

Additional features of PM12 compared to PM7

Introduction

The PM12 represents a significant enhancement over the PM7 in terms of performance and functionality. The electronics is based on the X-channel electronics that have been utilized in the SAM12 design, and the base software is the same as that in the SAM12. The instrument may be provided either with or without an LCD display.

The additional features are:

HARDWARE

- 8 identically sized detectors
- Aluminium detector panel covers
- Folding LCD Touch screen display
- Two thickness of lead available: 0.5 or 1"

FEATURES

- Five modes operation: Walkthrough, Stand and count, Stand and Turn, Two Step, Three step.
- Additional Optimised ^{60}Co alarm
- Low energy alarm indication
- High and Very high alarms
- Two modes of alarm setting
- Quicksan and Quick background
- Viewpoint Interface
- Sum zones: 8 double and 8 triple
- ^{60}Co Centroid efficiency 17.5% (12% for PM7)

Electronics and software

- 5 light system integrated into user screens
- USB connectivity
- Ethernet connectivity
- Dongle security, with 3 access levels
- Windows XP operating system
- Always display activity
- Measurement Record storage
- Calibration data storage
- Background monitoring and logging
- Data Archive
- Diagnostic count rate bar graphs
- Battery and sensor diagnostics
- Report generation
- High Voltage scans graphically displayed
- Variance test



- Dynamic checking for background changes during the measurement
- Automatic evaluation and display of detection probabilities
- Calibration mixes
- Extended Linearity
- Calibration Integrity Check
- Multi-language capability – Voice and Text.

OPTIONS

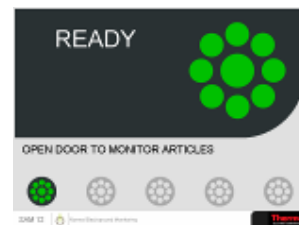
- Barriers and doors – not yet implemented
- EPD Reader
- Cameras (both sides)

Touch screen display

A 12.1 inch color LCD display is provided as the main user interface. This LCD display has been successfully used on the range of hand and foot monitors for many years. This LCD will display measurement results and status screens and lights. The user will not need to touch the screen for normal measurements.

The technician or health physicist will use the screen to setup and optimize, and to interrogate for previous measurement results, calibration data or background data.

The 5-light system, which is used on the PM7, is built into the user interface screens, with high visible large simulations of the colored lights.



Dongle Security

A dongle, which plugs into one of the USB ports, is required in order to access any supervisor function. When the dongle is attached, the supervisor is required to select the access level (Engineer, Health Physicist or Technician) and associated password.

Activity Display and units

The activity which may be displayed in a number of predefined units e.g. pCi, nCi, dpm, Bq, may be displayed in the event of an alarm, in all situations or never. In situation where the technician has requested that the activity is displayed in all situations, but the assessed activity is less than the minimum Detectable Activity, the “less than the MDA” will be displayed.

If the technician changes the display and alarm units, the alarm setting will be updated automatically.

Record Storage

All measurement results are stored in an internal database. Background measurement results may also be stored, with an optional logging frequency. The calibration test and source check data, and High Voltage scanning data are also stored. All this data may be accessed externally via the network link, or may be downloaded onto a USB memory stick.

The logging of the calibration data is useful for QA purposes to show that the instrument is being routinely checked. In addition, monitoring of the background over time is also a useful QA check.

Background Monitoring

The PM12 records the stored background count rate at an interval set by the technician between 1 hour and 1 week. This may then be presented in the form of a report with a graphical summary of the background variation. This is an excellent way to monitor plant changes both during times of work activity and quiet times.

This feature may also be used to detect a buildup of internal contamination over time.



Data Archive

Data may be archived and removed from the live database, and save on a USB memory stick, or in an archive directory on the 20 Gb hard drive.

Diagnostic Bar Graphs

In Diagnostics mode, the system will display bar graphs for count rates on each detector. If NBR is enabled, these bars will be subdivided and color-coded to show count rates above each threshold.



Battery and Sensor Diagnostics

All diagnostics associated with the battery and power statistics of the instrument are displayed on a single screen.



All the sensors conditions are shown on a single vault testing screen. This will allow technician to test all lights, button and door locks at the touch of the screen.

Report Generation

A number of predefined reports will exist. Initially reports will give summaries of background and measurement results, over user-defined periods. These reports will be sent to the screen, and may be download to printer, or to a USB memory stick in either PDF or Excel format.



