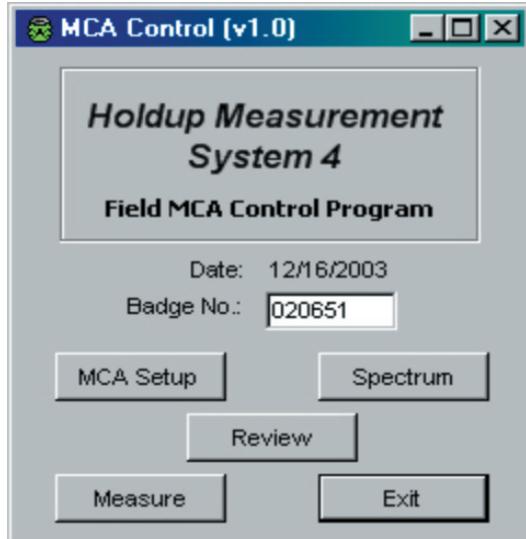


- Latest generation system for Materials Holdup Measurements for uranium and plutonium.
- Everything you need — gathers data, analyzes, and documents nuclear materials.
- Lightweight mobile unit.
- Powerful base-station desktop computer stores calibrations, equipment setup, and results.
- Method taught in the Los Alamos National Laboratory (LANL) Holdup Training Course.
- Incorporates the LANL Generalized Geometry Holdup algorithms.
- Available as a complete ready-to-use system.
- Components available for individual system integration.
- Recent HMS4 software updates allow Windows CE based mobile bar-code readers to be used.



## Introduction

"Holdup" refers to the accumulation of special nuclear material (SNM) inside the processing equipment of nuclear facilities. Holdup must be minimized and quantified: for radiation and criticality safety, safeguarding against theft or diversion, and economic reasons.

Accurate holdup measurements, while simple in principle, are demanding on the operator. The measurements by their nature are made *in situ* at specified points in the plant — often in awkward locations where SNM may be deposited, such as valves and ducts. The operator often must wear protective clothing, resulting in additional discomfort during the performance of the measurement under already unpleasant conditions of high temperature and humidity — perhaps up a ladder while holding a detector against a pipe with an outstretched arm. Beside those physical demands, the operator must keep track of the nuclear counting data and associated parameters (e.g., wall thickness, measurement distance).

## Operation

The HMS4 holdup measurement system makes it all as easy as possible for the operator, who need carry only a small, lightweight mobile unit which guides the operation and automatically logs the data with unique coding. This nearly eliminates the expense of having to repeat a measurement due to a data entry error.

The mobile unit is set up ready to go at the base station. When the operator completes the measurements, the unit is returned to the base to download the data. The host computer maintains all history and current data in an easy-to-use database. All needed reports and QA are available there.

## HMS4 Development

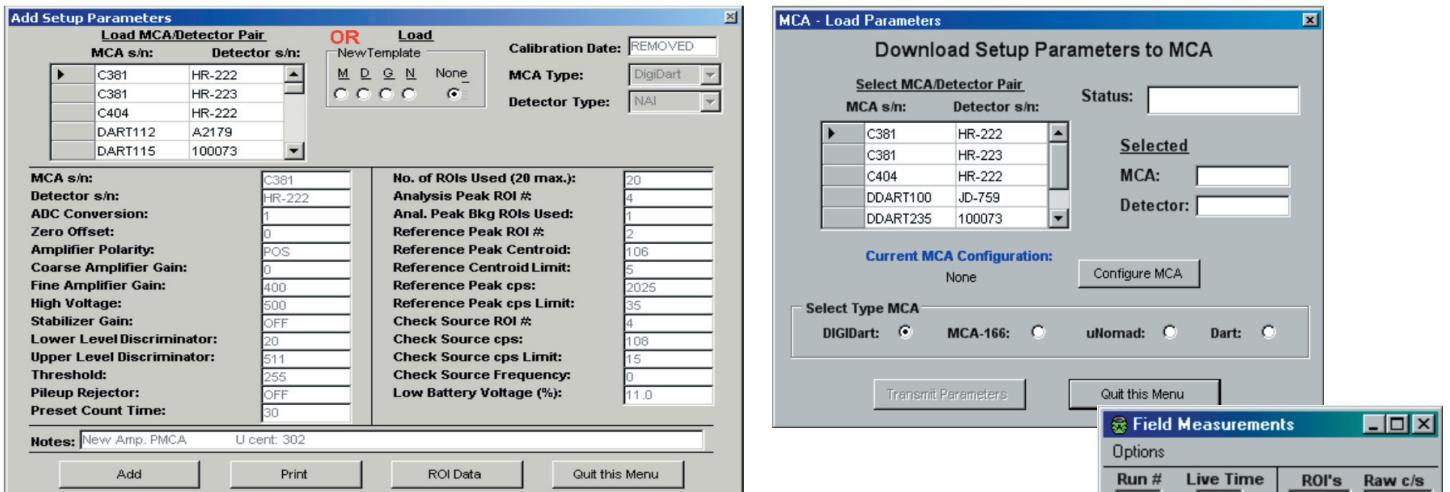
HMS4 was developed as a joint effort between LANL, ORNL and the Y-12 National Security Complex. Its predecessor, HMS3 was originally used and perfected for uranium holdup then extended for plutonium holdup.

