



UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

PDR

MAR 8 1979

MEMORANDUM FOR: Raymond F. Fraley, Executive Director
ACRS

FROM: Guy A. Arlotto, Director, Division of Engineering
Standards, Office of Standards Development

SUBJECT: DRAFT 1 OF PROPOSED REVISION 1 TO REGULATORY GUIDE
1.131, "QUALIFICATION TESTS OF ELECTRIC CABLES AND
FIELD SPLICES FOR LIGHT-WATER-COOLED NUCLEAR POWER
PLANTS"

Enclosed for initial review by the ACRS Regulatory Activities Subcommittee are fifteen copies of proposed Revision 1 to Regulatory Guide 1.131, "Qualification Tests of Electric Cables and Field Splices for Light-Water-Cooled Nuclear Power Plants," Draft 1, dated March 5, 1979. Also enclosed are fifteen copies of the Value/Impact Assessment for the proposed revision.

The guide was issued for public comment on August 16, 1977 and comments were received. Subsequent to the comment period, a decision was made to postpone issuance of Revision 1 of the guide pending the results of research on the sensitivity of variations in fire qualification test parameters being conducted for NRC at Underwriters' Laboratories (UL). Conclusions from the results of the UL research show the necessity of establishing more specific values for some of the fire test parameters. These conclusions have been incorporated in the proposed revision to the guide. Substantive changes have been made in the guide since the guide was issued for public comment. Therefore, the guide will be reissued for public comment before issuance as an effective guide. Copies of the public comments received during the first comment period and a resolution of comments are included for use by the Subcommittee.

Regulatory Guide 1.131 endorses, with certain exceptions, IEEE Std. 383-1974, "IEEE Standard for Type Test of Class IE Electric Cables, Field Splices and Connections for Nuclear Power Generating Stations." Copies of IEEE Std. 383-1974 were transmitted to the Subcommittee on February 11, 1977 preceding the Subcommittee's review prior to issuance of Regulatory Guide 1.131 for the first public comment period.

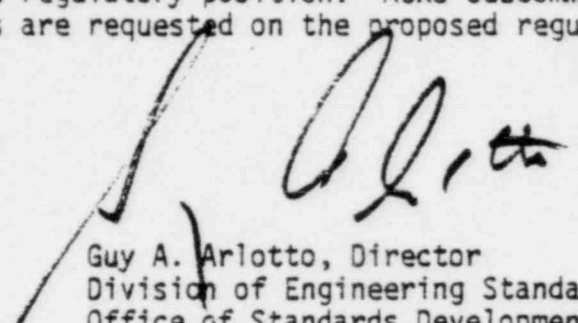
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To: R. F. Fraley

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Since the draft guide is preliminary, additional staff efforts, including review and resolution of public comments, will be necessary prior to implementation of a regulatory position. ACRS Subcommittee comments and recommendations are requested on the proposed regulatory position.



Guy A. Arlotto, Director
Division of Engineering Standards
Office of Standards Development

Enclosures: As Stated

cc: NRC Public Document Room



U.S. NUCLEAR REGULATORY COMMISSION

Draft 1
March 5, 1979

REGULATORY GUIDE

OFFICE OF STANDARDS DEVELOPMENT

REGULATORY GUIDE 1.131

AND

QUALIFICATION TESTS OF ELECTRIC CABLES, FIELD SPLICES, ~~AND CONNECTIONS~~ FOR LIGHT-WATER-COOLED NUCLEAR POWER PLANTS

A. INTRODUCTION

Criterion III, "Design Control," of Appendix B, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants," to 10 CFR Part 50, "Licensing of Production and Utilization Facilities," requires that, where a test program is used to verify the adequacy of a specific design feature, it include suitable qualification testing of a prototype unit under the most adverse design conditions. This regulatory guide describes a method acceptable to the NRC staff for complying with the Commission's regulations with regard to qualification testing of electric cables, field splices, and ~~connections~~ for service in light-water-cooled nuclear power plants to ensure that the cables, field splices, and ~~connections~~ can perform their safety-related functions.¹ The fire test provisions of this guide do not apply to qualification for an installed configuration.

