UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION I
631 PARK AVENUE
KING OF PRUSSIA, PENNSYLVANIA 19406

840828

Docket No. 030-08895 (Expired) License No. 20-13018-02 (Expired)

MEMORANDUM FOR: Maureen Moriarty, Acting Section Leader, Licensing Assistance Section, NMSS

FROM: John D. Kinneman, Nuclear Materials Section A, RI
John E. Glenn, Chief, Nuclear Materials Section B, RI

SUBJECT: LICENSE NO. 20-13018-02 (EXPIRED)

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John D. Kinneman, Chief
Nuclear Materials Section A

Original Signed By
Laurence F. Friedman, Ph.D.
for John E. Glenn, Chief
Nuclear Materials Section B

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PRODUCT BULLETIN

ANALYSIS

TEXAS NUCLEAR'S PORTABLE PAPER ANALYZER

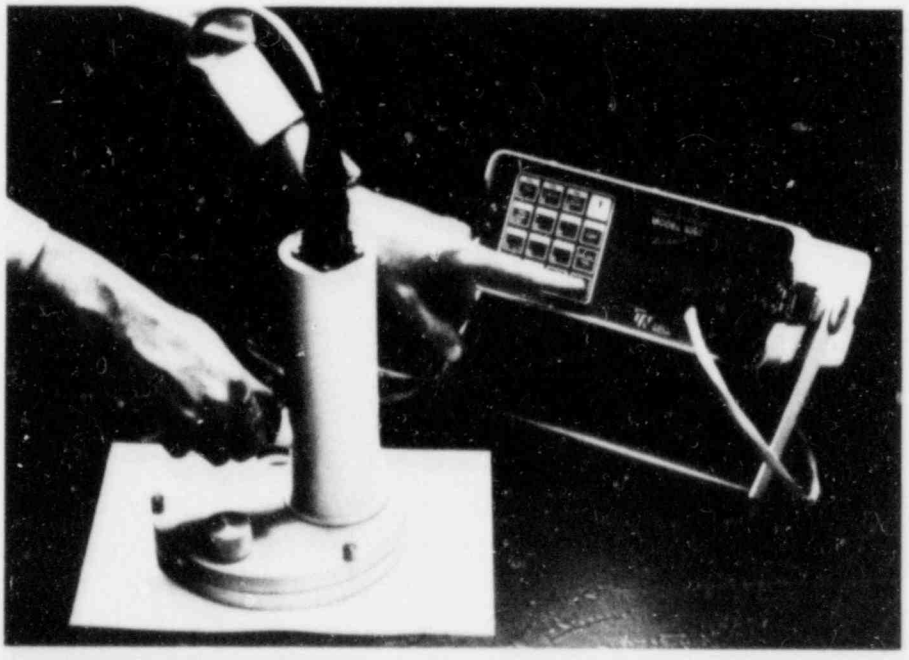
The Paper Analyzer is a portable instrument that provides rapid non-destructive analysis of both the percent concentrations of TiO_2 and $CaCO_3$ in fine papers, and the determination of coat-weight TiO_2 on board. Using microprocessor-based technology, the instrument's analysis time is less than one minute, with precision ranges from a few hundredths to a few tenths of a percent. The Paper Analyzer also can measure the percent of TiO_2 and $CaCO_3$ in powder or liquid samples.

Texas Nuclear (TN) designed the Paper Analyzer especially for the paper industry, so that the instrument automatically compensates for the matrix effects of calcium and titanium, when both are present. You can input your own standards data for calibration or use the factory calibration that is stored in the analyzer's permanent memory. This instrument provides a direct, digital readout of the percent of TiO_2 and $CaCO_3$ in paper and the weight per unit area of TiO_2 on board.

The TN Paper Analyzer is easy to operate, guiding an operator through each analysis sequence and identifying when an error in procedure has been made. The instrument can be carried to different areas of a plant easily, since it weighs only thirteen pounds and is powered by rechargeable internal batteries.

GENERAL DESCRIPTION

The TN Paper Analyzer is comprised of two interconnected parts: a hand-held measurement probe, which usually is placed on the sample to be analyzed; and a microprocessor-based electronic unit that presents the measurement results in an "easy-to-interpret" format on the alpha-numeric display. The display shows percentage data, coat weight in a variety of selectable units, chemical symbols and instructions for each step of the measurement procedure.



The electronic unit is battery-powered, compact and lightweight. It comes equipped with a shoulder strap, and a carrying handle that also can support the unit on a bench. Power for up to eight hours of operation is provided by a set of five internal Ni-Cad cells that are recharged, in-place, with a plug-in charger unit. The charger also can be used to operate the instrument from an AC supply. An auxiliary battery pack, which clips onto the base of the electronic unit, is an available option.

The measurement probe consists of two parts: a cylindrical detector unit, and a head assembly that is attached to the detector by a lockable fitting. This head assembly contains a shielded radioisotope source, which is covered by a retracting shutter activated by sample contact. The head also contains a set of special x-ray filters mounted on a rotatable disc.

Two metal plates, one aluminum and the other titanium, are provided. Most measurements are made on the aluminum plate to assure that there is no interference from elements in underlying materials. The titanium plate is used primarily for standardizing the instrument.

PRINCIPLES OF MEASUREMENT

The TN Paper Analyzer combines a well-established analytical technique, radioisotope excited x-ray fluorescence, with advanced microelectronics to measure TiO_2 and $CaCO_3$. X-ray fluorescence is ideal for the application because it is a rapid and non-destructive means to measure elements with high precision.

With the TN Paper Analyzer, the sample to be analyzed is exposed to x-rays from a radioisotope source for a few seconds. The atoms of titanium and calcium in the sample are caused to fluoresce and emit x-rays characteristic of each element. The detector system separates x-rays coming from the sample into discrete energies and, by measuring the intensity of each energy, determines the percent of element concentration.

The heart of the system is a central processor unit (CPU), which coordinates the operation of the probe with the electronics unit according to instructions contained in its permanent memory. All factory calibration data is stored in this memory and the data is based on TN's experience over the years with many different types of paper. Paper compositions do vary considerably, however, and the factory calibration may not apply accurately to all cases. For this reason, the analyzer provides storage for the user's standards data for calibration. That data is stored in an erasable, but still fairly permanent, second memory. The internal power supply is designed to always maintain adequate power to the second memory.

MODES OF OPERATION

The TN Paper Analyzer has two basic modes of measurement: percent TiO_2 and percent $CaCO_3$ in fine paper, and coat-weight TiO_2 on board. Each mode can be modified for a selected measurement unit, factory calibration, "user-generated" calibration and for other measurement conditions, through the touch-type keyboard on the instrument panel.

In TiO_2 and $CaCO_3$ analysis, the sample may be either a single sheet of paper or several in a stack. The sample is placed on the aluminum metal plate and the measurement probe is placed in position. The analysis sequence starts when the keyboard message ANALY is entered, along with the parameter to be analyzed; it is completed in 60 seconds, when the percent TiO_2 or percent $CaCO_3$ is displayed on the readout.

Analysis of coat-weight TiO_2 is designed to apply to a broad range of coat-material composition and thickness, and to take into account the influence of TiO_2 in the cardboard substrate.

PRECISION

The expected repeatability of measurement in paper when the TN Paper Analyzer is operating at normal precision level is shown in the tables below. You may select a lower precision option to reduce data-acquisition time. Or you may prefer a higher precision for a better-quality analysis. The result of selecting a precision that is different from normal precision will be to change the data shown in the tables by a factor of 2, ½ or ⅓, depending on the precision selected.

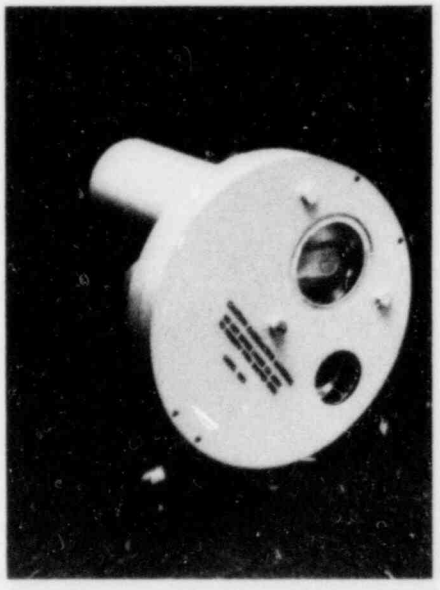


TABLE A: PRECISION (REPEATABILITY) OF % $CaCO_3$ ANALYSIS AT THE 95% CONFIDENCE LEVEL

Meas Wt lb/3300 ft²	± % $CaCO_3$ (Absolute)					
	0	5	10	15	20	25
20	0.2	0.25	0.30	0.34	0.40	0.44
40	0.12	0.18	0.22	0.26	0.32	0.38
60	0.10	0.15	0.20	0.26	0.31	0.38
80	0.08	0.14	0.18	0.24	0.32	0.39
100	0.08	0.13	0.19	0.25	0.32	0.40

SPECIFICATIONS

GENERAL

OPERATING TEMPERATURES
0°C to 60°C (32°F to 140°F)

POWER SUPPLY
Internal: 5 × 1.5V rechargeable D-size Ni-Cad Batteries.
External: clip-on battery pack, as above (optional).
AC (110V/220V) battery charger; typical operating time per charge is 8 hrs., recharging time is 15 hrs.

SYSTEM WEIGHT
13 lbs (6 kg).

SHIPPING WEIGHT
56 lbs (24.5 kg), in suitcase.

PROBE UNIT

X-RAY DETECTOR
By window, NaI (T1) crystal on 2 in.diameter photomultiplier tube; built-in reference source for stabilization.

DIMENSIONS
2 in.(6.4 cm) diameter × 8.75 in. (22 cm).

WEIGHT
2 lbs (0.9 kg).

MEASURING HEAD

EXCITATION SOURCE
20-mCi Fe-55.

SHUTTER MECHANISM
Sample actuated, fail-safe.

FILTERS
Set of 4, externally switchable.

DIMENSIONS
7 in.(17.8 cm) diameter × 1 in. (2.5 cm)

WEIGHT
3.3 lbs (1.5 kg).

TABLE B: PRECISION (REPEATABILITY) OF % TiO_2 ANALYSIS AT THE 95% CONFIDENCE LEVEL

Basis Wt. lb/3300 ft²	± % TiO_2 (Absolute)					
	0	5	10	15	20	25
20	0.04	0.07	0.10	0.12	0.14	0.16
40	0.02	0.05	0.07	0.10	0.12	0.14
60	0.02	0.04	0.07	0.09	0.12	0.15
80	0.02	0.04	0.06	0.09	0.12	0.15
100	0.01	0.04	0.07	0.09	0.12	0.16

ELECTRONIC UNIT

MICROPROCESSOR
Z80A central processor unit; 12K PROM, 8K RAM.

DIMENSIONS
9.5 in.× 4 in.× 9 in.deep (24 cm × 10 cm × 22 cm).

WEIGHT
8 lbs (3.6 kg), with internal batteries.

DISPLAY
Alpha-numeric (16 segment × 4) and numeric (7 segment × 4) LCD.

CONTROLS
4 × 4 touch-type keyboard.

SEALS
Weatherproof.

SYSTEM

MEASUREMENT MODES
TiO_2, $CaCO_3$ in paper; wt. TiO_2 in coating.

DISPLAY FORMAT
Instructions, readout and element symbols.

CALIBRATION
Factory calibrated in all modes and up to 48 user-controlled calibration storage locations in memory.

