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A study of isometric and pulsed isometric fatigue of the digital flexor muscle group

by

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INTRODUCTION

Electromyography has been growing in importance since the beginning of the twentieth century. Electromyography has proven to be a useful tool in the analysis and evaluation of muscular fatigue for more than thirty years. Using surface electrodes, electromyography offers a non-invasive method of tracking a muscle group's electrical activity throughout a fatiguing contraction or exercise.

The need to study the causes and effects of muscular fatigue has been realized for years. The ability to reliably predict and monitor muscular fatigue has great implications in ergonomics, as well as other health sciences. The study of muscular fatigue in the forearm could lead to an understanding of cumulative trauma disorders in the wrist and hand, such as carpal tunnel syndrome.

The majority of muscular fatigue research done to date has primarily focused on fatigue induced by maintaining an isometric contraction. Although the results generated from this type of study are crucial, a maintained isometric exercise can not be realistically applied to everyday occurrences. A pulsed isometric exercise which involves contracting to a high force level and holding for a short time period, then reducing to a low force level, and repeating until fatigue, is perhaps much more realistic than a maintained isometric contraction. To date, no studies have been reported in which repetitions of variable isometric contractions have been used to induce muscular fatigue. Therefore, it would appear that there is a need to verify the results of maintained isometric excercise determined by other investigators, as well as to evaluate fatigue due to pulsed isometric excercise.

LITERATURE REVIEW

Theory of Electromyography

The theory behind electromyography is fairly straight forward. Electrical variations of a muscle or individual muscle fibers are picked up with a set of electrodes, amplified, and then presented on a display medium.

There are two types of electrodes in common use, needle and surface. For use in non-invasive studies, the latter is of primary interest. Surface electrodes consist of small circular discs or cups which are paired and placed on the skin surface. They are most commonly made of silver and coated with AgCl to improve surface characteristics. Skin surface preparation is often required prior to the application of surface electrodes. This usually involves a thorough cleansing of the skin and the application of an electrode paste or gel to reduce the electrode-skin impedance.

Action potentials which were picked up from muscles are transmitted from the electrodes through shielded wires to an amplifier. The amplifier magnifies the minute potentials to dimensions large enough for recording and study. Voltages available at the electrodes are of the order of tens to hundreds of microvolts (Webster, 1992). The use of differential amplifiers allows these minute muscular potentials to be boosted even in the presence of large amounts of background voltages (noise). Normally, amplifiers amplify input voltages appearing between an input terminal and a ground terminal. The differential amplifier may be considered as a combination of two such amplifiers arranged so that the voltage to be amplified appears between the two input terminals. This allows signals (noise) common to both inputs to be eliminated. High and low band pass filters are also often incorporated to eliminate undesired frequencies. A common filtering scheme allows potentials in a frequency range of 20Hz to 10KHz; although, it has been shown that the usable frequency band of the EMG varies dramatically, depending on the muscle under study (Kwatny et al., 1970). By minimizing the recorded frequency range, it is possible to filter out much of the undesired noise associated with electrical signal amplification and recording. The unavoidable presence of instrumentation noise explains the necessity of the high frequency cutoff. The situation at low frequencies is quite different. Undoubtedly, there is a useful EMG signal at the very low frequencies which reflects the transition of the muscle from one state to another. However, there also exists low frequency noise due to polarization potentials and motion-induced potentials between the skin and electrode (Kwatny et al., 1970). Consequently, very low frequencies must also be eliminated.

Some systems and situations may require shielding. Shielding requirements depend upon the presence or possibility of electrical and electromagnetic interference in the vicinity of the test area. Such interference may be airborne or may be transmitted through the lab wiring. In any instance, the input leads from the electrodes and the leads from the alternating current source must be effectively shielded and grounded (Light, 1971).

The display medium of a myoelectric (ME) signal is most commonly an oscilloscope; however, to analyze a signal it needs to be permanently recorded. There are numerous methods to accomplish this, but recent developments in computer technology have made signal acquisition fast and efficient. Once an image is digitized, it can easily be manipulated and redisplayed.

The resulting electromyograph (EMG) is a complex wave form, typically represented by a spectrum of sinusoidal wave forms of different amplitudes and frequencies. A complex wave form having a rapid rise and a long duration has frequency components extending from the very low to the very high. EMGs are such wave forms; their significant frequency content extends from approximately 20 Hz to nearly 8,000 Hz (Light, 1971). Some investigators (Braakhekke et al., 1989) place the upper limit of this range around 10,000 Hz, but others (Bigland-Ritchie et al.,1981) believe it to be closer to 5,000 HZ. Electromyography relies heavily on interpretation which may produce varying conclusions. It is important to note that although an EMG is a complex wave form, it can be analyzed with precision by using Fourier analysis. With today's computer systems, it is not difficult to apply Fourier analysis to a properly digitized EMG.

Electrode Positioning

Proper and consistent positioning of surface EMG electrodes is crucial in the acquisition and replication of any signal. Significance of surface electrode placement has been specifically studied by several investigative teams. Zuniga and co-workers (1970) compared transverse and longitudinal orientations of the electrodes to the muscle's central axis. They found that the relationship between EMG and force decreases proportionally to the electrode's distance from the center of the muscle. Kramer and Kuchler (1971), in two studies which compared middle and peripheral surface electrode positions on the biceps and triceps, confirmed that the greatest level of electrical activity was obtained at the muscle's center. Vredenbregt and Rau (1973) also found that the EMG amplitude was smaller with transverse orientation of the electrodes than when they were aligned longitudinally over the muscle. Perry and Bekey (1981) reported that the peak height of the motor unit potential decreases inversely with the distance of the electrode from the muscle.

Reliability of electrode placement for repeated testing has been studied from several viewpoints. It has been observed that EMG and tension varies considerably between experiments unless particular care is taken to reproduce both the position of the electrodes and limb position. The relationship of limb position and EMG, as well as fatigue, has been investigated by a number of teams (Fransson and Winkel, 1991; Fothergill et al., 1991; Wiker et al., 1989; Schoenmarklin and Marras, 1989; Kroemer, 1986; Adams, 1988; Edwards and Lippold, 1956). It is clear that for repeatable measurements, accurate limb position and reposition are critical. Komi and Buskirk (1972), using the biceps brachii, did repeated testing on the same day without removing the electrodes. Their mean reliability coefficient for surface recording was a respectable 0.88, and for indwelling wire it was 0.62. When the electrodes were removed and then reapplied another day, reproducability predictably dropped; it was 0.22 for wire electrodes and 0.69 for the surface technique.

When locating surface electrodes, there are three important considerations: (1) signal-to-noise ratio, (2) signal stability (reliability), and (3) cross-talk from adjacent muscles. Basmajian and Deluca (1985) suggest that the preferred location of an electrode is in the region halfway between the center of the innervation zone and the further tendon. Zipp (1982) offers a standardizing procedure for surface electrode placement. The procedure involves six steps and encompasses the usage of anatomical landmarks, lead points and lead lines. For the flexor digitorum superficialis muscle group, Zipp suggests a sitting posture with the forearm on a table, the elbow turned inward slightly, and the palm up. The lead line extends from the medial epicondyle of the humerus to the skin folds at the wrist. The central lead point (location of the recording electrode) is then positioned 1/4 of the lead line length from the epicondyle (Figure 1). It is noted that there will be cross-talk from the other forearm muscles and that different portions of the muscle attached to the different fingers can be selected by shifting the orientation of the lead line either to the thenar or the hypothenar eminence. The final position should then be confirmed by palpation while moving the finger or fingers under study.

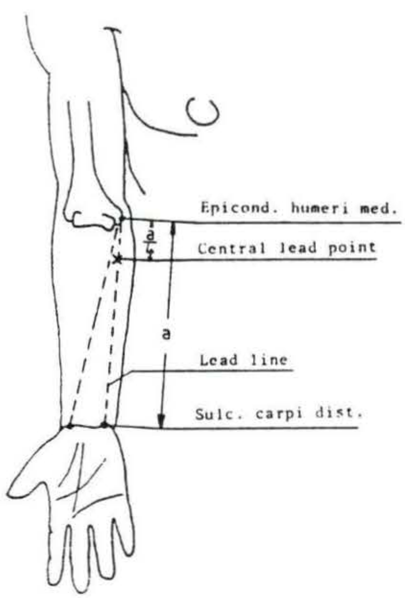


Figure 1. Electrode placement scheme, after Zipp (1982).

Physiology of Muscle

Striated skeletal muscle is composed of hundreds of muscle fibers; groups of which are innervated by single α motoneurons. Branches of the motoneuron axon terminate at the motor endplate of each muscle fiber. The motoneuron and all of the fibers it innervates is termed a motor unit. After a stimulus propagates through the α fiber, all of the muscle fibers of that motor unit contract. For this reason, the motor unit is deemed the biological unit of muscular function (Podolsky, 1971). The number of muscle fibers per motor unit varies greatly from muscle to muscle. The extraocular muscles, requiring great control, have as few as six fibers per unit, but the large muscles of the leg may have several thousand (Perry and Bekey, 1981).

The muscle fibers of a motor unit are not all clumped into one group, but rather the fibers of different units are interlaced. Especially in large human muscles, a certain functional subdivision of the muscle exists through the grouping of motor units (Light, 1971). Often, the organization of the central nervous system permits maximal activation of one group of motor units only, without any overflow of excitation to other motor unit groups in the same muscle.

In theory, a normal muscle at rest will have no potentials, although this is difficult to see experimentally due to spontaneous excitation, cross-talk from other muscles, and noise. With progressively increasing activity, one motor unit will become active and produce single, discrete, repetitive potentials at the frequency of discharge of the corresponding anterior horn cell (spinal cord). On further exertion, this frequency will increase, and a second motor unit will come into action at a frequency unrelated to the first. As volitional contraction increases, more and more units come into action, each at its own frequency. This results in potential overlapping, and some potentials summate and others cancel, producing a resultant interference pattern characteristic of full voluntary contraction (Basmajian, 1978). It is for this reason that surface electrodes are said to record summated electrical activity; they are seeing the potentials of many different fibers and motor units.

All motor units do not appear to produce similar potentials. The first units to be recruited seem to give rise to relatively low potentials. Subsequent units then appear to contribute progressively larger potentials (Light, 1971). This may be explained by assuming that motor units with a small muscle fiber component are introduced when precision without strength is required and large units interact when more strength is needed.

Muscles of higher-order mammals (including humans) consist of muscle fibers which vary widely in their physiological, morphological, and biochemical properties (Basmajian and DeLuca, 1985). Within any one animal, different muscles contain varying amounts of the different fiber types. There are two typical categories of muscle type: red and white; slow and fast, respectively. Numerous investigators have shown that when the motoneuron of a motor unit consisting of red fibers is stimulated, the resulting force twitch is slower rising and longer lasting than the force twitch of a motor unit consisting of white fibers. Engel (1964, 1974) proposed that the fiber types be distinguished by their myosin ATPase affinity, an indicator of the fiber's contractile speed. Histochemical testing led to categorization by enzyme types and amounts. Specific enzymes of the glycogenolytic and glycolytic pathways are an indication of the fiber's capacity to perform work in the absence of oxygen (anaerobic activity). Oxidative enzymes offer information concerning the ability of the contractile mechanism to use oxygen as its fuel (aerobic activity). It is of significance that a highly aerobic capacity indicates that a muscle fiber is resistant to fatigue as long as oxygen can be supplied by its vascularization.

To best understand the physiology of a contracting skeletal muscle, it is necessary to gain insight into the microscopic anatomy of the muscle. Skeletal muscle has a very hierarchical structure. Each muscle is divided into fascicles, or discrete bundles of individual muscle fibers, segregated from the rest of the muscle by a connective tissue sheath. Each muscle fiber, an elongated multinucleated cell, is then made up of hundreds of myofibrils. Myofibrils or fibrils are complex organelles composed of bundles of myofilaments. It is the myofibril that gives skeletal muscle its banded (striated) appearance. Myofibrils occupy most of the muscle cell volume. They are segmented into units termed "sarcomere". The sarcomere is the contractile unit of the organ. It is composed of myofilaments made up of contractile proteins. The myofilaments are of two types, thick and thin. The thick filaments contain bundled myosin molecules; the thin filaments contain actin molecules, plus other proteins (Podolsky, 1971).

The molecular composition of the myofilaments may also be useful to know. Each myosin molecule has a distinct structure; it has a rod-like tail, or axis, terminating in two globular heads, sometimes called cross bridges. Each thick filament within a sarcomere contains about 200 myosin molecules bundled in such a way that their tails form the center of the filament with their heads outward and in opposite directions at each end.

The heads of the myosin molecules contain ATPases that have the ability to hydrolyze ATP. The thin filaments are chiefly composed of actin. The polypeptide subunits of actin are called G actin (globular). These are polymerized into long linear strands called F actin (fibrous) (Marieb, 1989). The backbone of the thin filament is two strands of actin twisted around each other forming a helical structure. A rod-shaped protein, tropomyosin, accompanies the F actin as it twists. The other main protein of the thin filament is troponin, a complex of three polypeptides. One of these polypeptides binds to actin; another binds to tropomyosin; the third binds calcium ions.

Other structures important to the contraction of skeletal muscle would include the sarcoplasmic reticulum (SR), and the T-tubules. The SR inside each muscle cell is an elaborate form of smooth endoplasmic reticulum (Martini, 1989). The SR surrounds the individual fibrils, and is intricately weaved among them. The T-tubules, continuous with the extracellular space, protrude deep into the cell. The role of the SR is to regulate the intracellular levels of ionic calcium: "It sequesters calcium and releases it 'on demand' when the muscle fiber is stimulated to contract" (Marieb, 1989 p. 248). Since the T-tubules are literally a continuation of the sarcolemma, which receives the nerve stimulus, they can conduct the stimulus deep into the cell to virtually every sarcomere. Additionally, the T-tubules provide inlets through which extracellular fluid can be brought into close contact with deeper parts of the muscle cell. This could be critical to the concept of muscular fatigue, since it is the extracellular fluid that contains glucose, oxygen, and various other ions, and flushes the cells of waste products.

The mechanism of contraction is thought to be fairly well understood. Neural stimulation from the central nervous system via motoneurons causes action potentials in the muscle fibers. These in turn initiate a chain of biochemical events resulting in the energy required for muscular contraction (Kuroda et al., 1970). Contraction reflects the activity of individual sarcomeres. When a muscle cell contracts, its sarcomeres shorten. As the lengths of their sarcomeres decrease, the myofibrils shorten as well, resulting in shortening of the cell as a whole. According to the sliding filament theory, first proposed by Hugh Huxely in 1954, the contraction mechanism involves the sliding of the thin filaments past the thick ones so that the extent of myofilament overlap increases (Marieb, 1989). In the resting muscle, the myofilaments overlap only slightly, but, during contraction, the amount of overlap is considerably greater.

When muscle fibers are stimulated by the nervous system, the cross bridges attach to active sites on the actin subunits on the thin filaments. Each cross bridge attaches and detaches several times during a contraction, acting like a ratchet to generate tension and pull the thin filaments toward the center of the sarcomere. Since this event occurs simultaneously in sarcomeres throughout the cell, the muscle fiber shortens. The contraction process requires calcium ions. The muscle action potential leading to the contraction causes an increase in calcium ions within the cell. It appears that in the absence of calcium the myosin-binding sites on actin are physically blocked by tropomyosin molecules, and the muscle cell is relaxed (Grover and Daniel, 1985). When calcium ions become available, they bond to troponin, and the calcium-troponin complex undergoes a change in its conformation. This change physically moves tropomyosin into the center of the helical groove, uncovering the myosin-binding sites.

Once the binding-sites are exposed, filament sliding occurs in the follows steps: (1) cross bridge attachment, (2) power stroke, (3) cross bridge detachment, and (4) "cocking" of the myosin head (Marieb, 1989). It is during the power stroke that the myosin head changes from its high-energy configuration to its bent, low-energy shape. This causes the head to pull on the thin filament to which it is bound. Simultaneously, ADP and inorganic phosphate (P_i) generated during the prior contraction cycle are released from the myosin head. The cross bridge is released when a new ATP molecule binds to the myosin head. To this point in the cycle no energy has been required; however, to "cock" the myosin head back to its high-energy state for the next attachment-power stroke sequence, energy is required. This energy is provided by the hydrolysis of ATP to ADP and P_i by ATPase (Grover and Daniel, 1985). The cycle is now back to the first step where the cross bridge is ready to attach to the next open site. Sliding continues as long as the calcium signal is present. Removal of calcium ions from the sarcoplasm by the SR, restores the tropomyosin blockades, contraction ends, and the muscle relaxes.

The regulation of muscular contraction, however, is somewhat controversial. In the laboratory, a muscle twitch (response of a muscle to a single brief threshold stimulus) is simple to produce and study (in-vitro). However, in-vivo, muscle contractions do not appear as twitches. They are long and smooth, varying in strength as different demands are placed on them. Variations in the degree of muscle contraction are referred to as graded responses. In general, there are two theories offered to explain how muscle contraction can be graded: (1) by increasing the rapidity of stimulation to produce wave summation, and (2) by recruitment of larger and larger numbers of motor units to produce multiple motor unit summation (Clarke, 1966).

It has been shown that ATP provides the energy for contraction and the calcium pumps. As long as ATP synthesis is as great as ATP use, muscles can continue to respond to low-frequency stimuli for long periods of time. Surprisingly, muscles store very limited reserves of ATP. When contraction begins, ATP reserves are quickly exhausted, and ATP must be generated continuously for contraction to continue. There are three pathways by which ATP is regenerated during muscular contraction: (1) by interaction of ADP with creatine phosphate, (2) by aerobic respiration, and (3) by anaerobic respiration (Davson, 1959). This could be important in the physiology of muscular fatigue. As long as it gets enough oxygen and glucose, a muscle cell will form ATP by aerobic reactions. But when the circulatory system begins to fall behind in oxygen and glucose delivery, and the aerobic pathways can not function fast enough to keep pace with muscle demands, most of the pyruvic acid produced during glycosis is converted to lactic acid. Thus, during oxygen deficit, lactic acid, rather than carbon dioxide and water, is the end product of cellular respiration.

Definition of Muscular Fatigue

As could be expected, the definition of muscular fatigue varies among different disciplines. Health specialist and life scientists accept the concept of fatigue as being demonstrated or represented by an event occurring at an identifiable period of time (Deluca, 1981). On the other hand, engineers and physical scientists consider the concept of fatigue as a time-dependent process. Deluca (p. 251) offers the example of a steel girder that supports the main structure of a bridge. "It may well remain in place with no apparent, externally visible structural modification for many tens of years; then suddenly, in one instant a fracture develops, the girder fails and the bridge collapses. If one, observing from a distance, were to look at the bridge for signs of fatigue, none would be noted, until a point in time termed the failure point. All the while, however, the crystalline structure of the steel girder was continuously undergoing transformation caused by physical and chemical processes". To properly monitor the progression of fatigue, it would be necessary to examine samples from within the girder or to examine some external measure representative of the internal properties.

An analogy in terms of muscular fatigue in the human body would be maintaining a muscular contraction constant for as long as possible (isometric fatigue). Throughout the task, the involved muscles are continuously fatiguing, but at some instant in time the failure point will occur when the desired force output can no longer be maintained and contractile fatigue becomes observable (DeLuca, 1981).

The definition of human muscular fatigue also varies considerably among researchers and clinicians. Fatigue is usually defined as a decrease (reversible during rest) in the force developed during contraction, while the level of excitation remains constant (Boulange et al., 1979). Stephens and Taylor (1972) simply define fatigue as the failure to maintain force. Another investigator, studying the fatigue mechanisms in isolated intact fibers of frog and mouse, defines fatigue as any decline in force output during prolonged stimulation (Marconnet et al., 1992). More generally, fatigue has been defined as a transient decrease in the capacity to perform work due to prior physical activity (Sahlin, 1990).

Mechanisms of Muscular Fatigue

Many factors change during muscular fatigue; these range from a loss of force-generating capacity to biochemical changes such as a decline in the concentrations of creatine phosphate and adensine triphosphate (ATP) and an increase in the concentrations of inorganic phosphate and protons. When ATP production fails to keep up with ATP use, (metabolic) muscle fatigue sets in and muscle activity ceases, even though the muscle may still be receiving stimuli. Muscle fatigue is the state of physiological inability to contract due to various metabolic changes. It is important to note that this is a phenomenon of each individual muscle fiber; and not all fibers in a particular muscle fatigue at the same rate. The fatigue point (where the output force level can not be maintained) is seen as a late result of the majority of the fibers of a muscle fatiguing simultaneously, and the remaining contractile units are unable to produce the desired force.

Muscle fatigue results from a relative deficit of ATP, not its total absence (Marieb, 1989). When no ATP is available, contractures, or states of continuous contraction, result because of the inability of the cross bridges to detach. A familiar example of temporary contractures is "writer's cramp". Other factors contributing to muscle fatigue include excessive accumulation of lactic acid and ion imbalances. Lactic acid, which causes a decrease in the muscle pH, causes extreme fatigue, and limits the usefulness of the anaerobic mechanism for ATP production. It is also this drop in pH that causes the muscle to ache. The Ca^{2+} release rate is strongly dependent on pH (Herrmann-Frank and Meissner, 1990). It has been demonstrated that in intact skinned skeletal muscle fiber preparations, acidosis depresses maximum tension and ATPase activity.

As long as ATP is available to supply energy to the Na^+-K^+ pump, any slight ionic imbalances are readily corrected. However, in the absence of ATP, the pump is inactive, and severe ionic imbalances cause the cell to become unresponsive to stimulation. This is because the propagation and maintainance of the muscle action potential is a direct function of the transmembral movement of intracellular and extracellular ions; specifically, K^+, Na^+, Cl^-, and others. Davies (1990) states that an accumulation of extracellular K^+, which accompanies exercise, is solely a consequence of increased K^+ efflux from the muscle cell. Furthermore, during intensive activity the conductance properties of individual muscle fibers change, with the most noticeable effect being an increase in the resting K^+ conductance. It is hypothesized that there is a mechanism by which the increase in K^+ conductance is linked to the fall in intracellular pH.

Another team of investigators (Stulen and DeLuca, 1982) point out that the decrease in conduction velocity, correlated to fatigue (Lindström, 1977), has been attributed to the accumulation of metabolic by-products such as lactic acid. They note that the accumulation could be due to an increase in production and/or a decrease in removal due to diminished blood flow during a forceful contraction.

The recovery from muscular fatigue is dependent on several factors. The time course of force recovery depends on the type of fatiguing exercise, muscle fiber type, composition of extracellular fluid, and temperature (Marconnet et al., 1990). It has been shown that the majority of recovery is due to: (1) the removal of metabolic byproducts and wastes (i.e., lactic acid), and (2) the replenishment of oxygen and other nutrients to the muscle cells. These functions primarily occur when the flow of blood is restored to the muscle via relaxation.

Use of EMG to Evaluate Muscular Fatigue

The use of EMG to evaluate and describe muscle fatigue has long been a focus of research. Although there is a tremendous amount of information contained in the normal ME signal, there have been a limited number of ways in which researchers have chosen to look at the signal; EMG amplitude, the integrated EMG, and EMG frequency analysis. The RMS (Root-Mean-Square) of the ME signal is the primary method used to investigate EMG amplitude. The RMS is usually a fairy simple parameter to acquire. As is implied, the signal is squared, making all values positive since the average of the raw EMG signal is zero, then the arithmetic mean is found, and the square root of the mean is then taken. The final value is the average voltage of the absolute, or rectified signal (Equation 1).

$$RMS\{m(t)\}=\left(\frac{1}{T}\int_{t}^{t+T} m^{2}(t)dt\right)^{1/2} \qquad [1]$$

where: m is the voltage of the ME signal
T is the total integration time

The most commonly used, and abused, data reduction procedure in electromyography is the concept of integration (Basmajian and DeLuca, 1985). One of the earliest uses of this parameter was by Inman et al. (1952), in which the term was erroneously applied. Their procedure used a linear envelope detector to follow the envelope of the ME signal as the force output of the muscle was varied. The term "integration" has a defined meaning expressed in a mathematical sense when applied to the processing of a signal. It applies to the calculation that obtains the area under the signal. It is apparent that a signal such as an EMG which has an average value of zero, will also have a total area of zero. Therefore, the concept of integration must be applied to the rectified value of the EMG. The operation is expressed as:

$$I\{|m(t)|\}=\int_0^t |m(t)|\,dt \qquad [2]$$

It is important to note that the only difference between the integrated rectified value and the average rectified value (RMS) is that in the latter case the value is divided by the time over which the average is calculated. It follows, then, that no additional information is contained in the integrated rectified value. Basmajian and DeLuca (1985) state that they suspect that two principle reasons account for the wide spread use of this operation: (1) historical precedent, and (2) that the integrated rectified value will provide a smooth measure of the signal as a function of time, if a significantly long integration time is chosen.

EMG frequency analysis typically involves the use of the power density spectrum (PDS) of the ME signal. Spectral analysis is becoming an increasingly important tool for the study of EMG signals. Early work in this field was based on the use of octave band filters. Fast Fourier transform (FFT) methods for power spectral analysis are being used increasingly to avoid the restrictions of octave band filters to a small number of frequency bands (Perry and Bekey, 1981).

Three parameters of the PDS may be conveniently used to provide useful measures of the spectrum. They are: the median frequency (Equation 3), the mean frequency (Equation 4), and the bandwidth of the spectrum. Other parameters such as the mode frequency and ratio of segments of the PDS have been used by some researchers but are not considered reliable due to the inevitable noisy nature of the spectrum (Basmajian and DeLuca, 1985).

$$\int_0^{f_{med}} S_m(f)df = \int_{f_{med}}^{\infty} S_m(f)df \qquad [3]$$

$$f_{mean} = \frac{\int_0^{\infty} f S_m(f)df}{\int_0^{\infty} S_m(f)df} \qquad [4]$$

where : $S_m(f)$ is the PDS of the ME signal

Past Studies

The majority of the research performed to date using EMG parameters to study muscle fatigue has been isolated to the study of fatigue due to a maintained isometric contraction. These studies have concentrated on the changes over time of the EMG parameters of interest as a subject applies, and holds, a given force against an external resistance as long as possible. Several investigators have focused on the correlation between the amount of force produced by the muscle under study and these EMG parameters, while others have looked at shifts in these parameters for varying percentages of the subject's maximum voluntary contraction (%MVC). Studies have also investigated the dependency of the muscle group under study, the effects of muscle temperature, as well as the composition of fiber type.

A study of fatigue of the first dorsal interosseous muscle of the hand under maintained maximal voluntary contraction (100% MVC) by Stephens and Taylor (1972), stated that fatigue occurs in two phases. During the first, force falls to about 50%. The smoothed rectified EMG (SRE) falls with the same time course, and the normal linear relation between it and the force of unfatigued muscle is preserved. In the second phase, force falls relatively faster than the SRE. Their data showed that, in maximal contractions, force starts to fall within a few seconds, reaching 50% MVC in one minute and 25% MVC in 2 minutes. They also state that in submaximal efforts (< 100% MVC) the force could be maintained at a constant level for a longer period of time, but then fell in the same fashion.

Much of the research in the area of muscle fatigue has presented similar conclusions in reference to EMG parameters. Two of the more prominent results, for a variety of fatigue studies, are a relative increase in EMG amplitude, whether measured by RMS or any other data reduction method, and the relative shift of the PDS to lower frequencies (Viitasalo and Komi, 1977; Komi and Viitasalo, 1976; Petrofsky et al., 1975; Bigland-Ritchie et al., 1981). Bigland-Ritchie et al. (1981) report that as the contraction progresses, the action potentials recorded intramuscularly from a small sample of motor units become grouped. Such synchronization of motor neuron firing results in large, low frequency EMG oscillations and must increase the relative power in the low frequency bands of the PDS. It follows, that since the power of the EMG is a multiple of its amplitude, this also serves as an explanation for the rise in EMG amplitude over the time of contraction. Synchronization of the activities of the motor units has been one of the most favored explanations of these phenomena (Bigland-Ritchie et al., 1981; Deluca, 1981; Kuroda et al, 1970; Basmajian and Deluca, 1985).

It has been shown that the spectral changes of the ME signal produced by forceful contractions are due mainly to a decrease in the action potential conduction velocity (Viitasalo and Komi, 1977; Lindström et al., 1977). This velocity change has been attributed to alterations in the energy metabolism of the muscle. Since the intracellular and extracellular ion concentrations have been shown to change with fatigue, it is reasonable to assume that conduction velocity would consequently be affected. The drop in pH and deficit of ATP would presumably also lead to a decrease in conduction velocity.

Petrofsky et al. (1975) found that in an investigation of the extrinsic flexor muscles, the median frequency decreased linearly with time throughout the duration of a fatiguing isometric contraction. This linear relation has also been substantiated by several other investigators (Kwatny et al., 1970; Viitasalo and Komi, 1977; Petrofsky et al., 1975). Kuroda et al. (1970) have demonstrated that EMG activity increases almost linearly with the force output in the submaximal force range but increases more sharply near the maximal force (100% MVC).

Viitasalo and Komi (1977) studied maintained isometric knee extension at 60% MVC by analyzing the EMG activity of the medial rectus femoris muscle. Their results showed that the PDS was easily affected by fatigue such that the total power density curve was shifted towards lower frequencies with a higher frequency decay. They also reported a slight, but continuous, rise of the integrated EMG during the fatigue period. More importantly, they showed that the changes in these parameters varied from the upper portion to the lower portion of the muscle. This supports the notion that muscles are not homogeneous in their structure.

From animal experiments, it is known that muscles composed of slow twitch (ST) fibers possess a greater resistance to fatigue than muscles containing predominantly fast twitch (FT) fibers (Edström and Kugelberg, 1968; Baldwin and Tipton, 1972). Komi and Tesch (1979) have correlated the rise in amplitude and frequency shift during isometric contraction with the fiber type composition of the muscle. Their results show a mean power frequency decrease ($p < 0.01$) in individuals with a high percentage of slow twitch fibers, while those individuals with a high percentage of fast twitch fibers demonstrated only a slight decrease (non-significant). Data also showed an integrated EMG (IEMG) decline ($p < 0.01$) during 100 contractions in those subjects rich in fast twitch fibers, but only a slight reduction in IEMG in those with a high percentage of slow twitch fibers. It should be noted that this study involved dynamic contractions (repeated knee extensions) of the vastus lateralis muscle. If these observations are substantiated, the technique could provide a noninvasive alternative to muscle biopsy.

Surprisingly, in an experiment studying fatigue and EMG of repeated fast voluntary contractions of the quadriceps muscle, it was found that the RMS decreases with the number of contractions (Nilsson et al., 1977). A study of the EMG pattern of dynamic diaphragmatic fatigue resulted in the anticipated increase in EMG amplitude (Gross et al., 1979). The authors of the first study offered no explanation or theory for the deviation of their results.

The concept of heat production during muscle activity has also been investigated. If muscle contracted with 100% efficiency, no heat would be produced and all of the energy provided by ATP would be used in the mechanical sliding of the filaments. But, only 20% to 25% of the energy is actually converted into useful work (Marieb, 1989), with the rest given off as heat. An investigator tracking frequency and amplitude parameters during exercise on a bicycle ergonometer reports the same general trends in EMG amplitude and frequency, but not to the same extent (Petrofsky, 1979). It was noted that exercise of this "dynamic" type may produce more internal heat at the muscle. Therefore, although muscular fatigue caused an increase in RMS and decrease in the center frequency, the increase in muscle temperature associated with the work opposed these changes by causing a reduction in RMS and an increase in the center frequency.

It is interesting to note that in the majority of past research male subjects were used, with no references to possible gender differences. It seems that although the understanding of male and female muscle is the same, there might be variations in the amounts and ratios of metabolites, fiber types, and other factors influencing contraction and fatigue. It is known that, in other areas of physiology, there are distinct differences in hormonal and biochemical concentrations and their effects across the genders.

Applications of Quantitative Measures of Fatigue

Monitoring of the ME signal for the purpose of measuring muscle fatigue has several advantages: it is non-invasive; it may by performed on muscle *in situ*; it may be performed in real-time; and it provides information relating to events which occur inside the muscle. In addition, Lindström et al. (1977) have shown that the changes in the observed EMG parameters are directly related to increased subject sensation of perceived exertion during sustained muscle contraction performed at moderate levels. Many applications of this approach of measuring muscle fatigue are envisioned; some are only concepts and require experimental verification, whereas others have already been put into practice. Some of these applications include athletic training, physical therapy, industrial applications (ergonomics), and the diagnosis and prognosis of neuromuscular disorders.

The effects of athletic training and exercise on muscle fiber metabolism and architecture have been an issue of considerable discussion (DeLuca, 1981). Numerous studies have been reported with a variety of conflicting results. For a review of these details refer to Salmons and Henriksson (1981). As discussed previously in this chapter, these modifications within the muscle are theoretically accompanied by corresponding, observable changes in the parameters of the ME signal.

In rehabilitation programs involving muscle re-education and exercise, it is often necessary to assess the effectiveness of a prescribed physical therapy program. Manual muscle tests are currently the primary procedure for determining muscular strength and the progression or regression of strength. It has been noted that these tests are subjective and their accuracy depends on the training, skill and experience of the clinician performing the examination. During a physical therapy session, it is foreseeable that it may be possible to assess the response of the impaired muscle to treatment by measuring the changes in EMG parameters.

The use of ME signal analysis, specifically the phenomenon of frequency shift, as an indicator of muscle fatigue has been applied in the field of ergonomics (Broman et al., 1973; Schoenmarklin and Marras, 1989; Kroemer, 1986; Gomer et al., 1987). Studies have concluded that changes in the ME signal power density spectrum are useful for measuring the progression of fatigue as a function of limb position, orientation, and direction of motion (Adams, 1988; Asfour and Tritar, 1991; Fransson and Winkle, 1991; Kroemer, 1986). In fact, several of these investigators suggest preferred positions to minimize the "sensation" of fatigue. The technique may conceivably be used to distinguish between psychological fatigue derived from boredom and physiological fatigue derived from sustained effort in a work station.

Schoenmarklin and Marras (1989) state that muscle fatigue in the extrinsic muscles of the forearm is an important dependent measure because it is an indicator of the status of the internal components of the wrist and forearm. The study of muscle fatigue could facilitate an understanding of cumulative trauma disorders (CTDs) in the wrist, such as carpal tunnel syndrome (CTS) and tenosynovitis, in the substitutional patterns of muscular fatigue. It has also been suggested that the ability to predict hand grip forces is important in investigating occupational hand and wrist injuries (Li et al., 1989). And, as presented in an earlier section, EMG is proving to be a potentially sound procedure for this task. For specifics of CTD and CTS refer to Moore et al. (1991), Armstrong et al. (1986), and Konz and Mital (1990).

Present Study

It is evident that the use of EMG parameters in the previously discussed applications and in research holds a myriad of possibilities and potentials. The processes of muscular fatigue are numerous, and apparently complex, requiring a host of techniques for their study and analysis. Until the early 1980s, little work had been done using EMG frequency shifts. The frequency shift, as well as the shift in RMS, are prime candidates for the study and analysis of muscle fatigue, due to their non-invasive nature and direct (and non-direct) relationship to physiological, anatomical, and biochemical events and modifications within the muscle (Deluca, 1981). For this reason, among others, the present study will analyze muscular fatigue using the ME parameters of RMS and mean power frequency (MPF). Based on the research of Stulen and DeLuca (1982), the power density spectrum width will also be monitored via a high to low frequency ratio and difference.

The goal of the present study is to evaluate and analyze muscular fatigue in the digital flexor group of the right forearm under two conditions; sustained constant isometric contraction, and pulsed isometric contraction. The results of previous studies have shown specific trends in EMG parameters for various muscle groups, but it is evident that these trends are not stable from group to group. Little work has been published to date involving the digital flexors, and it is felt that this could be one of the more important muscle groups to understand, because of the strong implications it has for ergonomics and cumulative trauma disorders. The purposes behind the two phases of this study are that; a) it is necessary to substantiate past sustained isometric research for this particular muscle group, and b) no work has been published looking at pulsed isometric contractions. It would seem that although past results (nearly exclusively sustained isometric) have strong implications in the work place, tasks are not typically sustained until failure. Rather, tasks are dynamic, mixed with short intervals of isometric contraction. The hypothesis that the fatiguing parameters of the two contraction types may differ is based on the possible influences of the recovery mechanisms discussed earlier.

MATERIALS AND METHODS

The intent of this study was to induce voluntary muscular fatigue in the digital flexor muscle group and to acquire and analyze several myoelectric parameters. The experimental procedures were designed to offer the best approximation of true life, exercise or work induced fatigue for this muscle group, and so provide valid parallels to occupational hazards. Muscular fatigue was reached by the gripping and squeezing of a hand held dynamometer which also documented force output. EMG activity was acquired from surface electrodes places over the inner forearm. The signal was amplified and sent to a data acquisition system and a subject feedback display. Following acquisition, the EMG data and force data were reduced via computer algorithms. Great care was taken to guarantee subject safety and to ensure that there was no aliasing or other detriments to the acquired signals.

Subjects

The subject pool consisted of eight volunteers ranging in age from 24 to 29 years; four female and four male. The use of human subjects was approved by the University Human Subjects Review Committee (Appendix A). Subjects received no incentive and participated with complete knowledge of the study. Subjects were all of good health and showed no signs of difficulty, such as premature or severe cramping, intolerable pain, or inability to function. Subject 04 was unable to complete the pulsed isometric portion of the study due to an injury unrelated to the experiment; therefore, the data for that portion was exempted. Individual subject demographics are presented in Table 1. Muscle type and composition were unknown, but it was assumed that the subject pool, pseudo-randomly selected, was representative of a larger group.

Table 1. Subject Data

Subject	**S01**	**S02**	**S03**	**S04**	**S05**	**S06**	**S07**	**S08**
Sex	F	M	M	F	M	M	F	F
Age	23	25	23	22	28	24	28	23
Weight	135	190	210	130	250	195	120	110
Exercise	1	1	2ab	2ab	3a	3ab	2a	1
MVC Day 1	24	40	57	31	83	41	31	25
Day 2	26	40	55	31	76	53	32	25

Exercise: 1 = Average activity, 2 = Weekly, 3 = Daily
a = weight lifting, b = aerobic

Equipment

Refer to Figure 4 for a bock diagram of the equipment setup, Figure 5 for a representation of the lab setup, and Figure 6 for a flow chart of the signal reduction processes.

Dynamometer

The fatiguing exercise and force output signal was obtained by a model 76618 hand held dynamometer (Lafayette Instrument Co.). The device provided external resistance to the digital flexors by the compression of a spring. The unit had a force output dial which related the amount of spring compression to the amount of force producing that compression. It also provided an enclosed potentiometer (pot) that was positioned to rotate with the linear displacement of the spring. By passing a dc current through the pot, a voltage representative of the force was available. The unit was received with a pot installed; this was replaced by an extremely high quality, beringed, 10k ohm potentiometer which offered better low end sensitivity and negligible resistance to rotation. Voltage was supplied to the dynamometer via an Archer® AC Adapter step-down wall transformer, with an output of approximately 3 volts dc at 200mA. A 2.5 volt reference diode (LM336) was installed in-line prior to the dynamometer's potentiometer to ensure a steady, reliable input voltage. The dynamometer output was experimentally calibrated, and there was a strong linear relationship between the apparent voltage and force. This relationship was represented by y=0.290 + 0.018x, with R^2=0.9974; Figure 2.

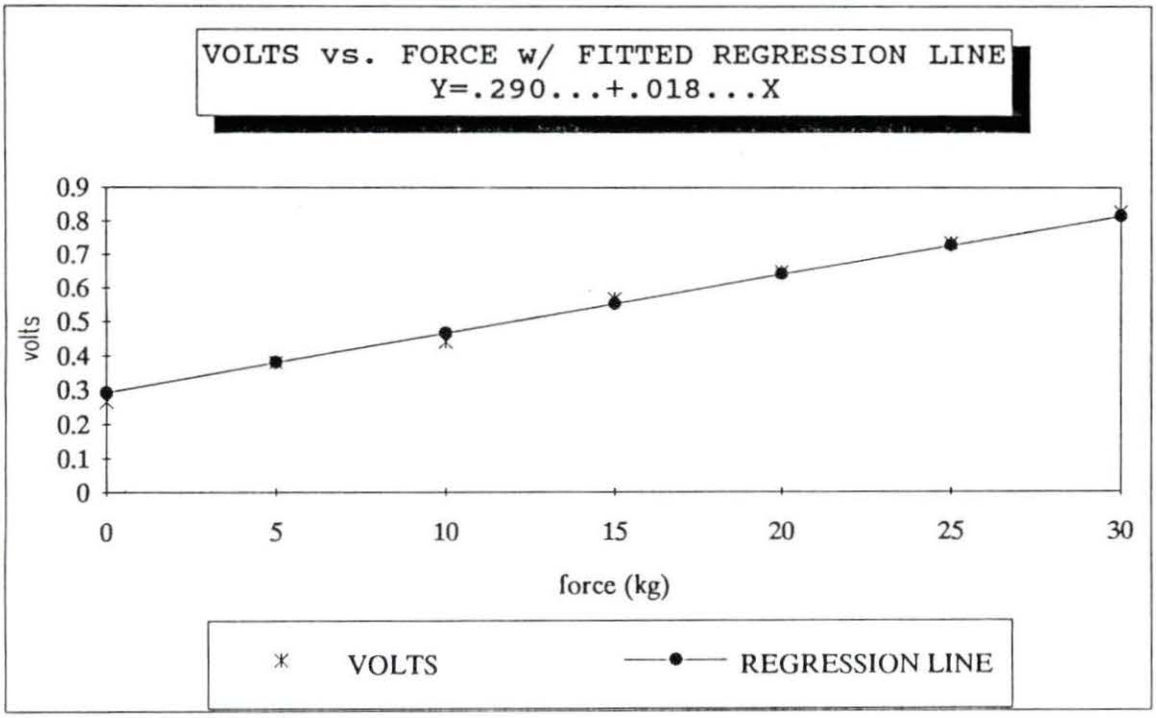


Figure 2. Calibration curve for the dynamometer

Digital Multimeter

Force output feedback for the subject came from a large display digital multimeter (Weston 11240) which displayed the dc voltage output of the dynamometer. Target voltages were calculated, and the subject concentrated on the multimeter display to produce the required force output.

Electrodes, Amplifier, and Shielding

The myoelectric signal was captured by a pair of Grass® 1cm, cup style, Ag-AgCl bipolar surface electrodes. The signal was then amplified through a homemade differential amplifier with bandpass filtering from 3 to 10,000 Hz. The amplifier was driven by two nine volt batteries and had an effective gain of 100x. A large 4 cm x 6 cm, Ag-AgCl surface electrode was used to ground the subject to the common ground pole of the amplifier. A wire cage enclosed the amplifier, all signal carrying leads, the electrodes, and the subject's lower arm. The cage, serving as shielding from 60 Hz noise and other electromagnetic interference, was then grounded to the amplifier. In addition, the table surface on which the amplifier rested was also grounded and connected to the common ground node (Figure 3d).

Contraction Pacer

A pacer/timer was built to tell the subject when to contract and when to relax during the pulsed isometric portion of the study. The pacer consisted of a LED display which counted from 1 to 10 seconds, an audible tone at ten seconds, and a "+" or "-" LED display depending on whether the subject was to be in a state of contraction or relaxation. Refer to circuit diagram in Appendix B.

Oscilloscopes

A Tektronix 5111A oscilloscope was used to display the EMG in real time. A second device, a Heath 4802 computer oscilloscope, was used to display, digitize, and record the force and EMG signals simultaneously. Operation the Heath scope was dependent on its software package. The program (Appendix C) was significantly altered for the purpose of this study. The majority of the changes occurred in the algorithms responsible for the storage of the displayed signals. The Heath scope and the computer had two-way communication via the RS-232 port.

Computer

The computer used to acquire, store, and manipulate the signal data was an IBM PC compatible (ACC Advanced Computer Systems). The computer was a 486DX running at 33 MHz which ensured adequate speed for acquisition, storage, and processing. All initial signal storage was to the hard disc drive to optimize speed.

Experimental Procedure

Subject Preparation

Prior to electrode attachment, both of the subject's inner forearms were shaved, scrubbed with a clean abrasive sponge, dried, and rubbed clean with 91% isopropyl alcohol. The electrode placement positions were located on the right forearm in accordance with the guidelines set forth by Zipp (1982) for surface EMG recording of the digital flexor muscle group. The positions were marked with a small dot of USDA blue meat dye applied to the skin with a cotton swab. Proper position was verified by palpation of the digital flexors as the subject contracted the muscle group (made a fist and squeezed).

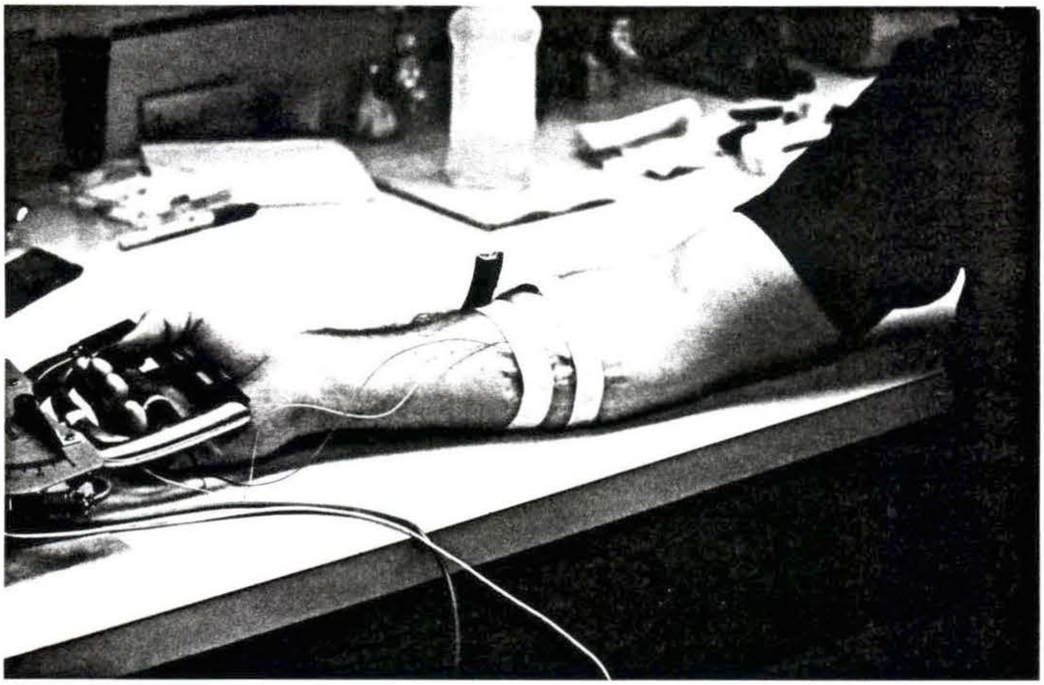
The electrodes were then secured to the subject directly over the dye marks. Good attachment and surface interface conditions were achieved by first applying Signa Gel® (Parker Laboratories, Inc.), a highly conductive electrolyte electrode gel, to the electrode, then placing it on the skin surface, and adding a small circular slice of cork over the top. A 2" x 2" piece of Transpore® medical tape (3M) was then used to hold the cork and electrode to the skin surface. Finally an elastic strap was placed over the assembly, stretched around the forearm and secured (Figures 3a, 3b). The ground electrode was attached in a similar fashion, approximately in the middle of the inner left forearm (Figure 3c). The electrode leads were then connected to the amplifier and electrode positioning and attachment were checked by subjective visual interpretation of the EMG displayed on the Tektronix oscilloscope.

The subject was then positioned for the experiment, seated with back straight and right arm resting on the lab bench. The arm was positioned palm up and bent slightly at the elbow. The left arm was relaxed with the left hand resting on the left knee.

