Gaithersburg Power Division

Specification No. 10866-J-820 (Q)
Job No. 10866

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TECHNICAL SPECIFICATION

FOR

SEISMIC QUALIFICATION REQUIREMENTS FOR CLASS 1E CONTROL AND INSTRUMENTATION DEVICES FOR THE STANDARDIZED NUCLEAR UNIT POWER PLANT SYSTEM (SNUPPS)

BECHTEL POWER CORPORATION
GAITHERSBURG, MARYLAND

NO.	DATE	REVISIONS	BY	CH'K	GS	PE
0	5/12/75	Issued for Client Comments	PJR	REB		
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1	0												
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Fig.1	0												
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Fig.3	1												
Fig.4	0												

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REVISION STATUS SHEET

STANDARDIZED NUCLEAR UNIT POWER PLANT SYSTEM

JOB NO. 10466

Specification J820(Q)

REV. 1

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SEISMIC QUALIFICATION REQUIREMENTS

FOR

CLASS 1E CONTROL AND INSTRUMENTATION DEVICES

1. SCOPE

1.1 General

This specification attachment establishes acceptable qualification methods and the requirements to verify that Class 1E and other safety-related control and instrumentation devices can perform their specified safety-related functions during and/or following a safe shutdown earthquake, SSE.

The safety-related function of a device will be specified in the device data sheet or procurement specification by using the classifications defined in this document.

The qualification procedure is to test the device on a vibration table which duplicates or exceeds the anticipated vibratory motions of the actual mounting surface on which the device will be mounted. The actual mounting surface may be a control panel, cabinet, console, instrument rack, building wall, piping system, etc. Ultimately, the devices may be located anywhere throughout the power plant, e.g., in the control room area or in the process area.

Although this specification is written primarily for electrical devices, it provisions apply equally to mechanical and electromechanical equipment, e.g., pneumatic instrumentation and air-operated control devices.

1.2 Responsibilities

The Buyer, Bechtel Power Corporation, will be responsible for defining the maximum vibratory motions throughout the power plant structure. The testing or analysis facility shall have direct access to the Buyer's project or staff personnel for obtaining explanatory information about this specification, however, any such information will not alter any existing contractual agreements.

Seismic qualification of each Class 1E device shall be the responsibility of the Supplier.

The device purchaser shall be responsible for assuring that the maximum anticipated vibratory motions at the actual device

mounting location do not exceed the motions for which the Class 1E device is qualified.

A list of testing facilities will be furnished upon request. However, selection of the test facility shall be the responsibility of the Supplier.

1.3 Intent

The intent of this specification attachment is to specify qualification procedures and acceptance criteria that conform to IEEE Standard 344-1975, Recommended Practices for Seismic Qualifications of Class 1E Equipment for Nuclear Power Generating Stations.

1.4 Acceptable Qualification Methods

It is recommended that the device manufacturer perform comprehensive, generic, one-time types of tests of standard devices which are used repeatedly in nuclear safety-related applications rather than to requalify the devices for each power plant project. Such a test program shall be based on a representative number of standard devices.

An acceptable generic qualification method is to perform fragility-level tests to determine the maximum vibratory motions which can be tolerated before malfunction occurs.

Another acceptable generic qualification method is to qualify a device for most U.S. plant locations as defined by the RRS shown in Figure 1 or the RIM shown in Figure 2 as appropriate for the device in question.

Alternatively, a device can be qualified at or above the seismic conditions for a specific power plant. The appropriate project curves are shown in Figures 3 and 4.

These three alternative test methods are defined further in Section 5.6.

Certain items in a nuclear power plant will be supplied in a number of similar configurations which do not significantly alter the item's response to a given seismic event. Qualification by testing a representative unit and, subsequently, analytically comparing each specific unit with the representative unit, will be acceptable.

1.5 Control Panel Assembly Qualification

Seismic qualification of Class 1E control panels, consoles, and cabinet assemblies is covered by Specification Attachment 10466-J821.

1.6 Environmental Exposure Prior to Seismic Testing

Certain devices, denoted in the procurement specification, must be qualified to withstand long-term exposure to severe ambient conditions. Examples are devices to be located within the reactor containment structure which may be exposed to aging effects of high ambient temperature and radiation. Such devices shall undergo the appropriate aging exposure prior to seismic qualification tests.

2. DEFINITIONS

This section defines words in the context in which they are used in this specification. The portions in quotations marks were excerpted from IEEE Standard 344.

Definitions of other terms used in this specification are given in IEEE Standard 344.

2.1 Device

An individual item of equipment with specific operational functions. Examples are sensors, transmitters, controllers, bistables, indicators, recorders, relays, control switches, etc. Devices may be mounted in two general categories: (a) on the building structure, control panels, racks, pressure vessels, etc., or (b) line mounted directly in or on piping systems.

