[redacted]

files

Cleveland, Ohio
Date JAN 6 1947

From Cleveland
To NACA

Subject: **Transmittal of memorandum concerning proposed program of thermodynamic research for nuclear energy application; also memorandum concerning research in progress in the High-Temperature Materials Section on Nuclear-energy problems and planned research.**

Please take the action indicated below:

A Advise status.
XB For your information, proper action, and files.
C For reply by your office.
D Forward (on loan) (for our files).
E Translate for laboratory files.
XF There (~~is~~) (are) transmitted herewith the following:
G The following visited the laboratory on dates given:
H Hold for further information.
I Copy of this letter enclosed with shipment.
J Advise whether order will be placed soon.
K Return catalogs and literature furnished by low bidder.
L Return samples submitted with letter of award.
M Send catalog and price list applying to general schedule.

Remarks:

1. Three copies subject memorandums, prepared by Mr. Benjamin Pinkel and Mr. John H. Collins, Jr., and dated January 3, 1947, respectively.

2. The attached memorandums will be discussed by Mr. Rothrock when he visits the Washington office this week.

Jesse U. Ball
for Carlton Kemper,
Executive Engineer.

AMR:ink
Encs.

[redacted]

Form No. 24

NATIONAL ADVISORY COMMITTEE
FOR AERONAUTICS
WASHINGTON, D. C.

Date 3-31

To CLEVELAND

------Direct reply	------Investigate and report
------Draft reply	------Note and return
------Approval and return	------Note and file
------Recommendation	------Proper action

Mr. Pinkel

Returned to Washington Office by Mr. Chamberlain by mistake.

From NACA

GPO 16—7081-1

[redacted]

NACA-Cleveland

A43053

Cleveland, Ohio,
January 3, 1947.

MEMORANDUM For Chief of Research.

Subject: Proposed program of thermodynamic research for nuclear energy application.

Reference: (a) Cleveland let. to NACA Oct. 9, 1946, BP:meb.
(b) Cleveland let. to NACA Nov. 29, 1946, EJM:dgr.

1. Cycle Analysis. - A study will be made of the following aircraft propulsion system cycles to determine the cycles most promising for the application of nuclear energy, and to establish the cycle operating conditions for optimum performance. In this study consideration of the weight and size of the power plant and reactor per unit thrust will be included.

(a) Closed cycle including both the condensing or vapor cycle (steam or other fluids) and the noncondensing or gas cycle (air, helium, or other gases). Single fluid and two fluid systems will be investigated.

(b) Open turbine cycle including both the turbojet and the propeller turbine cycles.

(c) Ram jet.

(d) Rocket.

2. Reactor analysis. - In order to determine the optimum cycle and cycle operating conditions, information is required on the size and weight per unit heat release rate of the reactor. Furthermore, it is necessary that the reactor be designed to function efficiently both as a nuclear energy generator and as a heat exchanger. A study of reactors of both the fission and radioactive types and shielding will be made to furnish the following information:

(a) The reactors best suited for the various types of aircraft propulsion systems.

(b) The weight and size of reactor per unit rate of heat release.

(c) Limitations imposed by nuclear energy considerations on the arrangements and dimensions of the pile elements as a heat exchanger.

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3. Heat transfer investigation. -

(a) Fundamental heat transfer

Fundamental information is required on heat transfer phenomonon at high temperature and high flux densities above the range of present available data. At these extreme conditions radiation and temperature gradient in the fluid film may become important for the case of surface-to-gas transfer, and boiling will markedly affect the surface-to-liquid transfer. Accordingly experimental investigations as suggested in references (a) and (b) will be made of heat transfer and associated phenomonon at high temperature and flux density for-

(1) surface-to-gas
(2) surface-to-liquid

The investigations will be made with electrically heated tubes where the tube itself will be the electrical resistance element. Initial experiments will be conducted with small scale set-ups using air and water as the gas and liquid, respectively. The initial work will then be continued with other gases and liquids and with larger scale equipment.

(b) Pile heat exchanger

Analytical studies will be made of arrangements of the reactor elements as a heat exchanger to determine the arrangement that provides the maximum heat release rate for the optimum conditions determined from the cycle analysis (paragraph 1) subject to the reactor limitations mentioned in paragraph 2(c). These studies will be supplemented by experimental investigations when required. Whenever possible in the experimental studies reactor conditions will be simulated artificially by conventional heating methods. It is anticipated that heat exchanger tests on actual reactors will ultimately be required.

(c) Auxiliary heat exchanger

Selection and design studies will be made of the various auxiliary heat exchangers required for the aircraft power plant (e.g. condensers, intermediate heat exchangers to transfer heat from the reactor fluid to the cycle primary fluid in the two fluid systems, etc.). These studies will be carried out in conjunction with the cycle analysis of paragraph 1 and experimental investigations will be made if required.

4. Personnel. -

(a) Now on project

During the past year two engineers have been working part time on cycle analysis, two Phd's have been assigned to Oakridge for nuclear training and recently two engineers have been designing equipment for heat transfer tests.