The calculations in the HMS4 software are performed in accordance with the Generalized Geometry Holdup (GGH) method, which simplifies the measuring process by reducing the large number of possible geometries to three: point, line, and area. By examining the plant carefully and choosing appropriate measurement points, one of the three standard geometries can assay holdup with acceptable accuracy at each plant location. The GGH methodology gives rapid and accurate quantitative analysis of holdup in literally miles of ductwork, hundreds of valves and pipes, and in dozens of pieces of process equipment — that is, every possible measurement location.

## HMS4 Software

The HMS4 software includes two sets of programs; the main program that runs on a host personal computer (PC), and others running on a bar-code reader or portable PC.

The bar-code reader or portable PC is referred to as the Controller. The Host computer program performs setup and calibration of multichannel analyzer/detector pairs, loads the controller with operational parameters, receives measurement data from the controller, maintains measurements and derived results in databases, and prints reports.



The Field Controller programs control multichannel analyzer (MCA) setup functions, data acquisition, store measurement data as accumulated, and allow the user to review previous collected data and spectra.

The Field Measurements screen is the heart of the HMS4 Field MCA Control software. All of the data acquisition is done within this screen.

Four other host computer programs included in the distribution are: (1) the standalone Windows based Controller program, (2) a standalone MCA control selection program, (3) an upgrade program to be used to update existing older HMS3 databases to HMS4 format, (4) and a program for extracting the embedded Region of Interest (ROI) information from a Controller-saved spectrum.

The Windows-based HMS4 software provides the user with several enhancements over HMS3 versions. It offers the user a completely new menu based environment. It contains several new holdup correction algorithms such as the Finite Source correction and the Self-Attenuation correction. These algorithms have been integrated into the software for the capability of full error correction. HMS4 now supports twenty (20) spectral regions-of-interest (ROI) to aid the user measuring plutonium. The data from each Measurement Period (or campaign) is easily accessed from the main menu. All measurement data dumps are date and time stamped and allow for an 80-character comment field, which can be used for extra notes.

Many improvements have been made in the way that HMS4 performs background calculations, and now, the user has the flexibility to make 20 background measurements and reference the order needed.

HMS4 is written in Microsoft Visual Basic .NET® as part of the Microsoft Visual Studio .NET® 2003 development package. It uses Microsoft Access® (Microsoft Office 2000/XP format) database files. The reports are generated with the Crystal Decisions, Inc., Crystal Reports report generator, which is included with the Visual Basic .NET package. The software for the Controller (Pocket PC devices) is written in Microsoft embedded Visual Basic® as part of the Microsoft embedded Visual Tools v3.0® development package for Windows CE.

