

Occupational Noise Exposure in U.S. Mines

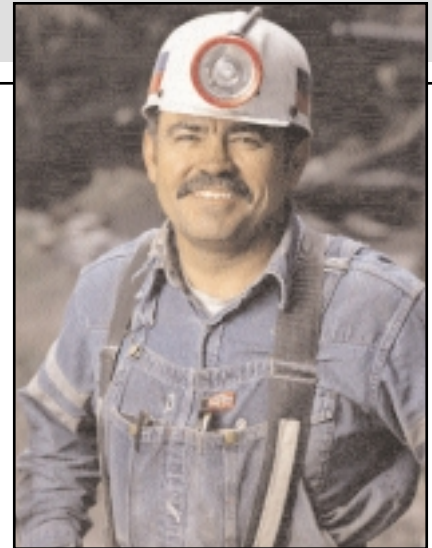
INTRODUCTION

The U.S. Mine Safety & Health Administration (MSHA) published a new occupational noise exposure rule on September 13, 1999. **The new rule applies to all coal, metal and non-metal mines and became effective September 13, 2000.**

HEALTH & OTHER RISKS

Noise is one of the most pervasive health hazards in mining. The National Institute for Occupational Safety and Health (NIOSH) has identified occupational noise-induced hearing loss as one of the ten leading work-related diseases and injuries. MSHA estimated that 13% of the mining population of the United States (about 37,000) would develop material hearing impairment during their working lifetime under the previous noise standards.

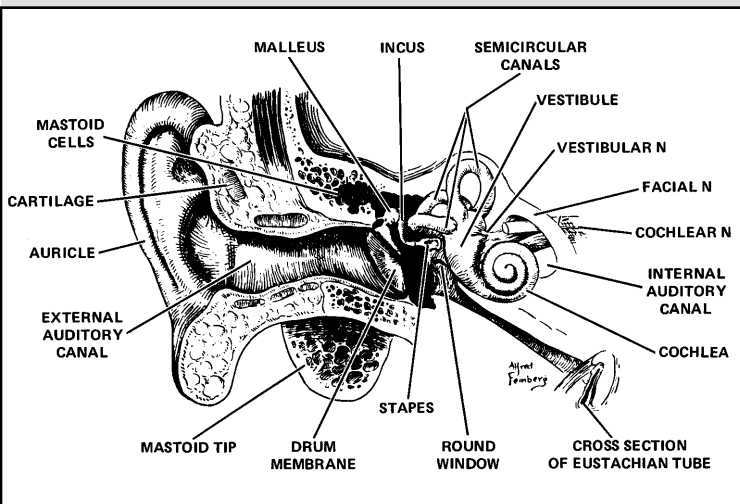
Prolonged exposure to hazardous sound levels over a period of years can cause permanent, irreversible damage to hearing. Hearing loss may occur under prolonged exposure to high sound levels, or gradually when levels are lower and exposures less frequent. An individual may not notice hearing impairment until after substantial hearing loss occurs. **In addition to adversely affecting the quality of life, hearing impairment can jeopardize the safety and productivity of affected miners as well as those around them.**



ROOT CAUSES

When the ear receives an acoustic signal, it first travels through the canal where the pressure changes move the tympanic membrane (ear drum). Located behind the eardrum is the middle ear in which the three smallest and hardest bones in the body are found: malleus, incus and stapes (hammer, anvil and stirrup). These bones are connected in a chain between the tympanic membrane and the round window of the cochlea (inner ear). When exposed to noise these bones start to vibrate and

act as an amplifier converting sound energy into mechanical energy. The mechanical energy is then converted into hydraulic energy in the cochlea. The fluid that has been set in motion in the cochlea will, depending on the signal frequency, affect different small hair-like cells in the cochlea. When a hair cell is stimulated it sends an electrical signal to the brain and the hydraulic energy is converted to electrical energy. A noise induced hearing loss in the inner ear occurs when the small hair-like cells become damaged or weakened due to overload (noise exposure).



