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# A TEST OF THE COMPUTER VOICE STRESS ANALYZER (CVSA)

## THEORY OF OPERATION

**By**

**Victor L. Cestaro, Ph.D.**

***Abstract***

This study was designed to test the underlying electronic theory of operation of the Computer Voice Stress Analyzer (CVSA). During this experiment the CVSA input/output was evaluated using simulation signals from laboratory test generators. The laboratory simulations established that the CVSA performs electrically according to the manufacturer's theory of operation. These results indicate there may be a systematic and predictable relationship between displayed voice patterns and changes in the speech envelope related to human physiology.

Voice analysis is the decomposition of a human voice into objectively measurable characteristics. It has been proposed that voice analysis can determine the amount of stress (voice stress analysis) that the speaker is experiencing (Brenner, Branscomb & Schwartz, 1979; Inbar & Eden, 1976). Further, it has been suggested that voice stress is linked to deception (Motley, 1974; O'Hair & Cody, 1987; Streeter, Krauss, Geller, Olson, & Apple, 1977). It should be noted that instruments designed to detect deception, such as the polygraph instrument, do not detect deception per se, but rather detect physiological activity related to the stress experienced by subjects during the act of deception.

The Computer Voice Stress Analyzer (CVSA) manufactured by the National Institute of Truth Verification (NITV, West Palm Beach, FL) is the latest in a series of instruments purported to detect deception in voice responses. Previous equipment, such as the Psychological Stress Evaluator (PSE), consisted mainly of a simple resistor-capacitor low pass filter circuit, and required responses to be recorded on audio tape and subsequently analyzed at reduced tape speed (VanDercar, Greaner, Hibler, Spielberger, & Block, 1980). Unlike the PSE, the CVSA analyzes and displays responses in real time, purportedly using state of the art computer technology. Responses do not have to be pre-recorded and then played back at the 1/4 to 1/8 speed required by the PSE.

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This project was funded by the Department of Defense Polygraph Institute as DoDPI94-P-0027. These results were previously reported in Cestaro (1995). The views expressed in this article are those of the author and do not reflect the official policy or position of the Department of Defense or the U.S. Government. For reprints, write to Dr. Cestaro at DoDPI, Building 3195, Ft. McClellan, Alabama 36205-5114.

The underlying theory of operation for the PSE and the CVSA is that the instruments detect physiological microtremor associated with muscles in the voice mechanism. Physiological tremor is described as a low amplitude oscillation of the reflex mechanism that controls the length and tension of a stretched muscle, and has a frequency between 8 and 12 hertz (Hz)(Lippold, 1971). According to Lippold, tremor is believed to be a function of the signals to and from motor neurons; it is analogous to a self-adjusting, closed-loop servo system. That is, the observed tremor is like the "hunting" behavior of mechanical servomechanisms. Stretch sensors in the muscle tissue signal the amount of stretching and transmit this information to the associated motor neuron in the spinal cord. This information is processed and the efferent motor neuron fiber is activated to increase or decrease the stretch of the muscle tissue. The finite delays in signal transmissions to and from the target muscle account for the low frequency oscillation, and hence, the hunting behavior.

Voice stress analyzers purportedly detect physiological microtremor in speech (oscillations of 8 to 12 Hz in muscle tissue), and convert those components to a graphical representation of stress experienced by the subject (Brenner, Branscomb, & Schwartz, 1979). Nerve fibers carried in the trunk of the vagus nerve innervate the laryngeal muscles, including the cricothyroid muscle (Kahane, 1986). Increases in voice frequency are accomplished by lengthening the vocal folds through activity of the cricothyroid muscle, while decreases are a result of relaxation and shortening of the vocal folds by the thyroarytenoid (Gray, 1977, p. 963). Laryngeal microtremor, indirectly assessed by analysis of changes in voice fundamental frequency, is purported to be inversely related to stress (Brenner, *et al.*, 1979; Inbar & Eden, 1976; Smith, 1977; VanDercar, *et al.*, 1980). It is argued that as stress increases, the amplitude of the microtremor decreases. Support for the laryngeal microtremor hypothesis is inconsistent (Inbar & Eden, 1976; Shipp & Izdebski, 1981). Shipp and Izdebski (1981) found no evidence to support the laryngeal microtremor hypothesis. These investigators examined electromyographic (EMG) activity directly from the laryngeal muscles (cricothyroid and posterior cricoarytenoid) during conversational speech and sustained phonation. They contend that EMG activity changed so rapidly over time during normal speech that no Fourier analysis could be calculated at the selected sampling rate. These signals were compared to normal microtremor of 9 Hz sampled from the biceps. They concluded that their findings cast doubt on the assumptions made by manufacturers of (voice) stress analysis instruments. Conversely, Inbar and Eden (1976), using similar procedures, found that EMG recordings were correlated with frequency changes in the voice spectrum, suggesting the existence of voice microtremor.

Voice stress research using instrumentation other than off-the-shelf voice stress analyzers has focused on discrete measures within the response as indicators of deception. Motley (1974) reported that response duration was the only reliable index of deception. Other investigators have shown that stress is related to a specific change in the fundamental frequency of the speaker's voice (Tolkmitt & Scherer, 1986; Streeter, *et al.*, 1977). Cestaro and Dollins (1994) calculated spectrum and time domain analyses of voice responses recorded during 28 peak of tension (POT) psychophysiological detection of deception (PDD) examinations. They found no single measure of the voice response that could serve as a reliable indicator of deception. While a systematic relationship was found among some combinations of speech parameters and stress, the

relationship was not consistent over time and between subjects. No systematic relationship was found between voice spectra and stress. Others have reported that speaker stress could not be related to the results of voice response spectral analysis (Zalewski, Majewski, & Hollien, 1975).

This study was designed to evaluate the published theory of operation of a second generation voice analyzer, the CVSA. According to the manufacturer, the CVSA detects stress related changes in the voice (laryngeal) microtremor (NITV, 1994). The experiment was designed to determine whether the CVSA instrument detects microtremor in the fundamental frequency of presented signals. The manufacturer claims that changes in the fundamental frequency of a signal presented at the input to the instrument are displayed as meaningful changes in the chart tracings; tracings with a constant, or nearly constant, amplitude (*i.e.*, containing little or no microtremor) are indicative of a stressed response (NITV, 1994). Conversely, tracings showing a cyclic or peaked pattern are claimed to be the result of microtremors in the response, and are indicative of a response containing little or no stress. Laboratory function generators were used to present simulated stressed and unstressed voice responses to the input of the CVSA. Constant amplitude unmodulated signals were used to represent a stressed voice response containing no microtremor. Unstressed responses were simulated by frequency modulating the function generator at a 10 Hz rate. The resultant CVSA output was examined at various fundamental frequencies.

## Method

### Apparatus

A Tektronix (Beaverton, OR) Model CFG280 Function Generator was used to present a constant amplitude sine wave signal to the microphone input of the CVSA. A Tektronix Model CFG250 Function Generator was used to modulate the frequency of the CFG280 signal and simulate speech microtremor. Frequency was verified with a Tektronix CDC250 Universal Counter. A Tektronix Model 2247 Oscilloscope was used to monitor the amplitude and frequency shift of the signals from the CFG280 Function Generator.

### Procedures

The CFG250 Function Generator was used to present a linear ramp (sawtooth) input to the modulation input of the CFG280 Function Generator. The starting frequency for the CFG280 Function Generator was initially adjusted with zero volts applied to the modulation input. The frequency of the signal on the output of the CFG280 Function Generator was then increased linearly by application of a positive-going linear voltage ramp at the modulation input. The CFG280 Function Generator has a modulation transfer function such that the instantaneous output frequency is a function of the instantaneous amplitude of the signal presented to the modulation input. The amplitude of that signal was adjusted so that the CFG280 provided a frequency modulated carrier signal to the CVSA, varying linearly from a starting frequency of 100 Hz to an ending frequency of 1000 Hz. The steady-state (unmodulated) amplitude of the sine wave output of the CFG280 was limited to 8 millivolts peak-to-peak except for the signal strength test,

in which a 32 millivolt signal was applied. The resulting output from the CVSA was recorded on 2 inch (508 mm) heat sensitive paper normally used for recording. Frequency and time were recorded respectively on the vertical and horizontal axes of the chart paper as shown in Figures 1 through 10. The ramp test was repeated using 500 Hz and 2500 Hz, respectively, as start and stop frequencies. The response of the CVSA was also recorded using unmodulated, or continuous wave signals, and frequency modulated (FM) signals. The modulation frequency was fixed at 10 Hz to simulate microtremor with an amplitude sufficient to achieve approximately 25% modulation from the target function generator. The 25% modulation level was selected as being representative of voice microtremor magnitude. Response patterns were checked at 200Hz, 500 Hz, and 1000 Hz to assess CVSA system linearity. The sensitivity setting on the CVSA was adjusted so that the light emitting diode range indicator on the CVSA instrument front panel stayed within the normal range during signal acquisitions. Chart sizing was adjusted to provide normal pen deflections on the CVSA prior to each simulation.

## Results

Laboratory test results indicate that the CVSA pen vertical position is dependent on the input frequency, within a narrow linear range (see Figures 1 and 2). When the CVSA input was an 8 millivolt sine wave, the frequency of which was increased from 100 to 1000 Hz--as illustrated in Figure 1--midscale corresponded to approximately 350 Hz. Figure 2 depicts the response relationship between frequency and pen position from 500 Hz to 2500 Hz. CVSA frequency response appears to be linear from 100 Hz to 600 Hz. Between 600 Hz and 2000 Hz, a gradual non-linear response pattern is observed in the CVSA output (Figures 1 and 2). Above 2000 Hz, the frequency response rolls off rapidly to become nearly flat.

Injecting a 200 Hz continuous sine wave signal into the microphone input of the CVSA resulted in the CVSA output shown in Figure 3. Figure 4 shows the same 200 Hz fundamental frequency input signal with 10 Hz FM modulation and approximately 25% modulation. A cyclic pattern is evidence, as predicted by the manufacturer's theory of operation. In accordance with that theory, the signal depicted in Figure 3 would correspond to a stressed (deceptive) response, while that of Figure 4 would indicate the absence of reduction of stress (truthful response). Similar response patterns are seen in Figures 5 and 6 (fundamental frequency = 500 Hz), and in Figures 7 and 8 (fundamental frequency = 1000 Hz).

Increasing the amplitude--but not the frequency--of the signal injected into the CVSA microphone input (*i.e.*, an increase in signal strength) resulted in a decrease in the amplitude modulated baseline component of the CVSA output, as shown in Figures 9 and 10. The signal riding on the detected FM may be front end or discriminator noise, which is reduced in amplitude as the input signal amplitude is increased (*i.e.*, FM quieting increases as the signal to noise ratio gets larger). In the CVSA the undetected AM component (noise) is largely a function of variations in carrier level (fundamental frequency amplitude). The FM detector responded primarily to changes in the carrier frequency (microtremor), with an output voltage change proportional to the change in frequency (Figures 4, 6, and 8).

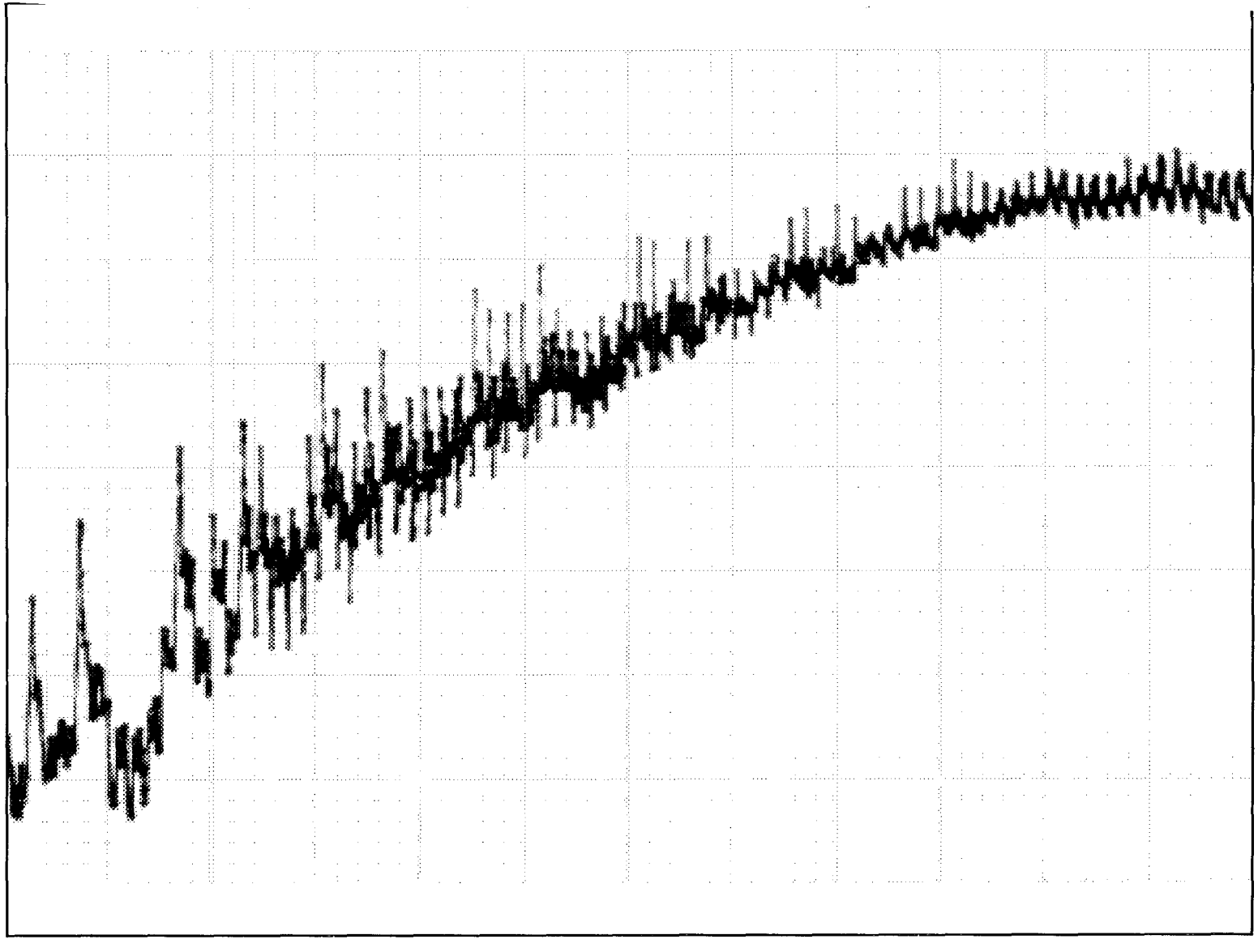

**Figure 1**
CVSA output when the input is an 8 millivolt peak-to-peak sine wave, swept from 100 to 1000 Hz (left to right).

