CONF-791103--73

HOT CELL MEASURING AND TEST EQUIPMENT CALIBRATION CONTROL

MASTER

by

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Prepared for

ANS-RSTD Conference

San Francisco, California

November 11-15, 1979

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ABSTRACT

The need for increasingly accurate data on the performance of fuels and materials in nuclear reactors has placed increased emphasis on the quality of measurement of data obtained in hot cells. A program has been proposed to incorporate the basic features of a standard measurement laboratory while recognizing the unique aspect of hot-cell measurements. That hot cells must comply with calibration procedures in order to maintain control of measurement parameters has been the basis for the system proposed for implementation in the Hot Fuel Examination Facility (HFEF) at the Argonne-West Site, Idaho Falls, Idaho.

HOT CELL MEASURING AND TEST EQUIPMENT CALIBRATION CONTROL

NEED FOR CALIBRATION CONTROL

Irradiation experiments in research reactors have long been used to support reactor research programs. The behavior of structural materials, fuels, and control rod materials under irradiation is a major factor in the design of reactor systems. A substantial part of the data which characterize this in-reactor behavior is obtained from out-of-reactor measurements and examinations. The control of measurements obtained in hot cells or other shielded facilities has not received the same degree of attention as that given to more conventional measurement laboratories.

The hostile environment of the hot cell with remotely controlled operations has focused attention on obtaining measurements first, and control of accuracy and precision became secondary. The increased social demands on nuclear energy today require accurate information for reactor physicists, engineers, and designers. There is an urgent need for data control at the source. This paper proposes a method for controlling the accuracy and precision of measurements obtained in hot cells or other hostile environments.

CALIBRATION PROGRAM REQUIREMENTS

The "standard" calibration program as outlined in RDT-F3-2T[1] and Mil-C-45662-A[2] lists the following requirements:

A. Program description

B. Adequacy of standards

C. Environmental control

D. Intervals of calibration

E. Calibration procedures, which should include the following as minimum:

   1. Identity of the item or system to be calibrated
   2. Calibration equipment and standards
   3. Sequence of operations
   4. Checks, test, measurements, and acceptance tolerance
   5. Method of presenting calibration data
   6. Special instructions when necessary

F. Traceability

G. Records

H. Labeling

I. Precalibration checks.

A feasible calibration program in hot cells may require some exceptions to the requirements of a "standard" calibration program. Experience at the Hot Fuel Examination Facility (HFEF) at Argonne-West has shown that

certain requirements, such as recalibration of measuring and test equipment and measuring standards, are difficult, if not impossible, to meet in a hot cell. Using this experience, the Argonne Quality Assurance Division (QAD) at Argonne-West prepared a program for the control of measuring and test equipment in hostile environments.

PROPOSED HOT CELL CALIBRATION CONTROL SYSTEM

A system of calibration for hot cell measurements is proposed to meet the following objectives:

A. Ensure that measurements obtained are accurate within the demonstrated capabilities of the equipment.

   1. All new measuring and test equipment will be characterized as to its accuracy and precision. This characterization will take place during the normal "qualification" before the equipment is inserted into the hot cell.

      a. Qualification is to be performed by HFEF personnel out-of-cell, simulating the in-cell environment.

      b. Use standards with sufficient accuracy that limits of equipment can be determined to ± 1%.

      c. A multiple sequence of measurement runs over a period of time and with different operators is to be made to eliminate bias or temporal errors. Probabilistic tests of data are to be generated to eliminate "out-liers" from computations.

d. HFEF is to establish tentative accuracy and precision limits.

2. All new measuring and test equipment will have an independent overcheck on its accuracy and calibration by QAD using standards controlled by QAD.

   a. HFEF personnel will measure "unknowns" provided by QAD. The operator will not be given the values of the "unknowns."

   b. Data analysis by QAD will include deterministic tests and probabilistic tests (Chi square) to establish conformity of measured values to calibrated values of the "unknowns."

3. Measuring and test equipment and standards used in hot cells at HFEF shall have established calibration/evaluation intervals. The following items shall be included in the calibration program:

   Balances, weights, length standards, profilometer standards, subassembly profilometer standards, dynamometers, force gauges, dial indicators, load cells, gauge blocks, flow meters, torque wrenches, cladding integrity standards, subassembly straightness standards, and fuel-capsule balance standards.