B. DISCUSSION

IEEE Std 383-1974, "IEEE Standard for Type Test² of Class IE Electric Cables, Field Splices and Connections for Nuclear Power Generating Stations," was prepared by Working Group 12-32 of

¹Regulatory Guide 1.29, "Seismic Design Classification," provides guidance with regard to identifying electric cables, field splices, and connections to which the design verification requirements of Appendix B to 10 CFR Part 50 apply.

²As used in this regulatory guide, the terms "qualification test" and "type test" are synonymous.

³Copies may be obtained from the Institute of Electrical and Electronics Engineers, United Engineering Center, 345 East 47th Street, New York, N.Y. 10017.

the Insulated Conductors Committee of the Power Engineering Society of the Institute of Electrical and Electronics Engineers, Inc. (IEEE), approved by the IEEE Nuclear Power Engineering Committee, and subsequently approved by the IEEE Standards Board on February 28, 1974. It was approved as an ANSI standard, ANSI N41.10-1975, on April 30, 1975. The standard delineates procedures for developing a program for qualification testing of cables, field splices, and ~~connections~~. It supplements IEEE Std 323-1974, "IEEE Standard for Qualifying Class IE Equipment for Nuclear Power Generating Stations," which describes basic requirements for equipment qualification. IEEE Std 323-1974 is endorsed, with certain exceptions, by Regulatory Guide 1.89, "Qualification of Class IE Equipment for Nuclear Power Plants."

Shortly after IEEE Std 383-1974 was issued, several laboratories and cable testing facilities experienced difficulty in producing a consistent flame source by using the burner and flame source procedures specified in the standard. An IEEE task force investigation into the problem was eventually expanded to include an evaluation of various flame sources to determine if the 70,000 Btu/hr flame source specified in the standard was correct for use in fire qualification testing. The investigation found that inconsistencies in the flame source were traceable to the inadvertent use of incorrectly sized burners during certain tests.

A series of tests to determine if the correct flame source had been selected was conducted, and the results, as evaluated by the IEEE task force and the NRC staff, indicated no basis for changing the 70,000 Btu/hr. ~~Investigation into the testing is continuing.~~

USNRC REGULATORY GUIDES

Regulatory Guides are issued to describe and make available to the public methods acceptable to the NRC staff of implementing specific parts of the Commission's regulations, to describe techniques used by the staff in evaluating specific problems or anticipated accidents, or to provide guidance to applicants. Regulatory Guides are not substitutes for regulations, and compliance with them is not required. Methods and solutions different from those set out in the guides will be acceptable if they provide a basis for the findings relative to the issuance or continuance of a permit or license by the Commission.

Comments and suggestions for minor items in these guides are encouraged at all times, and guides will be revised, as appropriate, to accommodate comments and to reflect new information or experience. However, comments on the guide, if received within about two months after its issuance, will be particularly useful in evaluating the need for an early revision.

Comments should be sent to the Secretary of the Commission, U.S. Nuclear Regulatory Commission, Washington, D.C. 20555, Attention: Document and Service Branch.

The guides are issued in the following ten broad divisions:

- | | |
|-----------------------------------|------------------------|
| 1. Power Reactors | 5. Products |
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| 4. Environmental and Siting | 9. Annual Review |
| 5. Materials and Plant Protection | 10. General |

Requests for three copies of issued guides (which may be reproduced) or for placement on an automatic distribution list for these copies of future guides in specific divisions should be made in writing to the U.S. Nuclear Regulatory Commission, Washington, D.C. 20555, Attention: Director, Division of Document Control.

~~IEEE Std 383-1974, and significant results will be in accordance with the~~

ability of the cable to retard

The flame tests covered by Section 2.3 of the standard provide a test primarily of the ~~retardancy~~ tendency of the cable ~~insulation~~ material. These tests are conducted with cables in a specific configuration and subjected to a defined fire source. However, the fire ~~retardancy~~ may vary significantly under different environmental conditions, cable configurations, and fire sources. It should be recognized that the objective of the flame test is to provide guidance for the selection of fire ~~retardant~~ cables rather than to establish the adequacy of the installation of cables in a nuclear power plant. Adequacy of cables as installed depends on many factors. Moreover, the adequacy of the cable system as installed depends on other factors in addition to the properties of the cables. For example, cable separation criteria are delineated in Regulatory Guide 1.75, "Physical Independence of Electric Systems," and fire protection guidelines are delineated in Regulatory Guide 1.120, "Fire Protection Guidelines for Nuclear Power Plants."

