Minimum Performance Criteria for Active Interrogation Systems Used for Homeland Security

ANSI N42.41

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Homeland Security

NIST

Published ANSI Standards

http://standards.ieee.org/getN42/index.html
http://www.rkp.mipt.org (search "DHS & IEEE")

- **ANSI N42.32** **Chair: Joe McDonald**
  - American National Standard Performance Criteria for Alarming Personal Radiation Detectors for Homeland Security
- **ANSI N42.33** **Chair: Morgan Cox**
  - American National Standard for Portable Radiation Detection Instrumentation for Homeland Security
- **ANSI N42.34** **Chair: Peter Chiaro**
  - American National Standard Performance Criteria for Hand-held Instruments for the Detection and Identification of Radionuclides
- **ANSI N42.35** **Chair: Leticia Pibida/ Brian Rees**
  - American National Standard for Evaluation and
  - Performance of Radiation Detection Portal Monitors
  - for Use in Homeland Security

- http://standards.ieee.org/getN42/index.html

- **http://www.rkp.mipt.org**

  (search entry “DHS & IEEE”)

Published ANSI Standards (Cont'd)

- **ANSI N42.37 Chair: Morgan Cox/ Alex Boerner**
  - Standard for Training Homeland Security Emergency Responders in the Uses and Maintenance of Radiation Detection Instruments
- **ANSI N42.38 Chair: Peter Chiaro**
  - Standard for Spectroscopy-Based Portal Monitors used for Homeland Security
- **ANSI N42.41 Chair: David Gilliam**
  - Performance Criteria for Active Interrogation Systems used for Homeland Security

    (**Final document sent for publication)**
- **ANSI N42.42 Chair: George Lasche/ Leticia Pibida**
  - Data format standard for radiation detectors used for Homeland Security
- **ANSI N42.43 Chair: Peter Chiaro**
  - Standard for Mobile and Transportable Systems Including Cranes used for Homeland Security Applications

Standards Under Development (cont.)

- **ANSI N42.39 Chair: Alan Thompson (NIST), Joe McDonald (PNNL)**
  Standard for Performance Criteria for Neutron Detectors for Homeland Security
- **ANSI N42.44 Chair: Mike Barrientos (TSL/SRA)**
  Performance and evaluation of checkpoint cabinet x-ray imaging security screening systems
- **ANSI N42.45 Chair: Lok Koo (TSL/SRA)/ Jim Connelly, (L3 Corporation)**
  Evaluating the image quality of x-ray computed tomography security screening systems
- **ANSI N42.46 Chair: Stacy Wright (TMEC)/ Jim Lamers (NTMI)**
  Measuring the performance of imagining x-ray and gamma-ray systems for cargo and vehicle security screening

- **ANSI N43.14 Chair: Siraj M. Khan (DHS/CBP)**
  Radiation Safety Guidelines for Active Interrogation Systems for Security Screening of Cargo

Proposed Standards

- **ANSI N42.XX Chair: Ed Groeber**
  - Standard or appendage to existing standards with regards to the use of radiation detection instruments under extreme conditions
- **ANSI N42.XX Chair: Peter Chiaro**
  - Performance requirements for spectroscopic personal radiation detectors (SPRDs)
- **ANSI N42.XX Chair: Morgan Cox/ Joe McDonald**
  - Performance criteria for personnel radiation dosimeters for homeland security
- **ANSI N42.XX Chair: to be determine**
  - Performance criteria for survey meters for emergency response for homeland security
- **ASTM E54 Chair: to be determine**
  - Mechanical, Electrical, Environmental Criteria

Wide range of comments

- Detailed
- General
- Helpful
- Trivial

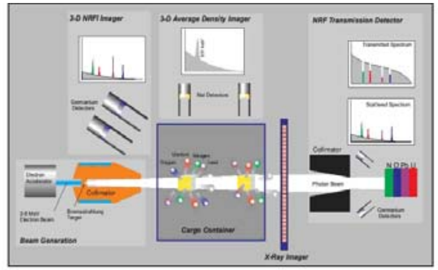
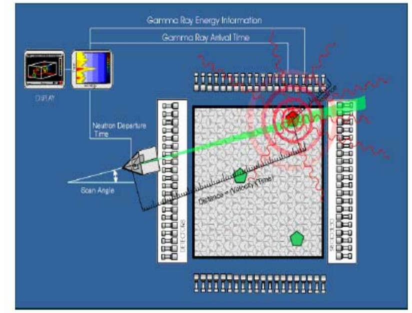


