RECORD #1

TITLE: Proposed Guidance for Calibration and Surveillance Requirements to Meet Item II.F.1

FICHE: 66337-250

0060/82

Ltr to Cunningham

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DGEisenhut (w/o encl)

AUG 16 1982

MEMORANDUM FOR: Regional Administrators

FROM: D. G. Eisenhut, Director
Division of Licensing, NRR

SUBJECT: PROPOSED GUIDANCE FOR CALIBRATION AND SURVEILLANCE REQUIREMENTS FOR EQUIPMENT PROVIDED TO MEET ITEM II.F.1, ATTACHMENTS 1, 2, AND 3, NUREG-0737

Reference: Memorandum, G. D. Brown, Chief, Technical Program Branch, Region IV, to R. J. Mattson, Director, Division of Systems Integration, NRR, April 20, 1982, Subject: Implementing Procedures for NUREG-0737, Item II.F.1

The referenced memorandum noted a number of difficulties with licensees' procedures for calibrating noble gas effluent monitors and containment high-range radiation monitors described in NUREG-0737, Item II.F.1, Attachments 1 and 3, and suggested that representatives from NRR and the Regions convene to establish guidelines for an acceptable program. Dr. Mattson responded by memorandum to J. T. Collins, Region IV, dated June 18, 1982, in which he committed his staff to the preparation of NRR recommended guidelines on this subject for transmittal to the Regional Administrators. This task has now been completed, coordinated with DOL and OIE, and the proposed guidelines are provided as an enclosure to this memorandum.

As noted in Dr. Mattson's June 18 memorandum, if after reviewing this information the Regional Administrators still feel the need for a meeting, we will be happy to make the arrangements.

Original signed by:
Robert A. Purple for

Darrell G. Eisenhut, Director
Division of Licensing
Office of Nuclear Reactor Regulation

Enclosures:
1. Proposed Guidelines
2. Collins to Mattson Memo dtd 4/20/82
3. Mattson to Collins Memo dtd 6/18/82

cc: See next page

*SEE PREVIOUS WHITE FOR CONCURRENCE

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NRC FORM 318 (10-80) NRCM 0240 OFFICIAL RECORD COPY USGPO: 1981—335-960

	$T_{1/2}$	E_β	E_γ	
normal				
Xe-133	5.27 d	.35	.081	
135				β .2-1.0
Kr-85	10.7 y	.67	.52	
immed. – 8-10 hrs				
Kr-88	2.8 h	.52 2.7	2.4 1.8 .85 .42 .57 1.5 2.2	γ- 1.0-2.5
Xe-138	17m	2.4		
10 hr – 2 d.				
Xe-135	9.2 h	.91 .55	.25	γ- .25
2-3 d →				
Xe-133				γ - .081

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RJMattson

MEMORANDUM FOR: J. T. Collins, Regional Administrator, Region IV

FROM: R. J. Mattson, Director
Division of Systems Integration, NRR

SUBJECT: PROPOSED GUIDANCE FOR CALIBRATION AND SURVEILLANCE REQUIREMENTS FOR EQUIPMENT PROVIDED TO MEET ITEM II.F.1, ATTACHMENTS 1, 2, AND 3, NUREG-0737

Reference: Memorandum, G. D. Brown, Chief, Technical Program Branch, Region IV, ~~OIE~~, to R. J. Mattson, Director, Division of Systems Integration, NRR, April 20, 1982, Subject: Implementing Procedures for NUREG-0737, Item II.F.1

The referenced memorandum noted a number of difficulties with licensees' procedures for calibrating noble gas effluent monitors and containment high-range radiation monitors described in NUREG-0737, Item II.F.1, Attachments 1 and 3, and suggested that representatives from NRR and the Regions convene to establish guidelines for an acceptable program. I responded by memorandum to you dated June 18, 1982, in which I committed my staff to the preparation of NRR recommended guidelines on this subject for transmittal to the Regional Administrators. This task has now been completed, coordinated with DOL and OIE, and the proposed guidelines are provided as an enclosure to this memorandum.

As noted in my June 18 memorandum, if after reviewing this information you still feel the need for a meeting, we will be happy to make the arrangements.

Roger J. Mattson, Director
Division of Systems Integration
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PROPOSED GUIDANCE FOR
CALIBRATION AND SURVEILLANCE REQUIREMENTS FOR
EQUIPMENT PROVIDED TO MEET ITEM II.F.1

The radioactive noble gas effluent monitors, the particulate and radioiodine samplers, and the in-containment radiation monitors described in NUREG-0737, Item II.F.1, Attachments 1, 2 and 3, represent substantial departures from conventional designs and operating concepts in the detection and measurement of plant radiological conditions. The nature and purpose of these monitors and samplers dictate an approach to calibration and surveillance requirements which will differ widely from existing requirements and procedures established for conventional monitors. The impracticality of applying existing calibration standards to these monitors was recognized in the memorandum from G. D. Brown to R. J. Mattson, dated April 20, 1982. The proposed guidance addresses the principal concerns noted relative to the review of licensee implementing procedures and provides guidance on certain matters pertaining to calibration. The attachments provide a more thorough discussion of the purpose and function of these monitors and samplers and should provide the necessary guidance to permit development of review and inspection procedures.

1. Application of ANSI N323-1978

The application of ANSI N323-1978 recommendations as requirements for the review of fixed area monitors and effluent monitors does not appear to be appropriate for either normal range monitors or for NUREG-0737 monitors. While N323-1978 contains much worth-while guidance of a general nature, it should be recognized that this standard is specifically addressed to hand-portable survey instrumentation and was never

intended to be wholly applicable to either fixed area monitors or effluent monitors. While some form of in-place calibration is necessary and proper, the invocation of N323-1978 as the basis for requiring in-place calibration of area radiation monitors and noble gas effluent monitors is not seen as a valid use of the standard.

2. MC 2515, Inspection Procedure 84710

MC 2515, Inspection Procedure 84710, was written specifically for monitors designed to operate at very low concentrations of radioactive materials. We believe this procedure is not appropriate for use in conjunction with the NUREG-0737 noble gas effluent monitors. The principal reasons for this are:

- o ALARA considerations may limit the handling of concentrations of gamma-emitting noble gases, such as Xe-133, in concentrations sufficient to perform on-site calibration of the upper ranges of these monitors. Calibration of the upper ranges of some models of these monitors will require the handling of curie quantities of radioactive gas while other models will require the handling of multi-curie quantities. The handling of such quantities of radioactive material will result in unnecessary extremity exposures and may result in the uncontrolled release of radioactive gases into occupied spaces.

- o Krypton-85 (Kr-85) gas, recommended for calibration use by Inspection Procedure 84710, is not a satisfactory calibration source for the

majority of NUREG-0737 effluent monitors which use gamma-sensitive detectors. For those NUREG-0737 monitors using beta detectors, Kr-85 is not readily available in concentrations of sufficient strength to be useful in calibration of the upper ranges.

- o The only practicable means of in-place calibration of NUREG-0737 effluent monitors in the upper ranges with the necessary radiation energies is through the use of "solid" sources, which is not consistent with 84710.

- o The release of calibration gases to the environment following completion of calibration could result in a violation of plant technical specificatior . For example, calibration of a noble gas effluent monitor with Xe-133 gas at a concentration of 10^4 uCi/cc could involve a total of more than 100 Ci of calibration gas. The instantaneous release of such a quantity of gas could well exceed Technical Specification limits.