2.1.1 Class 1E Devices

Devices which are in nuclear safety-related service and to which is applied "The safety classification of the electric equipment and systems that are essential to emergency reactor shutdown, containment isolation, reactor core cooling, and containment and reactor heat removal, or otherwise are essential in preventing significant release of radioactive material to the environment." For the purpose of this document, Class 1E is defined further to include all devices classified as Seismic Category 1.

2.2 Fragility Level

"The highest level of input excitation, expressed as a function of frequency, that an equipment can withstand and still perform the required Class 1E functions."

2.3 Required Input Motion (RIM)

"The required input motion to the equipment under test is the amplitude of acceleration expressed as a function of frequency that an equipment shall withstand and still perform the required Class 1E functions."

2.4 Required Response Spectrum (RRS)

"The response spectrum issued by the user or his agent as part of his specifications for proof testing, or artifically created to cover future applications. The RRS constitutes a requirement to be met."

2.5 Safe Shutdown Earthquake (SSE)

"That earthquake which produces the maximum vibratory ground motion for which certain structures, systems, and components are designed to remain functional. These structures, systems, and components are those necessary to assure: (1) The integrity of the reactor coolant pressure boundary, (2) The capability to shut down the reactor and maintain it in a safe shutdown conditions, or (3) The capability to prevent or mitigate the consequences of accidents which could result in potential offsite exposures comparable to the guideline exposures of Code of Federal Regulations, Title 10, Part 100 (December 5, 1973)."

2.6 Test Response Spectrum (TRS)

"The response spectrum which is constructed using analysis, or derived using spectrum analysis equipment based on the actual motion of the shaker table. When qualifying equipment by utilizing the response spectrum, the TRS is to be compared to the RRS."

3. DEVICE CLASSIFICATIONS

Devices requiring seismic qualification are designated as either Qf-1 or Qf-2 as a part of the procurement specification.

Qf-1 shall remain functional during and after an SSE.

Qf-2 shall remain functional after, but not necessarily during, an SSE.

4. FUNCTIONAL REQUIREMENTS

4.1 Operational Conditions

All devices shall be tested while in their normal operating condition, i.e., energized or de-energized, pressurized or depressurized. Operating pressure, voltage etc., shall be applied during and after the tests to determine that vibratory conditions shall not produce a malfunction or failure of the device.

The device qualification test shall consider the extremes of possible variations from nominal values which could result in incipient malfunction,e.g., when the relay coil voltage drops below its lower operating value, the relay contacts may chatter. Published operating limits for the device shall be used in the direction which is more likely to produce malfunction.

4.1.1 Qf-1 Classification

Devices that are classified as Qf-1 on data sheets shall be operated during testing to demonstrate that vibratory motions can be tolerated without malfunction or failure. Operability shall be monitored and recorded during and after vibratory excitation.

The Qf-1 devices shall be caused to change state during the test, e.g., de-energize the relay coil or trip a bistable unit. The measured parameter, or input signal, shall be varied as necessary to demonstrate compliance with the acceptance criteria specified in Section 4.2.

4.2 Acceptance Criteria

The acceptance criterion for qualification tests is that there be no device malfunction or failure that would inhibit the nuclear safety-related function of the device.

Unrestricted acceptance shall require that the following minimum conditions shall not occur, as applicable:

a. Loss of output signal, e.g., open or short circuit

b. Output variations greater than the published accuracy over the full range

c. Spurious or unwanted output, e.g., relay contact bounce. NOTE: If contact bounce is detected, the specific data of the test shall be recorded and submitted to the Buyer for written disposition of the deviation.

d. Drift of set point or trip setting greater than the published accuracy over the full range

e. Calibration shift greater than the published accuracy over the full range; this parameter need not be determined during vibratory excitation.

f. Structural failure, e.g., broken or loosened parts or deformation resulting in device failure

g. Loss of required performance characteristic,e.g., ability to change state

h. Loss of pressure-boundary integrity, e.g., leakage.

Sufficient instrumentation shall be provided to monitor and record device performance during vibratory excitation, i.e., that each of the above criteria has been satisfied. Malfunctions shall be analyzed to establish causative factors, and suitable remedial steps shall be undertaken prior to retest.

Whenever these criteria are not met, the specific deviation data shall be submitted formally to the Buyer for evaluation of acceptability for specific applications.

5. SEISMIC QUALIFICATION CONDITIONS

5.1 Test Procedures

Written test procedures shall be prepared for all tests and submitted to the Buyer as described in the Documentation Section, below. The test procedure shall require the use of a vibration table to produce vibratory motion.

The vibration table motion shall simulate conservatively, both in amplitude and frequency content, the anticipated seismic motions of the actual surfaces on which the device will (can) be mounted in the power plant.

