

# HIGHWAY RESEARCH CIRCULAR

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COMMITTEE ACTIVITY  
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Nuclear Principles and Applications  
Highway Research Board

## RESULTS OF THE 1964 QUESTIONNAIRE ON HIGHWAY APPLICATIONS OF NUCLEAR TECHNIQUES

### Foreword

During the summer and fall of 1964, HRB Special Committee No. 8 contacted the 50 state highway departments of the United States concerning the possession and use of nuclear equipment. The purpose of the questionnaire was to determine the present status of this relatively new facet of highway engineering. All 50 state highway departments answered the questionnaire.

Requests for information pertaining to current and past nuclear research and development projects were also included in this query as well as questions on personnel such as number of people engaged in nuclear work, salaries, and training. The following is a narrative on the results of the 1964 questionnaire.

### Number and Type of Nuclear Testing Systems Possessed

Seventy-four percent of the state highway departments are engaged in nuclear testing either on a field control or research basis or both.

A total of 150 surface moisture-density testing systems were reported as being in the possession of 37 state highway departments. (The word "systems" in this case means a combination of scaler and probes for a particular testing purpose.)

The Pennsylvania Department of Highways leads in this category with 31 systems. Illinois and Texas tie for second place with 11 each and Colorado is third with 10.

Nineteen asphalt density probes are operated by 11 states with the largest number (5) in New Mexico. Only 2 states reported using nuclear probes for asphalt content determination; Colorado has 2 and Oklahoma has 1.

Ten state highway departments have a total of 10 nuclear depth systems.

Three hundred seventy-four individual pieces of nuclear equipment (scalers and probes) were reported as being in the possession of the 37 departments having nuclear equipment.

#### Specification and Non-Specification Usage

Twenty-four percent of the state highway departments reported using the surface moisture-density nuclear equipment they possess for specification material control. These 12 states are: Arkansas, Colorado, Connecticut, Illinois, Maine, Maryland, North Dakota, Oklahoma, Pennsylvania, Rhode Island, Wisconsin, and Wyoming.

Two of these 12 states (Colorado and Connecticut) reported using nuclear asphalt density probes for specification material control.

Thirty-four percent of the states reported the use of surface nuclear probes for non-specification check for uniformity of moisture content and density. New Jersey checks for density uniformity only when using the nuclear equipment.

Taking into consideration the number of nuclear devices listed by the 50 state highway departments and their reported usage, it is obvious that no state has yet converted wholly to nuclear testing.

#### Nuclear Personnel Data

Two hundred twenty-six persons were reported engaged in nuclear work in the 50 state highway departments. This should be considered a conservative figure since not all 50 states submitted data concerning personnel having assignments pertaining to nuclear work. On the other hand, many of the 226 positions reported were on a part-time basis.

Monthly salaries ranged from a low of \$260.00 to a high of \$1166.00. The mean salary was \$524.00.

Thirty-four persons engaged in nuclear work are graduates of the Oak Ridge Institute of Nuclear Studies, Oak Ridge, Tennessee. ORINS sponsors courses in nuclear technology for highway engineers. These 34 persons came from 24 states. Michigan has the largest number of ORINS graduates with 4.

Twenty state highway departments expressed interest in sending participants to the 1965 ORINS Highway Engineers Course to be held in Oak Ridge, Tennessee, March 29 through April 16.

### Research Projects on Nuclear Testing

The 1964 nuclear questionnaire results indicate the California Division of Highways is the leader among highway departments in the area of research projects concerning nuclear applications. Of a total of 9 research projects reported on, 5 are complete and 4 are underway. Eight of these 9 projects concern moisture and density gauging in either the field or the testing laboratory and 1 research project (completed in November 1962) investigated the feasibility of the use of radioactive materials for the illumination of highway signs. California is the only state highway department to undertake such a research project to date according to the questionnaire.

The Michigan State Highway Department has completed 3 nuclear research projects. One concerned moisture-density testing, the second project pertained to concrete mixer efficiency, and the third was a project concerned with air content determination in hardened concrete by nuclear means. Michigan is presently continuing their research endeavors in the area of moisture-density determinations by the nuclear method.

Other highway departments currently engaged in nuclear research projects on moisture-density testing are: Alabama, Florida, Hawaii, Idaho, Louisiana, Montana, Oklahoma, Oregon, So. Carolina, Utah, and Virginia.

The following states are engaged in or have completed research projects involving nuclear asphalt density determinations: Alabama, Colorado, Florida, Illinois, Oregon, Utah, and Virginia.

Asphalt content determination by nuclear means is being investigated by Colorado, Florida, and Oklahoma.

