of element, no clad	$ 3250
2	4	Molybdenum matrix, flat surfaces on outside edges of element, no clad	3250
3	4	Niobium matrix, outside edges of element cut from continuous hexagonal pattern	3250
4	4	Molybdenum matrix, outside edges of element cut from continuous hexagonal pattern	3250
5	4	Niobium matrix, flat surfaces on outside edges of element, 4 mil clad on holes by vapor deposition on mandrels with subsequent transfer to grid	6855
6	4	Molybdenum matrix, balance same as Item 5	6855
7	4	Niobium matrix, 4 mil clad on grid by vapor deposition on completed grid	4520
8	4	Molybdenum matrix, balance same as Item 7	4520

One or all of the above items may be considered a part of this proposal, at your discretion.

The above cost estimates include only very limited development work towards optimizing the product. It should be understood that these pieces will be provided only as an indication of the potential of the pneumatic-impaction process for fabrication of these elements. Integrity or dimensional control may be good but should definitely not be expected at this point.

The sizeable difference in estimated cost for the clad mandrel technique does not reflect an inherently high cost for this process. It is the penalty for a small experimental lot of mandrels.

It is expected that delivery of 8 elements could be made six weeks from the time that authorization to proceed is received.

It is proposed that processing conditions for the grids be varied somewhat to provide information on the effects of pressure and temperature on matrix and fuel density.

[redacted]

It is planned that steel mandrel materials be used for these initial grids.

As you know, steel mandrels have not generally been satisfactory for work with tungsten. It is believed that with proper can design and surface treatment they will be satisfactory for Mo and Nb grids. One sound Mo grid has been made here with steel mandrels.

The probable range of maximum operating temperature for this type of element in on the order of 2100°C for Mo and 2000°C for Nb. We will withhold an estimate of operating life, in terms of burnup, cycles, or time, until we have had an opportunity for further study.

Pneumatic impaction at 1200°C or higher generally yields high density fuel particles in tungsten-UO_2 fuels or UO_2. However, some decrease in UO_2 density will be achieved by working at lower temperatures and pretreatment of the UO_2.

The pneumatic-impaction process is not a proprietary process. Information on this process has been acquired almost solely on government-sponsored programs.

The process is basically a production process. The steps of mandrel assembly, can loading, impaction, and mandrel dissolution are all applicable to high speed production techniques.

On the basis of a production rate of 100,000 elements per year, it is optimistically estimated that elements could be produced for $22 and $28 per element, in Mo and Nb respectively, not including the cost of the UO_2. A pessimistic estimate would be $113 per element for Mo and $130 per element for Nb. The pessimistic costs would result if a mandrel and can material such as titanium should be required. It is unlikely that this will be the case.

The principal cost factors in the $22 estimate are:

Materials	
Mandrels, 37 @ $.03	$ 1.00
Mandrel cladding	3.00
End Plates, 2 @ $.50	1.00
Can, 1 @ $1	1.00
Miscellaneous	1.00
Molybdenum, 1/2 lb. @ $2	1.00
Total Material	$ 8.00
Direct Labor, .8 hr @ $5	$ 4.00
Indirect Costs	10.00
TOTAL	$22.00

Achievement of the above will require quite a bit of development work, but the production rates considered would make this very worthwhile.

[redacted]

As you know, Battelle-Northwest has been active in research and development in connection with tungsten-UO_2 elements of this general configuration for many months. A very limited amount of irradiation testing of Mo-UO_2 and Nb-UO_2 cermets fabricated by pneumatic impaction has been conducted by Battelle-Northwest. No unusual problems were indicated.

Very truly yours,

F. W. Albaugh, Manager
Reactor and Materials Technology

FWA:KD:nb

cc: JM Nusser, Chief
Reactor and Fuels Branch
USAEC
Richland Operations Office

bcc: RF Dickerson
DR de Halas
K Drumheller
WE Roake
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FWA (2)

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