3, NRR Staff Recommendations for Calibration of Noble Gas Effluent Monitors

The NRR recommendations for calibration of NUREG-0737 noble gas effluent monitors would require licensees to obtain certain calibration services from instrument vendors or alternative sources. An acceptable approach calls for a one-time "type" calibration of a limited number of production-model monitors using radioactive gases; we consider this to be an acceptable alternative to in-place testing with radioactive gases,

principally due to ALARA considerations. Such calibration would be at either the manufacturer's facility or a suitable contractor facility and would provide for the use of NBS-traceable radioactive gaseous sources of appropriate emissive characteristics (e.g., Xe-133 for gamma-detecting systems or Kr-85 for beta-detecting systems) at a minimum of three on-scale values separated by not less than two decades of scale (e.g., 10^{-5} uCi/cc, 10^{-3} uCi/cc, and 10^{-1} uCi/cc; gases with higher concentrations of radioactive material should be used if reasonably available). From the observed system readouts and using the transfer procedures of ANSI N323-1978 (Section 5.1), one or more Laboratory Standard sources could be established using solid radioactive source material having emissive radiation characteristics similar to those of the calibration gas. The Laboratory Standard sources could then be used to develop Secondary Calibration sources, which would be used for on-site in-place calibration.

Ideally, gamma-detecting NUREG-0737 effluent monitoring systems should be type-calibrated against a minimum of three different gaseous radionuclides ranging in energy from Xe-133 (0.081 MeV) to Xe-138 (1.78/2.02 MeV), and varying in concentration from 10^{-6} uCi/cc to about 10^{5} uCi/cc; however, other than Xe-133, there appear to be no readily available calibration gases with the required energy range or with sufficiently long half-life to permit use, and none are available in sufficient concentration to permit upper range calibration. The only practicable alternative is the use of solid sources such as Cs-137, Co-60, or Ba-133, placed in a reproducible geometry and

utilizing the transfer procedures of ANSI N323-1978 to relate the resultant values to the gaseous calibration. The curie content of such sources could be determined by any of several analytical methods by reference to NBS standard sources. While it can be argued that such a procedure would not provide direct traceability to NBS standard gaseous sources other than Xe-133, there appears to be no other practicable alternative.

As envisioned by the NRR staff, calibration of NUREG-0737 effluent monitors would then be based on a one-time "type" calibration using a radioactive gas traceable to NBS. Subsequently, all production units would be calibrated against Laboratory Standard solid sources, with traceability to NBS. Secondary Calibration Sources would be furnished by the vendor to the licensee, who would then conduct, or contract others to conduct, all subsequent in-place calibration tests with these solid sources. These in-place calibration tests would be performed after system installation and at designated intervals in accordance with Plant Technical Specifications. It is suggested that some form of periodic confirmation or verification of calibration source values be made a part of surveillance procedures (e.g., recalibration of sources every two or three years).

It should be noted that the use of solid sources in sufficient strengths to permit calibration of the upper ranges of these monitors may pose ALARA problems in the handling and use of the sources during calibration. While the level at which calibration poses these problems is design specific, any

discussion of acceptable surveillance procedures should permit calibration of the affected ranges by appropriate electronic signal substitution if occupational exposures are unacceptably high.

4. In-Containment High-Range Radiation Monitors

While NRR recognizes the desirability of periodically demonstrating that a detector will properly respond to a radiation source over the full designated range, the program outlined in NUREG-0737 for testing and calibration of these monitors should provide adequate assurance that the monitor is functioning accurately for its intended purpose while maintaining doses to workers ALARA. NUREG-0737 specifies in-place calibration using a radioactive source at one point on the decade below 10 R/hr. This should assure proper functioning of the detector. To require in-place testing at over 10 R/hr is not consistent with ALARA considerations. NRR recommends, as an acceptable alternative, that the licensees require type-testing at sufficient points to demonstrate linearity through all scales up to 10^6 R/hr to verify the monitor design characteristics. NRR further recommends that licensees specify that each production detector be tested at levels of approximately 10^3 R/hr to assure satisfactory response to high levels of radiation. Testing of each production detector at over 10^3 R/hr is viewed as unwarranted when the costs, time, and probability of damage to the instrument from handling are considered.

NUREG-0737 recommends electronic calibration by signal substitution for all decades above 10 R/hr. Such substitution involves the injection of DC signals

(simulating detector response to radiation) into the system for the purpose of system calibration. Calibrated DC current generators should be specified by the monitor vendor and should be available from commercial suppliers. See Attachment IV for further discussion of electronic calibration.

5. Particulate and Radioiodine Sampling from Effluent Gas Streams

Some licensees have expressed concern over sampling line losses of radioactive particulates and iodines relative to their proposed sampling equipment installations to meet the criteria of Attachment 2, Item II.F.1, of NUREG-0737. NUREG-0737 references ANSI N13.1-1969 for design guidance for these sampling systems. Information in the Appendices to ANSI N13.1-1969 predicts severe losses in lines leading from effluent sampling points to effluent sample collection stations.

In a recent draft of a proposed revision to N13.1-1969, the appendices have been deleted and determination of sampling line losses is suggested to be accomplished by actual tests of systems or full-scale mockups rather than by calculational methods. While NRR does not normally endorse a preliminary draft of a standard undergoing revision, NRR would accept empirical data on sampling line losses based on actual tests of either the installed system or a full-scale mockup of the system in lieu of calculations based on ANSI N13.1-1969 appendices.

A more complete discussion of sampling line losses and loss evaluation appears in Attachment II.

6. Deviations from NUREG-0737 Criteria

NRR is reviewing requests for deviations from the criteria in NUREG-0737, Item II.F.1, Attachment 1, 2 and 3, and documenting its findings in SERs. Recent discussions by the staff with vendor representatives, licensee representatives and resident inspectors, however, indicate that previously undocumented deviations to NUREG-0737 requirements may exist at some plants. Examples of deviations include excessive sensitivity of response to variation in photon energy of the noble gas effluent monitors produced by at least two vendors and the use of protective shielding by licensees to cover in-containment radiation monitors, which effectively blocks the required response to low-energy gamma radiation.

Summary Recommendations

NRR recommends that OIE either substantially revise MC 2515, Inspection Procedure 84710, or consider preparation of a separate inspection procedure or temporary instruction for NUREG-0737 items. The suggested guidance in NUREG-0737, coupled with this memorandum and attachments, should provide the needed bases to initiate action. NRR staff will be available for any needed consultation or additional input. As noted in the June 18 memorandum from R. J. Mattson to J. T. Collins, NRR plans no post-implementation review. The nature of the equipment and plant-specific installations is such that an audit type review by NRR of licensee design proposals is not an appropriate form of review. It was the NRR position at the time of NUREG-0737 issuance that the most effective form of review is an onsite inspection, conducted by personnel experienced in the field of radiation monitoring instrumentation and well-briefed on the design of systems provided by individual vendors.

ATTACHMENT I

PURPOSE AND FUNCTION OF GASEOUS EFFLUENT MONITORS FOR ACCIDENT CONDITIONS

Effluent monitors provided for normal reactor operating conditions have historically been required to detect and measure trace concentrations of fission product noble gases which have undergone substantial dilution and radioactive decay in traversing a tortuous path from their point of origin in the fuel of the reactor core to the final point of release. The radiation detectors (sensors) in normal-range effluent monitors are usually beta-radiation detecting devices designed to function in the range of radioactive effluent concentrations from 10^{-6} uCi/cc to 10^{-2} uCi/cc. The lower end of the useful range is determined by natural radioactivity background considerations and radiation from non-effluent sources within the plant which limit the sensitivity to those concentrations of radioactive noble gases which are statistically differentiable from background contributions (Beta radiation detection is utilized to minimize the effects of varying background levels of gamma radiations produced by reactor operation).