(b) Available from present staff for project

It is proposed to transfer the efforts of the personnel of the Composite Engine Section (12 men) to heat transfer work progressively during the course of the next year. In addition, two Phd's who have had training in nuclear physics will be available for work on pile studies under the guidance of the men now at Oakridge. Personnel from the Thermodynamics Analysis Section may also be assigned to the cycle analysis work. It is thus anticipated that between 15 and 20 men of our present complement can be assigned to thermodynamic research for nuclear energy application within the next year.

5. Facilities for heat transfer investigations. - The available rooms and services in the Engine Research Building will be adequate for the initial phases of the proposed heat transfer research. Equipment required will be of an electrical nature such as transformers and voltage regulators and controls and should be readily obtainable. Although this initial work will be carried out without the use of nuclear reactor or radiation equipment, heat transfer investigations on actual nuclear piles will eventually be required. It would be advisable to conduct heat transfer investigations on the actual pile at and in cooperation with established nuclear energy laboratories. NACA will, however, ultimately require equipment of its own for investigating the performance of nuclear reactors.

6. The forgoing program is limited to the thermodynamic analysis, reactor analysis and the associated heat transfer research. Additional programs on the theoretical and experimental investigation on the overall power plants and their components are required to cover the scope of the anticipated Cleveland laboratories activities on nuclear energy power plants.

Benjamin Pinkel, Chief,
Fuels and Thermodynamics Research Division.

EJM:dgr:meb
BP

[redacted]

Cleveland, Ohio,
January 3, 1947.

A43053

MEMORANDUM For Chief of Research.

Subject: Research in progress in the High Temperature Materials Section on nuclear-energy problems and planned research.

1. Research in the High Temperature Materials Section on nuclear-energy problems may be placed in two general groups: That which is concerned with the effects of nuclear radiations, and that which deals with research on materials suitable to be used in the nuclear-energy power plant.

2. The research on the effects of nuclear radiations may be classified as follows:

a. Effects on engineering physical properties. These properties include creep, hardness, stress rupture, fatigue, impact, and tensile strengths.

b. Effects on fundamental physical properties. These properties include binding energy, cohesive strength, modulus of rigidity, and internal friction.

c. Effect on rate processes. These processes include age-hardening, formation and movement of dislocations, recrystallization, phase transformations, diffusion, and slip.

3. The research on materials for the nuclear-energy power plant may be classified as follows:

a. Investigation of ultra-high-temperature materials by scientific variation of composition. This research includes studies of ceramic compositions, alloy compositions, and ceramic-metal combinations.

b. Research on ultra-high-temperature materials by various processing techniques. This research includes the study of working, heat treating, hot forming, and extreme hydrostatic pressures as processes to develop metastable states having better high-temperature properties.

c. Study of materials with optimum shielding characteristics for particular applications. This research includes studies of absorption coefficients, cross sections, and combinations of materials for shielding purposes.

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4. The research in progress at the present time is as follows:

a. The effects of alpha radiation on creep rates of pure metals and the effect of both alpha and gamma radiation on the age-hardening rate of the aluminum alloy 24S.

b. The investigation of non-metallic composition for use at very high temperatures. (Part of this work is being done under contract by the National Bureau of Standards.)

c. The scientific study of alloy compositions for use at very high temperatures. (Part of this work is being done under contract by the University of Notre Dame.)

d. The investigation of hot-forming techniques for making compositions of high-melting components.

John H. Collins, Jr.

John H. Collins, Jr.,
Chief, Engine Performance
and Materials Division.

JHK:mg/js
ARB

Cleveland, Ohio,
August 28, 1947.

MEMORANDUM For Executive Engineer.

Subject: Proposed Research Authorizations for heat transfer research under Atomic Energy Commission sponsorship.

Reference: (a) NACA ltr. Cleveland, Aug. 11, 1947, AMR:bh.
(b) Cleveland ltr. NACA, May 5, 1947, EJM:dgr.
(c) Cleveland ltr. NACA, May 14, 1947, EJM:dgr.

1. In accordance with the request of the reference letter (a) there are attached two proposed Research Authorizations for heat transfer research that would be suitable for sponsorship by the Atomic Energy Commission. The research proposed in these two Research Authorizations is currently being conducted under E-199, requested by the Bureau of Aeronautics at the suggestion of NACA.

2. Attention is also called to the proposed Research Authorizations previously submitted in the letters of reference (b) and (c) covering investigations of aircraft propulsion cycles and heat exchangers (nuclear reactors), respectively, in connection with the utilization of nuclear energy. It would be desirable to have these Research Authorizations sponsored by the Atomic Energy Commission, however, the present time may not be propitious for including them with the other suggestions.

Eugene J. Manganiello,
Chief, Thermodynamics Branch.

EJM:dgr
BP

Approved:
Benjamin Pinkel,
Chief, Fuels and Thermodynamics Division.