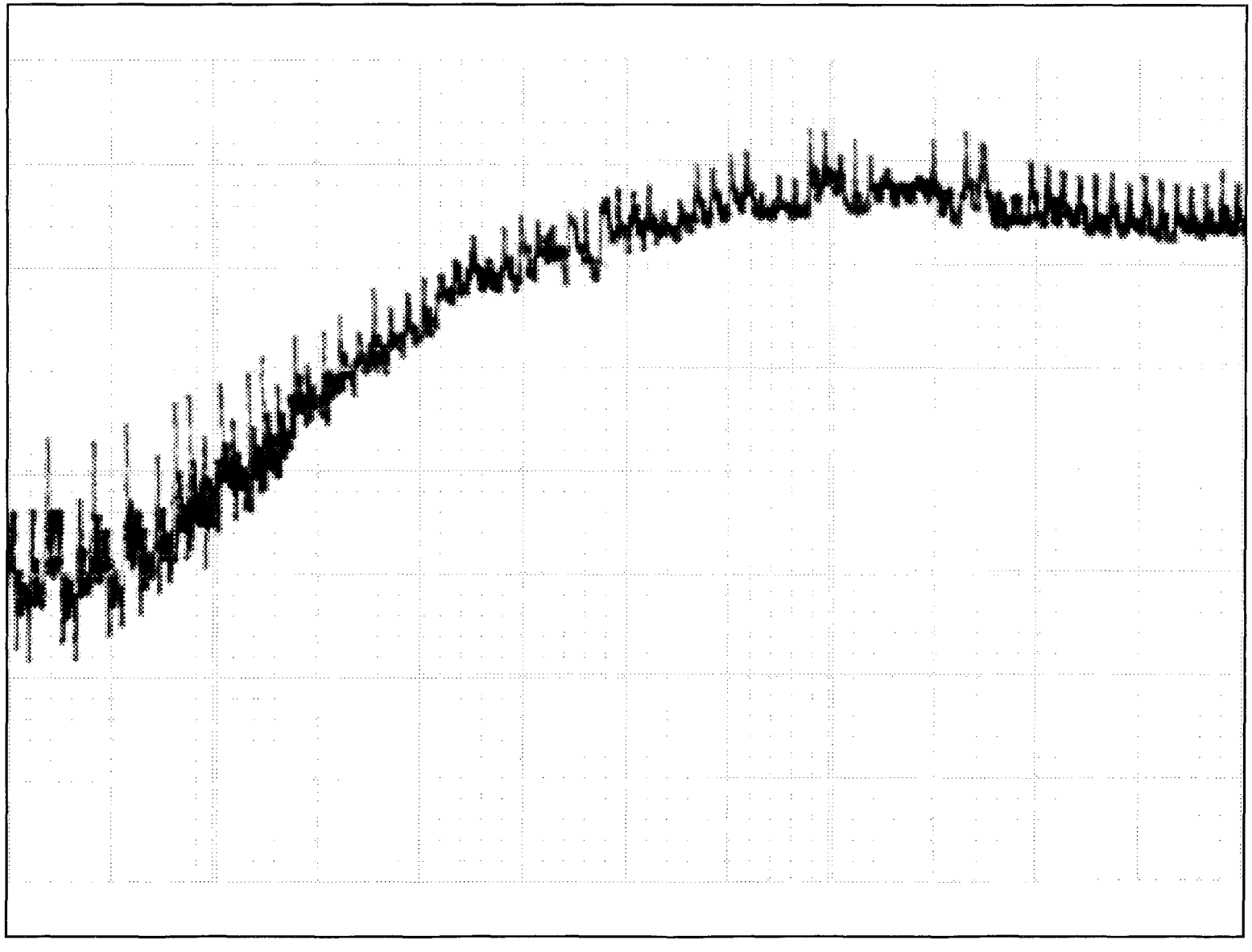

**Figure 2**
CVSA output when the input is an 8 millivolt peak-to-peak sine wave, swept from 500 to 2500 HZ (left to right).

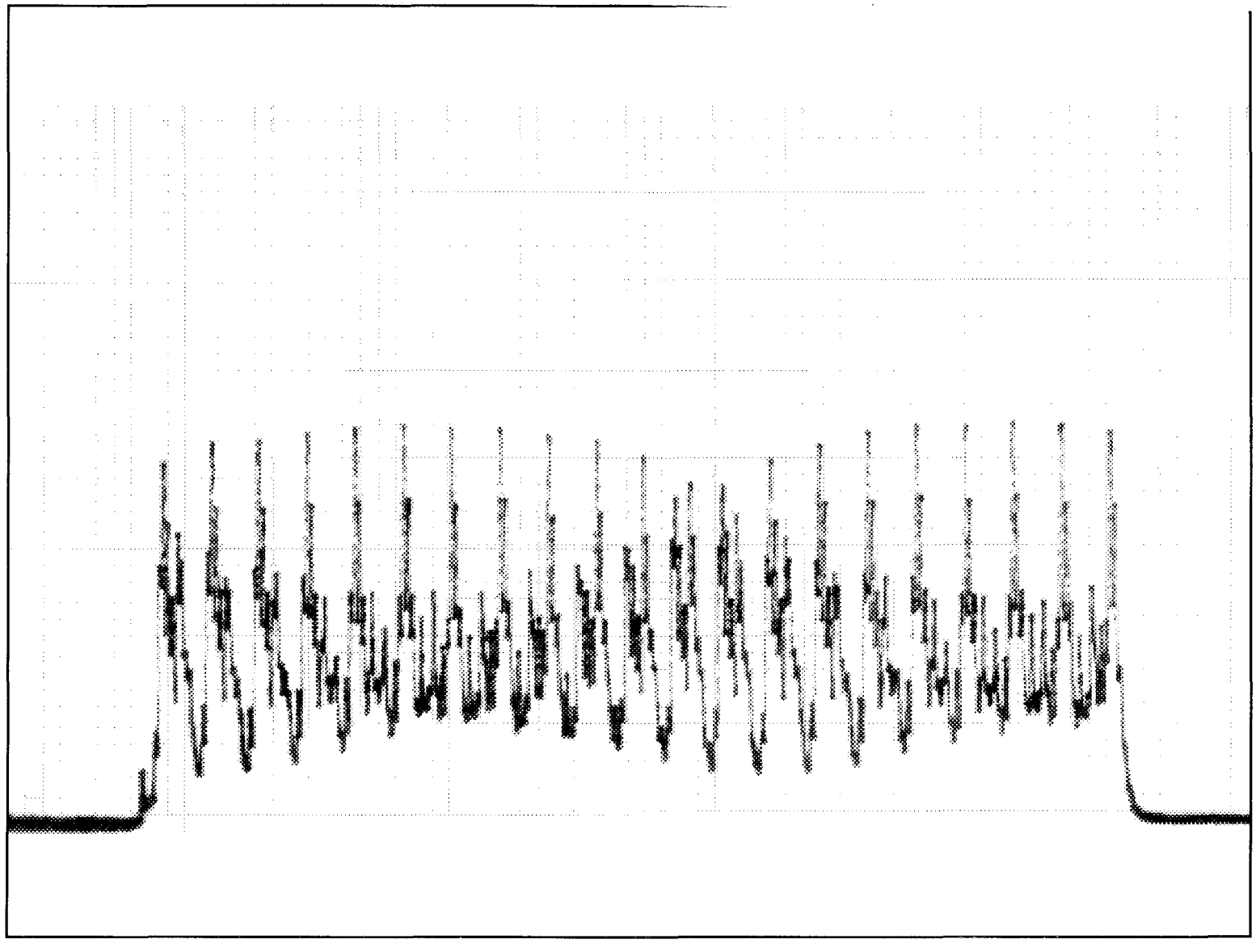

**Figure 3**
CVSA output when the input is an 8 millivolt peak-to-peak 200 Hz sine wave (stressed response).

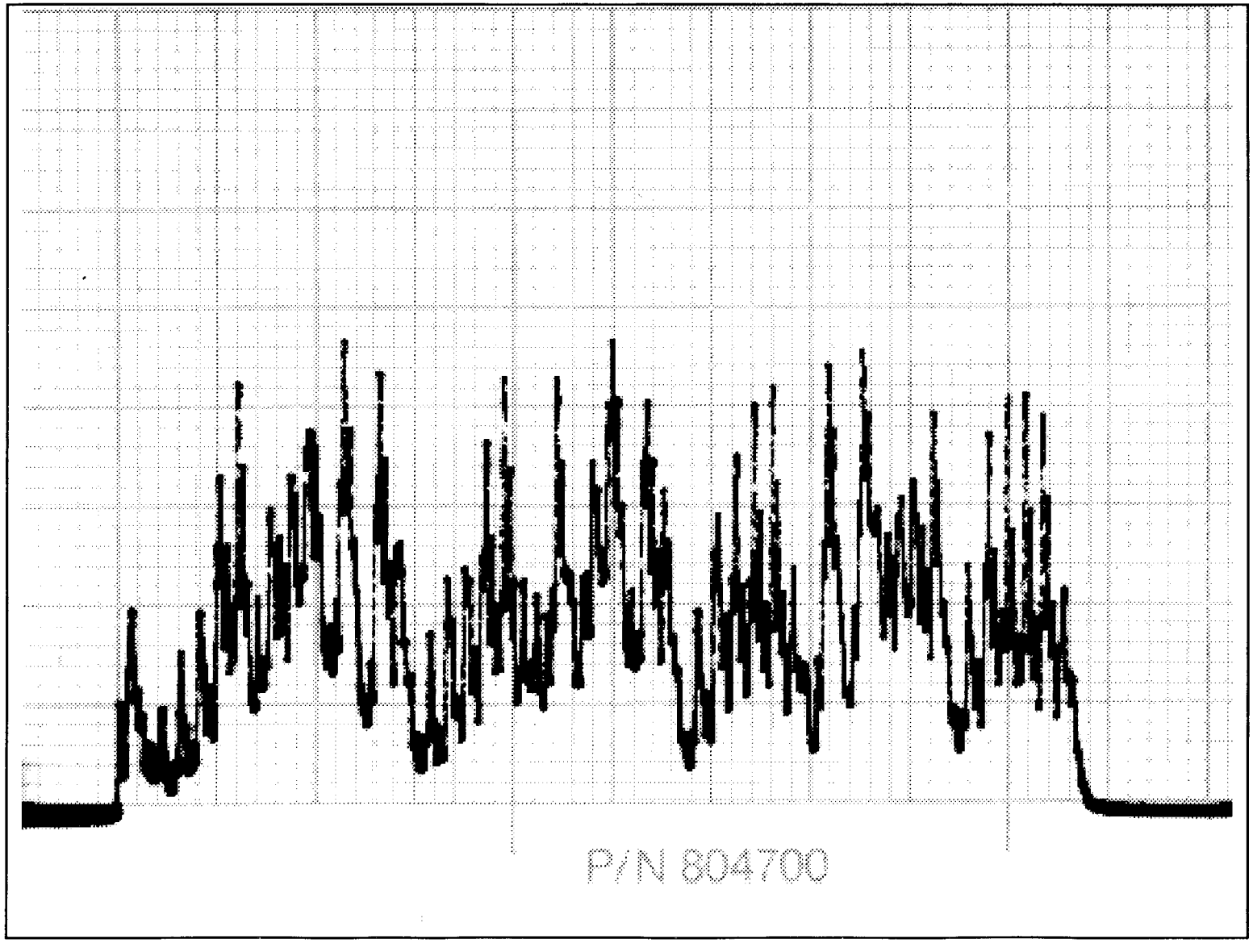


**Figure 4**

CVSA output when the input is an 8 millivolt peak-to-peak 200 Hz sine wave modulated at a 10 Hz rate (unstressed response).