Recent developments in computer-based monitors permit background subtraction and can extend the range of sensitivity to approximately 10^{-7} uCi/cc, however, relatively few of these monitors are in service. The principal radioactive noble gas radionuclides present in normal plant effluents are Xe-133 and Xe-135, with traces of Kr-85 also present. With each of these radionuclides emitting a beta particle in the energy range from 0.2-1 MeV, each nuclide is readily detected and the use of a beta detector permits a direct correlation between observed count rate and gross radionuclide concentration.

The noble gas effluent monitors described in NUREG-0737, Item II.F.1, Attachment 1, are specifically designed to operate at much higher concentrations of noble gases. They are intended to function under severe credible accident conditions and to detect and measure noble gas concentrations which may have undergone essentially zero decay in escaping from their point of origin in the fuel of the reactor core; however, a plant's monitoring system must also be able to function under a variety of accident conditions. For example, the monitoring system should be capable of detecting and measuring the mix of radionuclides which could be encountered from a release at zero decay and also that which would be present several days later or at any intermediate point in the accident sequence. The fundamental technical problem in this requirement lies in the change of energy spectrum with time and the unavoidable variations in energy response of the available detectors. Designs should incorporate detectors with minimum sensitivity to energy variation.

Beginning immediately after reactor scram the principal noble gases in accident-related releases--on the basis of relative concentration and energy--will be Kr-88 and Xe-138, which have high emissive energies between 1.0 and 2.5 MeV. The high energy gamma radiations of these short-lived nuclides dominate gaseous releases until about 8 to 10 hours after shutdown, when the principal nuclide becomes Xe-135, with a half-life of about 9 hours and an emissive energy of about 0.25 MeV. At 2 to 3 days following the accident, the dominant nuclide becomes Xe-133, with a half-life of 5.3 days and an emissive energy of 0.081 MeV.

Noble gas effluent monitors should be capable of maintaining on-scale readings and providing data on effluent concentrations through the entire accident sequence.

The simplest and probably most accurate means of providing information on effluent concentrations on a non-energy-sensitive basis would be the detection and measurement of the beta activity of the effluent gas. With the upper range capability of 10^5 uCi/cc specified in NUREG-0737 for certain release pathways, existing beta detectors (circa 1979) did not have sufficient dynamic range capacity and so most vendors went to gamma radiation detection as the only viable alternative.

The detection of the gamma radiation from the several nuclides which comprise the most significant portion of the noble gas release is complicated by the variables of emissive energy and short half-life of some of the nuclides. The practicalities of developing a gamma-detecting monitor which would read-out or be interpreted in terms of uCi/cc of specific nuclides were such as to lead the NUREG-0578 writing group to put forth another concept - the so-called Xe-133 equivalent.

A given volume of a radioactive noble gas produces a certain absorbed radiation dose in space which is defined by several factors, among which are the mass energy absorption coefficients, the concentration in uCi/cc, the gamma energy, the relative frequency of gamma emission, the volume of space occupied by the gas, density of the gas, etc. The principal differences in radiation dose between a given concentration of Xe-133 and the same concentration of Xe-135, for example, lie in the relative abundances of the characteristic gamma emissions and their emissive energies. With Xe-133 having a 0.081 MeV gamma in 37% of the disintegrations and Xe-135 having a 0.25 MeV gamma 91% of the time, and ignoring the slight difference

in the mass energy-absorption coefficient, Xe-135 should produce the higher radiation dose, by a factor of

$$\frac{(0.25\ \text{MeV})\ \ (0.91)}{(0.081\ \text{MeV})\ (0.37)} = \frac{0.2275}{0.0299} = 7.6$$

Kr-88, on the other hand, would produce a still higher dose by a factor of

$$\frac{(2.4)(0.35) + (0.18)(2.19) + (0.14)(1.55)}{0.0299} = \frac{1.45}{0.0299} = 48$$

For a gamma detector having an essentially linear dose rate response in either R/hr or rad/hr, there is a potential "mismatch" varying from about unity (for Xe-133m) to a factor of about 80 (for Xe-138). This was recognized early in the discussions leading to the NUREG-0737 requirements.

The projected source term ratios at any given point in time can be calculated and a table can be derived relating detector reading to an equivalent in Xe-133 activity in terms of dose (Xe-133 equivalent).

An alternative which is consistent with the needs of NRC in determining the effects of effluents on the population is the measurement of noble gases with readout in terms of MeV per second, or some equivalent unit. Such a parameter could be used in determining offsite doses in a more direct manner than is now possible.

Attachment I

TABLE I-1

CALCULATIONS -- RELATIVE ENERGY RELEASE RATE FOR A TYPICAL CORE INVENTORY

DATA SOURCES:

Curie values from AEB/NRC Accident Source Term. Abundance and Energy values are from the Radiological Health Handbook (HEW, 1970 edition).

Reactor Power: 3800 MW

Time Since Reactor Shutdown: Zero

Nuclide	Ci	d/sec	Abundance	MeV	MeV/sec
Xe-133	2.14×10^{8}	7.9×10^{18}	0.37	0.081	2.4×10^{17}
Xe-135	2.04×10^{8}	7.5×10^{18}	0.91	0.25	1.7×10^{18}
Xe-138	1.8×10^{8}	6.7×10^{18}	0.66 0.58	1.78 2.02	1.6×10^{19}
Kr-88	1.22×10^{8}	4.5×10^{18}	0.35 0.18 0.14	2.4 2.19 1.55	6.6×10^{18}
Kr-87	8.9×10^{7}	3.3×10^{18}	0.35	2.57	2.9×10^{18}
Xe-135m	5.9×10^{7}	2.2×10^{18}	0.80	0.527	9.2×10^{17}
Xe-133m	5.26×10^{6}	1.9×10^{17}	0.14	0.233	6.2×10^{15}

ATTACHMENT II

DRAFT STAFF POSITION ON DETERMINATION OF SAMPLING LINE LOSSES RELATING TO REQUIREMENTS OF NUREG-0737, ITEM II.F.1

I. INTRODUCTION

Absent a representative sample and analysis of the radioiodine content of plant gaseous effluents, the operator of a nuclear power plant in which a nuclear accident has occurred is faced with the alternative of calculating projected offsite doses to the population, which may be based on extremely conservative assumptions, or rapidly obtaining radiation measurements in the field. The requirements of Attachment 2, Item II.F.1, of NUREG-0737, were promulgated to assure that a plant operator would have the capability, under accident conditions, to obtain and analyze samples of his gaseous plant effluents which would be sufficiently representative of the actual discharge conditions to permit a realistic assessment of projected offsite doses to the population.

The staff recognizes that the collection of a "representative" sample of radioactive particulates and radioiodine from a plant gaseous effluent stream is subject to a number of problems or difficulties, not the least of which is the tendency for both radioactive particulates and radioiodines to deposit or "plate-out" in traversing long sample collection tubes or pipes. Also of concern is that while radioiodine is typically discussed and treated as though it is a gas or vapor, it actually exists in the plant atmosphere as both a gas or vapor and as a particulate aerosol. The relative proportions of the

particulate and gaseous forms of iodine vary with such factors as age and ambient temperature and are not readily predictable, especially under accident conditions.