Equipment shall be subjected to the acceleration values described in Section 5.6. Vibratory tests shall be conducted over the range of 1 to 40 Hz. However, 1 to 33 Hz shall be acceptable for tests performed prior to the receipt of the purchase order to which this seismic qualification specification is attached.

Figure 1 is an RRS and corresponds, in acceleration and frequency values, to the response of single-degree-of-freedom oscillators attached to the vibration table surface on which the test specimen is mounted. The three percent critical damping spectrum shall be used as the RRS unless written permission to deviate is granted by the Buyer. Line-mounted devices shall refer to Figure 2, which is the RIM of the test table.

5.2 Vibration Table Excitation (Wave Form)

The preferred excitation wave form is random motion; line-mounted devices may also be qualified by a resonance search and a sine dwell at each resonance. The resonance search shall consist of a sine sweep at two octaves per minute and with an amplitude at least 20 percent of the RIM. Testing with other wave form characteristics than those described in this paragraph may be acceptable, depending upon the particular test in question. However, test wave forms other than these shall be justified adequately for each type of device being qualified and its intended mounting arrangements.

The wave-form characteristics of the proposed test input motion shall be such that the TRS equals or exceeds the RRS for nonline-mounted devices or that the test table motion equals or exceeds the RIM for line-mounted devices. Test motions other than random shall be in conformance with the criteria of IEEE-344, Section 6.6, Test Methods.

5.3 Direction of Vibratory Motion

5.3.1 RRS Testing

The input motion shall be applied simultaneously to the vertical axis and a horizontal axis parallel to the front surface of the equipment when the equipment is in its normal mounting position. Independent random inputs are preferred, and, if used, the test shall be performed in two steps with the equipment rotated 90° in the horizontal plane for the second step. If in-phase inputs are used, four tests should be run: first, with the inputs in phase; next, with one input 180° out of phase; next, with the equipment rotated 90° horizontally and the inputs in phase; and, finally, with the same equipment orientation but with one input 180° out of phase. Any other methods of qualification shall require acceptable justification and written permission from the Buyer before proceeding with the tests.

5.3.2 RIM Testing

The input motion should be applied to each of the three mutually orthogonal axes individually.

5.4 Duration of Test Run

The duration of each test run, i.e., each combination of acceleration amplitude and frequency pattern, shall be not less than 30 seconds, except that the sine sweep described in Section 5.2 shall be of a duration dictated by the sweep rate and frequency range.

5.5 Test Acceleration Level

The required maximum test acceleration of the vibration table surface shall be determined from the curves shown in Figures 1 through 4, except for devices that will be qualified to the curve shown in Figure 3, and will be mounted in a panel. See Level C following.

5.6 Qualification Levels

Any of the three levels of acceleration herein specified are acceptable:

5.6.1 Level A

Conduct fragility tests to determine the maximum acceleration that the device can tolerate before malfunction or failure occurs. The Supplier shall assure that fragility level test amplitudes exceed the project acceleration levels of Figures 3 and 4, as applicable.

An acceptable method of fragility testing is to approach the level of Figure 1 RRS or the Figure 2 RIM incrementally in steps between 10 and 25 percent of the RRS or RIM. If the equipment failed at less than full level, the equipment would qualify for any RRS or RIM that the test data exceeded.

5.6.2 Level B

Subject the device to the worst-case test acceleration that will qualify the device for most plant sites in the continental United States. See Figure 1 for nonline-mounted devices and Figure 2 for line-mounted devices.

5.6.2.1 Nonline-Mounted Devices

Generic qualification of devices for use in virtually all continental United States power plant sites is covered by Level B. The results of generic qualification shall demonstrate that the TRS exceeds (in amplitude) the envelope of worst-case RRS shown in Figure 1, which applies both to horizontal and vertical directions.

5.6.2.2 Line-Mounted Devices

Generic qualification of devices for use in virtually all continental United States power plant sites is covered by Level B. The results of generic qualification shall demonstrate that the maximum qualification acceleration equals or exceeds the worst-case RIM shown in Figure 2, which applies to both the horizontal and vertical directions.

5.6.3 Level C

Proof test the device to the particular test acceleration which is unique to its mounting location in the specific power plant structure. Level C reflects the reference SSE for the specific power plant site. The appropriate curves are attached as Figure 3 for nonline-mounted devices and Figure 4 for line-mounted devices. In cases where nonline-mounted devices are mounted in a control panel assembly, the qualification TRS must equal or exceed the amplitude values of Figure 3 multiplied by the vibration amplification factor (1.4) (Refer to J-821, Paragraphs 3.2.1 and 3.2.2).

5.7 Test Facility Limitations

Figures 1 through 4 depict the dynamic characteristics of the device-mounting locations. It is recognized that the dynamic capability of actual vibration tables may be limited in some way. The figures do not attempt to anticipate such limitations. The Bidder shall describe in his proposal the extent of any limitations.