To summarize the research efforts, 52% of the state highway departments have been or are engaged in nuclear testing research projects as of 1964. Of these 26 states, 19 are engaged in or have been engaged in laboratory research and 25 are conducting or have conducted field research. Fifteen states had nuclear research projects underway during 1964.

Of the 26 states concerned with research, 17 researched the moisture-density phase in the laboratory and 21 researched this aspect in the field. Six states have concerned themselves with asphalt density research in the laboratory and 9 have researched this subject in the field.

### Results of 1962 HRB Nuclear Questionnaire

In 1962 the Highway Research Board Ad Hoc Committee on Nuclear Methods of Measurement composed a questionnaire concerning use and interest in application and research aspects of nuclear methods. (This Ad Hoc Committee was the forerunner of HRB Special Committee No. 8.) The questionnaire was distributed to some 384 appropriate governmental and educational agencies including the state highway departments, the civil engineering departments of educational institutions, and miscellaneous agencies. The following is a brief narrative on the 1962 questionnaire results.

Of the 384 agencies contacted, 234 replied to the questionnaire. This included replies from 43 of 50 state highway departments, 86 of 138 educational institutions, and 105 of 196 miscellaneous agencies.

#### State Highway Departments (1962)

The answers to the questionnaire by the state highway departments indicated that 6 of the 43 were using nuclear methods for control of routine construction activities. All 6 were using nuclear gauges for both moisture and density determinations in connection with compaction control of soil. Only 2 were using nuclear equipment for the determination of asphalt content and density of asphaltic concrete. Twenty-four of the 43 answering highway departments had conducted or were conducting evaluation studies of nuclear gauges to determine if they could be used for routine testing. This included all 6 of those using nuclear methods for control of routine construction activities.

Among the reporting state highway departments, 24 had completed or initiated a total of 33 studies, investigations or research projects concerning the use of nuclear methods for highway engineering purposes.

#### Educational Institutions (1962)

Sixteen University Civil Engineering Departments answering the 1962 questionnaire had nuclear equipment available for use. Two of these had developed their own nuclear gauges and the other 14 had commercially available gauges. Ten of these universities were engaged in evaluation studies of nuclear gauges to determine if they could be used in routine testing. Six of these were evaluating the gauges for quality control of soil, three for quality control of asphaltic concrete and one for both. Other materials on which nuclear gauges were being used by civil engineering departments of universities included portland cement concrete, concrete slurries, and granular base course materials. Among the reporting universities, 15 had started or completed a total of 44 studies or research projects concerning the use of nuclear methods for civil engineering purposes.

#### Miscellaneous Agencies (1962)

Agencies other than state highway departments and universities to which the questionnaire was distributed included large city public works departments, state water resources departments, various divisions of the Bureau of Reclamation, various districts of the U. S. Army Corps of Engineers, divisions of the U. S. Dept. of Agriculture, Forest Experiment Stations, U. S. Geological Survey, and miscellaneous utilities and associations. The questionnaire was sent to 196 such organizations of which 105 submitted replies. Of these 105, 32 had used or were using nuclear instruments. Twelve of the 32 were using nuclear gauges for moisture content and density determinations in connection with routine compaction control of soils. Only one was using nuclear gauges for routine control of density of asphaltic concrete.

In addition, 14 agencies were conducting evaluation studies on commercially available nuclear gauges to determine if they could be used in routine tests for soil moisture. Twelve of these 14 were also evaluating nuclear gauges for use in routine tests for soil density. Six of the 14 were previously noted as using nuclear gauges on routine compaction control of soils. Only one agency stated that they were running evaluation studies on a nuclear gauge for determination of density of asphaltic concrete.

Six other agencies were using nuclear gauges for routine testing and research and five others for evaluation studies in connection with such applications as moisture content of soils for agricultural purposes, moisture evaluation in watershed hydrologic studies, soils moisture and evaporation in forest stands, and moisture content and density of coal. Other materials for which nuclear gauges were being evaluated included soil cement and granular base and subbase materials. Only 8 of the 105 reporting miscellaneous agencies had conducted, initiated, or planned to conduct research on the application of nuclear methods, and only 4 of these research projects were applicable to highway engineering purposes.

In summary, the answers to the 1962 questionnaire indicated a considerable interest among highway departments in nuclear methods. Eighty-six percent of the highway departments responded to the questionnaire, and 56 percent of these were either using or evaluating nuclear gauges. The answers to the questionnaire show further that although there is considerable interest, the acceptance by state highway departments of nuclear devices produced for purposes relating to the highway engineering field had been slow.

The replies to the questionnaire show a lesser degree of activity and interest by educators than by highway engineers in nuclear methods as related to the civil engineer. Sixty-two and three-tenths percent of the civil engineering departments of universities contacted answered the questionnaire. Only 19 percent of those answering had nuclear equipment for either use or evaluation. Only a few of those not using nuclear equipment expressed any interest in it. This would seem to point up a need for a program to at least acquaint the educator with advances in nuclear science as related to the civil engineer.