Determine MVC and Target Level

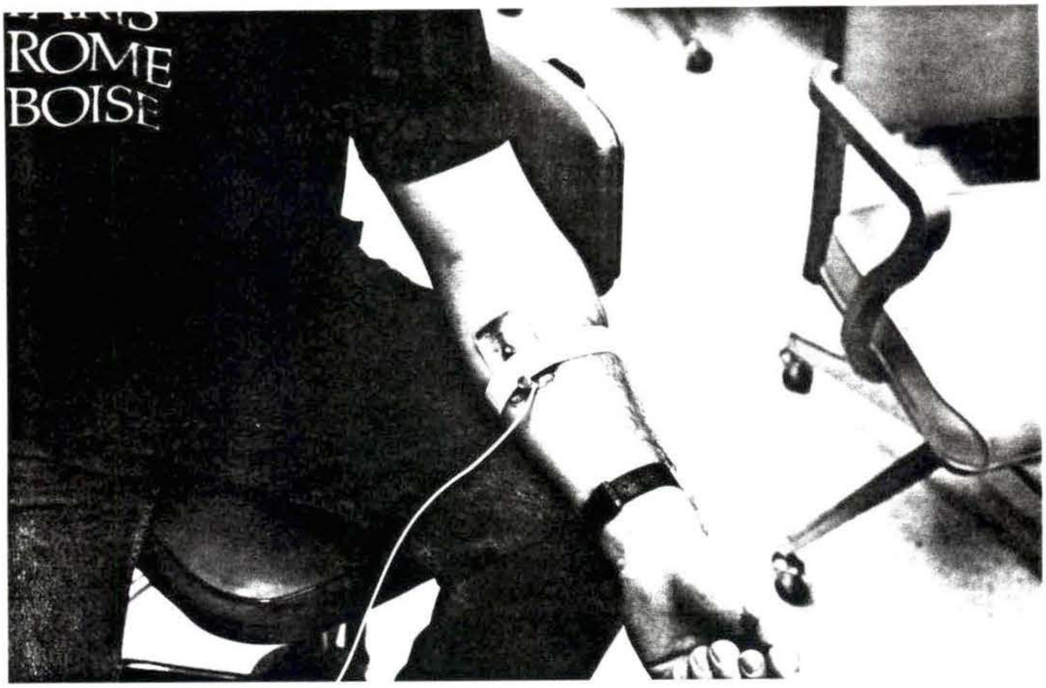
Prior to the EMG and force data acquisition, the subject's maximum voluntary contraction (MVC) level was obtained. This was done by having the subject grasp the dynamometer and squeeze it as strongly as possible. The voltage output of the contraction was then recorded from the digital multimeter. The subject's target level was then

(a)

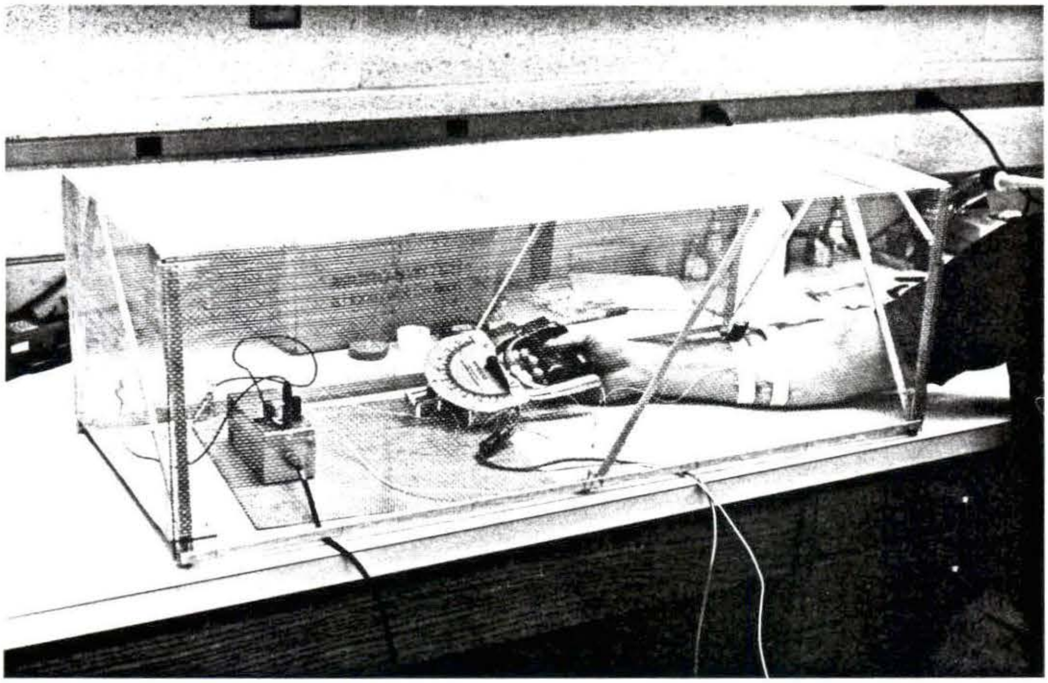


(b)

Figure 3. (a) Recording electrode positioning; interelectrode distance ~ 4cm (b) electrode attachment and limb position



(c)



(d)

Figure 3. (continued) (c) Ground electrode, (d) shielding

calculated as 30% of their MVC. The subject's MVC was attained independently prior to exercise on each day.

Isometric Exercise (Day 1)

The subject was instructed to grasp the dynamometer, but not to contract. At this time, a pre-fatigue resting EMG was recorded. Then, when ready, the subject squeezed the dynamometer to their predetermined target level and held at this level for as long as possible. The subject was given all instructions before the exercise began and was not coached or motivated during the exercise. The instructions given were simply a verbal explanation of the consent form that each subject had read and signed (Appendix A). Immediately following the exercise the subject again relaxed and a post-fatigue resting EMG was recorded.

The subjects initiated the contraction on their own; EMG and force recording began once force output reached the target level. Recordings were then taken every 10 seconds from 1 second until the subject absolutely could no longer hold the contraction. It should be noted that recording continued even as the subject's force output level fell below the target level, and each subject stopped contracting for a variety of reasons to be discussed in a later section.

Pulsed Isometric Exercise (Day 2)

Only the male subjects took part in the pulsed isometric portion of the study, while the females repeated the isometric (Day 1) routine for Day 2. This phase of the experiment was significantly more complex and demanding than the previous exercise.

The exercise again began with the recording of a pre-fatigue resting EMG. Then, when ready, the subjects squeezed the dynamometer up to the 30% (high) target level and held for ten seconds. At ten seconds the subjects then reduced their force output to a predetermined 10% (low) target level. The low level was also held for ten seconds and then the subjects contracted back up to the high level for another ten seconds. This cycle continued for as long as the subjects could attain the high level, but not necessarily maintain it for the entire ten second period. EMG and force recordings were taken only during the high level, at approximately 3 and 7 seconds. Again, immediately following the exercise a post-fatigue resting EMG was recorded.

Following this exercise bout, the subject relaxed for fifteen minutes with the electrodes remaining in place. During the rest period the subjects were allowed to loosen their hands and arms by shaking out or massaging any stiffness or cramps.

After the rest period, the subjects repeated the pulsed isometric exercise exactly as before, using the same target levels. The subjects completed a total of three pulsed isometric trials again with a resting period between the second and third. Following the third trial the electrodes were removed from the subjects.

Data Reduction

Data was recorded at a rate of 1024 samples per second with 512 points captured in each acquisition period. Four computer algorithms were written to reduce and organize the force and EMG signal data (Appendix C). The first routine reduced the force data by finding the arithmetic average for the sampled period (approximately 0.5 seconds). The next three programs reduced the EMG signal to the three parameters of interest; the root mean square (RMS), the mean power frequency (MPF), and the high/low frequency ratio.

The RMS was calculated by using equation 1. The MPF, perhaps more accurately described as the power weighted average frequency, was calculated by equation 4. The high/low frequency ratio, a measure of the EMG power density spectrum width, was calculated by locating the frequencies that corresponded to the power level P_s that was -3dB from the mean power (equations 5 & 6).

condition: $$\frac{P_s}{P_{av}} = 10^{(-3/20)} \qquad [5]$$

where: $$P_{av} = \frac{\Sigma P_s (df)_s}{\Sigma df_s} \qquad [6]$$

The algorithm then retained the first and last frequency that met these conditions and termed them the low and high frequencies, respectively.

DADISP®, a digital signal processing package, was used to graphically display the EMG signals and to derive the power density spectrum (PDS). Several command files (Appendix C) were written to bring the raw data into DADISP and output the PDS data to disc. DADISP was also used to calculate a 10 point moving average of the PDS; the smoothed PDS was used in the high/low frequency ratio algorithm.

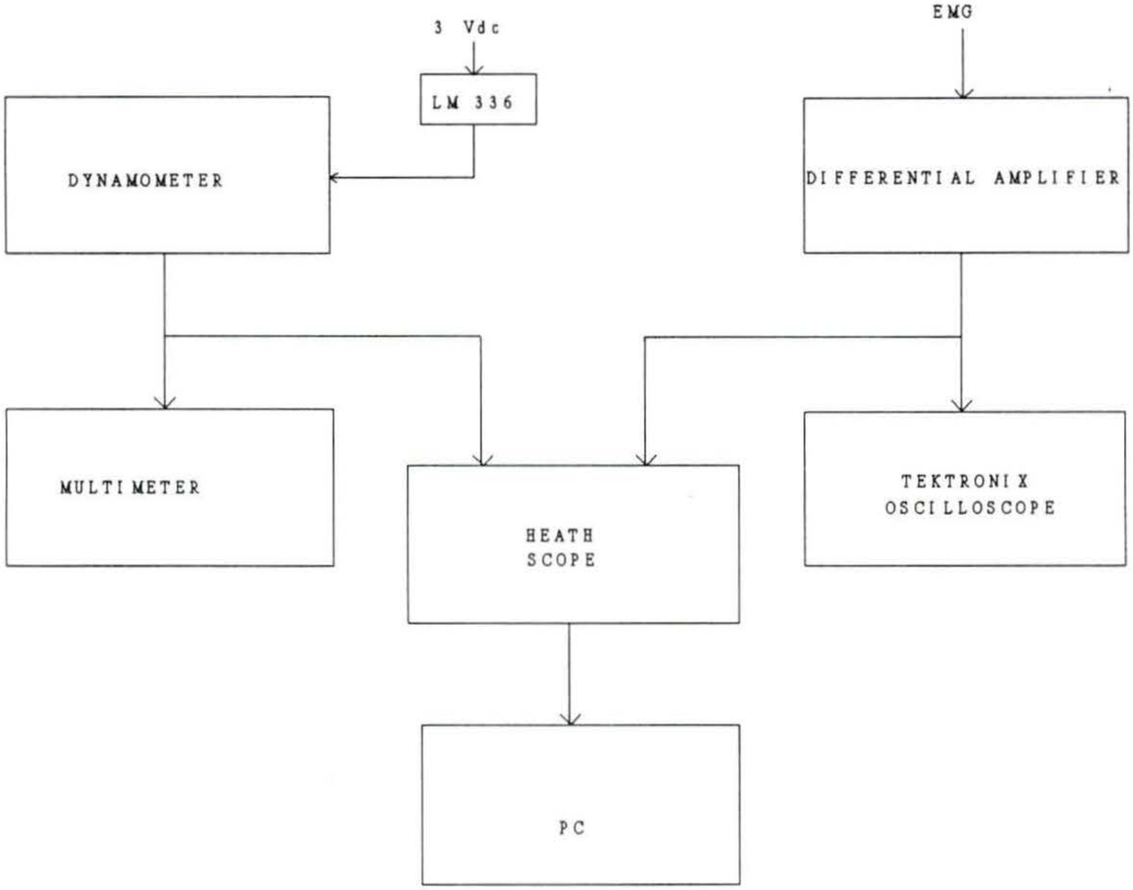


Figure 4. Block diagram of equipment set-up.

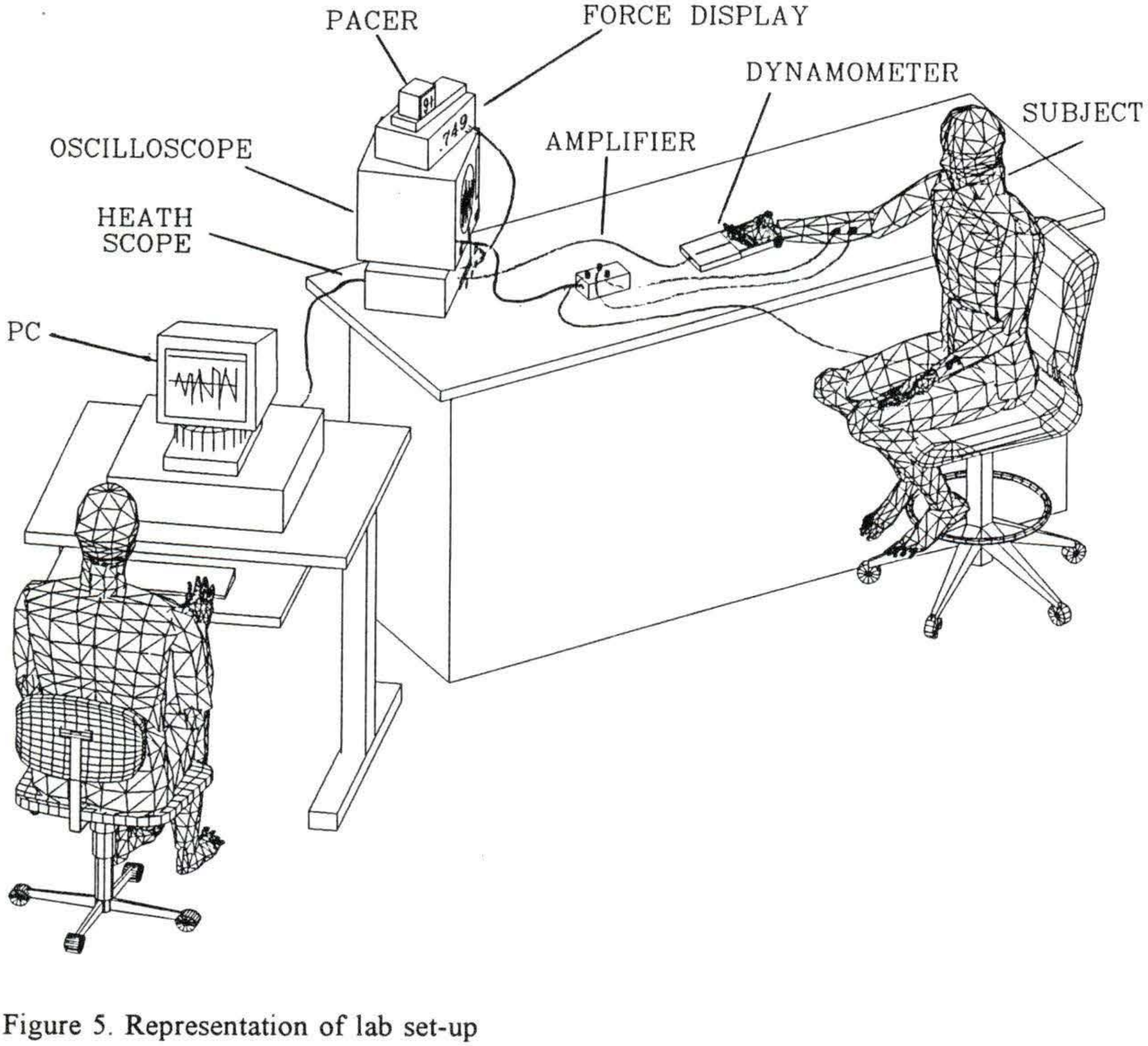


Figure 5. Representation of lab set-up

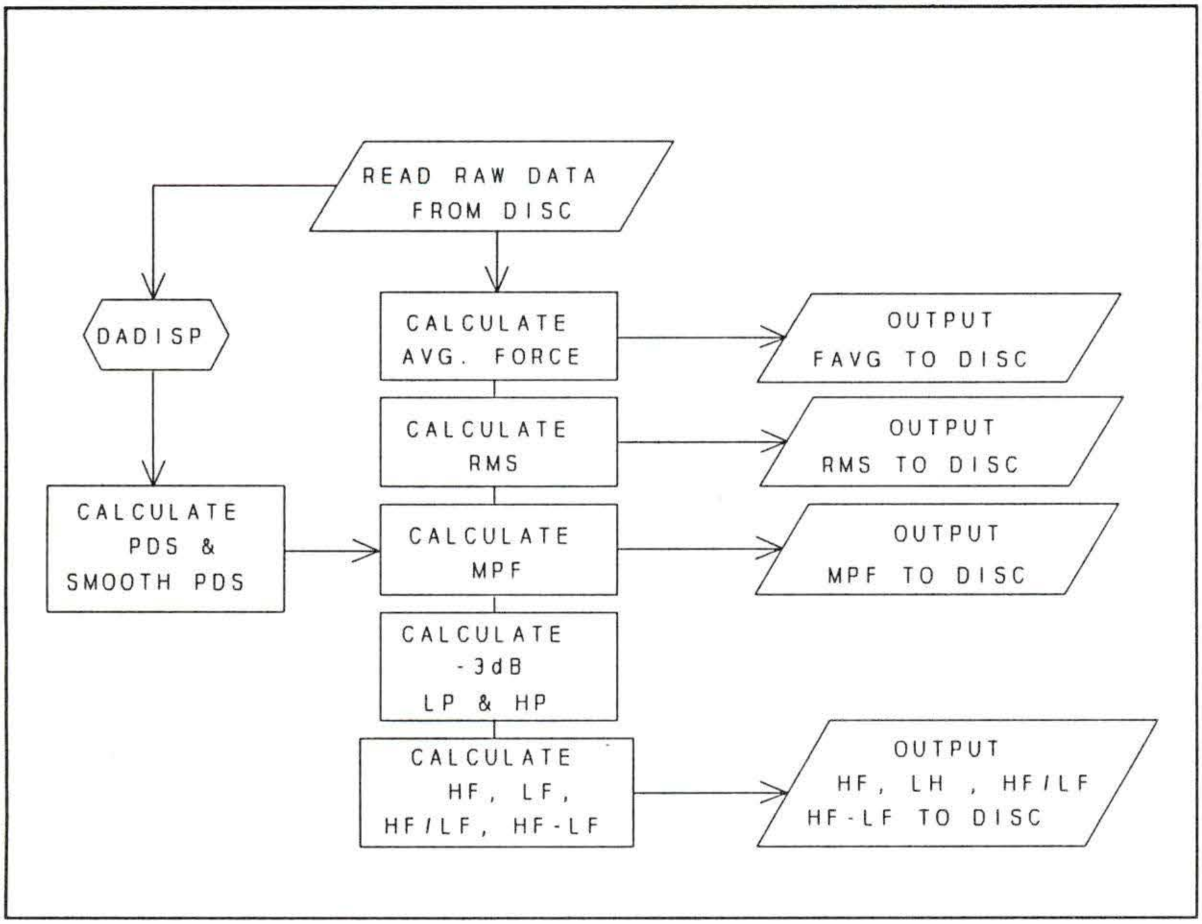


Figure 6. Signal reduction processes

RESULTS

The results of this study complement those of past research (Petrofsky et al., 1975; Kwatny et al., 1970; Viitasalo and Komi, 1977;and Basmajian and Deluca, 1985). Individual subject/trial data tables are located in Appendix D along with correlation and regression tables and any resulting graphs not presented in the text. Limited statistical analysis was used in the evaluation and preparation of the results. Due to the extreme variability of subject performance and results, it would be improper to attempt any statistical analysis between groups, or even amongst subjects and between trials. It was decided that the best way to present the results of this study was to report individual results based on the subject and trial. Where applicable, similarities and differences were alluded to and presented graphically. The extent of the statistics used was to perform individual regression analysis on each parameter of interest for each subject/trial level. From the regressions, best fit lines (predicted lines) were obtained and their slopes reported, along with their p-values and R^2 values, giving the goodness of fit and accuracy of the regression and its output. Correlations between all of the measured EMG parameters and time were also calculated for each subject/trial, and only those of outstanding value were reported. The results are presented in two parts; those of the maintained isometric study, and those of the pulsed isometric study.

Isometric

There was good consistency in the results of the maintained isometric portion of the study for male and female subjects. It was found that the mean power frequency (MPF) decreased over the time of contraction. The degree of this decrease, reported as the slope of the predicted line, varied from subject to subject but was fairly consistent among subject trials, for most subjects. The root mean square (RMS) of the EMG was found to increase over the time of contraction. Again, the slopes of the predicted lines varied among subjects. It should be noted that the slopes were based on calculations using the % time of contraction to standardize time to allow comparisons to be made between subjects and between subject trials. The subjects' total times of contraction varied considerably. Individual subject's results are presented in Table 2.

Although all of the predicted MPF slopes show a decrease, with some considerably greater than others, it is crucial to note that not all of the values are significant, i.e., $p < 0.01$. It can be seen in Table 2 and Figure 7 that there was a nearly linear, and significant, decrease in MPF for S06, $p < 0.001$. Any R^2 value greater than 0.6 is considered good for this type of data; S01, S03, S04, and S08 also show linearity in their results. The predicted MPF slope for S06 is atypical because it is nearly twice as large as any of the others. The average slope for the maintained isometric trials was -0.167.

Table 2. Maintained isometric MPF and RMS regression data; slopes are in y-units/%time.

Subject/Trial		Time	MPF Slope	MPF R^2	MPF p-value	RMS Slope $(10)^{-5}$	RMS R^2	RMS p-value
S01	Day 1	190s	-0.161	0.604	< 0.001	1.60	0.012	< 0.5
	Day 2	200s	-0.177	0.726	< 0.001	9.63	0.361	< 0.005
S04	Day 1	250s	-0.094	0.203	< 0.05	-1.20	0.067	< 0.5
	Day 2	260s	-0.137	0.563	< 0.001	0.62	0.026	< 0.5
S07	Day 1	300s	-0.116	0.258	< 0.005	2.22	0.187	< 0.01
	Day 2	220s	-0.127	0.281	< 0.01	0.87	0.034	< 0.5
S08	Day 1	400s	-0.279	0.661	< 0.001	9.74	0.708	< 0.001
	Day 2	260s	-0.052	0.031	< 0.5	7.60	0.738	< 0.001
S02	Day 1	180s	-0.168	0.483	< 0.001	6.14	0.353	< 0.01
S03	Day 1	210s	-0.192	0.747	< 0.001	16.90	0.775	< 0.001
S05	Day 1	220s	-0.150	0.154	< 0.05	6.40	0.357	< 0.005
S06	Day 1	210s	-0.493	0.837	< 0.001	7.50	0.170	< 0.05

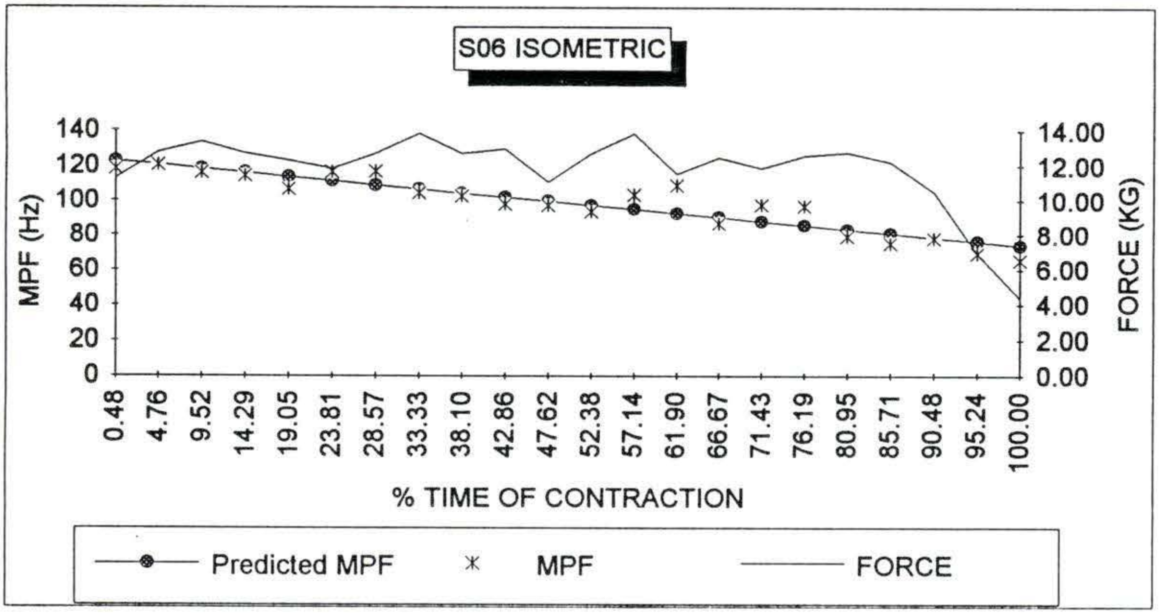


Figure 7. S06 MPF data for isometric trial; slope = -0.493, R^2 = 0.837, p < 0.001.

The RMS data varied more from subject to subject, and trial to trial, than did the MPF data. From Table 2 and Figure 8, it can be seen that the predicted RMS of S03 was the best, because it was the most linear and increased by $16.9(10)^{-5}$ (volts/%time), $p < 0.001$. Again, this example is atypical of the RMS results; the average predicted slope for all subject/trials was $5.67(10)^{-5}$ (volts/% time of contraction).

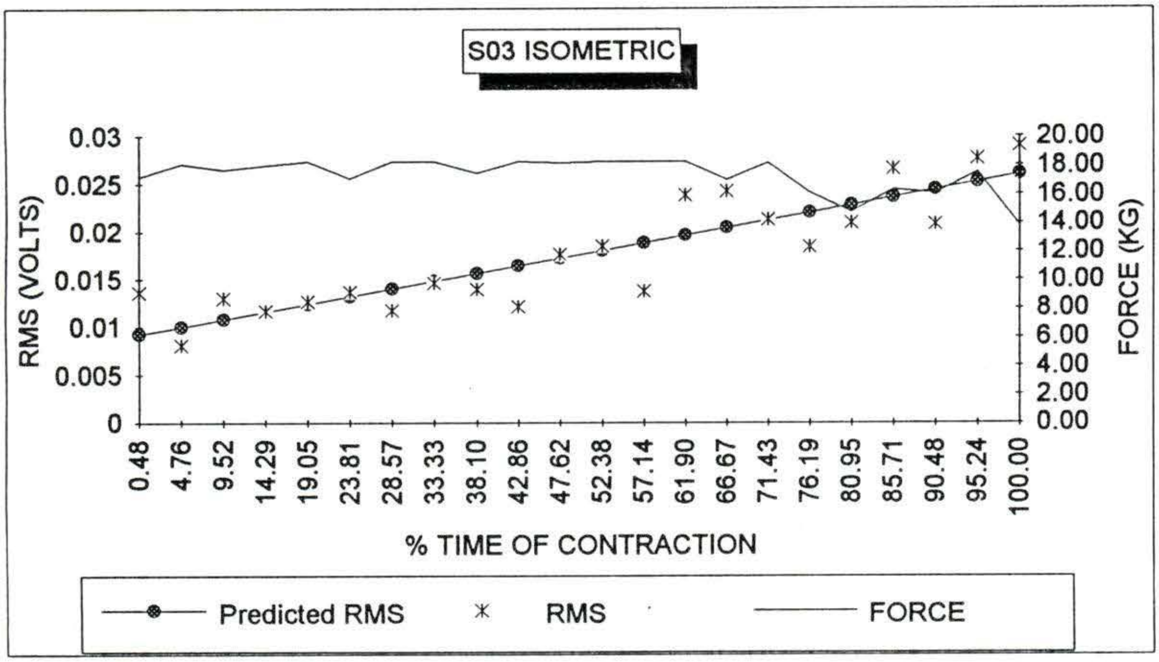


Figure 8. S03 RMS data for isometric trial; slope = $16.9(10)^{-5}$, $R^2 = 0.775$, $p < 0.001$.

Figures 9 through 12 present the predicted MPF and RMS curves based on the data in Table 2 for males and females. The results are fairly consistent, with the exception of magnitude. It can be seen that the starting, pre-fatigue, MPF ranged from about 60 Hz to 120 Hz, and RMS ranged from 5 to 15 millivolts. Figures 10 and 12 illustrate the consistency of the MPF and RMS between repetitions for the female subjects. The variations in the duration of contraction between subjects and between trials is also seen.

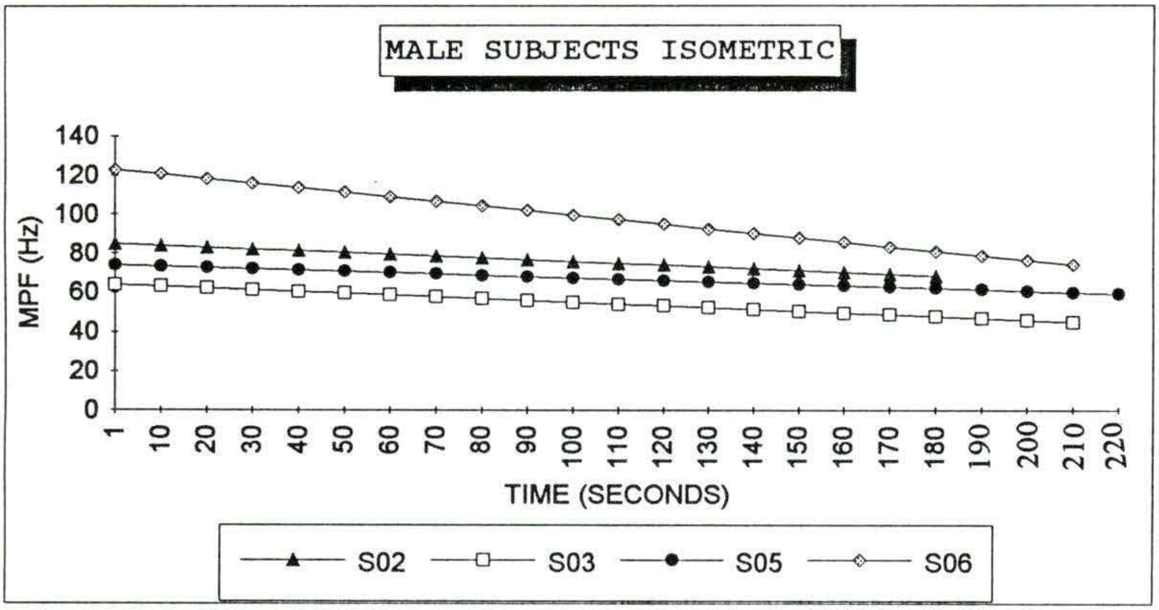


Figure 9. Predicted MPF curves for male isometric trials.

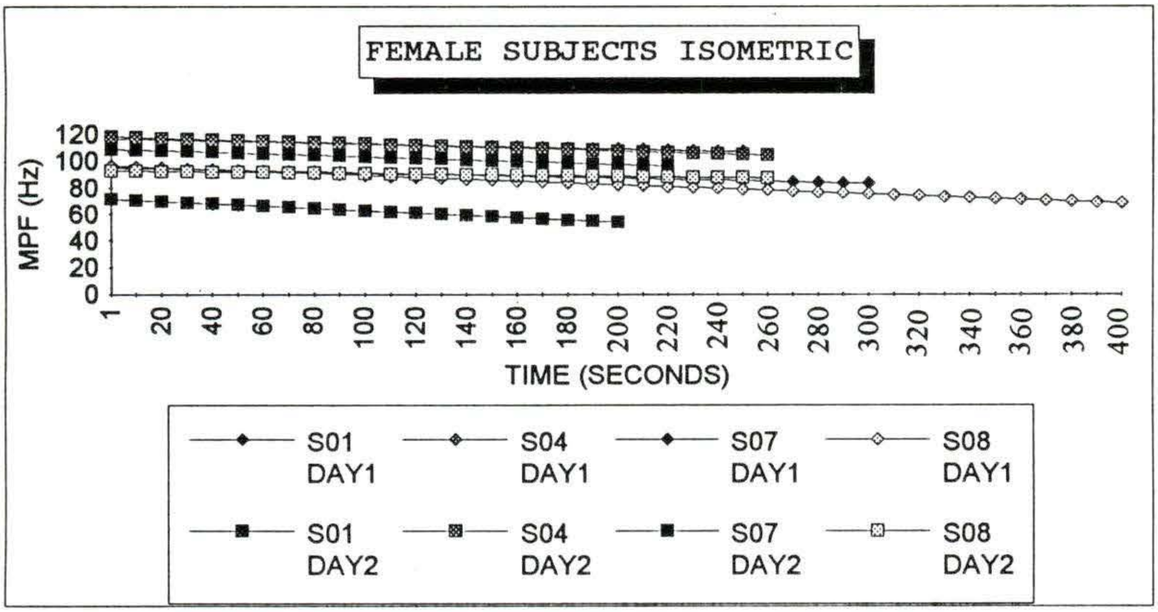


Figure 10. Predicted MPF curves for female isometric trials.

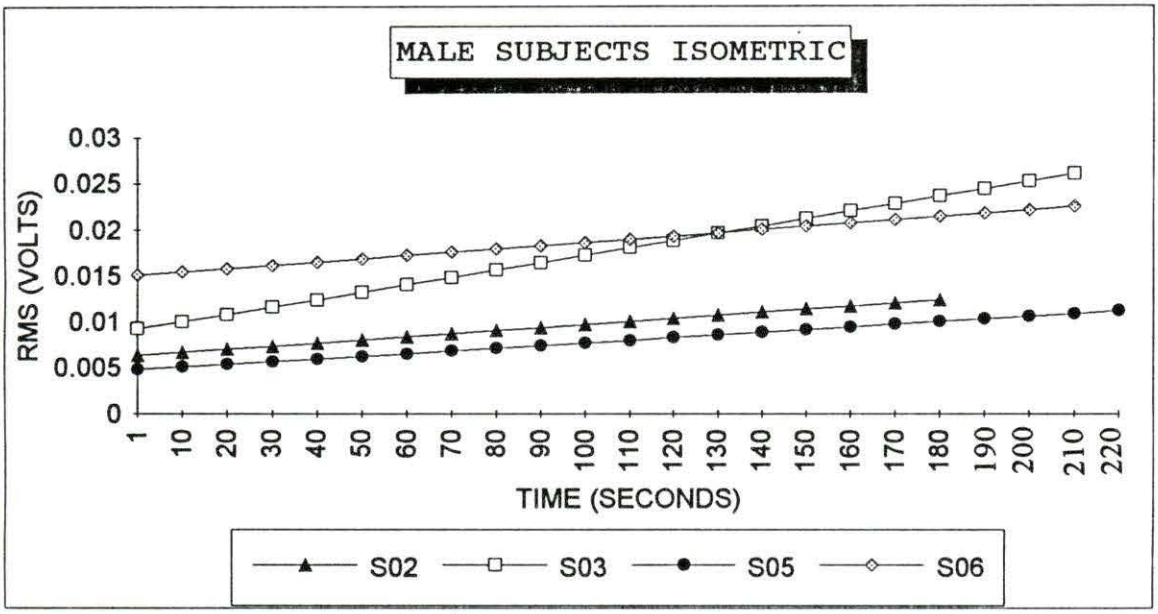


Figure 11. Predicted RMS curves for male isometric trials.

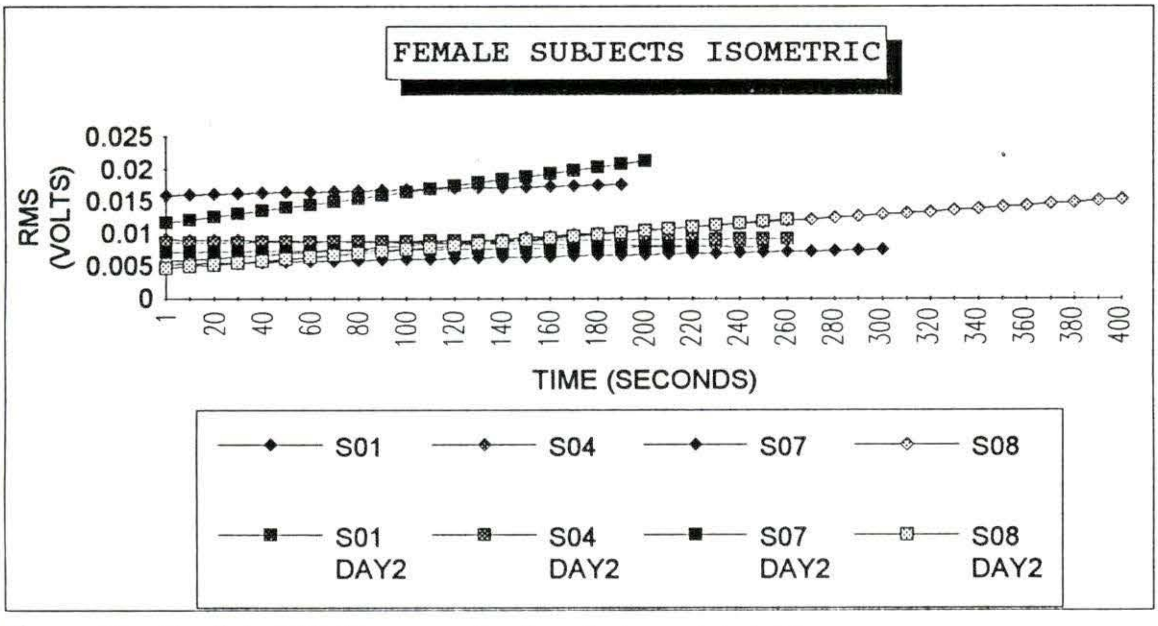


Figure 12. Predicted RMS curves for female isometric trials.

The third EMG parameter analyzed was the power density spectrum (PDS) band width. Two methods were originally used to evaluate this parameter; the ratio of the high frequency to the low frequency, and the difference between the high and low frequencies. It was quickly found that the latter was the better way to report this parameter because one of the frequencies must be stable for the ratio method to be accurate. Results showed that the entire PDS, as well as the MPF, shifts toward the lower end of the spectrum during a fatiguing contraction; therefore, only the difference of the high and low frequencies gives the true bandwidth. Figure 13 is an example of this parameter for an individual subject/trial, showing the shifts in the high and low frequency points and contrasting the "ratio" and "difference" methods. For this particular case, it appears that the majority of the MPF shift comes from a decrease in the high frequency, with less of a decrease in the low frequency.

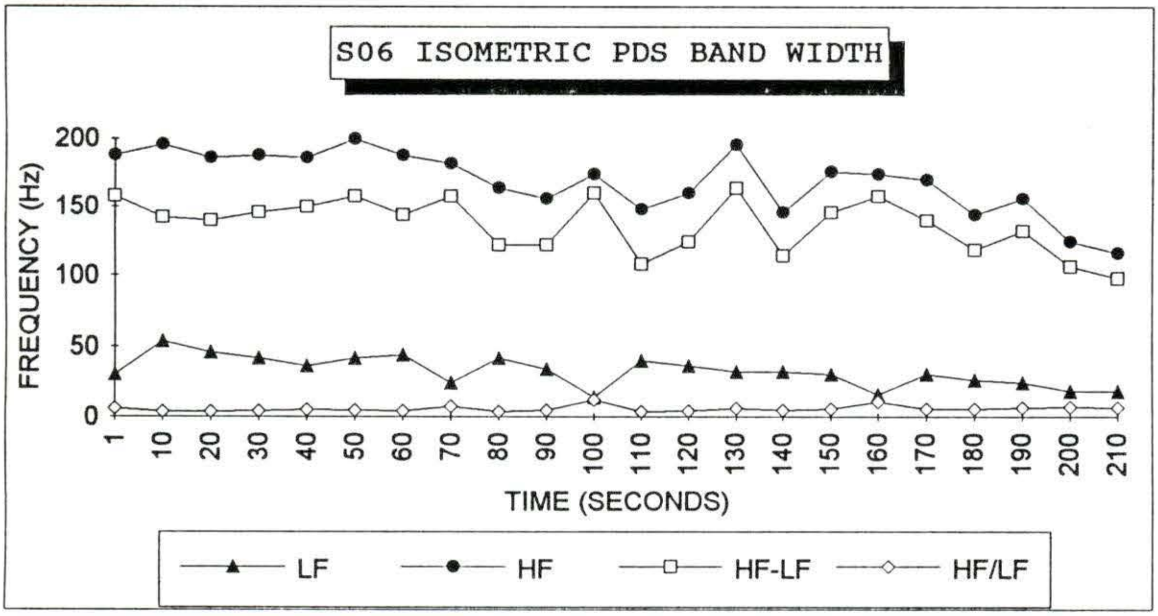


Figure 13. PDS bandwidth curves for S06 isometric trial.

Results for the isometric trials show that the PDS bandwidth decreases over the time period of the fatiguing contraction. However, there is little constancy in the slopes of the predicted curves and their magnitudes. From the data in Table 3 it would appear that no significant conclusions can be made. There was a trend for the majority of the predicted slopes to be negative, but the p-values are very poor and the R^2 values tend toward absolutely no linearity in the data. In a few cases, there was not even subject repeatability.

Table 3. PDS band width regression results; day 1 over day 2 for female subjects.

Subject	S01	S02	S03	S04	S05	S06	S07	S08
Slope	-0.154 -0.158	-0.129	-0.138	0.066 0.062	-0.084	-0.343	-0.138 -0.080	-0.149 0.054
R^2	0.176 0.368	0.158	0.247	0.021 0.024	0.054	0.258	0.085 0.052	0.158 0.015
p-value	< 0.1 < 0.005	< 0.1	< 0.05	< 0.5 < 0.9	< 0.5	< 0.05	< 0.5 < 0.5	< 0.05 < 0.1

Correlation tables for all subjects and trials are in Appendix D, where it can be seen that EMG parameter correlations vary considerably between subjects and trials. Table 4 is an example of a typical subject correlation table. It shows a strong negative correlation, inverse relationship, between time of contraction (% time) and MPF; time and the high frequency point; time and the low frequency point; and a positive relationship between time and RMS. Other relatively strong correlations are also evident in Table 4, such as, between force and MPF, and perhaps of most interest, between MPF and high frequency. The latter presents evidence that the shift in the MPF is primarily due to a corresponding shift of the high frequency point of the PDS. These correlations are supported by, and representative of, the regression results reported above and any resulting plots.

Table 4. Correlation data for S06 , isometric trial.

S06 ISOMETRIC CORRELATIONS								
	% TIME	*FORCE*	*MPF*	*RMS*	*LF*	*HF*	*HF/LF*	*HF-LF*
% TIME	1							
FORCE	-0.53102	1						
MPF	-0.91473	0.616459	1					
RMS	0.412817	0.303136	-0.12929	1				
LF	-0.6919	0.524177	0.678335	-0.10701	1			
HF	-0.75497	0.617711	0.887703	0.095186	0.513035	1		
HF/LF	0.321027	-0.25005	-0.24883	0.100202	-0.82401	-0.05772	1	
HF-LF	-0.5081	0.438128	0.669682	0.16786	0.062141	0.888589	0.373227	1

Pulsed Isometric

The results of the pulsed isometric study were considerably consistent with those of the maintained isometric study reported above. The major trends and conclusions that resulted from the maintained isometric study apply to this study as well. Table 5 shows the consistency among subjects and significant repeatability between trials.

Table 5. Pulsed isometric MPF and RMS regression data; slopes are in y-units/%time.

		MPF			RMS		
Subject/Trial	# of Cycles	Slope	R^2	p-value	Slope$(10)^{-5}$	R^2	p-value
S02 #1	12	-0.097	0.235	< 0.05	5.084	0.596	< 0.001
#2	11	-0.103	0.165	< 0.05	6.867	0.549	< 0.001
#3	10	-0.052	0.045	< 0.5	7.311	0.789	< 0.001
S05 #1	21	-0.036	0.038	< 0.5	6.091	0.296	< 0.001
#2	18	-0.008	0.003	< 0.5	9.116	0.650	< 0.001
#3	16	-0.057	0.066	< 0.5	6.504	0.412	< 0.001
S06 #1	21	-0.065	0.156	< 0.01	7.071	0.197	< 0.005
#2	17	-0.104	0.384	< 0.001	15.706	0.542	< 0.001
#3	15	-0.198	0.614	< 0.001	20.931	0.748	< 0.001

Although less prominent, the results of the pulsed isometric trials consistently show the decreasing trend of the MPF and the increasing trend of the RMS previously seen in the maintained isometric trials. Again, with S06 as an example, several elements of these results become evident (Figure 14).

First, for the pulsed isometric study, trials 1 through 3, the slopes of the predicted MPF lines were all negative, decreasing from trial 1 to trial 3. S06 was the only subject to show this trend significantly. Secondly, Figure 14 illustrates how well the three pulsed isometric trials fell within a small magnitude range. This result was representative of all subjects. What stands out the most about the S06 curves is the tremendous difference between the pulsed and maintain isometric trials. It was typical for all of the subjects, in the sense that the maintained isometric trial had a steeper slope, but the large offset is definitely not representative of the other subjects.

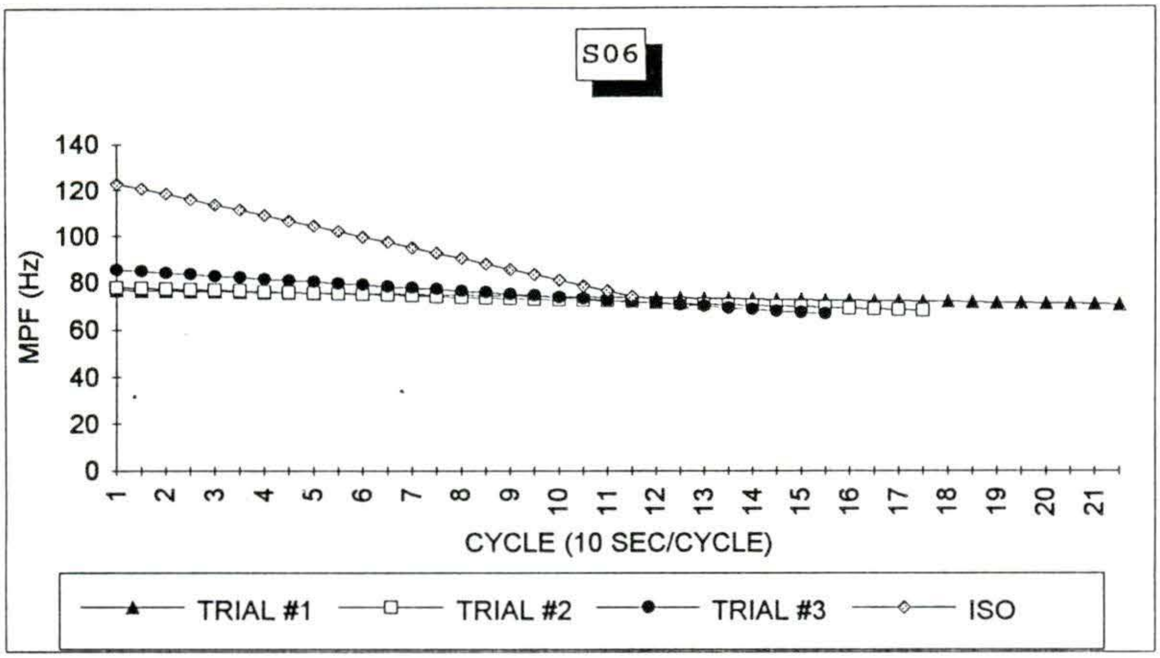


Figure 14. MPF predicted curves for S06, all trials.

Figure 15 illustrates the RMS data from Table 5 for S06. Again, a trend of increasing slope can be seen from trial 1 to trial 3, a result again not typical to all other subjects. No other subject showed any significant trends in trial ordering. Similar to the maintained isometric results, the results of the pulsed isometric study show a wide range of RMS magnitudes among subjects, yet the range between individual subject's trials in fairly tight.

The PDS bandwidth results for the pulsed isometric study also were in agreement with those of the maintained isometric study. Figure 16 illustrates that there was some consistency between trials, except for trial 2 where there was an unexplainable change in the direction of the curve from negative to positive. Overall, no substantial evidence was found to indicate a significant narrowing of the PDS bandwidth. Refer to regression tables in Appendix D for specific results.