# Holdup Measurement System 4 (HMS4)

## Systems for Safeguards Measurements

### Holdup Measurement Training

The HMS4 system operation requires some hands-on experience in real world holdup situations. Both operators and supervisors should be knowledgeable of "GGH" methodology. A course is offered at Los Alamos National Laboratory, titled "Nondestructive Assay of Special Nuclear Materials Holdup," (Course # MCA-243); a similar course is offered by Oak Ridge National Laboratory (ORNL). This will give a user the fundamentals of the "GGH" methodology and an introduction to the use of the HMS4 package. Training includes theory and actual measurements using instrumentation supported by the HMS4 package. Contact ORTEC or Los Alamos National Laboratory for further training information.

### HMS4 System

A typical HMS4 System is a complete holdup system with the following components:

#### Mobile Portion

##### Nal Detector

The Nal detector, compact and easy to use, includes shielding on the sides and back to minimize background interference from extraneous radiation sources. This improves the signal-to-noise ratio, resulting in short measurement times and accurate results. Several detector models are available to match specific measurement needs. The quality of the data (spectra) is assured by the use of a reference source (<sup>241</sup>Am) attached to the detector, which provides a signal for gain stabilization and resolution monitoring. Any resolution change is reported to the operator.

##### Portable Multichannel Analyzer

HMS4 supports the following multichannel analyzers (MCAs): the ORTEC digiDART, digiDART-R and the Rossendorf MCA-166. ORTEC recommends the use of the digiDART.

##### Field Controller

Recent updates to the HMS4 Software have made a new generation of hand-held computers available as HMS4 Field Controllers. The Intermec CN3 Series of Mobile PC with Windows Mobile 5 has been successfully tested with HMS4. It is the Field Controller of choice with full systems purchased from ORTEC. These portable devices with bar-code reader facilitate obtaining holdup measurements. As the operator travels around the facility, the Field Controller controls the MCA data acquisition and stores the count rate data along with a field location bar-code. (Bar-codes positioned around the plant specify the measurement locations.) This procedure, which dramatically simplifies the entire process of obtaining the right data at the right place, ensures reproducible measurements.

There is also a full Microsoft Windows version of the Controller software. This is for use by individuals who wish to use a laptop computer in the field.

##### Host Computer

The supervisor uses the host computer to set up and calibrate the multichannel analyzer/detector pairs and to program the bar-code readers before the operator takes the mobile unit to perform measurements. All of this is supported by an extensive, easy-to-use menu system. Upon the mobile unit's return, the supervisor receives the measurement data from the bar-code reader/controllers. The measurement data and the derived results are stored in databases. The associated reports and data summaries can then be viewed and printed. A single host computer can support multiple field systems.

### HMS4 Reports

The results report may be sent to the screen or the printer. It is generated using Crystal Reports. Spectra can be re-analyzed as needed. An example of the report is shown in the figure.