#### 1962 - 1964 Comparison

The following statements are submitted as a brief comparison of the status of nuclear testing in 1962 and 1964:

1. The number of state highway departments engaged in nuclear testing for either field control or research rose from 56 percent in 1962 to 74 percent in 1964.
2. Fourteen percent of those state highway departments answering the 1962 questionnaire used the nuclear devices in their possession for routine compaction control, whereas, this figure had increased to 24 percent in 1964.

3. Despite the increase in research and usage of the nuclear method, there still exists a certain reluctance to fully accept the nuclear method for quality control. This seems to point up the fact that improvement in both the instruments and methods of use as well as a decrease in equipment costs should be made before there is a general acceptance of the nuclear gauges.
4. There is a definite lack of research and development in the field of nuclear applications for purposes other than compaction control. These fields include radiography, self-luminous signs, groundwater tracing techniques, cement and asphalt content determinations, and tracer studies on optimum mixing times for both portland cement concrete and asphalt concrete.

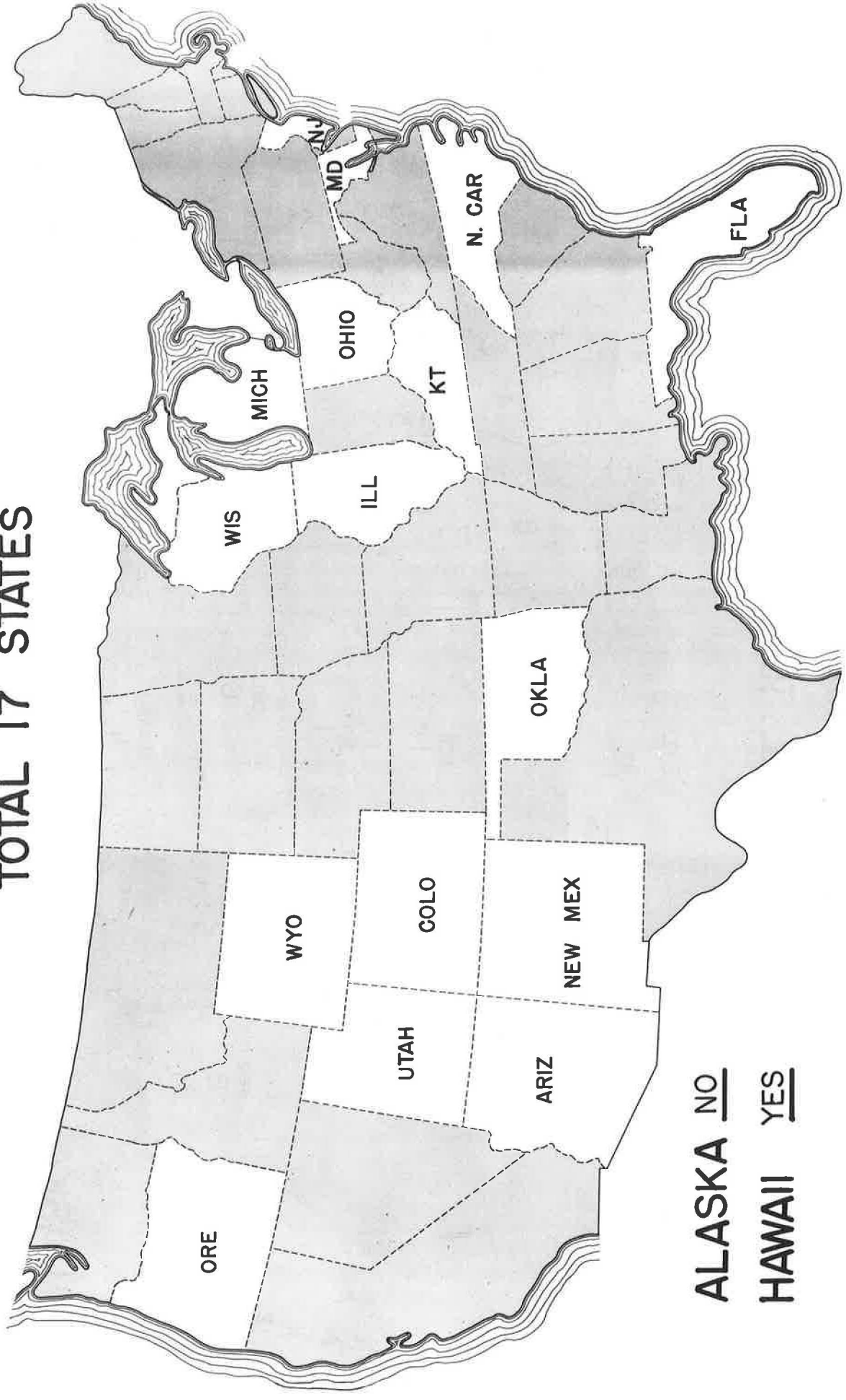
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NUCLEAR DEVICES USED FOR NON-SPECIFICATION  
CHECK FOR UNIFORMITY IN THE FIELD