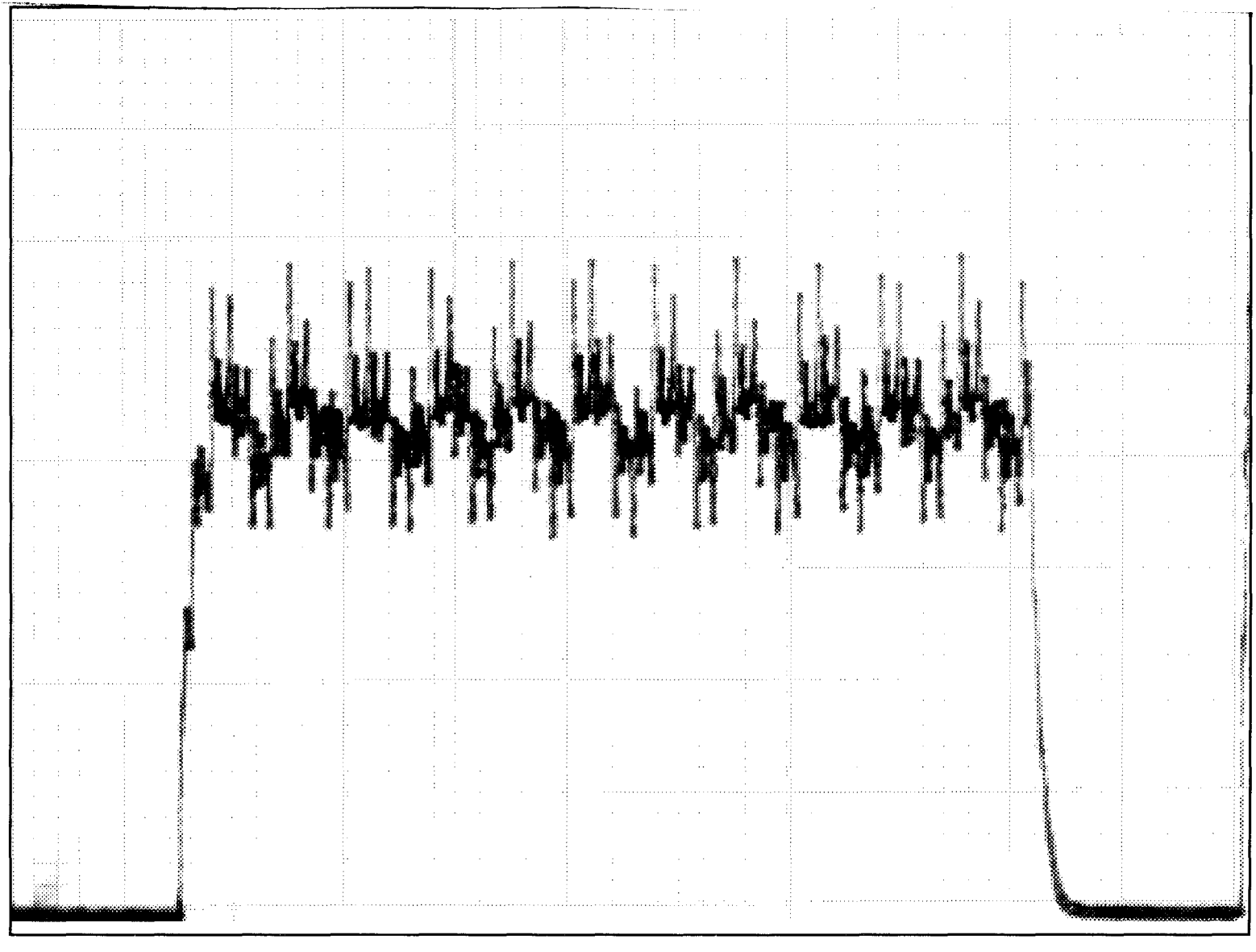

**Figure 5**
CVSA output when the input is an 8 millivolt peak-to-peak 500 Hz sine wave (stressed response).

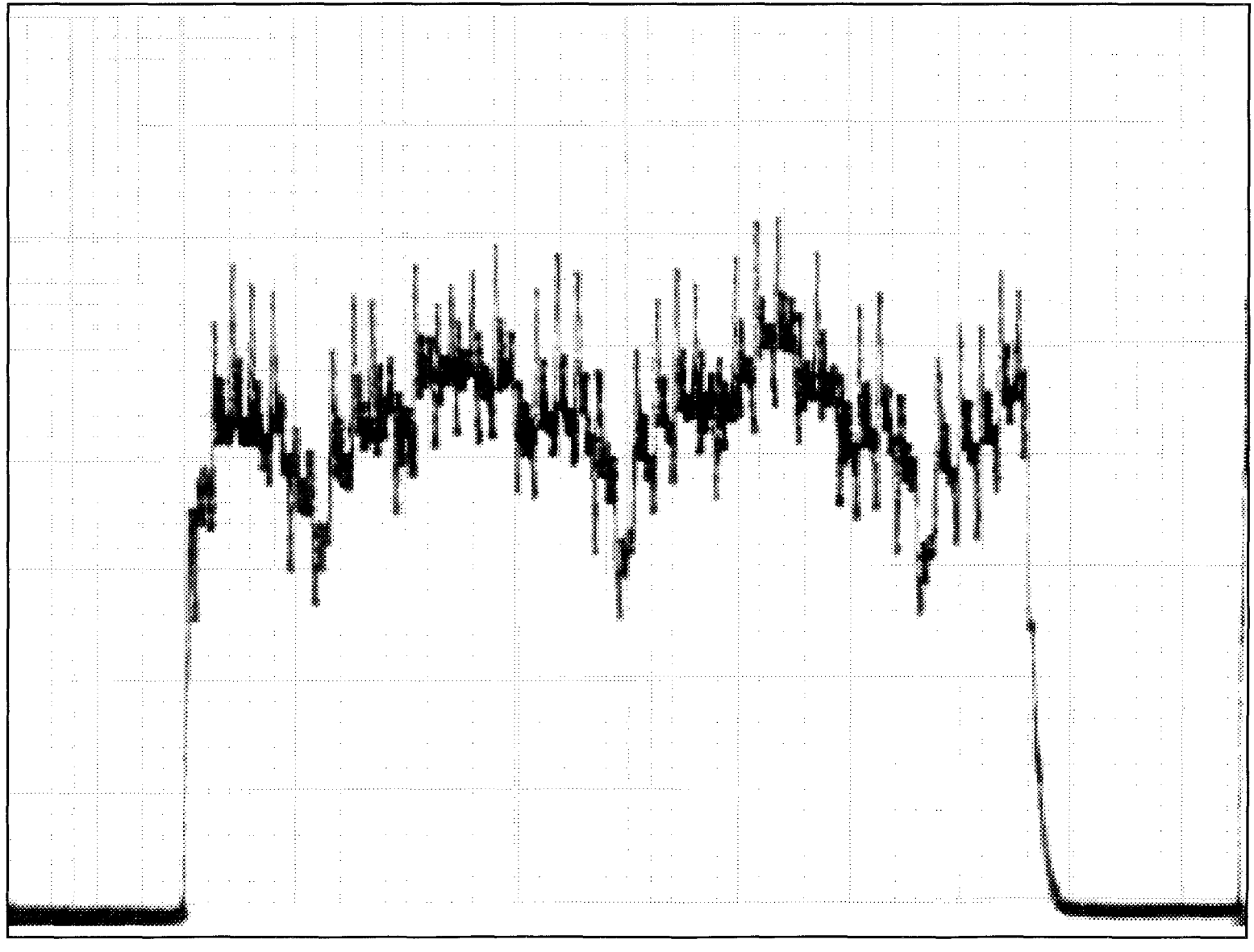

**Figure 6**

CVSA output when the input is an 8 millivolt peak-to-peak 500 Hz sine wave modulated at a 10 Hz rate (unstressed response).

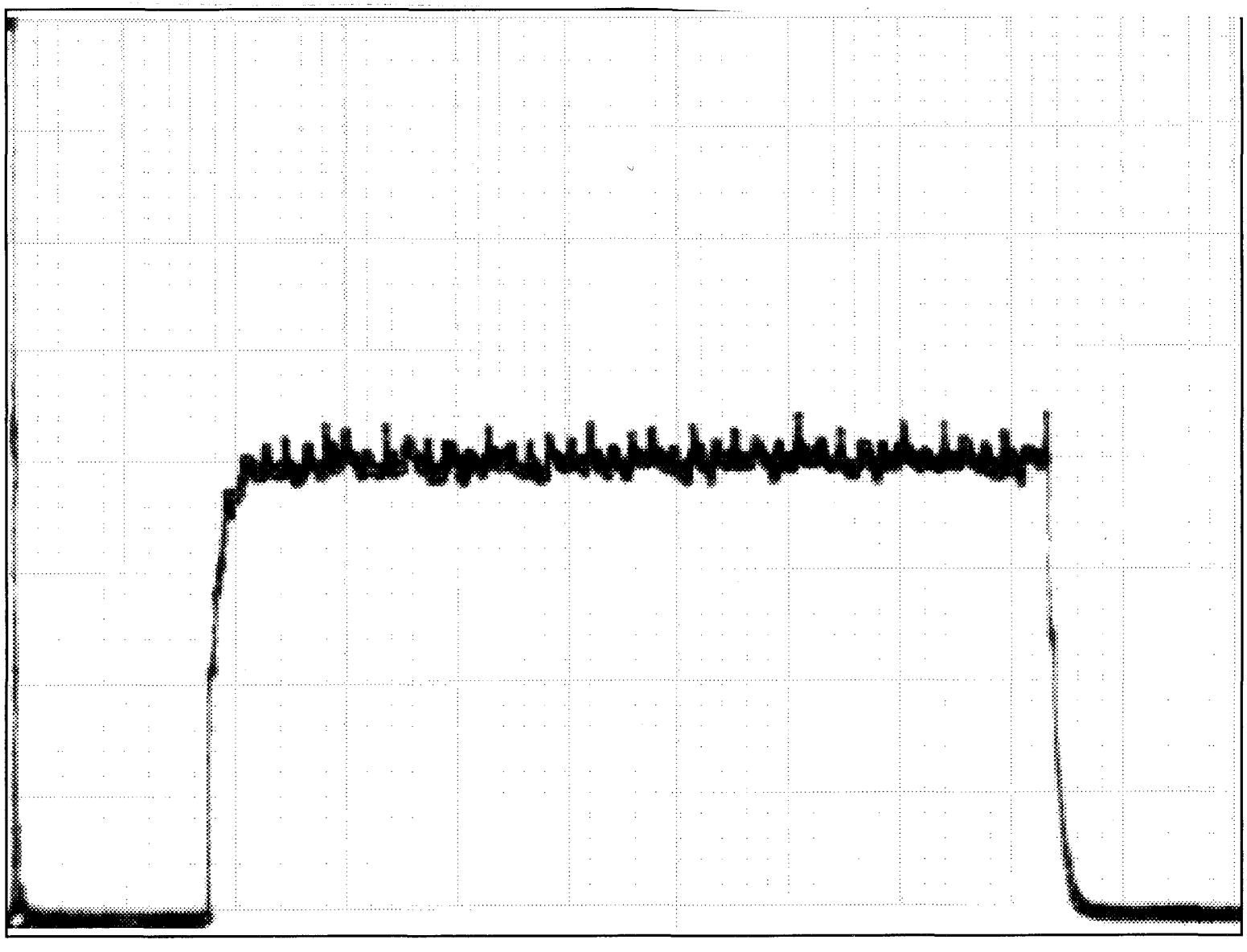

**Figure 7**
CVSA output when the input is an 8 millivolt peak-to-peak 1000 Hz sine wave (stressed response).

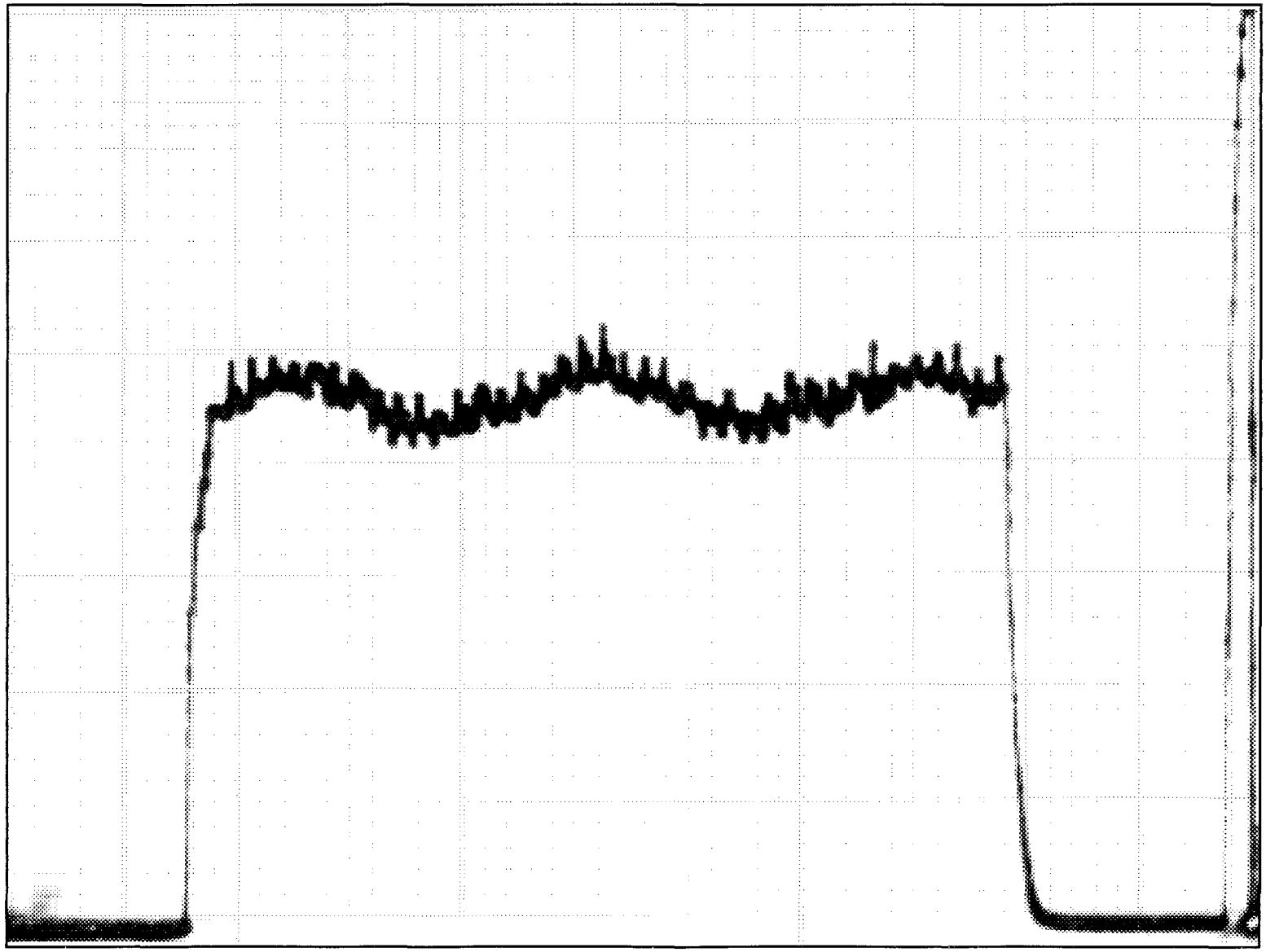

**Figure 8**

CVSA output when the input is an 8 millivolt peak-to-peak 1000 Hz sine wave modulated at a 10 Hz rate (unstressed response).