Activity Results Summary

ID	Measurement Date	Activity (Bq)	Uncertainty (Bq)	Alarmed	Calibration
487	02/01/2007 19:09	349000	61.8	True	CAL_Co-60
486	02/01/2007 16:58	354000	123	True	CAL_Co-60
485	02/01/2007 16:12	355000	118	True	CAL_Co-60
484	02/01/2007 14:05	355000	126	True	CAL_Co-60
483	02/01/2007 14:03	441000	141	True	CAL_Co-60
482	02/01/2007 14:02	59.1	11.9	False	CAL_Co-60
481	02/01/2007 13:59	-23.5	29.7	False	CAL_Co-60
480	02/01/2007 10:26	76.4	13.7	True	CAL_Co-60
479	02/01/2007 10:24	66.9	13.7	True	CAL_Co-60
478	02/01/2007 10:23	-45.9	19.3	False	CAL_Co-60

USB connectivity

The instrument is provided with 2 external USB ports. This allows for a security dongle, memory stick, printer, keyboard or mouse to be attached via a common port. If more than 2 peripherals are required at the same time, it is straightforward to add a USB hub. Note that during normal operation, no USB peripherals are required.

The USB connectivity allows for easy uploading of software updates and drivers by service personnel, and downloading of data.

Ethernet

The Ethernet port allows for access to the computer network, like any other networkable PC. However the customer would need to ensure they have suitable protection against viruses if they were to attach this instrument to their network.

Remote monitoring and control are particularly straightforward with this instrument.

Operating System

The software is designed for the latest Windows operating system, Embedded Windows XP. Therefore new peripherals with Windows XP drivers, may be easily attached to the PM12.

High Voltage Scans

The system will undertake high voltage scans on all detectors simultaneously, and plot the results graphically, and dynamically. The technician has the ability to change the high voltage range of the scan, the step size and the counting period. When the scan is complete, the technician may examine each scan in detail by tapping the graph once; this will explode the graph to full screen and display a figure of merit curve. The user may drag (using a finger) the voltage line to the required voltage, or simply type in the required voltage. The user also has the facility to check the optimum ratio between pulse height thresholds, which is important for the implementation of NBR (see later).



Variance Test

This test is also referred to as a background stability check. It is used on other Thermo products as a way to ensure that the variation of the background count rate follows the expected statistical pattern. The technician may set up a number of background counting cycles. The instrument will then compare the variance and the mean of these results. If they fall outside the expected Poisson distribution, then the test is failed. A failure may be due to some instability in the electronics, or some feature of the local environment that means the background is not stable. If the background is not sufficiently stable, this may invalidate some of the monitoring results.



Modes of operation

There are 5 modes of operation: Walkthrough, Single Step, Two Step, Three Step and “Stand and Turn”:

1. **Walkthrough** mode allows users to walk through at normal walking pace, and will alarm for any significant count rate deviation above background. The detection limits in this mode are based on a transit time of 0.4s. If the user passes through the monitor in less than 0.4 s, then an alarm is sounded.
2. **Single Step** mode requires the user to stand in the centre of the portal for a time calculated by the system, taking account of background count rate, probabilities of false alarm and detection, and the assigned alarm level.
3. **Two Step** is similar to Single Step but is a two phase operation. The user is required to place their front, then their back against each panel of detectors. The efficiency to contamination on the surface of the body is greater in this mode, although the affects of body attenuation are greater than in a central position.
4. **Three Step** is a combination of Single Step and Two Step. This ensures that both the front, back and side are monitored.
5. **Stand and Turn** is a two phase operation. The user is required to stand in the centre of the portal facing out of the portal in the first phase, then towards a detector panel in the second phase. The user should be in a central position during both phases. This mode allows monitoring all around the body, whilst minimizing the effects of user attenuation.

Sensitivity mode

The alarms may be set up in two different modes: maximum sensitivity or minimum count time.

Maximum sensitivity is the method used by the PM7, where any count rate on any detector that satisfies the false alarm criterion i.e. it is not background, will trigger an alarm. This method will have a higher incidence of false alarms for a given detector probability of false alarm setting.

Minimum count time will utilize an alarm setting on each detector and sum zone that satisfies the probability of detection criterion. Therefore the limiting detector, the monitoring count time will satisfy both the probability of false alarm and detection criteria. For all the other alarms the probability of false alarm will be less than the criterion specified. Therefore the probability of false alarm of the entire system will be significantly less in the Minimum count time mode compared to the maximum sensitivity mode..

QuickScan

This is a technique that has been used on Thermo products previously. It may be activated when the system is setup to evaluate it’s own monitoring time, based on statistical parameters and background count rate. At a number of intervals, which are set by the technician, during the monitoring time, the system will check whether Clean or Contaminated criteria are satisfied. The technique takes account of the fact that these criteria change as the monitoring time progresses.

In practice this means that any article that is clearly clean or contaminated will be assessed very quickly and a result posted early in the monitoring time. Only those articles that



are a borderline Clear or Contaminated will need to be counted for the full monitoring time. This technique is useful in situation where alarm levels are very low and counting times of more than 20 s are required to determine that the article is meets the alarm criterion.