II. DISCUSSION

1. Licensee's Proposed Systems

The NRR staff has reviewed submittals from several licensees concerned with sampling capabilities of proposed designs for particulate and radioiodine sampling systems to meet the criteria of Item II.F.1, Attachment 2, of NUREG-0737. The licensees are concerned that the proposed designs, which typically incorporate long horizontal sample runs in order to meet the dose criteria of Attachment 2, may have inherent problems of sample deposition and plateout which could affect the validity of any samples obtained through use of the sampling system.

Installation detail drawings indicate horizontal runs as long as 50 to 100 feet and vertical drops of approximately 50 feet with a total length of approximately 100 to 150 feet. The sample lines in each case are thermally-insulated and are heat-traced. Recommended standard installation practices are specified, such as requiring bends in sample tubing to be of as large a bend radius as practicable, avoiding sharp bends, the use of smooth-wall stainless-steel tubing, and provision for heat-tracing.

2. Staff Guidance in II.F.1, Attachment 2

Table II.F.1-2 of Item II.F.1, Attachment 2, cites ANSI N13.1-1969 for guidance on representative sampling. The aspect of representative sampling of principal concern to licensees is the N13.1 guidance for quantification or determination of sampling line losses or deposition occurring over long runs of sample system tubing. Long runs are used in the sample system to deliver the sample to a remote location, where shielding and distance provide the requisite control over radiation exposure to sampling personnel.

The guidance on sampling line loss calculations in ANSI N13.1-1969 appears in Appendix B, which addresses three forms of sampling line loss or deposition: (1) Gravity Deposition; (2) Brownian Diffusion; and (3) Turbulent Deposition.

Of the three forms of sampling line loss, Turbulent Deposition is the mechanism most likely to be of importance in determining sample line losses in the proposed sampling systems. However, due to the complexity of the mechanism of turbulent deposition, it is probably the least understood and least quantifiable mechanism of deposition and, therefore, the most difficult to predict by calculational methods when designing a sampling system.

Table B3 of ANSI N13.1-1969, while providing limited data for vertical sampling lines, can be considered to be applicable to a turbulent-flow

sampling line with both horizontal and vertical components. Table B3 would seem to indicate that long sampling lines are not practicable where particles over about 6 microns are involved.

Gaseous effluents from most nuclear plant effluent pathways can be described as comparatively free of particulates, while such particulates as may be present are usually of small size (i.e., less than 5 microns diameter) as the result of upstream filtration. In some plants, almost all potential sources which could contribute radioactive particulates to the plant's gaseous effluent stream are filtered through one or more stages of HEPA filtration. Such particulates as might be present in such a stream would tend to be very small. In what is perhaps the more typical case, a single plant main vent discharge may consist of a "mixed bag" of HEPA-charcoal filtered air from potentially radioactive areas, roughly filtered air (i.e., as through a fiberglass "furnace" filter) from non-radioactive work areas, and unfiltered air from sources such as a PWR turbine building. What happens in the mixing of such sources is that small radioactive particulates from the radiation areas--perhaps starting as sub-micron or even molecular-sized particles--tend to agglomerate with each other and with the larger particles from the unfiltered "clean" areas, thus forming relatively large (i.e., greater than 10-20 microns) radioactive particles which then become subject to deposition in sample lines.

3. Considerations in Determination of Line Losses By Deposition

Application of the guidance in Table B3 of ANSI, N13.1-1969 to sampling of a nuclear plant gaseous effluent stream, would lead one to the conclusion that long sampling lines are not practicable because calculated losses might well approach 100%. That this is not strictly true is indicated in recent discussions with persons having extensive field experience in nuclear plant sampling work. In several undocumented cases, samples of various types of plant atmospheres and plant effluents were taken through sampling lines ranging in length from about 50 feet to about 300 feet. In each case, particulate samples adequate to serve the purpose at hand were drawn through these sample lines. While some sample losses were observed at the time, the results being sought were largely qualitative in nature (e.g., isotopic identification) rather than quantitative, and no efforts were made to determine the precise extent of these losses.

The foregoing leads us to the tentative conclusion that the guidance of Appendix B of ANSI N13.1-1969 may not be wholly valid. We note a clue to this in Section B4 of Appendix B, which points out that the data is for dry, clean tubes and does not consider such factors as re-entrainment.

The staff is of the opinion that re-entrainment or re-suspension may well be a significant factor in determining actual sample line losses. In

particular, such behavior may be more likely to occur in a continuously operating system where equilibrium conditions have been established, rather than in a system which is used infrequently or intermittently.

A sampling system could be designed to utilize enhanced entrainment by increasing system flow. If only a limited volumetric flow is desired at the sample collection point, the sampling flow could be split, with one portion going through the sample collection device and the other portion being bypassed around the sampler, thus maintaining the flow conditions enhancing the entrainment characteristic.

4. Current Status of Staff Guidance

The staff is aware that a revision to ANSI N13.1-1969 is being prepared by a currently active ANSI working group. However, the expected dates of completion and publication are not known. The staff has seen a preliminary draft which deletes the guidance on sampling from stacks and on sampling line losses (Appendices A, B, and C of ANSI N13.1-1969). In lieu of the deleted guidance the draft revision of ANSI N13.1 recommends that either the the actual sample delivery system or a full-scale mockup be tested experimentally to determine the extent of sample loss.

The staff endorses the proposed approach of making actual system tests to determine line losses. At the same time, the staff is not prepared to either recommend a specific test method or endorse any given test

method as being acceptable to the staff. Therefore, the staff will be receptive to proposals for technically sound test procedures for determining sample line losses for both particulates and iodine vapors.

It should be emphasized that the staff's principal concern in establishing the criteria of Item II.F.1, Attachment 2, was the quantitative determination of the rate at which radioiodines can be released from the plant in gaseous effluents under accident conditions. Radioiodine is usually considered to be in a gaseous or vapor form; while this is partially true, it also appears in significant fractions in particulate forms under certain conditions and, therefore, any discussion of sampling must consider the collection, transport, and retention of both the gaseous (elemental and organic) and particulate forms.

Under normal reactor operating conditions, the forms of radioiodine observed in plant atmospheres and plant gaseous effluents are: (1) the elemental form of iodine, which appears as the two-atom molecule, I_2, and which can exist at normal ambient temperatures (50°F to 100°F) as either a gas or adsorbed on a solid (particle); (2) possibly the hypoiodous acid form, HOI, as a vapor or gas; and (3) the organic form, usually assumed to be CH_3I. Historically, for design basis accident analyses, the staff has assumed iodine species distribution to be 5% particulate, 4% organic, and 91% elemental.

In the initial release of iodine from irradiated fuel, in either normal leakage or in the accident case, the staff is considering postulating that most of the iodine released is in the form of cesium iodide (CsI). Cesium iodide, while being nominally a solid having a melting point of about 620°C, is very soluble in either hot or cold water and,as a result, most of the iodine released from fuel as cesium iodide tends to stay in solution; however, aerosols could be generated from steam leaks such as a high pressure primary coolant leak to atmosphere.

III. POSITION

In view of all of the variables which can be introduced in the sampling of particulates and radioiodines, especially in long runs of sample collection tubing, a definition of "representative sampling" acceptable to the staff for Item II.F.1, Attachment 2, only, is proposed as follows: "REPRESENTATIVE SAMPLING: The obtaining of the best practicable sample, accompanied by the application to analytical procedures of such empirically-determined line loss or line deposition correction factors as may be needed to obtain results which can be considered conservative "order-of-magnitude" approximations of the actual concentrations of particulates and radioiodines in plant gaseous effluents under accident conditions."