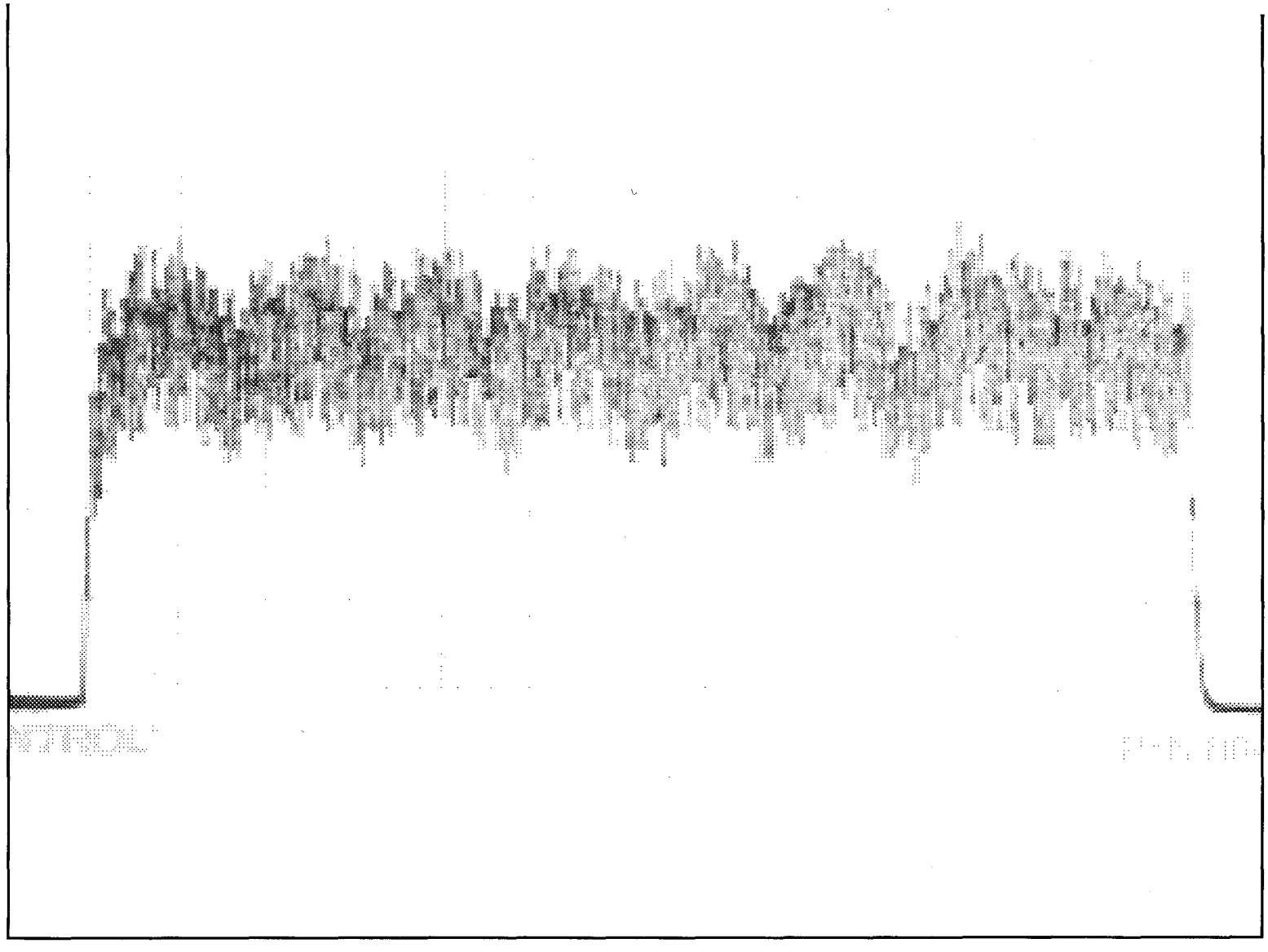

**Figure 9**
CVSA output when the input is an 8 millivolt peak-to-peak 300 Hz sine wave.

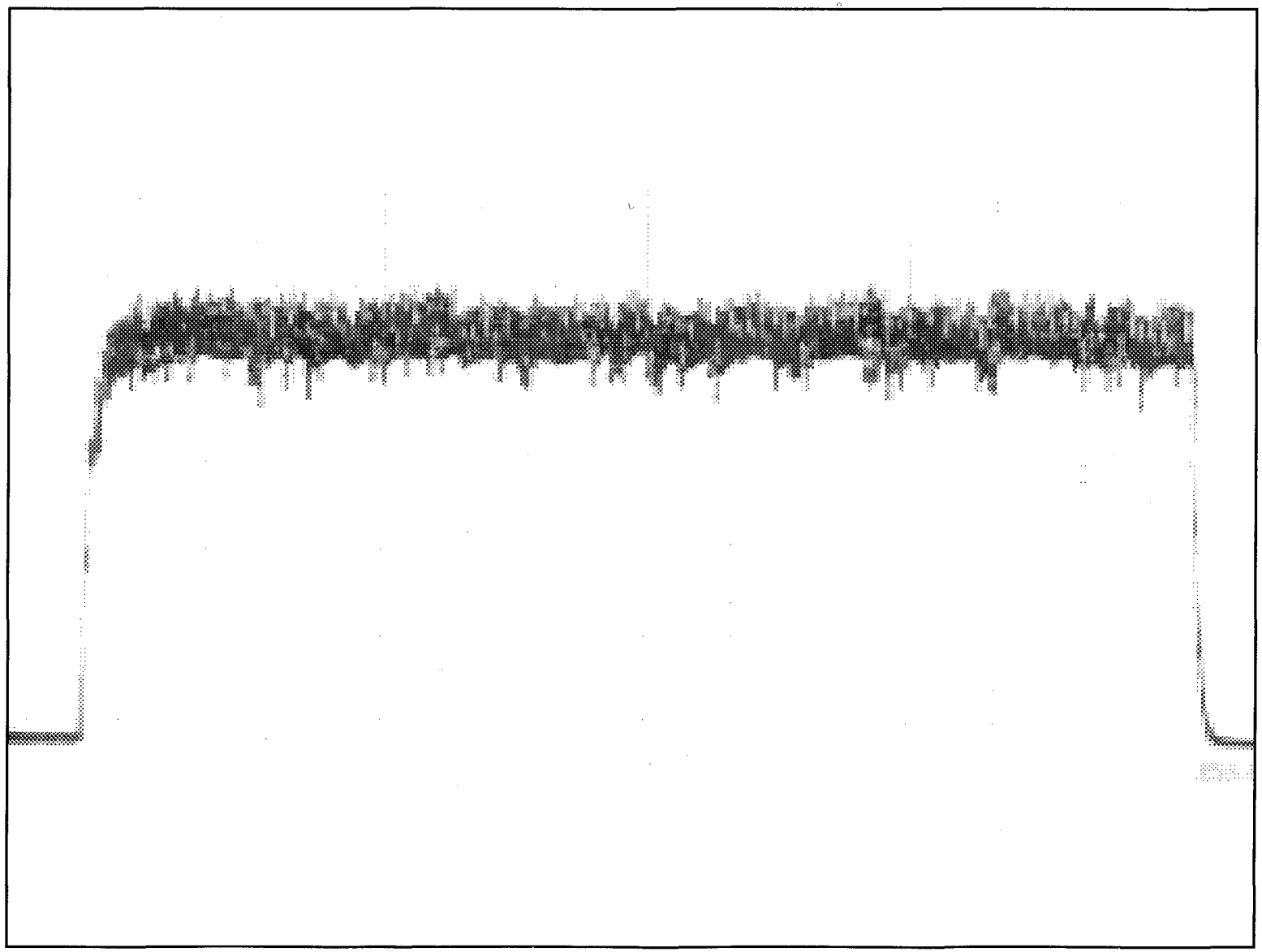

**Figure 10**
CVSA output when the input is a 32 millivolt peak-to-peak 300 Hz sine wave.

## Discussion

Results of laboratory tests indicate that the CVSA functions electrically according to frequency modulation detection theory. It was found that discrete changes in the frequency of the input signal caused discrete deflections of the CVSA pen, and that the amplitude of those deflections was proportional to the frequency of the input signal. Increases in the amplitude of the input signal resulted in reduction of the amplitude of extraneous (noise) signals on the CVSA chart tracings. These findings are consistent with the manufacturer's theory of operation. Thus, if there is an inverse relationship between stress and voice microtremor amplitude, and those changes have sufficient signal value to be detected by the CVSA, it should be possible to see pattern changes in the CVSA output under different levels of stress.

Research substantiating the basic underlying theory, by comparing simultaneous vocal tract muscle activity and voice microtremor, has been minimal (*e.g.*, Inbar & Eden, 1976). Additionally, there is limited research supporting the inverse relationship between microtremor and stress (*e.g.*, Smith, 1977), and that relationship was indirectly assessed by examination of speech patterns. Perhaps research in this area should focus on: (1) the existence of laryngeal microtremor as assessed concurrently by EMG and speech pattern analysis; and (2) autonomic mediation of muscle microtremor, particularly laryngeal microtremor. It has been established that autonomic innervation extends primarily to cardiac and smooth muscle tissue (slow response). Some of the striate (fast response) muscle groups in the larynx are innervated by the vagus nerve (cricothyroid, arytenoid), but there is insufficient information available regarding the function of the vagal innervation.

In summary, the CVSA instrument has been shown to detect discrete changes in speech fundamental frequency using laboratory instruments to simulate voice microtremor, confirming NITV's underlying theory of operation. However, these results do not confirm: (1) the existence of voice microtremor; (2) a relationship between microtremor amplitude and psychological or physical levels of stress; (3) a reduction of microtremor amplitude during the act of deception; and (4) that voice microtremor--if it exists--has sufficient signal value to be detected by the CVSA.

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# A COMPARISON BETWEEN DECISION ACCURACY RATES OBTAINED USING THE POLYGRAPH INSTRUMENT AND THE COMPUTER VOICE STRESS ANALYZER (CVSA) IN THE ABSENCE OF JEOPARDY

By

**Victor L. Cestaro, Ph.D.**

***Abstract***

This study was designed to evaluate the decision accuracy and agreement rates obtained using the traditional polygraph instrument and the computer voice stress analyzer (CVSA). Forty-two subjects took psychophysiological detection of deception (PDD) examinations administered with the polygraph and CVSA instruments within the context of Peak of Tension (POT) tests. Half of the subjects were tested on the polygraph instrument, then the CVSA instrument. The remaining half were tested using the instruments in the opposite order. PDD and CVSA based POT tests were blind-evaluated by four independent examiners for each instrument. The frequencies of accurate determinations made using each instrument were compared using proportionality tests. The CVSA instrument and associated processes were significantly less accurate than the polygraph instrument and PDD processes tested in similar circumstances (38.7% *vs.* 62.5%, with chance = 25%). Interrater reliability, assessed using a multiple rater Kappa test, showed that agreement among all blind evaluators within each instrument category was significantly better than chance ($p < .05$). These data indicate there may be a systematic and predictable relationship between voice patterns and stress related to deception, and that the differences observed in accuracy rates between the two instruments are attributable to instrument/procedure sensitivity rather than examiner data evaluation skills.

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The author wishes to express special thanks to the volunteers who participated in the study; Sarah Tidwell and Jeff St. Cyr who assisted throughout the study; David Devine and Special Agent Bob Tippett of the Florida Department of Law Enforcement for administering the psychophysiological detection of deception (PDD) and computer voice stress analyzer (CVSA) examinations; Larry Broadwell, John Schwartz, Dr. Gordon Barland, and Dr. William Yankee for evaluating the PDD tests; Dr. Andrew Dollins for his assistance in manuscript preparation; and Lt. Kelly Vaughan of the Martin County (Florida) Sheriff's Office, Detective Robert Neubauer of the Osceola County (Florida) Sheriff's Office, Don Nettles of Nettles and Associates Investigations, Inc., and Sheriff's Deputy Ronald Cucchiara of the Martin County Sheriff's Office for evaluating the CVSA tests. This project was funded by the Department of Defense Polygraph Institute as DoDPI94-P-0027. The views expressed in this article are those of the author and do not reflect the official policy or position of the Department of Defense or the U.S. Government. The results of this study were previously reported by Cestaro (1995). Write for reprints to Dr. Cestaro at Building 3195, Department of Defense Polygraph Institute, Ft. McClellan, AL 36205-5114.

According to Humble (1995), the detection of deception using voice stress analysis is rapidly gaining acceptance and receiving favorable reviews from many law enforcement agencies. Although reviews of the accuracy of voice analyzers, such as the Psychological Stress Evaluator (PSE, Dektor Counterintelligence and Security, Springfield, VA) have been mixed (*e.g.*, Horvath, 1978, 1979, 1982; VanDercar, Greaner, Hibler, Spielberger, & Block, 1980), the acceptance of instruments employing this technique has been facilitated by their ease of use, non-invasiveness, and short training period required for prospective operators.

Surprisingly, no controlled laboratory research has been conducted to test the validity or reliability of the recently developed computer voice stress analyzer (CVSA) instrument or the techniques employed in its use, nor are there any indications that it meets or exceeds the accuracy rates reported for the traditional polygraph instrument. The high accuracy rates claimed by the manufacturer--The National Institute for Truth Verification (NITV)--are based on field data rather than laboratory research, as stated by Dr. Charles Humble, president and founder of the NITV (G. Barland, personal communication, June 12, 1989):

> The CVSA is a computerized voice stress analyzer that is based on the older Psychological Stress Evaluator. As you are aware, the research concerning the validity of the PSE has always been controversial and never accepted in polygraph circles. The validation of the CVSA was accomplished by utilizing (sic) the audio portion of 75 known-conclusion cases. Twenty of these were NDI and 55 were DI. The CVSA correctly called all of the cases for a correlation rate of 100%.
>
> Rather than rely on laboratory studies which I do not feel accurately reflect the validity of either the polygraph or the CVSA, I would refer to field studies which, in my opinion, do.
>
> [Note: NDI = No Deception Indicated, DI = Deception Indicated].

Manufacturers and proponents of voice stress analysis attribute the failure to obtain high accuracy rates in analog (laboratory) studies to the low level of jeopardy in "game playing" laboratory scenarios (Horvath, 1982). *Webster's Dictionary* defines jeopardy as "exposure to loss, or damage." Individuals submitting to a detection of deception examination outside of the laboratory usually experience some jeopardy in association with the examination while those submitting to a detection of deception examination in the laboratory, a contrived situation, do not. Tippett (1995) indicates that previous testing has shown that artificially induced jeopardy produced only marginal results with the CVSA. He argues that when at least a moderate level of personal jeopardy was perceived by subjects, the CVSA and the polygraph instruments and processes were equally effective in determining truth or deception. In a study conducted by Tippett (1995), 54 subjects who were undergoing mandatory private therapy related to past sex offenses were tested using the CVSA and the polygraph instrument. According to Tippett, " ... there was a 100% agreement between the CVSA and the polygraph." He concluded that the CVSA is as effective as the polygraph instrument for detecting deception.

The personal jeopardy requirement can cause uncertainty in testing, as Horvath points out (1982, p. 344) when he asks, " ... if there is a certain degree of jeopardy (stress) necessary to obtain valid results with the voice stress devices, as the proponents also claim, what is the threshold and what is the criterion by which one determines it?" Horvath (1982) also questioned how the PSE was developed and perfected if it could not be tested in experimental situations. Nonetheless, it was found that PSE, the State/Trait Anxiety Index, and heart rate measures covaried and reflected levels of stress in the first portion of a pair of studies conducted by VanDercar, *et al.* (1980). The failure to validate the PSE in the second study was attributed to lower levels of induced stress. Furthermore, Barland (1974), in a low/high stress study, demonstrated that the PSE achieved high accuracy rates when stress levels were high, but did not do so with low stress levels. However, Lynch and Henry (1979) found no evidence that the PSE could discriminate between stressful and non-stressful responses at greater than chance levels.

In studies where jeopardy has been defined in terms of motivation (*e.g.*, monetary loss or gain) to pass or fail a detection of deception examination, the results have been mixed. Gustafson and Orne (1963) reported that detection rates were greater for subjects who were motivated than for subjects who were not. However, Lieblich, Naftali, Shmueli, and Kugelmass (1974) claimed that motivation had no significant effect on detection rates. Additionally, Horvath (1979) has shown that increased motivation does not improve the detection of deception with the PSE. Brenner, Branscomb, and Schwartz (1979) also question the validity of the PSE in the context of deception detection, although some aspects of the analysis may be valid for the measurement of stress.

This study was designed to evaluate a second generation voice analyzer, the CVSA, in a laboratory test in the absence of jeopardy. The experiment was designed to determine if accuracy rates obtained using the CVSA instrument and procedures differed from those obtained using the traditional polygraph instrument and procedures. The CVSA and the polygraph instrument were used to test subjects within a Peak of Tension (POT) numbers test paradigm. It was expected that a stressed response to the key number could be detected using both the CVSA and polygraph instruments and would be discriminable from all other responses. Evaluators who were not aware of the numbers selected by subjects made decisions regarding subject veracity based on the examination of paper charts collected during test administrations. Accuracy rates obtained by these evaluators were examined. Additionally, interrater agreement was assessed among evaluators within each instrument category.

## Method

### Subjects

Forty-two subjects recruited from the U.S. Army training command at Fort McClellan and a local civilian contract agency participated in this study. Subjects were 22 males and 20 females between the ages of 19 and 35 years.

## Apparatus

A polygraph instrument (Lafayette, lafayette, IN, Factfinder Model 76740/76741) was used to record skin resistance, respiratory, and cardiovascular activity on paper charts. A CVSA (NITV, West Palm Beach, FL) was used to record and display voice response data on paper charts. A lapel microphone (Radio Shack, Fort Worth, TX, Model 33-3003) was connected to the audio jack of the CVSA to present voice responses to the instrument. A voice recorder (TEAC, Montebello, CA, Model 134B) was used to collect voice responses for off-line analysis. A lavaliere microphone (Shure, Evanston, IL, Model 570S) was used with the audio recorder to record subjects' verbal responses. A desktop IBM compatible computer was employed to replay questions throughout testing in both portions of the study.

The questions presented to the subjects were digitized and recorded to computer hard disk using a Sound Blaster board (Model 16ASP, Creative Labs, Inc., Milpitas, CA). A parallel port interface, designed and fabricated inhouse, connected to a Radio Shack (Fort Worth, TX) integrated stereo amplifier (Model SA-155) and two Radio Shack speakers (Model Minimus-77) was used to present questions. This system ensured that each question was presented during the PDD examination and the CVSA examination with the same inflection, and at the same volume, each time it was asked. The question presentation software also controlled the TEAC recorder--which was used to record subject response--through an RS-232 interface designed inhouse.

## Examiners

A certified PDD examiner, who had administered more than 5000 examinations over a 30-year period, conducted the PDD portion of the study. A second certified PDD examiner, also trained and experienced in CVSA use by NITV, conducted the CVSA portion of the study. This examiner had over one and a half years PDD experience encompassing 150 examinations, and had also administered 450 CVSA examinations during two and a half years. Four additional certified PDD examiners, who were unaware of subjects' number selections, independently evaluated the polygraph tests to determine the number selected by each subject. The CVSA tests were also independently evaluated by four trained and certified CVSA examiners. Two of these examiners were also trained and certified PDD examiners.