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IEEE Std 383-1974 is concerned with cables both inside and outside the containment and establishes procedures for simulating operating conditions so that type testing will be adequate for the intended service conditions. It covers normal operating and design basis event conditions, except that the fire test is a reference configuration and flame rather than the design basis configuration and flame.

C. REGULATORY POSITION

Conformance with the requirements of IEEE Std 383-1974, "IEEE Standard for Type Test of Class IE Electric Cables, Field Splices, and Connections for Nuclear Power Generating Stations," is acceptable for qualifying electric cables, field splices, and ~~connections~~ as components (fire test provisions do not apply to qualification for an installed configuration) for service in light-water-cooled nuclear power plants to ensure that the cables, field splices, and ~~connections~~ can perform their safety-related function subject to the following:

1. In lieu of Section 1.3.4.2.3, "Other Design Basis Events," the following should be used:

"The remainder of the complete spectrum of design basis events (e.g., events such as a steam line break) shall be considered in case they represent different types or more severe hazards to cable operation."

2. In lieu of Section 1.3.5.3, "Test Design Basis Event," the following should be used:

"Type tests for design basis event conditions shall consist of subjecting non-aged and aged cables, field splices, and ~~connections~~ to a se-

quence of environmental extremes that simulate the most severe postulated conditions of a design basis event and specified conditions of installation. Type tests shall demonstrate margin by application of multiple transients, increased level, or other justifiable means. Satisfactory performance of the cable will be evaluated by electrical and physical measurements appropriate to the type of cable during or following the environmental cycle, or both. The factors for margin given in Section 6.3.1.5 of IEEE Std 323-1974 shall be used where applicable.

"The values of pressure, temperature, radiation, chemical concentrations, humidity, and time in IEEE Std 323-1974 do not represent acceptable limits for all nuclear power stations. The user of this standard shall ensure that the values used in the required type tests represent acceptable limits for the service conditions in which the cable ~~connections~~ will be installed." and field splices

3. In lieu of Section 2.1, "Introduction," the following should be used:

"Type tests described in this document are methods that shall be used to qualify electrical cables, field splices, and ~~connections~~ for use in nuclear power generating stations. Tests of the cable or connection assembly, as applicable, shall then supplement the cable tests in order to qualify the connections and other aspects unique to planned usage.

"The values of pressure, temperature, radiation, chemical concentrations, humidity, and time indicated in IEEE Std 323-1974 do not represent acceptable limits for all nuclear power generating stations.

"The user of this guide shall ensure that the values used in the required type tests represent acceptable limits for the service conditions in which the cable ~~connections~~ will be installed." and field splices

"Results of prior tests that are being used as the bases for the present tests shall be referenced in the documentation."

4. Section 2.3.1, "Temperature and Moisture Resistance," lists industry standard IPCEA S-19-81, "Rubber Insulated Cable" for a moisture resistant test. The exception allowed in the second paragraph of Section 6.9.1 of IPCEA S-19-81 should not be taken unless it can be certified that the insulation, in the absence of covering, can meet the requirements of IPCEA S-19-81.

5. In lieu of Section 2.3.2, "Long-Term Physical Aging Properties," the following should be used:

"Aging data shall be ~~developed~~ to establish long-term performance of the insulation. ~~Develop~~

→ Synergistic effects⁵ on aging due to simultaneous application of environmental conditions shall be considered in the accelerated aging program. Investigation shall be performed to determine if there are synergistic effects and, where identified, they shall be accounted for in the qualification program. The effects of temperature

or low er 136°C and two or more others at least 10°C apart in temperature, shall be used. one of

"If ~~where not~~ accelerated aging techniques can reliably produce end-of-life conditions, the following ongoing qualification procedure should be used:

"Ongoing Qualification Procedure—Some types of cables, field splices, and ~~connections~~ (hereafter referred to only as cables) may not respond in a representative manner to accelerated aging techniques to establish end-of-design-life conditions. Consequently, the qualified life would be less than the required design life. There are two suggested methods of achieving long-term (design life) qualification: (a) After a planned period less than the qualified life⁵ of the cable has been reached, representative cables should be replaced with new cables and the removed cables subjected to a qualification test similar to that performed prior to installation. This test should include additional accelerated aging. Successful completion of this test extends the qualified life of the installed cables. This procedure should be repeated until the qualified life equals or exceeds the required design life. (b) Additional identical cables should be installed in a nuclear power generating station location or other environmentally equivalent locations

where power loading and service conditions equal or exceed those of the cable to be qualified. A cable should be removed after a planned period less than the previously qualified life and subjected to a qualification test similar to that performed prior to installation. This test should include accelerated aging. Successful completion of this test extends the qualified life of the installed cable. Sufficient additional identical cables should be initially installed in order that the above procedure can be repeated until the qualified life equals or exceeds the required design life.

"If the above methods demonstrate that the qualified life is less than the design life, a periodic replacement plan should be instituted."

6. The radiological source term and exposure rate simulating LOCA conditions referred to in Section 2.4.2, "Radiation Exposure—Total," should be obtained from Regulatory Guide 1.39 rather than from IEEE Std 323-1974.

7. In lieu of Section 2.5.1, "General," the following should be used:

"This section describes the method for type testing of grouped cables via the vertical tray flame test to determine their relative ~~extinguishing tendencies. Testing shall include~~

flame retarding tendencies. Additional testing shall be done to demonstrate that the fire retarding properties of the cable are not adversely affected by aging; otherwise, the vertical tray flame test shall be conducted separately on aged as well as unaged cable."

8. In lieu of Section 2.5.2.2, the following should be used:

"The fire test provisions of the standard are and useful in screening out cable insulation jack- materials according to relative et flame retarding properties

~~but they shall not be construed as qualification of any installed cable system configuration. If field splices are to be used in cable trays, ~~connections~~ shall be made to demonstrate that the fire retardant properties of the cable are not altered unacceptably ~~connections~~ by the field splice."~~ fire tests

~~Section 2.5.1.3 Vertical tray configuration should be used and subjected to heat exposure to the plane of the wires.~~

⁵ Representative cables are to be selected from those cables that have received the most severe service conditions (including loading, mechanical stress and pressure, temperature, radiation and chemical environment).

⁶NUREG/CR-0276 (S.N.078-0799) "Qualification Testing Evaluation Program" August 1973

9. In lieu of Section 2.5.4.1, the following should be used: "Tests shall be conducted within a test enclosure. The test enclosure shall be a nominal 8 ft x 8 ft x 8 ft compartment as shown in Figure 1. The interior surfaces of the enclosure shall be mineral material such as Marinite board, or similar inorganic material. Several observation windows and an access door shall be provided. The interior surface shall be painted flat black. A nominal 12 inch high opening shall be provided at floor level across the entire front and rear walls. The top of the enclosure shall be completely open. Ventilation of the building or room in which the test is conducted shall be sufficient to prevent oxygen depletion by recirculation of combustion products. Ambient air and cable tray temperature shall be $78^{\circ} \pm 5^{\circ}F$ prior to each test.

10. In lieu of Section 2.5.4.2, the following should be used: "A tray configuration perpendicular to the plane of the horizon shall be used. The tray shall be a steel, open-ladder type cable tray nominally 8 ft long and 12 inches wide. The side channels shall be nominally 3 & 3/8 inches deep with 1 inch flanges and 0.060 inches thick. The rungs shall be nominally 1 inch x 1/2 inch U shaped channel, 0.125 inches thick and welded to the side rails at 9 inch intervals."

11. In lieu of Section 2.5.4.3, the following should be used: "Multiple lengths of cable shall be used and arranged in a single layer filling the center 6 inch portion of the tray with a separation of approximately 1/2 the cable diameter between each cable. The cables shall be tied at 18 inch intervals along the cable tray (every other rung) using No. 16 SWG steel wire ties. The test shall be conducted 3 times to demonstrate reproducibility using different samples of cable. All 3 tests must meet the requirements of Section 2.5.5 for the cable to be considered as having passed the test."