OPERATING UNITS
Up to 6 selectable; e.g., lb/3300 ft², g/m².

PRECISION OPTIONS
4 selectable precision levels for measurement times of 4 seconds, upwards.

STANDARDIZATION
Automatic for source decay, detector efficiency and zero drift.

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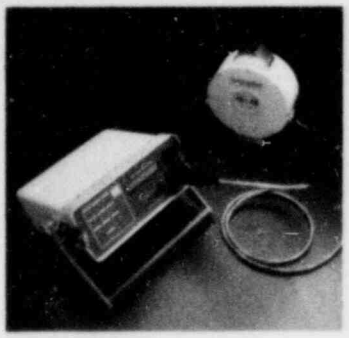
THE ALLOY ANALYZER™

TN's answer to positive material identification in the 1980s

9266

THE ALLOY ANALYZER

MICRO PROCESSOR



The Alloy Analyzer, from Texas Nuclear, is the state-of-the-art solution to the positive materials identification needs of industries around the world.

Now there is a quick, portable, accurate and non-destructive way to identify metals, and to make a quantitative analysis verifying both the type and elemental composition of alloys. If you have the responsibility for ensuring that alloy materials are of the correct specifications, the Alloy Analyzer,™ from Texas Nuclear, is the quality control solution you have been looking for. This state-of-the-art instrument is uniquely suited to combat the problem of materials mislabeling that normally runs about two percent, but often as high as ten to fifteen percent. It can help you quickly eliminate costly errors before they happen, reducing downtime and waste, and saving dollars.

The Alloy Analyzer is versatile enough for virtually any application that needs positive identification of metals in received shipments, in-stock materials, or at on-site jobs. In a matter of seconds (typically 20-30), materials can be checked thoroughly and non-destructively, so that your work can continue at an efficient pace. When it comes to combined performance and features, the Alloy Analyzer is the most practical instrument available today.

Positive material identification discovers a new era of technology.

The Alloy Analyzer operates on rechargeable batteries and is so lightweight, compact and portable that you can check on-site welds, small samples and varied pipe dimensions with little or no surface preparation. Operator interpretation is not needed, because the Alloy Analyzer provides direct LCD readouts of alloy type analyzed, element and percent of concentration. It is pre-calibrated at the factory for even greater convenience.

You can do more, quicker, without adding to the workload of lab technicians. One person can verify more materials with greater precision than he could using non-quantitative acid tests. With the Alloy Analyzer, he needs far less experience than spark-test readings require. He can handle the job with greater speed than previous, portable x-ray tests allowed; and he does not have to cut a sample, replace it, then go back and check the replacement–the piece he checks is not marked in any way.

You get accurate quantitative analyses, with no need for comparative standards. Surfaces can be rough and irregular, larger or smaller than the unit's testing aperture, as long as the area measured is free of paint and scale, and is chemically representative.

The chance of identity error with the TN Alloy Analyzer is less than one percent. Repeat measurements cut even that low figure dramatically. The equivalent of one hundred types of alloys are stored in its memory, to answer most needs with built-in, permanent calibration. Up to eleven elements can be analyzed.

The instrument represents a high-technological combination of proven analysis techniques with advanced microprocessor electronics. TN's Alloy Analyzer is so far advanced, in fact, that it needs no specific, radioactive-materials licensing on your part and can be shipped via normal air routes. On the job, it needs only the care you would give any other fine-quality test instrument.

Industry acceptance of the Alloy Analyzer already has ushered in a new era of positive material identification. This practical instrument is the means to future cost savings and to the increased profitability that results. It symbolizes the kind of progressive technology that has established a worldwide reputation for TN, Texas Nuclear.

TN's Alloy Analyzer is portable and can be used practically anyplace in your plant. It is versatile enough to perform non-destructive testing on a wide variety of sizes and shapes.

The Alloy Analyzer's electronic unit displays clear, LCD read-outs identifying the type of alloy and concentration of elements, with chemical symbol and percentage.

The Alloy Analyzer's measurement probe is hand-held, or it can be stood upright to allow materials to be placed over its aperture.

X-ray fluorescence gives you accurate, non-destructive testing.

TN's Alloy Analyzer comes to you conveniently packaged in its own carrying case. Included are a hand-held measurement probe with cable, electronic unit, shoulder strap, charger for the internal battery, auxiliary battery pack with charger and a 15-foot extension cable.

In operation, the probe can be either hand-held on the metal to be analyzed or set up on a bench, so that samples can be placed over the probe's aperture. When the operator initiates a measurement, the protective shutter mechanism opens, exposing the sample to low-energy source radiation. Atoms of elements in the metal fluoresce and emit x-rays characteristic of that particular element. The detector system then measures the intensity of the characteristic x-rays emitted, to determine the element concentrations. It identifies an alloy by its unique combination of elements. It provides quantitative analyses by making appropriate corrections for inter-element matrix effects. Results are shown on an alphanumeric LCD display.

The eleven elements included in the Alloy Analyzer's program are: *titanium* (Ti); *vanadium* (V); *chromium* (Cr); *manganese* (Mn); *iron* (Fe); *cobalt* (Co); *nickel* (Ni); *copper* (Cu); *niobium* (Nb); *molybdenum* (Mo); and *tungsten* (W). Approximately one hundred important engineering alloys can be identified by name. Alloys not in the memory can be interpreted from the element composition scan.

The two basic modes of identification and analysis can each be specially modified by the operator to alter the measurement precision, provide sample-size corrections and other features, through the touch-type keyboard. In this way, for example, the Alloy Analyzer can handle small-size, irregularly shaped samples and can perform non-contact measurements on high-temperature surfaces.

The system's direct readout clearly identifies the type of alloy; and, when analysis is requested, the concentration of elements in that alloy are displayed with the chemical symbol for each and its percentage. Measurement precision depends on the element and total alloy content, as illustrated in Table A.

The Alloy Analyzer's internal rechargeable batteries will provide six to eight hours of normal operation in the field. The rechargeable battery pack adds approximately seven more hours of continuous use.

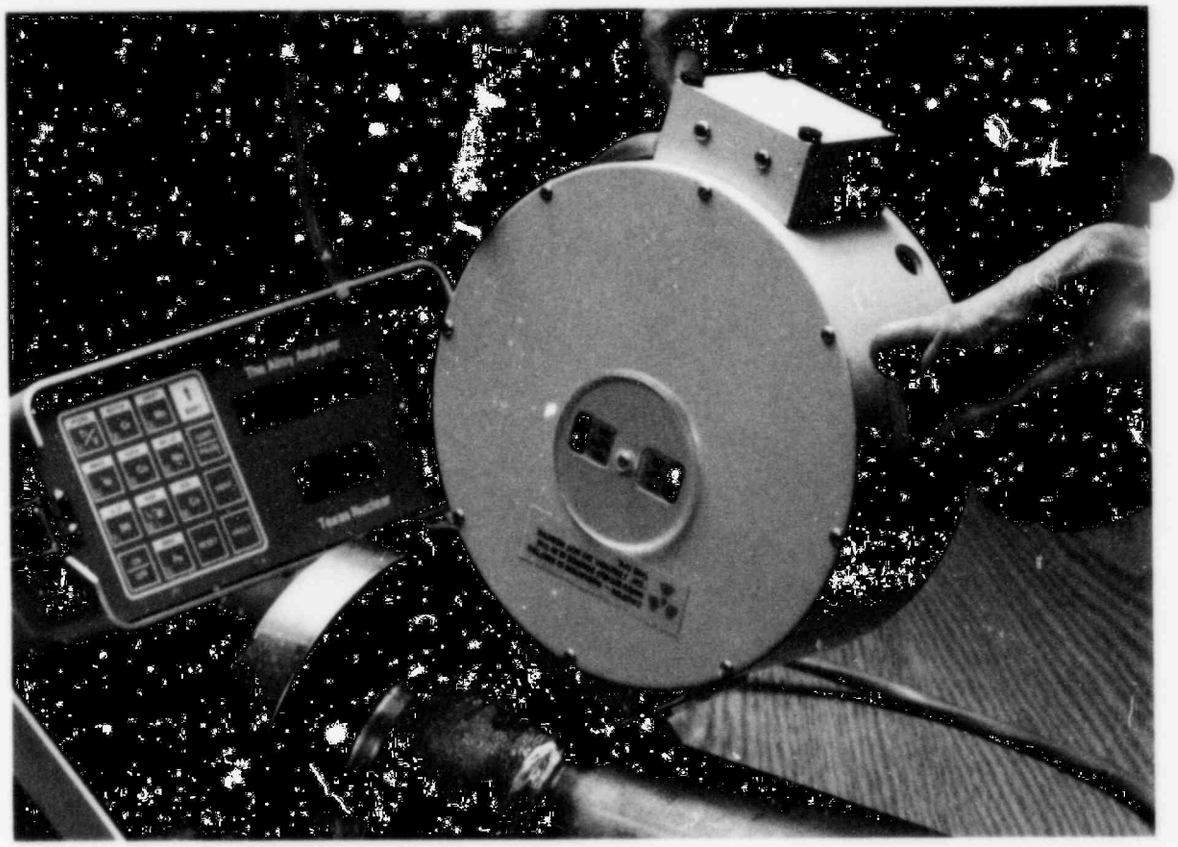
By combining the well-established technique of "radioisotope-excited x-ray fluorescence" with advanced micro-electronics, the TN Alloy Analyzer gives you the most practical means for rapid, accurate, non-destructive identification and analysis available today.

TABLE A
ANALYSIS PRECISION (%) ABSOLUTE ELEMENT FOR SOME LIBRARY ALLOYS

	ELEMENT %										
Alloy Type	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Nb	Mo	W
Cr Mo (2¼ Cr1Mo)	0.03	0.02	0.1	0.3	0.55	0.35	0.9	0.7	0.025	0.02	0.04
Stainless 304	0.03	0.02	0.3	0.3	0.55	0.5	0.6	0.5	0.02	0.02	0.04
Stainless 316	0.03	0.02	0.3	0.3	0.55	0.5	0.55	0.5	0.03	0.025	0.04
INCONEL 625	0.04	0.03	0.4	0.4	0.4	0.6	0.15	0.3	0.05	0.05	0.05
HASTELLOY X	0.04	0.03	0.35	0.35	0.5	0.6	0.2	0.35	0.04	0.045	0.05

Incoming shipments and in stock materials can be checked with the Alloy Analyzer, exactly and quickly. It can identify out of spec. metals before they become a problem or hazard.

In any industry where positive material identification is necessary, TN's Alloy Analyzer can pay for itself quickly in downtime saved and errors eliminated.



The one-of-a-kind investment in bottom-line savings.

TN's Alloy Analzyer is a unique instrument for solving a variety of critical needs in industry. Now you can check incoming shipments and in-stock materials, quickly and simply. You can pre-identify construction alloys with extraordinary confidence. You can identify materials after failures; or, better yet, discover problems before they become catastrophes.

Was that replacement valve 304 or 316 stainless? What alloy is in that long-stored box with no label? Did they deliver the right rods? Can you verify that certification before sending it to the customer? Is there a way to expedite failure analysis? Will that assembly hold up in critical service?

You can take the Alloy Analyzer to the stock room, the field, the lab or to the vendor's site–wherever those answers are needed.

Whether your job is engineering, construction, fabrication, refining, petrochemicals, processing, scrap metal, pulp and paper, nuclear power, military hardware or any other activity where the need for positive material identification exists, the TN Alloy Analyzer is an investment with tangible returns.