## Design

The standardized DoDPI acquaintance (stimulation) test, using a Known Solution POT test was employed for subject testing. The 42 subjects were pseudo-randomly assigned to each of two 21 subject groups. One group was tested with the polygraph instrument first, followed by CVSA testing. The other group was tested with the CVSA first, then the polygraph instrument, to counterbalance the order of testing. Within each group, half of the subjects were randomly assigned to Key A (third question is the key question), and half to Key B (the fourth question is the key number). Each subject was tested using six numbers in sequence. No more than three subjects having the same key position were tested consecutively by either examiner. Since the relevant questions for the two examinations were identical, digitized voice was used

to present the questions to the subjects. The only difference between the two examination was the inclusion of irrelevant questions in the CVSA test question format. Data from the PDD and CVSA examinations were independently assessed by four additional examiners who were unaware of subjects' key numbers. The dependent measures were the number of correct determinations, and the number of concurrent determinations made using the two instruments and their processes.

## Procedures

Upon arrival at the Department of Defense Polygraph Institute (Fort McClellan, AL), each participate was escorted by a member of the research team to a secluded room and asked to read a brief description of the research project. Individuals indicating that they would participate were asked to read and sign an informed consent affidavit. A brief biographical/medical questionnaire was completed, to ensure that the participant was in good health and not currently taking medication which could interfere with the examination results. The subject was then escorted to one of the examination rooms, determined by prior assignment, for testing. The examinations were then administered as described below. When both the PDD and CVSA examinations were completed, the subject was escorted back to the secluded room for subject debriefing, and to read and sign a debriefing statement.

**Procedures common to CVSA and PDD.** The examiner conducted a pretest interview prior to placing the sensors on the subject. During the interview, the subject was told to select a number between 3 and 8, not 3 or 8, and to write the number selected, one to two inches in height, in the middle of a sheet of paper. The examiner was given the key number position for each subject in order to properly pad the sequence of numbers. The examiner then wrote the padding numbers above and below the number written by the subject and placed the sheet of paper on the wall directly in front of the subject. The Key A sequence used two "padding numbers" before and three after the number selected by the subject. The Key B sequence used three padding numbers before and two after the key number. The subjects were instructed to answer "no" to the questions concerning numbers, even if it meant that they would be lying about the number they chose.

**PDD procedure.** If the CVSA examination was administered prior to the PDD examination, the previously selected number was used again. The POT test was then administered according to the procedures taught at the DoDPI, with the exception that the post-test interview was not conducted. In order to comply with the philosophy of the CVSA examination procedure to avoid situational stress, no psychological set was required, and the post-test would have served no purpose in this study. If the PDD examination was administered before the CVSA examination, the subject proceeded immediately thereafter to the CVSA examination.

**CVSA procedure.** If the PDD examination was administered prior to the CVSA examination, the previously selected number was used again. The examiner conducted the pre-test interview in a manner to remove any situational stress associated with detection of deception

examinations. The lavaliere and lapel microphones were then placed on the subject and the CVSA instrument was calibrated for the subject's voice level. The question sequence was in the CVSA POT format, IR-IR-R-IR-R-IR-R-IR-R-IR-R-IR-R-IR (where IR=irrelevant and R=relevant). Irrelevant questions had no connection to the issue at hand, caused no stress of themselves, and were known truth (*e.g.*, "Am I wearing a tie?"). Relevant questions consisted of numbers from the same set used during the PDD exam.

The CVSA examiner conducted two tests. In accordance with NITV procedures, the first test was discarded to avoid scoring data confounded by situational stress. The second test was retained for scoring. All examinations were recorded on audio and video tape for off-line analysis to confirm the live results.

**Data Reduction and Analysis**

**Test evaluation.** Each PDD test was independently evaluated by each of four certified PDD examiners. CVSA tests were independently evaluated by each of four certified CVSA examiners, trained by the NITV. PDD test data evaluation consisted of selection of the response showing the most reactivity, according to traditional PDD procedures. CVSA test data evaluation consisted of selection of the response showing the highest percentage of "blocking" (*i.e.*, rectangularity) on the relevant/associated irrelevant, in accordance with accepted CVSA scoring practices. Although data analysis procedures were clear and explicit, evaluators were not given the padding information (two or three padding numbers) in order to avoid the possibility of biased scoring. However, all evaluators were told that there was at least one padding question before and after the key question (*i.e.*, the key number was never in the first or last position in the sequence), leaving only four responses to be scored.

**Data reduction.** The dependent measures were: the number of times a scorer correctly identified the number selected by a subject and; the frequency that evaluators using different instruments and processes identified a subject as being deceptive to the same question, irrespective of the accuracy of the decision. Data were transformed from number sequence (1 to 10) to serial position of those numbers in the test series, adjusted for the two padding sequences. Thus, regardless of the starting number in a subject's sequence, all scored numbers would fall into the range 1 through 4, with the key appearing only in position 2 or 3. Each scorer had 1 chance in 4 of correctly identifying the key by chance alone.

**Data analyses.** Analyses included a test of the significance of the proportionality between correct number determinations and chance accuracy (25%). Effects of examination order on mean accuracy were also examined. A power analysis performed prior to the study indicated that with N-42, power > 0.09 for the expected effect size (0.25). The Fleiss (1981) multiple rater Kappa test was used to independently assess decision agreement among the four evaluators within each instrument category.

## Results

### Evaluator Accuracy

PDD evaluators correctly identified the correct key number in 105 of 168 (42 subjects x 4 evaluators) total trials, achieving a statistically significant overall accuracy of 62.5% ($p < .05$), with a range of 57% to 69%. Three of the four evaluators obtained accuracy rates equal to or greater than 60%. The CVSA evaluators correctly identified the correct key number in 65 of 168 total trials, obtaining a nonsignificant overall accuracy of 38.7%, with a range of 24% to 45%. Three of the four evaluators achieved accuracy rates equal to or greater than 40%. The difference (23.8%) between mean accuracy rates obtained using the two instruments and their procedures was statistically significant ($p < .05$).

### Order Effects on Accuracy

The order of examination administration had an effect on the accuracy of each instrument; accuracy declined on the second series of tests. The PDD mean accuracy obtained using the polygraph instrument was 75% ($p < .05$) for the 21 subjects undergoing the PDD examination before the CVSA examination. The mean accuracy obtained using the polygraph instrument was 50% ($p < .05$) for the 21 subjects undergoing the CVSA examination before the PDD examination. Similarly, when the PDD examination preceded the CVSA tests, overall CVSA accuracy dropped from 41% ($p > .05$) to 35% ($p > .05$). The changes in accuracy rates within each instrument category were not statistically significant. Decision accuracy was not affected by subject gender.

### Interrater Reliability

Three out of four PDD blind evaluators agreed on the number selected for 30 of the 42 subjects, with 16 unanimous agreements. The correct number was identified for 24 of those 30 subjects. Three out of four CVSA blind evaluators agreed on the number selected for 31 of the 42 subjects, with 2 unanimous agreements. Fourteen of those 31 subjects' numbers were correctly identified. There were six cases in which both the CVSA and PDD evaluators agreed, with five of the six correctly identifying the subjects' selected numbers.

The frequency of agreements on serial position of the key number among evaluators for each subject was examined using the Kappa statistic for multiple ratings (Fleiss, 1981), the results of which are shown in Table 1. With the exception of position 4, agreement among evaluators was statistically significant for each possible position of the key item, as was overall agreement. However, the key numbers could be physically located only in positions 2 and 3, dependent on question padding.

**Table 1**

**Interrater Agreement (Kappa) Among PDD and CVSA Evaluators**

| | POSITION | | | | | |
|---|---|---|---|---|---|---|
| Exam | 1 | 2 | 3 | 4 | Not Scored | Overall |
| PDD | .26* | .58* | .52* | .02 | .10 | .46* |
| CVSA | .65* | .35* | .48* | .20* | | .42* |

* $p < .05$

Note: PDD = psychophysiological detection of deception; CVSA = computer voice stress analyzer.

## Discussion

Data analysis indicates that, under similar test conditions, the percent of correct subject veracity decisions made using information gathered during a PDD examination exceeded the percent of correct subject veracity decisions made using information gathered during a CVSA examination by 23.8%--a statistically significant difference. These results suggest that, under the test conditions used, although the CVSA instrument performs electrically as theorized (Cestaro, 1995), it has less sensitivity to psychophysiological reactivity than the traditional polygraph instrument. These differences may be a function of the additive information, or Gestalt, provided by the multi-channel structure of the polygraph instrument versus the difficulties imposed by the single channel analysis of the CVSA, particularly when a conflict arises (*e.g.*, none of the responses meet the decision criterion). Although, in certain situations, individual PDD examiners may rely heavily on one of the measures, it is not likely that an experienced examiner will be satisfied with a decision based on that single component. A power analysis conducted prior to beginning the study indicated that the design had a 0.90 probability of correctly detecting an effect of at least 0.25 different from chance if such an effect actually exists. Thus, failure to obtain subject veracity decision accuracy rates significantly greater than chance using the CVSA suggests that, under the test conditions used, there is a probability of at least 0.90 that the CVSA is not sensitive enough to accurately detect effects at a level of at least 0.25 greater than chance accuracy.

Scoring procedures seem to be as consistent for the CVSA as for the polygraph instrument, as suggested by the high interrater reliability for both instruments and associated procedures. However, Horvath (1978) obtained interrater agreements that were greater for one component of the traditional polygraph instrument than for the voice stress analyzer; $\underline{r} = .92$ for the GSR and $\underline{r} = .38$ for the PSE. This suggests that scoring biases may have played a major role in the interpretation of voice stress responses using the older instrument. Brenner and Branscomb (1979) submit that the problem of scoring subjectivity is serious enough to bring into question any specific legal decisions made regarding PSE results. In this study, the absence of jeopardy, contrived or real, may have contributed to the low accuracy rates obtained using the polygraph and CVSA instruments and procedures. No incentives were offered to subjects to motivate them to act or react in a particular manner. It was not expected that subjects would experience anything other than very low levels of stress when answering untruthfully about a previously selected number. This lack of jeopardy may have contributed to the fact that the CVSA instrument and procedures obtained an accuracy which was not significantly different from chance.

Interpretation of the CVSA charts was consistent among evaluators, as evidenced by the high interrater reliability. Surprisingly, the CVSA accuracy results were comparable to those obtained in an earlier study (Cestaro & Dollins, 1996) using a similar numbers test paradigm. In that study, pitch and energy extraction techniques yielded an accuracy of 37% in a numbers test paradigm where chance level was 20%. Although the current study also showed that there may be a predictable relationship between measures of a voice component and stress, however, weak, that relationship is not well understood. There is conflicting evidence related to the laryngeal microtremor hypothesis (Shipp & Izdebski, 1981; Smith, 1977). Even if that relationship were well established, it can only be indirectly assessed by examination of speech patterns, and the patterns can be affected by other endogenous or exogenous mediators such as, voice tract pathology, ambient noise, instrument error (see Schoentgen & de Guchteneere, 1991). Increases in the magnitude of a subject's voice microtremor (an unstressed response) may be related to an underlying laryngeal pathology. Additionally, the use of cassette tape recorders for off-line analysis of voice responses for deception detection may be problematic due to distortions introduced by the recording into the measurement of interest (Doherty & Shipp, 1988). This type of analysis has been popularized by the proponents of the CVSA. One or more of these mitigating factors, in concert with a weak stress-inducing laboratory paradigm, can have a serious effect on successful differential diagnoses of response.

The arguments for or against the use of voice stress analysis may ultimately be counterproductive. Such arguments do not consider its potential utility in the arsenal of tools for deception detection. Perhaps investigators should re-examine speech as an additional component rather than to assess it as a singular response channel. Except for the findings of Horvath (1978) related to GSR and PSE, it has not been established how the voice stress channel would perform when compared with each of the three channels currently employed in the traditional polygraph instrument. Atypical differential responding across the three archetypal channels (GSR, pneumograph, and cardiovascular) is common and is largely a function of individual differences in responders.

In summary, the accuracy of examiner decisions concerning subject veracity obtained using the polygraph instrument and procedures was significantly greater than both chance and that obtained using the CVSA instrument. The accuracy of examiner decisions concerning subject veracity obtained using the CVSA instrument and procedures was not significantly greater than chance. While the study design was sufficiently powerful to detect such differences had they existed, subjects did not experience jeopardy during testing--as they would in the field. The lack of jeopardy may have contributed to the obtained relatively low accuracy rates for both instruments. Finally, interrater agreement for the CVSA and polygraph instruments and procedures were both relatively high and significantly better than chance--suggesting that the observed difference in accuracy rates are attributable to instrument/procedure sensitivity--or the lack thereof--rather than examiner test data evaluation skills.

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## IACP ESTABLISHES A MODEL POLICY ON POLYGRAPH

With assistance from David L. Motsinger, Steven K. Bartlett, and Billy J. Rakes, the National Policy Center of the International Association of Chiefs of Police has published its version of a Model Policy on the Polygraph.

## POLYGRAPH EXAMINATIONS - MODEL POLICY

**I. Purpose.** It is the purpose of this policy to provide investigative officers and others with general knowledge of, guidance and procedures for the use of polygraph examinations.

**II. Policy.** The polygraph examination is a valuable investigative aid as used in conjunction with, but not as a substitute for, a thorough investigation. The polygraph may be employed, consistent with this policy, to verify, corroborate or refute statements; obtain additional investigative leads; narrow or focus criminal investigations; serve to screen candidates for positions with this or other criminal justice agencies; and assist in the conduct of internal police investigations, among other authorized purposes.

**III. Definitions.** *Polygraph*: The polygraph is an instrument that records certain physiological changes in a person undergoing questioning in an effort to obtain truth or deception. A polygraph simultaneously records a minimum of respiratory activity, galvanic skin resistance or conductivity, and cardiovascular activity.

**IV. Procedures.**

A. Requesting Polygraph Examinations.

1. Following approval by their immediate supervisor, employees of this agency may request a polygraph examination from this agency's authorized polygraphist.

2. Polygraph examinations may be authorized when consistent with state law and agency policy. Situations in which authorization may be requested and approved include, but may not be limited to:

a. requests from the office of the prosecutor as part of an agreement with the defense attorney or for other investigative purposes;
b. an element of a background investigation of a candidate for a sworn or civilian position in this agency;
c. requests from other authorized criminal justice agencies;
d. attempts to verify or reconcile statements of parents or guardians (*e.g.*, in suspicious cases of missing or abused children) as well as witnesses or other individuals when alternative investigative means have been exhausted;
e. efforts to confirm or refute an allegation(s) that cannot be verified or disproved by other evidence;

f. efforts to establish probable cause to seek a search warrant; or
g. as part of an administrative or criminal internal investigation of an officer of this agency or another criminal justice agency consistent with this policy (see item A.4.).

3. The polygraph should not be used to verify a victim's[1] allegation without sufficient grounds for suspecting that the victim has given false or misleading statements.

4. Requests for polygraph examinations from another law enforcement agency pursuant to an internal investigation must be in writing and be approved by this agency's chief executive or his designate.

5. Submission to a polygraph examination must be a voluntary action with the exception of employees of this agency formally directed to take an examination as part of an internal investigation. In all other cases, polygraph examinations shall not be administered without the subject's written approval, waiver or other instrument as required by law.