The objective of the new MSHA Occupational Noise Exposure Standard is to reduce or eliminate the damage to these hair-like cells, which is the "root cause" of noise induced hearing loss. To aid in these efforts, MSHA has defined for the mine operator specific exposure limits. Mine operators are required to establish a system of monitoring that evaluates each miner's noise exposure sufficiently to determine continuing compliance with the rule.

MAJOR NOISE EXPOSURE LIMITS

Action Level	An 8-hour time-weighted average (TWA_8) sound level of 85 dBA integrating all sound levels from 80 dBA to at least 130 dBA
Permissible Exposure Level (PEL)	An 8-hour time-weight average (TWA_8) sound level of 90 dBA integrating all sound levels from at least 90 dBA to 140 dBA
Maximum Exposure Level	115 dBA at any time even if wearing hearing protection
Dual Hearing Protection Level	Any time the TWA_8 exceeds 105 dBA

SOLUTION

The rule specifies how a miner's noise dose is to be determined, but otherwise it is performance-oriented and neither the methodology nor the intervals of monitoring are specified. Fortunately simplified and cost effective methods are now available for the mine operator to assess a miner's noise exposure.

There are two basic types of instruments commonly used to sample noise. The first is a noise dosimeter, which measures personal exposure to noise. It consists of a microphone (placed in the miner's hearing zone) and a case containing the microprocessor-controlled monitor. The dosimeter continuously monitors, integrates and records the sound energy a miner is exposed to during the shift. This information is used by the dosimeter to generate all of the calculated values required by the rule for determining a miner's noise exposure. Examples of calculated values include:

Dose - Indicates the percentage of the PEL the miner has received during the actual period of testing.

Maximum Exposure Level - Indicates the highest sound level recorded at any time during the test.

TWA_8 - Indicates the 8-hour time weighted average noise exposure for the miner.



Q-300 Noise Dosimeter

In their most basic and economical configuration dosimeters provide results to the mine operator via an integral display. Other features possibly present in the dosimeter include the ability to generate hard copy reports directly to a printer and/or the ability to interface to a computer for storage, retrieval, analysis and reporting of exposure data on a desktop or notebook PC.

The second type of instrument is a sound level meter (SLM). The major difference between the SLM and the dosimeter is that the SLM is not intended to be worn by the miner. The primary applications for SLM's are in handheld surveys or area measurements. A broad range of SLM's are available with varying levels of functionality. Very basic SLM's might only provide an indication of the current decibel or sound level (SPL) and the maximum sound level detected. The most advanced SLM's enable the mine operator to understand the frequency components of the noise so that appropriate engineering controls may be selected and applied. This type of SLM is referred to as an Octave Band Analyzer.



Quest Basic Series Sound Level Meters

Quest Technologies offers several unique SLM and dosimeter solutions that allow the mine operator to determine a miner's noise exposure and assist in the implementation of administrative and engineering controls. Both sound level meters and dosimeters have significant value in an effective noise exposure management program.

SLM's allow the mine operator to:

- Perform initial walk through surveys of their operations to determine which subset of miner's are candidates for dosimeter studies.
- Develop a noise level map of their operations to facilitate implementation of effective administrative controls.
- Understand the frequency content of the noise in their operations to facilitate selection and implementation of the proper engineering controls.
- Test new incoming equipment for compliance with specified noise emission limits.
- Periodically test existing equipment for undesirable changes in noise emission levels as a result of mechanical wear.
- Perform follow-up walk through surveys of their operations to determine continuing compliance with noise exposure limits.

Dosimeters allow the mine operator to:

- Monitor the miner's exposure throughout the work shift without being physically present.
- Understand the miner's total noise dose under circumstances where the noise levels vary throughout the day.
- Determine the miner's full shift noise dose without conducting full shift sampling under circumstances where the noise levels are continuous throughout the day.
- Understand if the miner's noise exposure ever exceeded the 115 dBA maximum exposure level.
- Understand if the miner's noise exposure ever exceeded the 105 dBA dual hearing protection level.

ABOUT QUEST TECHNOLOGIES

Quest Technologies is one of the most widely recognized and respected manufacturers worldwide for life safety & health instrumentation and software. It is through our lifelong commitment to continuous quality improvement, product innovation and a mission to delight our customers that we have achieved this status. We specialize in regulatory compliance and personal safety solutions for noise, heat stress, indoor air quality and toxic/combustible gas monitoring applications. Quest Technologies solutions are available worldwide through a network of factory authorized dealers that specialize in life safety & health solutions.