For example, some users are wishing to set the activity alarm level on PMs to 20 nCi (740 Bq) of ^{60}Co . The derived counting time will depend on the centroid efficiency of the PM12, the local background count rate and the probabilities of detection and false alarm. However the instrument under test evaluated a monitoring time of 10 s in order to achieve the required statistical uncertainties. When the Quickscan period is set to 3 s, the system will check every 3 s during the monitoring period, whether the statistical uncertainty requirements have been met based on the average count rate up to that point. If the person is effectively clean from contamination, in the majority of situations, the PM12 will show the clean indication after 3 s, otherwise the system may need a further 3 s to confirm that it is clean. Similarly the PM12 would identify any level of contamination that is slightly above the alarm level at the first or second Quickscan check. Only when the activity on the sample/article is very close to the required alarm activity, will the PM12 count for the full 10 s. In practice, the situations when the user would wait for the full monitoring period are rare.

QuickBackground

This technique is similar in principle to Quickscan. In default mode, the instrument will accumulate background count for a full 100 s after a changing background condition. However with QuickBackground, the instrument will only accumulate as many counts as are required to provide a monitoring time within the minimum and maximum specified by the user. This will lead to a slightly longer user monitoring time, than if a full 100 s background count had been utilized, but minimizes the down time of the instrument. If Quickscan is also enabled, the monitoring time should not be affected by a previous QuickBackground, when a user is clearly contaminated or Clean.

Changing conditions checking

The system will check whether the background conditions are changing during the monitoring time. Note that the PM7 simply checks for changes in conditions during the background monitoring time.

The system will periodically check, at an interval defined by the technician, that the count rate from the article is statistically consistent with previous measurements from the same article during that monitoring period. This feature will protect against users approaching too close to the instrument during the monitoring cycle, and consequently changing the background, or an additional source of background radiation appearing during the monitoring cycle.

Display of detection probabilities

There is no longer a need to use look up tables to relate the probability of detection and false alarm to sigma values. The system will instantaneously evaluate and display the probability when the use enters the sigma value.



Further, the system will calculate the overall probability of false alarm of the entire system, taking account of all the alarms that are enabled. This technique is a genuine calculation based each alarm setting, and is far less pessimistic than historical techniques. For this reason, the overall system probability of false alarm is rarely significantly more than that for the worst detector, and consequently shorter monitoring times may be used in order to satisfy the system false alarm criteria.

Alarms

The system has 9 standard alarm settings: 8 alarms for each individual detector and a centroid sum zone alarm based on the summed count rate of all detectors. In addition the user may utilize the ^{60}Co window alarm facility, which uses a narrower pulse height window to provide a separate alarm for high energy gamma emitting radionuclides. The ^{60}Co window is also available on the 8 detectors and the centroid sum zone.

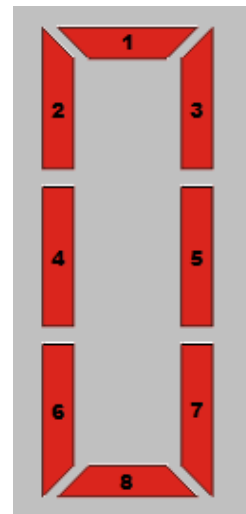
Double and triple sum zones are also available, for adjacent detectors.

Double sum zones: 1+3, 3+5, 5+7, 7+8, 8+6, 6+4, 4+2, 2+1

Triple sum zones: 1+3+5, 3+5+7, 5+7+8, 7+8+6, 8+6+4, 6+4+2, 4+2+1, 2+1+3

Centroid sum zone: 1+2+3+4+5+6+7+8

Each alarm may be set independently. The total number of alarms available per step is 50.



Low energy Indication



The PM12 uses a technique known as NBR to identify the energy of the photon radiation that triggered the activity alarm.

By comparing the pulse height spectrum with a typical spectrum associated with naturally occurring radioactive material (NORM), and that associated with artificial radionuclides the system can detect the presence of lower energy radionuclides, such as those associated with medical treatment. The assessment is based on comparisons between the measured count rates above a number of pulse height thresholds.

The technician may adjust the ratio between thresholds that would trigger a low energy indication. This feature may be disabled.

Waste Streams

The system may be calibrated against a number of radionuclides. In the process of calibrating the system to a given nuclide, a waste stream is setup for that nuclide. The system will allow for mixed waste streams, say 50%:50% ^{60}Co to ^{137}Cs , and the efficiency of the system will be adjusted accordingly.



In addition if there are some radionuclides in the stream which are not detectable by the PM12 e.g ^{55}Fe or ^3H , these may be accounted for by ensuring that the detectable radionuclides do not sum to 100%.

Extended Range

For applications where items which are significantly higher than the clearance monitoring criteria, the range of the instrument has been extended up to in excess of 10 MBq of ^{137}Cs .

Calibration Integrity Checking

An optional calibration integrity check is available. If the last date of checking of the calibration is outside of an agreed calibration period, the instrument will display “Out of Service”. Optionally, a message is displayed on entering Administration mode which does not prevent use, or the feature is turned off altogether.

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