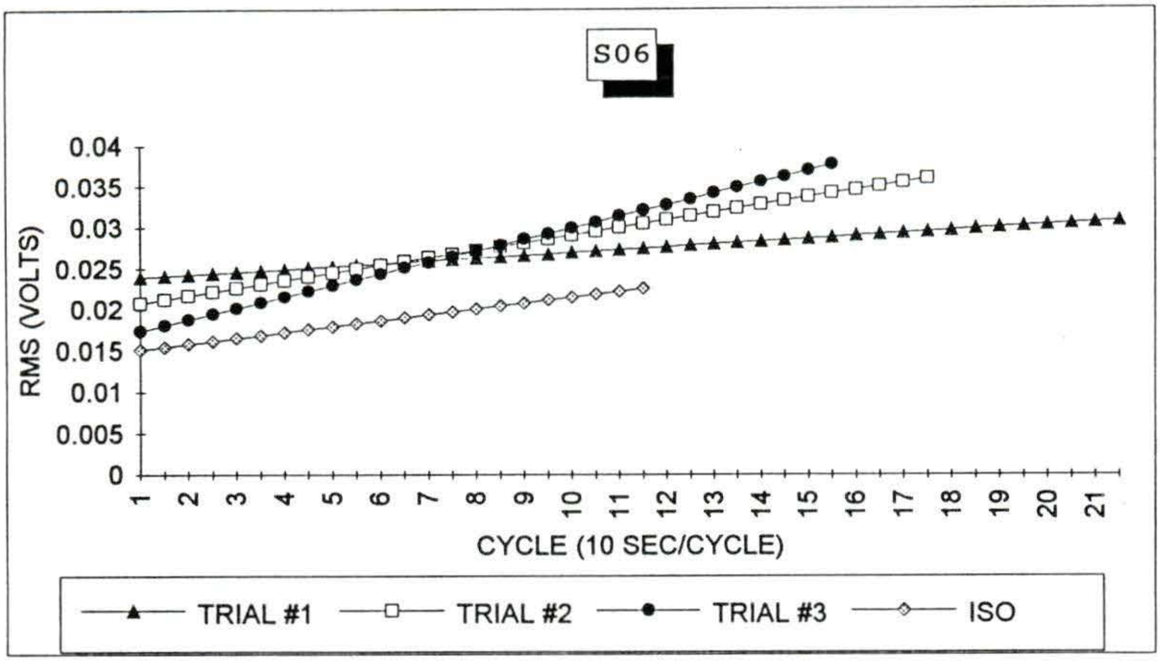


Figure 15. RMS predicted curves for S06, all trials.

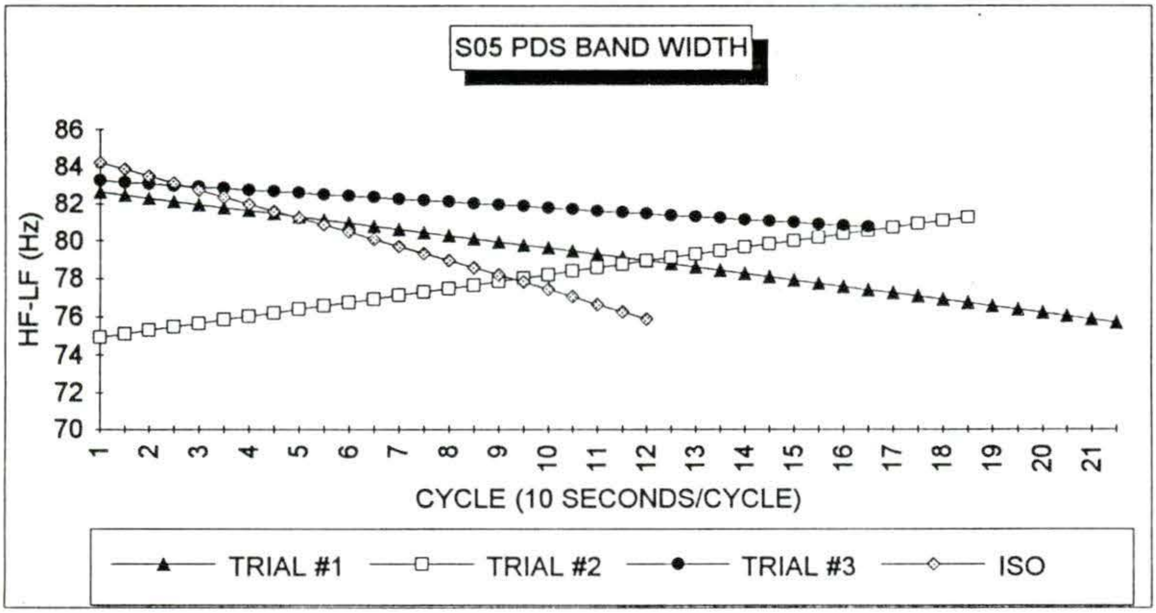


Figure 16. PDS bandwidth curves for S05, all trials.

DISCUSSION

The results of this study strongly support the findings of other researchers, substantiating past results for different muscle groups. Primarily, it was found that the MPF does shift toward the lower frequencies and that the RMS does increase throughout a fatiguing isometric contraction for the digital flexor muscle group. Also, this study found no gender based differences in these trends. The present study did not strongly support the idea that the PDS bandwidth narrows over the time of contraction (Stulen and DeLuca, 1982; Basmajian and DeLuca, 1985); although the tendency was seen, it was far from statistically reliable or significant.

This study is the first to focus on pulsed isometric fatiguing, as well as the traditional maintained isometric exercises. It was thought that fatigue brought on by a non-maintained isometric exercise was more realistic and applicable to the work place. Perhaps not surprisingly, there was little to no difference between the results of the pulsed and maintained studies. This suggests that conclusions made from maintained isometric fatigue studies may well apply to pulsed isometric fatigue. There is a dynamic component to the pulsed isometric exercise that is not present in the maintained isometric trials. The major difference seen between the two exercise types was that the slopes of the results from the pulsed trials were generally not as steep as their counterparts. This could be explained by the brief periods of recovery throughout the exercise. Obviously, this was why the subjects were able to hold the pulsed trials for longer periods of time; however, the resulting parameter shifts were usually the same. Petrofsky (1979), tracking frequency and amplitude parameters during dynamic exercise, reported the same general trends in EMG amplitude and frequency as those found in isometric studies, but not to the same extent. He attributed this to the possibility that dynamic exercise produces more internal heat in the muscle, which counteracts the parameter shifts due to fatigue.

Several past investigators made claims that the decrease in MPF and increase in RMS were linear (Petrofsky et al., 1975; Kwatny et al., 1970; Viitasalo and Komi, 1977; Kuroda et al., 1970). This study was not able to support that conclusion. Many of the studies performed by others used only one subject and, therefore, could be classified as single case studies. If only one of the subjects of this study were reported, for example S06, strong support of linearity could be made, but only about half of the subjects studied reflected strong linearity, and even fewer showed reliability of this linearity.

It should also be pointed out that the conclusions made in this study are based on EMG data assumed to be from a time period prior to the contractile failure point. As discussed earlier, muscular fatigue is an ongoing process which begins at the onset of contraction and culminates at, or slightly after, the failure point. Stephens and Taylor (1972) stated that only during the period prior to failure were the assumptions of linearity accurate; however, in the present study only one subject was able to continue past the failure point. Figure 17 shows S06 reaching the failure point (arrow) and continuing for a short period of time. It is interesting to note that by excluding the last three data points, the slope of the RMS regression line would be steeper and most likely would have a larger R^2 value. It can also be seen that it would appear that the RMS values drop off completely in a negative direction upon reaching the failure point. This conclusion, though, was not substantiated by any other subjects or trials.

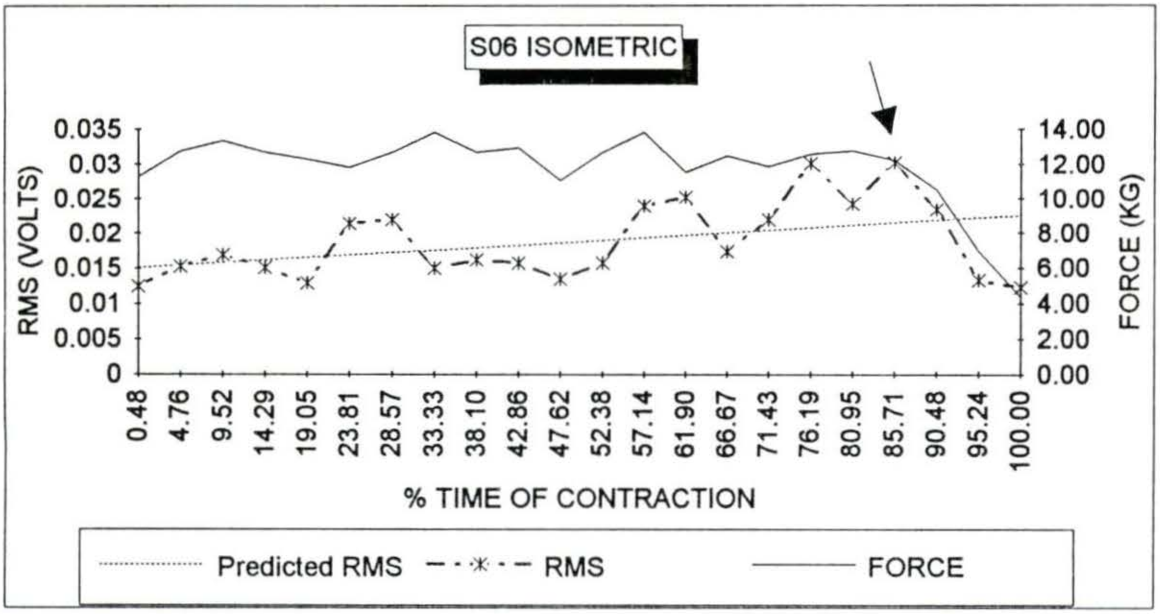


Figure 17. Predicted RMS curve for S06; arrow indicates contractile failure.

One of the major obstacles that makes results like those obtained in the present study difficult to interpret is the subject's perception of fatigue. That is, the subject may feel the symptoms that they are conditioned to recognizing as fatigue, but, in actuality, physically they are capable of continuing. For example, during the data acquisition phase of this study, subjects would hold the desired force level for a period of time and then suddenly report that they could go no longer, even though no steady decrease in force output was recorded. It is believed that this represents the subject's perception of fatigue and not their physical capability.

Some possible explanations for the dramatic inconsistencies found between subjects and trials can be advanced. First of all, and perhaps most crucial, was the inability to position the recording electrodes accurately and consistently from subject to subject. With out post-mortem or exploratory verification, it is not possible to know exactly where on the muscle group the recordings originate from. Anatomically, it is known muscle structure and location are not identical for all individuals. Therefore, it is conceivable that even with a well structured and standardized method, electrodes placed exactly over the belly of a muscle for one subject could be off by several millimeters for another. This does not account for the additional effects of the inability to ensure that the inter-electrode line was parallel with the muscle fibers from subject to subject. However, this study did support the findings of Komi and Buskirk (1972) that the replacement of surface electrodes after their removal was fairly reliable, as can be seen in the female subject trials between days 1 and 2. Another explanation for subject to subject variations could be differences in muscle fiber type and composition. Komi and Tesch (1979) reported that subjects with a higher percentage of slow twitch fibers showed a significant decrease in MPF, while those with a higher percentage of fast twitch fibers demonstrated only a slight, non-significant increase. Finally, biochemical concentration variations among subjects might also provide for some of the observed discrepancies in the EMG parameter shifts.

In conclusion, this study has substantiated the major findings of past isometric research and demonstrated that these conclusions may also hold for a more realistic type of exercise in which isometric contraction force levels may vary. It has been verified that the use of EMG to study, and possibly predict, muscular fatigue has excellent potential as a research and clinical tool. However, much work is still needed to: (a) further verify many of the conclusions made and (b) study subject differences and their causes. To improve the results of this type of study in the future, it may be necessary to very specifically group subjects by gender, muscle type and structure, biochemical concentrations and availability, and other physiological variables.

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I would also like to thank my wife and family for their support throughout this project and my graduate career. Without the encouragement of loved ones, I would not have been able to accomplish my goals and enjoy the experience.

Finally, thanks to the faculty, staff, and fellow students of the Biomedical Engineering Program for their help, support, and laughter.

APPENDIX A

HUMAN SUBJECT APPROVAL AND CONSENT FORMS

Information for Review of Research Involving Human Subjects

Iowa State University

(Please type and use the attached instructions for completing this form)

1. Title of Project "Study of Dynamic Fatigue in Lower Arm"

2. I agree to provide the proper surveillance of this project to insure that the rights and welfare of the human subjects are protected. I will report any adverse reactions to the committee. Additions to or changes in research procedures after the project has been approved will be submitted to the committee for review. I agree to request renewal of approval for any project continuing more than one year.

David D. Chappell	09/17/92	David D. Chappell
Typed Name of Principal Investigator	Date	Signature of Principal Investigator

Biomedical Engineering	1130 Vet. Med.	294-6520
Department	Campus Address	Campus Telephone

3. Signatures of other investigators — Date — Relationship to Principal Investigator

Signatures of other investigators	Date	Relationship to Principal Investigator
[signature]	9/21/92	Major Professor

4. Principal Investigator(s) (check all that apply)
   ☐ Faculty ☐ Staff ☒ Graduate Student ☐ Undergraduate Student

5. Project (check all that apply)
   ☐ Research ☒ Thesis or dissertation ☐ Class project ☐ Independent Study (490, 590, Honors project)

6. Number of subjects (complete all that apply)
   ___ # Adults, non-students 15 # ISU student ___ # minors under 14 ___ other (explain)
   ___ # minors 14 - 17

7. Brief description of proposed research involving human subjects: (**See instructions, Item 7**. Use an additional page if needed.)

   Please refer to attached page A.

(Please do not send research, thesis, or dissertation proposals.)

8. Informed Consent: ☒ Signed informed consent will be obtained. (Attach a copy of your form.)
   ☐ Modified informed consent will be obtained. (See instructions, item 8.)
   ☐ Not applicable to this project.

Last Name of Principal Investigator Chappell

list for Attachments and Time Schedule

llowing are attached (please check):

Letter or written statement to subjects indicating clearly:
a) purpose of the research
b) the use of any identifier codes (names, #'s), how they will be used, and when they will be removed (see Item 17)
c) an estimate of time needed for participation in the research and the place
d) if applicable, location of the research activity
e) how you will ensure confidentiality
f) in a longitudinal study, note when and how you will contact subjects later
g) participation is voluntary; nonparticipation will not affect evaluations of the subject

Consent form (if applicable)

Letter of approval for research from cooperating organizations or institutions (if applicable)

Data-gathering instruments

nticipated dates for contact with subjects:

irst Contact	Last Contact
11/15/92	01/01/93
Month / Day / Year	Month / Day / Year

applicable: anticipated date that identifiers will be removed from completed survey instruments and/or audio or visual apes will be erased:

08/01/93
Month / Day / Year

ignature of Departmental Executive Officer	Date	Department or Administrative Unit
Mary Helen Greer	9/21/92	Biomedical Engr.

ecision of the University Human Subjects Review Committee:

✓ Project Approved ___ Project Not Approved ___ No Action Required

Patricia M. Keith	9/22/92	PM Keith
ame of Committee Chairperson	Date	Signature of Committee Chairperson

/90

Page A.

7) This project will involve the recording and evaluation of EMG data prior to, during, and immediately following "localized" muscle fatigue of the digital flexor groups.
A unipolar EMG electrode will be secured to the subjects inner fore-arm, over the muscle group of interest. A ground electrode will be placed at the wrist or elbow. The electrodes will be secured with velcro/elastic straps, and conductive gel. The EMG signal will be amplified and sent to an oscilloscope and a computer based data acquisition system. The EMG amplifier will be driven by batteries, and has proven to be save with over ten years of use in this department.

To fatigue the muscle group, the subject will grip and squeeze a hand held ergonometer (dynamometer). Approximately ten subjects will go through a specified regimen of squeezing exercises per trial, and each subject will participate in a total of three trials on separate days, within a five day period. Each subjects specific exercise period will be dependent on his or her own abilities and can not be predetermined. The exercise periods will consist of systematic squeezing and resting intervals, the length and number of intervals will also be subject dependent. They are expected to fatigue within 10 minutes at an approximate 50% MVC (maximum voluntary contraction).

Subjects to be used will have average strength and body type, and will include males and females. They will range in age from 18 to 45 years.

9) Subjects will be designated by a project number which will be used from the onset of the study when ever referring to any subject data. The primary investigator will maintain subject identity on a floppy disc in a locked laboratory. Access to subject identity will be closely guarded and highly restrictive.

10) The attachment and operation of the equipment should cause no discomfort or injury. However, the subject may experience some normal discomfort as their muscles fatigue. The experience should be nothing that the subject hasn't felt before, and should subside upon release of the hand-grip. A subject could foreseeably also incur a muscular cramp due to extended fatigue, which may require more time, or minor massage, to alleviate. No permanent or lasting injury is expected.

11D) The exercise involved will be repeated flexing of the fingers against a moderate force. The subject will be in complete control and can release at their own discretion. If cramping were to occur, research staff will be present to assist in relaxing the muscle.

Signed informed consent for study of muscular fatigue in lower arm

1. The intent of this study is to analyze the effects of fatigue on the electrical activity of the muscles in the lower arm. We are interested in the electrical activity of a particular muscle group in the lower arm prior to, during, and immediately following voluntary subject induced muscular fatigue. The tests will consist of you (the subject) voluntarily gripping and squeezing a hand held force measuring device. You will squeeze and hold at a certain force level for about 10-30 seconds, and then release and relax for about 10 seconds; repeating this cycle until the muscle group of interest reaches the desired fatigued state. Fatiguing will be monitored by two parameters; the electrical activity of the muscle group, and your ability to maintain the prescribed force output level.

The electrical activity of the muscles will be monitored by placing three small surface recording electrodes on the skin over the muscle group of interest (inner forearm). The surface electrodes will be secured to the skin with elastic straps, and the skin may need to be precleaned with isopropyl alcohol and light scrubbing. A commercial conducting gel may also be used to ensure good skin to electrode contact. The signal from the recording electrodes will go to a computer based oscilloscope for viewing and further analysis. All electrical equipment in contact with you will be purely recording equipment, and all effects will be voluntarily self induced.

2. The exact length of time required for the squeezing and resting periods of the test cycles will be determined prior to testing based on your individual abilities. The number of cycles needed to reach the fatigued state will also be dependent on your abilities.

3. You will be in complete control of all exercising, and should feel free to stop at any time during the testing should you experience any pain or serious discomfort. It should be expected, though, to experience the usual effects of muscle fatigue; heat, tingling, tiredness, slight burning deep in the muscle , etc. Anything that is out of the ordinary or alarming should prompt you to stop the testing immediately.

4. You should feel free to ask any questions about the procedure or the research in general.

5. You will not bound in any way to complete the testing and may withdraw consent at any time.

6. All data and personal information will be kept confidential. Your name will not appear in any publication or thesis work.

7. The time required of you will be approximately 1 hour per trial, and a total of two trials within a three to five day period will be needed. A trial will consist of one series of squeezing cycles till fatigue is reached or you wish to stop for any other reason.

8. Emergency treatment of any injury that may occur as a direct result of participation in the research will be treated at the Iowa State University Student Health Services, Student Services Building, and/or referred to Mary Greeley Hospital or another physician. Compensation for treatment of any injuries that may occur as a result of participation in the research may or may not be paid by Iowa State University depending on the Iowa Tort Claims Act. Claims for compensation will be handled by the Iowa State University Vice President for Business and Finance.

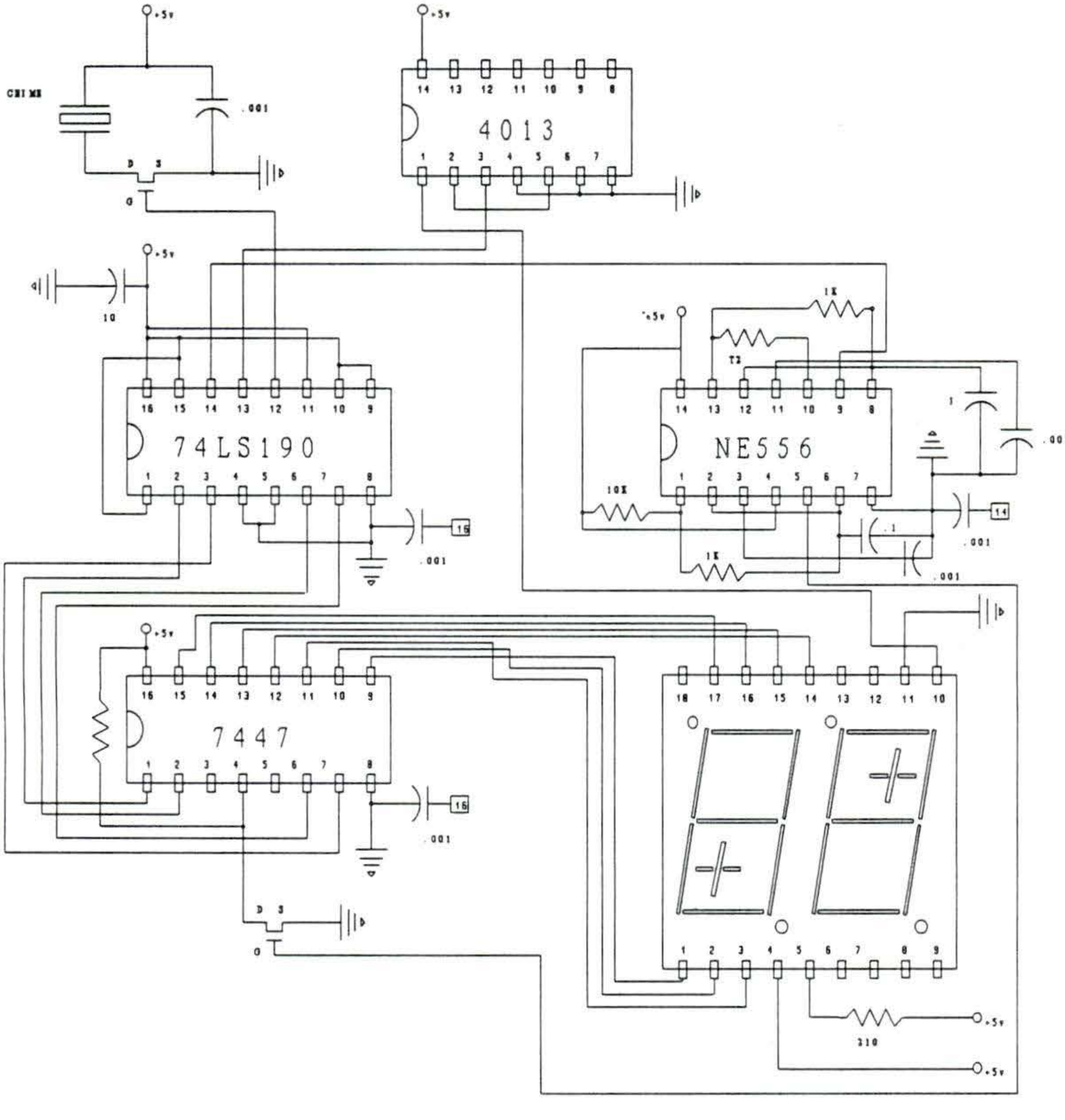
By signing below you state that you have read this consent form, understand it, have had your questions pertaining to it satisfactorily answered, and voluntarily agree to participate in the study accepting the risks entailed by it. You also understand that you may discontinue participation at any time for any reason without objection by the researchers or anyone involved with the study.

Volunteer Subject:______________________________ Date:________

Researcher/Witness:______________________________

APPENDIX B

PULSED ISOMETRIC EXERCISE PACER CIRCUIT DIAGRAM



Schematic for "Pulsed Isometric Fatiging Pacer".