B. Preparing for Polygraph Administration

1. The requesting officer is responsible for providing the examiner with all pertinent information concerning the case and for reviewing, clarifying or elaborating on that information as the examiner may deem necessary. This includes, but may not be limited to:

a. information obtained in the investigation that supports and justifies the use of the polygraph;
b. copies of crime/offense reports and investigative reports;
c. evidence available and withheld from the subject;
d. background information on the subject to be examined, to include criminal record and possible motivation;
e. any statements made by the subject, complainants and witnesses to include alibis; and
f. newspaper articles or other general information concerning the case.

2. If the subject is hearing impaired or does not speak English, the officer will help make arrangements for a sign language interpreter or translator as determined by the polygraph examiner.

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[1] In some jurisdictions, such as California, verification of victim statements is not permissible under state law.

3. Officers shall not interrogate a subject just before he/she is to take a polygraph.

4. In any interrogation of a suspect who has agreed or who may reasonably be asked to agree to a polygraph, officers shall not pursue questions that may reveal information only the perpetrator could know. This includes, but is not limited to:

a. method of entry;
b. property taken;
c. weapons or type of force used to commit the crime;
d. evidence left at the scene;
e. clothing worn by the subject during the crime;
f. unusual acts of the suspect during the crime; or
g. location from which property was taken.

5. Officers shall not attempt to explain procedures that will be used in the examination but shall advise subjects that these will be explained fully by the examiner. Subjects may be advised of the following:

a. The examination is voluntary, unless otherwise provided by this policy in cases of internal affairs;
b. Results of the examination are not acceptable in a court of law unless all parties agree in advance,[2] and
c. Results of the polygraph examination, taken alone, do not provide substantiation for a criminal charge.

6. Should the subject be late for or cancel the appointment, the requesting officer shall immediately notify the polygraph examiner.

7. If possible, the requesting officer shall report with the subject and any other authorized persons--such as attorneys, parents or legal guardians--to the examination location of the test. The polygraph examiner shall be solely responsible for authorizing any persons inside the examination or observation rooms.

C. Conducting Polygraph Examinations

1. Only fully trained polygraphists or intern polygraphists under their direction are authorized to administer polygraph examinations.

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[2] This is the case in nearly all states. New Mexico is one exception. Agencies should consult legal counsel for clarification on this point.

2. The polygraph examiner shall make such inquiries of the subject's health, medical history and/or use of medications as necessary to determine his/her ability to take the examination. Polygraph examinations shall not be conducted on any person whom the examiner reasonably believes to be physically or emotionally unsuitable for testing. This may include but is not limited to persons with heart conditions, women who are pregnant and individuals taking certain types of medication that may interfere with test results. When in doubt, the examiner may seek guidance from medical or psychological professionals as authorized by this agency and/or request the examinee to obtain a medical certificate from an appropriate health care provider.

3. An examiner shall not conduct a polygraph examination upon a subject if it is felt for any reason that an unbiased examination cannot be given.

4. Where appropriate, the examiner shall read *Miranda* rights to the subject and explain the voluntary nature of the test. Where required, the examiner shall obtain a signed consent prior to administering the examination as well as a signed waiver of *Miranda* rights.

5. An examination shall cease immediately if requested by the subject.

6. Prior to the test, the examiner shall explain the polygraph procedure to the subject and prepare him/her for the examination.

7. The examiner shall be responsible for preparing all questions used in the examination. Prior to the examination, each test question shall be reviewed with the person being tested.

8. The examiner shall independently interpret the chart tracings and render an opinion on findings that includes, but is not limited to, one of the following conclusions:

a. No Deception Indicated
b. Deception Indicated
c. Inconclusive

9. The polygraph examiner shall determine if a second polygraph examination is necessary and appropriate.

D. Pre-Employment Examinations

1. The polygraph examiner shall review all relevant applicant screening reports, applicant personal history summaries and any prior polygraph examination reports prepared by this agency before conducting the examination.

2. Pre-employment polygraph examinations shall be scheduled by authorized members of this agency's personnel authority according to established agency policy.

3. Polygraph examinations shall not be used as the sole determinant of suitability for employment.

4. Candidates shall be provided with a list of questions that may be used in the examination.

E. Equipment and Record Keeping

1. The polygraph examiner is responsible for the maintenance, safe-keeping and integrity of the polygraph equipment.

2. The polygraph examiner shall provide such summary activity or statistical reports as may be directed by the agency chief executive.

3. Unless otherwise provided in this policy or by state law, the polygraph examiner shall maintain copies of each polygraph report, together with polygraph charts and all allied papers, for a period of five years and indefinitely in capital offenses.

4. The results of all pre-employment examinations--including chart tracings, polygraph reports and related examination results--shall be maintained in a secure storage location, separately from criminal polygraph files. Duration of storage and stipulations for release of this information shall be governed by state law or the policy of this agency.

F. Examination Rooms

1. Tests and interviews shall be conducted in a clean, neat environment free of audible and visual distractions.

2. Certificates, diplomas and the like shall be displayed so as not to be in the sight of subjects during testing.

3. Examiners will be neat and well-groomed, and will dress in a manner consistent with standards of the professional business community.

> a. Duty uniforms, badges and other emblems of authority shall not be worn. This does not include departmental identification cards, where required.

b. Service weapons may be worn if required but should not be openly displayed.

G. Equipment

1. Polygraph instruments used shall be of commercial manufactures and shall have no fewer than three functioning recording channels.

2. Calibration

a. Calibration charts and/or maintenance logs shall be maintained at the instruments location or with case files.
b. Calibration checks of instruments should be conducted at least twice per month and whenever the instrument is moved to a different location.

H. Professional Development

1. Polygraphists are encouraged to participate in career development opportunities and are required to participate in professionally recognized annual in-service training.

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Every effort has been made by the IACP National Law Enforcement Policy Center staff and advisory board to ensure that this model policy incorporates the most current information and contemporary professional judgment on this issue. However, law enforcement administrators should be cautioned that no "model" policy can meet all the needs of any given law enforcement agency. Each law enforcement agency operates in a unique environment of federal court rulings, state laws, local ordinances, regulations, judicial and administrative decisions and collective bargaining agreements that must be considered. In addition, the formulation of specific agency policies must take into account local political and community perspectives and customs, prerogatives and demands; often divergent law enforcement strategies and philosophies; and the impact of varied agency resource capabilities, among other factors.

## *POLYGRAPH: ISSUES AND ANSWERS*

The American Polygraph Association welcomes the opportunity to present in this brief document a few essential facts about polygraph testing. We hope you will find the information to be of interest. We will be pleased to supply you with additional materials and information you may need.[1]

For additional information please call either Ms. Robbie S. Bennett, Manager of the National Office of the American Polygraph Association at 800-272-8037 or 423-892-3992, or the APA Publications and Reference Service, Ms. Janet Pumphrey at 410-647-0936.

### What Is a Polygraph?

The term "polygraph" literally means "many writings." The name refers to the manner in which selected physiological activities are simultaneously recorded. Polygraph examiners may use conventional instruments, sometimes referred to as analog instruments, or computerized polygraph instruments.

It is important to understand what a polygraph examination entails. A polygraph instrument will collect physiological data from at least three systems in the human body. Convoluted rubber tubes that are placed over the examinee's chest and abdominal area will record respiratory activity. Two small metal plates, attached to the fingers, will record sweat gland activity, and a blood pressure cuff, or similar device will record cardiovascular activity.

A typical polygraph examination will include a period referred to as a pre-test, a chart collection phase and a test data analysis phase. In the pre-test, the polygraph examiner will complete required paperwork and talk with the examinee about the test. During this period, the examiner will discuss the questions to be asked and familiarize the examinee with the testing procedure. During the chart collection phase, the examiner will administer and collect a number of polygraph charts. Following this, the examiner will analyze the charts and render an opinion as to the truthfulness of the person taking the test. The examiner, when appropriate, will offer the examinee an opportunity to explain physiological responses in relation to one or more questions asked during the test.

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[1] *Polygraph: Issues and Answers* was revised February 1, 1996.  Copies of the original document are available from the APA Publications Office, P.O. Box 1061, Severna Park, MD 21146-8061, $3.00 postpaid for APA Members and $5.00 postpaid for non-Members.

It is important to note that a polygraph does not include the analysis of physiology associated with the voice. Instruments that claim to record voice stress are not polygraphs and have not been shown to have scientific support.

**Who Uses Polygraph Examinations?**

The polygraph technique is most widely used today by the law enforcement community in one of two ways: 1) as part of the pre-employment screening process for police candidates, and 2) as a forensic technique to help resolve the investigation of criminal offenses.

According to a recent survey, over 60% of the large police departments in the United States use polygraph testing in the pre-employment screening process. Police agencies have found that polygraph testing is a very effective means by which to identify high risk candidates. For example, in case studies carried out in Illinois, Ohio, Maryland and Florida it was found that out of 3,576 police applicants given pre-employment polygraph examinations, 58% (2,068) were identified as high risk candidates for police work in that they had behavioral histories of involvement in activities such as felony thefts, burglaries, robberies, the use and sale of illegal drugs, bribery, car thefts, and various sexual offenses.

The value of the polygraph testing process is further illustrated by the fact that in most of these cases, the applicants had already successfully passed a series of mental, physical and psychological tests, as well as credit and background investigations.

For decades the law enforcement community has used polygraph testing as an investigative aid to: verify the statements of victims; establish the credibility of witnesses; and evaluate the truthfulness of suspects.

The most valuable aspect of the investigative use of polygraph testing is to help exonerate the innocent person who is surrounded by circumstantial evidence. It is particularly valuable in those investigations that rely only on testimonial evidence. At the same time, polygraph testing is very helpful in investigations involving multiple suspects by narrowing the focus of the investigation. Regardless of the circumstance in which polygraph testing is used, the test results are not the sole basis on which decisions are made; rather polygraph results are used in conjunction with other screening or investigative information.

All federal law enforcement agencies either employ their own polygraph examiners or use the services of examiners employed in other agencies. Staff examiners and quality control programs exist in the FBI, Secret Service, U.S. Army CID, U.S. Marine Corps CID, Air Force OSI, Navy NCIS, U.S. Customs, U.S. Marshal's, Defense Criminal Investigation Service, Internal Revenue Service, U.S. Capitol Police, Food & Drug Administration, Department of Energy, Metropolitan Police of the District of Columbia and Others. Also, U.S. intelligence agencies use polygraph tests in the pre-employment screening process.

## The Employee Polygraph Protection Act

### What is EPPA?

On December 27, 1988, the Employee Polygraph Protection Act (EPPA) became law. This federal law established guidelines for polygraph testing and imposed restrictions on most private examiners. The following is a brief summary of the essential elements of the law.

### Who is affected by EPPA?

This legislation only affects commercial businesses. Local, State and Federal governmental agencies (such as police departments) are not affected by the law, nor are public agencies, such as a school system or correctional institution. In addition, there are exemptions in EPPA for some commercial businesses. They are:

1. Businesses under contract with the Federal Government involving specified activities (*e.g.*, counterintelligence work).

2. Businesses whose primary purpose consists of providing armored car personnel, involved in the design, installation and maintenance of security alarm systems, or security personnel in facilities which have a significant impact on the health or safety of any state. Examples of these facilities would be a nuclear or electric power plant, public water works, or toxic waste disposal.

3. Companies which manufacture, distribute or dispense controlled substances.

### How does EPPA affect businesses which are not exempt?

In general, businesses cannot request, suggest or require any job applicant to take a pre-employment polygraph examination. Secondly, businesses can request a current employee take a polygraph examination or suggest to such a person that a polygraph examination be taken, only when specific conditions have been satisfied. However, the employer cannot require current employees to take the examination, and if an employee refuses a request or suggestion, the employer cannot discipline or discharge the employee based on the refusal to submit to the examination.

### What are the conditions that an employer must meet in order to ask a current employee to take a polygraph examination?

Four criteria must be met before an employer can ask a current employee to take a polygraph examination. These are:

1. The request must be relative to an ongoing specific investigation involving an economic loss to the employer.

2. The employee must have had access to the property, money or area central to the investigation. Access as defined in the law, can mean physical presence or special knowledge, such as the combination to a safe.

3. The employer must have a reasonable suspicion that the employee was involved in the incident under investigation. Reasonable suspicion goes beyond having access, and incorporates such factors as a witness' statement, suspicious behavior on the part of the employee, or contradictions between the employee's statements and documented records.

4. At least 48 hours prior to the examination the employer must give to the employee a written statement which describes the nature of the loss and the investigation, as well as the basis for the employer's "reasonable suspicion."

In addition to these four basic requirements, the law requires that the polygraph examiner follow certain procedures in the administration of the examination. Examples of these procedures include a minimum duration of 90 minutes for the examination, and reading a statement to the employee which enunciates certain rights under the act.

The American Polygraph Association has prepared a manual which describes the law and accompanying regulations in detail, and provides guidance on effective compliance with the law. A copy of this manual, prepared under the senior authorship of Attorney F. Lee Bailey, can be purchased from the APA. Contact the National Office at 800-272-8037 for details.

The U.S. Chamber of Commerce also has available a manual and brochure on compliance with EPPA. For more information contact the Chamber at 800-638-6582.

## Errors in Polygraph Examinations

### False positive, false negative

While the polygraph technique is highly accurate, it is not infallible and errors do occur.

Polygraph errors may be caused by the examiner's failure to properly prepare the examinee for the examination, or by a misreading of the physiological data on the polygraph charts. Errors are usually referred to as either false positives or false negatives. A false positive occurs when a truthful examinee is reported as being deceptive; a false negative when a deceptive examinee is reported as truthful. Some research indicates that false negatives occur more frequently than false positives, other research studies show the opposite conclusion. Since it is recognized that

any error is damaging, examiners utilize a variety of procedures to identify the presence of factors which may cause false responses, and to insure an unbiased review of the polygraph records; these include:

**Protective procedures**

an assessment of the examinee's emotional state

medical information about the examinee's physical condition

specialized tests to identify the overly responsive examinee and to calm the overly nervous

control questions to evaluate the examinee's response capabilities

factual analysis of the case information

a pre-test interview and detailed review of the questions

quality control reviews

**Examinee's remedies**

If a polygraph examinee believes that an error has been made, there are several actions that may be taken including the following:

request a second examination

retain an independent examiner for a second opinion

file a complaint with a state licensing board

file a complaint with the Department of Labor under EPPA

file a request for the assistance of the American Polygraph Association

## The Accuracy of Polygraph Examinations

### 85-95% Accuracy

In the past 75 years over 250 studies have been conducted on the accuracy of polygraph testing. Since many different conditions and factors are involved in the research, and since a polygraph examination is a very complex process, it is difficult to draw from the data a precise figure for

the accuracy of polygraph testing in all settings. Nevertheless, the preponderance of available information indicates that when a properly trained examiner utilizes an established testing procedure, the accuracy of the decision made by polygraph examiners is generally in the range of 85-95% for specific issue investigations. (On the last page you will find some of the references which support this statement.)

**Why critic's figures vary**

One of the problems in discussing accuracy figures and the difference between the statistics quoted by proponents and opponents of the polygraph technique is the way that the figures are calculated. At the risk of over simplification, critics, who often don't understand polygraph testing, classify inconclusive test results as errors. In the real life setting an inconclusive result simply means that the examiner is unable to render a definite diagnosis. In such cases a second examination is usually conducted at a later date. To illustrate how the inclusion of inconclusive test results can distort accuracy figures, consider the following example. If 10 polygraph examinations are administered and the examiner is correct in 7 decisions, wrong in 1 and has 2 inconclusive test results, we calculate the accuracy rate as 87.5% (8 definitive results, 7 of which were correct.) Critics of the polygraph technique would calculate the accuracy rate in this example as 70%, (10 examinations with 7 correct decisions). Since those who use polygraph testing do not consider inconclusive test results as negative, and do not hold them against the examinee, to consider them as errors is clearly misleading and certainly skews the figures.

