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ADVANCED CONCEPTS FOR A 1200
kV SHUNT REACTOR

DOE CONTRACT NO. ET-78-C-01-3007

FIRST QUARTERLY PROGRESS REPORT

OCTOBER TO DECEMBER 1978

REX

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ADVANCED CONCEPTS FOR A
1200 kV SHUNT REACTOR

FIRST QUARTERLY REPORT

FOR THE PERIOD

28 SEPTEMBER 1978 - 31 DECEMBER 1978

M. W. THOMAS, Program Manager
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PREPARED FOR THE

U.S. DEPARTMENT OF ENERGY
DIVISION OF ENERGY TECHNOLOGY
UNDER CONTRACT ET-78-C-01-3007

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II. CONTRACT OBJECTIVE

The objective of this program is to explore new concepts for inductive shunt reactor designs for integration into a 1200 kV gas insulated substation. The most promising design must exhibit low dimensional profile with reduced weight, lower losses, lower noise level and smaller amplitude of vibration when compared with the units of equivalent rating built with the present day technology.

III. FIRST QUARTER PROGRESS

With the award of Contract No. ET-78-C-01-3007 on September 28, 1978, planning and preparation was begun so that orderly work assignments will lead to the contract completion in the allotted 24 month period. The first quarter has been devoted primarily to planning and organizing of each task, as well as literature reviews.

The basic plan calls for the program to be divided into seven basic tasks as listed below:

- Task 1 Perform a system study of the proposed 1200 kV system
- Task 2 Electrostatic Studies
- Task 3 Electromagnetic Studies
- Task 4 Mechanical Studies
- Task 5 Thermal Studies
- Task 6 Electrical-Mechanical-Thermal Study
- Task 7 Engineering Design and Reports

Each of these tasks have been further divided into subtasks which more clearly define the assignment details that are necessary for attaining the goals of each task and ultimately that of the total project.

The planning and organization details have been entered into the Westinghouse FOCAS system for computer controlled cost and manpower scheduling.

Although much of the first quarter has been utilized in planning, organizing, and literature reviews, preliminary investigations were begun for Task 2. The foil coating equipment was set-up and pilot runs of coated foils were made to evaluate the coating methods and materials. Samples from these pilot runs have been tested in a 6 inch diameter acrylic test cell to determine the breakdown values. These initial foil samples were coated with B-115 oil modified polyester applied in 0.65 mil thickness.

A preliminary design of a 167 MVAR shunt reactor was begun using the proposed concepts. This design will establish some approximate design criteria so that investigators will have an approximation of component sizes.

IV. SECOND QUARTER FORECAST

The second quarter of this contract will feature activities in the work area of several tasks.

Task 1

Investigation will begin with a parametric steady state digital computer investigation of shunt inductive compensation requirements. A program has been defined in which ABCD constant representations will be formulated for the various power system elements. These ABCD constant module representations will be combined in the appropriate manner to represent the power system.

Three utility companies have been selected to discuss the philosophy of operation of a 1200 kV system. A list of questions that will serve as a guideline for these discussions is attached as Appendix 1.

Task 2

Coating of aluminum foils with various coating materials will continue for the purpose of evaluation of the materials, the methods and the quality. Dielectric tests of these coated foils will continue so as to determine the working dielectric strengths. In addition to determining the breakdown strength, the corona starting levels and the prebreakdown corona will be investigated for these turn-to-turn samples. Half-coil samples will also be made to evaluate the turn-to-turn strength of a multiple layer stack and also to evaluate the coil edge insulation.

A larger test vessel will be designed for performing the winding-to-ground insulation studies, the partial discharge and breakdown studies of larger models, the high voltage and neutral lead termination studies, and the impulse and switching surge transient studies.

Task 3

An estimate has been made of the shunt reactor requirements. These requirements will be altered as dictated by the system study of Task 1, the material and electrostatic investigations of Task 2, and the magnetic material evaluations of Task 3. In general the reactor must provide a linear E versus I relationship up to 130% of the maximum system voltage.

The core investigations in this quarter will center around core legs molded from coated microlaminations. Suppliers of the microlaminations will be contacted to determine the availability and the characteristics of the microlaminations. The factors to be considered in the material selection are:

1. Magnetic requirements of the shunt reactor core
2. Limitations in chopping the heavy gage materials
3. Commercial availability
4. Past experience on insulating and annealing

Investigations will be made into insulation materials for the microlaminations as well as an evaluation of bonds for bonding them into core sections.

Molds will be designed preparatory to making samples for testing of magnetic properties and mechanical strength.

Task 5

Investigation of the interior cooling parameters will begin. These investigations will include the coolant flow rates, determination of local heat transfer, and analysis gas-vapor diffusion and heat pipe coolant concepts.

Task 7

The 167 MVAR shunt reactor design will be completed and compared with a standard reactor of the same rating.

V. MILESTONE SCHEDULE AND STATUS REPORT

Contract No.: ET-78-C-01-3007

Start Date: 9/28/78

Completion Date: 9/28/80

Fiscal Years and Months

Contractor's Name:

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Conventions:

1. Blocked in bars show work completed
2. Open bars show work not completed
3. Δ Represents major milestone
4. ∇ Represents intermediate milestone

VI. APPENDIX

APPENDIX 1

QUESTIONS ON THE PHILOSOPHY OF OPERATION OF A 1200 kV SYSTEM WITH SHUNT COMPENSATION

- * What is your general philosophy of system VAR control?
- * What is the impact of your type of utility (T Vs. G&T) on the philosophy of VAR flow control?
- * How will UHV transmission be used on your system? - Overlay, Intertie - etc.
- * What range of operation voltage levels would you expect on your UHV system?
- * What range of short circuit capacities do you anticipate at UHV terminals?
- * Do you contemplate use of low side switching of UHV lines?
- * What need do you foresee for underload tap changers on UHV transformers?
- * Where will shunt compensation be located? - UHV line, UHV bus, transformer tertiary - etc.
- * Would a standard size UHV shunt reactor be suitable for your system? - What size or range of sizes?
- * What amount of line charging unbalance would be considered acceptable for a UHV line?
- * Would you build UHV lines on the same right-of-way with lower voltage lines?
- * Would you consider using single pole switching?
- * Do you foresee that UHV equipment would have significantly different characteristics than EHV equipment? - i.e., Transformer Impedance, Reactor Saturation Characteristics - etc.
- * Would you consider using metal-oxide UHV arresters?
- * What equipment surge protective margins do you foresee using on UHV systems?
- * Would you consider using static VAR compensators in conjunction with UHV system operation?