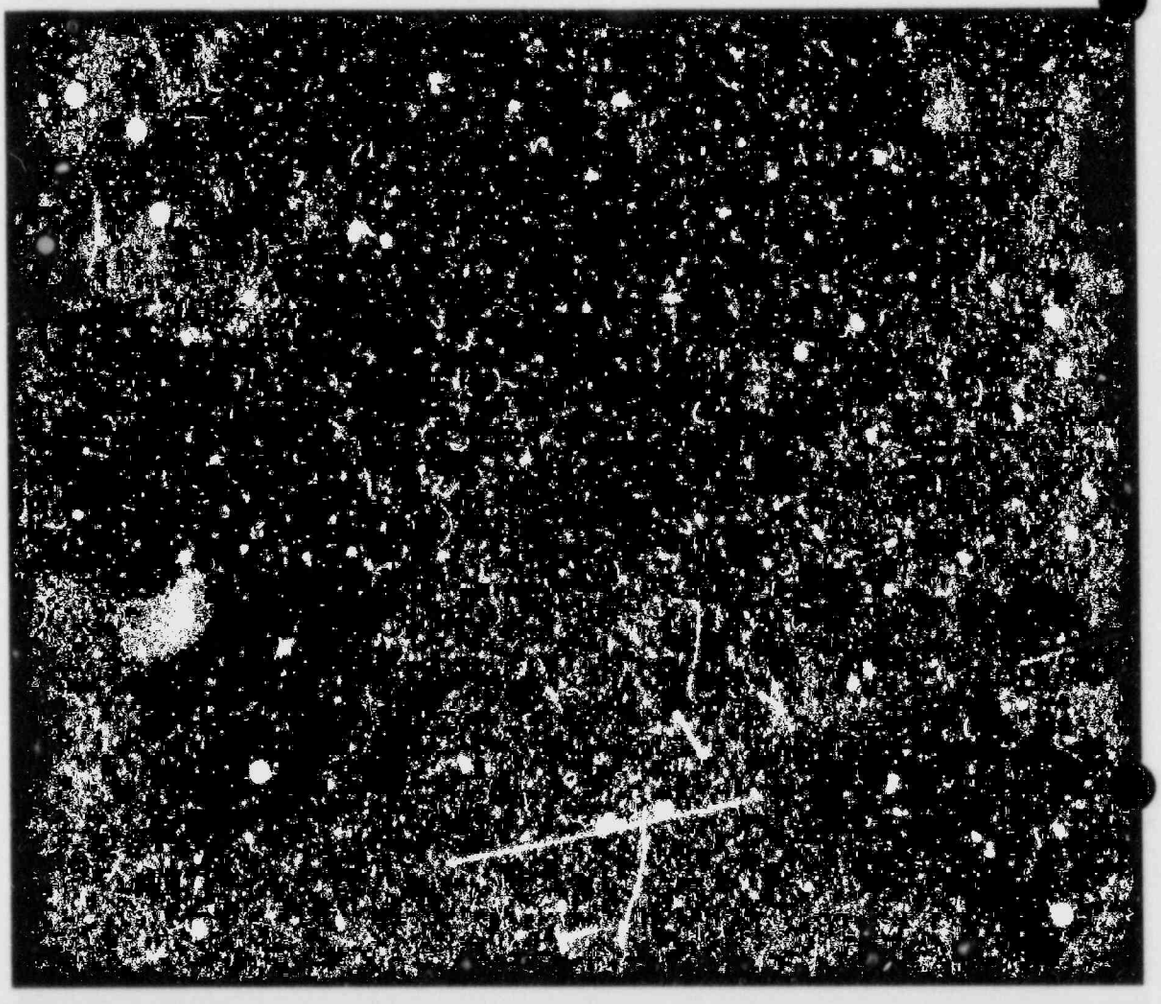
Downtime can be avoided. Safety can be improved. You can eliminate errors, promote efficiency and save total working time. Your customer relations can be enriched. And your bottom-line profits can earn a boost.

Texas Nuclear's 25 years of experience in instrumentation, plus its unmatched record for innovation, have given the company worldwide recognition as a leader in measurement technology. The Alloy Analyzer is an impressive example of TN's progressive approach to advancing the accuracy and ease of rapid, on-site verification of important engineering alloys.

Contact your nearest TN representative for the latest in today's (and tomorrow's) technology. Or write to Texas Nuclear, P.O. Box 9267, Austin, Texas 78766. Phone: (512) 836-0801. Telex: 77-6413.

You do not have to work through TN's Austin, Texas, headquarters for service. Parts and assistance are provided by affiliated companies located strategically throughout the free world.

Trained personnel can help you get started on improving your quality control, anywhere you need them. Write, call or wire the TN representative nearest you.



Thorough service on a worldwide basis.

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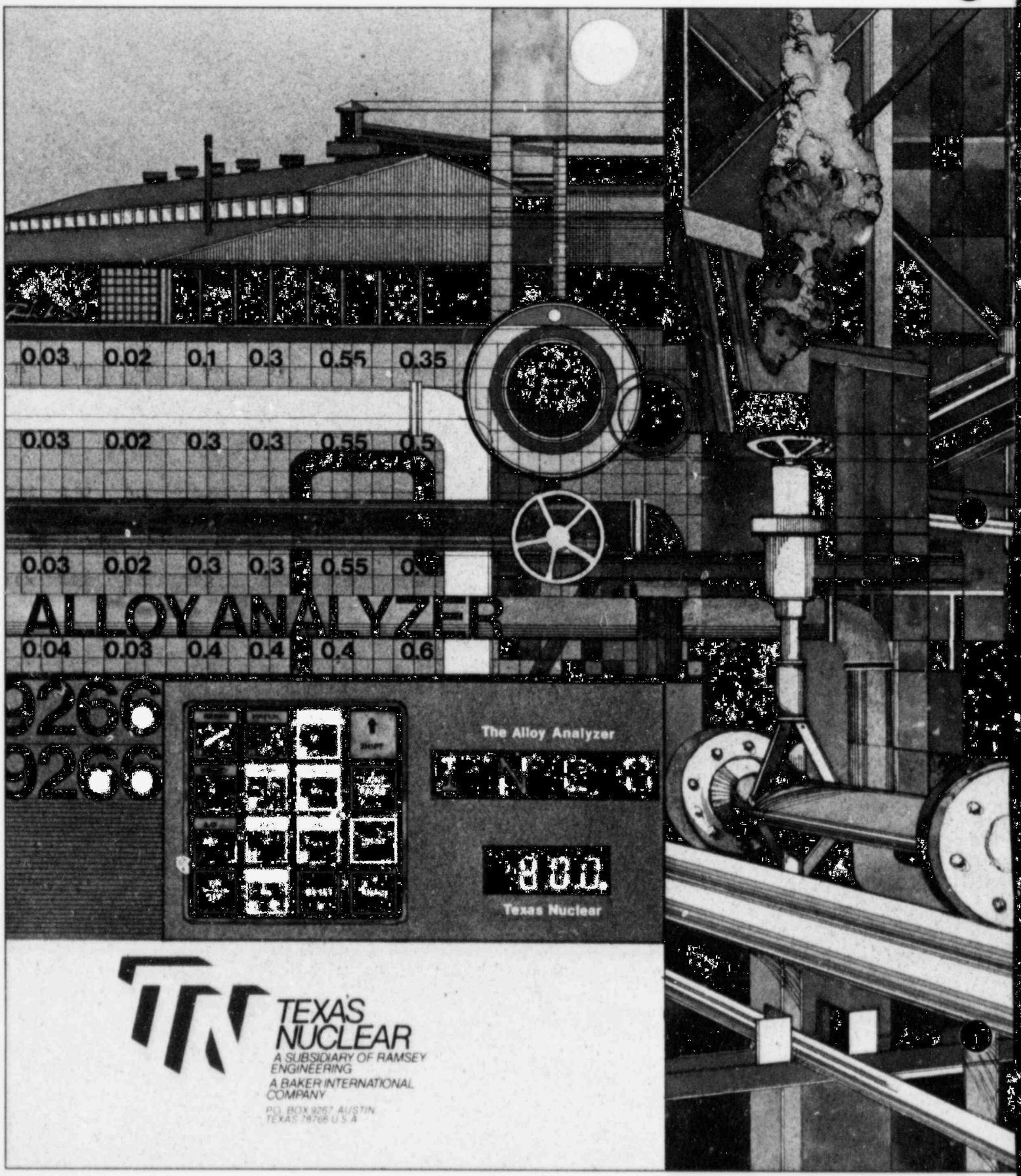
SPECIFICATIONS

General	
Ambient operating temperature:	32°F to 140°F (0°C to 60°C).
Maximum sample temperature:	248°F (120°C).
Battery life:	(contained in unit) 6 to 8 hours continuous use per charge (recharge time 14 hours; AC/DC charger included).
Extended battery pack life:	6 to 8 hours of continuous use per charge (recharge time 14 hours; AC/DC charger included)
System weight:	13 lbs (6 kg), basic system plus batteries.
Shipping weight:	40 lbs (18 kg), in carrying case with all accessories including back-up battery pack, standards, etc.
Probe Unit	
X-ray excitation sources:	Fe-55 and Cd-109.
X-ray detector:	High-quality, gain-stabilized.
Measurement area:	1.5 in × 0.5 in (3.8 cm × 1.3 cm), aperture size.
Probe size:	7.0 in (17.8 cm) diameter × 2.8 in (7.0 cm) wide housing.
Weight:	5.0 lbs (2.3 kg).
Electric Unit Dimensions:	9.5 × 4 in × 9 in (24.1 cm × 10.2 cm × 22.9 cm) deep; 12 in (30.5 cm) deep, with external battery pack.
Weight:	8 lbs (3.5 kg) including internal batteries; 11 lbs (5 kg), with additional battery pack.
Display:	dual window, liquid-crystal alpha-numeric readout.
Controls:	4 × 4 touch-type keyboard (plus remote control at probe).
Other features:	clip-on shoulder strap and carrying handle/bench stand.
System Element coverage:	11 elements (Ti, V, Cr, Mn, Fe, Co, Ni, Cu, Nb, Mo, W).
Display format:	alloy type (e.g. SS 316, INCO 625); element symbol (e.g. Cr) and % value.
Measurement modes:	Identification and analysis.
Modifiers:	precision (4 levels) ½, 1, 2, 3; size correction (3 factors) for size, shape and air gap.
Standardization:	automatic correction for source detector and its characteristics.



TEXAS NUCLEAR

A SUBSIDIARY OF RAMSEY ENGINEERING

A BAKER INTERNATIONAL COMPANY

P.O. BOX 9267, AUSTIN, TEXAS 78766 U.S.A.

PRODUCT BULLETIN

WEIGHT

CONVEYOR SCALES

For continuous weighing of materials on all types of conveyors

The WS Series Weigh Scale system provides a measurement of total weight and total weight per unit time. Typical uses include recording, controlling and totalizing materials for a wide variety of purposes such as shipping, storage, inventory, batching, and mixing. The system can be used on various conveyor types including drag chain conveyors, vibrating conveyors, and inclined chutes as well as standard conveyor belts. In most installations no modification of existing equipment is required; having "A" frame construction, the scale assembles around the conveyor and bolts to the frame. Since operation is non-contacting and there are no moving parts; there is no friction wear and maintenance is negligible.

Every component in the basic system has been engineered specifically for the scale. The result of this matched component design is reliability and performance far superior to any previously achieved with nuclear scales.

Design and construction meet the safety requirements of the NRC and Agreement State licensing agencies.