4. A surveillance program will be instituted to ensure that procedures and measurement standards are being correctly used. Surveillance should include:

a. Observation of measurement practices (following procedures)

b. Observation of calibration labels

c. Observation of qualification activities (standards, measuring and test equipment, and personnel).

5. An audit program will be instituted to ensure that procedures and measurement standards are being correctly used. The program should include the following:

a. Review of data records (trend and variance analysis, control charts, etc.)

b. Periodic review of system with the "unknowns" standard provided by QAD

c. Determination of adequacy of quality assurance program performance

d. Verification of implementation of corrective action.

B. Provide documented evidence that calibration control is being maintained.

1. Establish a system to provide evidence at the point of use that an item of measuring equipment or standard is in calibration. Standards or measuring equipment should be individually identified by stamping or etching, color coding, physical configuration, paint or ink, and serial numbers to maintain traceability. Labels of those items in-cell should be on a special board located out-of-cell adjacent to the cell window so that the operator has visible evidence of the calibration status of the equipment or standard. The labels should be in

plain view, not in loose-leaf binders, books, desks, or inside equipment panels.

2. Maintain an inventory, preferably computer generated, with the following features:

   a. Identification of measuring and testing equipment or standard

   b. Location

   c. Intervals of calibration

   d. Name of responsible group or individual

   e. Limitations or restrictions on the use of an item or standard

   f. Calibration recall and/or disposal

   g. Listing of overdue calibration

   h. Means for bringing reports of overdue calibration to the attention of higher levels of management.

C. Provide periodic "independent" evaluation of nonserviceable equipment and standards (equipment and standards located in an area inaccessible for recalibration) as follows:

1. All nonserviceable equipment is to be identified and labeled

2. Nonserviceable equipment is to be evaluated at prescribed intervals

3. Verification against "unknowns" standards is to be provided by QAD
4. Results are to be reported to management to maintain history records.

D. Provide periodic audit of personnel as follows:

1. Observation by independent (QAD) personnel of measurement practices
2. Verification of status of operator qualification.

E. Provide trend and variance analyses on measurement data.

1. HFEF Data Quality Group to make trend and variance analyses on data from routine standards measurements
2. Surveillance of Data Quality Group's data by QAD
3. Use of control charts on measuring and test equipment standards
4. Disposition of standards based on analysis of data.

F. Provide a cost-effective means of controlling the quality of data from measuring and test equipment.

1. Establish procedures whereby a comprehensive system of control can be phased in with a minimum disruption of activity.
2. Establish a realistic calibration schedule adjusted to reflect the precision, nature, and extent of use. Calibration schedules can be based on elapsed calendar time, amount of usage, or actual operating hours.

3. Establish responsibility for the calibration and recall system, both overall and individual.
4. Conduct a study of the inherent design characteristics of the measuring devices to see if equipment calibration intervals can be lenghtened.
5. Verify equipment has the degree of accuracy required for the measurements being performed. Overdesigned equipment is costly and could require more frequent calibration.
6. Establish a timetable for evaluation and disposition of equipment of questionable accuracy.
7. Provide a facility for remote calibration of those which cannot be decontaminated prior to calibration, and for remote repair of those items which are too expensive to be thrown away when beyond calibration. (See Fig. 1.)
8. Develop inexpensive throw-away standards which can be replaced rather than recalibrated.
9. Provide adequate storage for in-cell standards to protect them from damage and allow for inventory and accountability control.
10. Develop a training program for the users of the equipment to acquaint them with the proper handling and operation of measuring and test equipment. Include actions to be taken when the data appears not to conform with the data expected.

BENEFITS OF PROPOSED PROGRAM

The proposed program for calibrating hot-cell measuring and test equipment and standards would:

A. Demonstrate and verify capabilities of measuring and test equipment with regard to accuracy and precision.

B. Provide a common basis, among HFEF and users of its service, for understanding and accepting the limitations and capability of measuring and test equipment.

C. Ensure production of data to the highest standards reasonable.

D. Establish an objective basis for the acceptability of data.

E. Establish a system for the continuing monitoring and controlling of data quality.

F. Provide a rational basis for the establishment of criteria for new measuring and test equipment design.

G. Promote increased cost-effectiveness of measurements programs and fit the use of measuring and test equipment to job data requirements.

H. Increase the awareness among operating personnel of the importance of good measurements.

I. Enhance the "measurements laboratory" view of the HFEF operations and mission.

ACKNOWLEDGEMENTS

The assistance of the following is gratefully acknowledged: Vincent Aquino, Tom Cameron, Kermit Gill, and Gerry Sherman of Argonne National Laboratory. The help given by HEDL, LASL, and EG&G-Idaho is also gratefully acknowledged.