12. In lieu of Section 2.5.4.4, the following should be used:

"The gas burner flame source shall consume ~~Com~~ propane gas ~~approximately~~ approximately ~~70,000~~ 6.8 ~~Btu per hour~~ at an air-gas ratio of ~~1.0~~ 1.0. ~~Special~~ grade propane shall be used. The procedure detailed below shall be followed:"

13. In lieu of the first sentence of Section 2.5.4.4.1, the following should be used:

~~The ribbon burner shall be mounted parallel to the plane of the horizon. The burner head shall be midway between the tray rungs with the center of the burner positioned 24 ± 1/8 inches from the bottom of the tray. The burner face shall be located 4 ± 1/8 inches from the cable, in front of the cable tray.~~

"The ribbon burner* shall be mounted parallel to the plane of the horizon. The burner head shall be midway between the tray rungs with the center of the burner positioned 24 ± 1/8 inches from the bottom of the tray. The burner face shall be located 4 ± 1/8 inches from the cable, in front of the cable tray.

14. In lieu of Section 2.5.4.4.3, the following should be used:

~~The proper flame source shall be achieved when the fuel input rate is 70,000 ± 1,600 BTU per hour and the supply air flow is 163 ± 10 standard cubic feet per hour. Flow rates are to be monitored by rotameters as shown in Figure 2.~~

"The proper flame source shall be achieved when the fuel input rate is 70,000 ± 1,600 BTU per hour and the supply air flow is 163 ± 10 standard cubic feet per hour. Flow rates are to be monitored by rotameters as shown in Figure 2.

15. In lieu of Section 2.5.4.4.4, the following should be used. "Test procedure - ignite the burner and allow it to burn for 20 minutes. Record maximum flame height for each minute during the test, length of time flame continues to burn after the gas burner is shut off,

*An American Gas Furnace Co. 10-in. 11-55 drilling, ribbon-type, catalog no. 10X 11-55 with an air-gas Venturi mixer, catalog no. 14-18 (2 lb./in² max. gauge pressure) is the only presently available model that has been found satisfactory for purposes of these tests.

and maximum jacket/insulation damage (which includes the length of cable material consumed, melted, blistered, or charred)."

16. Section 2.5.4.5 is not endorsed by this regulatory guide.

17. Section 2.6, "Documentation of Type Testing," should be supplemented with the following: "Provide data necessary to document satisfactory compliance with the procedure outlined."

18. The recommendations indicated by "should" and the options indicated by "may" in the sections of IEEE Std 383-1974 indicated below have sufficient importance to be treated the same as requirements of the standard:

- a. Section 1.3.1, "Cable Description"
- b. Section 1.3.2, "Field Splices or Connection Description"
- c. Section 1.3.4.1, "Meeting Service Conditions"; the first sentence.
- d. Section 1.3.4.2.1, "Design Basis Event—LOCA"
- e. Section 1.4.1, "General"
- f. Section 1.4.3, "Test Results"
- g. Section 1.4.4, "Test Evaluation"
- h. Section 2.2, "Type Test Samples"
- ~~i. Section 2.3.2, "Thermal and Radiation Exposure"~~
- i. Section 2.3.3
- j. Section 2.3.4
- k. Section 2.4.3, "LOCA Simulation"
- l. Section 2.4.3.1
- m. Section 2.4.3.2
- n. Section 2.4.4, "Post LOCA Simulation Test"
- ~~o. Section 2.5.1~~
- ~~o. Section 2.5.2~~
- ~~o. Section 2.5.3~~
- o. Section 2.5.5, "Evaluation"
- p. Section 2.5.6, "Instrument Cable and Single Conductors from Multiconductor Assembly"; the recommendation that the tested cable pass a flame resistance test in accordance with ASTM D2220-68.

19. Section 3, "References," of IEEE Std 383-1974 lists additional applicable IEEE standards. The specific applicability or acceptability of these referenced standards has been or will be covered separately in other regulatory guides, where appropriate.

D. IMPLEMENTATION

The purpose of this section is to provide information to applicants and licensees regarding the NRC staff's plans for utilizing this regulatory guide.

