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Evaluation of Commercially Available Exterior Digital VMDs

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Abstract

This paper discusses the highlights from the full report, *"Evaluation of Commercially Available Exterior Digital VMDs", Charles E. Ringler, Chris E. Hoover, SAND94-2875,* on the testing and evaluation of thirteen commercially available exterior digital video motion detection (VMD) systems. The systems were evaluated for use in a specific perimeter outdoor application. The full report focuses primarily on the testing parameters, each system's advertised features, and the nuisance alarm and detection test results, this paper will summarize the nuisance alarm and detection test results and present some conclusions from the tests. The full report is available for DOE and DOE Contractors from the Office of Scientific and Technical Information, P O Box 62, OakRidge, Tennessee, 37831 or for the public at the National Technical Information Service, US Department of Commerce, 5285 Port Royal Rd, Springfield, Virginia, 22161.

Introduction

There has been considerable interest in the past few years concerning the use of VMD systems as exterior intrusion sensors. New-generation VMD systems advertise advanced video signal processing techniques and algorithms that are aimed at rejecting nuisance alarm sources inherent to the uncontrollable exterior environment. In the past, VMD systems had high nuisance alarm rates, which made them generally unacceptable for use as exterior sensors.

An increasing number of VMD systems are appearing on the commercial market that advertise to be outdoor or exterior VMD systems. All the evaluated VMD systems employ digital processing techniques for detection and nuisance alarm reduction. This evaluation focused on these new-generation VMDs with the primary goal to analyze their detection and nuisance alarm rejection characteristics.

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The systems included in the evaluation tests were:

3-Dimensional Intelligent Space (3DIS)
3-DIS Security System 4

American Dynamics
DigiTect II - 4500

Burle
TC8214

Detec Vision Systems
Auto Sentry SA3

EDS-Scicon Defence Ltd.
Sentinel

Geutebruck
TeleTect VS-30

GYYR
DVMD32

Quark Digital Systems Inc.
Q18VM4

Magal Security Systems, Ltd.
DTS-1000

Senstar
David 300

Senstar
David 200

Shorrock/Hymatom
Movicom 4

Tech. Services International (TSI)
TSI-2020

Vision Systems Limited
Adpro VMD-1

Senstar's David 200 was previously evaluated, but was re-evaluated to establish a baseline from previously evaluated VMDs to the VMDs in the current evaluation. Below is a list of previously evaluated VMD systems that were not included in this evaluation because they had not changed the algorithms since the last Sandia evaluation.

Digi-Spec Corporation
DS-1
(DS-4 was not made available at time of evaluation)

Sas-Tec USA Inc.
VSM 210

Sony
YS-D100

Vicon
V223MD

Test Zone

Figure 1 shows the dimensions of the perimeter test zone (zone 7) in which the evaluation was conducted. As illustrated, the test zone begins at a distance of 284 feet from the camera. This is the camera's 50-foot horizontal field of view (FOV). The end of the test zone is at the camera's 100-foot horizontal FOV, which is 568 feet from the camera. Markers were placed in the test zone at the camera's 50-, 60-, 70-, 80-, 90-, and 100-foot horizontal FOVs. The intrusion detection tests were conducted at these locations.