The design of systems for the sampling and analysis of radioiodine should take into consideration the multi-faceted nature of iodine. Both filtration (for particulates) and adsorption (for gases and vapors) sampling media should be used for the collection of iodine. Sampling lines should be designed to minimize losses due to deposition of particulates and should be heat-traced to minimize plate-out or deposition of iodine vapors on wall surfaces by minimizing temperature changes and eliminating "cold" spots.

Sampling lines should be as short as practicable, considering such limiting factors as ambient radiation from ducting or pipes leading to the discharge point and radiation from other items of plant equipment in the vicinity. The point of sample collection should be chosen with consideration being given to routes of access by sampling personnel, such that a sample can be retrieved and analyzed without incurring personnel radiation doses in excess of 5 rem whole-body exposure and 75 rem to the extremities.

When sampling line losses calculated in accordance with the appendices of ANSI N13.1-1969 show deposition approaching 100%, an alternative determination of sampling line losses for particulates can be obtained by test of sampling lines using the actual aerosols encountered in normal plant operation, or, preferably, by using test aerosols such as sodium chloride with particle sizes in the range expected to be present under

accident conditions. In situ or full-scale mockup test results will be acceptable to the staff in lieu of data or values determined by ANSI N13.1-1969 methodology.

ATTACHMENT III

CORRECTION FOR SAMPLE CONDITIONS (AIR AND GAS SAMPLING)

In the collection of gaseous radioactive effluent samples, whether for use in noble gas effluent monitors, in particulate or iodine samples, or in "grab" samples for analysis, there are certain correction factors to be considered.

A monitoring or sampling system extracts a continuous or discrete sample of air from a duct, vent, or stack by using a series - connected "string" consisting of a sample intake probe or nozzle, a sample delivery or transport tube, a particulate filtration assembly, an iodine adsorber assembly, a noble gas detection chamber, a flow measurement device, and a pump or air-mover. Each component, from the entry point of the sample nozzle down to the entry port of the air mover, contributes a degree of resistance to the flow of air through the "string"; this resistance to flow appears as a series of pressure drops across each component, with the total system pressure drop being the sum of the component pressure drops. At the noble gas detection chamber and at the flow measurement device, the difference in pressure between the gas space and the external atmosphere may be from 1 to 15 inches of mercury (partial vacuum).

The measurement of the radioactivity of the gas flowing through the detection chamber must be compensated to reflect the reduced pressure of the chamber relative to the pressure at the point of sample intake. For example, if the internal pressure of the detection chamber is 18 inches of mercury (12 inches below standard atmospheric pressure of 30 inches of mercury), there is a reduction of 40% density below that found at STP and a corresponding reduction in the quantity of radioactive gas in the chamber. Since calibration of normal range

noble gas detection (sensors) is usually done at atmospheric pressure using Kr-85 gas, it is essential that licensees either provide means for automatically correcting both calibration and operational readouts for the reduced pressure conditions encountered in system operation or establish procedures by which the application of appropriate correction factors can be assured. Current models of effluent air monitoring systems provided by major vendors are known to incorporate such correction factors and some models also include automatic temperature compensation features.

The measurement of sample flow rate in systems such as described above is of no consequence for noble gas determinations but can be the source of errors on the order of 10% to 50% in the calculation of releases of particulates and iodines if no compensation is provided for the measurement of actual gas flow at reduced pressure.

One of the simplest and most commonly used gas flow measurement devices is the variable area flow meter, commonly known as the rotameter. While the rotameter is quite accurate when used at atmospheric pressure, a rotameter calibrated at atmospheric pressure will not read correctly at either higher or lower pressure, unless properly compensated. It is often incorrectly assumed that since the the rotameter functions on the basis of mass flow per unit time, the observed reading under either pressure or vacuum will be correct in terms of standard volume flow-rate. This assumption has been shown to be invalid (D. K. Craig)[a].

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[a]Craig, D.K., The Interpretation of Rotameter Air Flow Readings, Health Physics. Pergamon Press 1971. Vol. 21 (August) pp. 328-332.

Pressure correction factors for specific rotameters are available from the various manufacturers as part of the instruction manuals supplied with equipment.

Data for one typical rotameter shows a 35% deviation between indicated scale readings at a ΔP of -12 inches of mercury and corresponding measurements made at standard atmospheric pressure. Such a deviation -- if uncorrected -- would result in calculation of effluent air contaminants that would be low by a corresponding value.

It is not enough to calibrate a sampling system rotameter at some specific operating pressure (e.g., -10 in. Hg) because this does not consider such operating variables as the length of sample run, variations in ΔP caused by variations in filter media manufacture, and operational variations in ΔP across a particulate filter resulting from dust loading. Variations in the length of sample run can make a difference of about 1 to 3 in. Hg in total sample line pressure drop. Given a fixed design flow rate, variations in pressure drop across filters from different production batches may vary slightly but this is usually a minor factor. Of potentially greater significance is the increase in pressure drop across a particulate filter caused by dust loading.

In extreme cases, increases in pressure drop across a filter of 5 inches Hg, or more, have been observed. Some media, such as membranes, are more susceptible to dust loading than others; glass fiber media, for example, accomodate relatively large dust loadings with comparatively small increases in pressure drop. Such changes in pressure drop produce changes in the indicated flowrate, as measured by a rotameter, which are not reflected on the rotameter scale.

Craig cites an example involving dust buildup on a filter where ΔP increased from 5.9 in. Hg to 10.7 in. Hg while the rotameter float reading was kept constant. The initial flow rate was measured at 5.08 l/min and the end flow rate was 4.02 l/min.

Assuming the change in flow rate was constant, the true mean value would have been 4.55 l/min. A determination of total volume flow made on the assumption that the 5.08 l/min initial value prevailed over the entire sampling period would have been 11.7% too high, while air contaminant concentrations obtained using the initial flow rate would have been too low by the same percentage.

Manufacturers of sampling/monitoring systems are aware of the flow-measurement discrepancies just discussed. Current systems provide built-in compensation of air flowrate indication for operation at less-than-atmospheric pressure through the use of pressure and temperature transducers and computer software algorithms. Older analog systems may require application of manual correction factors for given conditions of ΔP and flow. Instruction manuals provided to licensees by the vendors of older sampling/monitoring systems describe the procedures for making the necessary corrections.

Independent verification of calibration of a flow rate measurement system can be accomplished by placing a calibrated rotameter in series at the sample intake end of the system and comparing readings of the system rotameter under various system pressure conditions with those of the calibrated rotameter. Since the verification rotameter operates at essentially ambient pressure, the only corrections needed for the calibration procedure are the correction for altitude

and ambient pressure (relative to standard) and a small correction for temperature (the latter is only necessary for high precision work -- the error in assuming a standard condition of 70°F is less than 5% for the temperature range 24°F to 116°F, which encompasses most plant effluent streams).

ATTACHMENT IV

CALIBRATION OF CONTAINMENT HIGH RANGE MONITORS

Licensees have stated that it is difficult to obtain pulse generators with the necessary range to perform full scale electronic response tests of the electrical circuits of the containment high range monitors.

Tables 1, 2 and 3 show sensitivity of monitors from three vendors as follows:

General Atomic= 1.07×10^{-11} amps/R/hr*

Kaman Science = 1×10^{-11} amps/R/hr

Victoreen Instrument Co. = 7×10^{-11} amps/R/hr

For an exposure rate range of from 10^{0} to 10^{7} R/hr, the range of a current source required to perform full scale electronic response would be:

General Atomic: 1.07×10^{-11} amps to 1.07×10^{-4} amps

Kaman Science: 1×10^{-11} amps to 1×10^{-4} amps

Victoreen Instrument Co.: 7×10^{-11} amps to 7×10^{-4} amps

The Keithley Model 261, as described in Figure 1, has an output of from 10^{-11} amps to 1.1×10^{-4} amps, which should cover the range for the General Atomic and Kaman Science instruments. Although Victoreen is developing a current source to encompass the range of their instrument, we note the Keithley Model 225, Figure 2, as well as the Keithley Model 261, could be used to satisfy the range of sensitivity of the Victoreen system. Kaman states that they have a current source in the range of interest built into their system.