APPENDIX C

"SCOPE" PROGRAM AND DATA REDUCTION ALGORITHMS
"QUICK BASIC" CODE
"DADISP" COMMAND FILES

"SCOPE" PROGRAM

```
1 'VERSION 2.0
2 'COMPUTER OSCILLOSCOPE  -  HEATH/ZENITH COMPUTER BASED INSTRUMENTS GROUP
3 'MAY 19, 1987
4 'WRITTEN BY KIM MC CAVIT
5 'REVISED BY BARB ERWIN
10 'CLEAR MEMORY ABOVE 45000 FOR ASSEMBLY LANGUAGE ROUTINES
20 'TURN KEY DISPLAY OFF AND DISABLE THE FUNCTION KEYS
30 'SWITCH TO HIGH RESOLUTION GRAPHICS

50 CLEAR , 45000!: KEY OFF: FOR I = 1 TO 10: KEY I, "": NEXT I: SCREEN 2
60 CLS : LOCATE 15, 10: PRINT "LOADING........"
70 OUT &H3D9, &HA             'TURN SCREEN LIGHT GREEN
80 '
90 'DEFINE CONSTANTS ******************************************************
100 '
110 DEFINT A-Z: DIM Y1(511), Y2(511), Y1SUM(511), Y2SUM(511), M1(511), M2(511)
120 FOR I = 0 TO 511: Y1(I) = 128: Y2(I) = 128: Y1SUM(I) = 0: Y2SUM(I) = 0: NEXT I
130 OFFSETY1 = 0: OFFSETY2 = 0: HOFFSET = 0: FALSE = 0: TRUE = NOT FALSE: FRTCHG = 255
140 LYNE = TRUE: INVERTY1 = FALSE: INVERTY2 = FALSE: EROR = FALSE: MEM1 = FALSE:
MEM2 = FALSE
150 COMAND = 0: GRATON = TRUE: SCOPE = TRUE: MENU = 1: SAVMEM = FALSE
160 Y1SEN = 0: Y2SEN = 0: Y1COUP = 0: Y2COUP = 0: SLOPE = 0: MODE = 0: SOURCE = 0:
LEVEL = 0: RATE = 15
170 TRIG = 0: CURSOR = 1: C1Y = 3: C2Y = 3: MENU = 1: PNT = 0: COMAND = 0
180 X1 = -1: X2 = -1: X3 = -1: X4 = -1: AVGNUM = 1: AVGCNT = -1: AVGY1 = FALSE: AVGY2 =
FALSE
190 '
200 'DEFINE COMMANDS*********************************************************
210 '
220 Y1SENUP = 65: Y1SENDN = 66: Y2SENUP = 67: Y2SENDN = 68: Y1COUPLG = 69: Y2COUPLG
= 70
230 TBASEUP = 71: TBASEDN = 72: TRIGSLP = 73: TRIGMDE = 74: TRIGRST = 75: MANTRG = 75
240 TRIGSCR = 76: TRGLVL = 97: TRGZERO = 86: REQMEM = 87: REQSAV = 88
250 RSTREQ = 93: REQFRT = 89: RST = 94: REZERO = 95: SCOPEON = 92: TSAVE = 77
260 SCOPEOFF = 91: Y1POS = 98: Y2POS = 99: Y1ZERO = 84: Y2ZERO = 85
270 '
280 'DEFINE STRING ARRAYS AND FUNCTION POINTER LOCATIONS****************
290 '
300 DIM SEN$(9): FOR I = 0 TO 9: READ SEN$(I): NEXT I
310 DATA "5.0 mV","10. mV","20. mV","50. mV","100 mV","200 mV"
320 DATA "500 mV","1.0  V","2.0  V","5.0  V"
330 '
340 DIM RATE$(28): FOR I = 0 TO 28: READ RATE$(I): NEXT I
350 DATA "10. nS","20. nS","50. nS",",100 nS","200 nS","500 nS","1.0 uS","2.0 uS"
360 DATA "5.0 uS","10. uS","20. uS","50. uS","100 uS","200 uS","500 uS","1.0 mS"
370 DATA "2.0 mS","5.0 mS","10. mS","20. mS","50. mS","100 mS","200 mS","500 mS"
380 DATA "1.0  S","2.0  S","5.0  S","10.  S","20.  S"
390 '
```

```
400 DIM COUPLNG$(4): FOR I = 0 TO 4: READ COUPLNG$(I): NEXT I
410 DATA "OFF","AC ","GND","   ","DC "
420 '
430 DIM MODE$(4): FOR I = 0 TO 4: READ MODE$(I): NEXT I
440 DATA " "," auto","normal"," ","single"
450 '
460 DIM POINTER(13, 2)              ' X,Y,# OF CHARACTERS
470 FOR I = 0 TO 13: FOR J = 0 TO 2: READ POINTER(I, J): NEXT J: NEXT I
480 DATA 550,0,3, 582,0,6, 550,8,6, 574,16,8, 550,32,3, 582,32,6, 550,40,6
490 DATA 574,48,8, 597,64,3,550,72,6, 614,88,2, 622,104,1, 550,128,8, 590,144,6
500 '
510 'BRING IN ASSEMBLY LANGUAGE ROUTINES*****************************
520 '
530 BLOAD "MAP.BIN", 47050!: BLOAD "UARTINI.BIN", 47570!: UARTINI! = 47570!
540 BLOAD "PLOT.BIN", 47600!: PLOT! = 47600!: BLOAD "GRAT.BIN", 48275!: GRAT! = 48275!
550 BLOAD "REQ.BIN", 48860!: REQ! = 48860!: BLOAD "REQFRT.BIN", 49120!: REQFRT! = 49120!
560 BLOAD "SEND.BIN", 49500!: SEND! = 49500!: BLOAD "CKUART.BIN", 49540!: CKUART! =
49540!
570 BLOAD "AVG.BIN", 49605!: AVG! = 49605!
580 '
590 'MAKE REVERSE VIDEO BLOCKS AND MESSAGES*************************
600 '
610 LOCATE 20, 2: PRINT "SAMPLING": DIM S(34): GET (7, 152)-(72, 158), S
620 LOCATE 20, 2: PRINT "TRANSFER": DIM T(34): GET (7, 152)-(72, 158), T
630 LOCATE 20, 1: PRINT "          ": DIM BLANK8(34), BLANK6(27), BLANK5(23)
640 DIM BLANK4(20), BLANK3(16), BLANK2(13), BLANK1(9): GET (0, 152)-(65, 158), BLANK8
650 PUT (0, 152), BLANK8, PRESET: GET (0, 152)-(65, 158), BLANK8
660 GET (0, 152)-(49, 158), BLANK6: GET (0, 152)-(41, 158), BLANK5
670 GET (0, 152)-(33, 158), BLANK4: GET (0, 152)-(25, 158), BLANK3
680 GET (0, 152)-(17, 158), BLANK2: GET (0, 152)-(9, 158), BLANK1
690 PUT (0, 152), BLANK8, XOR: LOCATE 2, 1
700 PRINT SPC(9); : FOR I = 10 TO 22 STEP 2: FOR J = 10 TO 12: PSET (I, J): NEXT J: NEXT I
710 PSET (8, 11): PSET (12, 9): PSET (14, 8): PSET (14, 14): PSET (12, 13)
720 DIM ARROWL(13): GET (8, 8)-(28, 14), ARROWL: LOCATE 2, 1
730 PRINT SPC(9); : FOR I = 10 TO 22 STEP 2: FOR J = 10 TO 12: PSET (I, J): NEXT J: NEXT I
740 PSET (24, 11): PSET (20, 9): PSET (20, 13): PSET (18, 8): PSET (18, 14)
750 DIM ARROWR(13): GET (4, 8)-(24, 14), ARROWR: FOR I = 10 TO 20: PSET (I, 10): NEXT I
760 DIM TMARK(3): GET (10, 10)-(19, 10), TMARK
770 '
780 'SHOW INTRO SCREEN, HELP MESSAGE,SET BAUD RATE AND COM: CHANNEL*********
790 '
800 CLS : DEF SEG = &HB800: BLOAD "BANNER.SAV", 0: DEF SEG : ON ERROR GOTO 1090
810 OPEN "I", 1, "BAUD.SAV": INPUT #1, BAUD, COMM, SCOPE: CLOSE #1: ON ERROR GOTO 0
820 IF SCOPE = TRUE THEN COMAND = SCOPEON ELSE COMAND = SCOPEOFF
830 LOCATE 21, 19: PRINT "COMMUNICATION STATUS:    ";
840 IF COMM = 0 THEN PRINT "  COM1:"; ELSE PRINT "  COM2:";
850 PRINT SPC(2); : IF BAUD = 0 THEN PRINT " 110"; ELSE IF BAUD = 1 THEN PRINT " 150";
860 IF BAUD = 2 THEN PRINT " 300"; ELSE IF BAUD = 3 THEN PRINT " 600";
870 IF BAUD = 4 THEN PRINT "1200"; ELSE IF BAUD = 5 THEN PRINT "2400";
880 IF BAUD = 6 THEN PRINT "4800"; ELSE IF BAUD = 7 THEN PRINT "9600";
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```
890 PRINT "  BAUD"
900 X$ = INKEY$: IF X$ = "" THEN GOTO 900
910 IF X$ = "C" OR X$ = "c" THEN GOTO 960
920 IF X$ = "?" OR X$ = "/" THEN GOTO 930 ELSE GOTO 1130
930 CLS : DEF SEG = &HB800: BLOAD "HELP.SAV", 0: DEF SEG
940 X$ = INKEY$: IF X$ = "" THEN GOTO 940
950 GOTO 800
960 CLS                         'SELECT THE BAUD RATE
970 LOCATE 10, 1: PRINT "SELECT BAUD RATE FOR COMMUNICATIONS CHANNEL:"
980 PRINT "     1)  110": PRINT "     2)  150": PRINT "     3)  300"
990 PRINT "     4)  600": PRINT "     5) 1200": PRINT "     6) 2400"
1000 PRINT "     7) 4800": PRINT "     8) 9600": PRINT : PRINT "SELECTION";
1010 X$ = INKEY$: IF X$ = "" THEN GOTO 1010
1020 X = VAL(X$): IF X < 1 OR X > 8 THEN GOTO 960
1030 BAUD = X - 1: CLS : PRINT "SELECT COMMUNICATIONS CHANNEL:"
1040 PRINT "     1)  COM1:": PRINT "     2)  COM2:": PRINT : PRINT "SELECTION";
1050 X$ = INKEY$: IF X$ = "" THEN GOTO 1050
1060 X = VAL(X$): IF X = 1 THEN COMM = 0: GOTO 1080
1070 IF X = 2 THEN COMM = 1: GOTO 1080:  ELSE LOCATE 2, 1: GOTO 1040
1080 CLOSE : OPEN "O", 1, "BAUD.SAV": PRINT #1, BAUD, COMM, SCOPE: CLOSE #1: GOTO 800
1090 RESUME 960
1100 '
1110 'INITIALIZE UART *****************************************************
1120 '
1130 CALL UARTINI!(COMM,BAUD):ON ERROR GOTO 0
1140 FOR I = 1 TO 25: LOCATE I, 1: PRINT SPC(79); : NEXT I
1150 'INITIALIZE SCREEN***************************************************
1160 GOSUB 2230: GOSUB 5060: GOSUB 5430
1170 '
1180 '*****ERROR ENTRY POINT****************************
1190 '
1200 CALL GRAT!(GRATON):COMAND=1:CALL SEND!(COMAND,COMM):GOSUB 4740:GOSUB
4830
1210 LOCATE 22, 10: PRINT SPC(44); : LOCATE 23, 10: PRINT SPC(44); : LOCATE 24, 10: PRINT
SPC(44);
1220 ON POINTER(PNT, 2) GOSUB 2210, 2220, 2230, 2230, 2240, 2250, 2250, 2260, 2260, 2260
1230 GOSUB 3750
1240 ON POINTER(PNT, 2) GOSUB 2210, 2220, 2230, 2230, 2240, 2250, 2250, 2260, 2260, 2260
1250 I = FRE(""): LOCATE 20, 66: IF MODE < 4 THEN PRINT "  no trigger  ": GOTO 1300
1260 PRINT"    armed     ":CALL SEND!(RSTREQ,COMM):WATE=TRUE:GOTO 1400
1270 '
1280 '*****DON'T BLANK ENTRY POINT**********************
1290 '
1300 WATE = FALSE
1310 IF AVGCNT >= AVGNUM THEN WATE = TRUE
1320 GOSUB 4740:COMAND=1:CALL SEND!(COMAND,COMM):COMAND=0
1330 FOR I = 0 TO 10 / (BAUD + 1): GOSUB 3270: NEXT I
1340 CALL CKUART!(COMAND,COMM,EROR):IF COMAND=FRTCHG THEN
COMAND=0:EROR=0:GOTO 1200
1350 IF COMAND <> 0 OR EROR <> 0 THEN COMAND = 0: EROR = 0: GOTO 1330
```

```
1360 IF X$ <> "" THEN GOTO 1530
1370 '
1380 '*****START OF MAIN LOOP****************************
1390 '
1400 COUNT = 0: COMAND = 0: EROR = 0: FAST = FALSE: I = FRE(""): IF WATE = TRUE THEN GOTO 1420
1410 IF Y1Y2>0 AND MODE<4 THEN CALL SEND!(REQMEM,COMM):WATE=TRUE
1420 CALL CKUART!(COMAND,COMM,EROR)
1430 IF COMAND = 114 AND WATE = TRUE THEN GOTO 1460
1440 IF COMAND = 115 AND WATE = TRUE THEN COMAND = 0: PUT (0, 161), S, PRESET
1450 IF COMAND <> 0 OR EROR <> 0 THEN COMAND = 0: GOTO 1200 ELSE X$ = "": GOTO 1530
1460 WATE = FALSE: PUT (0, 161), T, PRESET
1470 CALL REQ!(Y1(0),Y2(0),Y1Y2,TRIG,COMM,BAUD,EROR):PUT(0,161),BLANK8,PRESET
1480 IF EROR = FALSE THEN GOTO 1490 ELSE GOTO 1530
1490 IF TRIG = 1 THEN MODE = MODE AND 7
1500 PUT (0, 161), BLANK8, PRESET: IF AVGY1 = TRUE OR AVGY2 = TRUE THEN GOTO 1690
1510 X$ = "": GOSUB 3270: GOSUB 1790
1520 ' CHECK FOR COMMANDS AND CLEAR KEYBOARD BUFFER
1530 GOSUB 3270: IF X$ = "" THEN GOTO 1630
1535 IF X$ = "S" THEN GOSUB 5600
1540 IF LEN(X$) <> 2 THEN GOTO 1610
1550 X = ASC(RIGHT$(X$, 1)) - 58
1555 IF X$ = "S" THEN GOSUB 5600
1560 ON X GOSUB 4400, 7040, 5210, 5250, 4980, 4465, 4535, 4900, 2170, 2170, 7040, 7040, 7040, 2350, 7040, 7040, 3330, 7040, 3320, 7040, 7040, 2360
1570 IF X = 13 AND PNT = 3 THEN OFFSETY1 = 0: GOSUB 1790: COMAND = Y1ZERO: GOTO 1620
1580 IF X = 13 AND PNT = 7 THEN OFFSETY2 = 0: GOSUB 1790: COMAND = Y2ZERO: GOTO 1620
1590 IF X = 13 AND PNT = 8 THEN HOFFSET = 0: GOSUB 1790: X$ = "": GOTO 1220
1600 IF X = 13 AND PNT = 12 THEN COMAND = TRGZERO: GOTO 1620:  ELSE X$ = "": GOTO 1530
1610 IF X$ = "?" OR X$ = "/" THEN GOTO 800 ELSE X$ = "": GOTO 1530
1620 CALL SEND!(COMAND,COMM):EROR=FALSE:COMAND=0:X$="":GOTO 1220
1630 IF Y1Y2 = 0 THEN GOSUB 1790: Y1Y2 = -1
1640 IF Y1Y2 = -1 THEN GOSUB 1860
1650 IF EROR = TRUE THEN EROR = FALSE: GOTO 1200:  ELSE GOTO 1400
1660 '
1670 '*****END OF MAIN LOOP******************************
1680 '
1690 AVGCNT = AVGCNT + 1: IF AVGCNT <= AVGNUM THEN GOTO 1710
1700 WATE = TRUE: GOTO 1530
1710 LOCATE 21, 20: PRINT "average #"; AVGCNT, "press F3 to restart averaging"
1720 IF AVGY1=TRUE THEN CALL AVG!(Y1(0),Y1SUM(0),AVGCNT)
1730 IF AVGY2=TRUE THEN CALL AVG!(Y2(0),Y2SUM(0),AVGCNT)
1740 IF AVGCNT = AVGNUM THEN WATE = TRUE
1750 GOTO 1510
1760 '
1770 '*****PLOT SCREEN SUBROUTINE************************
1780 '
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1790 LOCATE 20, 66: IF TRIG = 1 THEN PRINT "   triggered   ": GOTO 1820
1800 IF MODE = 12 THEN GOTO 1820
1810 IF MODE > 1 THEN PRINT " manual trigger" ELSE PRINT "   no trigger   "
1820 IF MEM1 = TRUE THEN LOCATE 22, 55: PRINT MEM1$; SPC(11 - LEN(MEM1$)); "=":
LOCATE 22, 67: PRINT SEN$(M1SEN); ";"; RATE$(M1RATE)
1830 IF MEM2 = TRUE THEN LOCATE 23, 55: PRINT MEM2$; SPC(11 - LEN(MEM2$)); "=":
LOCATE 23, 67: PRINT SEN$(M2SEN); ";"; RATE$(M2RATE)
1840 CALL GRAT!(GRATON)
1850 GOSUB 3270
1860 IF Y1COUP<>0 THEN CALL PLOT!(Y1(0),LYNE,INVERTY1,OFFSETY1,HOFFSET,X1,X2)
1870 IF Y2COUP<>0 THEN CALL PLOT!(Y2(0),LYNE,INVERTY2,OFFSETY2,HOFFSET,X3,X4)
1880 IF MEM1=TRUE THEN CALL
PLOT!(M1(0),LYNE,INVERTM1,OFFSETM1,HOFFSETM1,TRUE,TRUE)
1890 IF MEM2=TRUE THEN CALL
PLOT!(M2(0),LYNE,INVERTM2,OFFSETM2,HOFFSETM2,TRUE,TRUE)
1900 IF TRIG = 0 AND RATE < 14 THEN LOCATE 2, 20: PRINT "ERROR.....No Trigger"
1910 IF FAST = TRUE THEN RETURN
1920 IF C1Y = 3 AND C2Y = 3 THEN RETURN ELSE LOCATE 22, 10
1930 IF C1 = X1 THEN YC1! = (Y1(C1) - 128) * Y1SCALE!: GOTO 1950
1940 IF C1 = X3 THEN YC1! = (Y2(C1) - 128) * Y2SCALE! ELSE GOTO 1960
1950 YC! = YC1!: C = C1: GOSUB 2100: GOTO 1970
1960 PRINT SPC(25); : LOCATE 24, 10: PRINT SPC(25);
1970 LOCATE 23, 10: IF C2 = X2 THEN YC2! = (Y1(C2) - 128) * Y1SCALE!: GOTO 1990
1980 IF C2 = X4 THEN YC2! = (Y2(C2) - 128) * Y2SCALE! ELSE GOTO 2000
1990 YC! = YC2!: C = C2: GOSUB 2100: GOTO 2010
2000 PRINT SPC(25); : LOCATE 24, 10: PRINT SPC(25); : RETURN
2010 IF X1 = -1 AND X3 = -1 THEN RETURN
2020 LOCATE 24, 10: YC! = YC1! - YC2!: C = C1 - C2: GOSUB 2100
2030 LOCATE 24, 35: IF C = 0 THEN PRINT "                 "; : RETURN
2040 PRINT "("; : LOCATE 24, 36
2050 F! = 1 / (ABS(C) * FSCALE! * RSCALE!)                'CONVERT TO MHz
2060 IF F! > 999.999 THEN PRINT USING "#.####"; F! / 1000; : PRINT " GHz )"; : RETURN
2070 IF F! < .001 THEN PRINT USING "###.###"; F! * 1000000!; : PRINT " Hz  )"; : RETURN
2080 IF F! < 1 THEN PRINT USING "###.###"; F! * 1000; : PRINT " KHz )"; : RETURN
2090 PRINT USING "###.###"; F!; : PRINT " MHz )"; : RETURN
2100 IF ABS(YC!) < 1000 THEN PRINT USING "+###.#"; YC!; : PRINT " mV"; : GOTO 2120
2110 PRINT USING "+##.##"; YC! / 1000; : PRINT " V ";
2120 PRINT SPC(3); : PRINT USING "+####.##"; C * RSCALE!;
2130 PRINT R$; : GOSUB 3270: RETURN
2140 '
2150 '***** F9/F10 SELECT SUBROUTINES*******************
2160 '
2170 EROR = FALSE: COUNT = 0
2180 X$ = INKEY$: IF X$ <> "" THEN GOTO 2180
2190 ON POINTER(PNT, 2) GOSUB 2210, 2220, 2230, 2230, 2240, 2250, 2250, 2260, 2260, 2260
2200 GOTO 2270
2210 PUT (POINTER(PNT, 0), POINTER(PNT, 1)), BLANK1, XOR: RETURN
2220 PUT (POINTER(PNT, 0), POINTER(PNT, 1)), BLANK2, XOR: RETURN
2230 PUT (POINTER(PNT, 0), POINTER(PNT, 1)), BLANK3, XOR: RETURN
2240 PUT (POINTER(PNT, 0), POINTER(PNT, 1)), BLANK5, XOR: RETURN
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2250 PUT (POINTER(PNT, 0), POINTER(PNT, 1)), BLANK6, XOR: RETURN
2260 PUT (POINTER(PNT, 0), POINTER(PNT, 1)), BLANK8, XOR: RETURN
2270 IF X = 10 THEN PNT = PNT + 1: IF PNT > 13 THEN PNT = 0
2280 IF X = 9 THEN PNT = PNT - 1: IF PNT < 0 THEN PNT = 13
2290 ON POINTER(PNT, 2) GOSUB 2210, 2220, 2230, 2230, 2240, 2250, 2250, 2260, 2260, 2260
2300 X$ = "": GOSUB 3270: IF X$ = "" THEN RETURN 1280
2310 IF ASC(RIGHT$(X$, 1)) - 58 = X THEN GOTO 2170 ELSE RETURN 1280
2320 '
2330 '*****UP/DOWN ARROW SUBROUTINES******************
2340 '
2350 ARROW = 1: GOTO 2370
2360 ARROW = -1
2370 PUT (0, 161), BLANK8, PRESET: X$ = "": IF MODE < 5 THEN GOSUB 1840
2380 CMDCNT = 0: COUNT = 1: EROR = FALSE: T! = .3: RETURN 2390
2390 ON POINTER(PNT, 2) GOSUB 2210, 2220, 2230, 2230, 2240, 2250, 2250, 2260, 2260, 2260
2400 GOSUB 3270
2410 ON PNT + 1 GOTO 2420, 2440, 2460, 2510, 2570, 2590, 2610, 2660, 2940, 2720, 2770, 2790, 2810,
2900
2420 COMAND = Y1COUPLG: Y1COUP = Y1COUP + 1: Y1COUP = Y1COUP MOD 5: IF Y1COUP =
3 THEN Y1COUP = 4
2430 CMDCNT = CMDCNT + 1: GOTO 3030
2440 INVERTY1 = NOT INVERTY1: IF MODE < 5 THEN GOSUB 1840
2450 CMDCNT = 0: GOTO 3030
2460 IF ARROW = -1 THEN COMAND = Y1SENDN ELSE COMAND = Y1SENUP
2470 Y1SEN = Y1SEN - ARROW: IF Y1SEN > 9 THEN Y1SEN = 9
2480 IF Y1SEN < 0 THEN Y1SEN = 0
2490 CMDCNT = CMDCNT + 1: IF CMDCNT > 9 THEN CMDCNT = 9
2500 GOTO 3030
2510 COMAND = Y1POS: IF COUNT > 15 THEN COUNT = 15
2520 OFFSETY1 = OFFSETY1 + ARROW * COUNT
2530 IF OFFSETY1 >= 127 THEN OFFSETY1 = 127: GOTO 2550
2540 IF OFFSETY1 <= -128 THEN OFFSETY1 = -128
2550 Y = OFFSETY1: IF MODE < 5 THEN GOSUB 1840
2560 GOTO 3030
2570 COMAND = Y2COUPLG: Y2COUP = Y2COUP + 1: Y2COUP = Y2COUP MOD 5: IF Y2COUP =
3 THEN Y2COUP = 4
2580 CMDCNT = CMDCNT + 1: GOTO 3030
2590 INVERTY2 = NOT INVERTY2: IF MODE < 5 THEN GOSUB 1840
2600 CMDCNT = 0: GOTO 3030
2610 IF ARROW = -1 THEN COMAND = Y2SENDN ELSE COMAND = Y2SENUP
2620 Y2SEN = Y2SEN - ARROW: IF Y2SEN > 9 THEN Y2SEN = 9
2630 IF Y2SEN < 0 THEN Y2SEN = 0
2640 CMDCNT = CMDCNT + 1: IF CMDCNT > 9 THEN CMDCNT = 9
2650 GOTO 3030
2660 COMAND = Y2POS: IF COUNT > 15 THEN COUNT = 15
2670 OFFSETY2 = OFFSETY2 + ARROW * COUNT
2680 IF OFFSETY2 >= 127 THEN OFFSETY2 = 127: GOTO 2700
2690 IF OFFSETY2 <= -128 THEN OFFSETY2 = -128
2700 Y = OFFSETY2: IF MODE < 5 THEN GOSUB 1840
2710 GOTO 3030
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2720 IF ARROW = -1 THEN COMAND = TBASEDN ELSE COMAND = TBASEUP
2730 RATE = RATE - ARROW: IF RATE > 28 THEN RATE = 28
2740 IF RATE < 0 THEN RATE = 0
2750 CMDCNT = CMDCNT + 1: IF CMDCNT > 28 THEN CMDCNT = 28
2760 GOTO 3030
2770 COMAND = TRIGSCR: SOURCE = SOURCE + 1: SOURCE = SOURCE MOD 2
2780 CMDCNT = CMDCNT + 1: GOTO 3030
2790 COMAND = TRIGSLP: SLOPE = SLOPE + 1: SLOPE = SLOPE MOD 2
2800 CMDCNT = CMDCNT + 1: GOTO 3030
2810 COMAND = TRGLVL: IF COUNT > 10 THEN COUNT = 10
2820 IF SOURCE = 1 THEN LOFF = OFFSETY1 ELSE LOFF = OFFSETY2
2830 Y = 182.4 - (LEVEL + LOFF) * 4 / 5: IF Y > 0 AND Y < 160 AND CMDCNT <> 0 THEN PUT (1,
Y), TMARK, XOR
2840 LEVEL = LEVEL + ARROW * COUNT
2850 IF LEVEL < 1 THEN LEVEL = 1
2860 IF LEVEL > 255 THEN LEVEL = 255
2870 CMDCNT = 1: T! = .6
2880 Y = 182.4 - (LEVEL + LOFF) * 4 / 5: IF Y > 0 AND Y < 160 THEN PUT (1, Y), TMARK, XOR
2890 Y = LEVEL: GOTO 3030
2900 COMAND = TRIGMDE: IF MODE > 4 THEN Y = 8 ELSE Y = 0
2910 MODE = MODE + 1: MODE = MODE MOD 5: IF MODE = 0 THEN MODE = 1
2920 IF MODE = 3 THEN MODE = 4
2930 MODE = MODE + Y: CMDCNT = CMDCNT + 1: GOTO 3030
2940 IF COUNT > 25 THEN COUNT = 25
2950 HOFFSET = HOFFSET + ARROW * COUNT
2960 IF HOFFSET < -500 THEN HOFFSET = -500
2970 IF HOFFSET > 500 THEN HOFFSET = 500
2980 IF MODE < 5 THEN GOSUB 1840
2990 IF HOFFSET < 0 THEN PUT (600, 64), ARROWL, PSET ELSE PUT (600, 64), ARROWR, PSET
3000 IF HOFFSET = 0 THEN PUT (600, 64), ARROWL, OR
3010 CMDCNT = 0
3020 GOTO 3040
3030 ON PNT + 1 GOSUB 3830, 3830, 3830, 3830, 3920, 3920, 3920, 3920, 3830, 4000, 4030, 4030,
4060, 4030
3040 T0! = TIMER
3050 GOSUB 3270: IF X$ <> "" THEN GOTO 3070
3060 IF T0! + T! > TIMER THEN GOTO 3050 ELSE FAST = FALSE: GOTO 3130
3070 IF ASC(RIGHT$(X$, 1)) - 58 <> X THEN GOTO 3130
3080 GOSUB 3270: X$ = "": T0! = TIMER: KBD = 0
3090 GOSUB 3280: IF KBD > 1 THEN GOTO 3110 ELSE IF T0! + .18 > TIMER THEN GOTO 3090
3100 COUNT = 1: FAST = FALSE: GOTO 2410
3110 COUNT = COUNT * 3: IF COUNT > 50 THEN COUNT = 50
3120 FAST = TRUE: GOTO 2410
3130 ON POINTER(PNT, 2) GOSUB 2210, 2220, 2230, 2230, 2240, 2250, 2250, 2260, 2260, 2260
3140 IF PNT = 3 OR PNT = 7 OR PNT = 12 THEN GOTO 3170
3150 FOR I=1 TO CMDCNT:X!=TIMER:CALL SEND!(COMAND,COMM)
3160 IF X! + .1 > TIMER THEN GOTO 3160 ELSE NEXT I: GOTO 3200
3170 X!=TIMER:CALL SEND!(COMAND,COMM)
3180 IF X!+.1>TIMER THEN GOTO 3180 ELSE CALL SEND!(Y,COMM)
3190 IF X! + .2 > TIMER THEN GOTO 3190
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3200 COMAND = 0: COUNT = 0: CMDCNT = 0
3210 IF PNT = 1 OR PNT = 3 OR PNT = 5 OR PNT = 7 OR PNT = 8 THEN GOTO 3230
3220 WATE = FALSE: AVGCNT = 0
3230 IF PNT = 8 OR PNT = 1 OR PNT = 5 THEN GOTO 1280
3240 IF PNT <> 3 AND PNT <> 7 THEN GOTO 1200 ELSE X = OFFSETY1: Y = OFFSETY2
3250 CALL
REQFRT!(Y1SEN,Y2SEN,Y1COUP,Y2COUP,SLOPE,MODE,SOURCE,LEVEL,RATE,SAVMEM,SCOPE,
OFFSETY1,OFFSETY2,COMM,EROR)
3260 IF X <> OFFSETY1 OR Y <> OFFSETY2 THEN GOTO 1200 ELSE GOTO 1280
3270 Y$ = INKEY$: IF Y$ = "" THEN RETURN ELSE X$ = Y$: GOTO 3270
3280 Y$ = INKEY$: IF Y$ = "" THEN RETURN ELSE X$ = Y$: KBD = KBD + 1: GOTO 3280
3290 '
3300 '*****LEFT/RIGHT ARROW SUBROUTINES****************
3310 '
3320 ARROW = 1: GOTO 3340
3330 ARROW = -1
3340 PUT (0, 161), BLANK8, PRESET
3350 COUNT = 1: EROR = FALSE: IF PNT = 8 THEN GOSUB 2230: RETURN 3360 ELSE RETURN
3360
3360 IF PNT <> 8 THEN GOTO 3440
3370 IF COUNT > 25 THEN COUNT = 25
3380 HOFFSET = HOFFSET + ARROW * COUNT
3390 IF HOFFSET < -500 THEN HOFFSET = -500
3400 IF HOFFSET > 500 THEN HOFFSET = 500
3410 IF HOFFSET < 0 THEN PUT (600, 64), ARROWL, PSET ELSE PUT (600, 64), ARROWR, PSET
3420 IF HOFFSET = 0 THEN PUT (600, 64), ARROWL, OR
3430 GOTO 3580
3440 IF COUNT > 25 THEN COUNT = 25
3450 IF CURSOR <> 2 AND C1Y = 3 THEN LOCATE 24, 10: PRINT "CURSOR #1 IS OFF"; : GOTO
3710
3460 IF CURSOR <> 1 AND C2Y = 3 THEN LOCATE 24, 10: PRINT "CURSOR #2 IS OFF"; : GOTO
3710
3470 IF CURSOR <> 2 THEN C1 = C1 + COUNT * ARROW ELSE GOTO 3500
3480 IF C1 < 0 THEN C1 = 500
3490 IF C1 > 500 THEN C1 = 0
3500 IF CURSOR <> 1 THEN C2 = C2 + COUNT * ARROW ELSE GOTO 3530
3510 IF C2 < 0 THEN C2 = 500
3520 IF C2 > 500 THEN C2 = 0
3530 X1 = -1: X2 = -1: X3 = -1: X4 = -1
3540 IF C1Y = 1 AND Y1COUP <> 0 THEN X1 = C1
3550 IF C2Y = 1 AND Y1COUP <> 0 THEN X2 = C2
3560 IF C1Y = 2 AND Y2COUP <> 0 THEN X3 = C1
3570 IF C2Y = 2 AND Y2COUP <> 0 THEN X4 = C2
3580 X$ = "": IF MODE < 5 THEN GOSUB 1840
3590 T0! = TIMER
3600 GOSUB 3270: IF X$ <> "" THEN GOTO 3620
3610 IF T0! + .3 > TIMER THEN GOTO 3600 ELSE FAST = FALSE: GOTO 3690
3620 IF ASC(RIGHT$(X$, 1)) - 58 <> X THEN GOTO 3690
3630 GOSUB 3270: X$ = "": T0! = TIMER: KBD = 0
3640 GOSUB 3280: IF KBD > 1 THEN GOTO 3660 ELSE IF T0! + .18 > TIMER THEN GOTO 3640
```

```
3650 COUNT = 1: FAST = FALSE: GOTO 3670
3660 COUNT = COUNT * 3
3670 IF PNT = 8 THEN FAST = TRUE
3680 GOTO 3360
3690 IF PNT = 8 THEN GOSUB 2230
3700 COUNT = 0: FAST = FALSE: GOTO 1280
3710 LOCATE 24, 10: MT! = TIMER + 1: GOSUB 7830: PRINT SPC(17); : X$ = "": GOSUB 3270:
GOTO 3690
3720 '
3730 '*****REQUEST FRONT PANEL SUBROUTINE**************
3740 '
3750 PUT (0, 161), BLANK8, PRESET: COUNT = 0: GOSUB 3270
3760 CALL
REQFRT!(Y1SEN,Y2SEN,Y1COUP,Y2COUP,SLOPE,MODE,SOURCE,LEVEL,RATE,SAVMEM,SCOPE,
OFFSETY1,OFFSETY2,COMM,EROR)
3770 COMAND=1:CALL SEND!(COMAND,COMM):COMAND=0:IF EROR=FALSE THEN GOTO 3790
3780 IF EROR = TRUE THEN GOTO 3760 ELSE RETURN
3790 CALL CKUART!(COMAND,COMM,EROR)
3800 IF EROR <> 0 OR COMAND <> 0 THEN COMAND = 0: EROR = FALSE: GOTO 3760
3810 ON ERROR GOTO 4290
3820 GOSUB 3270
3830 LOCATE 1, 70: PRINT COUPLNG$(Y1COUP)
3840 LOCATE 1, 74: IF INVERTY1 = TRUE THEN PRINT "invert" ELSE PRINT "normal"
3850 LOCATE 2, 70: PRINT SEN$(Y1SEN)
3860 LOCATE 3, 73: X! = VAL(SEN$(Y1SEN)) / 25 * OFFSETY1
3870 IF Y1SEN = 5 OR Y1SEN = 6 THEN X! = X! / 1000
3880 IF Y1SEN < 5 THEN PRINT USING "+###.#"; X!; : PRINT "mV"
3890 IF Y1SEN > 5 THEN PRINT USING "+##.##"; X!; : PRINT " V"
3900 IF Y1SEN = 5 THEN PRINT USING "+#.###"; X!; : PRINT " V"
3910 IF COUNT > 0 THEN RETURN
3920 LOCATE 5, 70: PRINT COUPLNG$(Y2COUP)
3930 LOCATE 5, 74: IF INVERTY2 = TRUE THEN PRINT "invert" ELSE PRINT "normal"
3940 LOCATE 6, 70: PRINT SEN$(Y2SEN)
3950 LOCATE 7, 73: X! = VAL(SEN$(Y2SEN)) / 25 * OFFSETY2
3960 IF Y2SEN = 5 OR Y2SEN = 6 THEN X! = X! / 1000
3970 IF Y2SEN < 5 THEN PRINT USING "+###.#"; X!; : PRINT "mV"
3980 IF Y2SEN > 5 THEN PRINT USING "+##.##"; X!; : PRINT " V"
3990 IF Y2SEN = 5 THEN PRINT USING "+#.###"; X!; : PRINT " V"
4000 LOCATE 10, 70: PRINT RATE$(RATE): IF COUNT > 0 THEN RETURN
4010 IF HOFFSET < 0 THEN PUT (600, 64), ARROWL, PSET ELSE PUT (600, 64), ARROWR, PSET
4020 IF HOFFSET = 0 THEN PUT (600, 64), ARROWL, OR
4030 LOCATE 12, 78: IF SOURCE = 1 THEN PRINT "Y1" ELSE PRINT "Y2"
4040 LOCATE 14, 79: IF SLOPE = 1 THEN PRINT "+" ELSE PRINT "-"
4050 LOCATE 19, 75: PRINT MODE$(MODE MOD 8): IF COUNT > 0 THEN RETURN
4060 LOCATE 17, 70: GOSUB 3270
4070 IF SOURCE = 1 THEN TLVL! = VAL(SEN$(Y1SEN)) / 25 * (LEVEL - 128) ELSE GOTO 4120
4080 IF Y1SEN = 5 OR Y1SEN = 6 THEN TLVL! = TLVL! / 1000
4090 IF Y1SEN < 5 THEN PRINT USING "+###.#"; TLVL!; : PRINT "mV"
4100 IF Y1SEN > 5 THEN PRINT USING "+##.##"; TLVL!; : PRINT " V"
4110 IF Y1SEN = 5 THEN PRINT USING "+#.###"; TLVL!; : PRINT " V"
```

```
4120 IF SOURCE = 0 THEN TLVL! = VAL(SEN$(Y2SEN)) / 25 * (LEVEL - 128) ELSE GOTO 4180
4130 IF Y2SEN = 5 OR Y2SEN = 6 THEN TLVL! = TLVL! / 1000
4140 IF Y2SEN < 5 THEN PRINT USING "+###.#"; TLVL!; : PRINT "mV"
4150 IF Y2SEN > 5 THEN PRINT USING "+##.##"; TLVL!; : PRINT " V"
4160 IF Y2SEN = 5 THEN PRINT USING "+#.###"; TLVL!; : PRINT " V"
4170 IF COUNT > 0 THEN RETURN
4180 IF Y1COUP = 0 AND Y2COUP = 0 THEN Y1Y2 = 0
4190 IF Y1COUP <> 0 AND Y2COUP = 0 THEN Y1Y2 = 1
4200 IF Y1COUP = 0 AND Y2COUP <> 0 THEN Y1Y2 = 2
4210 IF Y1COUP <> 0 AND Y2COUP <> 0 THEN Y1Y2 = 3
4220 Y1SCALE! = VAL(SEN$(Y1SEN)) / 25: IF Y1SEN > 6 THEN Y1SCALE! = 1000 * Y1SCALE!
4230 Y2SCALE! = VAL(SEN$(Y2SEN)) / 25: IF Y2SEN > 6 THEN Y2SCALE! = 1000 * Y2SCALE!
4240 RSCALE! = VAL(RATE$(RATE)) / 50: R$ = RIGHT$(RATE$(RATE), 3)
4250 FSCALE! = 1: IF RATE < 6 THEN FSCALE! = .001
4260 IF RATE > 14 THEN FSCALE! = 1000
4270 IF RATE > 23 THEN FSCALE! = 1000000!
4280 ON ERROR GOTO 0: RETURN
4290 RESUME 3760
4300 '
4310 '*****LINE/DOT  GRAT ON/OFF  SUBROUTINES**********
4320 '
4340 PUT (0, 161), BLANK8, PRESET
4350 GRATON = NOT GRATON: GOTO 4420
4360 IF MENU <> 3 THEN GOTO 4410 ELSE RETURN 4400
4400 OPEN "O", 1, "BAUD.SAV": PRINT #1, BAUD, COMM, SCOPE: CLOSE #1: SYSTEM
4410 LYNE = NOT LYNE
4420 GOSUB 5070: EROR = FALSE: IF MODE < 5 THEN GOSUB 1790
4430 X$ = INKEY$: IF LEN(X$) <> 0 THEN GOTO 4430 ELSE RETURN 1280
4440 '
4450 '*****CURSOR CONTROL SUBROUTINE*******************
4460 '
4465 ON MENU GOTO 4470, 4340, 5620
4470 IF PNT = 8 THEN GOSUB 2230: PNT = 9: GOSUB 2250
4480 PUT (0, 161), BLANK8, PRESET
4490 CURSOR = CURSOR + 1: CURSOR = CURSOR MOD 3: GOSUB 5060: EROR = FALSE
4500 X$ = INKEY$: IF LEN(X$) <> 0 THEN GOTO 4500 ELSE RETURN 1280
4510 '
4520 '*****CURSOR SETUP SUBROUTINE*********************
4530 '
4535 ON MENU GOTO 4540, 4410, 6740
4540 IF PNT = 8 THEN GOSUB 2230: PNT = 9: GOSUB 2250
4550 PUT (0, 161), BLANK8, PRESET
4560 LOCATE 22, 1: PRINT SPC(54); : LOCATE 23, 1: PRINT SPC(54); : LOCATE 24, 1: PRINT
SPC(54);
4570 LOCATE 22, 1: PRINT "CHOOSE CHANNEL FOR CURSOR C1:  1) Y1   2) Y2   3) OFF "
4580 ON C1Y GOSUB 4800, 4810, 4820
4590 X$ = INKEY$: IF X$ = "" THEN GOTO 4590
4600 X = ASC(X$): IF X = 13 THEN GOTO 4630
4610 X = VAL(X$): IF X < 1 OR X > 3 THEN BEEP: GOSUB 3270: GOTO 4570
4620 ON C1Y GOSUB 4800, 4810, 4820: C1Y = X: ON C1Y GOSUB 4800, 4810, 4820
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4630 MT! = TIMER + 1: GOSUB 7830
4640 LOCATE 22, 1: PRINT "CHOOSE CHANNEL FOR CURSOR C2:  1) Y1   2) Y2   3) OFF "
4650 ON C2Y GOSUB 4800, 4810, 4820
4660 X$ = INKEY$: IF X$ = "" THEN GOTO 4660
4670 X = ASC(X$): IF X = 13 THEN GOTO 4700
4680 X = VAL(X$): IF X < 1 OR X > 3 THEN BEEP: GOSUB 3270: GOTO 4640
4690 ON C2Y GOSUB 4800, 4810, 4820: C2Y = X: ON C2Y GOSUB 4800, 4810, 4820
4700 MT! = TIMER + 1: GOSUB 7830: LOCATE 22, 1: PRINT SPC(54);
4710 GOSUB 4830
4720 GOSUB 4740: EROR = FALSE: X = 4: IF MODE < 5 THEN GOSUB 1790
4730 X$ = INKEY$: IF LEN(X$) <> 0 THEN GOTO 4730 ELSE RETURN 1280
4740 X1 = -1: X2 = -1: X3 = -1: X4 = -1
4750 IF C1Y = 1 AND Y1COUP <> 0 THEN X1 = C1
4760 IF C2Y = 1 AND Y1COUP <> 0 THEN X2 = C2
4770 IF C1Y = 2 AND Y2COUP <> 0 THEN X3 = C1
4780 IF C2Y = 2 AND Y2COUP <> 0 THEN X4 = C2
4790 RETURN
4800 PUT (271, 168), BLANK2, XOR: RETURN
4810 PUT (335, 168), BLANK2, XOR: RETURN
4820 PUT (399, 168), BLANK3, XOR: RETURN
4830 IF C1Y <> 3 THEN LOCATE 22, 6: PRINT "C1:"
4840 IF C2Y <> 3 THEN LOCATE 23, 6: PRINT "C2:"
4850 IF C1Y <> 3 AND C2Y <> 3 THEN LOCATE 24, 1: PRINT "[C1-C2]:";
4860 RETURN
4870 '
4880 '*****CHANGE MENU SUBROUTINE**********************
4890 '
4900 PUT (0, 161), BLANK8, PRESET
4910 MENU = MENU + 1: IF MENU = 4 THEN MENU = 1
4920 LOCATE 25, 1: GOSUB 5060
4930 X$ = INKEY$: IF X$ <> "" THEN GOTO 4930 ELSE RETURN 1280
4940 '
4950 '*****SCOPE ON/OFF SUBROUTINE
4960 '
4980 PUT (0, 161), BLANK8, PRESET
4990 SCOPE = NOT SCOPE: IF SCOPE = TRUE THEN COMAND = SCOPEON
5000 IF SCOPE = FALSE THEN COMAND = SCOPEOFF
5010 CALL SEND!(COMAND,COMM):COMAND=0:GOSUB 5070
5020 X$ = INKEY$: IF LEN(X$) <> 0 THEN GOTO 5020 ELSE RETURN 1280
5030 '
5040 '*****PRINT MENU SUBROUTINE***********************
5050 '
5060 LOCATE 25, 1: PRINT SPC(79);
5070 LOCATE 25, 1: PRINT "F1:EXIT          F3:ZCAL  F4:RST/MAN  F5:SCOPE  "; SPC(24);
"F8:NEXT";
5080 LOCATE 25, 49: IF MENU = 1 THEN PRINT "F6:C1/C2  F7:DEF CURSOR ";
5090 IF MENU = 2 THEN PRINT "F6:GRAT    F7:LINE/DOT  ";
5100 IF SCOPE = TRUE THEN PUT (328, 192), BLANK5, XOR
5105 IF MENU = 3 THEN PRINT "F6:MEMORY   F7:AVERAGE  "; : RETURN
5110 IF MENU = 1 AND CURSOR = 1 THEN PUT (408, 192), BLANK2, XOR: RETURN
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5120 IF MENU = 1 AND CURSOR = 2 THEN PUT (432, 192), BLANK2, XOR: RETURN
5130 IF MENU = 1 THEN PUT (408, 192), BLANK5, XOR: RETURN
5150 IF GRATON = TRUE THEN PUT (408, 192), BLANK4, XOR
5160 IF LYNE = TRUE THEN PUT (496, 192), BLANK4, XOR ELSE PUT (536, 192), BLANK3, XOR
5170 RETURN
5180 '
5190 '*****RE-ZERO  MANUAL TRIGGER/RESET SUBROUTINES************
5200 '
5210 AVGCNT = 0: WATE = FALSE
5220 PUT (0, 161), BLANK8, PRESET
5230 CALL SEND!(REZERO,COMM):GOSUB 5430
5240 X$ = INKEY$: IF LEN(X$) <> 0 THEN GOTO 5240 ELSE RETURN 1200
5250 PUT (0, 161), BLANK8, PRESET
5260 IF MODE<4 THEN CALL SEND!(MANTRG,COMM):RETURN
5270 ON POINTER(PNT, 2) GOSUB 2210, 2220, 2230, 2230, 2240, 2250, 2250, 2260, 2260, 2260
5280 GOSUB 3750
5290 ON POINTER(PNT, 2) GOSUB 2210, 2220, 2230, 2230, 2240, 2250, 2250, 2260, 2260, 2260
5300 IF MODE = 12 THEN GOTO 5370
5310 IF AVGCNT >= AVGNUM THEN RETURN
5320 X!=TIMER:CALL SEND!(REZERO,COMM):MODE=12
5330 IF X! + .1 > TIMER THEN GOTO 5330
5340 CALL SEND!(RSTREQ,COMM):WATE=TRUE:LOCATE 20,66:PRINT"      armed      "
5350 CALL GRAT!(GRATON)
5360 X$ = INKEY$: IF LEN(X$) <> 0 THEN GOTO 5360 ELSE RETURN 1400
5370 X!=TIMER:CALL SEND!(RSTREQ,COMM)
5380 IF X! + .1 > TIMER THEN GOTO 5380
5390 CALL SEND!(MANTRG,COMM):MODE=4:GOTO 5350
5400 '
5410 '*****RIGHT SIDE SUBROUTINE**********************
5420 '
5430 ON POINTER(PNT, 2) GOSUB 2210, 2220, 2230, 2230, 2240, 2250, 2250, 2260, 2260, 2260
5440 LOCATE 1, 65: PRINT "Y1:": LOCATE 1, 73: PRINT "(": LOCATE 1, 80: PRINT ")"
5450 LOCATE 2, 77: PRINT "/div": LOCATE 3, 66: PRINT "Offset:"
5460 LOCATE 5, 65: PRINT "Y2:": LOCATE 5, 73: PRINT "(": LOCATE 5, 80: PRINT ")"
5470 LOCATE 6, 77: PRINT "/div": LOCATE 7, 66: PRINT "Offset:": LOCATE 9, 65: PRINT
"TIMEBASE:"
5480 PUT (600, 64), ARROWL, OR: PUT (600, 64), ARROWR, OR: LOCATE 10, 77: PRINT "/div"
5490 LOCATE 12, 65: PRINT "TRIG SOURCE:"
5500 LOCATE 14, 65: PRINT "TRIG SLOPE:  (": LOCATE 14, 80: PRINT ")"
5510 LOCATE 16, 65: PRINT "TRIG LEVEL:": LOCATE 19, 65: PRINT "TRIG MODE:"
5520 LOCATE 20, 65: PRINT SPC(16);
5530 ON POINTER(PNT, 2) GOSUB 2210, 2220, 2230, 2230, 2240, 2250, 2250, 2260, 2260, 2260
5540 IF AVGY1 <> TRUE AND AVGY2 <> TRUE THEN RETURN
5550 LOCATE 21, 20: PRINT "average #"; AVGCNT, "press F3 to restart averaging"
5560 IF AVGY1 = TRUE THEN LOCATE 2, 64: PRINT "avg" ELSE PRINT "   "
5570 IF AVGY2 = TRUE THEN LOCATE 6, 64: PRINT "avg" ELSE PRINT "   "
5580 RETURN
5590 '
5600 '*****MEMORY SUBROUTINE**************************
5610 '
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5620 LOCATE 25, 1: PRINT SPC(79); : X1 = -1: X2 = -1: X3 = -1: X4 = -1
5630 PUT (0, 161), BLANK8, PRESET
5640 RETURN 5650
5650 'LOCATE 22, 1: PRINT "SELECTION:  1) SAVE WAVEFORM ON DISK"; : PRINT SPC(16);
5660 'LOCATE 23, 1: PRINT SPC(13); "2) RECALL WAVEFORM FROM DISK"; : PRINT SPC(12);
5670 'LOCATE 24, 1: PRINT SPC(13); "3) MEMORY ON/OFF"; : PRINT SPC(24);
5680 GOSUB 6680
5690 'X$ = INKEY$: IF X$ = "" THEN GOTO 5690
5700 IF ASC(RIGHT$(X$, 1)) = 64 THEN GOSUB 6650
5710 X = 1: LOCATE 22, 1: PRINT SPC(54); : PRINT : PRINT SPC(54); : PRINT : PRINT SPC(54);
5720 ON X GOTO 6000, 6000, 5740
5730 BEEP: GOSUB 3270: GOTO 5650
5740 LOCATE 22, 1: PRINT "MEM1:  1) ON ": LOCATE 23, 8: PRINT "2) OFF ": GOSUB 5830
5750 X$ = INKEY$: IF X$ = "" THEN GOTO 5750
5760 IF ASC(RIGHT$(X$, 1)) = 64 THEN GOSUB 6650
5770 X = ASC(X$): IF X = 13 THEN GOTO 5850
5780 X = VAL(X$): IF X < 1 OR X > 2 THEN BEEP: GOSUB 3270: GOTO 5740
5790 GOSUB 5830: IF X = 1 AND MEM1$ = "" THEN MEM1 = FALSE: LOCATE 24, 1: PRINT
"ERROR....Data has not been loaded into MEM1"; : MT! = TIMER + 3: GOSUB 7830: LOCATE 24, 1:
PRINT SPC(54);
5800 GOSUB 6680
5810 IF X = 1 AND MEM1$ <> "" THEN MEM1 = TRUE ELSE MEM1 = FALSE
5820 GOSUB 5830: MT! = TIMER + 1: GOSUB 7830: GOTO 5850
5830 IF MEM1 = TRUE THEN PUT (79, 168), BLANK2, XOR ELSE PUT (79, 176), BLANK3, XOR
5840 RETURN
5850 LOCATE 22, 1: PRINT "MEM2:  1) ON ": LOCATE 23, 8: PRINT "2) OFF ": GOSUB 5980
5860 X$ = INKEY$: IF X$ = "" THEN GOTO 5860
5870 IF ASC(RIGHT$(X$, 1)) = 64 THEN GOSUB 6650
5880 X = ASC(X$): IF X = 13 THEN GOTO 5930
5890 X = VAL(X$): IF X < 1 OR X > 2 THEN BEEP: GOSUB 3270: GOTO 5850
5900 GOSUB 5980: IF X = 1 AND MEM2$ = "" THEN MEM2 = FALSE: LOCATE 24, 1: PRINT
"ERROR....Data has not been loaded into MEM2"; : MT! = TIMER + 3: GOSUB 7830: LOCATE 24, 1:
PRINT SPC(54);
5910 IF X = 1 AND MEM2$ <> "" THEN MEM2 = TRUE ELSE MEM2 = FALSE
5920 GOSUB 5980: MT! = TIMER + 1: GOSUB 7830
5930 GOSUB 5060
5940 LOCATE 22, 1: PRINT SPC(54); : PRINT : PRINT SPC(54);
5950 IF MEM1 = FALSE THEN LOCATE 22, 55: PRINT SPC(25);
5960 IF MEM2 = FALSE THEN LOCATE 23, 55: PRINT SPC(25);
5970 GOSUB 4710
5980 IF MEM2 = TRUE THEN PUT (79, 168), BLANK2, XOR ELSE PUT (79, 176), BLANK3, XOR
5990 RETURN
6000 GOTO 6190: 'LOCATE 22, 1: PRINT "Do you wish to see the directory <Y or N>?          ";
6010 ON ERROR GOTO 6620
6020 X$ = INKEY$: IF X$ = "" THEN GOTO 6020
6030 IF ASC(RIGHT$(X$, 1)) = 64 THEN GOSUB 6650
6040 IF X$ = "N" OR X$ = "n" THEN GOTO 6190
6050 IF X$ = "Y" OR X$ = "y" THEN GOTO 6070
6060 BEEP: GOSUB 3270: GOTO 6000
6070 LOCATE 25, 1: PRINT SPC(54);
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6080 LOCATE 22, 1: PRINT "Drive name <Type 'RETURN' for default drive> ? ": LINE INPUT X$
6090 PRINT " "; : LOCATE 23, 1: IF X$ = "" THEN FILES ELSE FILES X$
6100 PRINT : PRINT "Press any key to continue.";
6110 X$ = INKEY$: IF X$ = "" THEN GOTO 6110
6120 GOSUB 6680
6130 FOR I = 1 TO 24: LOCATE I, 1: PRINT SPC(40); SPC(40); : NEXT I
6140 GOSUB 5440: GOSUB 1790
6150 ON POINTER(PNT, 2) GOSUB 2210, 2220, 2230, 2230, 2240, 2250, 2250, 2260, 2260, 2260
6160 GOSUB 3830
6170 ON POINTER(PNT, 2) GOSUB 2210, 2220, 2230, 2230, 2240, 2250, 2250, 2260, 2260, 2260
6180 ON ERROR GOTO 6620
6190 GOTO 6200
6200 'LOCATE 22, 1: PRINT "Which channel do you want to save?    1) Y1        "
6210 'LOCATE 23, 40: PRINT "2) Y2 "
6220 'X$ = INKEY$: IF X$ = "" THEN GOTO 6220
6230 'IF ASC(RIGHT$(X$, 1)) = 64 THEN GOSUB 6650
6240 'X = VAL(X$): IF X < 1 OR X > 2 THEN BEEP: GOSUB 3270: GOTO 6200
6250 LOCATE 25, 1: PRINT SPC(54);
6255 IF CNTR > 0 THEN 6273
6257 CNTR = 64
6260 LOCATE 22, 1: PRINT SPC(54); : PRINT : PRINT SPC(54); : LOCATE 22, 1: PRINT "PATH TO
SAVE AND SUBJECT NUMBER (C:\EMGDATA\S01\DYNA1)";
6270 LINE INPUT SN$: LOCATE 23, 1: PRINT " "
6271 LOCATE 22, 1: PRINT SPC(54); : PRINT : PRINT SPC(54);
6272 EMGSEN! = .01: LOCATE 23, 1: PRINT " "
6273 CNTR = CNTR + 1
6274 IF CNTR > 90 THEN SIG$ = "A" + CHR$(CNTR - 26): GOTO 6278
6277 SIG$ = CHR$(CNTR)
6278 P$ = SN$ + "EMG" + "." + SIG$
6279 OPEN "O", 1, P$
6280 'PRINT #1, Y1SEN; RATE; INVERTY1; OFFSETY1; HOFFSET;
6285 FOR I = 0 TO 511: EMG! = ((Y1(I) - 128) * EMGSEN!) / 25
6290 WRITE #1, EMG!: NEXT I
6300 'PRINT #1, Y2SEN; RATE; INVERTY2; OFFSETY2; HOFFSET;
6302 CLOSE #1
6303 FSEN! = .5
6305 F$ = SN$ + "F" + "." + SIG$
6306 OPEN "O", 1, F$
6308 FOR I = 0 TO 511: V! = ((Y2(I) - 128) * FSEN!) / 25
6309 F! = (V! - .290357) / 1.807143E-02
6310 WRITE #1, F!: NEXT I
6320 CLOSE #1: ON ERROR GOTO 0
6330 'LOCATE 22, 1: PRINT "Would you like to save another waveform <Y or N>?"
6340 X = 1
6350 'X$ = INKEY$: IF X$ = "" THEN GOTO 6350
6355 X$ = "N"
6360 IF ASC(RIGHT$(X$, 1)) = 64 THEN GOSUB 6650
6370 IF X$ = "Y" OR X$ = "y" THEN GOTO 6000
6380 LOCATE 22, 1: PRINT SPC(54); : PRINT : PRINT SPC(54); : PRINT : PRINT SPC(54);
6390 GOSUB 5060: GOSUB 4710
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6400 LOCATE 22, 1: PRINT "Which memory do you want to use?  1) MEM1         "
6410 LOCATE 23, 36: PRINT "2) MEM2 "
6420 X$ = INKEY$: IF X$ = "" THEN GOTO 6420
6430 IF ASC(RIGHT$(X$, 1)) = 64 THEN GOSUB 6650
6440 X = VAL(X$): IF X < 1 OR X > 2 THEN BEEP: GOSUB 3270: GOTO 6400
6450 LOCATE 25, 1: PRINT SPC(54);
6460 LOCATE 22, 1: PRINT SPC(54); : PRINT : PRINT SPC(54); : LOCATE 22, 1: PRINT
"FILENAME? ";
6470 LINE INPUT X$: LOCATE 23, 1: PRINT " ": OPEN "I", 1, X$: GOSUB 6680: ON X GOTO 6480,
6510
6480 INPUT #1, M1SEN, M1RATE, INVERTM1, OFFSETM1, HOFFSETM1
6490 FOR I = 0 TO 511: INPUT #1, M1(I): NEXT I
6500 MEM1 = TRUE: MEM1$ = LEFT$(X$, 11): GOTO 6540
6510 INPUT #1, M2SEN, M2RATE, INVERTM2, OFFSETM2, HOFFSETM2
6520 FOR I = 0 TO 511: INPUT #1, M2(I): NEXT I
6530 MEM2 = TRUE: MEM2$ = LEFT$(X$, 11)
6540 CLOSE #1: ON ERROR GOTO 0: GOSUB 1790
6550 LOCATE 22, 1: PRINT "Would you like to recall another waveform  <Y or N>?"
6560 X = 2
6570 X$ = INKEY$: IF X$ = "" THEN GOTO 6570
6580 IF ASC(RIGHT$(X$, 1)) = 64 THEN GOSUB 6650
6590 IF X$ = "Y" OR X$ = "y" THEN GOTO 6000
6600 LOCATE 22, 1: PRINT SPC(54); : PRINT : PRINT SPC(54); : PRINT : PRINT SPC(54);
6610 GOSUB 5060: GOSUB 4710
6620 LOCATE 22, 1: PRINT SPC(54); : PRINT : PRINT SPC(54); : PRINT : PRINT SPC(54);
6630 LOCATE 22, 1: PRINT "DISK ERROR......Error Code: "; ERR
6640 FOR I = 0 TO 3000: NEXT I: CLOSE #1: RESUME 5650
6650 LOCATE 22, 1: PRINT SPC(54); : PRINT : PRINT SPC(54); : PRINT : PRINT SPC(54);
6660 GOSUB 5060: RETURN 6670
6670 CLOSE #1: ON ERROR GOTO 0: GOSUB 4710
6680 LOCATE 25, 15: PRINT "Press F6 again to exit this function";
6690 PUT (110, 192), BLANK8, XOR: PUT (176, 192), BLANK8, XOR: PUT (242, 192), BLANK8, XOR
6700 PUT (308, 192), BLANK8, XOR: PUT (374, 192), BLANK6, XOR: RETURN
6710 '
6720 '************AVERAGING SUBROUTINE*****************
6730 '
6740 PUT (0, 161), BLANK8, PRESET
6750 LOCATE 21, 10: PRINT SPC(65); : GOSUB 1790: AVGCNT = 0: WATE = FALSE
6760 LOCATE 22, 1: PRINT SPC(54); : PRINT : PRINT SPC(54); : PRINT : PRINT SPC(54);
6770 LOCATE 22, 1: PRINT "Select channel to be averaged:"
6780 PRINT "          1) Y1        3) Y1 and Y2"
6790 PRINT "          2) Y2        4) AVERAGING OFF";
6800 GOSUB 6970
6810 X$ = INKEY$: IF X$ = "" THEN GOTO 6810
6820 IF ASC(X$) = 13 THEN GOTO 6880
6830 X = VAL(X$): IF X < 1 OR X > 4 THEN BEEP: GOSUB 3270: GOTO 6770
6840 GOSUB 6970: IF X = 1 THEN AVGY1 = TRUE: AVGY2 = FALSE: GOTO 6880
6850 IF X = 2 THEN AVGY1 = FALSE: AVGY2 = TRUE: GOTO 6880
6860 IF X = 3 THEN AVGY1 = TRUE: AVGY2 = TRUE: GOTO 6880
6870 IF X = 4 THEN AVGY1 = FALSE: AVGY2 = FALSE: AVGCNT = -1
```

```
6880 GOSUB 6970: LOCATE 22, 1: PRINT SPC(54); : PRINT : PRINT SPC(54); : PRINT
6890 LOCATE 24, 1: PRINT SPC(54); : IF AVGY1 = FALSE AND AVGY2 = FALSE THEN WATE =
FALSE: GOTO 4710
6900 LOCATE 22, 1: PRINT "Select number of averages <"; : ON ERROR GOTO 7030
6910 PRINT USING "###"; AVGNUM; : PRINT ">"; : PUT (215, 168), BLANK3, XOR
6920 INPUT "   ", X$: IF X$ = "" THEN GOTO 6960
6930 X = VAL(X$): IF X > 0 AND X < 251 THEN AVGNUM = X: GOTO 6960
6940 BEEP: GOSUB 3270: LOCATE 24, 1: PRINT "Number of averages must be between 1 and 250";
6950 FOR I = 0 TO 3000: NEXT I: LOCATE 24, 1: PRINT SPC(54); : GOTO 6880
6960 ON ERROR GOTO 0: LOCATE 22, 1: PRINT SPC(54); : WATE = FALSE: GOSUB 5430: GOTO
4710
6970 LOCATE 2, 64: IF AVGY1 = TRUE THEN PRINT "avg" ELSE PRINT "   "
6980 LOCATE 6, 64: IF AVGY2 = TRUE THEN PRINT "avg" ELSE PRINT "   "
6990 IF AVGY1 = TRUE AND AVGY2 = TRUE THEN PUT (215, 176), BLANK6, XOR: PUT (265,
176), BLANK3, XOR: RETURN
7000 IF AVGY1 = FALSE AND AVGY2 = FALSE THEN PUT (215, 184), BLANK8, XOR: PUT (281,
184), BLANK5, XOR: RETURN
7010 IF AVGY1 = TRUE THEN PUT (103, 176), BLANK2, XOR: RETURN
7020 PUT (103, 184), BLANK2, XOR: RETURN
7030 RESUME 6940
7040 RETURN
7800 '
7810 '*** TIMER ROUTINE
7820 LOCATE 25, 1: PRINT "<press any key to continue>";
7830 XTX$ = INKEY$: T! = TIMER: IF (T! < MT!) AND (XTX$ = "") THEN 7830
7840 RETURN
```

```
'CALCULATE RMS FOR EACH EMG RECORD
'************************************************
DIM V!(512), NAME$(78), AVGV!(78), VS!(512), RMS!(78)
'CLS : LOCATE 10, 10
'PRINT "VERIFY THAT PRINTER IS ON LINE....................": INPUT Z
'CLS : LOCATE 10, 10: PRINT "ENTER SUBJECT NUMBER:": LINE INPUT SUBN$
'LPRINT SUBN$, SUBN$, SUBN$, SUBN$, SUBN$
'LPRINT
5 CLS : LOCATE 10, 1
NS = 0
PRINT "ENTER PATH TO FORCE FILES (B:\BOB\BOB1) :": LINE INPUT PATH$
10 PRINT "ENTER NUMBER OF FILES TO CALCULATE, (MAX. NUMBER IS 78) :": INPUT NS
IF NS > 78 THEN GOTO 10
NSA = 64 + NS
FILE1$ = PATH$ + "\EMG.A": FILE2$ = PATH$ + "\EMG." + CHR$(NSA)
LOCATE 17, 1
PRINT "IS THIS CORRECT (Y,N):"
PRINT "                    READ FILES "; FILE1$; " - "; FILE2$
LINE INPUT X$: IF X$ = "N" THEN GOTO 5
CLS
'********************MAIN LOOP**********************
FOR J = 65 TO NSA
L = J - 64
IF J > 90 THEN SIG$ = "A" + CHR$(J - 26): GOTO 20
IF J > 116 THEN SIG$ = "B" + CHR$(J - 52): GOTO 20
SIG$ = CHR$(J)
20 NAME$(L) = PATH$ + "\EMG." + SIG$
OPEN "I", 1, NAME$(L)
'********************READ IN DATA********************
VSTOT! = 0: AVGV! = 0: VS! = 0: RMS! = 0
FOR I = 1 TO 512
INPUT #1, V!(I)
VS!(I) = (V!(I)) ^ 2
VSTOT! = VSTOT! + VS!(I)
NEXT I
CLOSE #1
'********************CALCULATE MEAN VOLTAGE**********
AVGV!(L) = VSTOT! / 512
RMS!(L) = SQR(AVGV!(L))
'********************PRINT MEAN**********************
PRINT "RMS FOR "; NAME$(L); " = "; RMS!(L)
'LPRINT "RMS FOR "; NAME$(L); " = "; RMS!(L)
NEXT J
OUTFILE$ = PATH$ + "\RMS.CSV"
OPEN "O", 1, OUTFILE$
WRITE #1, "PATH", "RMS"
FOR K = 1 TO NS
WRITE #1, NAME$(K), RMS!(K)
NEXT K
CLOSE #1
```

```
'CALCULATE MEAN FORCE DURING EACH EMG RECORD
'***********************************************
DIM F!(512), AVGF!(78)
CLS : LOCATE 10, 10
NSA = 64 + NS
FILE1$ = PATH$ + "\F.A": FILE2$ = PATH$ + "\F." + CHR$(NSA)
LOCATE 17, 1
CLS
'********************MAIN LOOP**********************
FOR J = 65 TO NSA
L = J - 64
IF J > 90 THEN SIG$ = "A" + CHR$(J - 26): GOTO 30
IF J > 116 THEN SIG$ = "B" + CHR$(J - 52): GOTO 30
SIG$ = CHR$(J)
30 NAME$(L) = PATH$ + "\F." + SIG$
OPEN "I", 1, NAME$(L)
'********************READ IN DATA********************
FTOT! = 0: AVGF! = 0
FOR I = 1 TO 512
INPUT #1, F!(I)
FTOT! = FTOT! + F!(I)
NEXT I
CLOSE #1
'********************CALCULATE MEAN FORCE**********
AVGF!(L) = FTOT! / 512
'********************PRINT MEAN**********************
PRINT "MEAN FORCE FOR "; NAME$(L); " = "; AVGF!(L)
'LPRINT "MEAN FORCE FOR "; NAME$(L); " = "; AVGF!(L)
NEXT J
OUTFILE$ = PATH$ + "\AVGFORCE.CSV"
OPEN "O", 1, OUTFILE$
WRITE #1, "PATH", "FORCE"
FOR K = 1 TO NS
WRITE #1, NAME$(K), AVGF!(K)
NEXT K
CLOSE #1


'CALCULATE MEAN POWER FREQUENCY MPF
'*******************************
DIM PSD!(256), MEAN!(78)
CLS : LOCATE 10, 10
IF NS > 78 THEN GOTO 10
NSA = 64 + NS
CLS
'********************MAIN LOOP**********************
FOR J = 65 TO NSA
L = J - 64
IF J > 90 THEN SIG$ = "A" + CHR$(J - 26): GOTO 40
IF J > 116 THEN SIG$ = "B" + CHR$(J - 52): GOTO 40
```

```
SIG$ = CHR$(J)
40 NAME$(L) = PATH$ + "\PSD." + SIG$
OPEN "I", 1, NAME$(L)
'********************READ IN DATA********************
FOR I = 1 TO 256
INPUT #1, PSD!(I)
NEXT I
CLOSE #1
FP! = 0: FREQ = 0: PSDTOT! = 0: MEAN! = 0
'********************CALCULATE MEAN*******************
'*******************************FROM 1 TO 350 Hz******
FOR I = 1 TO 175
FP! = FP! + PSD!(I) * FREQ
FREQ = FREQ + 2
PSDTOT! = PSDTOT! + PSD!(I)
NEXT I
MEAN!(L) = FP! / PSDTOT!
'********************PRINT MEAN**********************
PRINT "MEAN FREQUENCY OF PSD FOR "; NAME$(L); " = "; MEAN!(L)
'LPRINT "MEAN FREQUENCY OF PSD FOR "; NAME$(L); " = "; MEAN!(L)
NEXT J
OUTFILE$ = PATH$ + "\FREQMEAN.CSV"
OPEN "O", 1, OUTFILE$
WRITE #1, "PATH", "MPF"
FOR K = 1 TO NS
WRITE #1, NAME$(K), MEAN!(K)
NEXT K
END


'***CALCULATE FREQUENCIES OF -3dB POWER*************
'*****FREQUENCY RANGE OF 0 TO 200 Hz***************
'**************************************************
Q = 500
DIM P!(256), NAME$(78), PT(Q), F!(256), PDB!(Q)
DIM AP!(78), BP!(78), AF!(78), BF!(78), RATIO!(78), DIFF!(78)
CLS : LOCATE 10, 10
PRINT "VERIFY THAT PRINTER IS ON LINE..................": INPUT Z
CLS : LOCATE 10, 10: PRINT "ENTER SUBJECT NUMBER :": LINE INPUT SUBN$
'LPRINT SUBN$, SUBN$, SUBN$, SUBN$, SUBN$
'LPRINT
5 CLS : LOCATE 10, 1
NS = 0
PRINT "ENTER PATH TO PSD FILES (B:\BOB\BOB1) :": LINE INPUT SN$
10 PRINT "ENTER NUMBER OF FILES TO CALCULATE, (MAX. NUMBER IS 78) :": INPUT NS
IF NS > 78 THEN GOTO 10
NSA = 64 + NS
FILE1$ = SN$ + "\SMOOTH.A": FILE2$ = SN$ + "\SMOOTH." + CHR$(NSA)
LOCATE 17, 1
PRINT "IS THIS CORRECT (Y,N):"
```

```
PRINT "                        READ FILES "; FILE1$; " - "; FILE2$
LINE INPUT X$: IF X$ = "N" THEN GOTO 5
CLS
'*******************MAIN LOOP**********************
K! = 10 ^ (-3 / 20)
FOR J = 65 TO NSA
L = J - 64
IF J > 90 THEN SIG$ = "A" + CHR$(J - 26): GOTO 20
IF J > 116 THEN SIG$ = "B" + CHR$(J - 52): GOTO 20
SIG$ = CHR$(J)
20 NAME$(L) = SN$ + "\SMOOTH." + SIG$
TPF! = 0: FBW = 2: TF = 200
OPEN "I", 1, NAME$(L)
'*******************READ IN DATA*******************
FOR I = 1 TO 100
INPUT #1, P!(I)
F!(I) = ((I - 1) * 2)
TPF! = TPF! + P!(I) * FBW
NEXT I
CLOSE #1
PAVG! = TPF! / TF
SC = 0
'**************************************************************
'****************SEARCH FOR -3dB POWERS AND FREQ.'S**************
B! = PAVG! * K!: C! = (B! + .01)
FOR X = 1 TO 100
IF (P!(X) < B!) OR (P!(X) > C!) THEN GOTO 35
SC = SC + 1
PT(SC) = X
'PRINT SC; PT(SC); F!(X)
35 NEXT X
'*******************PRINT RESULTS**********************
FS = PT(1)
LS = PT(SC)
40 PRINT NAME$(L); "  THE SEARCH FOUND "; SC; " POINTS!"
   PRINT "          "; "FIRST"; FS; P!(FS); F!(FS)
   PRINT "          "; "LAST"; LS; P!(LS); F!(LS)
'  LPRINT NAME$(L); "  THE SEARCH FOUND "; SC; " POINTS!  :  PAVG ="; PAVG!
'  LPRINT "          "; "FIRST"; FS; P!(FS); F!(FS)
'  LPRINT "          "; "LAST"; LS; P!(LS); F!(LS)

AP!(L) = P!(FS): AF!(L) = F!(FS)
BP!(L) = P!(LS): BF!(L) = F!(LS)
IF AF!(L) = 0 THEN AF!(L) = 1
RATIO!(L) = BF!(L) / AF!(L)
DIFF!(L) = BF!(L) - AF!(L)
NEXT J

OUTFILE$ = SN$ + "\DBELL.CSV"
OPEN "O", 1, OUTFILE$
```

```
WRITE #1, "PATH", "LF", "HF", "HF/LF", "HF-LF"
FOR K = 1 TO NS
WRITE #1, NAME$(K), AF!(K), BF!(K), RATIO!(K), DIFF!(K)
NEXT K
CLOSE #1
END
```

```
!DADISP COMMAND FILE TO READ EMG'S

Q
@POP("P1",-1,-1,"ENTER LABBOOK TO OPEN")
O
@SUSPEND("@CR")
@UNPOP("P1")
U
I
@F2
@POP("P2",-1,-1,"SUBJECT# \ TRIAL")
C:\EMGDATA\
@SUSPEND("@CR")
@UNPOP("P2")
@PAUSE(3)
EMG.A
@CR
E
@DN @DN @DN @DN @DN @DN
V @CR
@DN
1024 @CR
@F2
@PAUSE(3)
P

I
EMG.B
@CR
P

I
EMG.C
@CR
P

I
EMG.D
@CR
P

I
EMG.E
@CR
P

-- CONTINUED THROUGH EMG.AZ --
```

```
!DADISP COMMAND FILE TO
!GET AND SAVE SMOOTHED PSD'S
@POP("P3",-1,-1,"PUT STORAGE DISC IN A DRIVE [SPACE BAR]")
@BEEP(3)
@SUSPEND_NOPASS("@SP")
@UNPOP("P3")
Q
@POP("P1",-1,-1,"ENTER LABBOOK TO OPEN")
O
@SUSPEND("@CR")
@UNPOP("P1")


W
A 3 @CR
E @F8 EMG.1 @CR @CR
@DN PSD(W1) @CR
@DN MOVAVG(W2,10) @CR
WRITEA("A:\SMOOTH.A",W3) @CR
WRITEA("A:\PSD.A",W2) @CR

@CNTL_HOME
@F8 EMG.2 @CR @CR
@DN PSD(W1) @CR
@DN MOVAVG(W2,10) @CR
WRITEA("A:\SMOOTH.B",W3) @CR
WRITEA("A:\PSD.B",W2) @CR

@CNTL_HOME
@F8 EMG.3 @CR @CR
@DN PSD(W1) @CR
@DN MOVAVG(W2,10) @CR
WRITEA("A:\SMOOTH.C",W3) @CR
WRITEA("A:\PSD.C",W2) @CR

@CNTL_HOME
@F8 EMG.4 @CR @CR
@DN PSD(W1) @CR
@DN MOVAVG(W2,10) @CR
WRITEA("A:\SMOOTH.D",W3) @CR
WRITEA("A:\PSD.D",W2) @CR

@CNTL_HOME
@F8 EMG.5 @CR @CR
@DN PSD(W1) @CR
@DN MOVAVG(W2,10) @CR
WRITEA("A:\SMOOTH.E",W3) @CR
WRITEA("A:\PSD.E",W2) @CR

-- CONTINUED THROUGH EMG.52 --
```