Another important feature of the WS system is built-in recalibration. The time required for recalibration is considerably less than that required for conventional weighing methods and there is no need for costly and hard to handle accessory equipment.

Outputs are compatible with standard recording and control equipment.

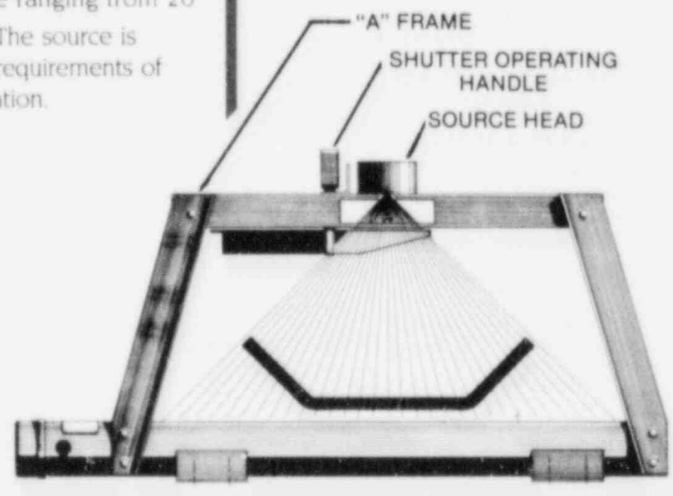
The accuracy and simplicity of the system make it ideal for weighing applications in the mining, fertilizer, chemical, cement, pulp, paper, and food industries, to name a few.

Source Housing, Detector and Integrator

The basic WS system consists of two major components—an "A" frame which houses the source and detector, and an integrator. The upper portion of the "A" frame contains the source and shutter assembly. The bottom section houses the detector. The source housing is supplied with a Cesium-137 source ranging from 20 to 200 millicuries. The source is sized to meet the requirements of the specific application.

The detector is a high efficiency ion chamber which is heated and thermostatically controlled to eliminate temperature variations and moisture condensation. The detector housing is weather-proof and is constructed to meet the explosion-proof requirements for Class I, Group D Division I hazardous environments.

The integrator is of modular, solid state design. It is housed in a dust-proof, weather-proof NEMA 4 enclosure (explosion-proof available) specifically constructed for operation in severe environments. The meter is of the rugged taut-band variety calibrated 0 to 100 percent of span in ten major divisions. Standard current outputs are available (4–20 mA, 10–50 mA and 1–5 mA).



Scale Features

- Easy and economical to install without alteration of existing equipment.
- Non-contacting, eliminates wear of scale and conveyor parts.
- Operates equally well on inclined or flat conveyors.
- Absence of moving parts minimizes operating and maintenance costs.
- Operates on reversing belts without modification.
- Not affected by belt tension.
- Not affected by idler alignment.
- Rugged construction for severe environments.
- Installs in only one foot of belt length.

Installation

The WS weigh scale is designed with a "A" frame construction to simplify installation. The "A" frame is assembled around the conveyor and bolts to the conveyor frame. The unit is installed at a convenient point in the process stream. The integrator may be mounted at the point of measurement or up to 5000 feet away from the actual installation on the belt.

Operation/Optional Output and Control Signals

The WS Belt Weigh Scale operates on the principle of gamma ray absorption. A radioactive source emits gamma rays which pass through the material on the conveyor to the detector. The rays are absorbed in proportion to the mass of the material on the belt. Those rays passing through without being absorbed produce an electrical current in the detector. The integrator converts this current to a signal output that is proportional to the mass of material on the belt (belt loading).

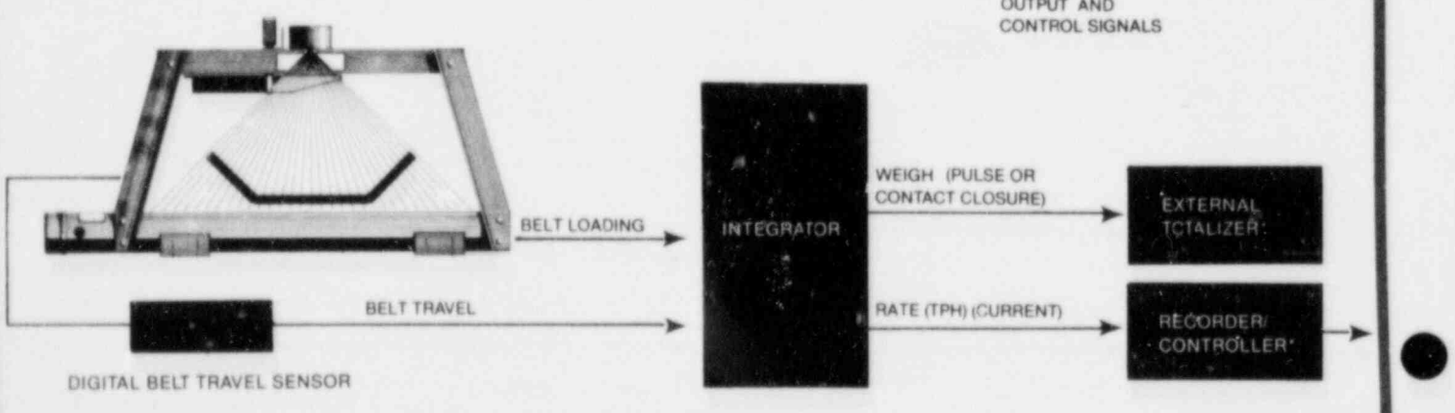
The WS Belt Weigh Scale eliminates one signal handling step common to other nuclear and electronic scales. In the WS Scale, the linearized loading (lb/ft) signal is multiplied directly by a belt travel signal (ft); to produce a total weight (lb) signal eliminating the lb/ft to lb/min conversion. This is accomplished by use of a digital belt travel sensor which produces a pulse for each increment of distance traveled by the belt. Each time the scale receives a pulse it accumulates a group of counts which is proportional to belt loading. The weight signal is monitored by a current converter to produce a current output which represents throughput (TPH).

Calibration

It is not necessary to plot the response for various belt loadings. For most applications, the linearity correction is adjusted automatically when the unit is standardized. THIS IS AN EXCLUSIVE TN FEATURE.

The Scale is calibrated by setting an approximate sensitivity, running a material test and setting in a correction factor on a calibrated dial. There are five different calibration techniques available so that any application situation can be accommodated.

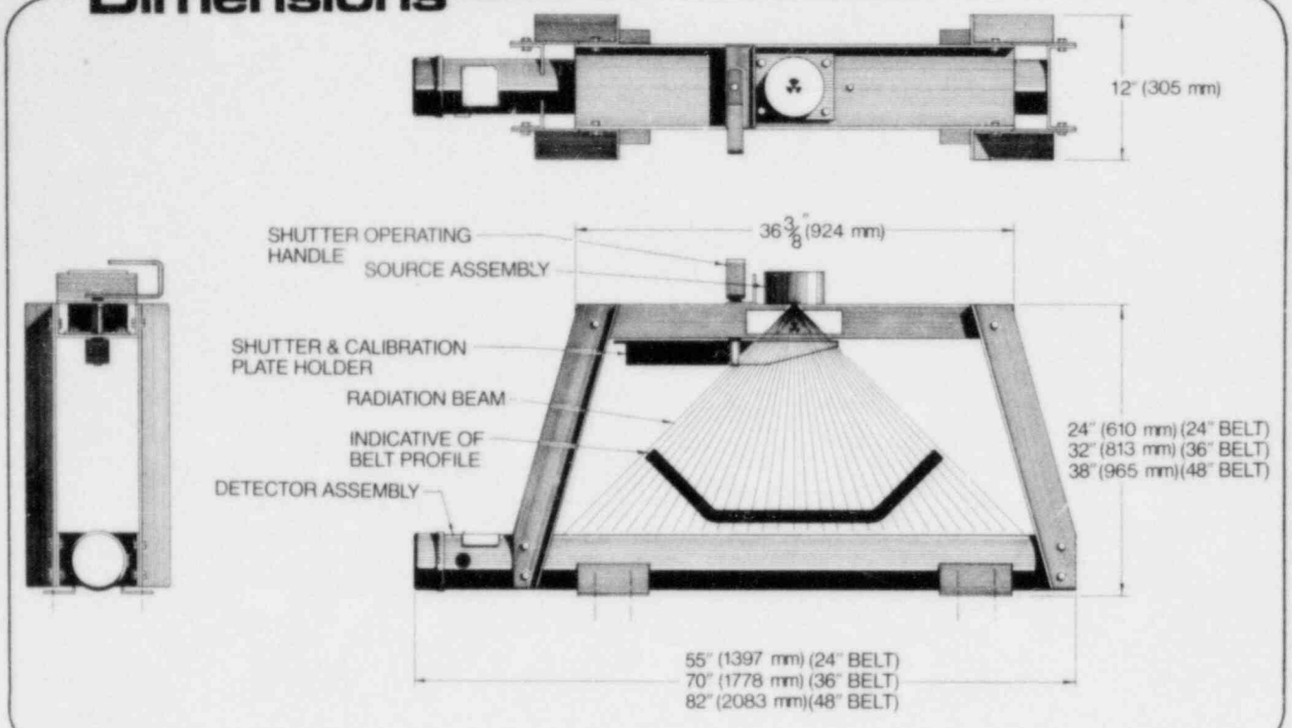
A convenient time-saving method of recalibration is provided. No costly equipment is needed. To recalibrate, the calibration plate is put in position in the radiation beam when the belt is empty. The calibration plate represents a known belt loading and provides a fixed reference point for recalibration regardless of changes in source, detector, or electronics.



Operation of the WS Scale Output options permit almost any conceivable weighing and control mode.

*User supplied

Dimensions



Specifications

General—

Accuracy: within 1–3% of test load depending on application. (Consult factory.)

Current Output: Throughput 1–5mA (0–6000 ohms); 4–20mA (0–1500 ohms); 10–50mA (0–600 ohms). (May be grounded or isolated).

Readout: Taut-band meter (indicates throughput), 5 Digit Totalizer

Time Constant: (Adjustable) Range is selected for application.

Power Requirements: 115 or 230 VAC ± 10% @ 50–60 Hz.

Construction: Designed to meet CSA requirements.

Gauge Head—

Radiation Source: Cesium–137, doubly encapsulated in a heliarc welded, stainless steel capsule. Source sizes ranges from 20 to 200 milliCuries.

Radiation Source Housing: Lead and special metal alloys. Radiation levels are below 5 mR/hr one foot from any accessible surface except within the measurement beam. Design and construction meet the safety requirements of the NRC and Agreement State licensing agencies.

Shutter: Three position, lever actuated, steel encased lead block. May be locked in closed position.

Detector: Ion Chamber, heliarc welded, stainless steel, guard ring construction. Temperature controlled to eliminate humidity effects.

Operating Temperature: –40° to 155°F. Thermal isolation or insulation must be provided if temperatures exceed these limits. Consult factory.

Process Temperature: Unlimited.

Interconnecting Wiring: Single four conductor shielded cable.

Threaded Conduit Connector: ¾ inch (19 mm).

Weight: 220 to 280 lb. (99.7 to 127 Kg), depending on belt width.

Integrator—

Circuitry: All solid state. Integrated circuits used where applicable. Modular construction.

Linearity: Better than 0.1%

Operating Ambient Temperature: –20°F (–29°C) to 140°F (60°C).

Enclosure: NEMA-4 enclosure. Dust-proof, moisture-proof construction. Designed for operation in severe environments. (explosion-proof optional.)