*Based on the average response to the x and gamma rays source used for the analysis.

From the above, it appears that there are electronic devices available to perform full scale response tests of the high range radiation monitors' electrical circuits. For example, the General Atomic catalogue for this instrument specifically states that the aforementioned Keithly current sources provide a source for instrument sensitivity check.

A concern of the Region IV memorandum was: "Is it necessary to periodically demonstrate that the detector will properly respond to a radiation source over the designated range (10^7 R/hr)?".

It is our position that electronic checks by signal substitution using a calibrated current source would be a satisfactory method of demonstrating that the system electronics would respond to radiation fields over the range of 10 R/hr to 10^7 R/hr. Using a radiation source to show that the ionization chamber is responding commensurately over the entire range is not justifiable because of practical considerations in radioactive source size requirements and the radiation dose that would be received by personnel handling such sources. Since the low-ranges (< 10 R/hr) are required to be checked with a radiation source in accordance with Table II.F.1-3, the integrity and operability of the ionization chambers will be satisfactorily assured.

The final concern was: "Should procedures include calculations for converting monitor readings (R/hr) into concentrations (uCi/cc) for dose assessments?".

TMI Action Plan item II.F.1 does not require a licensee to convert monitor dose rate readings into concentrations of radioactive material.

With respect to the approach for the regional review of Item II.F.1 instrumentation, we suggest that inspections to verify that licensees meet the criteria of Attachment 3 of II.F.1 take the same approach as used in routine preoperational inspections of FSAR commitments regarding area radiation monitors. We suggest that the inspections audit the basic elements of II.F.1, Attachment 3, including:

(1) Determination that the detectors are located in containment so that they are capable of measuring a "representative" dose rate inside containment.

(2) Verification that the instruments have been calibrated prior to installation in accordance with Table II.F.1-3, (NUREG-0737).

(3) Verification that they are capable of being calibrated in situ, in accordance with Table II.F.1-3, (NUREG-0737) at low ranges (<10 R/hr).

(4) Verification that they will be electronically checked on ranges >10 R/hr to assure calibration integrity at the high ranges.

Inspection and acceptance by the Regions of each of the above items and the criteria of II.F.1 would be compatible with our position on how II.F.1 should be reviewed for acceptability.

GENERAL ATOMIC COMPANY
P.O. BOX 81608
SAN DIEGO, CALIFORNIA 92138
(714) 455-3000

HIGH RANGE RADIATION MONITOR TYPE CALIBRATION REPORT SUMMARY ABSTRACT FROM E-115-939 (PRELIMINARY)

SOURCE	ENERGY	DOSE RATE (R/HR)	RESPONSE (A/R/HR)
Co-60 (RADCAL)		.66	1.06×10^{-11}
Co-60 (R-S)	1.17+1.33MEV	10^2	1.16×10^{-11}
Co-60 (SALK)		4×10^3	1.1×10^{-11}
		3×10^4	1.03×10^{-11}
Cs-137	662 KEV	1	1.13×10^{-11}
		2	1.08×10^{-11}
		5	1.07×10^{-11}
		2×10^1	1.01×10^{-11}
XRAY	70 KEV (EFF)	3.7	9.14×10^{-12}
	117 KEV (EFF)	1.5	1.39×10^{-11}
	167 KEV (EFF)	1.9	1.019×10^{-11}
	210 KEV (EFF)	1.4	1.013×10^{-11}
LINEAR ACCELERATOR	4.5 MEV (AV)	5×10^6	1.13×10^{-11}

$\bar{A}_{R/hr} = 1.073 \times 10^{-11}$

Table 1

APPLICATION		REVISIONS			
XT ASS'Y	USED ON	REV	DESCRIPTION	DATE	APPROVED

RATING CHARACTERISITIC

Gamma Flux	
Operating Range	10^0 to 10^7 R/hr
@ 2 kV and 80% Saturation	10^8 R/hr
Gamma Sensitivity	1×10^{-11} amp/R/hr
Voltage Range	400 to 1,000 Volts Minimum
Live Zero, U^{234} Source	2×10^{-11} amp +20%, -60%
Energy Response	1) ±20% for the range of 100 KeV to 3 MeV

VIRONMENTAL CONDITIONS

Vibration	
Horizontal	Curve A, Figure 1
Vertical	Figure 2

TABLE 2

TERIAL—	DRAWN	DATE	KAMAN SCIENCES CORPORATION Garden of the Gods Rd., Colorado Springs, Colorado 80907			
	CHECKED					
ISH—	ENGR		TITLE HIGH RANGE AREA MONITOR IONIZATION CHAMBER			
	QC					
ESS OTHERWISE CIFIED DIMEN- NS ARE IN INCHES.	PROD					
OLERANCES:	PROJ		COOL IDENT NO. 21732	SIZE A	DWG. NO. 824578-001	REV A
.XX =	APPROVED					
XXX =	CONTRACT NO.		SCALE	SPLC	SHT 2 OF 7	
GLES =						

TABLE 3

SPECIFICATIONS

DETECTOR - MODEL 877

RADIATION DETECTED: Photons above 60 keV.

RANGE: 10 R/h to 10^7 R/h. Corresponds to over 10^8 Rads/h of surface tissue dose from mixed radiation.

ENERGY RESPONSE: Within 20% from 80 keV thru 2 MeV.

SENSITIVITY: Nominal 7×10^{-11} amps/R/h.

CALIBRATION: Co^{60} at approx. 300 R/h, 35 R/h and 12 R/h.

DESIGN CRITERIA: Fulfills NRC Reg. Guide 1.97. Meets NRC Reg. Guide 1.89 and IEEE 323 (1974). Request latest test report.

CONSTRUCTION: Hermetically sealed, stainless steel, outer surfaces. Contains no active electronics. Ion chamber type with 1 atm. of air.

DIMENSIONS: 31.75 cm (12.5")H x 22.86 cm (9")W x 25.4 cm (10")D.

WEIGHT: 8 Kg (18 lbs.). Shipping wt.: 16 Kg (35 lbs.)

READOUT - MODEL 876

METER: Six decade, logarithmic, panel mounted. 10 cm (4") span, 90° arc.

RANGE MAGNIFICATION: Function switch allows choice of any two consecutive decades of operational range to be put across full scale.

DESIGN CRITERIA: NRC Reg. Guides 1.29/1.100 and IEEE 323 (1971). Request latest test report.

CONNECTORS: All back panel mounted. Signal input from detector, type BNC. High voltage output to detector, type BNC. Alarm output, 26 pin MS type. Recorder output, computer output, battery input, 10 pin MS type. AC power input, 3 pin MS type.

ALARM FUNCTIONS: Two separate radiation alarms plus a failure alarm, each with an associated front panel light and closure output from a Form C, 5 amp. normally energized relay. Radiation alarms offer choice of manual or auto reset. Each radiation alarm is set behind front panel, at any point on the range. Depressing radiation alarm indicator light causes meter to indicate set point.

TEST FUNCTIONS: ECS test is pushbutton and automatically initiated. Checks electrode configuration and electrical operation of detector, cable, polarizing voltage application and detector output measurement function. Each successful check lights green light until next check. Unsuccessful test extinguishes green light and initiates failure relay closure.