APPENDIX D

SUBJECT DATA, CORRELATION AND REGRESSION TABLES, AND GRAPHS

S01 ISOMETRIC DAY 1 MVC=28KG (FEMALE)								
TIME	% TIME	FORCE	MPF	RMS	LF	HF	HF/LF	HF-LF
1	0.53	7.08	77.46	1.19E-02	32	124	3.88	92
10	5.26	7.14	65.63	1.59E-02	34	108	3.18	74
20	10.53	7.14	65.63	1.59E-02	34	108	3.18	74
30	15.79	7.14	65.63	1.59E-02	34	108	3.18	74
40	21.05	7.17	72.47	1.78E-02	32	118	3.69	86
50	26.32	7.88	63.51	1.67E-02	26	120	4.62	94
60	31.58	7.46	67.01	1.95E-02	30	118	3.93	88
70	36.84	7.17	62.77	1.90E-02	32	106	3.31	74
80	42.11	7.18	73.64	9.62E-03	20	122	6.10	102
90	47.37	7.95	61.52	1.71E-02	24	106	4.42	82
100	52.63	7.15	65.63	1.70E-02	26	110	4.23	84
110	57.89	7.13	57.76	2.11E-02	30	86	2.87	56
120	63.16	7.13	57.76	2.11E-02	30	86	2.87	56
130	68.42	6.32	58.39	1.48E-02	32	108	3.38	76
140	73.68	7.18	60.50	1.40E-02	30	108	3.60	78
150	78.95	7.10	62.63	1.98E-02	28	102	3.64	74
160	84.21	6.07	59.87	2.50E-02	30	106	3.53	76
170	89.47	6.09	58.05	2.44E-02	30	102	3.40	72
180	94.74	3.41	50.51	1.02E-02	22	92	4.18	70
190	100.00	1.01	55.58	9.47E-03	28	98	3.50	70
REST 1		-5.07	80.26	5.87E-04	1	142	142.00	141
REST 2		-5.00	100.52	8.04E-04	1	176	176.00	175

S01 ISOMETRIC DAY 2 MVC=26KG (FEMALE)								
TIME	% TIME	FORCE	MPF	RMS	LF	HF	HF/LF	HF-LF
1	0.50	7.84	74.46	1.29E-02	32	112	3.50	80
10	5.00	7.76	67.63	1.19E-02	33	114	3.45	81
20	10.00	7.93	65.63	9.20E-03	34	108	3.18	74
30	15.00	7.53	66.26	1.59E-02	32	118	3.69	86
40	20.00	7.72	72.47	1.73E-02	32	116	3.63	84
50	25.00	7.88	65.23	1.27E-02	28	118	4.21	90
60	30.00	7.64	67.02	1.57E-02	26	118	4.54	92
70	35.00	8.17	62.77	1.70E-02	30	106	3.53	76
80	40.00	7.80	72.64	1.62E-02	26	122	4.69	96
90	45.00	7.95	66.58	1.71E-02	24	106	4.42	82
100	50.00	7.48	65.63	1.80E-02	26	112	4.31	86
110	55.00	7.83	56.56	1.93E-02	28	114	4.07	86
120	60.00	8.13	57.76	2.01E-02	30	110	3.67	80
130	65.00	7.32	58.37	1.76E-02	30	106	3.53	76
140	70.00	7.18	60.50	1.70E-02	28	108	3.86	80
150	75.00	7.10	57.62	1.78E-02	28	104	3.71	76
160	80.00	6.07	59.87	2.38E-02	32	100	3.13	68
170	85.00	6.09	57.04	2.40E-02	30	102	3.40	72
180	90.00	7.13	51.54	1.82E-02	24	92	3.83	68
190	95.00	3.01	56.18	2.17E-02	28	98	3.50	70
200	100.00	4.58	53.85	1.71E-02	28	96	3.43	68
REST 1		-5.07	91.61	6.87E-04	1	140	140.00	139
REST 2		-5.00	102.56	8.19E-04	1	162	162.00	161

S02 ISOMETRIC MVC=40KG (MALE)								
TIME	% TIME	FORCE	MPF	RMS	LF	HF	HF/LF	HF-LF
1	0.56	12.19	76.36	4.49E-03	14	114	8.14	100
10	5.56	12.06	88.14	6.63E-03	34	116	3.41	82
20	11.11	11.99	87.75	6.27E-03	32	126	3.94	94
30	16.67	12.09	81.95	0.006637	32	126	3.94	94
40	22.22	12.12	81.10	6.14E-03	34	128	3.76	94
50	27.78	11.90	85.64	8.92E-03	30	126	4.20	96
60	33.33	12.06	82.96	8.12E-03	40	126	3.15	86
70	38.89	12.09	77.07	8.62E-03	30	124	4.13	94
80	44.44	12.06	76.03	1.08E-02	26	116	4.46	90
90	50.00	12.06	69.12	1.18E-02	10	118	11.80	108
100	55.56	12.11	70.39	1.18E-02	32	120	3.75	88
110	61.11	12.01	80.90	8.63E-03	30	132	4.40	102
120	66.67	12.04	67.15	9.78E-03	30	108	3.60	78
130	72.22	11.86	76.30	1.51E-02	28	116	4.14	88
140	77.78	12.06	76.30	1.51E-02	28	116	4.14	88
150	83.33	11.20	67.22	6.99E-03	26	98	3.77	72
160	88.89	12.00	71.50	1.07E-02	26	104	4.00	78
170	94.44	10.01	78.81	1.45E-02	28	130	4.64	102
180	100.00	6.46	60.00	6.71E-03	26	98	3.77	72
REST1		-5.00	29.73	8.33E-04	1	78	78.00	78
REST2		-5.00	31.45	8.10E-04	1	18	18.00	18

S02 PULSED ISOMETRIC @ 30% MVC TRIAL #1									
TIME	% TIME	CYCLE	FORCE	MPF	RMS	LF	HF	HF/LF	HF-LF
10	4.17	1	10.45	100.25	3.40E-03	38	162	4.26	124
20	8.33		10.45	100.25	3.40E-03	38	162	4.26	124
30	12.50	2	12.69	103.35	6.61E-03	36	152	4.22	116
40	16.67		12.70	100.84	4.96E-03	34	160	4.71	126
50	20.83	3	12.47	98.12	3.89E-03	46	160	3.48	114
60	25.00		12.86	89.04	4.67E-03	44	128	2.91	84
70	29.17	4	10.47	86.81	4.02E-03	36	118	3.28	82
80	33.33		12.18	95.06	3.81E-03	32	136	4.25	104
90	37.50	5	11.28	93.62	3.38E-03	32	128	4.00	96
100	41.67		11.28	93.62	3.38E-03	32	128	4.00	96
110	45.83	6	12.64	102.93	6.12E-03	40	130	3.25	90
120	50.00		11.63	99.13	5.30E-03	34	128	3.76	94
130	54.17	7	11.33	99.95	7.56E-03	34	140	4.12	106
140	58.33		11.33	99.95	7.56E-03	34	140	4.12	106
150	62.50	8	11.03	90.27	6.00E-03	28	124	4.43	96
160	66.67		11.03	90.27	6.00E-03	28	124	4.43	96
170	70.83	9	14.97	83.80	7.97E-03	32	122	3.81	90
180	75.00		12.63	98.14	8.31E-03	32	132	4.13	100
190	79.17	10	10.88	91.82	6.91E-03	36	126	3.50	90
200	83.33		12.13	83.57	5.40E-03	30	116	3.87	86
210	87.50	11	9.37	89.13	6.45E-03	40	130	3.25	90
220	91.67		9.28	97.64	8.85E-03	32	134	4.19	102
230	95.83	12	10.12	91.73	9.68E-03	34	136	4.00	102
240	100.00		10.41	90.04	8.31E-03	30	134	4.47	104
REST 1			-0.39	64.33	7.31E-04	1	94	94.00	93
REST 2			0.29	46.08	6.63E-04	1	36	36.00	35

S02 PULSED ISOMETRIC @ 30% MVC TRIAL #2									
TIME	% TIME	CYCLE	FORCE	MPF	RMS	LF	HF	HF/LF	HF-LF
10	4.55	1	13.81	107.00	2.55E-03	18	140	7.78	122
20	9.09		13.81	107.00	2.55E-03	18	140	7.78	122
30	13.64	2	10.89	91.56	3.74E-03	18	168	9.33	150
40	18.18		12.00	88.26	2.58E-03	12	122	10.17	110
50	22.73	3	12.41	96.76	5.04E-03	32	140	4.38	108
60	27.27		12.41	96.76	5.04E-03	32	140	4.38	108
70	31.82	4	9.17	89.62	3.37E-03	28	170	6.07	142
80	36.36		12.71	99.24	4.72E-03	40	162	4.05	122
90	40.91	5	13.22	99.59	3.87E-03	34	160	4.71	126
100	45.45		13.17	109.70	4.46E-03	30	174	5.80	144
110	50.00	6	13.12	84.60	6.77E-03	28	144	5.14	116
120	54.55		13.12	84.60	6.77E-03	28	144	5.14	116
130	59.09	7	10.38	91.01	4.49E-03	34	152	4.47	118
140	63.64		12.66	95.29	4.09E-03	32	132	4.13	100
150	68.18	8	12.64	96.64	0.0058796	36	144	4.00	108
160	72.73		12.51	94.76	4.83E-03	32	146	4.56	114
170	77.27	9	12.97	101.22	6.85E-03	30	134	4.47	104
180	81.82		12.42	94.82	5.54E-03	36	134	3.72	98
190	86.36	10	10.57	94.66	7.92E-03	30	160	5.33	130
200	90.91		10.57	94.66	7.92E-03	30	160	5.33	130
210	95.45	11	11.40	83.00	1.51E-02	28	112	4.00	84
220	100.00		13.03	83.01	7.98E-03	32	116	3.63	84
REST 1			0.19	48.26	1.32E-03	1	66	66.00	65
REST 2			0.14	45.64	6.63E-04	1	32	32.00	31

S02 PULSED ISOMETRIC @ 30% MVC TRIAL #3									
TIME	% TIME	CYCLE	FORCE	MPF	RMS	LF	HF	HF/LF	HF-LF
10	5.00	1	12.73	99.19	4.49E-03	36	128	3.56	92
20	10.00		11.95	83.25	3.05E-03	30	126	4.20	96
30	15.00	2	12.81	87.23	5.60E-03	34	148	4.35	114
40	20.00		12.81	87.23	5.60E-03	34	148	4.35	114
50	25.00	3	13.38	80.84	5.02E-03	30	124	4.13	94
60	30.00		13.38	80.84	5.02E-03	30	124	4.13	94
70	35.00	4	10.45	92.55	7.03E-03	32	132	4.13	100
80	40.00		12.68	104.48	6.18E-03	44	166	3.77	122
90	45.00	5	14.11	95.66	7.54E-03	44	126	2.86	82
100	50.00		11.43	100.51	7.61E-03	50	148	2.96	98
110	55.00	6	9.09	86.44	7.76E-03	38	124	3.26	86
120	60.00		9.74	82.45	8.81E-03	28	152	5.43	124
130	65.00	7	8.80	82.94	8.27E-03	34	156	4.59	122
140	70.00		11.12	92.28	1.14E-02	38	140	3.68	102
150	75.00	8	16.44	82.60	1.09E-02	38	122	3.21	84
160	80.00		12.32	91.35	7.61E-03	30	136	4.53	106
170	85.00	9	11.63	84.76	8.80E-03	30	126	4.20	96
180	90.00		11.63	84.76	8.80E-03	30	126	4.20	96
190	95.00	10	10.62	77.78	1.04E-02	30	122	4.07	92
200	100.00		12.74	91.19	1.21E-02	30	132	4.40	102
REST 1			0.24	53.46	6.43E-04	1	38	38.00	37
RETS 2			0.72	40.33	7.14E-04	1	34	34.00	33

S03 ISOMETRIC MVC=57KG (MALE)								
TIME	% TIME	FORCE	MPF	RMS	LF	HF	HF/LF	HF-LF
1	0.48	17.16	64.37	0.013627	44	116	2.64	72
10	4.76	18.07	70.12	8.13E-03	32	114	3.56	82
20	9.52	17.65	61.92	1.30E-02	36	102	2.83	66
30	14.29	17.98	62.98	1.16E-02	32	100	3.13	68
40	19.05	18.24	63.57	1.27E-02	28	110	3.93	82
50	23.81	17.06	61.14	1.37E-02	30	108	3.60	78
60	28.57	18.22	58.29	1.18E-02	30	108	3.60	78
70	33.33	18.24	53.44	1.46E-02	28	94	3.36	66
80	38.10	17.42	55.71	1.39E-02	26	94	3.62	68
90	42.86	18.22	53.03	1.21E-02	24	98	4.08	74
100	47.62	18.16	50.83	1.76E-02	32	80	2.50	48
110	52.38	18.24	49.12	1.85E-02	22	92	4.18	70
120	57.14	18.24	46.04	1.37E-02	20	88	4.40	68
130	61.90	18.24	51.36	2.39E-02	26	86	3.31	60
140	66.67	16.99	49.68	2.43E-02	22	88	4.00	66
150	71.43	18.15	52.13	2.13E-02	24	104	4.33	80
160	76.19	16.07	51.12	1.85E-02	24	94	3.92	70
170	80.95	14.77	50.16	2.10E-02	24	92	3.83	68
180	85.71	16.33	52.32	2.66E-02	26	90	3.46	64
190	90.48	16.03	43.41	2.09E-02	22	80	3.64	58
200	95.24	17.54	49.65	2.77E-02	22	86	3.91	64
210	100.00	13.83	47.89	2.90E-02	24	80	3.33	56
REST 1		0.15	88.79	4.43E-04	1	68	68.00	67
REST 2		0.52	102.38	4.27E-04	6	126	21.00	120

S04 ISOMETRIC DAY 1 MVC=31KG (FEMALE)								
TIME	% TIME	FORCE	MPF	RMS	LF	HF	HF/LF	HF-LF
1	0.00	10.52	122.33	9.73E-03	50	176	3.52	126
10	4.00	9.39	107.59	1.06E-02	42	168	4.00	126
20	8.00	9.36	115.95	7.80E-03	46	162	3.52	116
30	12.00	9.39	114.70	8.38E-03	48	156	3.25	108
40	16.00	9.37	120.02	8.15E-03	34	182	5.35	148
50	20.00	9.37	109.10	9.09E-03	40	136	3.40	96
60	24.00	9.39	120.16	1.16E-02	52	166	3.19	114
70	28.00	9.15	112.61	8.31E-03	56	150	2.68	94
80	32.00	8.56	124.22	1.06E-02	40	166	4.15	126
90	36.00	9.32	110.31	7.75E-03	40	156	3.90	116
100	40.00	9.39	115.66	8.02E-03	52	184	3.54	132
110	44.00	9.39	109.65	6.77E-03	48	160	3.33	112
120	48.00	9.31	105.50	8.58E-03	50	164	3.28	114
130	52.00	9.15	115.23	7.86E-03	52	178	3.42	126
140	56.00	9.37	108.48	7.59E-03	42	142	3.38	100
150	60.00	8.50	110.33	5.07E-03	32	164	5.13	132
160	64.00	8.29	110.90	7.33E-03	44	146	3.32	102
170	68.00	8.83	96.87	9.13E-03	44	160	3.64	116
180	72.00	8.32	117.91	7.92E-03	40	176	4.40	136
190	76.00	8.93	109.36	9.09E-03	44	150	3.41	106
200	80.00	7.18	105.67	8.49E-03	44	186	4.23	142
210	84.00	9.24	114.94	8.69E-03	42	162	3.86	120
220	88.00	9.22	114.38	0.010641	42	160	3.81	118
230	92.00	9.26	113.60	6.17E-03	40	178	4.45	138
240	96.00	8.03	101.05	8.79E-03	38	160	4.21	122
250	100.00	7.30	106.03	8.03E-03	34	154	4.53	120
REST 1		0.50	104.36	5.75E-04	6	126	21.00	120
REST 2		0.13	128.33	7.67E-04	2	176	88.00	174

S04 ISOMETRIC DAY 2 MVC=31KG (FEMALE)								
TIME	% TIME	FORCE	MPF	RMS	LF	HF	H/L	H-L
1	0.38	9.52	121.43	8.73E-03	46	168	3.65	122
10	3.85	9.49	117.59	9.06E-03	48	170	3.54	122
20	7.69	9.49	115.95	7.80E-03	42	162	3.86	120
30	11.54	9.47	116.02	8.38E-03	46	156	3.39	110
40	15.38	9.50	118.02	8.20E-03	38	176	4.63	138
50	19.23	9.47	109.10	9.29E-03	40	136	3.40	96
60	23.08	9.49	115.12	1.06E-02	44	166	3.77	122
70	26.92	9.45	112.61	9.53E-03	56	150	2.68	94
80	30.77	9.36	120.02	1.01E-02	44	160	3.64	116
90	34.62	9.42	110.31	7.87E-03	40	156	3.90	116
100	38.46	9.39	115.66	8.02E-03	50	184	3.68	134
110	42.31	9.49	112.65	9.77E-03	48	160	3.33	112
120	46.15	9.45	105.50	8.79E-03	46	166	3.61	120
130	50.00	9.45	111.23	8.86E-03	48	178	3.71	130
140	53.85	9.47	108.48	7.59E-03	42	142	3.38	100
150	57.69	9.50	113.33	7.07E-03	38	158	4.16	120
160	61.54	9.39	110.90	7.33E-03	44	146	3.32	102
170	65.38	9.43	107.87	9.13E-03	38	164	4.32	126
180	69.23	9.42	112.40	9.16E-03	40	176	4.40	136
190	73.08	9.43	109.38	9.09E-03	44	154	3.50	110
200	76.92	9.18	105.67	8.65E-03	42	186	4.43	144
210	80.77	9.24	110.95	9.19E-03	39	162	4.15	123
220	84.62	9.22	110.38	0.009065	42	160	3.81	118
230	88.46	8.26	113.60	7.17E-03	38	170	4.47	132
240	92.31	8.03	101.04	8.79E-03	40	160	4.00	120
250	96.15	7.30	104.01	9.50E-03	34	154	4.53	120
260	100.00	6.54	97.03	1.27E-02	38	150	3.95	112
REST 1		0.48	108.59	5.53E-04	6	122	20.33	116
REST 2		0.12	126.38	7.67E-04	4	186	46.50	182

S05 ISOMETRIC MVC=85KG (MALE)								
TIME	% TIME	FORCE	MPF	RMS	LF	HF	HF/LF	HF-LF
1	0.45	23.64498	68.97372	6.20E-03	34	110	3.235294	76
10	4.55	24.36485	66.84908	8.65E-03	42	112	2.666667	70
20	9.09	24.04706	69.22954	6.40E-03	28	118	4.214286	90
30	13.64	24.95935	75.28671	4.91E-03	26	114	4.384615	88
40	18.18	25.81747	88.3802	4.23E-03	34	142	4.176471	108
50	22.73	25.80882	79.82309	3.77E-03	38	122	3.210526	84
60	27.27	25.88447	60.36009	6.35E-03	28	100	3.571429	72
70	31.82	24.90315	73.35574	4.16E-03	30	114	3.8	84
80	36.36	24.88154	72.61201	5.35E-03	34	120	3.529412	86
90	40.91	25.92122	62.75618	7.68E-03	36	108	3	72
100	45.45	24.88802	62.71139	7.12E-03	32	110	3.4375	78
110	50.00	25.98822	65.43689	4.69E-03	32	106	3.3125	74
120	54.55	24.88154	62.73973	7.01E-03	28	106	3.785714	78
130	59.09	24.88154	58.18106	8.76E-03	30	104	3.466667	74
140	63.64	26.98026	58.91986	1.57E-02	28	104	3.714286	76
150	68.18	21.17425	59.0735	8.37E-03	24	104	4.333333	80
160	72.73	23.21916	54.99537	1.12E-02	26	98	3.769231	72
170	77.27	16.15739	101.5224	1.11E-02	36	142	3.944444	106
180	81.82	27.95296	60.53203	1.52E-02	30	104	3.466667	74
190	86.36	16.31522	68.15078	6.16E-03	26	120	4.615385	94
200	90.91	17.89963	51.00027	8.61E-03	24	92	3.833333	68
210	95.45	13.48573	51.04969	1.20E-02	24	92	3.833333	68
220	100.00	12.0806	59.137	9.47E-03	28	98	3.5	70
REST 1		-0.37425	96.34179	4.42E-04	1	46	46	45
REST 2		0.295834	120.6594	4.41E-04	8	168	21	160

S05 PULSED ISOMETRIC @30%MVC TRIAL #1									
TIME	% TIME	CYCLE	FORCE	MPF	RMS	LF	HF	HF/LF	HF-LF
10	2.38	1	7.06	67.94	1.45E-03	1	106	3.50	105
20	4.76		23.78	81.72	5.24E-03	32	128	4.00	96
30	7.14	2	23.47	62.77	7.83E-03	30	110	3.67	80
40	9.52		22.90	63.15	8.73E-03	26	112	4.31	86
50	11.90	3	22.70	63.59	7.59E-03	30	102	3.40	72
60	14.29		23.22	84.68	3.37E-03	34	132	3.88	98
70	16.67	4	20.34	63.99	5.75E-03	36	108	3.00	72
80	19.05		23.03	65.59	6.50E-03	32	104	3.25	72
90	21.43	5	23.90	58.66	6.77E-03	34	106	3.12	72
100	23.81		20.66	71.51	3.76E-03	32	122	3.81	90
110	26.19	6	23.68	65.10	7.96E-03	32	112	3.50	80
120	28.57		23.68	65.10	7.96E-03	32	112	3.50	80
130	30.95	7	24.76	69.62	8.77E-03	38	118	3.11	80
140	33.33		24.00	64.82	5.67E-03	28	104	3.71	76
150	35.71	8	23.15	64.46	7.15E-03	30	114	3.80	84
160	38.10		22.52	58.78	1.15E-02	30	110	3.67	80
170	40.48	9	27.13	65.85	7.72E-03	36	110	3.06	74
180	42.86		27.13	65.85	7.72E-03	36	110	3.06	74
190	45.24	10	25.92	68.18	1.10E-02	32	118	3.69	86
200	47.62		23.84	64.92	1.01E-02	32	114	3.56	82
210	50.00	11	22.86	69.24	4.60E-03	32	110	3.44	78
220	52.38		23.25	67.09	8.91E-03	32	110	3.44	78
230	54.76	12	23.47	67.22	9.31E-03	38	114	3.00	76
240	57.14		23.47	67.22	9.31E-03	38	114	3.00	76
250	59.52	13	20.95	62.65	9.63E-03	32	106	3.31	74
260	61.90		20.95	62.65	9.63E-03	32	106	3.31	74
270	64.29	14	25.03	69.47	6.59E-03	30	118	3.93	88
280	66.67		23.72	59.85	7.92E-03	28	98	3.50	70
290	69.05	15	24.47	65.94	9.24E-03	32	104	3.25	72
300	71.43		23.77	64.45	8.06E-03	34	108	3.18	74
310	73.81	16	21.70	66.37	6.73E-03	24	106	4.42	82
320	76.19		15.13	68.55	4.20E-03	28	108	3.86	80
330	78.57	17	25.02	67.45	1.17E-02	32	116	3.63	84
340	80.95		23.78	78.59	4.66E-03	36	112	3.11	76
350	83.33	18	29.69	68.80	1.54E-02	34	112	3.29	78
360	85.71		19.83	58.89	1.07E-02	28	104	3.71	76
370	88.10	19	24.63	66.60	0.0157185	38	114	3.00	76
380	90.48		20.35	63.32	0.010688	26	108	4.15	82
390	92.86	20	21.70	59.59	1.41E-02	32	104	3.25	72
400	95.24		19.58	67.90	3.95E-03	30	108	3.60	78
410	97.62	21	23.05	63.56	1.34E-02	32	102	3.63	84
420	100.00		26.46	62.68	1.38E-02	32	106	3.31	74
REST 1			-0.57	55.54	6.19E-04	1	38	38.00	37
REST2			-0.57	64.13	6.10E-04	1	34	34.00	33

S05 PULSED ISOMETRIC TRIAL #2									
TIME	% TIME	CYCLE	FORCE	MPF	RMS	LF	HF	HF/LF	HF-LF
10	2.78	1	19.40	76.71	6.17E-03	36	112	3.11	76
20	5.56		23.39	69.13	0.006325	46	118	2.57	72
30	8.33	2	24.16	70.40	7.59E-03	36	116	3.22	80
40	11.11		22.38	66.88	0.007615	42	112	2.67	70
50	13.89	3	23.04	63.37	7.58E-03	38	110	2.89	72
60	16.67		22.63	61.71	7.41E-03	34	116	3.41	82
70	19.44	4	24.62	66.07	6.71E-03	36	112	3.11	76
80	22.22		21.91	63.34	7.53E-03	30	110	3.67	80
90	25.00	5	19.83	67.47	6.06E-03	32	108	3.38	76
100	27.78		23.35	66.81	5.22E-03	26	104	4.00	78
110	30.56	6	20.10	61.43	5.89E-03	30	108	3.60	78
120	33.33		20.84	59.57	6.55E-03	26	110	4.23	84
130	36.11	7	24.59	59.76	6.70E-03	26	100	3.85	74
140	38.89		21.41	63.03	7.01E-03	30	110	3.67	80
150	41.67	8	30.05	63.36	8.48E-03	30	102	3.40	72
160	44.44		30.05	63.36	8.48E-03	30	102	3.40	72
170	47.22	9	15.04	60.56	6.42E-03	28	92	3.29	64
180	50.00		23.57	64.08	8.31E-03	24	102	4.25	78
190	52.78	10	20.37	62.36	6.89E-03	28	112	4.00	84
200	55.56		23.77	72.03	6.89E-03	32	120	3.75	88
210	58.33	11	24.43	66.51	7.70E-03	36	108	3.00	72
220	61.11		22.02	64.73	7.24E-03	38	102	2.68	64
230	63.89	12	23.36	68.49	8.07E-03	30	120	4.00	90
240	66.67		23.36	68.49	8.07E-03	30	120	4.00	90
250	69.44	13	23.78	69.99	1.28E-02	38	114	3.00	76
260	72.22		23.78	69.99	1.28E-02	38	114	3.00	76
270	75.00	14	23.78	62.18	1.29E-02	30	106	3.53	76
280	77.78		23.04	65.33	8.65E-03	28	116	4.14	88
290	80.56	15	25.42	62.66	1.45E-02	30	110	3.67	80
300	83.33		25.42	62.66	1.45E-02	30	110	3.67	80
310	86.11	16	26.02	70.96	1.52E-02	36	116	3.22	80
320	88.89		23.14	66.94	1.25E-02	32	110	3.44	78
330	91.67	17	24.31	66.20	0.015894	34	116	3.41	82
340	94.44		22.48	67.73	1.23E-02	32	122	3.81	90
350	97.22	18	23.78	65.48	1.67E-02	38	116	3.05	78
360	100.00		19.84	61.80	1.22E-02	32	108	3.38	76
REST 1			-0.57	56.45	6.41E-04	1	40	40.00	39
REST 2			-0.57	62.34	9.34E-04	1	86	86.00	85

S05 PULSED ISOMETRIC TRIAL #3

TIME	% TIME	CYCLE	FORCE	MPF	RMS	LF	HF	HF/LF	HF-LF
10	3.13	1	19.32	77.33	0.004811	36	128	3.56	92
20	6.25		23.34	75.59	7.98E-03	44	116	2.64	72
30	9.38	2	22.75	68.36	7.32E-03	36	118	3.28	82
40	12.50		22.79	67.40	6.00E-03	34	118	3.47	84
50	15.63	3	22.49	69.85	6.45E-03	32	114	3.56	82
60	18.75		22.74	65.22	6.20E-03	38	114	3.00	76
70	21.88	4	23.77	68.37	5.82E-03	36	110	3.06	74
80	25.00		23.35	82.37	3.50E-03	36	128	3.56	92
90	28.13	5	22.96	83.62	4.72E-03	40	126	3.15	86
100	31.25		22.48	81.52	5.54E-03	40	116	2.90	76
110	34.38	6	25.36	73.92	9.45E-03	38	120	3.16	82
120	37.50		25.36	73.92	9.45E-03	38	120	3.16	82
130	40.63	7	24.76	75.96	5.26E-03	34	116	3.41	82
140	43.75		24.76	75.96	5.26E-03	34	116	3.41	82
150	46.88	8	23.69	82.12	8.62E-03	34	128	3.76	94
160	50.00		23.10	79.54	5.13E-03	34	116	3.41	82
170	53.13	9	15.64	66.97	8.27E-03	24	114	4.75	90
180	56.25		24.19	67.78	9.91E-03	30	110	3.67	80
190	59.38	10	25.60	65.47	1.14E-02	28	116	4.14	88
200	62.50		22.45	64.89	1.03E-02	34	104	3.06	70
210	65.63	11	23.78	68.71	7.86E-03	27	115	4.26	88
220	68.75		23.51	75.38	8.89E-03	28	116	4.14	88
230	71.88	12	25.54	66.65	6.72E-03	34	122	3.59	88
240	75.00		20.59	66.70	8.39E-03	36	118	3.28	82
250	78.13	13	30.76	69.36	1.51E-02	38	116	3.05	78
260	81.25		21.57	66.98	1.02E-02	32	114	3.56	82
270	84.38	14	23.80	82.61	6.43E-03	46	122	2.65	76
280	87.50		23.80	82.61	6.43E-03	46	122	2.65	76
290	90.63	15	27.61	70.75	1.33E-02	40	118	2.95	78
300	93.75		23.66	67.89	1.48E-02	30	110	3.67	80
310	96.88	16	23.49	63.25	0.01156	32	112	3.50	80
320	100.00		23.49	63.25	0.01156	32	112	3.50	80
REST 1			-0.57	62.10	6.29E-04	1	62	62.00	61
REST 2			-0.57	143.96	3.80E-03	62	198	3.19	136

S06 ISOMETRIC MVC=40KG (MALE)								
TIME	% TIME	FORCE	MPF	RMS	LF	HF	HF/LF	HF-LF
1	0.48	11.30	118.24	0.0123774	30	188	6.27	158
10	4.76	12.78	120.39	1.52E-02	54	196	3.63	142
20	9.52	13.35	116.24	1.69E-02	46	186	4.04	140
30	14.29	12.71	114.30	0.0150828	42	188	4.48	146
40	19.05	12.32	106.66	1.28E-02	36	186	5.17	150
50	23.81	11.83	116.53	2.14E-02	42	200	4.76	158
60	28.57	12.71	116.80	2.20E-02	44	188	4.27	144
70	33.33	13.84	104.53	1.50E-02	24	182	7.58	158
80	38.10	12.70	102.75	1.61E-02	42	164	3.90	122
90	42.86	12.96	97.84	1.57E-02	34	156	4.59	122
100	47.62	11.05	97.42	1.34E-02	14	174	12.43	160
110	52.38	12.72	93.65	1.57E-02	40	148	3.70	108
120	57.14	13.82	103.43	2.40E-02	36	160	4.44	124
130	61.90	11.56	108.90	2.52E-02	32	196	6.13	164
140	66.67	12.50	86.67	1.73E-02	32	146	4.56	114
150	71.43	11.88	97.49	2.20E-02	30	176	5.87	146
160	76.19	12.60	96.90	3.01E-02	16	174	10.88	158
170	80.95	12.76	79.03	2.43E-02	30	170	5.67	140
180	85.71	12.22	75.11	3.02E-02	26	144	5.54	118
190	90.48	10.53	77.82	2.35E-02	24	156	6.50	132
200	95.24	6.94	69.42	1.32E-02	18	124	6.89	106
210	100.00	4.34	65.21	1.22E-02	18	116	6.44	98
REST 1		-0.57	59.15	9.67E-04	12	80	6.67	68
REST 2		-0.57	106.39	1.80E-03	10	278	27.80	268

S06 PULSED ISOMETRIC TRIAL #1									
TIME	% TIME	CYCLE	FORCE	MPF	RMS	LF	HF	HF/LF	HF-LF
10	2.38	1	14.92	78.22	1.95E-02	44	134	3.05	90
20	4.76		15.95	80.23	2.04E-02	44	124	2.82	80
30	7.14	2	14.56	81.95	2.17E-02	38	134	3.53	96
40	9.52		14.95	71.74	3.05E-02	44	116	2.64	72
50	11.90	3	13.79	76.64	2.44E-02	32	128	4.00	96
60	14.29		15.93	70.81	2.38E-02	42	120	2.86	78
70	16.67	4	15.25	79.53	2.63E-02	36	122	3.39	86
80	19.05		15.84	71.04	2.69E-02	36	108	3.00	72
90	21.43	5	14.54	71.56	2.11E-02	38	124	3.26	86
100	23.81		15.96	74.48	2.60E-02	38	134	3.53	96
110	26.19	6	15.53	69.01	2.80E-02	38	124	3.26	86
120	28.57		15.00	80.94	2.65E-02	38	138	3.63	100
130	30.95	7	14.03	67.39	3.54E-02	34	112	3.29	78
140	33.33		16.00	77.47	0.027068	34	126	3.71	92
150	35.71	8	16.02	67.98	2.80E-02	32	124	3.88	92
160	38.10		14.88	71.55	2.72E-02	34	116	3.41	82
170	40.48	9	14.95	72.81	2.70E-02	34	116	3.41	82
180	42.86		15.89	77.33	2.54E-02	36	124	3.44	88
190	45.24	10	15.19	74.62	2.80E-02	38	132	3.47	94
200	47.62		13.78	78.73	2.07E-02	30	124	4.13	94
210	50.00	11	15.91	71.33	3.09E-02	36	114	3.17	78
220	52.38		15.91	71.33	3.09E-02	36	114	3.17	78
230	54.76	12	17.83	79.10	3.41E-02	28	122	4.36	94
240	57.14		15.22	67.68	2.02E-02	30	108	3.60	78
250	59.52	13	16.03	73.89	2.86E-02	32	106	3.31	74
260	61.90		15.28	82.46	1.78E-02	32	144	4.50	112
270	64.29	14	15.93	78.16	2.59E-02	34	126	3.71	92
280	66.67		14.52	78.47	2.50E-02	32	160	5.00	128
290	69.05	15	15.23	78.00	2.54E-02	31	120	3.87	89
300	71.43		14.01	72.19	0.022579	28	130	4.64	102
310	73.81	16	15.52	67.41	3.22E-02	28	112	4.00	84
320	76.19		18.03	77.58	3.14E-02	34	126	3.71	92
330	78.57	17	15.11	69.57	3.26E-02	32	114	3.56	82
340	80.95		15.87	69.08	2.97E-02	36	106	2.94	70
350	83.33	18	15.14	75.05	0.035192	32	138	4.31	106
360	85.71		15.14	75.05	0.035192	32	138	4.31	106
370	88.10	19	15.81	70.43	2.74E-02	28	104	3.71	76
380	90.48		14.06	65.93	2.31E-02	34	100	2.94	66
390	92.86	20	15.08	68.24	3.42E-02	32	102	3.19	70
400	95.24		14.93	67.03	2.81E-02	26	96	3.69	70
410	97.62	21	20.11	65.29	3.28E-02	30	112	3.73	82
420	100.00		14.93	69.95	3.14E-02	30	108	3.60	78
REST 1			0.13	79.53	8.63E-04	16	198	12.38	182
REST 2			0.53	102.06	5.56E-04	1	84	84.00	83

S06 PULSED ISOMETRIC TRIAL #2									
TIME	% TIME	CYCLE	FORCE	MPF	RMS	LF	HF	HF/LF	HF-LF
10	2.94	1	16.02	72.21	2.80E-02	68	114	1.68	46
20	5.88		16.04	84.79	1.98E-02	40	120	3.00	80
30	8.82	2	14.81	78.20	1.95E-02	42	132	3.14	90
40	11.76		16.03	72.84	2.79E-02	44	114	2.59	70
50	14.71	3	15.99	77.78	2.29E-02	34	128	3.76	94
60	17.65		16.03	79.29	1.64E-02	32	126	3.94	94
70	20.59	4	15.20	81.68	1.45E-02	34	118	3.47	84
80	23.53		16.21	75.99	1.86E-02	38	128	3.37	90
90	26.47	5	16.06	75.86	1.91E-02	36	130	3.61	94
100	29.41		16.10	74.23	2.04E-02	32	132	4.13	100
110	32.35	6	17.15	71.95	2.57E-02	32	118	3.69	86
120	35.29		16.05	66.04	2.70E-02	34	104	3.06	70
130	38.24	7	16.74	74.32	2.56E-02	36	112	3.11	76
140	41.18		16.19	74.71	2.66E-02	40	126	3.15	86
150	44.12	8	16.04	70.46	3.37E-02	34	112	3.29	78
160	47.06		16.04	70.46	3.37E-02	34	112	3.29	78
170	50.00	9	16.07	78.42	3.43E-02	32	122	3.81	90
180	52.94		16.29	66.89	3.33E-02	42	108	2.57	66
190	55.88	10	15.93	72.16	2.95E-02	34	123	3.62	89
200	58.82		17.58	74.06	2.64E-02	30	120	4.00	90
210	61.76	11	16.59	68.47	3.17E-02	32	115	3.59	83
220	64.71		15.86	71.37	3.21E-02	28	118	4.21	90
230	67.65	12	16.86	75.65	3.26E-02	38	126	3.32	88
240	70.59		16.86	75.65	3.26E-02	38	126	3.32	88
250	73.53	13	14.52	69.93	3.45E-02	30	112	3.73	82
260	76.47		15.47	72.82	3.17E-02	30	114	3.80	84
270	79.41	14	17.18	70.19	3.83E-02	36	112	3.11	76
280	82.35		16.03	68.02	3.44E-02	32	104	3.25	72
290	85.29	15	14.51	73.16	3.69E-02	38	116	3.05	78
300	88.24		14.52	70.86	3.28E-02	32	102	3.19	70
310	91.18	16	17.50	70.41	2.95E-02	32	94	2.94	62
320	94.12		17.50	70.41	2.95E-02	32	94	2.94	62
330	97.06	17	14.86	68.18	0.033346	34	124	3.65	90
340	100.00		15.11	58.14	3.19E-02	30	106	3.53	76
REST 1			0.53	95.40	5.23E-04	1	80	80.00	79
REST 2			0.53	77.74	6.51E-04	1	80	80.00	79

S06 PULSED ISOMETRIC TRIAL #3									
TIME	% TIME	CYCLE	FORCE	MPF	RMS	LF	HF	HF/LF	HF-LF
10	3.33	1	17.50	85.54	1.92E-02	44	126	2.86	82
20	6.67		17.50	85.54	1.92E-02	44	126	2.86	82
30	10.00	2	13.65	87.47	1.41E-02	38	116	3.05	78
40	13.33		16.33	87.37	1.60E-02	32	176	5.50	144
50	16.67	3	16.21	83.64	2.24E-02	42	122	2.90	80
60	20.00		16.06	82.74	1.33E-02	40	138	3.45	98
70	23.33	4	16.25	80.13	2.11E-02	32	138	4.31	106
80	26.67		16.04	78.52	2.50E-02	38	116	3.05	78
90	30.00	5	16.11	82.26	2.83E-02	35	129	3.69	94
100	33.33		16.04	82.87	2.04E-02	44	114	2.59	70
110	36.67	6	16.84	79.38	2.48E-02	34	126	3.71	92
120	40.00		16.84	79.38	2.48E-02	34	126	3.71	92
130	43.33	7	15.51	76.80	2.58E-02	34	118	3.47	84
140	46.67		15.81	73.01	2.80E-02	42	120	2.86	78
150	50.00	8	16.00	71.15	2.91E-02	33	118	3.58	85
160	53.33		15.77	70.02	2.82E-02	34	114	3.35	80
170	56.67	9	16.37	69.60	0.033802	36	106	2.94	70
180	60.00		16.37	69.60	0.033802	36	106	2.94	70
190	63.33	10	15.92	74.43	2.67E-02	36	128	3.56	92
200	66.67		16.21	64.28	3.43E-02	36	104	2.89	68
210	70.00	11	12.21	87.25	3.70E-02	34	144	4.24	110
220	73.33		16.44	66.87	3.00E-02	26	106	4.08	80
230	76.67	12	16.03	67.71	2.95E-02	32	114	3.56	82
240	80.00		16.03	67.71	2.95E-02	32	114	3.56	82
250	83.33	13	15.89	74.17	3.48E-02	30	118	3.93	88
260	86.67		15.89	74.17	3.48E-02	30	118	3.93	88
270	90.00	14	17.30	64.43	3.44E-02	26	110	4.23	84
280	93.33		16.03	72.18	3.12E-02	24	104	4.33	80
290	96.67	15	14.19	71.11	3.22E-02	34	100	2.94	66
300	100.00		13.19	66.23	4.32E-02	31	99	3.19	68
REST 1			0.53	52.20	5.83E-04	1	80	80.00	79
REST 2			0.53	55.67	6.95E-04	1	80	80.00	79

S07 ISOMETRIC DAY 1 MVC=32KG (FEMALE)								
TIME	% TIME	FORCE	MPF	RMS	LF	HF	HF/LF	HF-LF
1	0.33	7.73	108.76	5.16E-03	44	158	3.59	114
10	3.33	8.31	98.61	5.28E-03	34	152	4.47	118
20	6.67	8.29	98.73	6.15E-03	44	162	3.68	118
30	10.00	8.69	89.90	5.72E-03	44	132	3.00	88
40	13.33	8.76	86.85	5.64E-03	46	112	2.43	66
50	16.67	7.52	94.07	4.71E-03	36	142	3.94	106
60	20.00	8.33	88.49	4.61E-03	42	154	3.67	112
70	23.33	7.69	93.41	7.76E-03	38	156	4.11	118
80	26.67	8.28	86.28	5.99E-03	34	134	3.94	100
90	30.00	8.97	92.90	8.49E-03	40	156	3.90	116
100	33.33	8.07	88.93	7.19E-03	42	142	3.38	100
110	36.67	9.05	93.99	5.16E-03	38	152	4.00	114
120	40.00	8.26	95.85	4.16E-03	42	156	3.71	114
130	43.33	8.42	97.23	6.99E-03	38	166	4.37	128
140	46.67	8.30	79.37	6.49E-03	30	126	4.20	96
150	50.00	8.14	86.76	5.59E-03	36	156	4.33	120
160	53.33	7.99	89.78	4.78E-03	34	152	4.47	118
170	56.67	8.60	83.54	5.27E-03	30	136	4.53	106
180	60.00	8.34	84.40	6.31E-03	44	136	3.09	92
190	63.33	6.89	85.97	4.76E-03	36	138	3.83	102
200	66.67	9.40	85.23	6.88E-03	36	154	4.28	118
210	70.00	8.28	83.50	5.95E-03	28	142	5.07	114
220	73.33	7.68	87.45	4.50E-03	38	138	3.63	100
230	76.67	7.53	80.70	1.11E-02	36	122	3.39	86
240	80.00	7.35	87.13	5.91E-03	40	128	3.20	88
250	83.33	5.87	88.26	6.50E-03	36	138	3.83	102
260	86.67	6.37	77.67	7.22E-03	30	114	3.80	84
270	90.00	6.73	84.34	9.41E-03	36	130	3.61	94
280	93.33	8.53	97.26	7.51E-03	40	156	3.90	116
290	96.67	6.92	97.49	7.44E-03	42	132	3.14	90
300	100.00	8.30	79.74	8.18E-03	28	114	4.07	86
REST 1		-0.57	83.72	6.13E-04	2	80	40.00	78
REST 2		-0.57	65.64	8.16E-04	1	80	80.00	79