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1. Calibration Program Requirements, RDT Standard F3-2T USAEC, February 1973.

2. Calibration System Requirements, Military Specification Mil-C-45662A, February 9, 1962.

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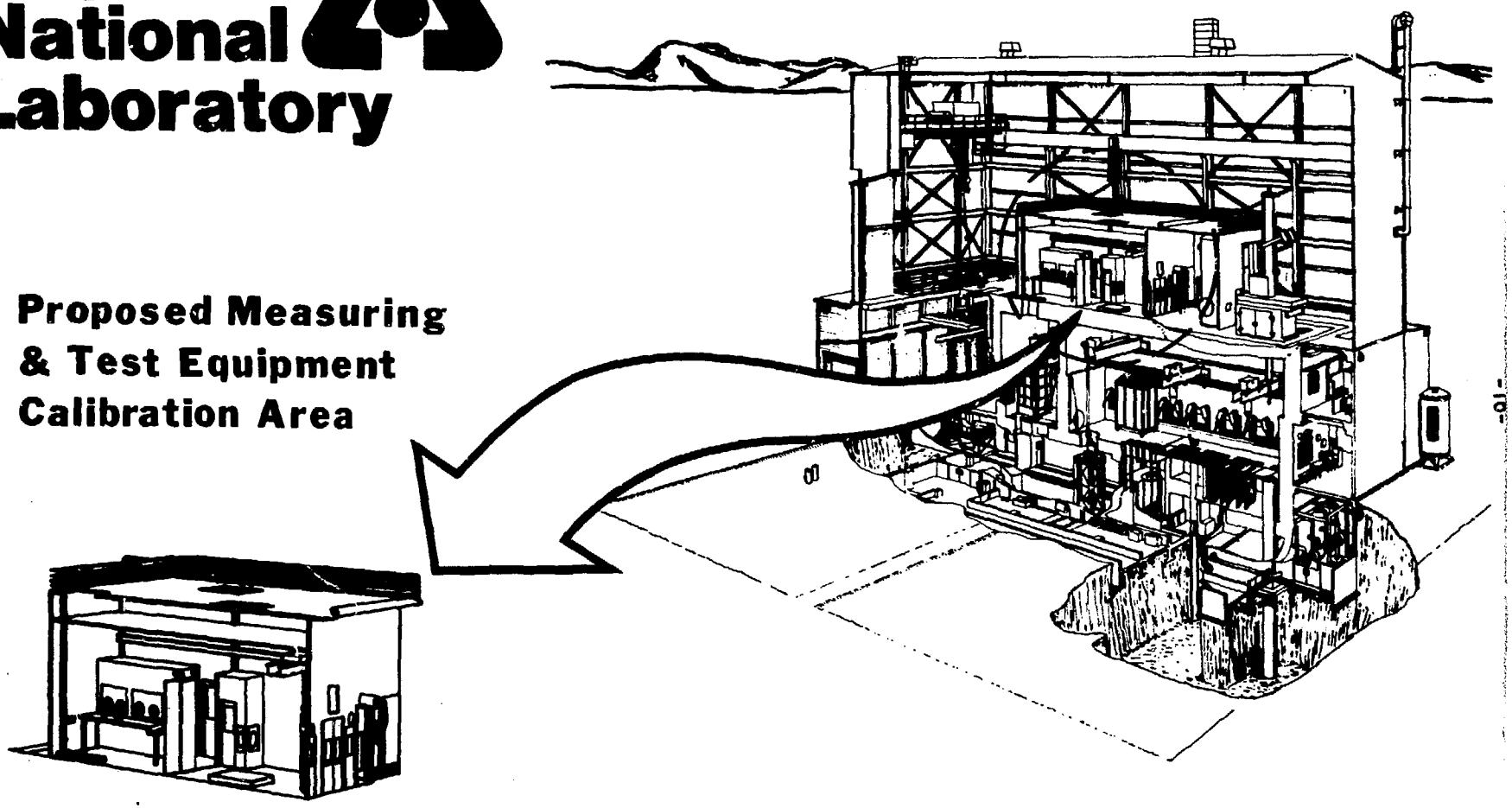

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Figure 1

FIGURE CAPTION

1. Proposed Measuring and Test Equipment Area in the Hot Fuel Examination Facility/North, Argonne-West.