5.8 Testing Requirements

The devices shall be tested in all the physical orientations in which they can be used normally. If a standard mounting fixture will be used in the actual plant installation, that fixture shall be used during vibratory testing. Any additional attachments to the vibration table shall be dynamically rigid and shall not change the input motion at the device undergoing the test. If a special mounting fixture is required for actual installation, the dynamic properties of that fixture shall be conservative relative to the fixture used during the test.

6. DOCUMENTATION

6.1 Submittals

The Bidder shall provide with his proposal the proposed qualification procedure delineating the steps to achieve qualification.

After purchase order award, the Supplier shall submit his qualification procedure for Buyer approval. Sufficient detail shall be used to demonstrate adequacy of the selected method (see Section 6.2).

Prior to the seismic testing of any device, the Supplier shall inform the Buyer of the time and place of the tests so that the Buyer may have his representatives witness these tests.

6.2 Documentation Requiring Approval

The following seismic qualification data for each device type shall be provided for Buyer approval and shall demonstrate that the device meets the requirements of this specification attachment. All engineering documentation shall have been approved by the Buyer prior to shipment of any device to the jobsite.

6.2.1 The identification of each device being qualified by a type test shall be included in the report for that device type.

6.2.2 Record of compliance with the applicable acceptance criteria or specific deviations. Show that the TRS envelope exceeds the RRS envelope for nonline-mounted devices and that the table motion exceeds the RIM for line-mounted devices.

6.2.3 Identification of the device features which were qualified by generic tests; also justification and certification that the devices being supplied are sufficiently similar in performance, size, material, or other characteristics so that requalification is not needed.

6.2.4 Limitations of the device application, such as possible limitation to physical orientation, etc.

6.2.5 Description of the test method, including justification if other than random motion input is employed (see Section 5.2).

6.2.6 Test data, including graphs and/or tables, and the TRS.

6.2.7 Test results and the analyses or conclusions achieved from those results.

6.2.8 Approval signature and date. Approval shall be by an engineer qualified in the field of dynamic response testing/analysis.

6.3 Additional Documentation

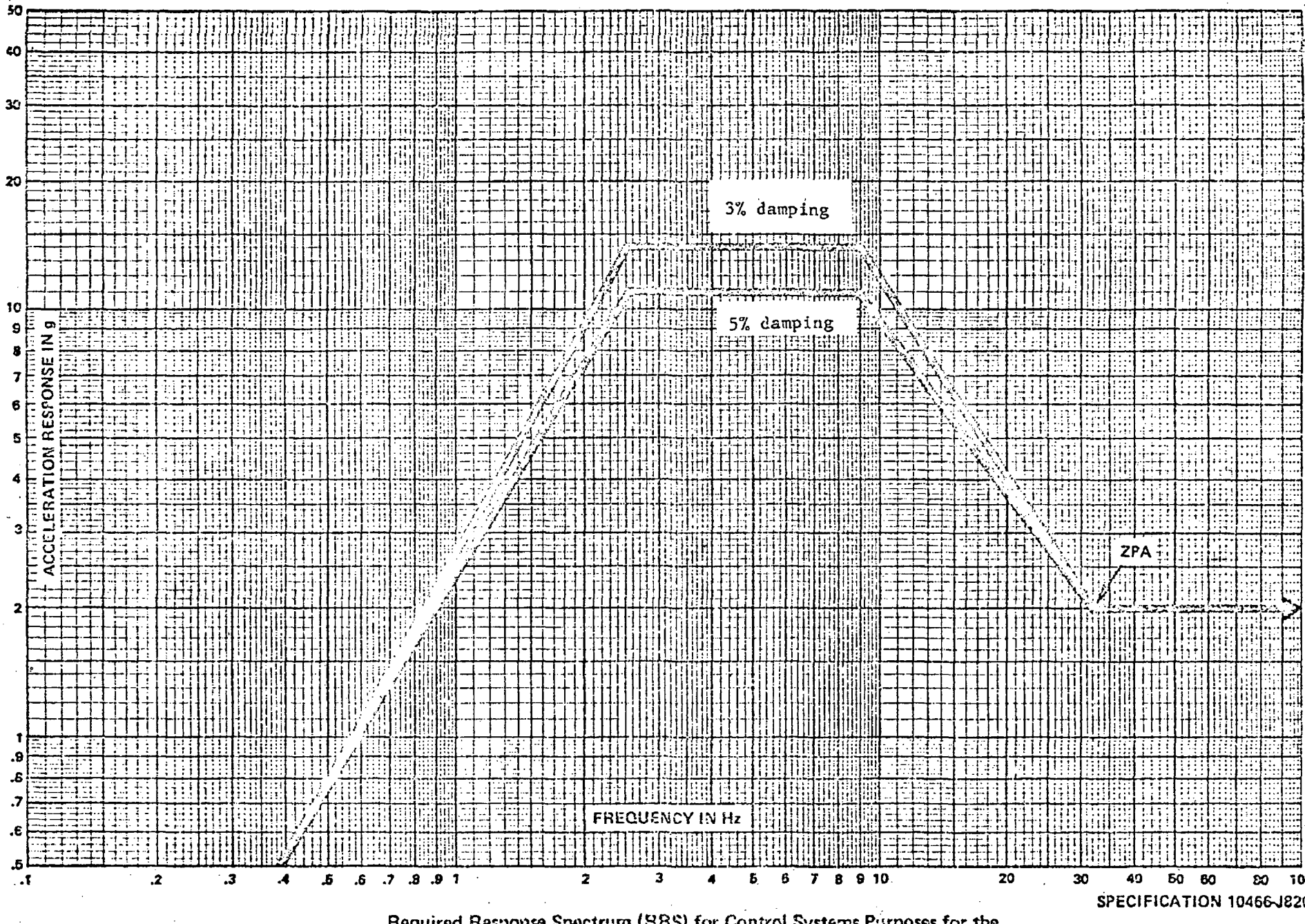
In addition to the documentation required by Section 6.2, the following documentation shall be provided. This documentation is for information and engineering design. Approval by the Buyer is not required.