FOR MORE INFORMATION

If you have any questions concerning our technology, pricing, availability or would like to schedule a product demonstration, you may contact our customer service representatives at (800) 245-0779 or e-mail us at sales@quest-technologies.com.

PERTINENT WEBSITE LINKS

U.S. Mine Safety & Health Administration (MSHA)
 National Institute for Occupational Safety & Health (NIOSH)
 National Hearing Conservation Association
 American Industrial Hygiene Association

<http://www.msha.gov>
<http://www.cdc.gov/niosh>
<http://www.hearingconservation.org>
<http://www.aiha.org>

Datalogging Noise Dosimeter

Q-300

BENEFITS

- Instructions Where You Want Them** - A complete manual is included, but quick reference the basic operating information is right on the unit's cover.
- Log All the Information You Need** - Including sound levels and peaks.
- Meet All the Requirements** - Three simultaneous dosimeter studies using independent, threshold, criterion level and exchange rate assures you will have what you need today and tomorrow.
- The Power to Do the Job Right** - Long battery life, easy changes without tools, information backup during battery changes and clear "LOWBAT" warning means you will have performance when you need it.
- See it Now, Print it Later** - The LCD display lets you see what you want now, and post-labeled output allows direct printing of all the details.
- Security** - Two levels of security allow you to lock out setler access or all keys, plus reset override functions are designed to protect the data from accidental erasure.
- Run it Even if You are Not There** - Auto on and auto run time mean you can set the Q-300 to run fast.
- Paperless Surveys** - The unique event function makes surveying a variety of locations easy. Just keep track of where you went, and the Q-300 will do the rest, keeping information associated to you can analyze each location at your convenience.
- Field Replaceable Microphone**
- Easy Calibration**
- Supported by QuestSuite® for Windows Software**

SPECIFICATIONS

Standards: ANSI S1.25 - 1991, ANSI S1.4 - 1985, Type 2; IEC 60801 - 1985; IEC 60804 - 1985; Type 2; IEC 2152 - 1993

Range: 40-140 dB or 70-140 dB

Time RMS, 63 dB Pulse Range: 40-110 dB or 70-140 dB

Data Storage: Uses interface modules connected to the microphone connector. Parallel operation or serial with selectable baud rate.

Microphone: Field replaceable, 8mm shoulder-mount, Type 2 One-piece system, cable, connector, and microphone.

Battery: Single 9-volt alkaline provides approximately 48 hours of operation.

Operating Temperature: -10 to 50°C (-14 to 122°F)

Storage (Battery removed): -20 to 60°C (-4 to 140°F)

Resolution: 0.1 dB, non-condensing

Accuracy: Negligible below 50 Onsets at 50 to 60 Hz. Tested for RFI susceptibility with ± 1 dB error at field strengths to 10 V/m over the frequency range of 10 MHz to 500 MHz.

Size: 5.5 x 2.8 x 1.4 inches (140 x 70 x 40 mm)

Weight: 155.0g (440 g)

Phone: 262-567-9157 • **Toll Free:** 800-245-0779

QUEST TECHNOLOGIES

Integrating/Datalogging SLM

1900/2900

FEATURES

- User-Controlled Logging** - The user is in ultimate control of what is logged, displayed and printed, selecting from SPL, Leq, Avg, TWA, Lmax, Lmin, LDN, CNEL, PkA, SEL, excitation levels, time information, and more.
- Battery-Protected Memory** - To protect loss of data the 1900/2900 has a special battery-protected memory.
- Optional Octave Filter** - Optional 1/1 or 1/1-1/3 Octave Filters are available for octave band analysis.
- Printer/Computer Interface** - With most any serial or parallel printer, analysis reports are possible. Data can be further enhanced with the use of an IBM-compatible computer.
- Response and Weighting Options** - The 1900/2900 provides fast, size, peak and impulse response with "A", "C", or Linear weighting.
- Easy-to-Operate** - The soft-touch keypad and large LCD with fiber optic back light make the unit easy to use in any situation.
- Integration and Datalogging Capabilities** - For specific situations, the capability of integration and datalogging provides to you an invaluable tool.