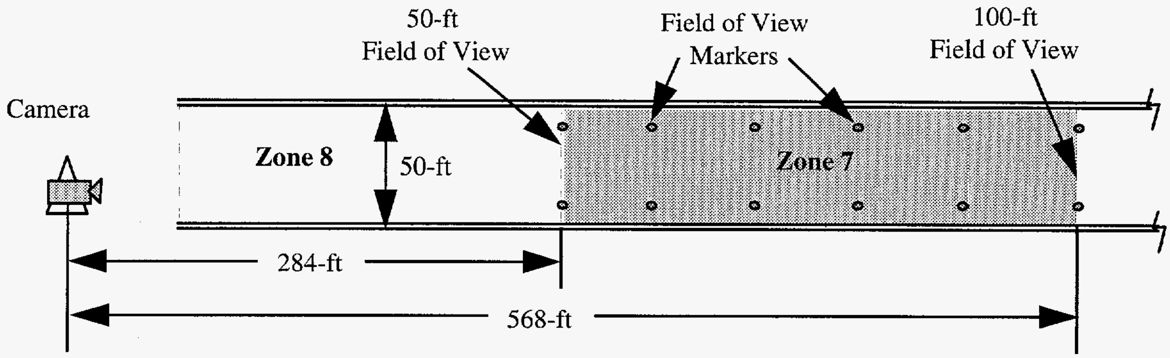

Figure 1. Test Zone Details

Camera/Video Signal

The camera used in this evaluation was a Cohu model 4815, 2/3-inch format, with a 50mm lens. The video signal (NTSC, 1Vp-p, 75-ohm) was transmitted over fiber-optic cable to a trailer where the data collection equipment was located. The video signal from the fiber-optic system was connected to the distribution amplifiers (figure 2), with the outputs from each amplifier adjusted to an equal level. The outputs from the distribution amplifier were connected to the video inputs of each VMD system. The VMD units that had more than one channel available in the evaluation had a second input tied to a separate channel for monitoring. The video outputs for each VMD system were routed to a video switcher to allow manual switching of each system's output screen to a monitor.

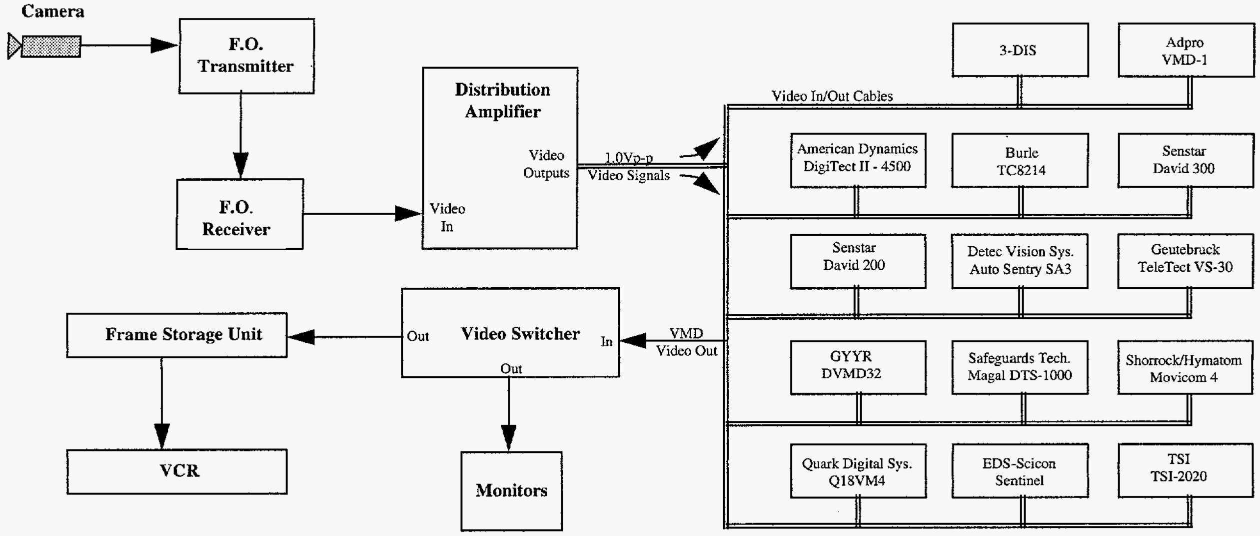

Figure 2. Video Signal Block Diagram

VMD Test Guidelines

The basic test guidelines used for the VMD evaluation called for a setup of each VMD system to detect an intruder crossing the test zone from either direction. In general, the detection area or area of interest (AOI) for each VMD was set up to cover the area inside the FOV markers. These markers were placed approximately 10 feet in from each fence, which allowed the AOI to be 30 feet wide. Figure 3 shows the camera's view, with details showing the 50-foot and 100-foot FOVs and the other FOV marker locations.