Figure 1 – Schematic of Nuclear Resonance Fluorescence Imaging (NRFI)



American National Standard ANSI N42.41

Examples -- imaging, non-imaging

Size -- Hand-portable to large installations

Detection of HEU by Counting Neutrons from Induced Photofission
Prof. James L. Jones, Idaho State

Nuclear Resonance Fluorescence Imaging (NFRI) - Schematic

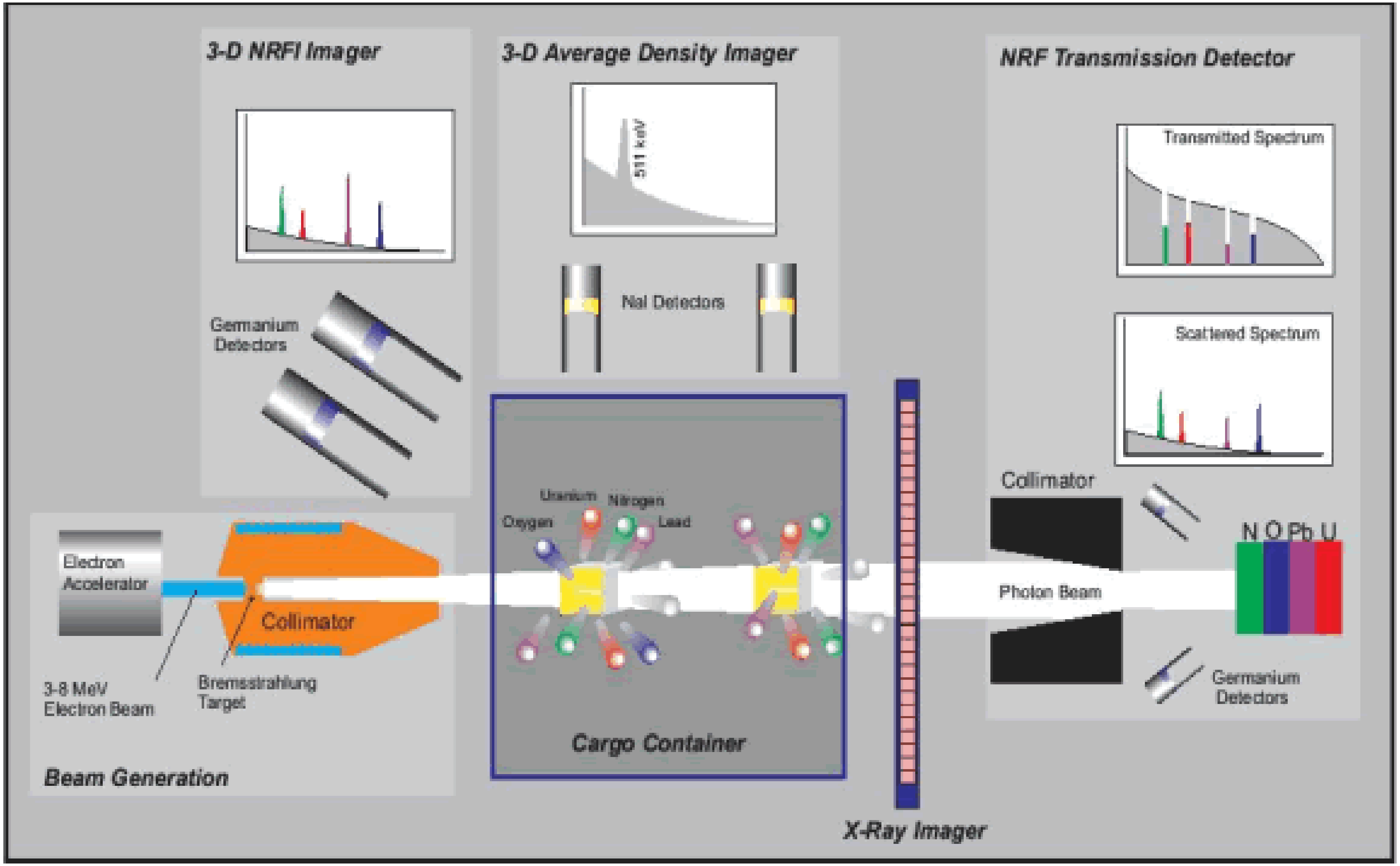
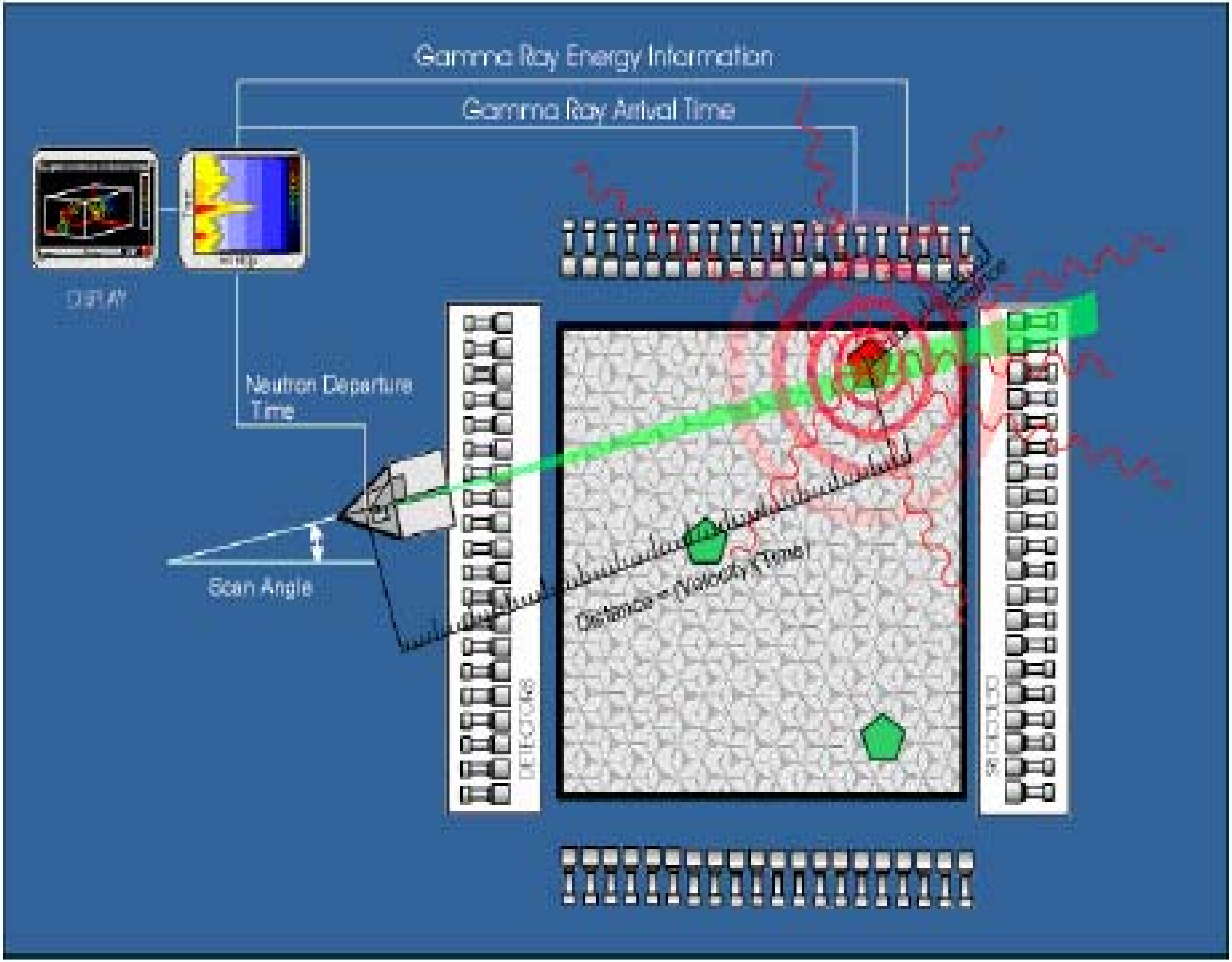