The Quest 1900 (Type 1) and 2900 (Type 2) Integrating/Datalogging Sound Level Meters enable the use of one instrument to analyze "A", "C", or Linear weighted sound levels using a choice of exchange rates. With the use of 1/3 or 1/1 octave band studies, integrating the information together in one file is easy.

Create and store multiple files without having to print or download the instrument. The information will stay in memory, even if the instrument is turned off or the 9 V batteries are taken out.

The hand-held 1900/2900 is ideal for compliance, noise control analysis, traffic studies, worker exposure profiles and most any industrial or community noise measurements.

Expand the powerful sound level meter by adding an optional Octave Band Filter. Both the OB-300 and OB-100 filter sets conform to the most stringent requirements of IEC 325 and ANSI S1.11, Class 3. When the OB-300 is connected to the 1900 or 2900, 23 selectable frequency ranges may be analyzed. Each range is 1/3 octave in width with center frequencies from 16 Hz to 16 kHz. The OB-100 has 10 full-octave ranges with center frequencies from 31.5 Hz to 16 kHz.

Manual or automatic operation is provided with the OB-300, OB-100 or the OB-200. In the manual mode you select the frequency to be monitored. In the automatic mode, the instrument will sequentially step through each filter band, record the measurement, and store it for future review. Filter filter uses the battery power supplied by the sound level meter.

Memory capacity of the 1900 or 2900 can be increased from the standard 128K to 512K. With the standard memory, for example, you could log five quintiles each second for up to four hours. The extended memory would allow the same information to be logged for 14.5 hours. The same data logged each minute would allow over 200 hours with 128K memory and over 900 hours with 512K memory.

QUEST TECHNOLOGIES

Sound Level Meter

1100/2100

BENEFITS

- User-Friendly Features** - A large, easy-to-read LCD display and simple slide switches combine for easy operation and viewing of data.
- Simple One-Button Calibration** - It is as easy as a press of a button. No tools or screwdrivers required.
- Portable Design** - The "granite-look" molded polymer case is extremely lightweight and compact.
- Optional Removable Microphone Cables for 1100R/2100R** - Available in 2 ft., 10 ft. and 50 ft. cables.
- RF Shielding** - The 1100/2100 are housed in a rugged RF shielded case.
- Frequency Weighting Options** - Choose between "A" and "C" frequency weighting.
- Slide-In Battery Compartment** - To simplify battery connection failure, the meter has a unique slide-in battery compartment.

Wide, Selectable dB Range - With a wide 70dB range and three range settings, the meters can be tailored to a specific application. In fact, overrange and underrange indicators designate the appropriate setting.
- Two Operating Modes** - With two operating modes the 1100/2100 offers great flexibility. SPL mode continuously displays sound pressure level and automatically updates the current reading at a rate of once per second. Max mode causes the display to hold the highest SPL during the sampling time.
- Output Jack** - Connection to peripheral devices, such as recorders and submixers, is made possible with an output jack.

Specifications:

Standards: IEC 61010-1, IEC 61010-2-1, IEC 61010-2-2, IEC 61010-2-3, IEC 61010-2-4, IEC 61010-2-5, IEC 61010-2-6, IEC 61010-2-7, IEC 61010-2-8, IEC 61010-2-9, IEC 61010-2-10, IEC 61010-2-11, IEC 61010-2-12, IEC 61010-2-13, IEC 61010-2-14, IEC 61010-2-15, IEC 61010-2-16, IEC 61010-2-17, IEC 61010-2-18, IEC 61010-2-19, IEC 61010-2-20, IEC 61010-2-21, IEC 61010-2-22, IEC 61010-2-23, IEC 61010-2-24, IEC 61010-2-25, IEC 61010-2-26, IEC 61010-2-27, IEC 61010-2-28, IEC 61010-2-29, IEC 61010-2-30, IEC 61010-2-31, IEC 61010-2-32, IEC 61010-2-33, IEC 61010-2-34, IEC 61010-2-35, IEC 61010-2-36, IEC 61010-2-37, IEC 61010-2-38, IEC 61010-2-39, IEC 61010-2-40, IEC 61010-2-41, IEC 61010-2-42, IEC 61010-2-43, IEC 61010-2-44, IEC 61010-2-45, IEC 61010-2-46, IEC 61010-2-47, IEC 61010-2-48, IEC 61010-2-49, IEC 61010-2-50, IEC 61010-2-51, IEC 61010-2-52, IEC 61010-2-53, IEC 61010-2-54, IEC 61010-2-55, IEC 61010-2-56, IEC 61010-2-57, IEC 61010-2-58, IEC 61010-2-59, IEC 61010-2-60, IEC 61010-2-61, IEC 61010-2-62, IEC 61010-2-63, IEC 61010-2-64, IEC 61010-2-65, IEC 61010-2-66, IEC 61010-2-67, IEC 61010-2-68, IEC 61010-2-69, IEC 61010-2-70, IEC 61010-2-71, IEC 61010-2-72, IEC 61010-2-73, IEC 61010-2-74, IEC 61010-2-75, IEC 61010-2-76, IEC 61010-2-77, IEC 61010-2-78, IEC 61010-2-79, IEC 61010-2-80, IEC 61010-2-81, IEC 61010-2-82, IEC 61010-2-83, IEC 61010-2-84, IEC 61010-2-85, IEC 61010-2-86, IEC 61010-2-87, IEC 61010-2-88, IEC 61010-2-89, IEC 61010-2-90, IEC 61010-2-91, IEC 61010-2-92, IEC 61010-2-93, IEC 61010-2-94, IEC 61010-2-95, IEC 61010-2-96, IEC 61010-2-97, IEC 61010-2-98, IEC 61010-2-99, IEC 61010-2-100, IEC 61010-2-101, IEC 61010-2-102, IEC 61010-2-103, IEC 61010-2-104, IEC 61010-2-105, IEC 61010-2-106, IEC 61010-2-107, IEC 61010-2-108, IEC 61010-2-109, IEC 61010-2-110, IEC 61010-2-111, IEC 61010-2-112, IEC 61010-2-113, IEC 61010-2-114, IEC 61010-2-115, IEC 61010-2-116, IEC 61010-2-117, IEC 61010-2-118, IEC 61010-2-119, IEC 61010-2-120, IEC 61010-2-121, IEC 61010-2-122, IEC 61010-2-123, IEC 61010-2-124, IEC 61010-2-125, IEC 61010-2-126, IEC 61010-2-127, IEC 61010-2-128, IEC 61010-2-129, IEC 61010-2-130, IEC 61010-2-131, IEC 61010-2-132, IEC 61010-2-133, IEC 61010-2-134, IEC 61010-2-135, IEC 61010-2-136, IEC 61010-2-137, IEC 61010-2-138, IEC 61010-2-139, IEC 61010-2-140, IEC 61010-2-141, IEC 61010-2-142, IEC 61010-2-143, IEC 61010-2-144, IEC 61010-2-145, IEC 61010-2-146, IEC 61010-2-147, IEC 61010-2-148, IEC 61010-2-149, IEC 61010-2-150, IEC 61010-2-151, IEC 61010-2-152, IEC 61010-2-153, IEC 61010-2-154, IEC 61010-2-155, IEC 61010-2-156, IEC 61010-2-157, IEC 61010-2-158, IEC 61010-2-159, IEC 61010-2-160, IEC 61010-2-161, IEC 