**Pre-employment test accuracy**

To date there has been only a limited number of research projects on the accuracy of polygraph testing in the pre-employment context, primarily because of the difficulty in establishing ground truth. However, since the same physiological measures are recorded and the same basic psychological principles may apply in both the specific issue and pre-employment examinations, there is no reason to believe that there is a substantial decrease in the accuracy rate for the pre-employment circumstance. The few studies that have been conducted on pre-employment testing support this contention.

While the polygraph technique is not infallible, research clearly indicates that when administered by a competent examiner, the polygraph test is one of the most accurate means available to determine truth and deception.

For an excellent review of the research involving validity and reliability, including pre-employment screening, see: *The Accuracy and Utility of Polygraph Testing.* (1984) Washington, D.C.: U.S. Department of Defense, 1984. Complete reprints may be purchased from: APA Publications, P.O. Box 1061, Severna Park, Maryland 21146-8061.

## Polygraph Screening in Police Agencies

The Employee Polygraph Protection Act (EPPA) prohibits most private employers from using polygraph testing to screen applicants for employment. It does not affect public employers such as police agencies or other governmental institutions. In the testimony regarding EPPA it became clear that there were no current and reliable data on a variety of important issues about police applicant screening, although polygraph testing had reportedly been used for that purpose since at least the early 1950's. In recognition of this gap, the APA Research Center at Michigan State University embarked on a survey of police executives in the United States to determine the extent of, and conditions in which, polygraph testing is being used for pre-employment screening. The survey population included 699 of the largest police agencies in the United States, excluding federal agencies, and produced usable returns from 626 agencies, a response rate of 90%. The major results of the survey showed the following.

Among the respondents, 62% had an active polygraph screening program, 31% did not and 7% had discontinued polygraph screening, usually because of prohibitive legislation. These results make it clear that a great majority of our largest police agencies do have a polygraph screening program in effect. These agencies employ, on average, 447 officers and serve a population averaging 522,000 citizens. They primarily use the polygraph to screen applicants for sworn positions, although 54% also screen persons interested in non-sworn positions. Approximately 25% of the persons tested are disqualified from police employment based on the information developed during polygraph testing which, by the way, is used both to verify information provided in an application form and to develop information that cannot be gotten by other means. Only a very small proportion (2%) of agencies use polygraph testing as a substitute for a background investigation. A rank ordered listing of topics covered during polygraph testing revealed that investigation of illegal drug usage, employment related dishonesty, and involvement in felonies are the most important.

When asked to indicate what their reasons were for using polygraph screening, the great majority of the agencies indicated that it reveals information that cannot be obtained by other selection methods. Closely following this item, in order, was that polygraph testing makes it easier to establish background information, that it deters undesirable applicants, and that it is faster than other methods of selection. The three leading benefits of polygraph screening were that applications were more honestly completed; that higher quality employees were hired; and that there were fewer undesirable employees. Over 90% of these agencies expressed either moderate or high confidence in their polygraph screening program and 80% of them reported that in their experience the accuracy of the testing ranged between 86% and 100%. The only procedure that was considered to be as useful as polygraph screening was a background investigation; all others, including written psychological tests, psychological or psychiatric interviews, personal interviews, and interviews by a selection board were judged to be less useful. Finally, this survey also showed that polygraph screening revealed applicant's involvement in serious, undetected criminality. For example, 9% of the agencies said that polygraph screening detected involvement by some applicants in unsolved homicides; 34% indicated some applicant involvement in forcible

rape; and 38% showed some applicant participation in armed robberies. Other serious, unsolved crimes, such as burglary, arson and drug offenses were also revealed by polygraph screening.

## Scope of Test Questions and Dissemination of Test Results

### Prohibited inquiries

Personal and intrusive questions have no place in a properly conducted polygraph examination. Many state licensing laws, the Employee Polygraph Protection Act, as well as the American Polygraph Association, have so stated in language similar to the following:

No examiner should inquire into any of the following areas during pre-employment or periodic employment examinations:

religious beliefs or affiliations

beliefs or opinions regarding racial matters

political beliefs or affiliations

beliefs, affiliations or lawful activities regarding unions or labor organizations

sexual preferences or activities

In a law enforcement pre-employment polygraph examination, the questions focus on such job related inquiries as the theft of money or merchandise from previous employers; falsification of information on the job application; the use of illegal drugs during working hours and criminal activities. The test questions are limited in the time span they cover, and all are reviewed and discussed with the examinee during a pre-test interview before any polygraph testing is done. There are no surprise or trick questions.

In a specific issue polygraph examination the relevant questions focus on the particular act under investigation.

### Who gets results?

According to the various state licensing laws and the American Polygraph Association's Standards and Principles of Practice, polygraph results can be released only to authorized persons. Generally those individuals who can receive test results are the examinee and anyone specifically designated in writing by the examinee, the person, firm, corporation or governmental agency which requested the examination, and others as may be required by due process of law.

## Legislation

### Licensing

Currently there are 29 states and 3 counties which have laws requiring licensure or certification for polygraph examiners. Most laws require formal instruction, an internship training period and successful completion of a licensing examination. For example, the following are basic requirements for licensure in one state.

A person is qualified to receive a license as an examiner:

> (a) who establishes that he or she is a person of good moral character; and,
>
> (b) who has passed an examination conducted by the Licensing Committee, or under its supervision, to determine his or her competency to obtain a license to practice as an examiner; and,
>
> (c) who has conferred upon him or her an academic degree, at the baccalaureate level, from an accredited college or university; and,
>
> (d) who has satisfactorily completed 6 months of study in the detection of deception, as prescribed by rule ...

### Prohibitive legislation

In addition to the Employee Polygraph Protection Act, to date there are 20 states and the District of Columbia which have enacted legislation designed to regulate an employer's use of the polygraph. No state prohibits polygraph testing in all settings. A typical statute states:

> No employer may require a prospective or current employee to take a polygraph examination as a condition of employment or continued employment.

Most of these states make exceptions for testing of certain occupational groups. Commonly exempted are law enforcement agencies and companies that manufacture, distribute or dispense drugs and controlled substances.

The American Polygraph Association has consistently supported licensing efforts throughout the country. The APA encourages efforts to establish proper qualifications for polygraph examiners and criteria for testing procedures.

The Employee Polygraph Protection Act of 1988 prohibits much but not all pre-employment polygraph testing. Testing of employees is permitted to solve an employer's "economic loss." There are exemptions for guards, armored car personnel and those who handle drugs and narcotics. EPPA does not affect testing for attorneys or local, state or federal agencies. Se: PL

199 347. Final Rules in the *Federal Register*, 56 (42), Monday, March 4, 1991, 29 CRF Part 801.

## Admissibility

Polygraph results (or psychophysiological detection of deception examinations) are admissible in some federal circuits and some states. More often, such evidence is admissible where the parties have agreed to their admissibility before the examination is given, under terms of a stipulation. Some jurisdictions have absolute bans on admissibility of polygraph results as evidence and even the suggestion that a polygraph examination is involved is sufficient to cause a retrial. The United States Supreme Court has yet to rule on the issue of admissibility, so the rules in federal circuits vary considerably. The Supreme Court has said, in passing, that polygraph examinations raise the issue of Fifth Amendment protection, [*Schmerber v. California*, 86 S.Ct. 1826 (1966).] The Supreme Court has also held that a *Miranda* warning before a polygraph examination is sufficient to allow admissibility of a confession that follows an examination, [*Wyrick v. Fields*, 103 S.Ct. 394 (1982).] In 1993, the Supreme Court removed the restrictive requirements of the 1923 *Frye* decision on scientific evidence and said Rule 702 requirements were sufficient, [*Daubert v. Merrell Dow Pharmaceuticals*, 113 S.Ct. 2786.] *Daubert* did not involve lie detection, per se, as an issue, as *Frye* did, but it had a profound effect on admissibility of polygraph results as evidence, when proffered by the defendants under the principles embodied in the Federal Rules of Evidence expressed in *Daubert*, see*United States v. Posado* (5th Cir. 1995) WL 368417. Some circuits already have specific rules for admissibility, such as the 11th Circuit which specifies what must be done for polygraph results to be admitted over objection, or under stipulation, [*United States v. Piccinonna* 885 F.2d 1529 (11th Cir. 1989).] Other circuits have left the decision to the discretion of the trial judge. The rules that states and federal circuits generally follow in stipulated admissibility were established in [*State v. Valdez*, 371 P.2d 894 (Arizona, 1962).] The rules followed when polygraph results are admitted over objection of opposing counsel usually cite [*State v. Dorsey*, 539 P.2d 204 (New Mexico, 1975).] Primarily because of *Daubert*, as well as the impact the other cited cases have had, polygraph examination admissibility is changing in many states. Many appeals, based on the exclusion of polygraph evidence at trial are now under review by appellate courts.

Representative case citations are provided for reference:

Alabama: *Clements v. State*, 474 So.2d 695 (1984).
*Green v. Am. Cast Iron*, 464 So.2d 294 (1984).

Arizona: *State v. Valdez*, 91 Ariz. 274, 371 P.2d 894 (1962).
*State v. Molina*, 117 Ariz. 454, 573 P.2d 528 (App. 1977).

Arkansas: *Hays v. State*, 767 S.W.2d 525 (1989).

California: *People v. Houser*, 85 Cal.App.2d 686, 193 P.2d 937 (1948).
*Robinson v. Wilson*, 44 Cal.App.3d 92, 118 Cal.Rptr. 569 (1974).
*Witherspoon v. Superior Court*, 133 Cal.App.3rd 24 (1982).

Delaware: *Williams v. State*, 378 A.2nd 117 (1977).

Georgia: *State v. Chambers*, 240 Ga. 76, 239 S.E.2d 324 (1977).
*Miller v. State*, 380 S.E.2d 690 (1989).

Idaho: *State v. Fain*, 774 P.2d 252 (1989).

Indiana: *Barnes v. State*, 537 N.E.2d 489 (1989).
*Davidson v. State*, 558 N.E.2d 1077 (1990).

Iowa: *State v. McNamara*, 104 N.W.2d 568 (1960).
*Haldeman v. Total Petroleum*, 376 N.W.2d 98 (1985).

Kansas: *State v. Roach*, 570 P.2d 1082 (1978).

Nevada: *Corbett v. State*, 584 P.2d 704 (1978).

New Jersey: *State v. McDavitt*, 297 A.2d 849 (1972).
*State v. McMahon*, 524 A.2d 1348 (1986).

New Mexico: *State v. Dorsey*, 539 P.2d 204 (1975).

North Dakota: *State v. Newman*, 409 N.W.2d 79 (1987).

Ohio: *Moss v. Nationwide*, 493 N.E.2d 969 (1985).
*State v. Souel*, 372 N.E.2d 1318 (1978).

Utah: *State v. Jenkins*, 523 P.2d 1232 (1974).
*State v. Rebetevano*, 681 P.2d 1265 (1984).

Washington: *State v. Grigsby*, 647 P.2d 6 (1982).

Wyoming: *Cullin v. State*, 565 P.2d 445 (1977).

## What is the American Polygraph Association?

The American Polygraph Association (APA) is an international association which represents the polygraph profession in programs which establish standards of ethical practice, techniques, instrumentation, and training. The APA has approximately 2,000 members, of which the majority are in the United States. The APA also represents many other examiners who are members of foreign, regional and state associations which are affiliated with the APA.

APA members are required to maintain the highest standards of moral, ethical and professional conduct. They are required to discharge their duties with complete impartiality, dignity and respect. They recognize that their primary responsibility is to the person being examined, and they are forbidden to allow considerations of race, religion, politics, union activity, or economic status to play any part in their examinations.

They are pledged to issue an objective and unbiased opinion and to protect the confidentiality of the examination. In an effort to facilitate public understanding and to enhance the proper use of the polygraph technique, the APA has established a variety of programs, including the following:

a Grievance committee established to investigate allegations of examiner misconduct,

educational programs and audio, video and printed materials.

For additional information, please call Ms. Robbie Bennett, Manager of the APA National Office at 1-800-272-8037 or 423-892-3992. The office Fax number is 423-894-5435. The mailing address is P.O. Box 8037, Chattanooga, TN 37414-0037.

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* These publications may be purchased from the American Polygraph Association Publications and Reference Office, P.O. Box 1061, Severna Park, Maryland 21146-8061. Telephone: (410) 647-0936.

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# I WANT A LAWYER ... NOW!

## When Does an Interrogation Have to Stop?

**By**

**Donald A. Weinstein**

As all in law enforcement are aware, in 1966, the Supreme Court handed down the *Miranda v. Arizona* decision regarding the unequivocal right to counsel for a criminal suspect. While many felt then, as now, that the *Miranda* decision was the right thing to do, there are considerable numbers who believe that decision has only served to "hamstring" the law enforcement effort. Recently, a decision was handed down from the Supreme Court that addresses that very issue and, it would appear, gives law enforcement less restrictions in the performance of their jobs. Unfortunately, at least in my opinion, these new rules do not apply to all in law enforcement.

The case which brought this all about was decided in June 1994. In *Davis v. United States*, No. 92-1949, the suspect was questioned by investigators for the Naval Criminal Investigative Service (NIS) regarding the murder of a sailor. Subsequent to the proper completion of the appropriate forms and his acknowledgement of his *Miranda* rights, the suspect agreed to answer questions posed to him by the investigators. About an hour into the interrogation, the suspect commented, "Maybe I should talk to a lawyer." Based on a directive that they had previously received, the investigators stopped questioning the suspect and attempted to clarify the statement made by the suspect. Subsequently, the suspect stated that he did not wish to talk with a lawyer and the interrogation continued. A confession was obtained and the suspect convicted. Despite the somewhat loose interpretation of *Miranda*, the U.S. Court of Military Appeals approved what was termed the investigator's "stop and clarify" approach and affirmed the defendant's conviction.

The defendant appealed to the Supreme Court and in a 5-4 decision, that court rejected his protestations, citing an explanation previously handed down in *Edwards v. Arizona*, 451 U.S. 477 (1981). That decision in essence stated, and referred to in the majority opinion by Justice Sandra Day O'Connor, that "a suspect must articulate his desire to have counsel present sufficiently clearly that a reasonable police officer in the circumstances would understand the statement be to a request for an attorney."

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What was rather surprising about this case was that even though the lower courts had approved the "stop and clarify" approach, Supreme Court Justice Anthony Scalia questioned any need to clarify the statements regarding counsel that are made by a suspect during interrogation. Even though Justice O'Connor acknowledged what the agents did might be good police practice, she refused to adopt any requirement for the police to do so.

So where does that leave us? It would appear from the sources with which I have checked, those agencies not under the auspices of the Department of Defense, such as the FBI, Secret Service, Customs, et cetera, have no absolute requirement to adopt the "stop and clarify" approach. But, in checking with some military attorneys, it would appear that some very specific guidelines have been provided that present an awkward position. What was formerly called the Court of Military Appeals (COMA) and is now called the Court of Appeals for the Armed Forces (CAAF), have issued guidance from what was part of the "bright line" rule that was suggested in the *Edwards* case. That guidance calls for continuation of the "stop and clarify" approach determined to be unnecessary in Justice O'Connor's majority opinion.