Figure 1 – Schematic of Nuclear Resonance Fluorescence Imaging (NRFI)

Pulsed Fast Neutron Analysis (PFNA) - Schematic

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ANSI N42.41 (Active Interrogation) Working Group

Chairman and Project Leader: David M. Gilliam, NIST

William Bertozzi	MIT, Passport Systems
David Chichester	INL (formerly Thermo, Sandia)
Ed Franco	Rapiscan Systems (formerly ARACOR)
Tsahi Gozani	Rapiscan Systems (formerly Ancore)
Siraj M. Khan	Customs and Border Protection / DNDO
James L. Jones	INL
Steve Korbly	Passport Systems
Robert Ledoux	Passport Systems
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Thomas L. Moore	LLNL
Calvin E. Moss	LANL
Frank H. Ruddy	Westinghouse
Dennis R. Slaughter	LLNL
George Vourvopoulos	SAIC

Our Definition of Active Interrogation: A process in which the contents of an inspection zone are irradiated with ionizing radiation (e.g., neutrons or high-energy photons) to determine the presence of a hidden substance-of-interest **by the analysis of stimulated secondary radiation** that is indicative of the chemical and/or isotopic composition of the substance-of-interest.

Scope: These systems employ ionizing radiation (e.g., neutrons, high-energy x-rays, gamma-rays) to detect and identify hidden **chemical, nuclear, and explosive agents** by detection of stimulated secondary radiations **or by nuclear resonance contrast**, giving elemental and/or isotopic identification of the composition of the substances of interest.

Table 1. Container* Categories and Inspection Zone Dimensions for Active Interrogation

Container* Category	Container* Type	Maximum Dimensions of Inspection Zone: Depth, Height (meters)	Inspection Zone Maximum Length or Length Scanned (meters)
A	Small article, Carry-on, Suitcase	0.3, 0.57	0.71 or Scanned
B	Airline Cargo Container	1.53, 1.56	1.60 or Scanned
C	Automobile	2.0, 1.8	5.6 or Scanned
D	Two Axle Vehicle ≤ 2 Ton Cargo	2.2, 2.2	7.6 or Scanned
E	Intermodal Cargo Container (≤ 30 feet)	2.6, 3.0	9.1 or Scanned
F	Intermodal Cargo Container (> 30 feet)	2.6, 3.0	12 or Scanned
G	Truck (> 30 feet)	2.6, 4.2	12 or Scanned
H	Tractor/Semi-trailer	2.6, 4.2	26 or Scanned
I	Rail Car	2.9, 5.0	27.4 or Scanned

Table 2. Average Allowed Inspection Time for Clearing the Full Inspection Zone Containing only Normal Cargo Packages

Container Category	Container Type	Allowed Average Inspection Time* (seconds)
A	Small article, Carry-on, Suitcase	90
B	Airline Cargo Container	900
C	Automobile	150
D	Two Axle Vehicle ≤ 2 Ton	200
E	Intermodal Cargo Container (≤ 30 feet)	300
F	Intermodal Cargo Container (> 30 feet)	600
H	Truck (> 30 feet)	600
G	Tractor with Semi-trailer	600
I	Rail Car	900

*Includes all re-scans made to clear any initial scan alarms.

Table 3. Average Allowed Inspection Time for Clearing a Single, Externally-specified Sub-zone* Containing only Normal Cargo Packages

Container Category	Container Type	Allowed Average Inspection Time (seconds)
A	Small article, Carry-on, Suitcase	60
B	Airline Cargo Container	300
C	Automobile	80
D	Two Axle Vehicle ≤ 2 Ton	90
E	Intermodal Cargo Container (≤ 30 feet)	140
F	Intermodal Cargo Container (> 30 feet)	200
H	Truck (> 30 feet)	200
G	Tractor with Semi-trailer	200
I	Rail Car	300

*A specified sub-zone may not be larger than one eighth of the full inspection zone in volume as indicated in Table 1. The greatest dimension of a sub-zone shall not be larger than one fourth of the greatest dimension of the full test zone for container categories A-G, and shall not be larger than one eighth of the greatest dimension of the full test zone for categories H and I.