6.3.1 Test facility identification: location and test equipment

6.3.2 Calibration records of test instrumentation

6.3.3 Total weight of the device to within ±5 percent

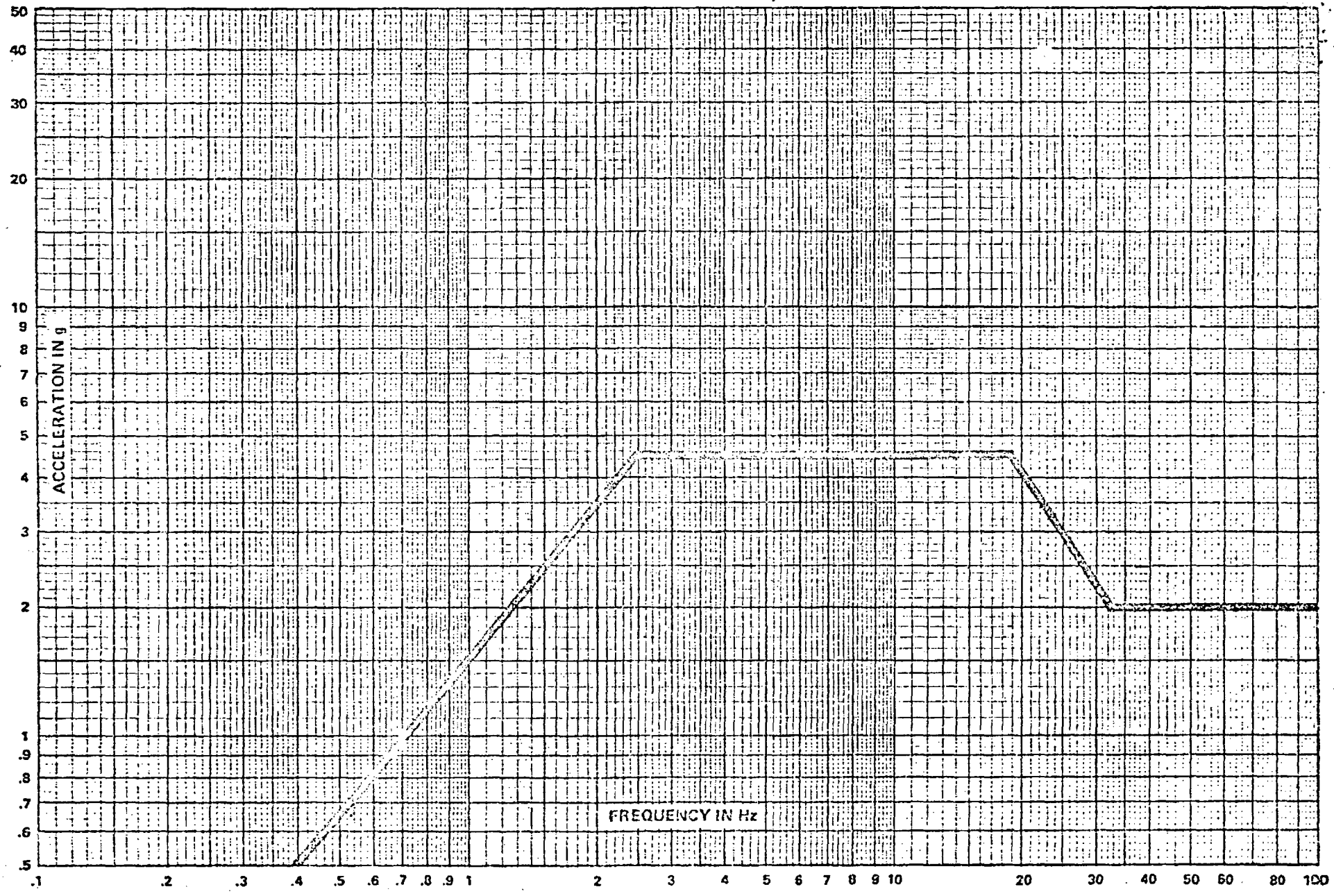
6.3.4 Location of the center of gravity to within ±2 percent



SPECIFICATION 10466-J820

Required Response Spectrum (RRS) for Control Systems Purposes for the Majority of Nuclear Power Plant Locations in the Continental United States.