Dimensions: 12 in. (31 cm) high, 10 in. (26 cm) wide, 5¼ in. (13.5 cm) deep.

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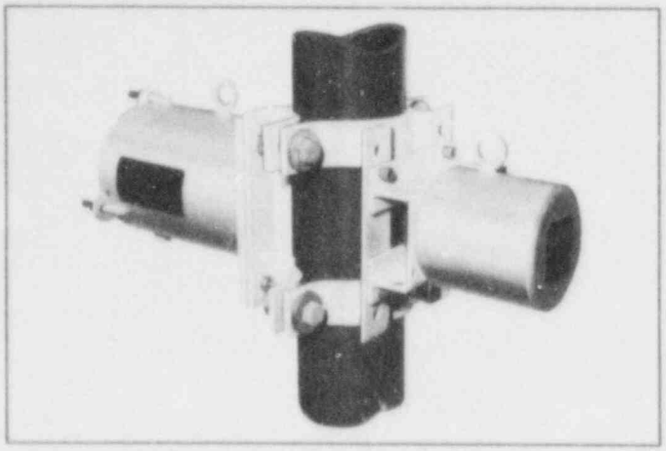
TEXAS NUCLEAR
A SUBSIDIARY OF RAMSEY ENGINEERING

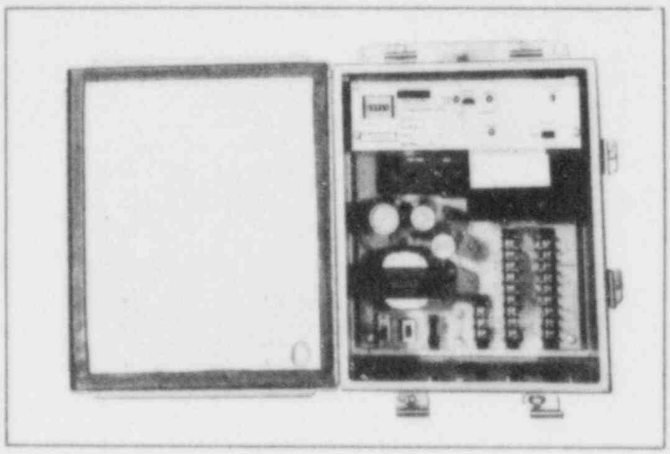
SGF & SGH Series

SG Series Density Gauge

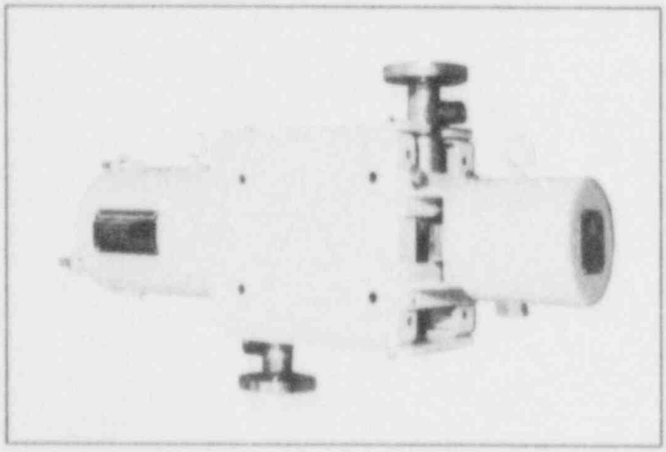
Technical Specifications



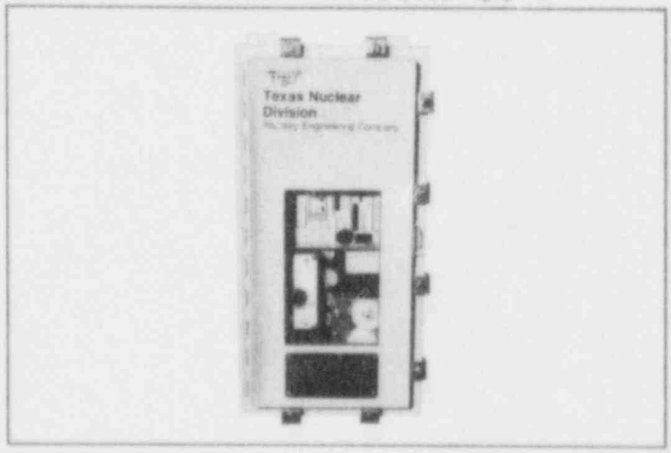
Detector and Source/Source Head
Mounted on Vertical Pipe



SGH Amplifier, NEMA Enclosure



Detector and Source / Source Head
Mounted on Z-section pipe



SGF Amplifier, NEMA Enclosure

- Non contacting - unaffected by process temperature, pressure, viscosity, flow, caustic or abrasive material.
- All solid-state circuitry for utmost in reliability and ease of field maintenance.
- Glass epoxy plug-in circuit boards.
- Factory Precalibration available for all systems.
- Span Calibration plates available on all systems.
- Gain Independent Standardization eliminates span adjustment when restandardizing.
- Broad spectrum of system configurations matches performance to application requirements.
- Applications include:
  Density Control
  Percent Solids Control
  Mass Flow Measurement and Control
  Other material characteristics
- Integrally mounted options: source decay and temperature compensation, linearization, mass flow multiplication and totalization.

GENERAL

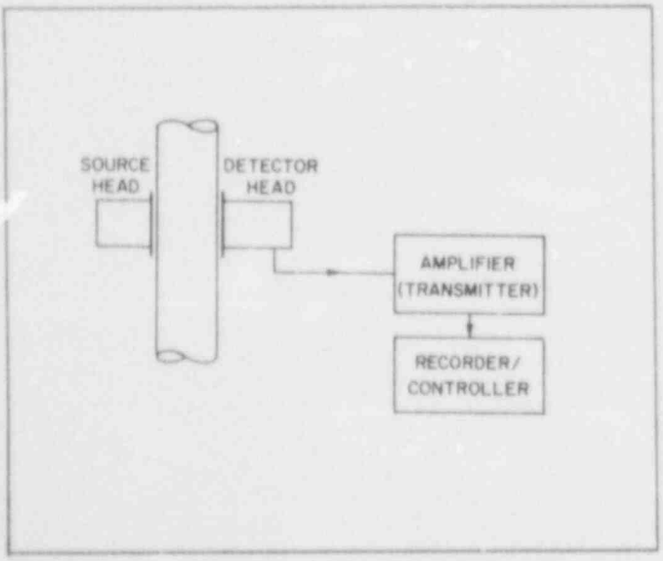
The Texas Nuclear SG Series Density Gauges are rugged, low maintenance instruments designed for continuous, on-stream service in all industrial environments. In addition to being widely used to measure the density of liquids or slurries in process lines, the gauges are also adaptable to the measurement of solids in bins and on conveyors. The sensing head contains no moving parts and functions without contacting the process stream. In most cases, it is simply clamped to the pipe without interrupting the process.

The accuracy, simplicity and proven performance of Texas Nuclear Density Gauges have led to their extensive use in chemical, petro chemical, mining, pulp and paper, food, and cement industries. Their rugged construction and high tolerance for industrial environments have enabled users to improve quality, increase productivity, and reduce production costs without taxing instrument maintenance capabilities.

OPERATION

SG Series Density Gauges consist of three components: a source head, a detector, and a transmitter which incorporates the power supply and signal handling circuitry. The source head and detector are installed at a convenient measuring point on the process stream. Gamma rays from the source pass through the process material and are absorbed in proportion to material density. The radiation reaching the detector produces a signal which is inversely related to material density. An increase in product density results in a reduced detector signal.

The detector signal is processed by the transmitter which is a separate unit that can be located conveniently in any general purpose area. A wide range of electronic configurations, in various types of enclosures, is offered in the SG Series allowing for the selection of an instrument best fitted for the individual application at the lowest possible cost.

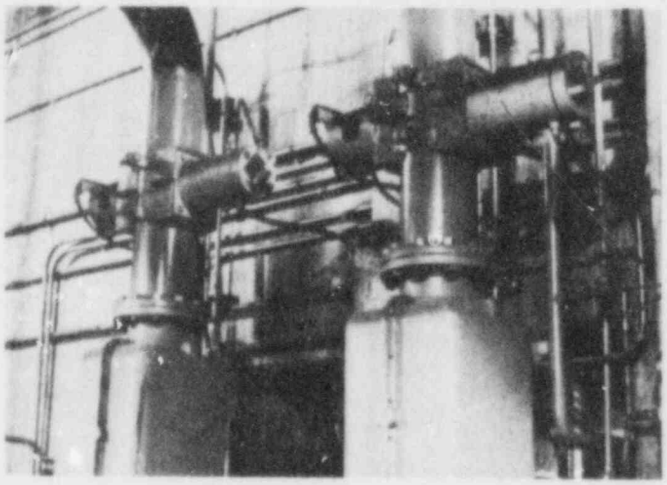


SYSTEM CONFIGURATIONS

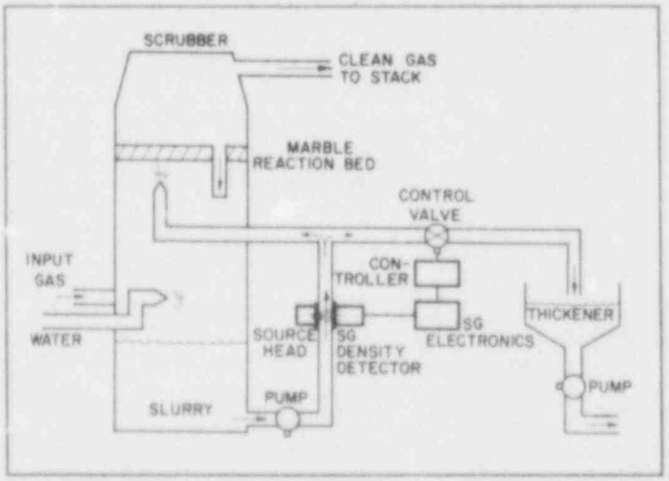
Using high stability solid state circuitry, the SG Series density systems will satisfy the performance requirements of even the most stringent applications. Two basic systems, the SGF and SGH may be selected to meet requirements for options and ease of set up and use features.

A large selection of optional features are available with the SG Systems, including linearization, mass-flow multiplication, totalization, temperature compensation, source decay compensation, Hi-Lo Alarm relays, shutter switches, explosion-proof gauge head, factory precalibration, and calibration plates. NEMA, panel mount, or explosion-proof transmitter enclosures may be provided.

SG Series gauges are easily installed on pipes and containers. A pipe saddle requiring four bolts is used to clamp the source and detector to process pipes. Installation can be quickly accomplished on either vertical or horizontal lines. Vertical pipes are preferred on most slurry applications when solids in the product have a tendency to settle out. In addition, standard Z-mount saddles are available for pipe sizes from one through four inches to provide increased sample thickness when required.



Typical Installation of Density Systems in Conjunction with Magnetic Flow Meters



Wet Scrubber Control

CALIBRATION

GENERAL

The SG systems may be calibrated using one of several procedures tailored to various applications. These include techniques utilizing only a single sample point such as water or a process sample as well as techniques utilizing data from complete sets of sample points.

FACTORY PRECALIBRATION. (Optional) Given complete process material data, Texas Nuclear can accurately establish a calibration curve for a particular application. The operating level of the user's gauge is established by setting up the gauge on a pipe full of water (or empty if operating density is closer to zero than 1.0 specific gravity units). This operating level along with the process material description and other application variables are fed into a computer program which calculates the gauge calibration settings.