Table 4. Amount of Specified Substance in an Active Interrogation System Test

Container Category	Explosive Mass (kg)	Chemical Warfare Agent Mass (kg)	Fissionable Material[1] Mass (kg)	Weapon Shell[2] Mass (kg)
A	1	5	5	16
B	5	5	25	16
C	50	100	25	16
D	200	200	25	16
E	200	200	25	16
F	200	200	25	16
G	200	200	25	16
H	200	200	25	16
I	300	300	25	16

[1]LEU at 19.5% enrichment.

[2]Spherical shell of tungsten carbide, 14 cm O.D., 8 cm I.D., at a density of 13.7 g/cm^3.

Four simulated cargo loadings:

- Test zone empty (air-filled except for the simulant and very light supports for the simulant mass)

- Test zone filled uniformly with newsprint at a specific gravity of 0.6 (+0 %, - 20%)

- Test zone filled uniformly with aluminum at a specific gravity of 0.4 (± `10 %)

- Test zone filled quasi-uniformly with steel at a specific gravity of 0.4 (± 10 %)

Simulants

Explosives

- Military Plastic Explosives
- Ammonium-nitrate-fuel-oil

Chemical Agents

- Sarin Nerve Gas
- Mustard Gas Blister Agent

Nuclear

- Low-enrichment Uranium (19.5 %)
- Tungsten carbide spherical shell

Performance Requirements:
PD – Probability of Detection
PFA – Probability of False Alarm

For full points, the probability of detection and identification must exceed 90% (at the 68 % confidence level) and the false positive rate must be less than 5% (at the 68 % confidence level), achieved within the allowed average inspection times.

Table A2.1. Detection Criteria for Verifying a Lower Bound on the Probability of Detection, with 68 % Confidence

In a single set of ***n*** trials, the minimum number of successes ***m*** required to assure the indicated lower bound on the probability of detection PD[A]

m ↘	**PD > 0.50**	**PD > 0.75**	**PD > 0.80**	**PD > 0.85**	**PD > 0.90**	**PD > 0.95**
***n* = 9**	**6**	**8**	**9**	**9**	**...**[B]	**...**
***n* = 10**	**6**	**9**	**10**	**10**	**10**	**...**
***n* = 15**	**9**	**13**	**14**	**14**	**15**	**...**
***n* = 20**	**12**	**17**	**18**	**19**	**20**	**...**
***n* = 25**	**14**	**21**	**22**	**23**	**24**	**25**
***n* = 30**	**17**	**24**	**26**	**27**	**29**	**30**

[A] For a single set of ***n*** trials, the detection probability is established as greater than the PD column heading value with at least 68 % confidence, based on ***m*** or more successes.

[B] When the minimum required number of correct results is indicated as "...", then the number of trials in that set is insufficient to verify (at the 68% confidence level) that the detection probability is greater than the PD column heading**,** even if the result of every trial in that set were correct.

Table A2.2. Detection Criteria for Verifying Upper Bound on False Positives with 68% Confidence

In a single set of ***k*** trials, the maximum permissible number ***j*** of false positives to assure the indicated upper bound on the probability of a false positive[A] (PFA)

j	PFA < 0.10	PFA < 0.075	PFA < 0.05	PFA < 0.025
k = 10	0	**...**[B]	**...**	**...**
k = 15	0	0	**...**	**...**
k = 20	0	0	**...**	**...**
k = 21	0	0	**...**	**...**
k = 22	1	0	**0**	**...**
k = 23	1	0	0	**...**
k = 24	1	0	0	**...**
k = 25	1	0	0	**...**
k = 30	1	1	0	**...**
k = 40	2	1	0	**...**
k = 50	3	2	1	0

[A] For a single set of ***k*** trials, the probability of a false positive is established as less than the PFA column heading value with at least 68% confidence, based on no more than ***j*** false results.

[B] When the maximum number of permissible false positives is indicated as "**...**", then the number of trials in that set is insufficient to verify (at the 68% confidence level) that the probability of a false positive is less than the PFA column heading**,** even if there were no false positives in the trials.