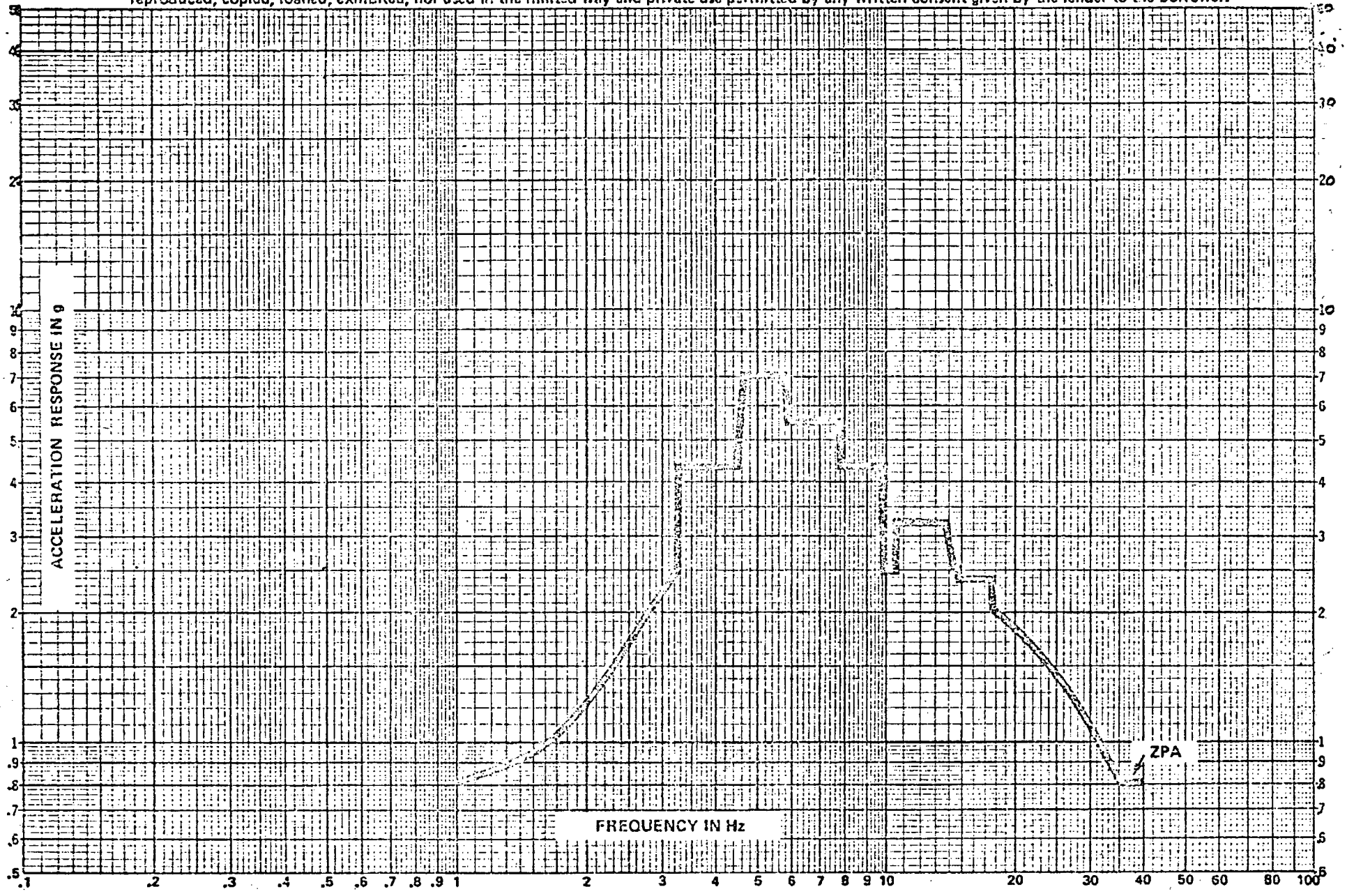
FIGURE 1
REVISION 0



SPECIFICATION 10466-J820

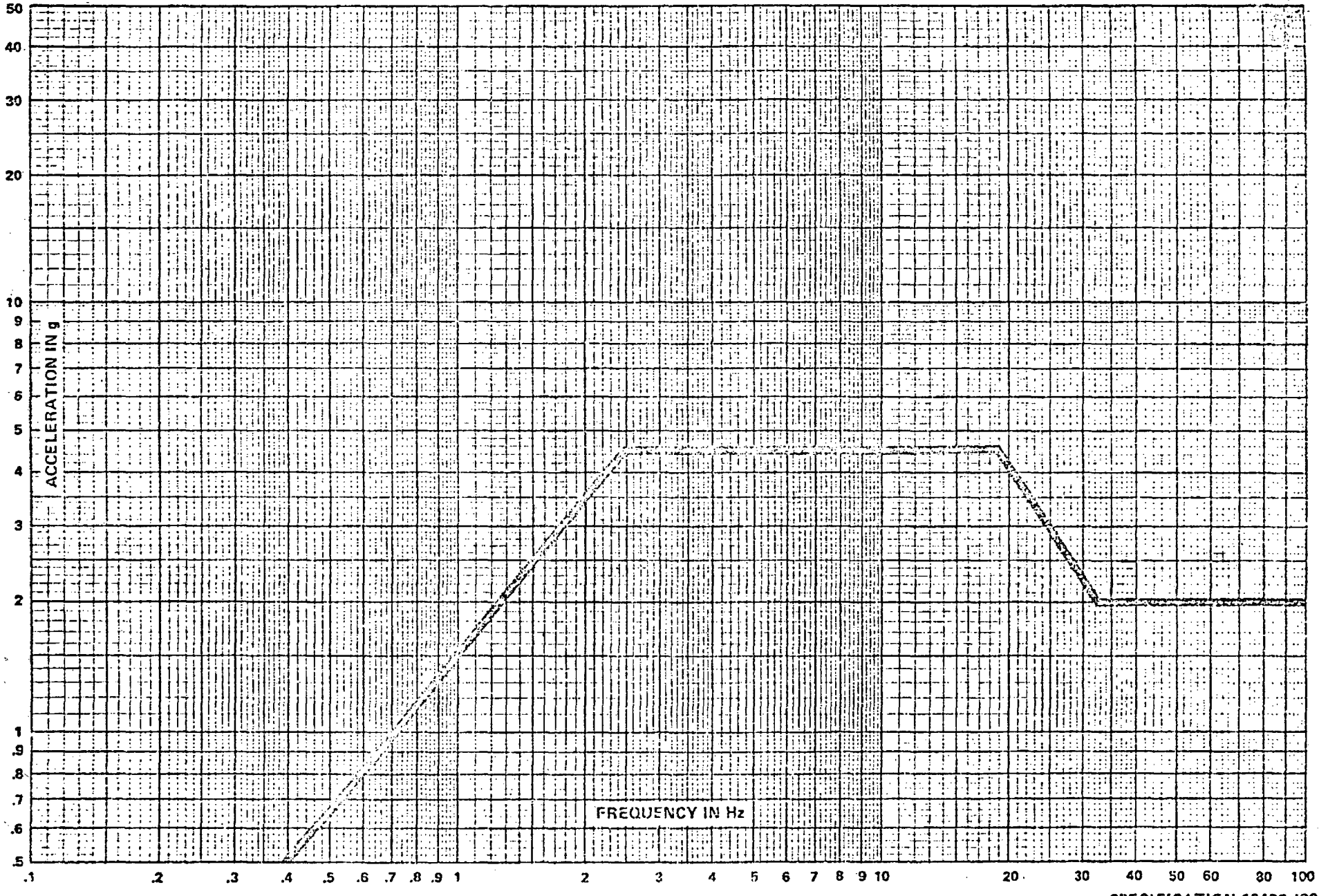
Required Input Motion (RIM) for Control Systems Purposes for Line Mounted Devices for the Majority of Nuclear Power Plant Locations in the Continental United States.

FIGURE 2
REVISION 0



Required Response Spectrum (RRS) for Control Systems Purposes for the SNUPPS Project (Preliminary)

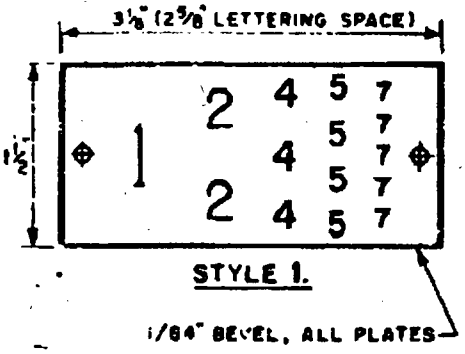
SPECIFICATION 10466-J820
FIG. 3 REV. 1



SPECIFICATION 10466-J820

Required Input Motion (RIM) for Control Systems Purposes for Line Mounted Devices for the Majority of Nuclear Power Plant Locations in the Continental United States.