Channel test pushbutton allows user to inject a signal greater than full scale into the meter/alarm circuit. Tests alarm actuation including relays, panel lights and meter circuit.

RECORDER OUTPUT: 0-5 V, standard. Other output levels available up to 10 V.

COMPUTER OUTPUT: Additional and same as recorder output.

POWER REQUIREMENTS: 120 V, 60 Hz, 0.2 amp. 240 V, 50 Hz is available on special order. 22 to 32 V DC auxiliary power, 0.6 amp. max. can be optionally connected to the unit and will be utilized when AC power is not present.

DIMENSIONS: 13.4 cm (5.25")H x 21.6 cm (8.5")W x 39.4 cm (15.5")D.

WEIGHT: 9 Kg (20 lbs.) Shipping Wt.: 16 Kg (35 lbs.)

AVAILABLE ASSOCIATED EQUIPMENT

MODEL 879 OPTICAL ISOLATOR: Isolates Class 1E equipment from associated ancillaries.

RECORDER: Various types can be furnished to record rates of change of radiation level with time as a parameter. Recorder operation can be initiated by "on scale" radiation level.

MODEL 878-1-5 TERMINATED RADIATION PROOF CABLE: Tested as terminated and connected to be consistent with detector test criteria.

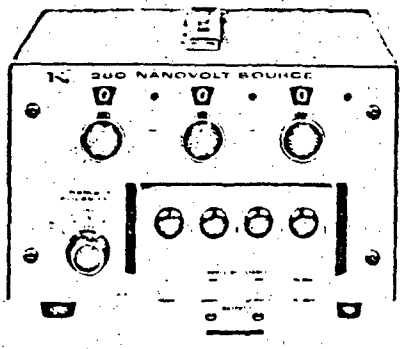
MODEL 876-1-55 DUAL COMPARTMENT CHASSIS: Accommodates 2 Model 876 Readouts or a Model 876 Readout/Model 879 Isolator combination. Tested to meet Reg. Guide 1.29/1.100 seismic qualification. Includes flame barrier.

VICTOREEN, INC. 10101 WOODLAND AVE • CLEVELAND, OHIO 44104
A Sheller Globe Corporation Subsidiary Phone: (216) 795-8200 • TWX: (810) 421-8287
Litho In U.S.A. S-001679

Model 260 Nanovolt Source

- Output from 10^{-9}V to 1.11V
- Accuracy from ±0.25% to ±0.75%
- Less than 10nV absolute thermal emfs

The Model 260 Nanovolt Source is a secondary standard for nanovoltmeter and microvoltmeter calibration. It can also be used as an accurate voltage source for potentiometric measurements and/or zero suppression.



Three front panel dials determine the output voltage, from 1nV to 1.11V. Separate low-thermal binding posts provide outputs of nanovolts, microvolts, or millivolts. The binding posts are located inside a compartment which may be enclosed, so that thermal emf variations due to ambient air currents may be minimized.

Thermal emfs are less than 10nV after 1 hour stabilization; the output changes less than 2nV for a 1°C step change. This extremely stable performance is acheived by using only copper components in the output circuitry. Circuit ground and chassis (power line) ground are connected to separate binding posts, which may be connected by a "link". Thus, the entire circuit may be connected to ground at the most appropriate point for any given situation.

Calibration certificate is furnished including temperature and date of calibration. Certification traceable to the National Bureau of Standards is also available.

Model 261 Picoampere Source

- ±0.25% accuracy at 10^{-7}A, ±0.7% at 10×10^{-12}A
- Designed for use in calibrating feedback ammeters and electrometers.

The Model 261 Picoampere source is a secondary standard for calibration of picoammeters and electrometers. It is a "passive" source, consisting of a selectable 0 to 10V voltage in series with a specially selected and tested hi-meg resistor.

This circuit is designed for use in calibrating feedback picoammeters and electrometers in the FAST mode. Since there is no feedback loop controlling the output voltage, there will be no interaction between the source and the ammeter.

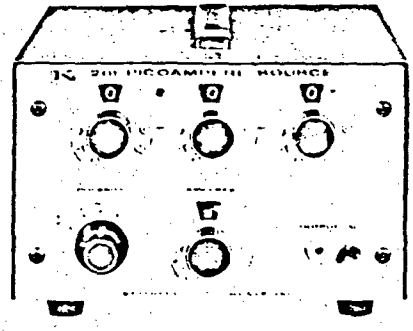
Current output is 10^{-14}A to 1.1×10^{-4}A. Accuracy varies from ±0.25% ±1 digit on 10^{-7} and higher ranges, to ±1.6% ±1 digit on the 10^{-11} range. Long-term stability is better than ±0.15% per month (typically ±0.05 to ±0.1% per month) on the most sensitive ranges, beyond 3 months after calibration.

Calibration maintains stated accuracy for 3 months.

The instrument may also be used as a decade resistance standard, having ±0.02% accuracy at $10^{5}\Omega$, ±0.1% accuracy at 10^{6} and $10^{7}\Omega$, and ±0.5% accuracy at 10^{8} through $10^{12}\Omega$.

The characterization of the hi-meg resistors is based on a 10-year Keithley program of collecting data on these components, and on individual time stability measurements of each resistor.

A calibration certificate including range resistor values, temperature coefficients, and temperature and date of calibration is furnished with each Model 261. Certification traceable to the National Bureau of Standards and recalibration are also optionally available.



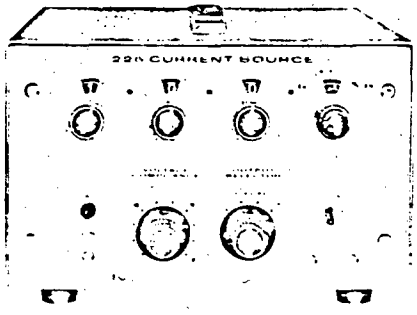
Models 225 and 227 Constant Current Sources

Model 225

- 3-dial settability from 100nA to 100mA, plus trim adjustment
- Voltage compliance from 10V to 100V
- 500V floating capability
- AC modulation input

The Keithley Model 225 is a true current source with full scale ranges of 10^{-7} to 10^{-1} A, capable of outputting currents from 100pA to 100mA. Resolution and stability are both within 0.02%. For ranges of 10^{-1} through 10^{-6} A, the output is regulated to within ±0.05% on the 10^{-7}A range. This regulation can be maintained over the ±10V to ±100V compliance limits. Noise is less than 0.01% of full range.

Output current is adjusted using three calibrated in-line switches. A fourth in-line dial provides continuous adjustment with 0.02% resolution on each current range except 10^{-7}A.



The output voltage is determined by the voltage required to force the selected current through the device under test. The maximum output voltage is set by a front panel control. As this compliance voltage is exceeded, automatic crossover from current mode to voltage limiting protects the device connected to the input.

A light on the front panel indicates operation in the voltage-limiting mode.

When necessary, the 225 can be floated up to 500V off ground. Change in output current is only 5 ppm of full range per volt.

A modulation input may be used to modulate the current supplied by the 225 with a signal from 50Hz to 500Hz.