S07 ISOMETRIC DAY 2 MVC=32 (FEMALE)								
TIME	% TIME	FORCE	MPF	RMS	LF	HF	HF/LF	HF-LF
1	0.45	6.33	113.94	5.58E-03	38	172	4.53	134
10	4.55	8.72	115.66	6.86E-03	52	176	3.38	124
20	9.09	9.37	107.70	7.21E-03	46	172	3.74	126
30	13.64	9.72	118.10	8.87E-03	48	188	3.92	140
40	18.18	8.24	108.95	7.62E-03	48	172	3.58	124
50	22.73	8.09	99.29	6.39E-03	36	172	4.78	136
60	27.27	7.58	98.71	0.007791	44	160	3.64	116
70	31.82	7.17	105.55	7.53E-03	38	168	4.42	130
80	36.36	7.80	91.43	6.02E-03	32	162	5.06	130
90	40.91	9.39	98.41	8.22E-03	40	158	3.95	118
100	45.45	9.38	97.09	7.61E-03	40	174	4.35	134
110	50.00	9.37	104.02	1.09E-02	34	176	5.18	142
120	54.55	9.39	99.17	6.48E-03	32	158	4.94	126
130	59.09	8.85	99.33	7.94E-03	42	160	3.81	118
140	63.64	8.28	100.14	5.39E-03	36	148	4.11	112
150	68.18	10.11	113.76	0.010431	44	178	4.05	134
160	72.73	10.40	100.02	7.48E-03	34	164	4.82	130
170	77.27	7.15	104.08	5.76E-03	38	166	4.37	128
180	81.82	8.59	97.37	7.00E-03	44	148	3.36	104
190	86.36	9.33	98.32	5.95E-03	30	140	4.67	110
200	90.91	7.17	89.96	7.68E-03	28	138	4.93	110
210	95.45	10.04	99.80	9.05E-03	36	180	5.00	144
220	100.00	9.39	102.75	9.13E-03	36	168	4.67	132
REST 1		-1.29	51.02	7.76E-04	1	80	80.00	79
REST 2		-1.41	64.81	7.21E-04	1	46	46.00	45

S08 ISOMETRIC DAY 1 MVC=25KG (FEMALE)								
TIME	% TIME	FORCE	MPF	RMS	LF	HF	HF/LF	HF-LF
1	0.25	9.48	101.11	6.35E-03	34	160	4.71	126
10	2.50	7.15	93.82	6.44E-03	34	150	4.41	116
20	5.00	7.03	95.76	6.31E-03	52	140	2.69	88
30	7.50	7.16	90.02	7.81E-03	18	152	8.44	134
40	10.00	7.14	96.74	6.58E-03	38	130	3.42	92
50	12.50	7.07	100.71	6.02E-03	34	146	4.29	112
60	15.00	7.02	85.63	7.04E-03	36	138	3.83	102
70	17.50	7.12	90.41	7.83E-03	30	148	4.93	118
80	20.00	7.09	96.59	6.94E-03	36	160	4.44	124
90	22.50	6.69	87.65	8.98E-03	34	140	4.12	106
100	25.00	7.07	92.62	7.89E-03	42	152	3.62	110
110	27.50	6.97	92.42	1.05E-02	44	154	3.50	110
120	30.00	7.06	87.39	9.85E-03	32	132	4.13	100
130	32.50	7.13	87.31	0.007504	44	142	3.23	98
140	35.00	7.09	71.97	1.01E-02	28	136	4.86	108
150	37.50	7.09	74.60	9.09E-03	28	124	4.43	96
160	40.00	7.16	87.01	8.61E-03	32	136	4.25	104
170	42.50	7.11	80.99	6.72E-03	24	134	5.58	110
180	45.00	8.60	83.70	0.011949	38	134	3.53	96
190	47.50	7.14	88.67	9.92E-03	38	152	4.00	114
200	50.00	7.10	86.57	7.33E-03	28	140	5.00	112
210	52.50	6.97	90.07	6.59E-03	40	138	3.45	98
220	55.00	7.17	81.72	8.01E-03	34	126	3.71	92
230	57.50	7.10	77.05	1.09E-02	34	122	3.59	88
240	60.00	6.99	79.60	0.011167	28	134	4.79	106
250	62.50	7.14	67.23	1.35E-02	22	124	5.64	102
260	65.00	7.14	67.23	1.35E-02	22	124	5.64	102
270	67.50	6.42	81.04	1.33E-02	36	124	3.44	88
280	70.00	7.05	91.91	1.32E-02	40	152	3.80	112
290	72.50	7.14	82.24	0.010886	28	124	4.43	96
300	75.00	7.17	75.61	1.50E-02	28	124	4.43	96
310	77.50	7.13	77.30	1.75E-02	24	134	5.58	110
320	80.00	7.22	82.82	1.56E-02	32	156	4.88	124
330	82.50	7.11	77.82	1.26E-02	26	130	5.00	104
340	85.00	6.62	74.43	1.35E-02	32	124	3.88	92
350	87.50	6.85	70.63	1.40E-02	24	124	5.17	100
360	90.00	6.74	68.72	1.03E-02	26	110	4.23	84
370	92.50	7.16	64.88	1.56E-02	24	128	5.33	104
380	95.00	5.37	71.23	1.56E-02	24	122	5.08	98
390	97.50	6.89	63.84	1.28E-02	22	118	5.36	96
400	100.00	5.01	67.10	1.88E-02	24	124	5.17	100
REST 1		-1.68	34.17	1.54E-03	1	80	80.00	79
REST 2		-1.68	67.16	1.33E-03	1	100	100.00	99

S08 ISOMETRIC DAY 2 MVC =25KG (FEMALE)								
TIME	% TIME	FORCE	MPF	RMS	LF	HF	HF/LF	HF-LF
1	0.38	9.39	95.75	4.89E-03	34	142	4.18	108
10	3.85	9.39	80.59	5.38E-03	32	126	3.94	94
20	7.69	9.39	88.21	5.35E-03	38	146	3.84	108
30	11.54	9.39	85.59	6.37E-03	32	134	4.19	102
40	15.38	9.39	87.11	7.53E-03	36	142	3.94	106
50	19.23	9.39	101.42	5.74E-03	34	162	4.76	128
60	23.08	9.40	89.91	7.04E-03	36	152	4.22	116
70	26.92	9.39	89.97	5.76E-03	26	160	6.15	134
80	30.77	9.39	100.28	6.21E-03	40	160	4.00	120
90	34.62	9.44	87.97	8.18E-03	38	140	3.68	102
100	38.46	9.39	79.55	6.63E-03	34	138	4.06	104
110	42.31	9.39	84.33	6.40E-03	36	130	3.61	94
120	46.15	9.39	91.19	8.63E-03	36	144	4.00	108
130	50.00	9.39	109.97	6.82E-03	36	174	4.83	138
140	53.85	9.39	93.71	6.11E-03	44	142	3.23	98
150	57.69	9.39	96.01	6.20E-03	34	172	5.06	138
160	61.54	9.39	90.95	9.40E-03	36	150	4.17	114
170	65.38	9.39	104.44	1.15E-02	52	158	3.04	106
180	69.23	9.39	102.27	1.06E-02	38	158	4.16	120
190	73.08	9.39	93.94	9.32E-03	38	172	4.53	134
200	76.92	9.63	92.36	1.12E-02	34	162	4.76	128
210	80.77	9.56	96.78	1.26E-02	38	154	4.05	116
220	84.62	9.36	73.41	1.10E-02	20	124	6.20	104
230	88.46	8.82	83.64	9.71E-03	26	134	5.15	108
240	92.31	9.38	78.11	1.25E-02	26	144	5.54	118
250	96.15	8.30	74.92	1.49E-02	22	122	5.55	100
260	100.00	7.83	84.68	1.09E-02	30	138	4.60	108
REST 1		0.53	84.06	1.42E-03	14	118	8.43	104
REST 2		0.55	88.39	5.63E-04	1	144	144.00	143

S01 ISOMETRIC DAY 1 CORRELATIONS								
	% TIME	*FORCE*	*MPF*	*RMS*	*LF*	*HF*	*HF/LF*	*HF-LF*
% TIME	1							
FORCE	-0.61791	1						
MPF	-0.77748	0.534932	1					
RMS	0.112341	0.405927	-0.16961	1				
LF	-0.41354	0.195691	0.160104	0.343557	1			
HF	-0.59752	0.386848	0.821567	-0.26668	0.006026	1		
HF/LF	-0.04632	0.087328	0.372722	-0.4605	-0.80738	0.561495	1	
HF-LF	-0.42004	0.296724	0.718056	-0.36914	-0.33833	0.938972	0.806129	1

S01 ISOMETRIC DAY 2 CORRELATIONS								
	% TIME	*FORCE*	*MPF*	*RMS*	*LF*	*HF*	*HF/LF*	*HF-LF*
% TIME	1							
FORCE	-0.69354	1						
MPF	-0.85228	0.516208	1					
RMS	0.75948	-0.50014	-0.55805	1				
LF	-0.44717	0.08445	0.264748	-0.23903	1			
HF	-0.76949	0.622831	0.767933	-0.46567	0.160938	1		
HF/LF	-0.14149	0.352763	0.306228	-0.11863	-0.75451	0.521305	1	
HF-LF	-0.60624	0.589066	0.669363	-0.37808	-0.19453	0.936802	0.785561	1

S02 ISOMETRIC CORRELATIONS

	% TIME	*FORCE*	*MPF*	*RMS*	*LF*	*HF*	*HF/LF*	*HF-LF*
% TIME	1							
FORCE	-0.54421	1						
MPF	-0.69519	0.51761	1					
RMS	0.5939	0.058881	-0.18529	1				
LF	-0.11964	0.080255	0.463569	-0.09935	1			
HF	-0.47457	0.423484	0.75417	0.062277	0.340726	1		
HF/LF	-0.13135	0.118013	-0.20805	0.070784	-0.88361	0.003782	1	
HF-LF	-0.39811	0.372905	0.450625	0.12884	-0.32273	0.779892	0.592072	1

S02 PULSED ISOMETRIC TRIAL 1 CORRELATIONS									
	TIME	*CYCLE*	*FORCE*	*MPF*	*RMS*	*LF*	*HF*	*HF/LF*	*HF-LF*
TIME	1								
CYCLE	1	1							
FORCE	-0.28408	-0.20272	1						
MPF	-0.48479	-0.57224	-0.00969	1					
RMS	0.77214	0.7485	-0.07131	-0.07741	1				
LF	-0.4697	-0.31308	0.09361	0.27862	-0.30372	1			
HF	-0.59851	-0.59804	-0.02456	0.717245	-0.23128	0.434853	1		
HF/LF	0.004931	-0.19512	-0.10936	0.280222	0.128134	-0.67666	0.360153	1	
HF-LF	-0.49023	-0.57587	-0.06091	0.690225	-0.14527	0.118114	0.94556	0.641697	1

S02 PULSED ISOMETRIC TRIAL #2 CORRELATIONS								
	CYCLE	*FORCE*	*MPF*	*RMS*	*LF*	*HF*	*HF/LF*	*HF-LF*
CYCLE	1							
FORCE	-0.15557	1						
MPF	-0.37454	0.400312	1					
RMS	0.7897	-0.17919	-0.51057	1				
LF	0.54716	-0.02861	-0.0173	0.277808	1			
HF	-0.4474	-0.33703	0.383789	-0.39611	0.151637	1		
HF/LF	-0.69244	-0.07219	0.140633	-0.4908	-0.92215	0.152923	1	
HF-LF	-0.58791	-0.31909	0.383098	-0.49824	-0.24695	0.920375	0.514736	1

S02 PULSED ISOMETRIC TRIAL #3 CORRELATIONS								
	CYCLE	*FORCE*	*MPF*	*RMS*	*LF*	*HF*	*HF/LF*	*HF-LF*
CYCLE	1							
FORCE	-0.16999	1						
MPF	-0.64361	0.106162	1					
RMS	0.934373	-0.10029	-0.09869	1				
LF	-0.17026	0.164337	0.717422	0.006973	1			
HF	-0.23196	-0.28488	0.428611	-0.05962	0.331936	1		
HF/LF	0.022643	-0.36205	-0.4598	-0.02201	-0.79198	0.293285	1	
HF-LF	-0.15109	-0.37745	0.111293	-0.06601	-0.12415	0.894795	0.683364	1

S03 ISOMETRIC CORRELATIONS								
	% TIME	*FORCE*	*MPF*	*RMS*	*LF*	*HF*	*HF/LF*	*HF-LF*
% TIME	1							
FORCE	-0.58047	1						
MPF	-0.86445	0.343818	1					
RMS	0.880525	-0.56089	-0.68782	1				
LF	-0.76581	0.193683	0.771351	-0.50689	1			
HF	-0.7844	0.369726	0.872097	-0.69872	0.629415	1		
HF/LF	0.390052	0.055259	-0.37778	0.124651	-0.79186	-0.0524	1	
HF-LF	-0.49726	0.343874	0.605264	-0.55766	0.146676	0.860985	0.451612	1

SO4 ISOMETRIC DAY 1 CORRELATIONS								
	% TIME	*FORCE*	*MPF*	*RMS*	*LF*	*HF*	*H/L*	*H-L*
% TIME	1							
FORCE	-0.64968	1						
MPF	-0.4503	0.422065	1					
RMS	-0.25863	0.174217	0.202587	1				
LF	-0.37465	0.438572	0.176513	0.26377	1			
HF	-0.01982	-0.01411	0.346772	-0.0119	0.080311	1		
H/L	0.289794	-0.39309	0.046129	-0.28727	-0.84336	0.440839	1	
H-L	0.145609	-0.20533	0.24683	-0.12668	-0.36303	0.899613	0.781575	1

S04 ISOMETRIC DAY 2 CORRELATIONS								
	% TIME	*FORCE*	*MPF*	*RMS*	*LF*	*HF*	*H/L*	*H-L*
% TIME	1							
FORCE	-0.65212	1						
MPF	-0.75	0.670588	1					
RMS	0.161111	-0.47196	-0.34484	1				
LF	-0.51305	0.476355	0.384497	0.029455	1			
HF	-0.04411	0.16498	0.28883	-0.12491	0.126208	1		
H/L	0.443691	-0.35371	-0.17231	-0.09189	-0.79384	0.485277	1	
H-L	0.153961	-0.02226	0.133513	-0.13286	-0.26095	0.9247	0.77689	1

S05 ISOMETRIC CORRELATIONS								
	% TIME	*FORCE*	*MPF*	*RMS*	*LF*	*HF*	*HF/LF*	*HF-LF*
% TIME	1							
FORCE	-0.64315	1						
MPF	-0.3925	-0.55002	1					
RMS	0.597892	0.370771	-0.59878	1				
LF	-0.54336	0.800016	-0.35896	0.353038	1			
HF	-0.40025	0.089344	0.515242	-0.15752	0.301742	1		
HF/LF	0.250697	-0.77288	0.563279	-0.5067	-0.82942	-0.3606	1	
HF-LF	-0.23213	-0.23851	0.686587	-0.3108	-0.09977	0.91853	-0.0324	1

S05 PULSED ISOMETRIC TRIAL #1									
	% TIME	*CYCLE*	*FORCE*	*MPF*	*RMS*	*LF*	*HF*	*HF/LF*	*HF-LF*
% TIME	1								
CYCLE	1	1							
FORCE	0.145023	0.402973	1						
MPF	-0.19598	0.098276	0.042077	1					
RMS	0.544025	0.753896	0.489237	-0.44639	1				
LF	0.181053	0.315365	0.758502	0.118448	0.345944	1			
HF	-0.32481	0.006135	0.20664	0.768766	-0.19361	0.267335	1		
HF/LF	-0.08161	0.107761	-0.22658	0.145117	-0.21182	-0.47584	0.210765	1	
HF-LF	-0.35814	-0.16207	-0.40102	0.571526	-0.37059	-0.531	0.628212	0.573349	1

S05 PULSED ISOMETRIC TRIAL#2									
	% TIME	CYCLE	FORCE	MPF	RMS	LF	HF	HF/LF	HF-LF
% TIME	1								
CYCLE	1	1							
FORCE	0.158671	0.285405	1						
MPF	-0.05752	-0.15806	0.078876	1					
RMS	0.806054	0.859706	0.324887	0.059484	1				
LF	-0.16769	-0.01672	0.067358	0.502718	0.155624	1			
HF	0.16796	0.231466	0.110519	0.559161	0.268217	0.39673	1		
HF/LF	0.207842	0.157178	-0.03169	-0.30767	-0.10263	-0.90124	0.010218	1	
HF-LF	0.297689	0.294037	0.06235	0.193771	0.157211	-0.34594	0.724015	0.687685	1

S05 PULSED ISOMETRIC TRIAL #3	% TIME	CYCLE	FORCE	MPF	RMS	LF	HF	HF/LF	HF-LF
% TIME	1								
CYCLE	1	1							
FORCE	0.257359	0.441172	1						
MPF	-0.25773	-0.2419	0.026785	1					
RMS	0.642046	0.647381	0.407722	-0.53962	1				
LF	-0.14587	0.050107	0.288882	0.543434	-0.23885	1			
HF	-0.27106	-0.21093	0.008606	0.686389	-0.44424	0.395568	1		
HF/LF	0.099596	-0.04396	-0.3677	-0.31727	0.107072	-0.92784	-0.08296	1	
HF-LF	-0.12865	-0.24282	-0.24376	0.174013	-0.21103	-0.49856	0.598936	0.730699	1

S06 PULSED ISOMETRIC TRIAL #1	% TIME	CYCLE	FORCE	MPF	RMS	LF	HF	HF/LF	HF-LF
% TIME	1								
CYCLE	1	1							
FORCE	0.204953	0.508907	1						
MPF	-0.39468	-0.4562	-0.07653	1					
RMS	0.443501	0.664209	0.347747	-0.3978	1				
LF	-0.73728	-0.7178	-0.05555	0.25745	-0.2819	1			
HF	-0.31649	-0.55419	-0.12084	0.7104	-0.274	0.239	1		
HF/LF	0.384289	0.346354	-0.0441	0.31401	0.02236	-0.671	0.5506	1	
HF-LF	-0.06783	-0.31608	-0.10447	0.63817	-0.1827	-0.103	0.9413	0.79725	1

S06 PULSED ISOMETRIC TRIAL #2

	% TIME	CYCLE	FORCE	MPF	RMS	LF	HF	HF/LF	HF-LF
% TIME	1								
CYCLE	1	1							
FORCE	-0.01842	0.04228	1						
MPF	-0.61954	-0.6164	0.042146	1					
RMS	0.736133	0.745246	-0.02185	-0.6161	1				
LF	-0.48209	-0.46366	-0.01678	0.15995	-0.1061	1			
HF	-0.52584	-0.43309	-0.14329	0.5886	-0.4704	0.1234	1		
HF/LF	0.159271	0.216479	-0.07396	0.11454	-0.1323	-0.8097	0.4032	1	
HF-LF	-0.16726	0.003043	-0.11502	0.41733	-0.3467	-0.4983	0.7989	0.84297	1

S06 PULSED ISOMETRIC TRIAL #3									
	% TIME	CYCLE	FORCE	MPF	RMS	LF	HF	HF/LF	HF-LF
% TIME	1								
CYCLE	1	1							
FORCE	-0.32019	-0.18823	1						
MPF	-0.78372	-0.73478	0.560284	1					
RMS	0.865126	0.855486	0.596411	0.0043	1				
LF	-0.70518	-0.72198	0.836765	0.73802	0.39232	1			
HF	-0.56741	-0.41048	0.541968	0.80202	0.04783	0.54486	1		
HF/LF	0.162817	0.334129	-0.95767	-0.5982	-0.6922	-0.867	-0.5332	1	
HF-LF	-0.33042	-0.13392	0.103216	0.47744	-0.1976	0.00072	0.83892	-0.0732	1

S07 ISOMETRIC DAY 1 CORRELATIONS								
	% TIME	*FORCE*	*MPF*	*RMS*	*LF*	*HF*	*HF/LF*	*HF-LF*
% TIME	1							
FORCE	-0.4339	1						
MPF	-0.50748	0.130841	1					
RMS	0.432585	-0.16383	-0.279	1				
LF	-0.42242	0.14942	0.568177	-0.1338	1			
HF	-0.42174	0.341305	0.701067	-0.28775	0.280684	1		
HF/LF	0.069588	0.156005	-0.04924	-0.11801	-0.74047	0.421987	1	
HF-LF	-0.29164	0.303018	0.531465	-0.25275	-0.05617	0.942518	0.696762	1

S07 ISOMETRIC DAY 2 CORRELATIONS								
	% TIME	*FORCE*	*MPF*	*RMS*	*LF*	*HF*	*HF/LF*	*HF-LF*
% TIME	1							
FORCE	0.14735	1						
MPF	-0.4686	0.83012	1					
RMS	0.09196	0.79195	0.73151	1				
LF	-0.61292	0.74046	0.90674	0.6377	1			
HF	-0.46172	0.82987	0.9028	0.79203	0.83052	1		
HF/LF	0.4402	-0.90671	-0.84724	-0.71273	-0.80501	-0.8151	1	
HF-LF	-0.18747	0.72935	0.72301	0.74411	0.54972	0.92183	-0.6623	1

S08 ISOMETRIC DAY1 CORRELATIONS								
	% TIME	*FORCE*	*MPF*	*RMS*	*LF*	*HF*	*HF/LF*	*HF-LF*
% TIME	1							
FORCE	-0.45299	1						
MPF	-0.81322	0.409302	1					
RMS	0.84163	-0.40606	-0.72545	1				
LF	-0.50569	0.211873	0.682788	-0.47173	1			
HF	-0.64677	0.396248	0.787993	-0.44906	0.466947	1		
HF/LF	0.187307	-0.0674	-0.35665	0.270538	-0.85118	-0.02888	1	
HF-LF	-0.3971	0.306911	0.440497	-0.19736	-0.12574	0.818554	0.520522	1

S08 ISOMETRIC DAY 2 CORRELATIONS								
	% TIME	*FORCE*	*MPF*	*RMS*	*LF*	*HF*	*HF/LF*	*HF-LF*
% TIME	1							
FORCE	-0.46586	1						
MPF	-0.17468	0.349281	1					
RMS	0.858837	-0.38946	-0.23463	1				
LF	-0.26778	0.401956	0.69385	-0.23518	1			
HF	-0.00876	0.377749	0.816524	-0.14334	0.452195	1		
HF/LF	0.381952	-0.25451	-0.35974	0.284207	-0.86339	-0.00701	1	
HF-LF	0.124129	0.22245	0.568373	-0.04306	0.006763	0.894957	0.424019	1

S01 ISOMETRIC DAY 1 REGRESSION ON MPF

Regression Statistics	
Multiple R	0.777475
R Square	0.604468
Adjusted R Square	0.582494
Standard Error	4.15639
Observations	20

Analysis of Variance

	df	m of Squares	ean Square	F	ignificance F
Regression	1	475.2223	475.2223	27.50833	5.48E-05
Residual	18	310.9604	17.27558		
Total	19	786.1827			

	Coefficients	tandard Error	t Statistic	P-value	Lower 95%	Upper 95%
Intercept	71.14303	1.793734	39.66198	9.74E-20	67.37453	74.91153
% TIME	-0.16085	0.030667	-5.24484	4.61E-05	-0.22528	-0.09642

S01 ISOMETRIC DAY 1 REGRESSION ON RMS

Regression Statistics	
Multiple R	0.112341
R Square	0.01262
Adjusted R Square	-0.04223
Standard Error	0.004521
Observations	20

Analysis of Variance

	df	m of Squares	ean Square	F	ignificance F
Regression	1	4.7E-06	4.7E-06	0.230072	0.637247
Residual	18	0.000368	2.04E-05		
Total	19	0.000373			

	Coefficients	tandard Error	t Statistic	P-value	Lower 95%	Upper 95%
Intercept	0.016016	0.001951	8.209362	1.14E-07	0.011917	0.020115
% TIME	1.6E-05	3.34E-05	0.479658	0.636945	-5.4E-05	8.61E-05

S01 ISOMETRIC DAY 2 REGRESSION ON MPF

Regression Statistics	
Multiple R	0.852281
R Square	0.726383
Adjusted R Square	0.711982
Standard Error	3.444274
Observations	21

Analysis of Variance

	df	m of Squares	ean Square	F	ignificance F
Regression	1	598.3735	598.3735	50.44022	9.37E-07
Residual	19	225.3975	11.86302		
Total	20	823.771			

	Coefficients	tandard Error	t Statistic	P-value	Lower 95%	Upper 95%
Intercept	71.47929	1.452936	49.19645	2.42E-22	68.43825	74.52032
% TIME	-0.17654	0.024857	-7.10213	6.97E-07	-0.22856	-0.12451

S01 ISOMETRIC DAY 2 REGRESSION ON RMS

Regression Statistics	
Multiple R	0.601244
R Square	0.361494
Adjusted R Square	0.327888
Standard Error	0.004072
Observations	21

Analysis of Variance

	df	m of Squares	ean Square	F	ignificance F
Regression	1	0.000178	0.000178	10.75696	0.003941
Residual	19	0.000315	1.66E-05		
Total	20	0.000493			

	Coefficients	tandard Error	t Statistic	P-value	Lower 95%	Upper 95%
Intercept	0.011661	0.001718	6.78904	1.33E-06	0.008066	0.015257
% TIME	9.64E-05	2.94E-05	3.27978	0.003746	3.49E-05	0.000158

S01 ISOMETRIC DAY 1 REGRESSION ON HF-LF

Regression Statistics						
Multiple R	0.420037					
R Square	0.176431					
Adjusted R Square	0.130677					
Standard Error	10.61089					
Observations	20					
Analysis of Variance						
	df	*of Squares*	*ean Square*	*F*	*gnificance F*	
Regression	1	434.1615	434.1615	3.856094	0.065203	
Residual	18	2026.638	112.591			
Total	19	2460.8				
	Coefficients	*ndard Error*	*t Statistic*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	85.29104	4.579242	18.62558	1.16E-13	75.6704	94.91168
% TIME	-0.15374	0.078291	-1.96369	0.064369	-0.31822	0.010744

S01 ISOMETRIC DAY 2 REGRESSION ON HF-LF

Regression Statistics						
Multiple R	0.606242					
R Square	0.367529					
Adjusted R Square	0.334241					
Standard Error	6.591323					
Observations	21					
Analysis of Variance						
	df	*of Squares*	*ean Square*	*F*	*gnificance F*	
Regression	1	479.6776	479.6776	11.04089	0.003577	
Residual	19	825.4652	43.44554			
Total	20	1305.143				
	Coefficients	*ndard Error*	*t Statistic*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	87.47818	2.78049	31.46143	1.65E-18	81.65855	93.29782
% TIME	-0.15806	0.047568	-3.32278	0.003394	-0.25762	-0.0585

S02 ISOMETRIC REGRESSION ON MPF

Regression Statistics

Multiple R	0.695186
R Square	0.483284
Adjusted R Square	0.452889
Standard Error	5.584695
Observations	19

Analysis of Variance

	df	m of Squares	ean Square	F	ignificance F
Regression	1	495.904	495.904	15.90006	0.000953
Residual	17	530.2098	31.18881		
Total	18	1026.114			

	Coefficients	tandard Error	t Statistic	P-value	Lower 95%	Upper 95%
Intercept	84.97626	2.468356	34.42626	7.01E-18	79.76848	90.18404
% TIME	-0.16816	0.042171	-3.98749	0.000864	-0.25713	-0.07918

S02 ISOMETRIC REGRESSION ON RMS

Regression Statistics

Multiple R	0.5939
R Square	0.352718
Adjusted R Square	0.314642
Standard Error	0.002634
Observations	19

Analysis of Variance

	df	m of Squares	ean Square	F	ignificance F
Regression	1	6.43E-05	6.43E-05	9.263657	0.007339
Residual	17	0.000118	6.94E-06		
Total	18	0.000182			

	Coefficients	tandard Error	t Statistic	P-value	Lower 95%	Upper 95%
Intercept	0.006326	0.001164	5.433673	3.67E-05	0.00387	0.008782
% TIME	6.05E-05	1.99E-05	3.043626	0.006989	1.86E-05	0.000103

S02 PULSED ISOMETRIC TRIAL #1 REGRESSION ON MPF

Regression Statistics	
Multiple R	0.484793
R Square	0.235024
Adjusted R Square	0.200252
Standard Error	5.263503
Observations	24

Analysis of Variance

	df	m of Squares	ean Square	F	ignificance F
Regression	1	187.2564	187.2564	6.759071	0.016352
Residual	22	609.4982	27.70446		
Total	23	796.7546			

	Coefficients	tandard Error	t Statistic	P-value	Lower 95%	Upper 95%
Intercept	99.60012	2.217779	44.90984	6.58E-24	95.00072	104.1995
% TIME	-0.09685	0.037251	-2.59982	0.016016	-0.1741	-0.01959

S02 PULSED ISOMETRIC TRIAL #1 REGRESSION ON RMS

Regression Statistics	
Multiple R	0.77214
R Square	0.5962
Adjusted R Square	0.577845
Standard Error	0.001259
Observations	24

Analysis of Variance

	df	m of Squares	ean Square	F	ignificance F
Regression	1	5.15E-05	5.15E-05	32.4824	9.87E-06
Residual	22	3.49E-05	1.59E-06		
Total	23	8.64E-05			

	Coefficients	tandard Error	t Statistic	P-value	Lower 95%	Upper 95%
Intercept	0.003269	0.000531	6.161133	2.76E-06	0.002168	0.004369
% TIME	5.08E-05	8.91E-06	5.699333	8.38E-06	3.23E-05	6.93E-05

S02 PULSED ISOMETRIC TRIAL #2 REGRESSION ON MPF

Regression Statistics						
Multiple R	0.406704					
R Square	0.165408					
Adjusted R Square	0.123679					
Standard Error	7.064154					
Observations	22					
Analysis of Variance						
	df	*m of Squares*	*ean Square*	*F*	*ignificance F*	
Regression	1	197.8034	197.8034	3.963815	0.060327	
Residual	20	998.0454	49.90227			
Total	21	1195.849				
	Coefficients	*tandard Error*	*t Statistic*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	100.1512	3.117887	32.12151	2.45E-19	93.64744	106.655
% TIME	-0.10398	0.052226	-1.99093	0.059659	-0.21292	0.004963

S02 PULSED ISOMETRIC TRIAL #2 REGRESSION ON MPF

Regression Statistics						
Multiple R	0.740943					
R Square	0.548996					
Adjusted R Square	0.526446					
Standard Error	0.001881					
Observations	22					
Analysis of Variance						
	df	*m of Squares*	*ean Square*	*F*	*ignificance F*	
Regression	1	8.62E-05	8.62E-05	24.34549	8E-05	
Residual	20	7.08E-05	3.54E-06			
Total	21	0.000157				
	Coefficients	*tandard Error*	*t Statistic*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	0.00196	0.00083	2.36048	0.028001	0.000228	0.003692
% TIME	6.86E-05	1.39E-05	4.934115	7E-05	3.96E-05	9.76E-05

S02 PULSED ISOMETRIC TRIAL #3 REGRESSION ON MPF

Regression Statistics						
Multiple R	0.211246					
R Square	0.044625					
Adjusted R Square	-0.00845					
Standard Error	7.317399					
Observations	20					
Analysis of Variance						
	df	*m of Squares*	*ean Square*	*F*	*ignificance F*	
Regression	1	45.01846	45.01846	0.84077	0.371299	
Residual	18	963.7978	53.54432			
Total	19	1008.816				
	Coefficients	*tandard Error*	*t Statistic*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	91.14699	3.399162	26.81455	1.46E-16	84.00561	98.28837
% TIME	-0.05204	0.056751	-0.91694	0.370669	-0.17127	0.067193

S02 PULSED ISOMETRIC TRIAL #3 REGRESSION ON RMS

Regression Statistics						
Multiple R	0.888341					
R Square	0.78915					
Adjusted R Square	0.777436					
Standard Error	0.001148					
Observations	20					
Analysis of Variance						
	df	*m of Squares*	*ean Square*	*F*	*ignificance F*	
Regression	1	8.88E-05	8.88E-05	67.36874	1.7E-07	
Residual	18	2.37E-05	1.32E-06			
Total	19	0.000112				
	Coefficients	*tandard Error*	*t Statistic*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	0.003766	0.000533	7.063405	1.01E-06	0.002646	0.004886
% TIME	7.31E-05	8.9E-06	8.207846	1.14E-07	5.44E-05	9.18E-05

S02 PULSED ISOMETRIC TRIAL #1 REGRESSION ON HF-LF

Regression Statistics	
Multiple R	0.490234
R Square	0.240329
Adjusted R Square	0.205799
Standard Error	11.23351
Observations	24

Analysis of Variance

	df	*m of Squares*	*ean Square*	*F*	*ignificance F*
Regression	1	878.2826	878.2826	6.959908	0.015017
Residual	22	2776.217	126.1917		
Total	23	3654.5			

	Coefficients	*tandard Error*	*t Statistic*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	111.6739	4.733244	23.59353	1.28E-17	101.8578	121.4901
% TIME	-0.20974	0.079502	-2.63816	0.014696	-0.37462	-0.04486

S02 PULSED ISOMETRIC TRIAL #2 REGRESSION ON HF-LF

Regression Statistics	
Multiple R	0.488181
R Square	0.238321
Adjusted R Square	0.200237
Standard Error	15.39503
Observations	22

Analysis of Variance

	df	*m of Squares*	*ean Square*	*F*	*ignificance F*
Regression	1	1483.135	1483.135	6.257771	0.021163
Residual	20	4740.138	237.0069		
Total	21	6223.273			

	Coefficients	*tandard Error*	*t Statistic*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	131.0649	6.794864	19.28882	7.73E-15	116.8911	145.2388
% TIME	-0.28472	0.113817	-2.50155	0.020709	-0.52214	-0.0473

S02 PULSED ISOMETRIC TRIAL #3 REGRESSION ON HF-LF

Regression Statistics	
Multiple R	0.075107
R Square	0.005641
Adjusted R Square	-0.0496
Standard Error	12.86318
Observations	20

Analysis of Variance

	df	*m of Squares*	*ean Square*	*F*	*ignificance F*
Regression	1	16.89624	16.89624	0.102116	0.752984
Residual	18	2978.304	165.4613		
Total	19	2995.2			

	Coefficients	*tandard Error*	*t Statistic*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	102.4737	5.97535	17.1494	5.11E-13	89.91993	115.0274
% TIME	-0.03188	0.099763	-0.31956	0.752792	-0.24147	0.177714

S02 ISOMETRIC REGRESSION ON HF-LF

Regression Statistics	
Multiple R	0.398115
R Square	0.158495
Adjusted R Square	0.108995
Standard Error	9.541427
Observations	19

Analysis of Variance

	df	*m of Squares*	*ean Square*	*F*	*ignificance F*
Regression	1	291.4979	291.4979	3.201907	0.091383
Residual	17	1547.66	91.03882		
Total	18	1839.158			

	Coefficients	*tandard Error*	*t Statistic*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	96.23948	4.217175	22.82084	9.76E-15	87.342	105.1369
% TIME	-0.12892	0.07205	-1.78939	0.090392	-0.28094	0.023087

S03 ISOMETRIC REGRESSION ON MPF

Regression Statistics						
Multiple R	0.864448					
R Square	0.74727					
Adjusted R Square	0.734633					
Standard Error	3.539798					
Observations	22					
Analysis of Variance						
	df	*m of Squares*	*ean Square*	*F*	*ignificance F*	
Regression	1	740.9818	740.9818	59.1358	2.13E-07	
Residual	20	250.6035	12.53017			
Total	21	991.5853				
	Coefficients	*tandard Error*	*t Statistic*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	64.08768	1.461054	43.86399	3.87E-22	61.03997	67.13538
% TIME	-0.19233	0.02501	-7.68998	1.54E-07	-0.2445	-0.14016

S03 ISOMETRIC REGRESSION ON RMS

Regression Statistics						
Multiple R	0.880525					
R Square	0.775324					
Adjusted R Square	0.76409					
Standard Error	0.002879					
Observations	22					
Analysis of Variance						
	df	*m of Squares*	*ean Square*	*F*	*ignificance F*	
Regression	1	0.000572	0.000572	69.01694	6.48E-08	
Residual	20	0.000166	8.29E-06			
Total	21	0.000738				
	Coefficients	*tandard Error*	*t Statistic*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	0.009184	0.001188	7.729108	1.42E-07	0.006706	0.011663
% TIME	0.000169	2.03E-05	8.307643	4.47E-08	0.000127	0.000211

S03 ISOMETRIC REGRESSION ON HF-LF

Regression Statistics	
Multiple R	0.497259
R Square	0.247267
Adjusted R Square	0.20963
Standard Error	7.62171
Observations	22

Analysis of Variance

	df	*of Squares*	*ean Square*	*F*	*gnificance F*
Regression	1	381.6453	381.6453	6.569846	0.018544
Residual	20	1161.809	58.09046		
Total	21	1543.455			

	Coefficients	*ndard Error*	*t Statistic*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	75.35895	3.145866	23.95491	9.88E-17	68.79679	81.92111
% TIME	-0.13803	0.053851	-2.56317	0.018117	-0.25036	-0.0257

S04 ISOMETRIC DAY 1 REGRESSION ON MPF

Regression Statistics	
Multiple R	0.450298275
R Square	0.202768536
Adjusted R Square	0.169550558
Standard Error	5.799322054
Observations	26

Analysis of Variance

	df	Sum of Squares	Mean Square	F	Significance F
Regression	1	205.2966352	205.2966352	6.104180641	0.020977263
Residual	24	807.1712709	33.63213629		
Total	25	1012.467906			

	Coefficients	Standard Error	t Statistic	P-value	Lower 95%	Upper 95%
Intercept	116.7036927	2.210611723	52.79248791	3.64663E-27	112.1412153	121.2661701
% TIME	-0.093667019	0.037911678	-2.470664008	0.020656702	-0.171912861	-0.015421177

S04 ISOMETRIC DAY 1 REGRESSION ON RMS

Regression Statistics	
Multiple R	0.258629866
R Square	0.066889407
Adjusted R Square	0.028009799
Standard Error	0.001402931
Observations	26

Analysis of Variance

	df	Sum of Squares	Mean Square	F	Significance F
Regression	1	3.38616E-06	3.38616E-06	1.720423914	0.202047959
Residual	24	4.72372E-05	1.96822E-06		
Total	25	5.06233E-05			

	Coefficients	Standard Error	t Statistic	P-value	Lower 95%	Upper 95%
Intercept	0.009069281	0.000534776	16.95904187	3.17738E-15	0.007965558	0.010173003
% TIME	-1.20296E-05	9.17132E-06	-1.311649311	0.201556894	-3.09582E-05	6.89912E-06

S04 ISOMETRIC DAY 2 REGRESSION ON MPF						
Regression Statistics						
Multiple R	0.750001					
R Square	0.562502					
Adjusted R Square	0.545002					
Standard Error	3.770768					
Observations	27					
Analysis of Variance						
	df	*of Squares*	*an Square*	*F*	*nificance F*	
Regression	1	457.033	457.033	32.14312	6.67E-06	
Residual	25	355.4672	14.21869			
Total	26	812.5002				
	Coefficients	*ndard Error*	*t Statistic*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	118.2163	1.413077	83.65878	3.8E-33	115.306	121.1266
% TIME	-0.13745	0.024243	-5.66949	5.8E-06	-0.18738	-0.08752

S04 ISOMETRIC DAY 2 REGRESSION ON RMS						
Regression Statistics						
Multiple R	0.161111					
R Square	0.025957					
Adjusted R Square	-0.013					
Standard Error	0.001175					
Observations	27					
Analysis of Variance						
	df	*of Squares*	*an Square*	*F*	*nificance F*	
Regression	1	9.2E-07	9.2E-07	0.666213	0.422084	
Residual	25	3.45E-05	1.38E-06			
Total	26	3.54E-05				
	Coefficients	*ndard Error*	*t Statistic*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	0.008559	0.00044	19.43527	5.24E-17	0.007652	0.009466
% TIME	6.17E-06	7.56E-06	0.816219	0.421791	-9.4E-06	2.17E-05

S04 ISOMETRIC DAY 1 REGRESSION ON HF-LF

Regression Statistics	
Multiple R	0.145609
R Square	0.021202
Adjusted R Square	-0.01958
Standard Error	13.96291
Observations	26

Analysis of Variance

	df	*of Squares*	*ean Square*	*F*	*gnificance F*
Regression	1	101.3556	101.3556	0.519872	0.477862
Residual	24	4679.106	194.9627		
Total	25	4780.462			

	Coefficients	*ndard Error*	*t Statistic*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	116.1708	5.322443	21.82659	8.53E-18	105.1858	127.1558
% TIME	0.065814	0.091279	0.721021	0.477585	-0.12258	0.254205

S04 ISOMETRIC DAY 2 REGRESSION ON HF-LF

Regression Statistics	
Multiple R	0.153961
R Square	0.023704
Adjusted R Square	-0.01535
Standard Error	12.45111
Observations	27

Analysis of Variance

	df	*of Squares*	*ean Square*	*F*	*gnificance F*
Regression	1	94.10088	94.10088	0.606985	0.443238
Residual	25	3875.751	155.03		
Total	26	3969.852			

	Coefficients	*ndard Error*	*t Statistic*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	115.9548	4.665992	24.85105	1.21E-19	106.345	125.5646
% TIME	0.062367	0.080051	0.779092	0.442959	-0.1025	0.227236

S05 ISOMETRIC REGRESSION ON MPF

Regression Statistics

Multiple R	0.392503
R Square	0.154059
Adjusted R Square	0.113776
Standard Error	11.0388
Observations	23

Analysis of Variance

	df	m of Squares	ean Square	F	ignificance F
Regression	1	466.0251	466.0251	3.824417	0.063947
Residual	21	2558.959	121.8552		
Total	22	3024.984			

	Coefficients	tandard Error	t Statistic	P-value	Lower 95%	Upper 95%
Intercept	74.04419	4.462157	16.59381	6.33E-14	64.76463	83.32375
% TIME	-0.14945	0.076423	-1.95561	0.063329	-0.30838	0.009477

S05 ISOMETRIC REGRESSION ON RMS

Regression Statistics

Multiple R	0.597892
R Square	0.357474
Adjusted R Square	0.326878
Standard Error	0.002707
Observations	23

Analysis of Variance

	df	m of Squares	ean Square	F	ignificance F
Regression	1	8.56E-05	8.56E-05	11.68352	0.002586
Residual	21	0.000154	7.33E-06		
Total	22	0.00024			

	Coefficients	tandard Error	t Statistic	P-value	Lower 95%	Upper 95%
Intercept	0.004758	0.001094	4.348051	0.000258	0.002482	0.007034
% TIME	6.41E-05	1.87E-05	3.418116	0.002462	2.51E-05	0.000103

S05 PULSED ISOMETRIC TRIAL #1 REGRESSION ON MPF						
Regression Statistics						
Multiple R	0.195977					
R Square	0.038407					
Adjusted R Square	0.014367					
Standard Error	5.302852					
Observations	42					
Analysis of Variance						
	df	*of Squares*	*an Square*	*F*	*nificance F*	
Regression	1	44.92616	44.92616	1.597645	0.213554	
Residual	40	1124.809	28.12024			
Total	41	1169.736				
	Coefficients	*ndard Error*	*t Statistic*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	68.12812	1.666163	40.88924	7.38E-35	64.76068	71.49556
% TIME	-0.03584	0.028353	-1.26398	0.213376	-0.09314	0.021466

S05 PULSED ISOMETRIC TRIAL #1 REGRESSION ON RMS						
Regression Statistics						
Multiple R	0.544025					
R Square	0.295963					
Adjusted R Square	0.278362					
Standard Error	0.00278					
Observations	42					
Analysis of Variance						
	df	*of Squares*	*an Square*	*F*	*nificance F*	
Regression	1	0.00013	0.00013	16.81517	0.000196	
Residual	40	0.000309	7.73E-06			
Total	41	0.000439				
	Coefficients	*ndard Error*	*t Statistic*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	0.005234	0.000873	5.992476	4.43E-07	0.003469	0.006999
% TIME	6.09E-05	1.49E-05	4.10063	0.00019	3.09E-05	9.1E-05

S05 PULSED ISOMETRIC TRIAL #2 REGRESSION ON MPF						
Regression Statistics						
Multiple R	0.057522					
R Square	0.003309					
Adjusted R Square	-0.02601					
Standard Error	3.869723					
Observations	36					
Analysis of Variance						
	df	*of Squares*	*an Square*	*F*	*nificance F*	
Regression	1	1.690218	1.690218	0.112871	0.738963	
Residual	34	509.1416	14.97475			
Total	35	510.8318				
	Coefficients	*ndard Error*	*t Statistic*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	65.98486	1.317258	50.09257	3.58E-34	63.30788	68.66185
% TIME	-0.00751	0.02235	-0.33596	0.738905	-0.05293	0.037913

S05 PULSED ISOMETRIC TRIAL #2 REGRESSION ON RMS						
Regression Statistics						
Multiple R	0.806054					
R Square	0.649723					
Adjusted R Square	0.639421					
Standard Error	0.001986					
Observations	36					
Analysis of Variance						
	df	*of Squares*	*an Square*	*F*	*nificance F*	
Regression	1	0.000249	0.000249	63.06615	2.99E-09	
Residual	34	0.000134	3.94E-06			
Total	35	0.000383				
	Coefficients	*ndard Error*	*t Statistic*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	0.004531	0.000676	6.701776	9.3E-08	0.003157	0.005905
% TIME	9.11E-05	1.15E-05	7.94142	2.43E-09	6.78E-05	0.000114

S05 PULSED ISOMETRIC TRIAL #3 REGRESSION ON MPF

Regression Statistics	
Multiple R	0.257727
R Square	0.066423
Adjusted R Square	0.035304
Standard Error	6.39331
Observations	32

Analysis of Variance

	df	*of Squares*	*an Square*	*F*	*nificance F*
Regression	1	87.24566	87.24566	2.134481	0.154415
Residual	30	1226.232	40.87441		
Total	31	1313.478			

	Coefficients	*ndard Error*	*t Statistic*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	75.14794	2.314417	32.46949	1.67E-25	70.42128	79.87461
% TIME	-0.05723	0.03917	-1.46099	0.154082	-0.13722	0.022769

S05 PULSED ISOMETRIC TRIAL #3 REGRESSION ON RMS

Regression Statistics	
Multiple R	0.642046
R Square	0.412223
Adjusted R Square	0.392631
Standard Error	0.002311
Observations	32

Analysis of Variance

	df	*of Squares*	*an Square*	*F*	*nificance F*
Regression	1	0.000112	0.000112	21.0398	7.46E-05
Residual	30	0.00016	5.34E-06		
Total	31	0.000273			