STANDARDIZATION. In order to compensate for wear or buildup in the process line, the effects of source decay and minor electronic changes, the gauge may be periodically restandardized. Restandardizing the gauge references the measurement to a fixed point. This type of standardization usually provides the optimum reference for a radiation density measurement. A pipe full of water, with or without Standard Block, or an empty pipe, with or without Standard Block, may be used as a standardization reference point as appropriate for the particular application.

EQUIVALENT ABSORBER PLATES. (Optional) The normal standardization and recalibration technique employed with all SG Density Gauges provides for complete and accurate calibration checking (both suppression and span settings). "On-Scale" calibration plates are also available for use as an additional calibration check. Either of these calibration methods can be performed readily by non-technical personnel.

COMPONENT CONSTRUCTION

The size of the source head supplied with the SG System is determined by the source activity required for the application.

The source has a three position (open-closed-standard) manually operated shutter. A slide-type shutter is normally supplied. A rotary shutter is available as an option. Shutter position indicator switches are also optional.

DETECTORS. The high efficiency ion chamber detector is thermostaticaly controlled to insure stable operation. The detector is contained in a weather-tight housing. Explosion-proof detector housings (Class I, Group C & D, Class II, Groups E, F, & G and Class III) are available.

INDICATOR-TRANSMITTERS. All SG transmitters use plug-in circuit boards with gold plated contacts for ease of maintenance and high reliability. Boards are of the highest quality epoxy-glass material. Industrial grade circuit components which have been tested for extreme environmental conditions are utilized. All SG systems are designed to meet the requirements set by the Canadian Standards Association.

ACCURACY CONSIDERATIONS ON SG SYSTEMS

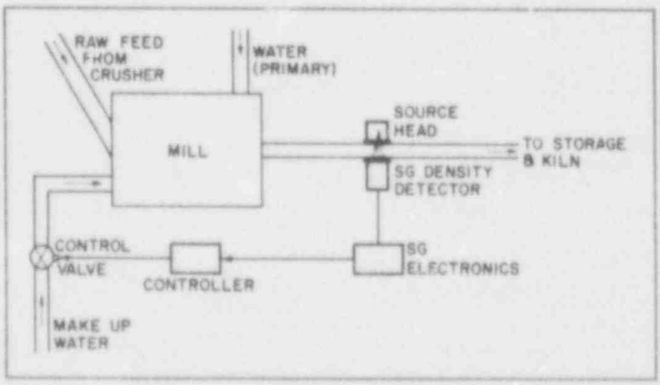
The major accuracy parameters of concern in a radiation density gauge are Precision (Repeatability), Linearity (Tracking), Stability and Calibration Accuracy. For any set of application parameters, the expected performance of an SG system can be determined by your Texas Nuclear representative.

PRECISION. Precision is determined by many factors. The most important are source size, system time constant, pipe size, pipe wall and the process material. SG systems, employing a high efficiency detector in conjunction with a wide range of source sizes, easily meet the precision requirements of the most stringent applications. Standard deviations of better than ± 0.00001 specific gravity units may be realized depending on the application. Typical precisions are in the range of ± 0.0001 to 0.001 specific gravity units.

LINEARITY. The radiation absorption process produces an inherent non-linearity in the output of all nuclear density gauges. The degree of non-linearity and its importance to the user is dependent upon the application. In very narrow span applications, the non-linearity is negligible. In many situations, however, such as mass flow measurements, signal linearization is essential. The non-linearity of a density gauge may be anywhere from $\pm 0.1\%$ to more than $\pm 25\%$ depending on the application. The main parameters affecting non-linearity are density span and pipe size. A Texas Nuclear linearizer may be provided to insure a linear output over the entire measurement span.

STABILTY. The principal factor affecting the stability of a density gauge is source decay. Since the source (normally Cs137) decays at a fixed rate, the effect of source decay on the measurement will be dependent solely on the fraction of the available radiation which is absorbed over the range of density measurement. The main parameters determining the effect of source decay are density span and pipe size. When this effect exceeds acceptable limits, a source decay compensator can be provided.

CALIBRATION ACCURACY. Ultimate calibration accuracy is dependent upon the care with which the user takes samples which are representative of process material. In most cases, factory precalibration may be provided. Given complete process material data, Texas Nuclear can accurately precalibrate an SG system limited only by the difference in pipe ID between user's pipe and the factory's calibration pipe.



Raw Mill Control System—Wet Cement Process

FEATURES OF THE SG SYSTEMS

GENERAL

SATURATION IMMUNITY. The apparent change in specific gravity represented by an empty pipe condition is often several times the range for which the instrument is calibrated. Hence, a density gauge can require several response time constant intervals to recover to an on-scale reading from an empty pipe condition. Texas Nuclear SG gauges are designed to eliminate this phenomena. The SG will come on scale shortly after the process is reestablished and, then, recover to a proper reading with the normal time constant.

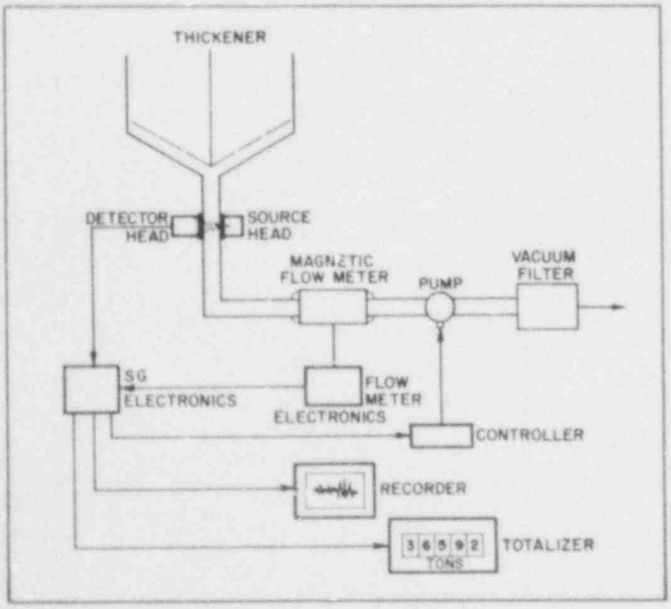
MANUAL OVERRIDE. The SGF System is provided with a manual override feature which may be actuated (either internally or remotely) in the event of a process anomaly. This allows the output of the gauge to be held at a fixed point independent of the actual process density. This hold point is adjustable.

HI-LO LIMIT ALARM RELAYS. (Optional) The Hi-Lo Limit circuit provides contact closures for high density or low density conditions. The high and low points are separately adjustable and have independent relays.

COMPUTATIONAL

MASS FLOW COMPUTATION. (Optional) In order to make mass flow measurements, the input signal from a magnetic (or other type) flow meter may be fed into the SG Mass Flow Transmitter. The mass signal (density) is multiplied by the flow signal input to yield a current output which is a direct representation of true mass flow, expressed as any weight units per unit time, i.e., tons/hour, kilograms/minute, etc. Continuously adjustable density offset is provided.

TOTALIZATION. (Optional) The mass flow totalizer circuit integrates the mass flow signal over time. The totalized mass is displayed on an integral register. The totalizer also supplies pulses and/or contact closures to drive external totalizer, batching totalizers, and/or printing totalizers.



Thickener Underflow Density Measurement and Control

ACCURACY ENHANCEMENT

OUTPUT LINEARIZATION (Optional). The Texas Nuclear Density Gauge Linearizer is specifically designed to linearize the signal from a gamma ray absorption type density gauge. This unique device generates a mathematically true representation of the radiation absorption function using no diode function generators, piece-wise approximation devices, or breakpoints. Non-linearity correction is automatic and there are no linearity controls to be adjusted. Calibration is accomplished using exactly the same calibration data as employed for a density gauge without linearizer. In addition, the linearizer automatically corrects the sensitivity changes due to source decay when the system is restandardized, either manually or by the source decay compensator. This is an exclusive feature of Texas Nuclear's SG systems.

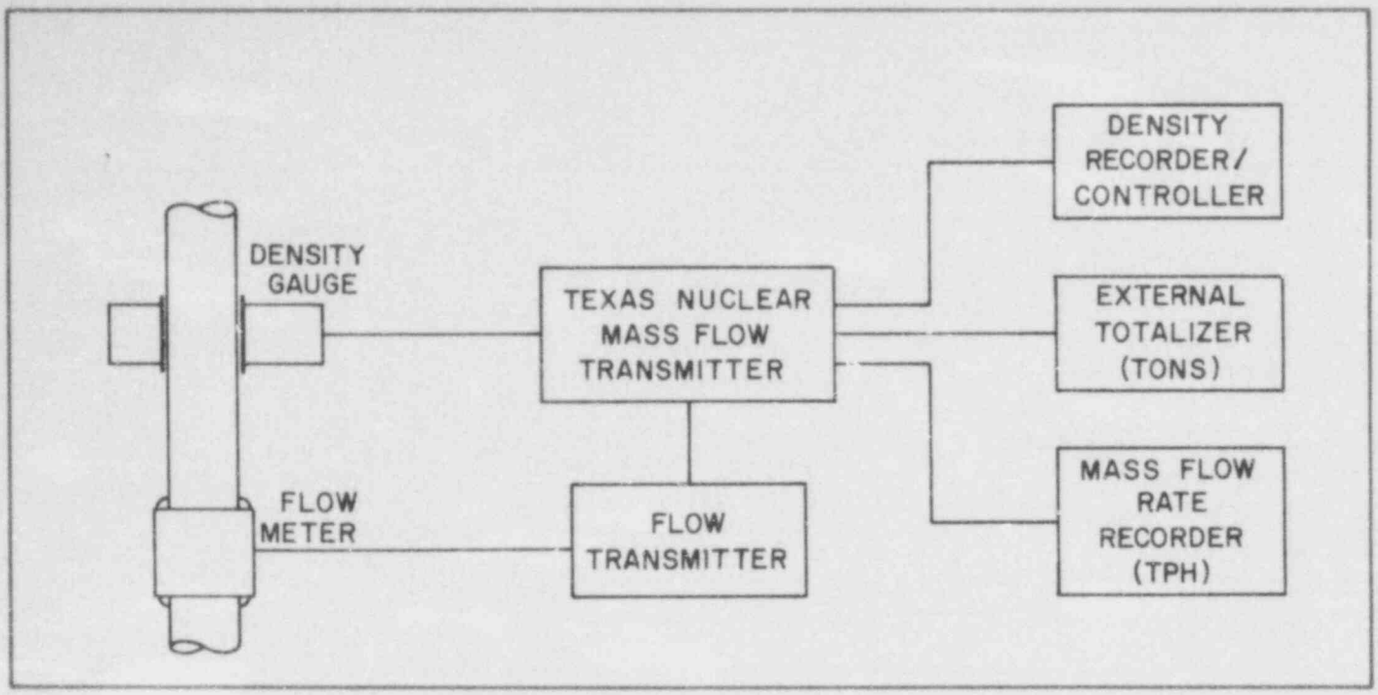
The unique design of the Texas Nuclear linearizer allows it to be set up without plotting response curves as is required with conventional linearizers. Maximum calibration accuracy may be obtained using only two operating points and use of only one operating point will normally yield very good results.

TEMPERATURE COMPENSATION. (Optional) The output of a density gauge will reflect the density changes due to constituent changes in addition to density changes due to other parameters, such as temperature. In some processes, the primary quantity of interest is not the absolute specific gravity of the material itself, but rather the variation of constituent concentration in the material. If the change in density due to temperature in this type of application exceeds the acceptable error limits for the measurement, the gauge may be temperature compensated to ignore density changes due to temperature, thus reflecting only density changes due to the parameter of interest. This is accomplished by use of a temperature sensing probe in the process material. This technique is effective to the extent that the temperature coefficient (SGU/°C) of the process material is constant over the operating temperature range.