Model 227

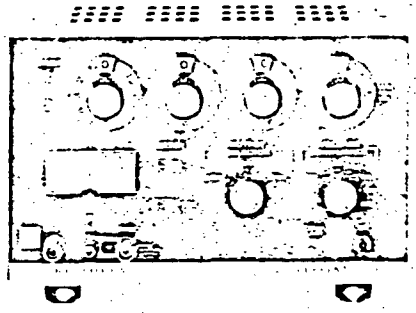
- Up to 1A, 50W regulated output
- Current output is voltage programmable
- Optionally programmable range and compliance limit

The programmable Model 227 current source delivers accurate, stable, high-power current constant over full-scale ranges of 1 to 1000mA, with adjustable compliance voltage. The 3-digit in-line readout of the Model 227 enables the current output to be set to within 0.005% of range, with a full-range accuracy of 0.62%.

The 227 has a continuously adjustable compliance voltage limit, which can be easily set from approximately 3V to 300V on the 100mA and lower ranges. The 1000mA range compliance is similarly adjustable from approximately 3V to 50V. This compliance voltage limit can be preset using the convenient front-panel meter as a guide. This meter also indicates current and voltage output levels under load.

Other features include excellent output current regulation, low output noise, low output capacitance (with correspondingly high output impedance at high frequencies), fast programming ability and a buffered rear-panel voltage monitor output.

The output current may be determined by the voltage applied to the VOLTAGE PROGRAMMING input; 10V corresponds to full range output.



Using the 2271 programming option, range and compliance limit may also be programmed, and current output may be programmed by a resistance or a voltage level. The option also includes a "compliance limit" flag.

The 227 has a true bipolar current output that can be modulated, allowing operation as a true AC constant current source. The output can be floated up to ±500V off chassis ground, with less than 5 ppm of full-range change in output current per volt off ground.

ENCLOSURE 2

NUCLEAR REGULATORY COMMISSION

REGION IV

611 RYAN PLAZA DRIVE, SUITE 1000
ARLINGTON, TEXAS 76011

April 20, 1982

MEMORANDUM FOR: R. J. Mattson, Director, Division of Systems Integration, NRR

THRU: John T. Collins, Regional Administrator, Region IV 4/19

FROM: Glen D. Brown, Chief, Technical Program Branch, Region IV

SUBJECT: IMPLEMENTING PROCEDURES FOR NUREG-0737, ITEM II.F.1

This Region is in the process of reviewing licensee implementing procedures for the noble gas effluent monitors and containment high-range radiation monitors described in NUREG-0737, Item II.F.1, Attachments 1 and 3. As a result of these initial reviews, several problem areas have been identified regarding established guidance for an acceptable program for these instruments. Under normal operating conditions, this Region has usually required that licensees satisfy the recommendations of ANSI-N323-1978 for fixed area monitors and effluent monitors. ANSI-N323 recommends that instruments be calibrated with radiation sources over the range of the instrument at approximately 20% and 80% of full scale and be within ±20% of the known value. The following is a discussion of some of the concerns:

1. Noble Gas Effluent Monitors

MC 2515, Inspection Procedure 84710 requires the inspector to verify that effluent monitors are calibrated over the entire range with a radioactive source traceable to the National Bureau of Standards. Licensees normally calibrate noble gas monitors by filling the sample chamber with various concentrations of ^{85}Kr. For pre-TMI instrumentation, concentrations between about E-05 uCi/cc - E-02 uCi/cc were required to establish calibration points at 1/4, 1/2, and 3/4 of the full scale range. NUREG-0737 now requires monitors with an upper range capacity of E+05 uCi/cc. Some of the problems involved with NUREG-0737 noble gas effluent monitors include:

.Availability of ^{85}Kr in concentrations of E+05 uCi/cc.

.Will full range gas calibrations be required?

.ALARA considerations associated with handling E+05 uCi/cc calibration sources.

2. Containment High-Range Monitors

NUREG-0737 acknowledges the difficulties of performing a full range calibration of the containment monitors. As such, the NUREG only requires a radioactive source calibration at one decade below 10 R/h for installed monitors. This establishes a calibration point at about 0.00001 percent of the full scale range. An electronic response test of the electrical circuit is considered acceptable for ranges above 10 R/h. Some of the concerns with the containment monitors include:

- Is it necessary to periodically demonstrate that the detector will properly respond to a radiation source over the designated range (E+07 R/h)?
- Licensees have stated that it is difficult to obtain pulse generators with the necessary range to perform full scale electronic response tests of the electrical circuit.
- Should procedures include calculations for converting monitor readings (R/h) into concentrations (uCi/cc) for dose assessments?

Discussions with other Regions indicate that a uniform approach has not been taken regarding the review of Item II.F.1 instrumentation. With some licensees, it appears that the review of installed instrumentation and implementing procedures is followed closely as part of routine inspections. These reviews show that certain licensees have expended a considerable effort in establishing a comprehensive program. However, workload demands in some Regions are such that only limited reviews have been possible.

The above concerns have been discussed with Doug Collins, RAB and Dave Verrelli, ORAB. From these discussions, it is our understanding that NRR plans to initiate a post-implementation review of NUREG-0737 items. We assume that this review will include participation by Regional personnel. Before such a review is started, it is suggested that representatives from NRR and the Regions convene for the purpose of establishing guidelines for an acceptable program. Items that should be discussed include:

- Technical Specification requirements
- Surveillance frequencies for checks, tests, and calibrations
- Compliance with ANSI standards, NRC Inspection procedures, Regulatory Guides, etc.

.ALARA considerations

.Calibration sources

.Electronic response tests

.Dose assessment requirements

.Periodic verification of full range detector response

.Acceptance Criteria

After guidelines are established, this information should be made available to the licensees and included in MC 2515 inspection procedures.

Glen D. Brown, Chief
Technical Program Branch

cc: Regional Administrators
H. R. Denton, NRR
R. C. DeYoung, NRR
R. W. Houston, NRR
J. M. Taylor, IE
B. K. Grimes, IE
C. A. Hackney, RIV

ENCLOSURE 3

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JUN 18 1982

MEMORANDUM FOR: John T. Collins, Regional Administrator, Region IV

FROM: Roger J. Mattson, Director
Division of Systems Integration

SUBJECT: IMPLEMENTING PROCEDURES FOR NUREG-0737, ITEM II.F.1

This is in response to your memorandum and request for assistance dated April 20, 1982 and your reminder of May 24, 1982. Please be assured that, in spite of the fact that we had not yet acknowledged your request, we are preparing a more detailed response to the specific inspection concerns you identified in connection with the Noble Gas Effluent Monitor and Containment High Range Monitor requirements of NUREG-0737. Phil Stoddart of the Effluent Treatment Systems Branch has the lead for preparation of NRR recommended guidelines for the post-implementation inspection effort associated with these Action Plan items. In this capacity he is coordinating with the Radiological Assessment Branch in this Division, with the Division of Licensing, and with the Division of Emergency Preparedness, and the Division of Engineering and Quality Assurance in OIE. We have set June 30, 1982 as a target date for transmittal of these recommended guidelines to you and to the other Regional Administrators. If a need for a meeting with Regional representatives still exists following our transmittal, we will be happy to make the necessary arrangements.

At this time, however, I would like to clarify some matters referred to in your memo. First, although NUREG-0737 specified a January 1, 1982 implementation date for these items, enforceable implementation dates are being worked out by DOL for each licensee separately and are to be identified in confirmatory orders. Second, the post-implementation review has always been understood to be an OIE initiative as part of the inspection process. It has been our understanding, however, that NRR assistance would be provided in the development of the relevant inspection modules, and this is the technical effort we have now resumed pursuant to your request. Third, the matter of Technical Specifications associated with these items is a separate and distinct, follow-up, activity with the lead in DOL. We anticipate that this task will be initiated during FY 83.

Original Signed by:
Roger J. Mattson

Roger J. Mattson, Director
Division of Systems Integration

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