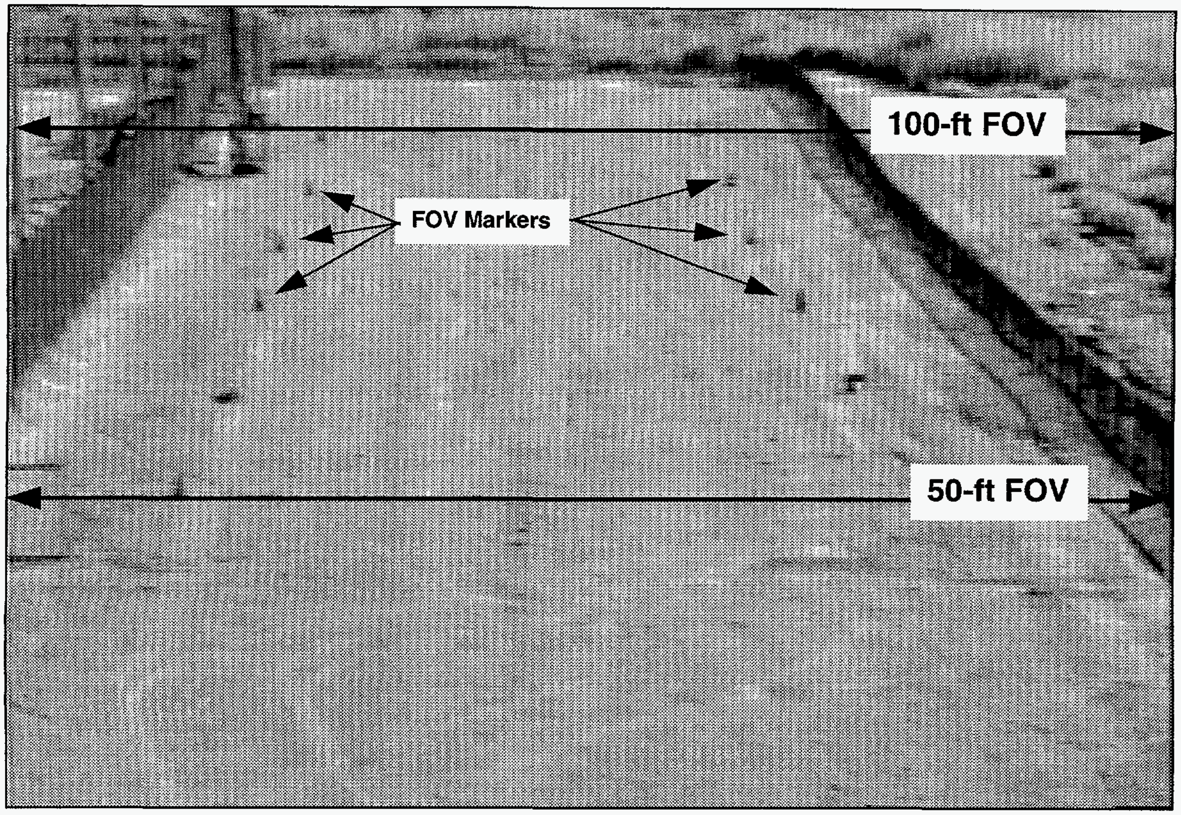

Figure 3 Camera View

Detection Criteria

Based on our requirements, the detection criteria were based on the following parameters:

- A running *intruder* (maximum speed of 5 meters/second).
- A crawling intruder or dummy to simulate a crawler (slowest speed .15 meters/second).
- Minimum cross-sectional size of intruder or dummy (one square foot).
- Intruder could cross through the test zone in any manner (run, walk, crawl), as long as the total elapsed time of each intrusion attempt fell between the above specified speeds.
- Intruder could dress in any manner required to blend into the background as closely as possible.
- Detection tests would be performed at all times of day, including dusk, dawn, night, and daytime, with the majority of detection testing done at times when the intruder blended best into the background.

The ***goal of the detection tests*** was to set-up each VMD system to achieve 90% probability of detection (Pd) at 95% confidence. If possible, each system had its parameters adjusted to achieve this level of detection. The results of the tests are shown in figure 4.