FIGURE 4
REVISION 0



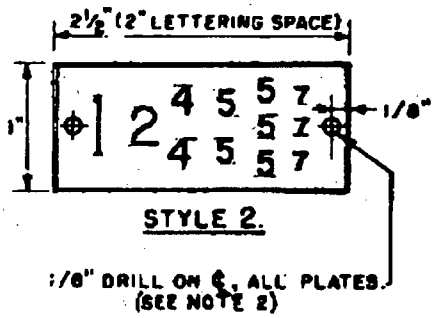
STYLE 1.

1/64" BEVEL, ALL PLATES

LETTER SIZE	1	2	3	4	5	6	7
HEIGHT (SEE DET. 'A')	1/2"	3/8"	5/16"	1/4"	3/16"	5/32"	1/8"
NO. PER INCH	2-1/4	3	3-3/4	4-1/2	6-1/2	7-1/2	9-1/2
NO. PER LINE STY. 1	6	8	10	12	17	19	25
NO. PER LINE STY. 2, 3 & 4	4	6	7	9	13	15	19
NO. PER LINE STY. 5			1	2	3	3	4
NO. OF LINES MAX. STY. 1	2	3	3	3	4	4	5
NO. OF LINES MAX. STY. 2	1	1	1	2	3	3	5
NO. OF LINES MAX. STY. 3	1	1	1	1	2	2	3
NO. OF LINES MAX. STY. 4 & 5			1	1	1	1	2

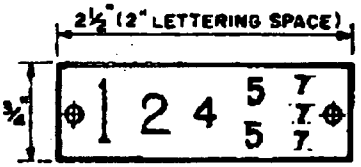
3I — LETTER HEIGHT MEASURED BETWEEN CENTER LINES

— DETAIL 'A' —

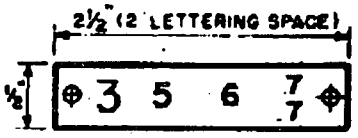


STYLE 2.

1/8" DRILL ON ℄, ALL PLATES (SEE NOTE 2)



STYLE 3.



STYLE 4.

SEPARATION GROUP	NAMEPLATE MATERIAL (TWO OR THREE-PLY LAMICOID)
1	Red Face, White Core
2	White Face, Black Core
3	Blue Face, White Core
4	Yellow Face, Black Core
5	Black Face, White Core
6	Black Face, White Core
1 & 4	Red Face, Yellow Border, White Letters

4

NOTES:

1. FOR ALL INSTRUMENTS USE STYLES 2, 3 OR 4 WHERE POSSIBLE WITH LETTERS NO SMALLER THAN SIZE 5.
2. THICKNESS OF NAMEPLATE IS 1/16".
3. FURNISH PLATES WITH DRILLED HOLES UNLESS SPECIFIED OTHERWISE.
   (ALTERNATIVE APPLICATION): ADHESIVES MAY BE USED FOR MOUNTING NAMEPLATES ON THE REAR OF PANELS. IN THIS CASE NO HOLES WILL BE REQUIRED.)
4. ENGRAVE LETTERS THROUGH TO CORE WITH A ROUNDED OR SQUARE END CUTTER. V-SHAPED GROOVES ARE ACCEPTABLE IF FINISHED PRODUCT IS COMPARABLE TO THAT OBTAINED WITH A SQUARE-END CUTTER.

4

⊕ REVISED / O ISSUED	INCORPORATED CHG. DOC.	WIP-J4-104-03-A R/1	CHANGE PKG. NO.	04317	THIS DWG. SUPERSEDES / THIS DWG. SUPERSEDED BY — REV.

REVISION NOTES:

WOLF CREEK NUCLEAR OPERATING CORPORATION

ELECTRONIC APPROVAL

NAMEPLATE STANDARDS

SCALE	DRAWING NUMBER	SHEET	REV
NONE	J4-104	1 OF 2	4

8 1/2X11 A SIZE

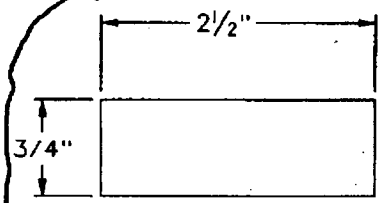
PSC-

DELETED

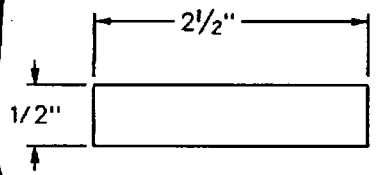
6.

7. MODIFIED STYLES 3 & 4 BOTH HAVE 1/16" MIN. BETWEEN FIRST & LAST LETTER/NUMBER & THE EDGE OF THE LAMICOID.

4



STYLE MOD 3



STYLE MOD 4

SCALE	DRAWING NUMBER	SHT	REV
NONE	J4-104	2 OF 2	4

8 1/2X11 A SIZE

PSC-