SOURCE DECAY COMPENSATION. (Optional) The Cs137 radiation source normally employed in this type of gauge decays with a 30 year half life. This results in about 0.05% per week change in the absolute radiation level. The equivalent SGU drift per week effect on typical applications will be 0.004 divided by pipe ID (in inches)(i.e., 0.0005 SGU /wk on an 8 inch pipe). Although on large pipes or broad spans, this drift rate may be unimportant, on small pipes with narrow density spans, this rate will often be unacceptable and a source decay compensator is recommended.

The source decay compensator functions to change the suppression signal at the same rate that the radiation level is changing, thus, nullifying the zero offset drift created by the decay of the source. This is accomplished by the use of a synchronous clock motor which runs for a two year period before it is reset to start again. This reset can be accomplished in 5 minutes, without turning off the unit.

When used in conjunction with the Texas Nuclear linearizer, sensitivity drift (.05%/wk regardless of pipe size or span) is also automatically compensated—an exclusive Texas Nuclear feature.



Mass Flow Using SGF or SGH Systems

	SGH	SGF
FEATURES, STANDARD	Current output* (grounded or isolated), gain independent standardization, calibration reference, variable time constant.	Same features as SGH plus push button mode selector, selectable time constant range, override circuit, time constant bypass.
FEATURES, OPTIONAL	Factory Precalibration, Explosion-Proof Gauge Head, Source Decay Compensation, Calibration Check Plates (redundant), Shutter Indicator Switches, Automatic Span Correction during Standardization, Second Current Output, Linearization, Mass Flow-Multiplication, Totalization, Hi-Lo Limit Relays, Product Temperature Compensation.	Same optional features as SGH plus AC preamp (called SGE), linear dial reading of span (with linearizer)
TRANSMITTER ENCLOSURE	NEMA 4 (Explosion-proof available)	NEMA 4 (Explosion-proof available) or Panel Mount
GAUGE HEAD	Oil, Weather tight, (Explosion-Proof available, Class I, Group C & D, Class II, Groups E, F, & G, Class III).	Oil, Weather tight, (Explosion-Proof available, Class I, Group C & D, Class II, Groups E, F, & G, Class III)
READOUT	Panel Meter: 0-100 in 10 major and 50 minor divisions.	Panel Meter: 0-100 in 10 major and 50 minor divisions.
CURRENT OUTPUT* (One or two outputs, for density and/or mass flow)	1-5mA (load of 6000 ohms or less) 4-20mA (load of 1500 ohms or less) 10-50mA (load of 600 ohms or less)	1-5mA (load of 6000 ohms or less) 4-20mA (load of 1500 ohms or less) 10-50mA (load of 600 ohms or less)

* ...trument common (neg current) may be isolated from earth ground at the amplifier to provide compatibility with common negative control panel system without the need for an external isolator.

	SGH	SGF
MINIMUM MEASUREMENT SPAN	Down to .15 SGU-inches (SGU x Pipe ID) depending on performance requirements and process material.	Down to .075 SGU-inches (SGU x Pipe ID) depending on performance requirements and process material.
PRECISION (REPEATABILITY)	Standard deviation from 0.00001 specific gravity units, depending on application.	Standard deviation from 0.00001 specific gravity units, depending on application.
SOURCE DECAY EFFECTS (without compensation)	Approx. 0.004-ID (inches) specific gravity units per week depending on application.	Approx. 0.004-ID (inches) specific gravity units per week depending on application.
LINEARITY (Tracking) (without linearizer)	From ±0.1% depending on application.	From ±0.1% depending on application
RESPONSE TIME CONSTANT	Adjustable over a range of 15 to 240 seconds. Other ranges available on request.	Adjustable over a range of 15 to 240 seconds. Other ranges available on request.
SATURATION IMMUNITY	Amplifier will not saturate under empty pipe conditions. On-scale reading will be achieved in less than one time constant after restoration of process.	Amplifier will not saturate under empty pipe conditions. On-scale reading will be achieved in less than one time constant after restoration of process.
MANUAL OVERRIDE	None	Panel switch or remote contact closure locks out effects of process density and holds output at adjustable pre-set level.
MASS FLOW MULTIPLICATION	Plug-in module multiplies by flow meter signal to yield mass flow of dry solids or total material. Density offset level is continuously adjustable. (Optional feature)	Plug-in module multiplies by flow meter signal to yield mass flow of dry solids or total material. Density offset level is continuously adjustable. (Optional feature)
TOTALIZATION (Available in NEMA enclosure only)	Totalization rates continuously variable from 1 to 450 counts per minute are available with a 6 digit non reset totalizer standard and optional remote devices such as batchers and printers. Contact closure output also available. (Optional feature)	Totalization rates continuously variable from 1 to 450 counts per minute are available with a 6 digit non reset totalizer standard and optional remote devices such as batchers and printers. Contact closure output also available. (Optional feature)
FLOW METER INPUT	0-5V, 0-4mA or V, 1-5mA or V, 0-16mA, 4-20mA, 0-40mA, or 10-50mA. Neg. side connected to instrument common.	0-5 V, 0-4mA or V, 1-5mA or V, 0-16mA, 4-20mA, 0-40mA, or 10-50mA. Neg. side connected to instrument common.
HI-LO LIMIT ALARM RELAYS	Independently adjustable high limit and low limit relay trips. Each has SPDT 5 amp contacts. (Optional feature, not available with mass flow)	Independently adjustable high limit and low limit relay trips. Each has SPDT 5 amp contacts. (Optional feature, not available with mass flow)
RADIATION SOURCE	Cs 137 or Co 60 doubly encapsulated in stainless steel.	Cs 137 or Co 60 doubly encapsulated in stainless steel.

	SGH	SGF
SOURCE SIZE (Cs 137)	200mCi to 4000mCi	200mCi to 4000mCi
SURFACE RADIATION (one foot from surface of gauge)	Less than 5mR/hr. Design meets or exceeds safety requirements of State Licensing Agencies, Nuclear Regulatory Commission and the Department of Transportation.	Less than 5mR/hr. Design meets or exceeds safety requirements of State Licensing Agencies, Nuclear Regulatory Commission and the Department of Transportation.
AMBIENT TEMPERATURE (Gauge Head and Amplifier)	-20° F to 140°F (-30°C to 60°C)	-20°F to 140°F(-30°C to 60°C) +40°F to 120°F(4°C to 50°C) for Panel Mount Amp
PROCESS TEMPERATURE	Unlimited so long as gauge head is held within above limits.	Unlimited so long as gauge head is held within above limits.
POWER REQUIREMENTS	115 or 230VAC ±10%, 50- to 60 Hz @ 110VA (including heater circuits).	115 or 230VAC ± 10%, 50 to 60 Hz @ 130VA (including heater circuits).
ENCLOSURE DIMENSIONS (Panel Mount)	(SGH not available in panel mount enclosure)	6" (152 mm) high × 9⅜" (238 mm) wide × 18" (457 mm) deep. Cutout 6¼" (159 mm) high × 9⅝" (245 mm) wide. Weight: 25 lbs (11.4 kg).
ENCLOSURE DIMENSIONS (NEMA)	12" (305 mm) high × 10" (254 mm) wide × 5¼" (133 mm) deep. Mounting holes on 12¾ (324 mm) × 8" (203 mm) centers. Weight: 16 lbs (7.3 kg).	24" (610 mm) high × 12" (305 mm) wide × 10" (254 mm) deep. Mounting holes on 25¼" (641 mm) × 9½" (241 mm) centers. Weight: 50 lbs (22.7 kg).
GAUGE HEAD DIMENSIONS	Occupies up to 16" (406 mm) of pipe and extends up to 19" (483 mm) from pipe. Detector Weight: 95 lbs (43 kg). Source Head Weight: Up to 180 lbs (82 kg).	Occupies up to 16" (406 mm) of pipe and extends up to 19" (483 mm) from pipe. Detector Weight: 95 lbs (43 kg). Source Head Weight: Up to 180 lbs (82 kg).
TRANSMITTER LOCATION	Up to 5000 feet (1500M) of cable from detector unit.	Up to 1000 feet (300M) cable length from detector unit.

Ordering Information:
Please specify 1) Pipe size, material and schedule; 2) Measurement range; 3) Complete quantitative description of process material; 4) System required; 5) Amplifier enclosure; 6) Outputs required; 7) Detailed performance requirements; 8) Measurement objectives.

TEXAS NUCLEAR

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Austin, Texas 78766 USA
Telephone (512) 836-0801
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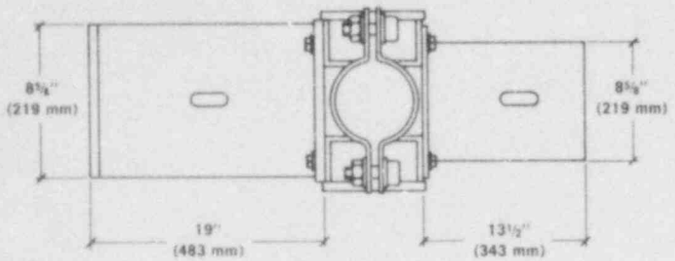
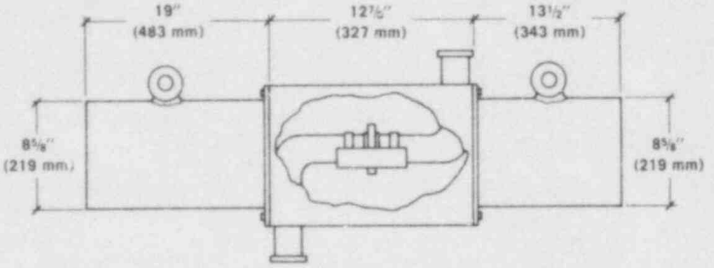
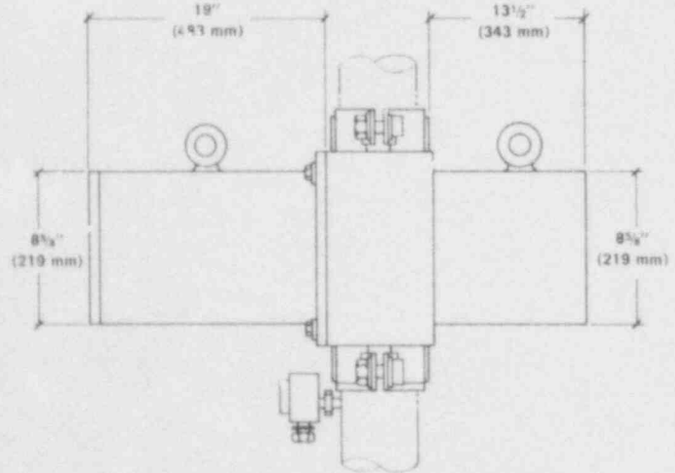
For additional information, contact:



Typical Radial Mount configuration.



Typical "Z" Mount configuration.



Radial Mount showing Temperature Compensation.