Nuisance Alarm Criteria

Once the systems were set up to meet (if possible) the detection alarm criteria, each system was monitored to establish the rate of nuisance alarms at the current parameter settings. If the false or nuisance alarm rate of a VMD system was very high (more than 10 in a 24-hour period on a clear day), the system(s) parameter settings were adjusted to limit the number of alarms generated to an acceptable level, which in this case, was an average of fewer than 10 false/nuisance alarms in a 24-hour period on a clear day. The results from the live nuisance alarm tests and the results from the taped nuisance alarms are shown in figures 5 and 6.

Conclusions

Commercially available video motion detectors were tested and evaluated for a specific application. It is acknowledged that the systems may act differently when used in applications other than the one in which they were evaluated. The evaluation was meant to push the detection and nuisance alarm rejection capabilities of each system to their limits for this particular application.

Generally, video motion detectors when used in an outdoor environment are susceptible to nuisance alarms from environmental effects, especially cloud movements. Some of the systems handled these conditions better than others, but **all** had some problems rejecting nuisance alarms. To keep detection levels high for small targets at the camera's far FOV the VMD systems' sensitivities had to be set below recommended values, which caused a high nuisance alarm rate. Each of the systems performed better when used on shorter zones where the minimum target size was larger and the sensitivity levels could be raised.

Using VMDs as ***stand-alone*** perimeter security sensor would not be recommended for our Ultra-high security applications. There are periods in which the VMD systems are vulnerable. For instance, any condition in which the operator cannot see something in the zone, such as fog, rain, shadows, etc., will also pose detection problems for a VMD system. If the VMD system did detect something in the shadows, then the operator would probably discount the alarm, since the operator would not be able to verify the detection given the poor visibility of the camera image. We would use a VMD in conjunction with other perimeter sensors that would compliment the detection capabilities of both sensors in a perimeter security system application.

The state of VMD's have been improving with each major revision from the commercial vendors. As the state of technology improves in processing speed and capabilities the processing necessary to identify real intrusions in a VMD will also improve. This processing power will allow newer improved VMD's to be able to reject more types of nuisance alarm sources and identify more situations of real intrusions than is possible today.