	Coefficients	*ndard Error*	*t Statistic*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	0.004863	0.000837	5.812049	2.1E-06	0.003154	0.006572
% TIME	6.5E-05	1.42E-05	4.586916	6.99E-05	3.6E-05	9.39E-05

S05 PULSED ISOMETRIC TRIAL #1 REGRESSION ON HF-LF						
Regression Statistics						
Multiple R	0.316453					
R Square	0.100142					
Adjusted R Square	0.077646					
Standard Error	6.293206					
Observations	42					
Analysis of Variance						
	df	*m of Squares*	*ean Square*	*F*	*ignificance F*	
Regression	1	176.2984	176.2984	4.451479	0.041175	
Residual	40	1584.178	39.60445			
Total	41	1760.476				
	Coefficients	*tandard Error*	*t Statistic*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	82.82462	1.977333	41.88703	2.81E-35	78.82828	86.82096
% TIME	-0.07099	0.033648	-2.10985	0.041019	-0.139	-0.00299

S05 PULSED ISOMETRIC TRIAL #2 REGRESSION ON HF-LF						
Regression Statistics						
Multiple R	0.297689					
R Square	0.088619					
Adjusted R Square	0.061813					
Standard Error	6.211905					
Observations	36					
Analysis of Variance						
	df	*m of Squares*	*ean Square*	*F*	*ignificance F*	
Regression	1	127.5717	127.5717	3.306014	0.077846	
Residual	34	1311.984	38.58776			
Total	35	1439.556				
	Coefficients	*tandard Error*	*t Statistic*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	74.75873	2.11454	35.3546	5.6E-29	70.46147	79.05599
% TIME	0.065236	0.035878	1.818245	0.077594	-0.00768	0.138149

S05 PULSED ISOMETRIC TRIAL #3 REGRESSION ON HF-LF

Regression Statistics

Multiple R	0.128648
R Square	0.01655
Adjusted R Square	-0.01623
Standard Error	5.928063
Observations	32

Analysis of Variance

	df	m of Squares	ean Square	F	ignificance F
Regression	1	17.74194	17.74194	0.504865	0.482858
Residual	30	1054.258	35.14194		
Total	31	1072			

	Coefficients	tandard Error	t Statistic	P-value	Lower 95%	Upper 95%
Intercept	83.33065	2.145995	38.83078	7.44E-28	78.94794	87.71335
% TIME	-0.02581	0.03632	-0.71054	0.482682	-0.09998	0.048368

S05 ISOMETRIC REGRESSION ON HF-LF

Regression Statistics

Multiple R	0.232125
R Square	0.053882
Adjusted R Square	0.008829
Standard Error	11.0615
Observations	23

Analysis of Variance

	df	m of Squares	ean Square	F	ignificance F
Regression	1	146.3346	146.3346	1.195967	0.286516
Residual	21	2569.492	122.3567		
Total	22	2715.826			

	Coefficients	tandard Error	t Statistic	P-value	Lower 95%	Upper 95%
Intercept	84.27603	4.47133	18.84809	4.59E-15	74.97739	93.57467
% TIME	-0.08375	0.07658	-1.0936	0.28596	-0.24301	0.075509

S06 ISOMETRIC REGRESSION ON MPF						
Regression Statistics						
Multiple R	0.914732					
R Square	0.836735					
Adjusted R Square	0.828572					
Standard Error	6.894315					
Observations	22					
Analysis of Variance						
	df	*m of Squares*	*ean Square*	*F*	*ignificance F*	
Regression	1	4872	4872	102.5003	2.57E-09	
Residual	20	950.6317	47.53158			
Total	21	5822.632				
	Coefficients	*tandard Error*	*t Statistic*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	123.0935	2.845634	43.25695	5.17E-22	117.1576	129.0293
% TIME	-0.49316	0.048711	-10.1242	1.56E-09	-0.59477	-0.39155

S06 ISOMETRIC REGRESSION ON RMS						
Regression Statistics						
Multiple R	0.412817					
R Square	0.170418					
Adjusted R Square	0.128939					
Standard Error	0.005233					
Observations	22					
Analysis of Variance						
	df	*m of Squares*	*ean Square*	*F*	*ignificance F*	
Regression	1	0.000113	0.000113	4.108518	0.056208	
Residual	20	0.000548	2.74E-05			
Total	21	0.00066				
	Coefficients	*tandard Error*	*t Statistic*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	0.015052	0.00216	6.968678	6.99E-07	0.010546	0.019558
% TIME	7.49E-05	3.7E-05	2.026948	0.055552	-2.2E-06	0.000152

S06 PULSED ISOMETRIC TRIAL #1 REGRESSION ON MPF						
Regression Statistics						
Multiple R	0.39468					
R Square	0.155772					
Adjusted R Square	0.134666					
Standard Error	4.468217					
Observations	42					
Analysis of Variance						
	df	*of Squares*	*an Square*	*F*	*nificance F*	
Regression	1	147.3527	147.3527	7.380563	0.009694	
Residual	40	798.5986	19.96496			
Total	41	945.9513				
	Coefficients	*ndard Error*	*t Statistic*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	76.82842	1.403919	54.72424	5.91E-40	73.99099	79.66584
% TIME	-0.0649	0.02389	-2.71672	0.009612	-0.11319	-0.01662

S06 PULSED ISOMETRIC TRIAL #1 REGRESSION ON RMS						
Regression Statistics						
Multiple R	0.443501					
R Square	0.196693					
Adjusted R Square	0.176611					
Standard Error	0.004223					
Observations	42					
Analysis of Variance						
	df	*of Squares*	*an Square*	*F*	*nificance F*	
Regression	1	0.000175	0.000175	9.794179	0.003264	
Residual	40	0.000713	1.78E-05			
Total	41	0.000888				
	Coefficients	*ndard Error*	*t Statistic*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	0.023729	0.001327	17.88203	5.71E-21	0.021047	0.026411
% TIME	7.07E-05	2.26E-05	3.129565	0.003221	2.5E-05	0.000116

S06 PULSED ISOMETRIC TRIAL #2 REGRESSION ON MPF

Regression Statistics						
Multiple R	0.619542					
R Square	0.383832					
Adjusted R Square	0.364577					
Standard Error	3.921972					
Observations	34					
Analysis of Variance						
	df	*of Squares*	*an Square*	*F*	*nificance F*	
Regression	1	306.6206	306.6206	19.9339	9.34E-05	
Residual	32	492.2196	15.38186			
Total	33	798.8402				
	Coefficients	*ndard Error*	*t Statistic*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	78.16829	1.375459	56.8307	1.67E-34	75.36658	80.97001
% TIME	-0.10407	0.02331	-4.46474	8.84E-05	-0.15155	-0.05659

S06 PULSED ISOMETRIC TRIAL #2 REGRESSION ON RMS

Regression Statistics						
Multiple R	0.736133					
R Square	0.541892					
Adjusted R Square	0.527576					
Standard Error	0.004282					
Observations	34					
Analysis of Variance						
	df	*of Squares*	*an Square*	*F*	*nificance F*	
Regression	1	0.000694	0.000694	37.85247	6.99E-07	
Residual	32	0.000587	1.83E-05			
Total	33	0.001281				
	Coefficients	*ndard Error*	*t Statistic*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	0.020313	0.001502	13.52601	5.15E-15	0.017254	0.023372
% TIME	0.000157	2.55E-05	6.152436	6.16E-07	0.000105	0.000208

S06 PULSED ISOMETRIC TRIAL #3 REGRESSION ON MPF

Regression Statistics						
Multiple R	0.783718					
R Square	0.614214					
Adjusted R Square	0.600435					
Standard Error	4.681954					
Observations	30					
Analysis of Variance						
	df	*of Squares*	*an Square*	*F*	*nificance F*	
Regression	1	977.2027	977.2027	44.57901	3.02E-07	
Residual	28	613.7793	21.92069			
Total	29	1590.982				
	Coefficients	*ndard Error*	*t Statistic*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	86.07236	1.753264	49.09263	1.82E-29	82.48095	89.66376
% TIME	-0.19782	0.029628	-6.67675	2.53E-07	-0.25851	-0.13713

S06 PULSED ISOMETRIC TRIAL #3 REGRESSION ON RMS

Regression Statistics						
Multiple R	0.865126					
R Square	0.748444					
Adjusted R Square	0.73946					
Standard Error	0.003626					
Observations	30					
Analysis of Variance						
	df	*of Squares*	*an Square*	*F*	*nificance F*	
Regression	1	0.001095	0.001095	83.30715	6.94E-10	
Residual	28	0.000368	1.31E-05			
Total	29	0.001463				
	Coefficients	*ndard Error*	*t Statistic*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	0.016677	0.001358	12.2833	5.13E-13	0.013895	0.019458
% TIME	0.000209	2.29E-05	9.127275	5.02E-10	0.000162	0.000256

S06 PULSED ISOMETRIC TRIAL #1 REGRESSION ON HF-LF

Regression Statistics

Multiple R	0.067827
R Square	0.004601
Adjusted R Square	-0.02028
Standard Error	12.83489
Observations	42

Analysis of Variance

	df	m of Squares	ean Square	F	ignificance F
Regression	1	30.45495	30.45495	0.184873	0.669526
Residual	40	6589.378	164.7345		
Total	41	6619.833			

	Coefficients	tandard Error	t Statistic	P-value	Lower 95%	Upper 95%
Intercept	88.34379	4.032739	21.90665	3.01E-24	80.19332	96.49425
% TIME	-0.02951	0.068625	-0.42997	0.66947	-0.1682	0.109189

S06 PULSED ISOMETRIC TRIAL #2 REGRESSION ON HF-LF

Regression Statistics

Multiple R	0.167258
R Square	0.027975
Adjusted R Square	-0.0024
Standard Error	11.4392
Observations	34

Analysis of Variance

	df	m of Squares	ean Square	F	ignificance F
Regression	1	120.5146	120.5146	0.920976	0.344414
Residual	32	4187.368	130.8552		
Total	33	4307.882			

	Coefficients	tandard Error	t Statistic	P-value	Lower 95%	Upper 95%
Intercept	84.29947	4.011794	21.01291	1.12E-20	76.12771	92.47122
% TIME	-0.06525	0.067988	-0.95968	0.344198	-0.20373	0.073241

S06 PULSED ISOMETRIC TRIAL #3 REGRESSION ON HF-LF

Regression Statistics						
Multiple R	0.330419					
R Square	0.109177					
Adjusted R Square	0.077362					
Standard Error	14.77439					
Observations	30					
Analysis of Variance						
	df	*m of Squares*	*ean Square*	*F*	*ignificance F*	
Regression	1	749.0573	749.0573	3.431596	0.07453	
Residual	28	6111.909	218.2825			
Total	29	6860.967				
	Coefficients	*tandard Error*	*t Statistic*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	93.98161	5.532606	16.98686	1.3E-16	82.64857	105.3147
% TIME	-0.17319	0.093493	-1.85246	0.074164	-0.36471	0.01832

S06 ISOMETRIC REGRESSION ON HF-LF

Regression Statistics						
Multiple R	0.508099					
R Square	0.258165					
Adjusted R Square	0.221073					
Standard Error	17.54637					
Observations	22					
Analysis of Variance						
	df	*m of Squares*	*ean Square*	*F*	*ignificance F*	
Regression	1	2142.863	2142.863	6.960172	0.015765	
Residual	20	6157.5	307.875			
Total	21	8300.364				
	Coefficients	*tandard Error*	*t Statistic*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	153.0877	7.242276	21.13806	1.24E-15	137.9805	168.1948
% TIME	-0.34264	0.129876	-2.63821	0.015371	-0.61356	-0.07172

S07 ISOMETRIC REGRESSION ON MPF

Regression Statistics	
Multiple R	0.50748
R Square	0.257536
Adjusted R Square	0.231934
Standard Error	6.070205
Observations	31

Analysis of Variance

	df	*m of Squar*	*Mean Square*	*F*	*Significance F*
Regression	1	370.653	370.6529556	10.0591383	0.0035676
Residual	29	1068.574	36.84738622		
Total	30	1439.227			

	Coefficients	*tandard Err*	*t Statistic*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	95.24177	2.130049	44.71341171	5.1221E-29	90.88532596	99.59821036
% TIME	-0.11605	0.03659	-3.171614469	0.00348399	-0.190883636	-0.041214222

S07 ISOMETRIC REGRESSION ON RMS

Regression Statistics	
Multiple R	0.432585
R Square	0.18713
Adjusted R Square	0.1591
Standard Error	0.001427
Observations	31

Analysis of Variance

	df	*m of Squar*	*Mean Square*	*F*	*Significance F*
Regression	1	1.36E-05	1.35901E-05	6.67604408	0.015077179
Residual	29	5.9E-05	2.03564E-06		
Total	30	7.26E-05			

	Coefficients	*tandard Err*	*t Statistic*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	0.005237	0.000501	10.45969455	1.5899E-11	0.004212731	0.006260634
% TIME	2.22E-05	8.6E-06	2.583804187	0.01488642	4.63184E-06	3.98106E-05

S07 ISOMETRIC DAY 2 REGRESSION ON MPF

Regression Statistics

Multiple R	0.530282
R Square	0.281199
Adjusted R Square	0.246971
Standard Error	6.382839
Observations	23

Analysis of Variance

	df	m of Squares	ean Square	F	ignificance F
Regression	1	334.698	334.698	8.215336	0.009244
Residual	21	855.5533	40.74063		
Total	22	1190.251			

	Coefficients	tandard Error	t Statistic	P-value	Lower 95%	Upper 95%
Intercept	109.0991	2.580101	42.28482	1.45E-22	103.7335	114.4647
% TIME	-0.12666	0.044189	-2.86624	0.008973	-0.21855	-0.03476

S07 ISOMETRIC DAY 2 REGRESSION ON RMS

Regression Statistics

Multiple R	0.184451
R Square	0.034022
Adjusted R Square	-0.01198
Standard Error	0.001463
Observations	23

Analysis of Variance

	df	m of Squares	ean Square	F	ignificance F
Regression	1	1.58E-06	1.58E-06	0.739628	0.399492
Residual	21	4.5E-05	2.14E-06		
Total	22	4.65E-05			

	Coefficients	tandard Error	t Statistic	P-value	Lower 95%	Upper 95%
Intercept	0.007081	0.000591	11.9706	4.17E-11	0.005851	0.008311
% TIME	8.71E-06	1.01E-05	0.860016	0.399055	-1.2E-05	2.98E-05

S07 ISOMETRIC DAY 1 REGRESSION ON HF-LF

Regression Statistics

Multiple R	0.291645
R Square	0.085057
Adjusted R Square	0.053507
Standard Error	13.91364
Observations	31

Analysis of Variance

	df	of Squares	ean Square	F	gnificance F
Regression	1	521.9071	521.9071	2.695949	0.111405
Residual	29	5614.093	193.5894		
Total	30	6136			

	Coefficients	ndard Error	t Statistic	P-value	Lower 95%	Upper 95%
Intercept	110.8868	4.88233	22.71186	1.87E-20	100.9013	120.8723
% TIME	-0.13771	0.083868	-1.64193	0.111047	-0.30924	0.033824

S07 ISOMETRIC DAY 2 REGRESSION ON HF-LF

Regression Statistics

Multiple R	0.228599
R Square	0.052258
Adjusted R Square	0.007127
Standard Error	10.7975
Observations	23

Analysis of Variance

	df	of Squares	ean Square	F	gnificance F
Regression	1	134.9972	134.9972	1.157919	0.294105
Residual	21	2448.307	116.5861		
Total	22	2583.304			

	Coefficients	ndard Error	t Statistic	P-value	Lower 95%	Upper 95%
Intercept	130.1974	4.364617	29.83021	2.74E-19	121.1207	139.2742
% TIME	-0.08044	0.074753	-1.07607	0.293557	-0.2359	0.075018

S08 ISOMETRIC DAY 1 REGRESSION ON MPF

Regression Statistics	
Multiple R	0.813223939
R Square	0.661333175
Adjusted R Square	0.65264941
Standard Error	6.04367124
Observations	41

Analysis of Variance

	df	*Sum of Squares*	*Mean Square*	*F*	*Significance F*
Regression	1	2781.723271	2781.723271	76.15743	1.04402E-10
Residual	39	1424.51252	36.52596205		
Total	40	4206.235791			

	Coefficients	*Standard Error*	*t Statistic*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	96.46977988	1.854354955	52.02336242	2.33E-38	92.71899663	100.22056
% TIME	-0.27855568	0.031919485	-8.726822246	8.41E-11	-0.343118866	-0.213992

S08 ISOMETRIC DAY1 REGRESSION ON RMS

Regression Statistics	
Multiple R	0.841629544
R Square	0.70834029
Adjusted R Square	0.700861836
Standard Error	0.001894724
Observations	41

Analysis of Variance

	df	*Sum of Squares*	*Mean Square*	*F*	*Significance F*
Regression	1	0.000340034	0.000340034	94.71748	5.48695E-12
Residual	39	0.000140009	3.58998E-06		
Total	40	0.000480043			

	Coefficients	*Standard Error*	*t Statistic*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	0.005670065	0.00058135	9.753265867	3.95E-12	0.004494174	0.006846
% TIME	9.73904E-05	1.00069E-05	9.732290329	4.2E-12	7.71495E-05	0.0001176

S08 ISOMETRIC DAY 2 REGRESSION ON MPF

Regression Statistics

Multiple R	0.174677
R Square	0.030512
Adjusted R Square	-0.00827
Standard Error	9.072425
Observations	27

Analysis of Variance

	df	Sum of Squares	Mean Square	F	Significance F
Regression	1	64.7610687	64.76107	0.78681	0.3835219
Residual	25	2057.7222	82.30889		
Total	26	2122.48327			

	Coefficients	Standard Error	t Statistic	P-value	Lower 95%	Upper 95%
Intercept	92.84816	3.39984741	27.30951	1.1E-20	85.846049	99.85027
% TIME	-0.05174	0.05832885	-0.88702	0.3832	-0.1718693	0.068392

S08 ISOMETRIC DAY 2 REGRESSION ON RMS

Regression Statistics

Multiple R	0.858837
R Square	0.737602
Adjusted R Square	0.727106
Standard Error	0.001418
Observations	27

Analysis of Variance

	df	Sum of Squares	Mean Square	F	Significance F
Regression	1	0.00014132	0.000141	70.2751	9.912E-09
Residual	25	5.0272E-05	2.01E-06		
Total	26	0.00019159			

	Coefficients	Standard Error	t Statistic	P-value	Lower 95%	Upper 95%
Intercept	0.004579	0.00053141	8.616044	4.3E-09	0.0034842	0.005673
% TIME	7.64E-05	9.117E-06	8.383022	7.3E-09	5.765E-05	9.52E-05

S08 ISOMETRIC DAY 1 REGRESSION ON HF-LF

Regression Statistics

Multiple R	0.397103
R Square	0.157691
Adjusted R Square	0.136093
Standard Error	10.4659
Observations	41

Analysis of Variance

	df	of Squares	ean Square	F	gnificance F
Regression	1	799.7457	799.7457	7.301281	0.010148
Residual	39	4271.864	109.535		
Total	40	5071.61			

	Coefficients	ndard Error	t Statistic	P-value	Lower 95%	Upper 95%
Intercept	111.5664	3.211208	34.74282	1.69E-31	105.0711	118.0617
% TIME	-0.14936	0.055275	-2.70209	0.01006	-0.26116	-0.03755

S08 ISOMETRIC DAY 2 REGRESSION ON HF-LF

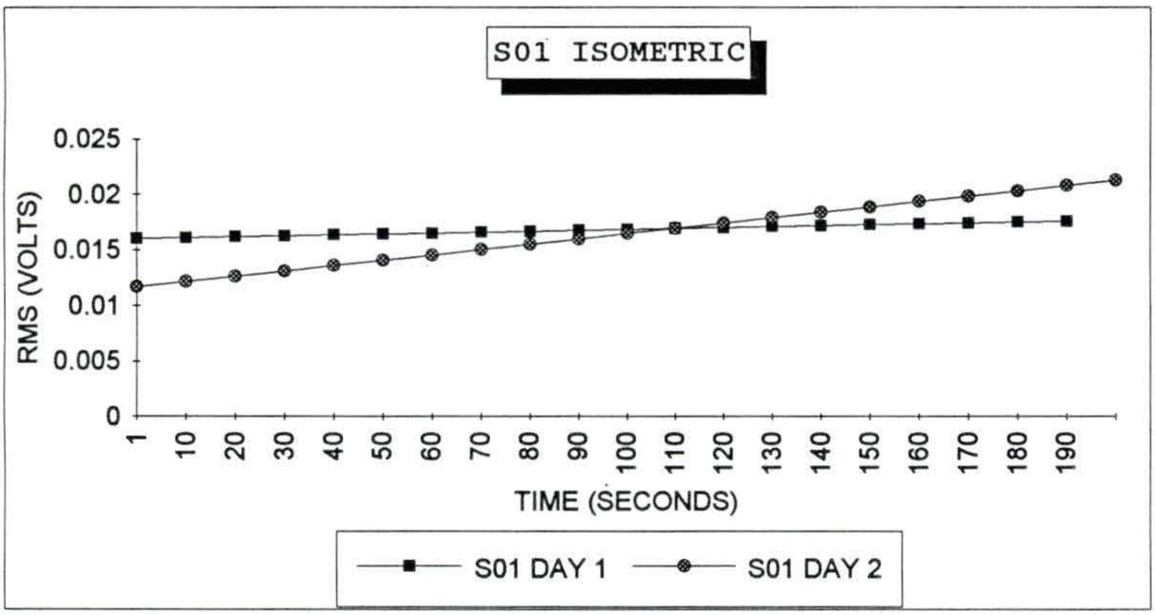
Regression Statistics

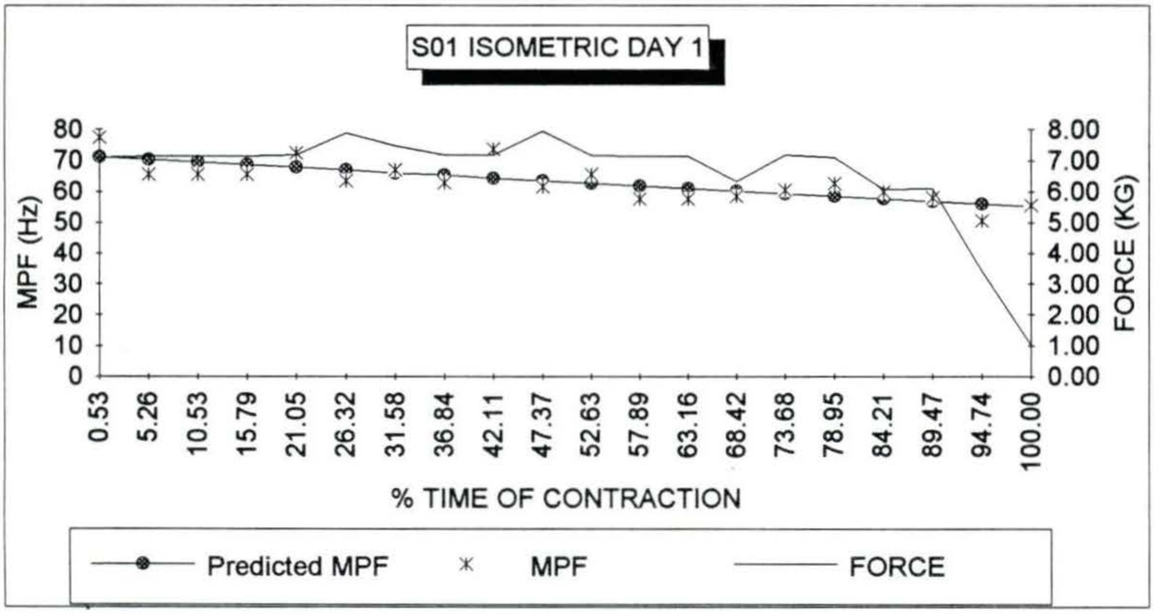
Multiple R	0.124129
R Square	0.015408
Adjusted R Square	-0.02398
Standard Error	13.26325
Observations	27

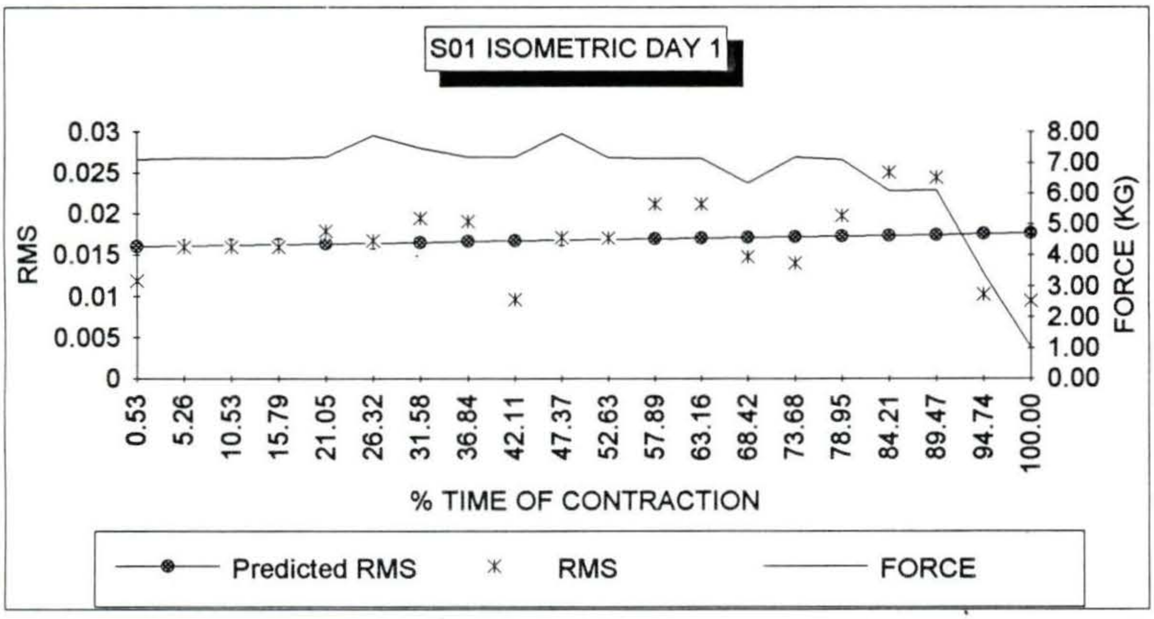
Analysis of Variance

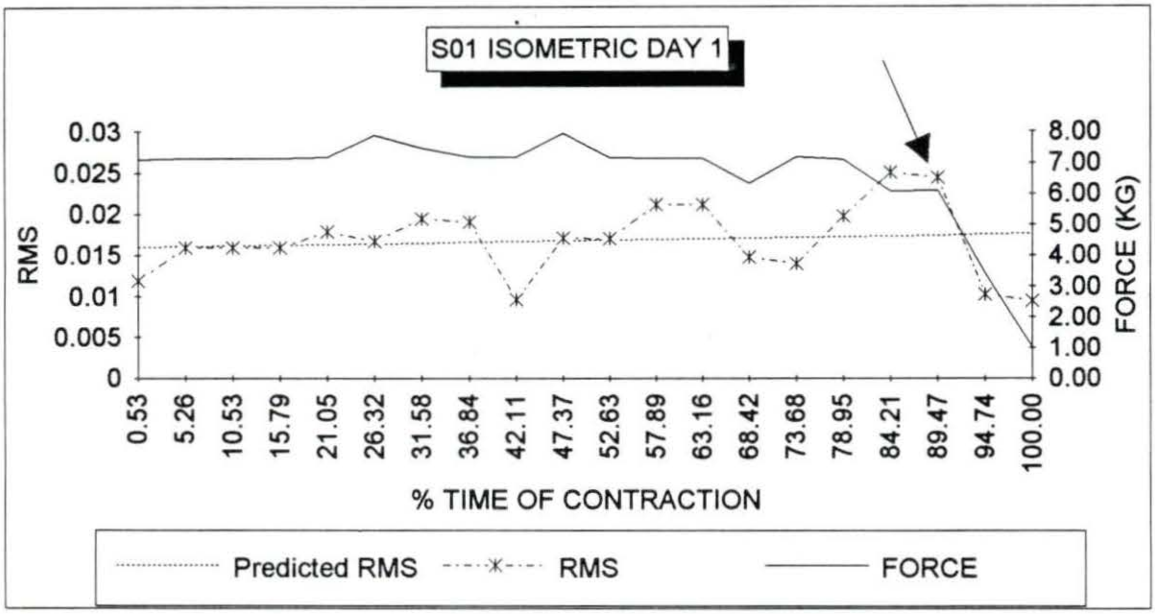
	df	of Squares	ean Square	F	gnificance F
Regression	1	68.82239	68.82239	0.391228	0.537323
Residual	25	4397.844	175.9138		
Total	26	4466.667			

	Coefficients	ndard Error	t Statistic	P-value	Lower 95%	Upper 95%
Intercept	110.4435	4.970339	22.22052	1.95E-18	100.2069	120.6801
% TIME	0.053337	0.085273	0.625482	0.537107	-0.12229	0.228959

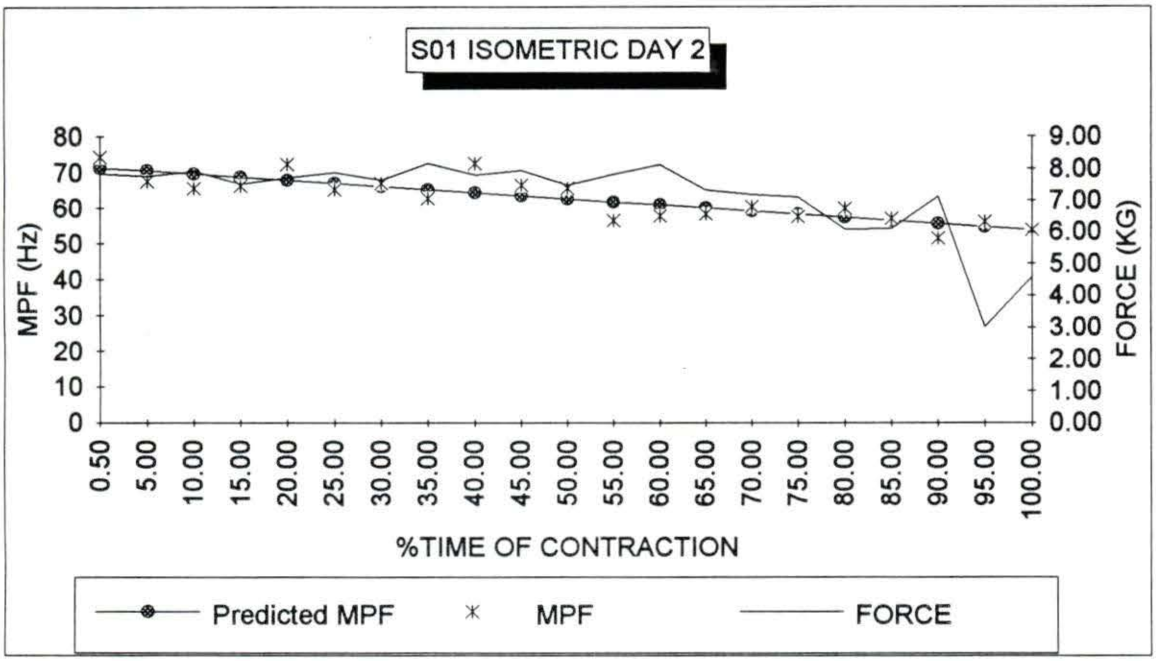

S01 ISOMETRIC
RMS (VOLTS)
0.025
0.02
0.015
0.01
0.005
0
1
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
TIME (SECONDS)
S01 DAY 1
S01 DAY 2


S01 ISOMETRIC DAY 1
MPF (Hz)
80
70
60
50
40
30
20
10
0
FORCE (KG)
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
0.53
5.26
10.53
15.79
21.05
26.32
31.58
36.84
42.11
47.37
52.63
57.89
63.16
68.42
73.68
78.95
84.21
89.47
94.74
100.00
% TIME OF CONTRACTION
Predicted MPF
MPF
FORCE

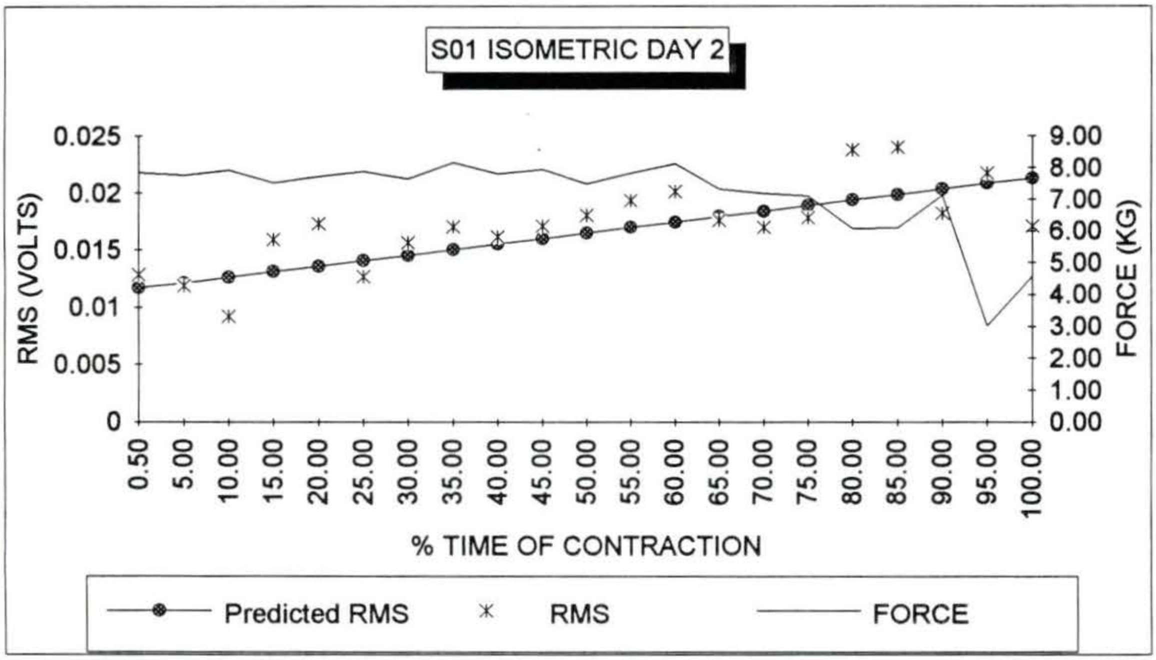

S01 ISOMETRIC DAY 1
RMS
0.03
0.025
0.02
0.015
0.01
0.005
0
FORCE (KG)
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
0.53
5.26
10.53
15.79
21.05
26.32
31.58
36.84
42.11
47.37
52.63
57.89
63.16
68.42
73.68
78.95
84.21
89.47
94.74
100.00
% TIME OF CONTRACTION
Predicted RMS
RMS
FORCE

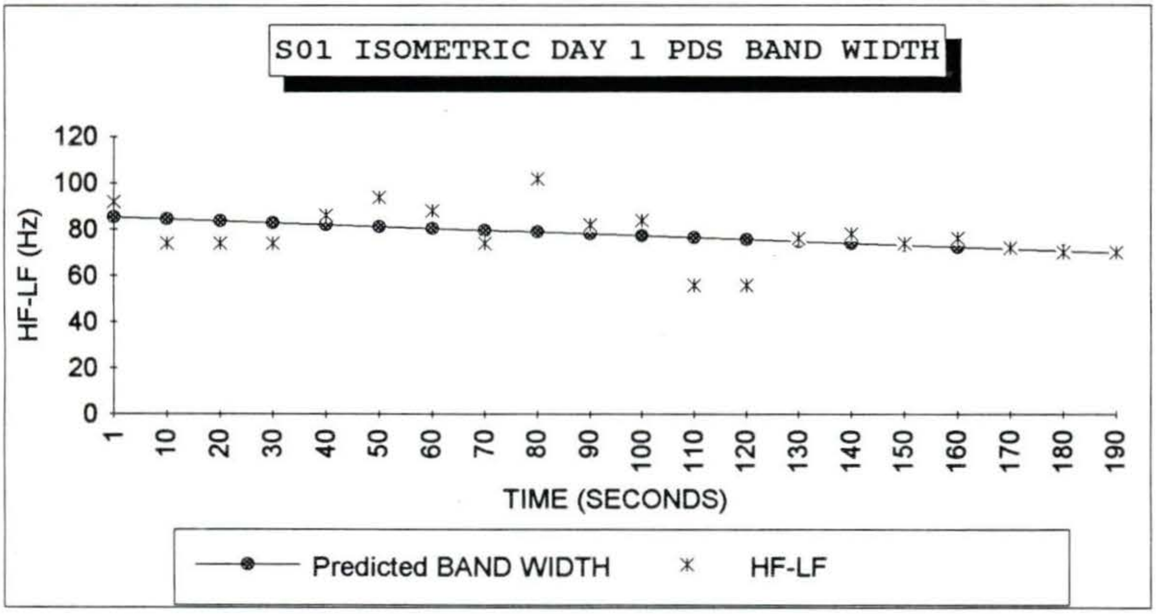


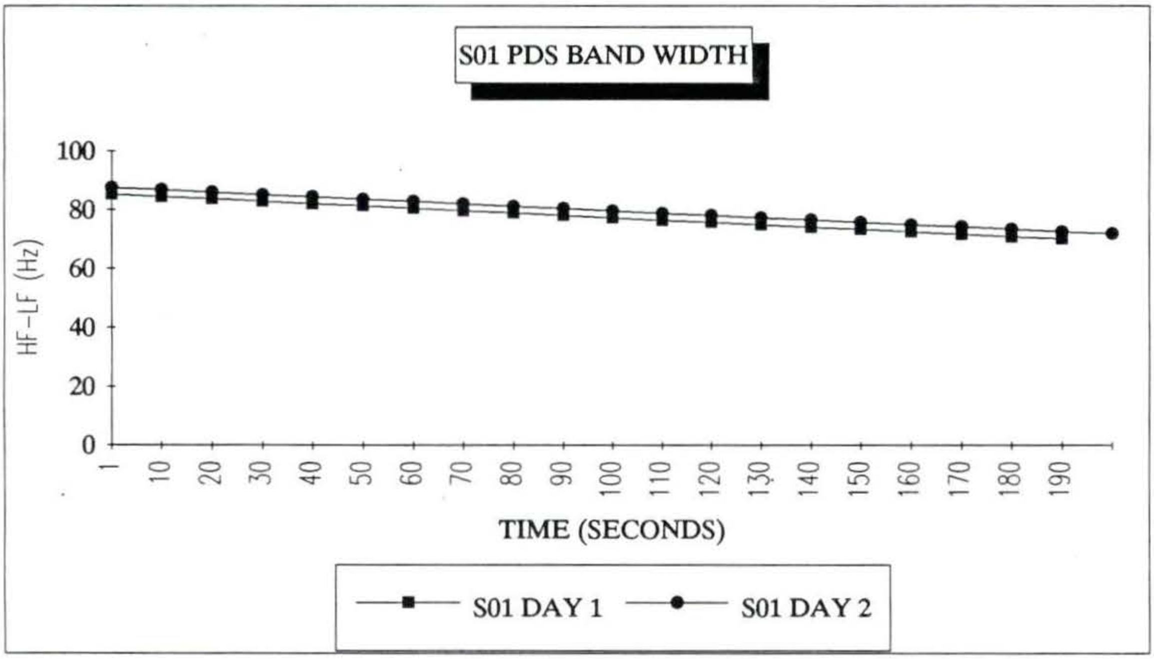
S01 ISOMETRIC DAY 1
RMS
0.03
0.025
0.02
0.015
0.01
0.005
0
FORCE (KG)
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
0.53
5.26
10.53
15.79
21.05
26.32
31.58
36.84
42.11
47.37
52.63
57.89
63.16
68.42
73.68
78.95
84.21
89.47
94.74
100.00
% TIME OF CONTRACTION
Predicted RMS
RMS
FORCE

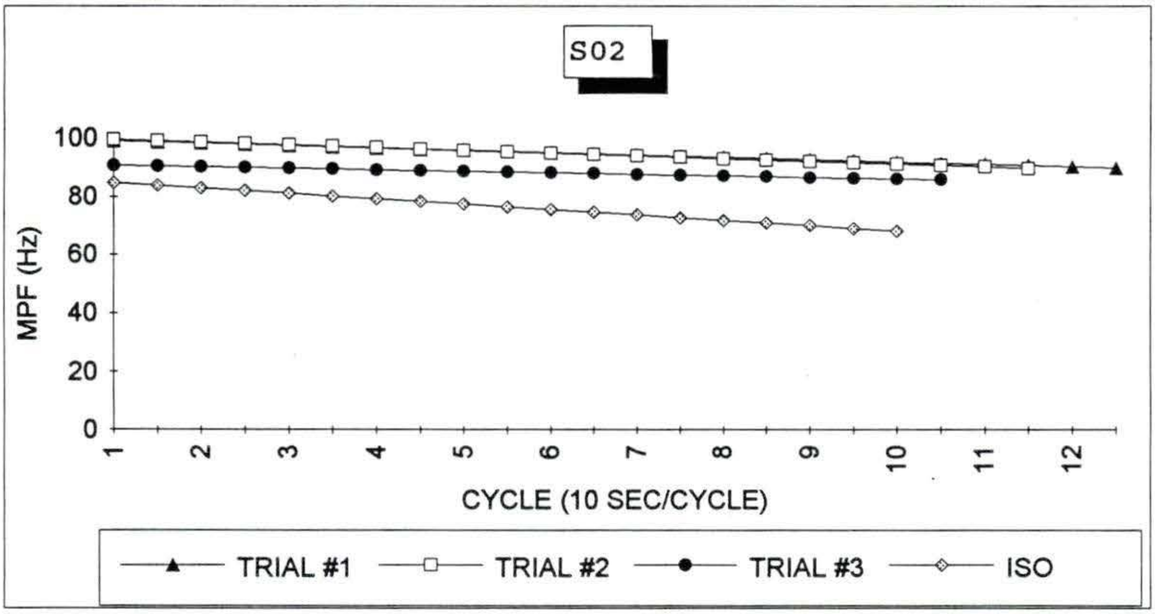


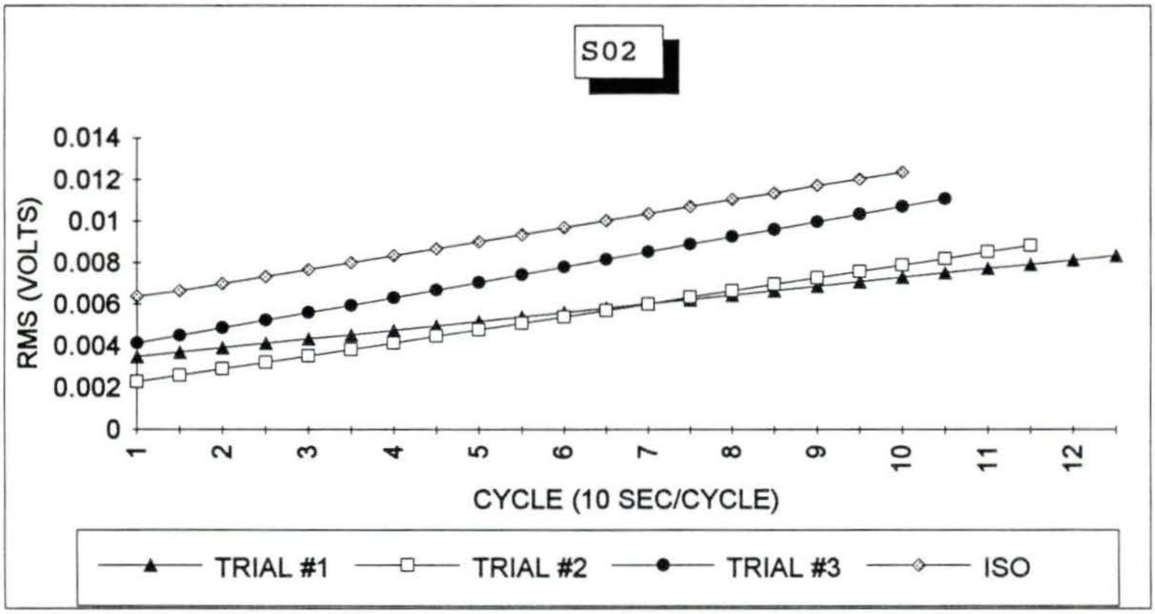
S01 ISOMETRIC DAY 2
MPF (Hz)
FORCE (KG)
80
70
60
50
40
30
20
10
0
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
0.50
5.00
10.00
15.00
20.00
25.00
30.00
35.00
40.00
45.00
50.00
55.00
60.00
65.00
70.00
75.00
80.00
85.00
90.00
95.00
100.00
%TIME OF CONTRACTION
Predicted MPF
MPF
FORCE

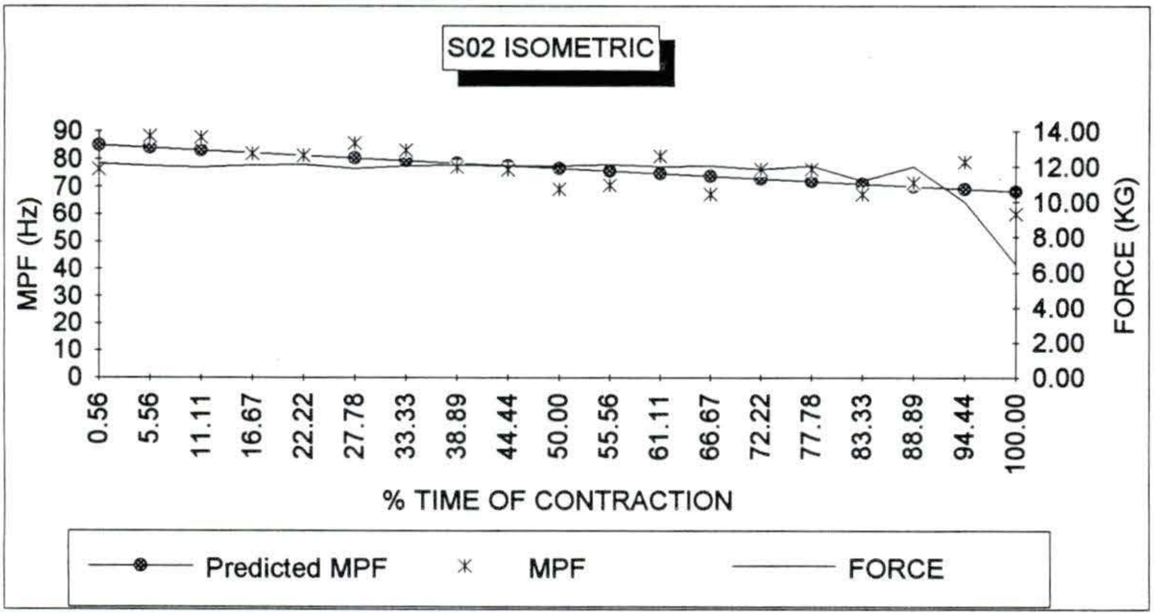

S01 ISOMETRIC DAY 2
RMS (VOLTS)
0.025
0.02
0.015
0.01
0.005
0
FORCE (KG)
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
0.50
5.00
10.00
15.00
20.00
25.00
30.00
35.00
40.00
45.00
50.00
55.00
60.00
65.00
70.00
75.00
80.00
85.00
90.00
95.00
100.00
% TIME OF CONTRACTION
Predicted RMS
RMS
FORCE