61010-2-162, IEC 61010-2-163, IEC 61010-2-164, IEC 61010-2-165, IEC 61010-2-166, IEC 61010-2-167, IEC 61010-2-168, IEC 61010-2-169, IEC 61010-2-170, IEC 61010-2-171, IEC 61010-2-172, IEC 61010-2-173, IEC 61010-2-174, IEC 61010-2-175, IEC 61010-2-176, IEC 61010-2-177, IEC 61010-2-178, IEC 61010-2-179, IEC 61010-2-180, IEC 61010-2-181, IEC 61010-2-182, IEC 61010-2-183, IEC 61010-2-184, IEC 61010-2-185, IEC 61010-2-186, IEC 61010-2-187, IEC 61010-2-188, IEC 61010-2-189, IEC 61010-2-190, IEC 61010-2-191, IEC 61010-2-192, IEC 61010-2-193, IEC 61010-2-194, IEC 61010-2-195, IEC 61010-2-196, IEC 61010-2-197, IEC 61010-2-198, IEC 61010-2-199, IEC 61010-2-200, IEC 61010-2-201, IEC 61010-2-202, IEC 61010-2-203, IEC 61010-2-204, IEC 61010-2-205, IEC 61010-2-206, IEC 61010-2-207, IEC 61010-2-208, IEC 61010-2-209, IEC 61010-2-210, IEC 61010-2-211, IEC 61010-2-212, IEC 61010-2-213, IEC 61010-2-214, IEC 61010-2-215, IEC 61010-2-216, IEC 61010-2-217, IEC 61010-2-218, IEC 61010-2-219, IEC 61010-2-220, IEC 61010-2-221, IEC 61010-2-222, IEC 61010-2-223, IEC 61010-2-224, IEC 61010-2-225, IEC 61010-2-226, IEC 61010-2-227, IEC 61010-2-228, IEC 61010-2-229, IEC 61010-2-230, IEC 61010-2-231, IEC 61010-2-232, IEC 61010-2-233, IEC 61010-2-234, IEC 61010-2-235, IEC 61010-2-236, IEC 61010-2-237, IEC 61010-2-238, IEC 61010-2-239, IEC 61010-2-240, IEC 61010-2-241, IEC 61010-2-242, IEC 61010-2-243, IEC 61010-2-244, IEC 61010-2-245, IEC 61010-2-246, IEC 61010-2-247, IEC 61010-2-248, IEC 61010-2-249, IEC 61010-2-250, IEC 61010-2-251, IEC 61010-2-252, IEC 61010-2-253, IEC 61010-2-254, IEC 61010-2-255, IEC 61010-2-256, IEC 61010-2-257, IEC 61010-2-258, IEC 61010-2-259, IEC 61010-2-260, IEC 61010-2-261, IEC 61010-2-262, IEC 61010-2-263, IEC 61010-2-264, IEC 61010-2-265, IEC 61010-2-266, IEC 61010-2-267, IEC 61010-2-268, IEC 61010-2-269, IEC 61010-2-270, IEC 61010-2-271, IEC 61010-2-272, IEC 61010-2-273, IEC 61010-2-274, IEC 61010-2-275, IEC 61010-2-276, IEC 61010-2-277, IEC 61010-2-278, IEC 61010-2-279, IEC 61010-2-280, IEC 61010-2-281, IEC 61010-2-282, IEC 61010-2-283, IEC 61010-2-284, IEC 61010-2-285, IEC 61010-2-286, IEC 61010-2-287, IEC 61010-2-288, IEC 61010-2-289, IEC 61010-2-290, IEC 61010-2-291, IEC 61010-2-292, IEC 61010-2-293, IEC 61010-2-294, IEC 61010-2-295, IEC 61010-2-296, IEC 61010-2-297, IEC 61010-2-298, IEC 61010-2-299, IEC 61010-2-300, IEC 61010-2-301, IEC 61010-2-302, IEC 61010-2-303, IEC 61010-2-304, IEC 61010-2-305, IEC 61010-2-306, IEC 61010-2-307, IEC 61010-2-308, IEC 61010-2-309, IEC 61010-2-310, IEC 61010-2-311, IEC 61010-2-312, IEC 61010-2-313, IEC 61010-2-314, IEC 61010-2-315, IEC 61010-2-316, IEC 61010-2-317, IEC 61010-2-318, IEC 