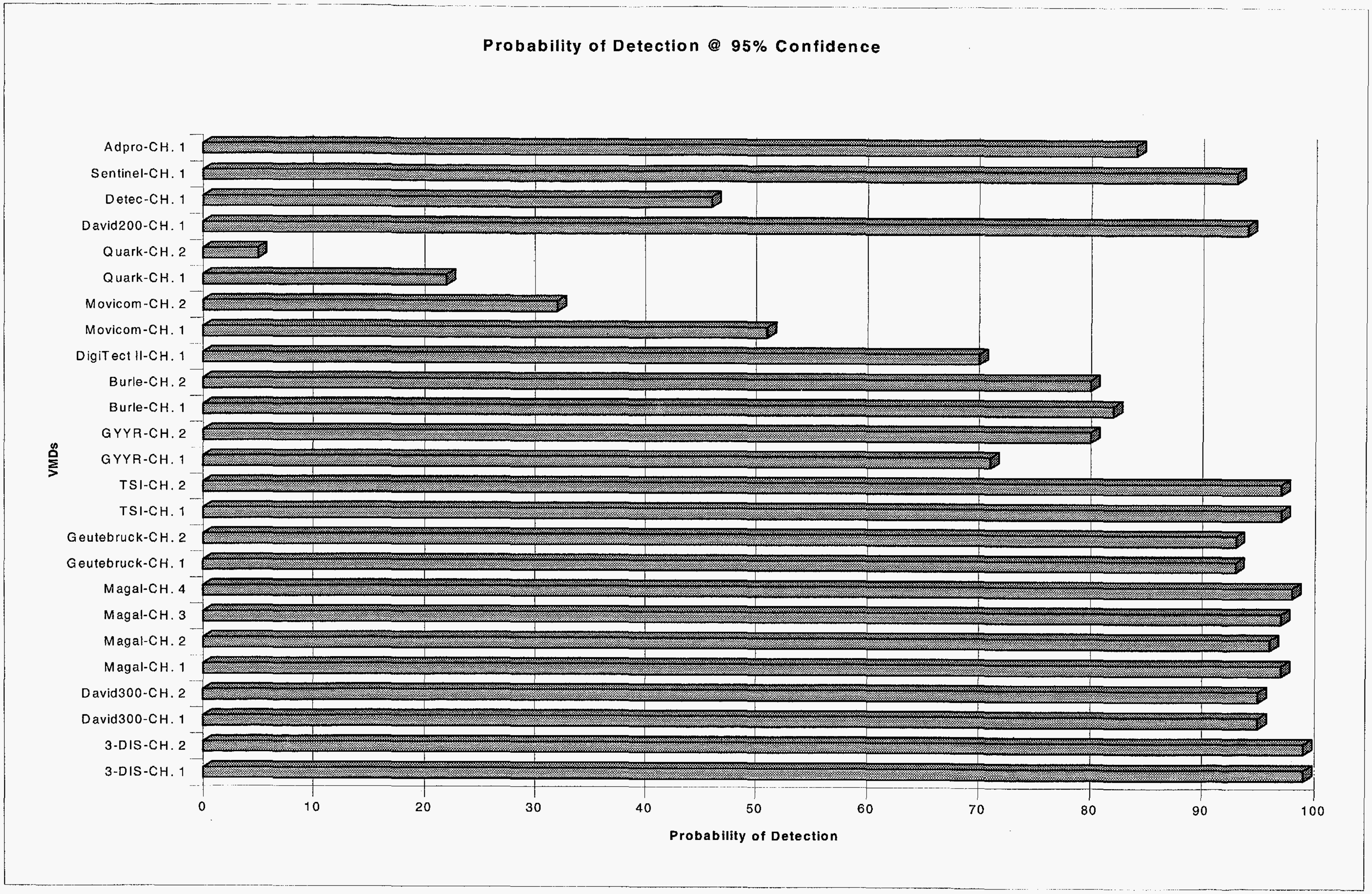
Probability of Detection @ 95% Confidence
Adpro-CH. 1
Sentinel-CH. 1
Detec-CH. 1
David200-CH. 1
Quark-CH. 2
Quark-CH. 1
Movicom-CH. 2
Movicom-CH. 1
DigiTect II-CH. 1
Burle-CH. 2
Burle-CH. 1
GYYR-CH. 2
GYYR-CH. 1
TSI-CH. 2
TSI-CH. 1
Geutebruck-CH. 2
Geutebruck-CH. 1
Magal-CH. 4
Magal-CH. 3
Magal-CH. 2
Magal-CH. 1
David300-CH. 2
David300-CH. 1
3-DIS-CH. 2
3-DIS-CH. 1
VMDs
0
10
20
30
40
50
60
70
80
90
100
Probability of Detection