Except in those cases in which the applicant proposes an acceptable alternative method, ~~the method described herein for complying with specified portions of the Commission's regulations will be used by the staff in evaluating all construction permit applications submitted after May 1, 1973.~~

of complying with the specified portions of the Commission's regulations, the method described herein will be used in the evaluation of all construction permit applications and reference system preliminary design applications (PDA) for which the issue date of the Safety Evaluation Report (SER) is (one month after issuance date of the guide), except those portions of a construction permit application which:

- (a) reference an approved PDA or FDA,
- (b) reference parts of a base plant design qualified and approved for replication,
- (c) reference a plant design approved or under review for approval for manufacture under a Manufacturing License, or applications for such approval.

For those construction permit applications for which an SER was issued prior to (one month after issuance date of guide), the NRC staff may, subsequent to issuance of construction permit (or operating license), reevaluate the SER on a case-by-case basis to assure that acceptable methods for qualification of electric cables have been specified in purchase orders executed for such cable on or after (effective date of guide).

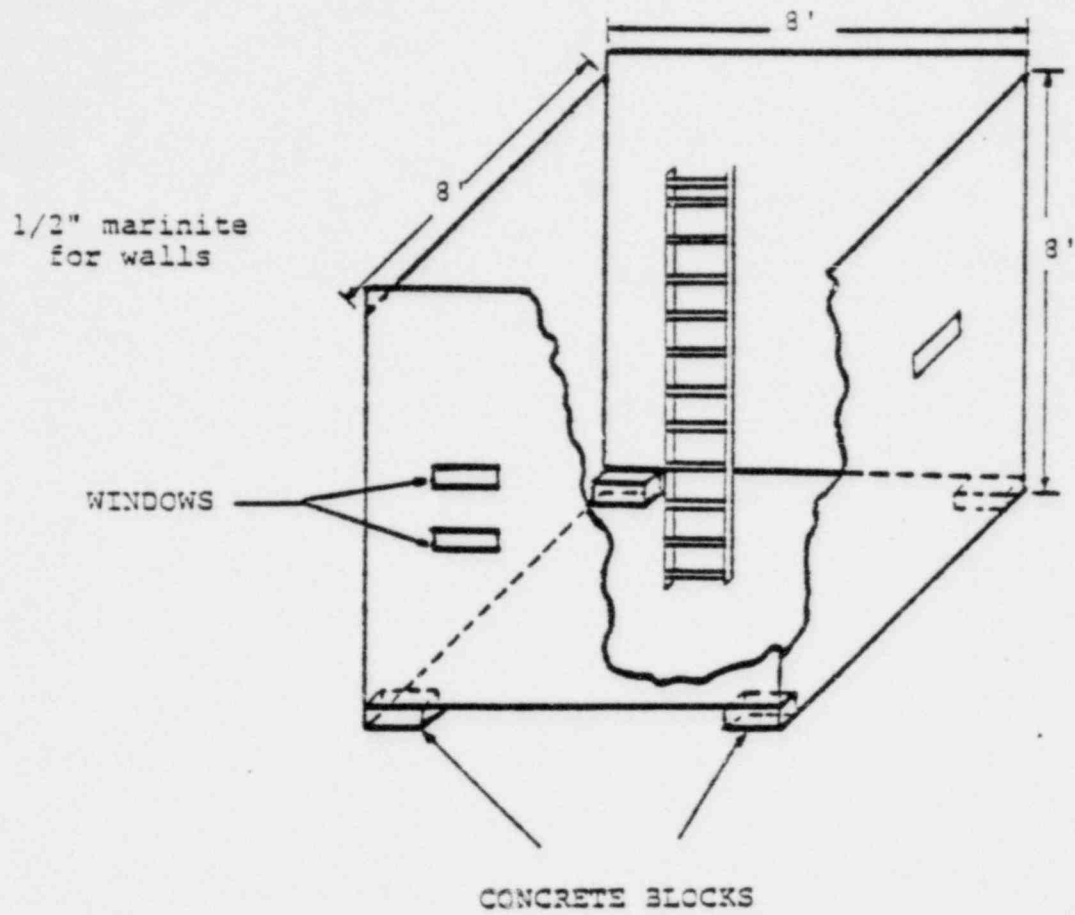


Figure 1 - Enclosure

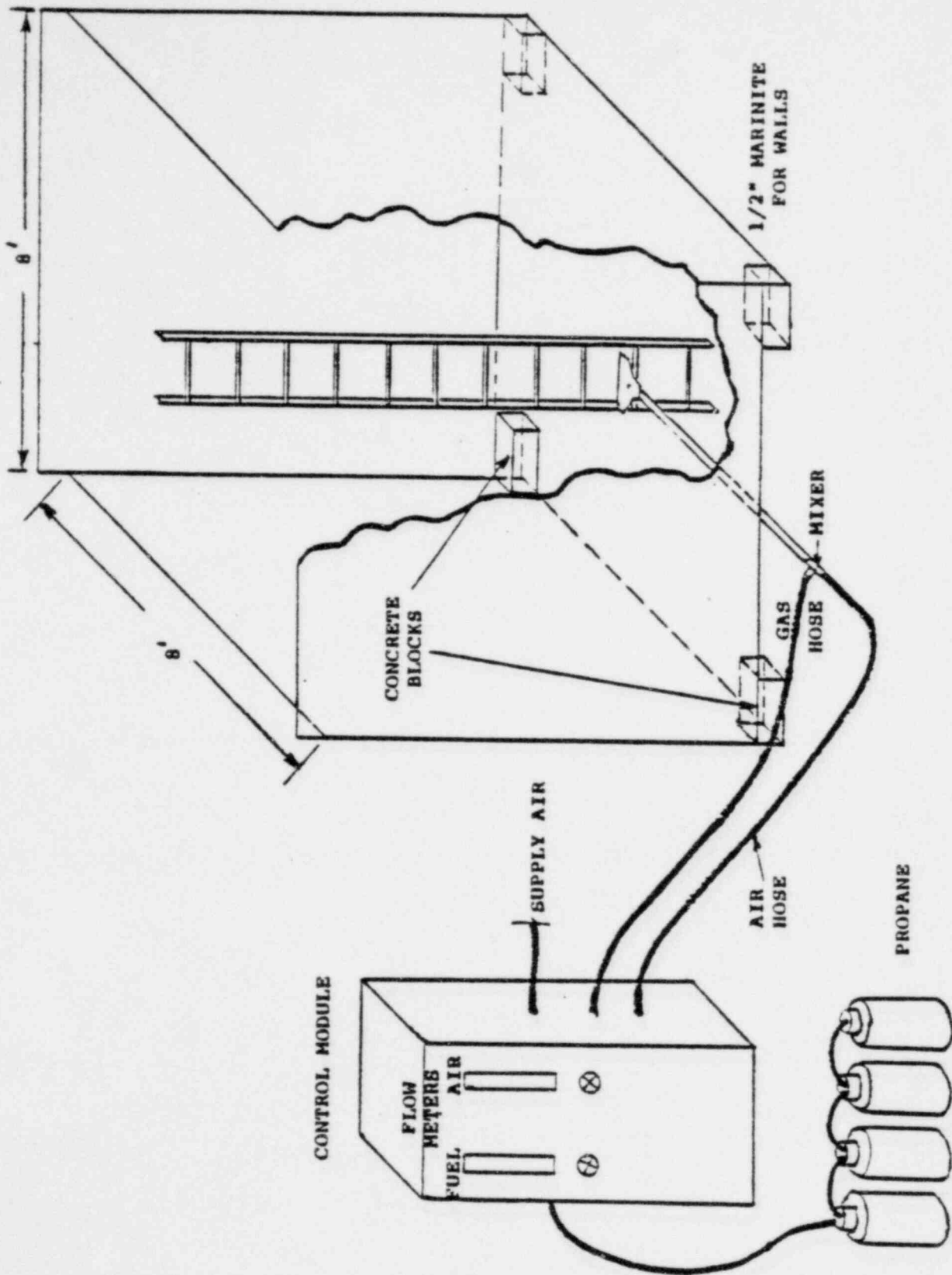


Figure 2 - Test Setup