Four simulated cargo loadings:

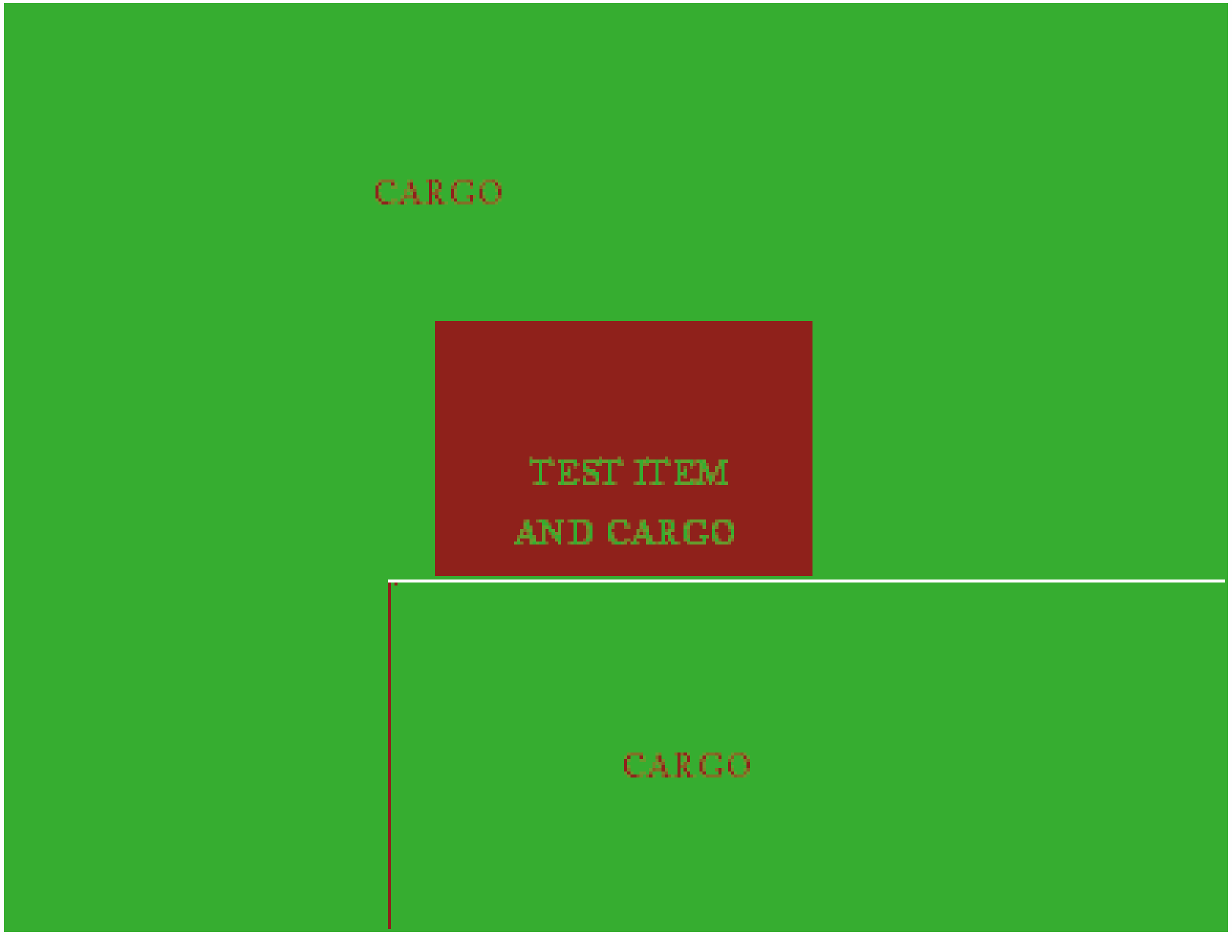
Test zone empty (air-filled except for the simulant and very light supports for the simulant mass)

Test zone filled uniformly with newsprint at a specific gravity of 0.6 (+0 %, - 20%)

Test zone filled uniformly with aluminum at a specific gravity of 0.4 (± `10 %)

Test zone filled quasi-uniformly with steel at a specific gravity of 0.4 (± 10 %)

One of 4 uniform Cargo sections



1 ton section on linear bearings moved