Figure 4

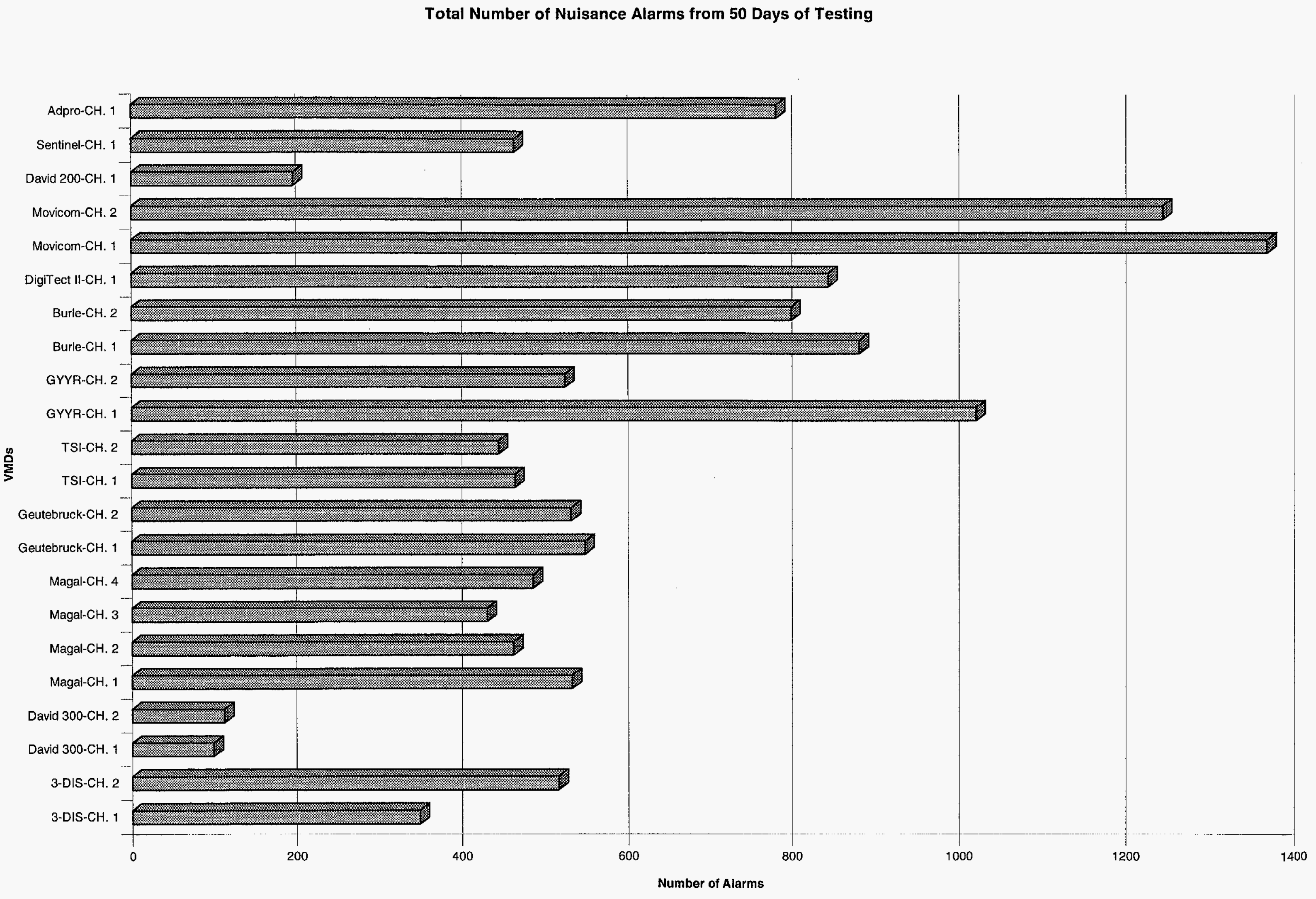
Total Number of Nuisance Alarms from 50 Days of Testing
VMDs
Adpro-CH. 1
Sentinel-CH. 1
David 200-CH. 1
Movicom-CH. 2
Movicom-CH. 1
DigiTect II-CH. 1
Burle-CH. 2
Burle-CH. 1
GYYR-CH. 2
GYYR-CH. 1
TSI-CH. 2
TSI-CH. 1
Geutebruck-CH. 2
Geutebruck-CH. 1
Magal-CH. 4
Magal-CH. 3
Magal-CH. 2
Magal-CH. 1
David 300-CH. 2
David 300-CH. 1
3-DIS-CH. 2
3-DIS-CH. 1
0
200
400
600
800
1000
1200
1400
Number of Alarms