List of Affiliates

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TEXAS NUCLEAR
A SUBSIDIARY OF RAMSEY ENGINEERING

CNH Series

Continuous Level Gauge

Technical Specifications

Figure 1. CNH Series Continuous Level Gauge

Features:

- Full line of system configurations, including point, strip and insertion sources are available
- Non-contacting level sensor, unaffacted by temperature, pressure, viscosity or other characteristics of process materials
- Spans with single detector from 4 inches (10 cm) to 12 feet (3.7 meters)
- Linear response (with optional linearizer)
- High-reliability ionization-chamber detector for the rugged industrial environment
- Transmitter/indicator up to one mile from sensor
- Current outputs for recorders or controllers
- High/low limit relays (optional)
- Detector meets design requirements for hazardous environments (CSA, Class 1, Groups A, B, C & D; Class 2, Groups E, F, & G; Class 3)
- External mounting, even on multiwall vessels, provides simple installation and trouble free operation

Introduction

Texas Nuclear offers the most complete line of non-contact instrument systems designed for measuring the level of materials in process tanks, reactors, bins, pipes, silos, hoppers and other types of vessels.

Each system is made up basically of three components: radiation source, detector and transmitter/indicator. Selection from a family of standard components allows the design of a system that meets the requirements of specific applications at minimum cost. A variety of proportional output signals are available—for use with controllers, recorders or high/low limit alarms.

Because of their high reliability, low radiation level requirements, and the ability to operate at high temperatures, these systems are particularly useful in the most demanding level measurements of liquids, slurries and solids. Since all components of the system are external to the vessel, the chemical or physical characteristics of the process material cannot affect the performance or the life of the system. The level-sensor head has no moving parts. Adverse conditions, such as high or low temperature, humidity, dust and abrasive or corrosive products do not affect operation.

The accuracy, simplicity and proven performance of Texas Nuclear Level Gauges have led to their use in such diverse industries as organic and inorganic chemicals, ore processing, petroleum refining, steam generation, pulp and paper, food processing, steel and cement manufacture. Their rugged construction and insensitivity to industrial environments have produced improved product quality, increased productivity and reduced costs without taxing instrument maintenance capabilities.

This brochure describes the CNH Series Continuous Level instruments shown in Figure 1. For applications which require only single point, high/low, "on-off" level indication, the Texas Nuclear PN Series Point Level Switch is recommended. This device is described in more detail in a separate brochure available upon request.

Principles of Operation

The configuration of the basic continuous level gauge is shown in Figure 2a. The source head contains a gamma radiation source from which a beam is projected across the vessel toward the sensor head.

The sensor head contains an ionization chamber radiation detector and preamplifier. The preamplifier increases the detector signal to a substantial level so that it may be transmitted over a standard cable (up to one mile) to the transmitter/indicator, without interference from electrical noise.

While "point" sources are most frequently used, other configurations are available. A "strip" source, as shown in Figure 3a, can be provided when vessel geometry and linearity requirements dictate its use. Final recommendation of source configuration depends on measurement parameters of the application such as: material flow characteristics, system linearity, response time required, and vessel construction and configuration. Texas Nuclear's engineering staff is available to assist you in evaluation of your application and optimum system recommendation.

Generally, the process material can be considered to be "opaque" to the gamma radiation. Essentially no radiation reaches the part of the detector which is below the level of the process material. As the level drops, more of the detector is exposed to radiation and the detector output increases. Conversely, the detector output decreases with rising level as more of the detector is "shadowed" by the process material. The signal from the level sensor is inverted and suppressed in the transmitter in order to make indicator readings increase with increasing level. Zero and span are continuously adjustable and are non-interacting.

Most applications involve external mounting of the system to a bin, hopper or vessel walls. However, sometimes very thick walls make this arrangement impractical. In such a case, the source and/or detector may be mounted

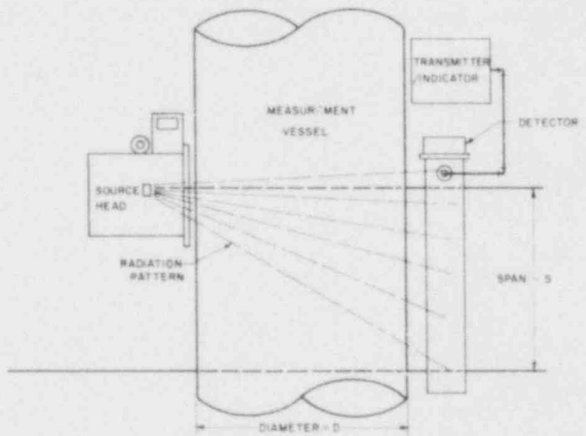

FIGURE 2a.
TYPICAL MOUNTING ARRANGEMENT, POINT SOURCE LEVEL GAUGE

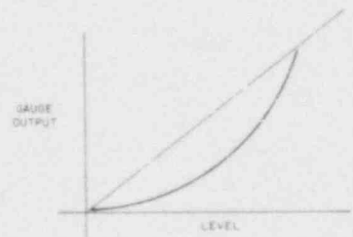

FIGURE 2b.
NON-LINEAR OUTPUT PROVIDED BY POINT SOURCE AND CONTINUOUS LEVEL DETECTOR

in a well projecting into the vessel. A source well "insertion" system, shown in Figure 4, can be used with either point or strip sources.

In continuous level measurement, the linearity requirement is a major point of consideration in resolving an optimum system. The **point** source provides a non-linear response as shown in Figure 2b. The degree of non-linearity is a function of the vessel wall thickness and D/S (diameter/span) ratio. Non-linearity decreases as the ratio gets larger and becomes negligible for very large diameter vessels. Linear response, with the point source system, may be obtained by use of the Texas Nuclear level gauge linearizer.

The **strip** source system is particularly useful in narrow vessels where tight operational input-output balance requires a linear response. End effects from the source restrict the linear portion of the response curve (control range), to the center section as shown in Figure 3b. If the span length is made larger than the control range desired, linear control can be obtained without the use of a linearizer.

The linearity of a strip source system is also dependent on the D/S ratio and wall thickness. However, in this case these parameters operate in opposite directions. Hence, applications which are poor for the point source are good for the strip source and vice versa.

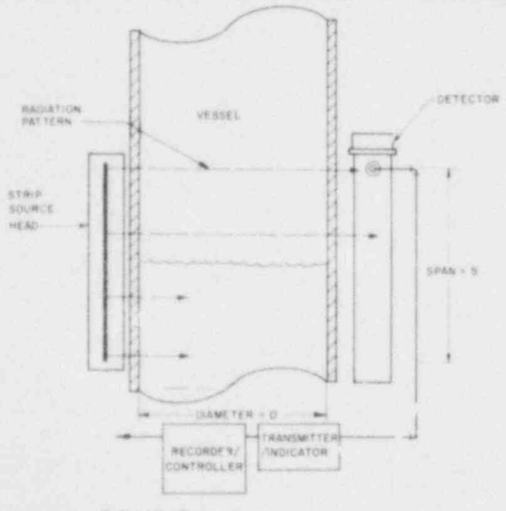

FIGURE 3a
TYPICAL LEVEL GAUGE SYSTEM
STRIP SOURCE CONFIGURATION

FIGURE 3b
LINEAR CONTROL RANGE, SMALLER THAN SPAN, PROVIDED BY STRIP SOURCE AND CONTINUOUS LEVEL DETECTOR

Description of System Components

Source heads are constructed of steel and are filled with lead to provide radiation shielding. Positive-action, lockable shutters are provided so that the radiation beam can be blocked for shipment, installation or maintenance of the equipment. Pneumatically operated, fail-safe shutters are available as an option; shutters close automatically on loss of air pressure. Shutter-position indicator switches and personnel safety interlocks which prevent access to the vessel while the gauge is operating are also available.

The radioactive source (usually Cesium-137) is made from an inert ceramic material which is double encapsulated in welded stainless steel cyclinders. The size and weight of the source head depends upon the source strength required for each application. Source strength is determined by vessel diameter, wall thickness and material and other details of the installation. All source heads for CNH gauges meet or exceed the safety requirements of the U.S. Nuclear Regulatory Commission, the U.S. Department of Transportation and state regulatory agencies.

The **radiation sensor** is an ion chamber constructed of stainless steel, and mounted in a head which is approved for use in hazardous environments. Texas Nuclear recommends that the preamplifier be mounted in the detector head when possible. This configuration is used in our standard detector and allows the preamplifier to raise the signal to a significant level that can be transmitted over conventional cable to the transmitter/indicator. The detector head and transmitter/indicator can be separated by one mile and still be free of interference from plant noise and cable flexing problems. When necessary, the preamplifier may be remotely located from the vessel. In this configuration, special low-noise cable is provided to transmit the sensor signal to the preamplifier. It is good practice to put the low-noise cable in a rigid dedicated conduit to avoid flexing and pick-up from other plant equipment. The detector and preamplifier are temperature controlled to insure stable operation over extreme changes in ambient temperature and humidity. This technique eliminates the need for desiccant packages and periodic opening of the detector head is avoided. Detectors are supplied with sensitive lengths up through 12 feet (3.7 meters).

The CNH **level system** employs the "H" series transmitter/indicator, as shown in Figure 5, which contains the system power supplies, amplifiers and output converter. This unit features plug-in modular construction and is available in NEMA-4 or explosion-proof housings, as shown in Figure 6. In addition to the basic circuits, the transmitter will accept a linearizer and/or high/low alarm limit, plug-in module. The rugged, compact design of the

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For additional information, contact:

or Factory

Specifications

Performance

Span: 4 inches (10 cm) to 12 feet (3.7 meters)
Precision: ±1% of span, on factory approved installations
Response time constant: adjustable 15 to 240 seconds (other ranges on request)
Electronic drift: less than ±0.1% of span per month

Environmental

Ambient temperature (detector and transmitter): −20°F (−30°C) to +140°F (+60°C), air or water cooled detectors are available
Process temperature: unrestricted
Enclosure: detector head—explosion proof
transmitter/indicator—NEMA-4, standard; explosion proof, optional

Source Head

Source material: Cesium-137 (other sources optional)
Source strength: application dependent
Dimensions: application dependent
Weight: application dependent
Options: pneumatic shutter operator and shutter indicator switches

Detector Head

Sensor: ionization chamber
Preamplifier: all solid state
Dimensions: diameter, excluding mounting brackets: 4.5 inches (11.5 cm) length, integral number of feet (meters) large enough to include span plus 15 inches (39 cm)
Housing material: steel. Designed to meet: Explosion-proof Class I, Groups A, B, C, & D; Class II, Groups E, F, & G; Class III. Testing Agency Certification for individual detectors can be provided as an option.

Transmitter/Indicator

Enclosure (NEMA-4) dimensions: 12 inches (31 cm) high × 10 inches (26 cm) wide × 5¼ inches (13.5 cm) deep. Mtg. holes on 12¾ inches (33 cm) × 8 inch (21 cm) centers
Indicator: panel meter, 0-100% of span, in 10 major, 50 minor divisions
Current output: 1-5mA, load of 6000 ohms or less, or 4-20mA, load of 1500 ohms or less, or 10-50mA, load of 600 ohms or less
Controls: zero, span, upper limit and lower limit
Options: linearizer, high/low limit relays
Power: 115/230 VAC ±10% at 35VA, 50-60 Hz

Ordering Information:

Please supply the following:

A. A sketch of the vessel showing:
   1. Dimensions of vessel
   2. Wall thickness(es) and material(s) including liner(s) and insulating jacket(s)
   3. Densities of wall materials
   4. Density and composition of process material
   5. Span of measurement
B. Performance Requirements:
   1. Desired precision (repeatability) of the measurement
   2. Desired time constant of the system
   3. Desired linearity of the output

List of Affiliates

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Ramsey REC Ltd.
385 Enford Road, Richmond Hill, Ontario, CANADA

Ramsey Engineering B.V.
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