TOTAL 17 STATES

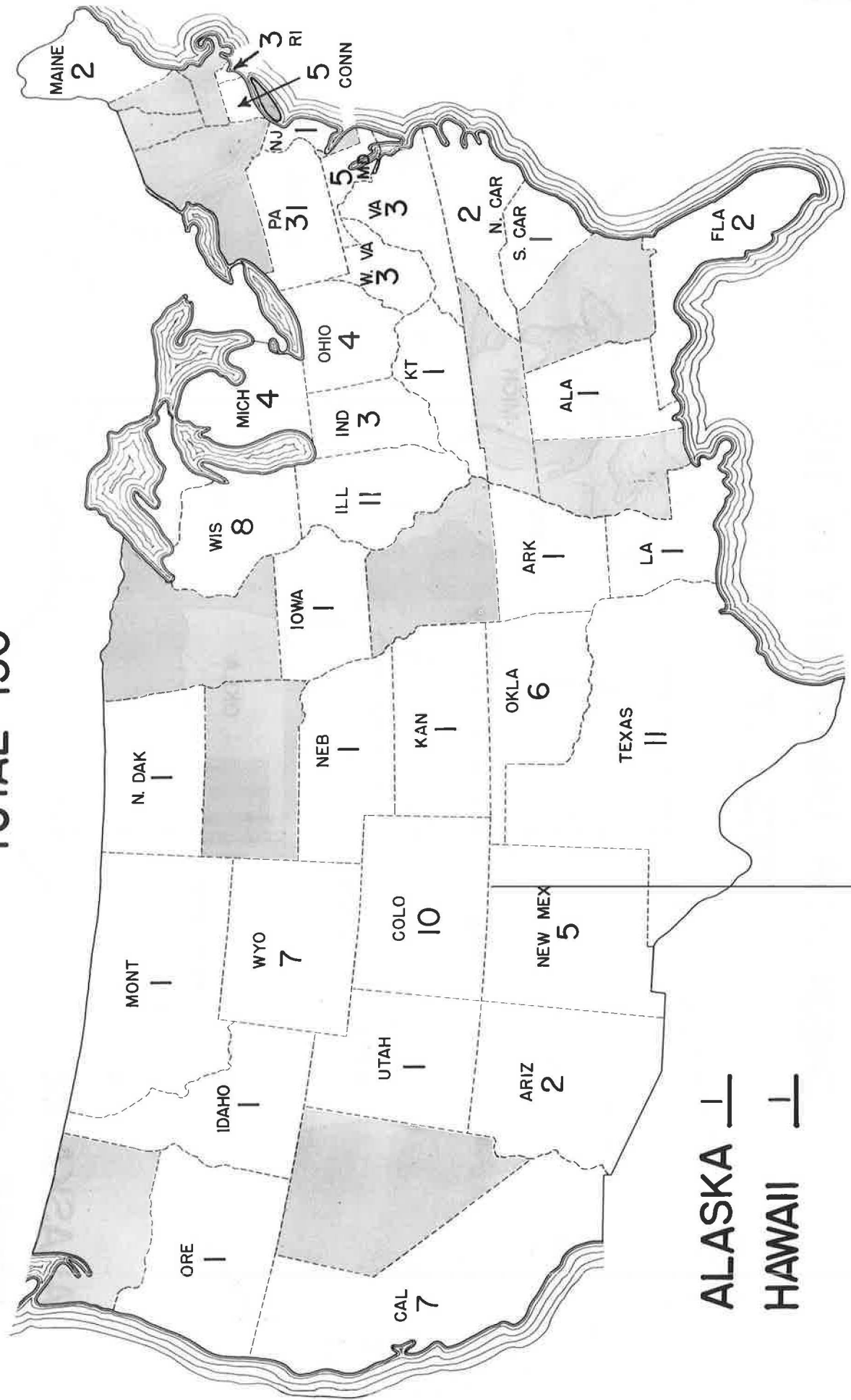


ALASKA NO  
HAWAII YES



# NUCLEAR SURFACE M/D SYSTEMS IN USE

TOTAL 150



NUCLEAR DEVICES USED FOR SPECIFICATION  
MATERIAL CONTROL IN THE FIELD

TOTAL 12 STATES