Figure 5

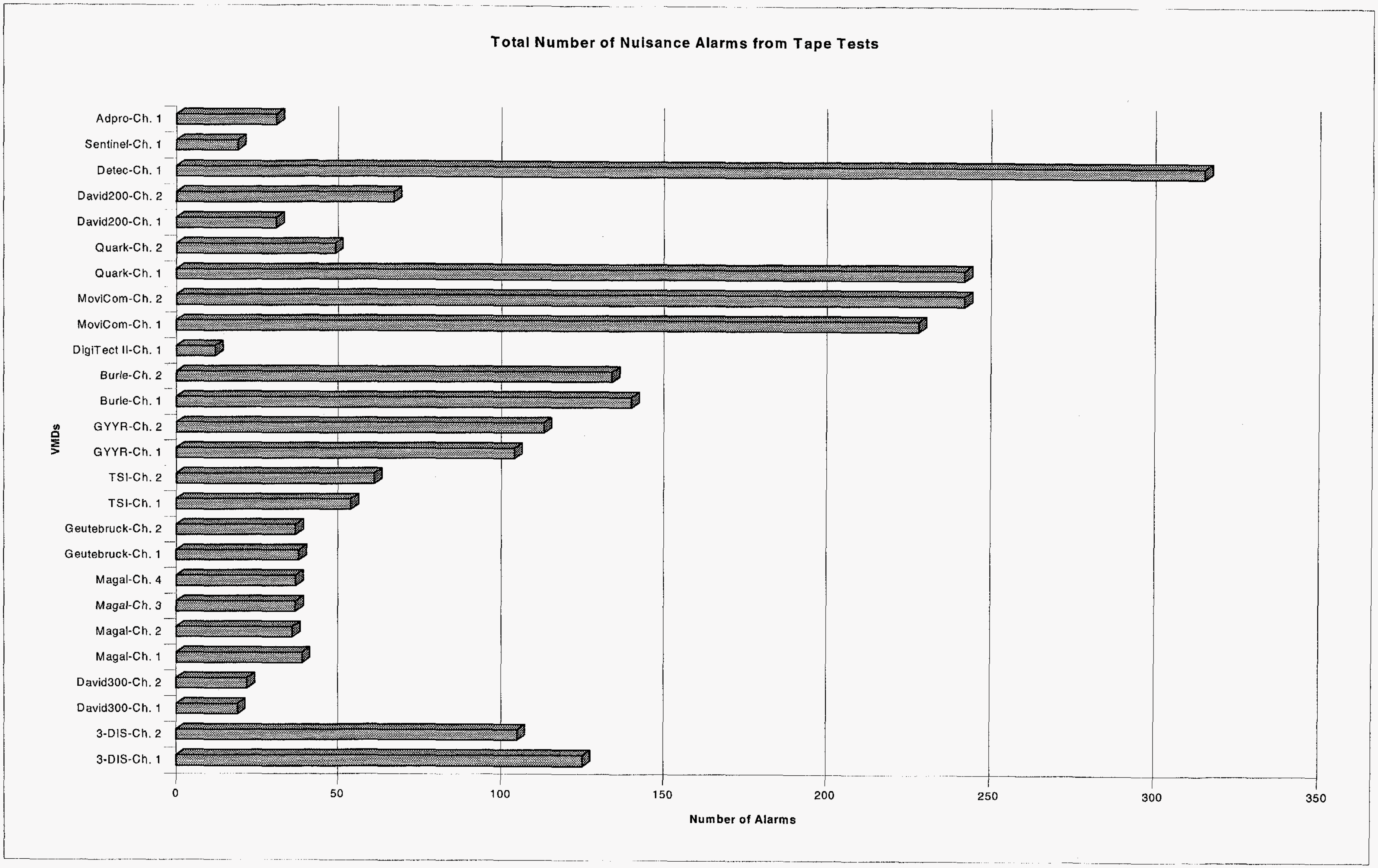
Total Number of Nuisance Alarms from Tape Tests
Adpro-Ch. 1
Sentinel-Ch. 1
Detec-Ch. 1
David200-Ch. 2
David200-Ch. 1
Quark-Ch. 2
Quark-Ch. 1
MoviCom-Ch. 2
MoviCom-Ch. 1
DigiTect II-Ch. 1
Burle-Ch. 2
Burle-Ch. 1
GYYR-Ch. 2
GYYR-Ch. 1
TSI-Ch. 2
TSI-Ch. 1
Geutebruck-Ch. 2
Geutebruck-Ch. 1
Magal-Ch. 4
Magal-Ch. 3
Magal-Ch. 2
Magal-Ch. 1
David300-Ch. 2
David300-Ch. 1
3-DIS-Ch. 2
3-DIS-Ch. 1
VMDs
0
50
100
150
200
250
300
350
Number of Alarms

Figure 6