Holdup Measurement System 4										
MCA Controller Data Dump Analysis Report										
Page No.: 1										
Dump #: 001	User ID: R08011	MCA S/N: DART135	Det. S/N: A2057							
AREA LOCATION DATE	TIME	ANAL PEAK UNCTV.	SRC.	DIST. (cm)	FS	SA	SPEC. MASS. (g. g/cm <sup>2</sup> )	MASS UNCTV. (counts/lat)	WARN.	BKG. DNA
0991 002 02/09/00	09:37	1,300	0.381	L 52.54	1,000	1,000	0.0057	0.0030	-	B -
0991 002 02/09/00	09:39	0.800	0.332	L 52.54	1,000	1,000	0.0000	0.0000	-	B -
0991 001 02/09/00	09:40	0.800	0.505	L 52.54	1,000	1,000	0.0244	0.0154	-	-
0991 001 02/09/00	09:41	1,000	0.671	L 52.54	1,000	1,000	0.0064	0.0049	-	-
0991 001 02/09/00	09:42	2,950	0.716	L 52.54	1,000	1,000	0.0091	0.0219	-	-
0991 004 02/09/00	09:42	2,150	0.665	L 52.54	1,000	1,000	0.0057	0.0030	-	-
0991 005 02/09/00	09:43	2,500	0.667	L 52.54	1,000	1,000	0.0764	0.0294	-	-
0991 006 02/09/00	09:44	3,000	0.628	L 52.54	1,000	1,000	0.0916	0.0192	-	-
0993 001 02/09/00	09:51	1,850	0.397	L 52.54	1,000	1,000	0.0000	0.0000	-	B -
0993 001 02/09/00	09:52	6,400	0.794	L 52.54	1,000	1,000	0.2111	0.0262	-	-
0993 002 02/09/00	09:53	7,950	0.847	L 52.54	1,000	1,000	0.2622	0.0277	-	-
0993 003 02/09/00	09:54	21,200	0.557	L 52.54	1,000	1,000	0.0000	0.0000	-	B -
0993 003 02/09/00	09:54	6,900	0.806	L 52.54	1,000	1,000	0.2276	0.0266	-	-
0993 004 02/09/00	09:55	7,800	0.854	L 52.54	1,000	1,000	0.2573	0.0282	-	-
0994 003 02/09/00	09:57	2,500	0.406	L 60.30	1,108	1,000	0.0000	0.0000	-	B -
0994 001 02/09/00	09:58	9,350	0.887	L 60.30	1,108	1,000	0.3922	0.0372	-	-
0994 002 02/09/00	09:59	21,200	1.182	L 60.30	1,108	1,000	0.5392	0.0413	-	-
0994 003 02/09/00	10:00	12,650	0.984	L 60.30	1,108	1,000	0.5386	0.0413	-	-
0994 004 02/09/00	10:01	3,350	0.726	L 60.30	1,108	1,000	0.1405	0.0085	-	D
0994 004 02/09/00	10:01	1,600	0.671	L 60.30	1,108	1,000	0.0671	0.0281	-	-

# Holdup Measurement System 4 (HMS4)

## Systems for Safeguards Measurements

### Ordering Information

ORTEC offers a complete HMS4 holdup system through our Integrated Systems Group which should be contacted for detailed system specifications and a price quote. The system which follows is an example configuration:

Model	Description
HMS4-SYS-1	Complete HMS4 system consisting of: Detector EFC (1X.5/N), Special NaI Detector, description below. ORTEC digiDART-R or digiDART with serial communications, includes MAESTRO-32 MCA emulator. ORTEC DIM-POSNAI NaI detector bias module. Intermec Controller, comprising: Intermec CN3 Wireless Mobile Computer (CN3BQH84000E100) Single Dock (871-025-002) 4 Pack Battery Charger (852-558-003) Extended Battery (318-016-002) 115 V AC Power Supply (851-082-203) RS232 CN3 Adapter (850-558-003) AC Power Cord (CTG-03130 for US) Mini-SD Card 512 MB (856-069-003) USB Cable, PC to Single Dock (CTG-13172) (Equivalents as necessary) Host Computer with following requirements: Windows XP Professional (or XP Virtual Mode under Windows 7). Printer. HMS4-B32 Holdup Software. Factory Integration and Test.

### HMS4 Software ONLY

HMS4-B32 Software for controller and host (supplied on CD-ROM).

### Holdup Detector ONLY

- 1X.5/N** 1 in.-diameter by 0.5 in.-thick NaI(Tl) integral detector with 1 in.-depth and diameter collimator, 0.320 in.-thick lead side shield, 0.375 in.-thick lead back shield, with Mu-metal shield surrounding front-end electronics. Cable included. Resolution <8% FWHM at 662 keV; weight ~3.8 lbs.
- 1X.5/U** Same as 1X.5/N, but with side shield wall thickness of 0.170 in., for measuring low-energy gamma emitters such as HEU; weight ~2.6 lbs.
- 1X2/P** Same as 1X.5/N, except with 1 in.-diameter by 2 in.- thick NaI crystal, typically used for high-energy gamma emitters such as plutonium.

### Detector Options

- 1X.5/HSG** Extra housing and shielding to allow for added flexibility, converts 1X.5/U to 1X.5/N.
- 1X.5/2/CBL** Extra Cable for above detectors with PVC sleeving for easy cleaning.

Specifications subject to change  
040412

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