61010-2-319, IEC 61010-2-320, IEC 61010-2-321, IEC 61010-2-322, IEC 61010-2-323, IEC 61010-2-324, IEC 61010-2-325, IEC 61010-2-326, IEC 61010-2-327, IEC 61010-2-328, IEC 61010-2-329, IEC 61010-2-330, IEC 61010-2-331, IEC 61010-2-332, IEC 61010-2-333, IEC 61010-2-334, IEC 61010-2-335, IEC 61010-2-336, IEC 61010-2-337, IEC 61010-2-338, IEC 61010-2-339, IEC 61010-2-340, IEC 61010-2-341, IEC 61010-2-342, IEC 61010-2-343, IEC 61010-2-344, IEC 61010-2-345, IEC 61010-2-346, IEC 61010-2-347, IEC 61010-2-348, IEC 61010-2-349, IEC 61010-2-350, IEC 61010-2-351, IEC 61010-2-352, IEC 61010-2-353, IEC 61010-2-354, IEC 61010-2-355, IEC 61010-2-356, IEC 61010-2-357, IEC 61010-2-358, IEC 61010-2-359, IEC 61010-2-360, IEC 61010-2-361, IEC 61010-2-362, IEC 61010-2-363, IEC 61010-2-364, IEC 61010-2-365, IEC 61010-2-366, IEC 61010-2-367, IEC 61010-2-368, IEC 61010-2-369, IEC 61010-2-370, IEC 61010-2-371, IEC 61010-2-372, IEC 61010-2-373, IEC 61010-2-374, IEC 61010-2-375, IEC 61010-2-376, IEC 61010-2-377, IEC 61010-2-378, IEC 61010-2-379, IEC 61010-2-380, IEC 61010-2-381, IEC 61010-2-382, IEC 61010-2-383, IEC 61010-2-384, IEC 61010-2-385, IEC 61010-2-386, IEC 61010-2-387, IEC 61010-2-388, IEC 61010-2-389, IEC 61010-2-390, IEC 61010-2-391, IEC 61010-2-392, IEC 61010-2-393, IEC 61010-2-394, IEC 61010-2-395, IEC 61010-2-396, IEC 61010-2-397, IEC 61010-2-398, IEC 61010-2-399, IEC 61010-2-400, IEC 61010-2-401, IEC 61010-2-402, IEC 61010-2-403, IEC 61010-2-404, IEC 61010-2-405, IEC 61010-2-406, IEC 61010-2-407, IEC 61010-2-408, IEC 61010-2-409, IEC 61010-2-410, IEC 61010-2-411, IEC 61010-2-412, IEC 61010-2-413, IEC 61010-2-414, IEC 61010-2-415, IEC 61010-2-416, IEC 61010-2-417, IEC 61010-2-418, IEC 61010-2-419, IEC 61010-2-420, IEC 61010-2-421, IEC 61010-2-422, IEC 61010-2-423, IEC 61010-2-424, IEC 61010-2-425, IEC 61010-2-426, IEC 61010-2-427, IEC 61010-2-428, IEC 61010-2-429, IEC 61010-2-430, IEC 61010-2-431, IEC 61010-2-432, IEC 61010-2-433, IEC 61010-2-434, IEC 61010-2-435, IEC 61010-2-436, IEC 61010-2-437, IEC 61010-2-438, IEC 61010-2-439, IEC 61010-2-440, IEC 61010-2-441, IEC 61010-2-442, IEC 61010-2-443, IEC 61010-2-444, IEC 61010-2-445, IEC 61010-2-446, IEC 61010-2-447, IEC 61010-2-448, IEC 61010-2-449, IEC 61010-2-450, IEC 61010-2-451, IEC 61010-2-452, IEC 61010-2-453, IEC 61010-2-454, IEC 61010-2-455, IEC 61010-2-456, IEC 61010-2-457, IEC 61010-2-458, IEC 61010-2-459, IEC 61010-2-460, IEC 61010-2-461, IEC 61010-2-462, IEC 61010-2-463, IEC 61010-2-464, IEC 61010-2-465, IEC 61010-2-466, IEC 61010-2-467, IEC 61010-2-468, IEC 61010-2-469, IEC 61010-2-470, IEC 61010-2-471, IEC 61010-2-472, IEC 61010-2-473, IEC 61010-2-474, IEC 