In questioning the rationale for these two very different approaches, I as informed that this approach is more on the "safe side" and would serve to preclude the overturning of any conviction in which the issues of "counsel-less" interrogation was raised. Just how far, or in how much detail, the investigators must pursue this requirement for clarification remains unclear.

From my perspective, this affects the polygraph profession, when the data analysis of the collected tests results in a deception indicated opinion. From that point, the polygraph examiner must be acutely aware of any statements the examinee may make with regard to speaking with an attorney. Until some further guidance is provided that would resolve this apparent disparity between agencies. If you are part of an agency that adheres to the DoD guidelines and your examinee makes such an inquiry, remember what must be done. Affected agencies are urged to check with their respective legal offices for further information.

Syllabus of the Opinion, No. 92-1949, *Robert L. Davis Petitioner v. United States*, on Writ of Certiorari to the United States Court of Military Appeals. Argued March 29, 1994, decided June 24, 1994.

> Petitioner, a member of the United States Navy, initially waived his rights to remain silent and to counsel when he was interviewed by Naval Investigative Service agents in connection with the murder of a sailor. About an hour and a half into the interview, he said, "Maybe I should talk to a lawyer." However, when the agents inquired if he was asking for a lawyer, he replied that he was not. They took a short break, he was reminded of his rights, and the interview continued for another hour, until he asked to have a lawyer present before saying anything more. A military judge denied his motion to suppress statements made at the interview, holding that his mention of a lawyer during the interrogation was not, a request for counsel. He was convicted of murder, and, ultimately, the Court of Military Appeals affirmed.

*Held:*

1. After a knowing and voluntary waiver of rights under *Miranda v. Arizona*, 384 U.S. 436, law enforcement officers may continue questioning until and unless a suspect clearly requests an attorney. A suspect is entitled to the assistance of counsel during custodial interrogation even though the Constitution does not provide for such assistance. *Id.*, at 469-473. If the suspect invokes that right at any time, the police must immediately cease questioning him until an attorney is present. *Edwards v. Arizona*, 451 U.S. 477, 484-485. The *Edwards* rule serves the prophylactic purpose of preventing officers from badgering a suspect into waiving his previously asserted *Miranda* rights, and its applicability requires courts to determine whether the accused actually invoked his right to counsel. This is an objective inquiry, requiring some statement that can reasonably be construed to be an expression of a desire for an attorney's assistance. However, if a reference is ambiguous or equivocal in that a reasonable officer in light of the circumstances would have understood only that the suspect *might* be invoking the right to counsel, *Edwards* does not require that officers stop questioning the suspect. Extending *Edwards* to create such a requirement would transform the *Miranda* safeguards into wholly irrational obstacles to legitimate investigative activity by needlessly preventing the police from questioning a suspect in the absence of an attorney, even if the suspect does not wish to have one present. The *Edwards* rule provides a bright line that can be applied by officers in the real world of investigation and interrogation without unduly hampering the gathering of information. This clarity and ease of application would be lost if officers were required to cease questioning based on an ambiguous or equivocal reference to an attorney, since they would be forced to make difficult judgment calls about what the suspect wants, with the threat of suppression if they guess wrong. While it will often be good police practice for officers to clarify whether a suspect making an ambiguous statement really wants an attorney, they are not required to ask clarifying questions.

2. There is no reason to disturb the conclusion of the courts below that petitioner's remark--"Maybe I should talk to a lawyer"-- was not a request for counsel.
36 M.J. 337, affirmed.

O'Connor, J., delivered the opinion of the Court, in which Rehnquist, C.J., and Scalia, Kennedy, and Thomas, JJ., joined. Scalia, J., filed a concurring opinion. Souter, J., filed an opinion concurring in the judgment, in which Blackmun, Stevens, and Ginsburg, JJ., joined.

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## HABITUATION AND POLYGRAPH TESTING

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[Ed.]

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# HISTORICAL NOTE:

# POLYGRAPH RESEARCH STUDY OF FEAR IN A FIELD SITUATION

# REVIEW OF A 1951 STUDY

**By**

**John G. Linehan**

## Background

Fear is one of the basic emotions of individual behavior. The founder of the school of behaviorism, John B. Watson, concluded newborn infants show only three emotions. These are fear (aroused by pain, injury, loud noises or sudden loss of support), rage or anger (aroused by restriction of movement), and love (aroused by soft noises or gentle stroking of the skin).

Fear has been defined as the excited response to danger, coupled with the impulse to seek safety through withdrawal. The affective states of emotions and feelings are synonymous, the difference being intensity. If an experience is mild it is usually called a "feeling," and if more intense it is called an "emotion." In all emotional responses bodily changes occur, creating a disturbed condition of the body, and an impulse to act, brought about by the prospect of some value's being lost or gained.

The polygraph technique is based on the emotion of fear--the fear of being detected in the lie that may result in a value being lost. In times of physical or psychological stress the body prepares to fight the enemy or flee to safety, and these body changes are not under voluntary control. This is the "fight or flight" response taught in introductory psychology courses and in basic polygraph school programs.

Laboratory experiments utilizing polygraphic instrumentation to record and measure the simulated emotion of fear and duplication of the "fight or flight" response is inherently difficult owing to limitations imposed by the academic atmosphere. These experiments customarily do not have the greater stress found in field situations of the practicing polygraphist. Tenably, this limitation on locale of experimentation, and lack of dynamic approach, invalidates much research, for the simple reason that experimenters could never be sure they were truly measuring the unquestioned stress or fear complex. Since fear is customarily the main component, presumably inadequacy of the stress situation leads to failure to differentiate deception and truth.

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In 1951 a polygraphic research program involving fear in a field situation was conducted. Details and findings are set forth hereafter (Troop Performance ... 1951).

**The Chatham & Trovillo Study**

In the Autumn of 1951 the Operations Research Office of Johns Hopkins University, operating under contract with the Department of the Army, conducted a study to appraise and evaluate the performance and psychological reactions of troops undergoing their first tactical maneuver experience with the Atom Bomb. Analysts were with the troops before, during and after the experience to observe individual behavior as evidenced by views expressed publicly and privately, by conduct, and by emotional reactions indicated by polygraph instrumentation. Polygraphists collected data by observation, questioning, and by instrumental recording of physiological responses by individuals participating in the experience. Control subjects were also measured. The control group consisted of military personnel at the home base who had not been instructed in the nature of the exercise and did not participate in the potentially dangerous experiment.

The polygraph program was sub-contracted by ORO to Russell Chatham, Inc., who also had the Oak Ridge AEC polygraph program contract at that time. Paul V. Trovillo was chief polygraphist, assisted by William Davis and William McFatridge. The examiners collaborated in development of an experimental design aimed at determining (1) whether physiological reactions could be recorded and measured under field conditions involving fear, and (2) whether the physiological and accompanying psychological states would differ significantly before and after a highly stressful experience. Chatham polygraphs, a Keeler type instrument made by Associated Research, Inc., were used in the testing. The Chatham instrument is essentially a pneumatic and mechanical type polygraph and enables the examiner to note bodily reactions at the time they occur. The instrument recorded relative alteration in systolic and diastolic blood pressure, pulse rate, pulse pressure, and respiration rate and depth. Overt muscular responses also are recorded indirectly in the polygrams.

The tactical maneuver, termed DESERT ROCK, was conducted in October-November 1951. On 1 November 1951 at 0725 an atomic bomb was exploded over emplacements at Yucca Flats, Nevada. An augmented Battalion Combat Team, including paratroopers of the lst Battalion, 188th Airborne Infantry Regiment from Fort Campbell, Kentucky, witnessed the explosion at seven miles from Ground Zero. Sixty minutes later the troops advanced to a previously prepared Battalion Combat Team position, approximately two miles from Ground Zero. Here, inspection was made of damage to weapons and emplacements. They then advanced to about 500 yards from Ground Zero, then to positions where inspection could be made of damage to animals and heavy equipment exposed to the bomb. Troops then returned to base camp.

Observers, including Mr. Trovillo, and his polygraph equipment, arrived at Camp Desert Rock a week prior to D-Day and accompanied the Team during the exercise. Three observers, including Mr. Trovillo, visited Fort Campbell for post-exercise studies.

On D-2 and D-1, a random sample of 29 paratroopers of the 1st Battalion, 188th Airborne Infantry Regiment, 11th Airborne Division, who were members of the Battalion Combat Team, were given polygraph tests and their verbal and physiological responses to a series of bomb-oriented and control questions were recorded. On D+13 through D+36, 27 of these paratroopers were given a second polygraph test at Fort Campbell in which their physiological and verbal responses to control questions and questions concerning the A-bomb and a parachute jump were recorded. During these tests critical questions were used in the same relative positions, interspersed with non-critical questions.

Three paratroopers at Fort Campbell were given polygraph tests under conditions of known stress--while in a place immediately prior to making a parachute jump--and were retested on the ground three days later.

A control group of 29 members of the 11th Airborne Division were given polygraph tests at Fort Campbell on D+14 through D+33. These were men who did not receive A-bomb indoctrination, did not participate in Desert Rock exercise, and did not have parachute jump experience.

The Exercise Desert Rock research study was classified Secret until 1965 when it was de-classified. Mr. Chatham and Mr. Trovillo collaborated on an unpublished manuscript and from this the following is extracted:[1]

> The experimenter was interested in the possible revelation of fears and apprehensiveness or other stresses arising from the formal instructions which had been given to prepare the men for the danger, instabilities, and the strain of participating in a potentially dangerous situation; and likewise, in the relative absence of autonomic nervous system disruption, if such were found. Cross-sectional samples of participants, obtained in random order, provided a representative study group.
>
> Analysis of polygrams included initial study of whether the subjects were responsive to the polygraph test situation. Criteria for responsiveness, and hence for reliability of subjects, included the following evidences (based on reactions to questions about sensed dangers, to control questions, to questions dealing with known and admitted fears of the subjects:
>
> 1. Specific and immediate increase in blood pressure.
> 2. Respiratory suppression or change in respiratory rate.
> 3. Heart rate changes.

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[1] Extracted from ORO-T-170 (*Troop Performance On a Training Maneuver Involving the Use of Atomic Weapons*) from pages 47 through 64 of the study.

4. anticipatory tension, as revealed in mounting and sustained blood pressure increases, or muscular tension, throughout a test.
5. Clear-cut peak of tension in blood pressure at the one pertinent question of a series about which the subject had been completely informed in advance by the experimenter.
6. Obvious rhythmical variations in blood pressure throughout a test.

Polygrams studied were all obtained in the impersonal privacy of a laboratory situation in which the subject and examiner did not face each other, but where the subject's bodily reactions were continuously scrutinized by the examiner as they were recorded. This was done in a private office, or in the field, or in a special tent, and sometimes in a mobile laboratory. Short initial periods of testing without verbal stimuli were used in all cases. In addition, "control questions" were used with each subject to check the person's ability to respond to the test, these consisting of questions designed to evoke an emotional response unrelated to the test experience.

Responsiveness, and duration of stress patterns, were measured on a continuous scale by a test made both before and after the exposure to the danger, by noting (1) existence of reaction, and (2) degree of reaction. Familiar fears were incorporated in some of the control questions. For example, all participants informally admitted their fear of jumping from a high place.

Criteria employed for interpreting specific response levels and forms, and for terming them significant or not, are standard criteria, the significance of which had been established during the previous 25 years by professional workers in research hospitals and penal institutions and by those psychologists who have applied the technique in the field of detection of deception.

Polygrams were studied to determine the existence and the degree of change in the respiration, blood pressure and pulse pattern, both before and after the dangerous experience, and also to determine the duration of stress patterns from such experiences. Heart rates were computed for each subject before and after the event, and millimeters of rise in recorded blood pressure from the recorded baseline were measured in many of the polygrams obtained.

The technique proved itself of high value as an objective determination of attitude and behavior in relation to the results of instruction regarding the anticipated nature of the danger. The research has suggested the feasibility of using the polygraph technique for the measurement of psychological stresses inherent in dangerous activities and in personality disorders. This study enabled the experimenters to assess degrees of excitement, of relative organismal stress and personal alertness. It successfully differentiated the stresses before and after an

experience involving danger; and it underlined the importance of using the polygraph as a laboratory aid in interpreting personality stability.

In terms of the criteria of responsiveness used in this study (rhythmical variations in systolic blood pressure, gradual rise in systolic blood pressure, and/or specific reactions in respiration, blood pressure, or pulse), the experimental subjects and also the control subjects appeared responsive, or sensitive, to the measurement technique in 90% of the cases. Responses to specific questions involving fears, and to control questions which simulated danger, were equally effective as test forms (76% of the experimental group showed these reactions).

The most productive criteria for revealing emotion was shown to be the increase in the systolic blood pressure, which differentiated fears of a danger situation before the event in 80% of the cases, and after the experience in 92% of the cases. The control subjects showed such reactions in only 51% of the cases. Respiratory suppression was found in all subjects tested in the actual danger situation, but did not appear to a significant extent in the main experimental or control groups before the danger. Specific heart rate changes concerning relevant questions appeared symptomatic only in those tested before the experience. Pulse pressure variations pervading entire charts were found in 76% of the subjects tested before the experience, and an abnormally fast heart rate before the experience (found not due to chance factors) was discovered in approximately 80% of the cases.

A tabulation of "yes" and "no" responses of the experimental group was made and this was compared with the polygraphic evidence of emotion. Before the experience most of the subjects showed in the polygrams apprehension or fear about the experience, but only one-fourth of the men were willing at time of test to concede orally any fear! Half of the control group showed fear of the experience, as indicated in the polygrams, but this group (which did not expect to experience the danger) was willing to admit fear orally in as many as nine out of the ten cases.

Tests made in the field just prior to the danger, revealed gross disruptions in recorded responses in every case, in respiratory rate and depth, in systolic blood pressure changes, in heart rate and muscular movement.

Chatham and Trovillo expressed regret that military restriction on publication of tabular data made it necessary (at that time) to omit such data; but stated the general conclusions presented are well supported in the statistical treatment.

The use of polygraph by Chatham, Inc., in the ORO Desert Rock Exercise appears to demonstrate the "laboratory - field" means is supportive in the duplication of anticipated stresses, and measurement of these stresses, for prediction of individual behavior. Duplication of stress

to measure individual behavior is contentious, as pointed out by Lt.Col. Roy E. Grinker and Major John P. Spiegel of the Army Air Force in their 1945 publication entitled *Men Under Stress*. The authors stated:

> . . . The greatest difficulty in selection is to determine the quantity of stress and the type of stress that will cause specific personality types to react adversely.
>
> All these difficulties confront the psychiatrist in selection. He is unable to deal with large quantities of men objectively and is unable to control the goal of his selection or the subsequent disposition of these men. He has no laboratory means of duplicating the stress to which an individual will be exposed in combat, hence the tolerance of the ego for the quantity of anxiety stimulated by camp combat cannot be measured.

In a critique of Desert Rock the study by Chatham and Trovillo noted the marked dissimilarities to an actual combat situation and that these dissimilarities must be considered in attempts to predict the probable behavior of troops in actual combat situations involving nuclear weapons. Dissimilarities included, but not limited to, no attempt to duplicate a combat situation, the artificiality of preparations by the troops, although some of the men commented they "never before tried to improve a perfect foxhole for 3 days."

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