61010-2-475, IEC 61010-2-476, IEC 61010-2-477, IEC 61010-2-478, IEC 61010-2-479, IEC 61010-2-480, IEC 61010-2-481, IEC 61010-2-482, IEC 61010-2-483, IEC 61010-2-484, IEC 61010-2-485, IEC 61010-2-486, IEC 61010-2-487, IEC 61010-2-488, IEC 61010-2-489, IEC 61010-2-490, IEC 61010-2-491, IEC 61010-2-492, IEC 61010-2-493, IEC 61010-2-494, IEC 61010-2-495, IEC 61010-2-496, IEC 61010-2-497, IEC 61010-2-498, IEC 61010-2-499, IEC 61010-2-500, IEC 61010-2-501, IEC 61010-2-502, IEC 61010-2-503, IEC 61010-2-504, IEC 61010-2-505, IEC 61010-2-506, IEC 61010-2-507, IEC 61010-2-508, IEC 61010-2-509, IEC 61010-2-510, IEC 61010-2-511, IEC 61010-2-512, IEC 61010-2-513, IEC 61010-2-514, IEC 61010-2-515, IEC 61010-2-516, IEC 61010-2-517, IEC 61010-2-518, IEC 61010-2-519, IEC 61010-2-520, IEC 61010-2-521, IEC 61010-2-522, IEC 61010-2-523, IEC 61010-2-524, IEC 61010-2-525, IEC 61010-2-526, IEC 61010-2-527, IEC 61010-2-528, IEC 61010-2-529, IEC 61010-2-530, IEC 61010-2-531, IEC 61010-2-532, IEC 61010-2-533, IEC 61010-2-534, IEC 61010-2-535, IEC 61010-2-536, IEC 61010-2-537, IEC 61010-2-538, IEC 61010-2-539, IEC 61010-2-540, IEC 61010-2-541, IEC 61010-2-542, IEC 61010-2-543, IEC 61010-2-544, IEC 61010-2-545, IEC 61010-2-546, IEC 61010-2-547, IEC 61010-2-548, IEC 61010-2-549, IEC 61010-2-550, IEC 61010-2-551, IEC 61010-2-552, IEC 61010-2-553, IEC 61010-2-554, IEC 61010-2-555, IEC 61010-2-556, IEC 61010-2-557, IEC 61010-2-558, IEC 61010-2-559, IEC 61010-2-560, IEC 61010-2-561, IEC 61010-2-562, IEC 61010-2-563, IEC 61010-2-564, IEC 61010-2-565, IEC 61010-2-566, IEC 61010-2-567, IEC 61010-2-568, IEC 61010-2-569, IEC 61010-2-570, IEC 61010-2-571, IEC 61010-2-572, IEC 61010-2-573, IEC 61010-2-574, IEC 61010-2-575, IEC 61010-2-576, IEC 61010-2-577, IEC 61010-2-578, IEC 61010-2-579, IEC 61010-2-580, IEC 61010-2-581, IEC 61010-2-582, IEC 61010-2-583, IEC 61010-2-584, IEC 61010-2-585, IEC 61010-2-586, IEC 61010-2-587, IEC 61010-2-588, IEC 61010-2-589, IEC 61010-2-590, IEC 61010-2-591, IEC 61010-2-592, IEC 61010-2-593, IEC 61010-2-594, IEC 61010-2-595, IEC 61010-2-596, IEC 61010-2-597, IEC 61010-2-598, IEC 61010-2-599, IEC 61010-2-600, IEC 61010-2-601, IEC 61010-2-602, IEC 61010-2-603, IEC 61010-2-604, IEC 61010-2-605, IEC 61010-2-606, IEC 61010-2-607, IEC 61010-2-608, IEC 61010-2-609, IEC 61010-2-610, IEC 61010-2-611, IEC 61010-2-612, IEC 61010-2-613, IEC 61010-2-614, IEC 61010-2-615, IEC 61010-2-616, IEC 61010-2-617, IEC 61010-2-618, IEC 61010-2-619, IEC 61010-2-620, IEC 61010-2-621, IEC 61010-2-622, IEC 61010-2-623, IEC 61010-2-624, IEC 61010-2-625, IEC 61010-2-626, IEC 61010-2-627, IEC 61010-2-628, IEC 61010-2-629, IEC 61010-2-630, IEC 61010-