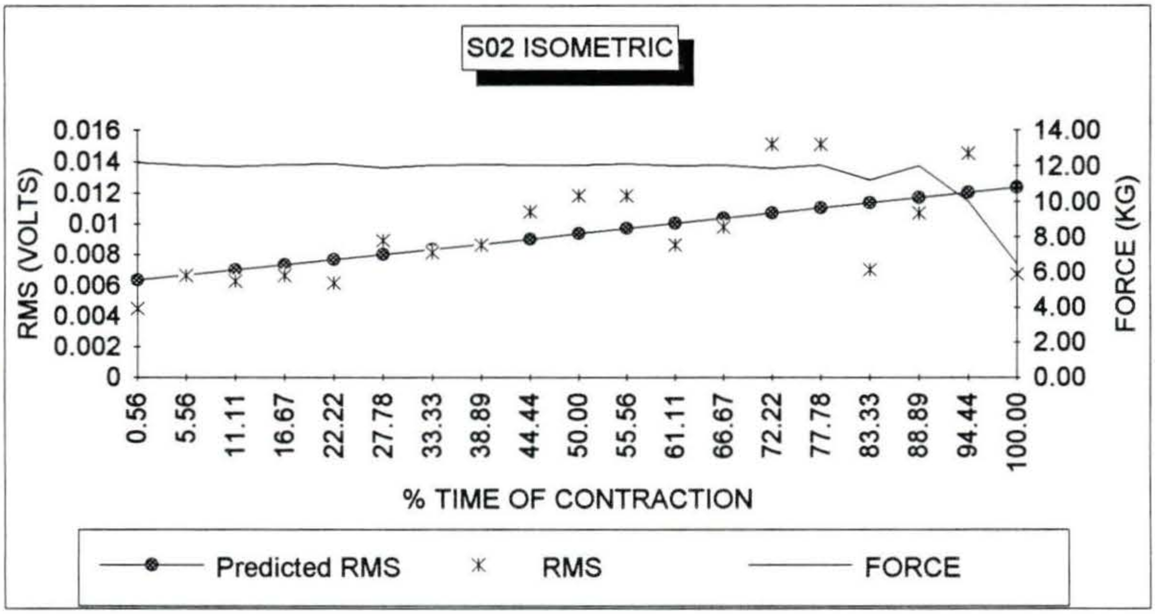

S01 ISOMETRIC DAY 1 PDS BAND WIDTH
HF-LF (Hz)
120
100
80
60
40
20
0
1
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
TIME (SECONDS)
Predicted BAND WIDTH
HF-LF

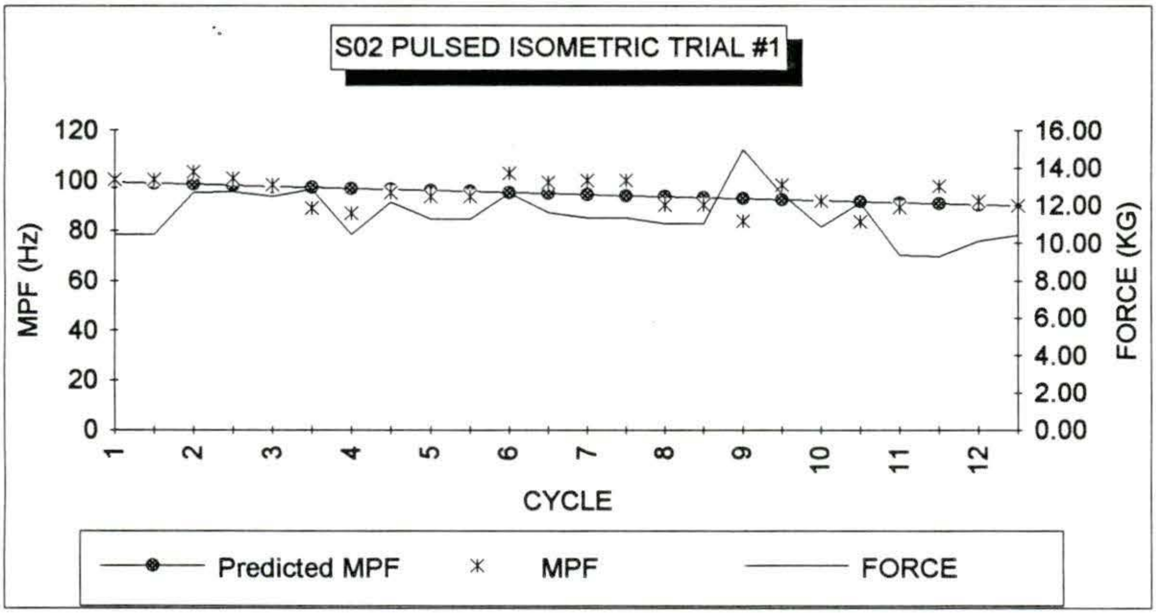

S01 PDS BAND WIDTH
100
80
60
40
20
0
HF-LF (Hz)
1
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
TIME (SECONDS)
S01 DAY 1
S01 DAY 2

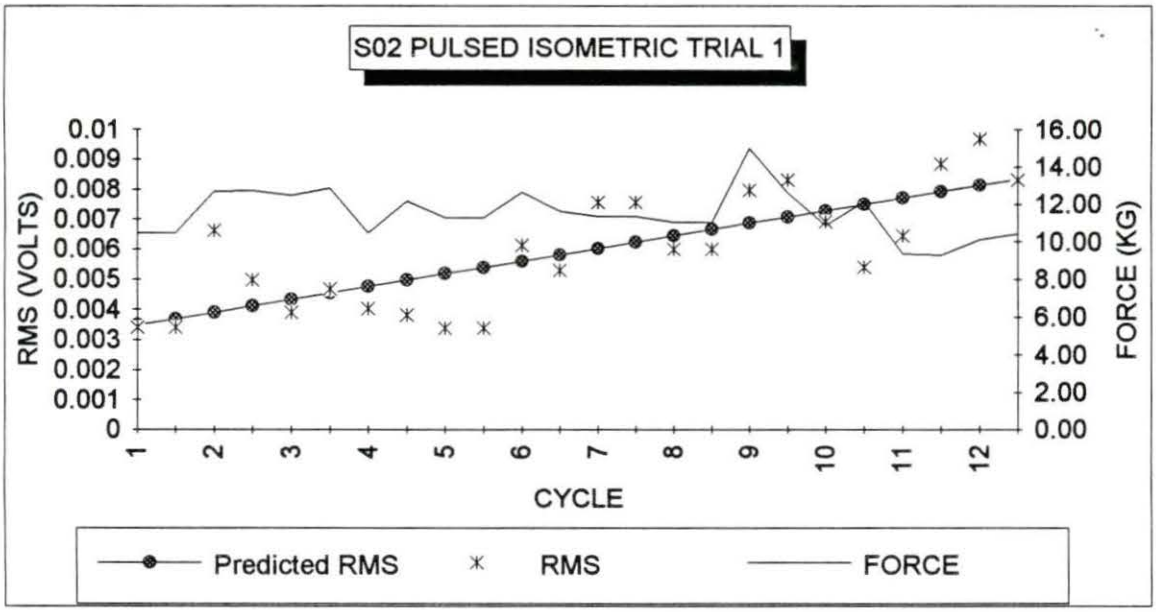

S02
100
80
60
40
20
0
MPF (Hz)
1
2
3
4
5
6
7
8
9
10
11
12
CYCLE (10 SEC/CYCLE)
TRIAL #1
TRIAL #2
TRIAL #3
ISO

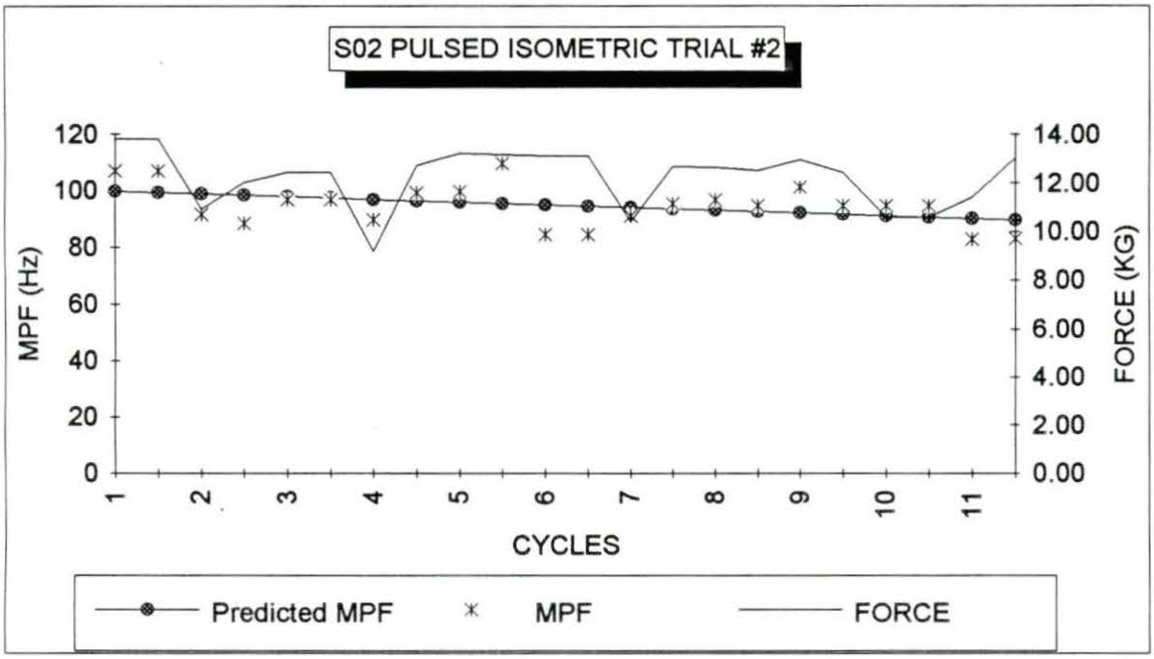

S02
0.014
0.012
0.01
0.008
0.006
0.004
0.002
0
RMS (VOLTS)
1
2
3
4
5
6
7
8
9
10
11
12
CYCLE (10 SEC/CYCLE)
TRIAL #1
TRIAL #2
TRIAL #3
ISO


S02 ISOMETRIC
MPF (Hz)
90
80
70
60
50
40
30
20
10
0
FORCE (KG)
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
0.56
5.56
11.11
16.67
22.22
27.78
33.33
38.89
44.44
50.00
55.56
61.11
66.67
72.22
77.78
83.33
88.89
94.44
100.00
% TIME OF CONTRACTION
Predicted MPF
MPF
FORCE

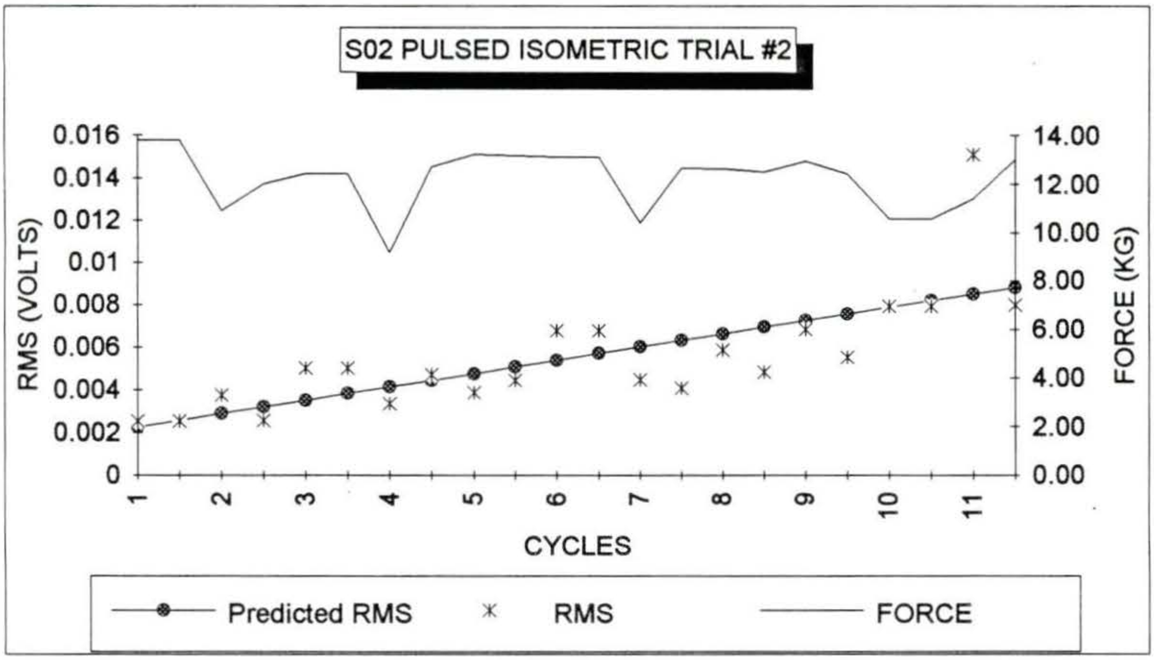

S02 ISOMETRIC
RMS (VOLTS)
0.016
0.014
0.012
0.01
0.008
0.006
0.004
0.002
0
FORCE (KG)
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
0.56
5.56
11.11
16.67
22.22
27.78
33.33
38.89
44.44
50.00
55.56
61.11
66.67
72.22
77.78
83.33
88.89
94.44
100.00
% TIME OF CONTRACTION
Predicted RMS
RMS
FORCE

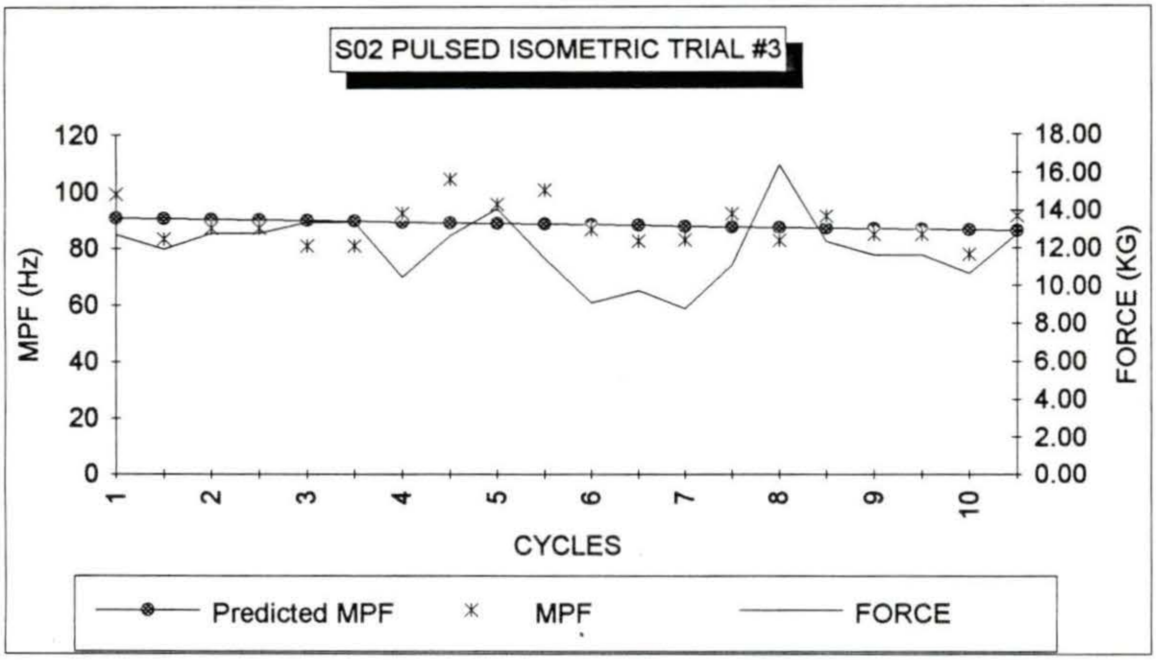

S02 PULSED ISOMETRIC TRIAL #1
120
100
80
60
40
20
0
MPF (Hz)
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
FORCE (KG)
1
2
3
4
5
6
7
8
9
10
11
12
CYCLE
Predicted MPF
MPF
FORCE

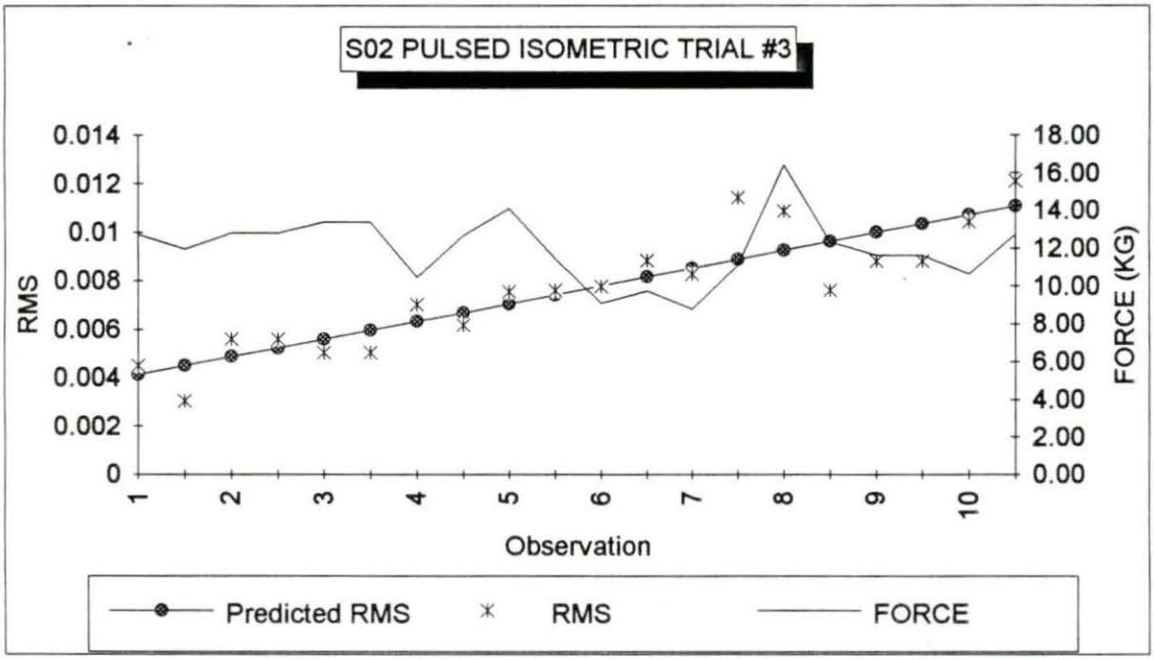

S02 PULSED ISOMETRIC TRIAL 1
RMS (VOLTS)
0.01
0.009
0.008
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0
FORCE (KG)
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
1
2
3
4
5
6
7
8
9
10
11
12
CYCLE
Predicted RMS
RMS
FORCE

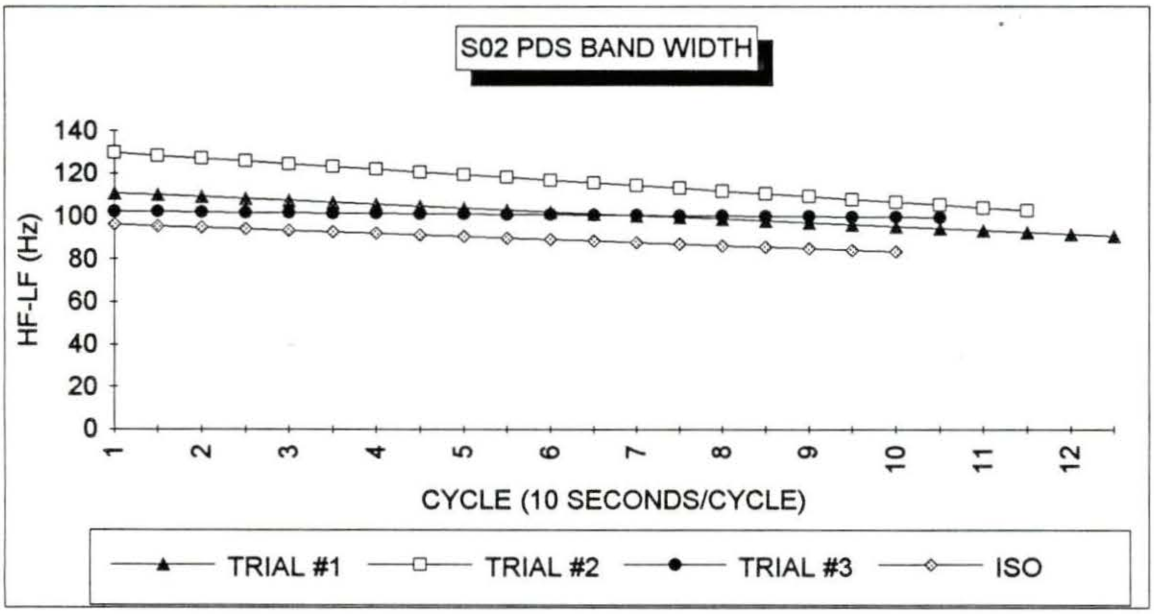


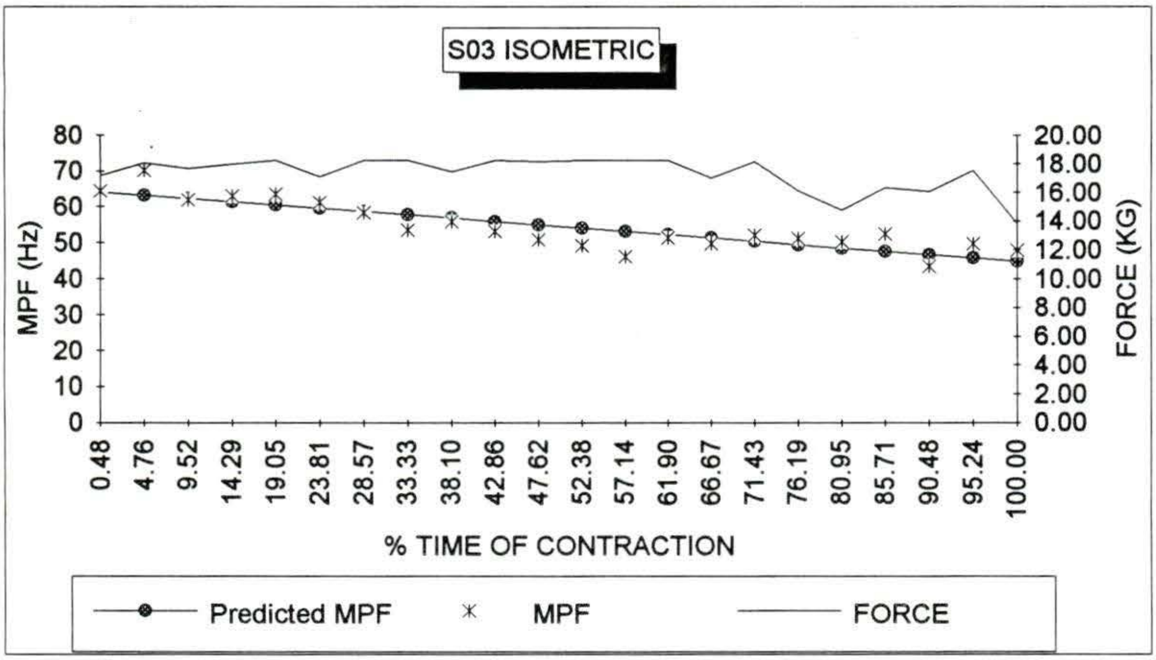
S02 PULSED ISOMETRIC TRIAL #2
120
100
80
60
40
20
0
MPF (Hz)
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
FORCE (KG)
1
2
3
4
5
6
7
8
9
10
11
CYCLES
Predicted MPF
MPF
FORCE


S02 PULSED ISOMETRIC TRIAL #2
RMS (VOLTS)
0.016
0.014
0.012
0.01
0.008
0.006
0.004
0.002
0
FORCE (KG)
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
1
2
3
4
5
6
7
8
9
10
11
CYCLES
Predicted RMS
RMS
FORCE

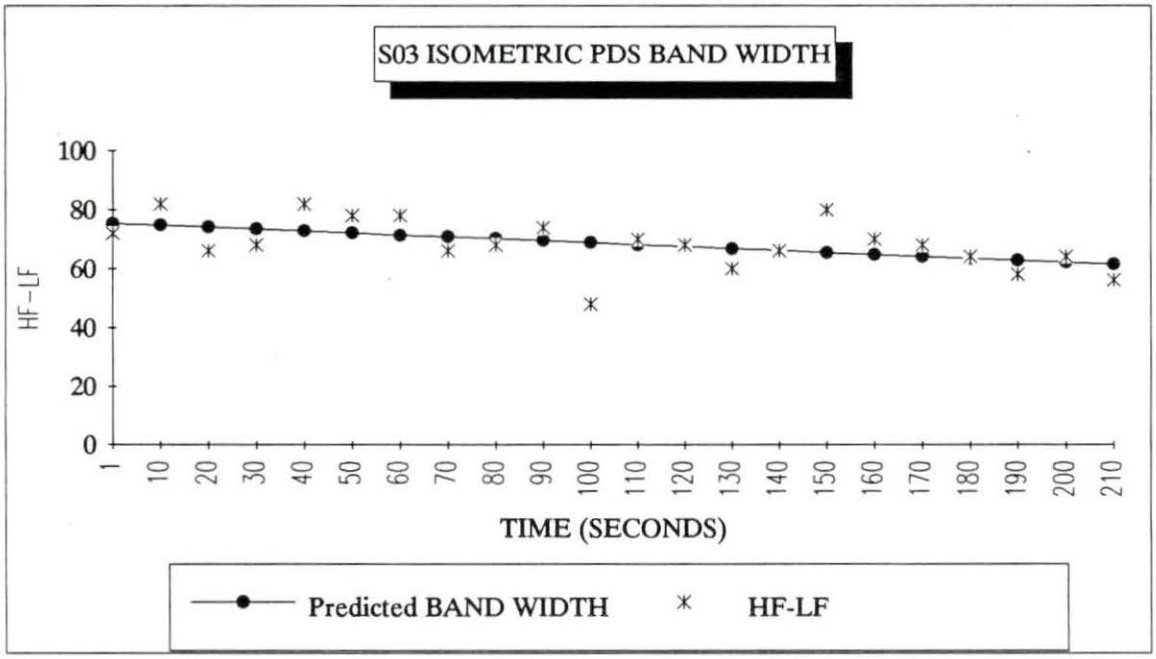

S02 PULSED ISOMETRIC TRIAL #3
MPF (Hz)
120
100
80
60
40
20
0
FORCE (KG)
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
1
2
3
4
5
6
7
8
9
10
CYCLES
Predicted MPF
MPF
FORCE

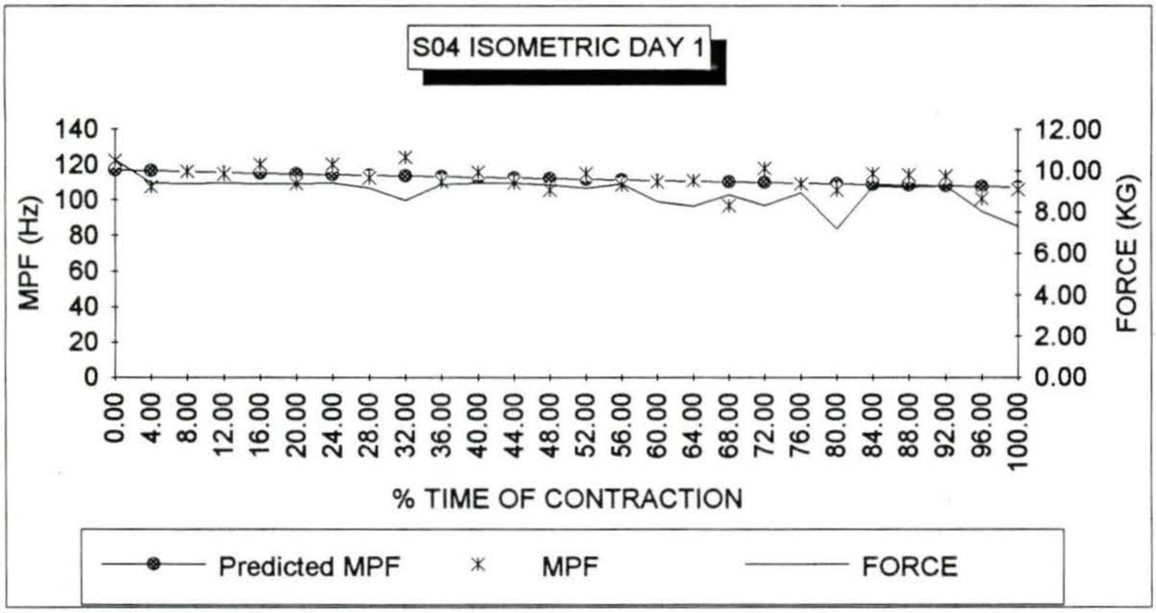

S02 PULSED ISOMETRIC TRIAL #3
0.014
0.012
0.01
0.008
0.006
0.004
0.002
0
RMS
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
FORCE (KG)
1
2
3
4
5
6
7
8
9
10
Observation
Predicted RMS
RMS
FORCE

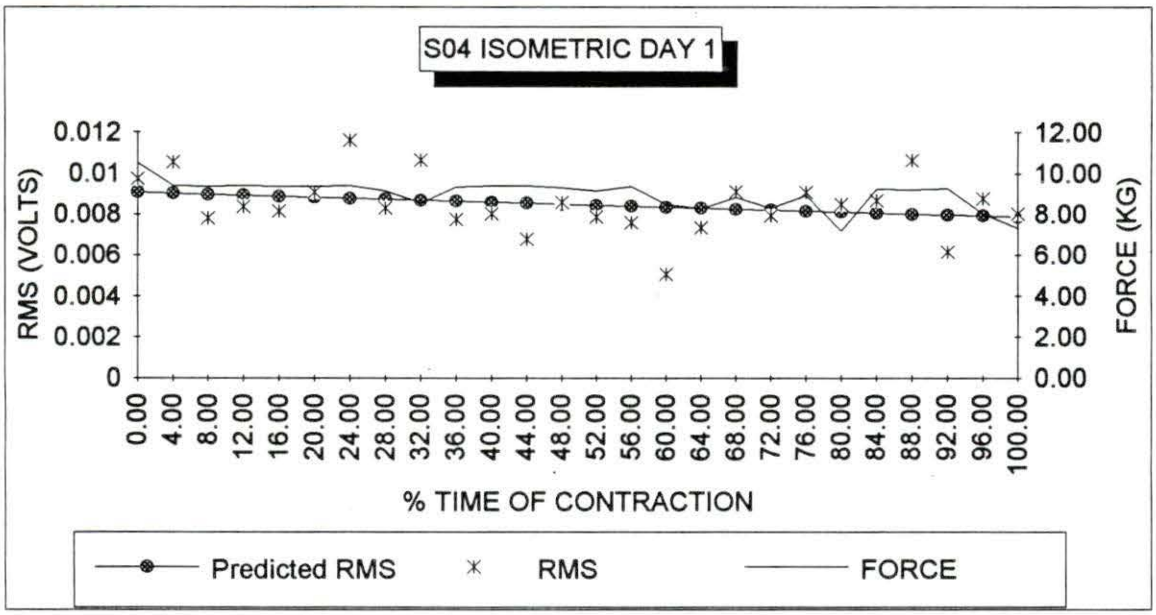

S02 PDS BAND WIDTH
140
120
100
80
60
40
20
0
HF-LF (Hz)
1
2
3
4
5
6
7
8
9
10
11
12
CYCLE (10 SECONDS/CYCLE)
TRIAL #1
TRIAL #2
TRIAL #3
ISO

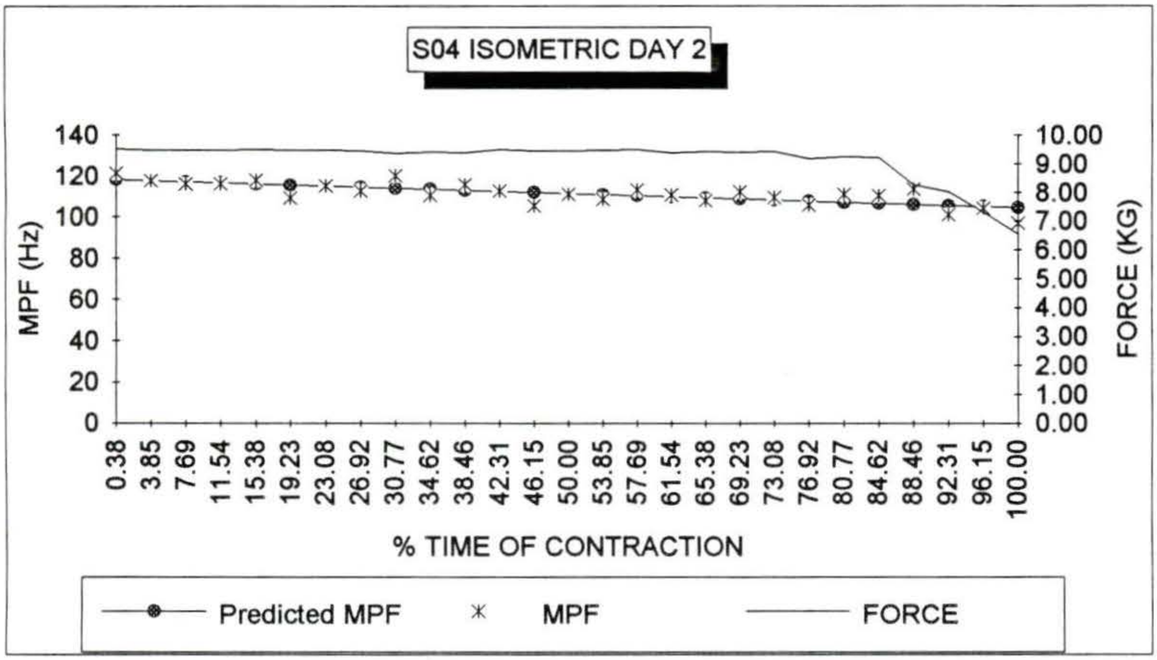


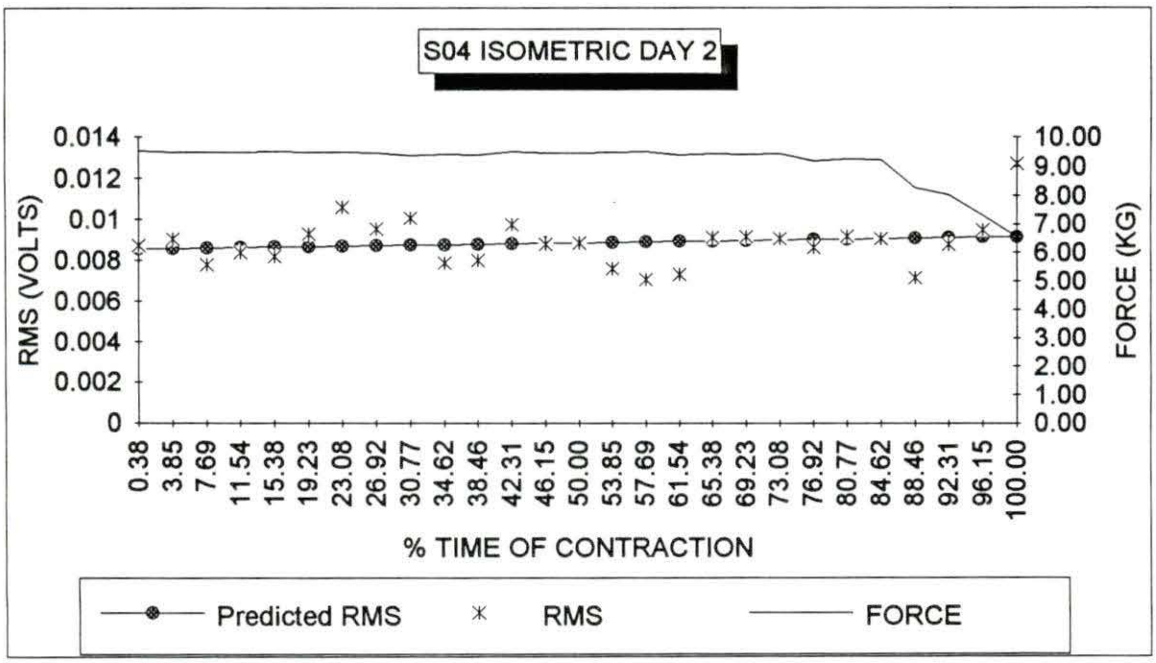
S03 ISOMETRIC
MPF (Hz)
80
70
60
50
40
30
20
10
0
FORCE (KG)
20.00
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
0.48
4.76
9.52
14.29
19.05
23.81
28.57
33.33
38.10
42.86
47.62
52.38
57.14
61.90
66.67
71.43
76.19
80.95
85.71
90.48
95.24
100.00
% TIME OF CONTRACTION
Predicted MPF
MPF
FORCE

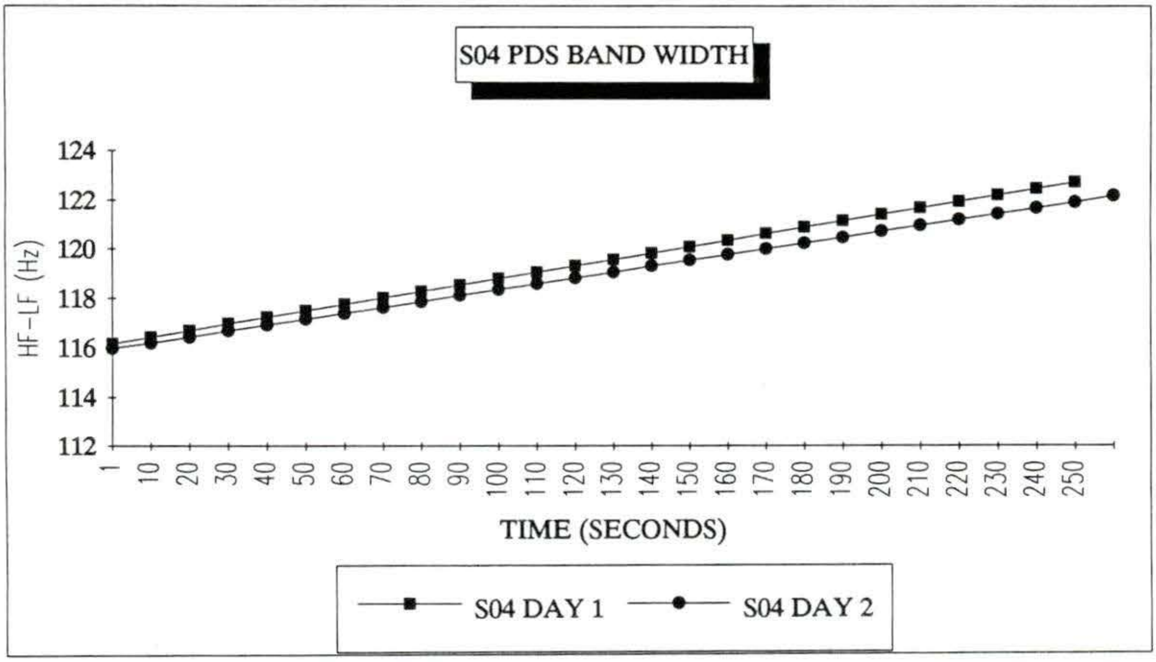

S03 ISOMETRIC PDS BAND WIDTH
100
80
60
40
20
0
HF-LF
1
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
TIME (SECONDS)
Predicted BAND WIDTH
HF-LF

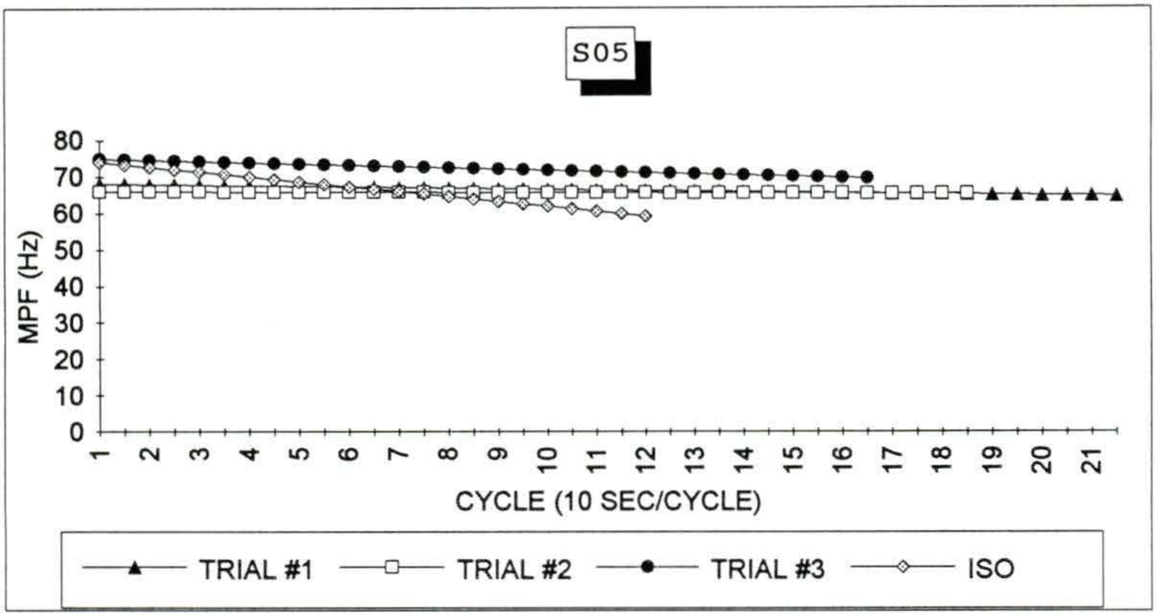

S04 ISOMETRIC DAY 1
MPF (Hz)
FORCE (KG)
140
120
100
80
60
40
20
0
12.00
10.00
8.00
6.00
4.00
2.00
0.00
0.00 4.00 8.00 12.00 16.00 20.00 24.00 28.00 32.00 36.00 40.00 44.00 48.00 52.00 56.00 60.00 64.00 68.00 72.00 76.00 80.00 84.00 88.00 92.00 96.00 100.00
% TIME OF CONTRACTION
Predicted MPF
MPF
FORCE

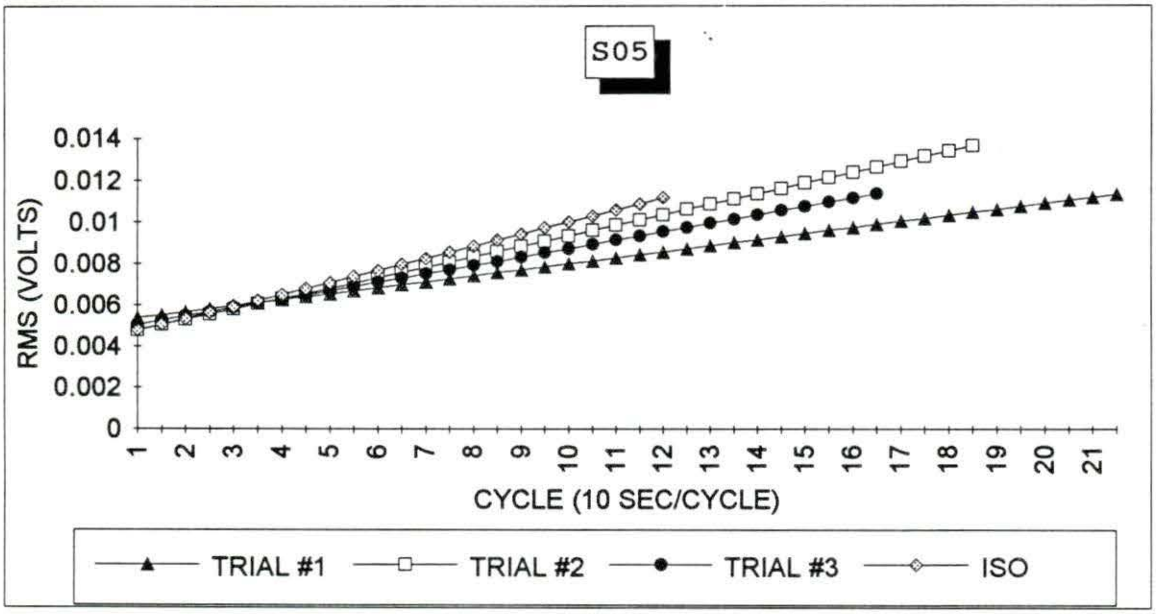

S04 ISOMETRIC DAY 1
RMS (VOLTS)
FORCE (KG)
0.012
0.01
0.008
0.006
0.004
0.002
0
12.00
10.00
8.00
6.00
4.00
2.00
0.00
0.00 4.00 8.00 12.00 16.00 20.00 24.00 28.00 32.00 36.00 40.00 44.00 48.00 52.00 56.00 60.00 64.00 68.00 72.00 76.00 80.00 84.00 88.00 92.00 96.00 100.00
% TIME OF CONTRACTION
Predicted RMS
RMS
FORCE

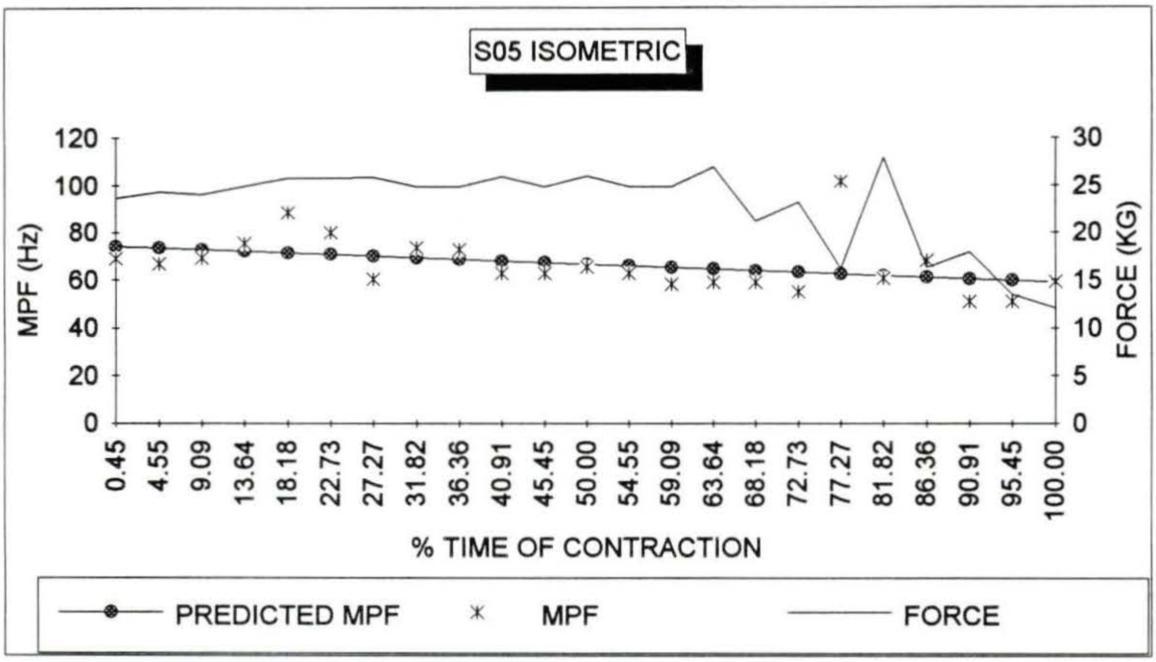

S04 ISOMETRIC DAY 2
MPF (Hz)
140
120
100
80
60
40
20
0
FORCE (KG)
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
0.38 3.85 7.69 11.54 15.38 19.23 23.08 26.92 30.77 34.62 38.46 42.31 46.15 50.00 53.85 57.69 61.54 65.38 69.23 73.08 76.92 80.77 84.62 88.46 92.31 96.15 100.00
% TIME OF CONTRACTION
Predicted MPF
MPF
FORCE


S04 ISOMETRIC DAY 2
RMS (VOLTS)
0.014
0.012
0.01
0.008
0.006
0.004
0.002
0
FORCE (KG)
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
0.38
3.85
7.69
11.54
15.38
19.23
23.08
26.92
30.77
34.62
38.46
42.31
46.15
50.00
53.85
57.69
61.54
65.38
69.23
73.08
76.92
80.77
84.62
88.46
92.31
96.15
100.00
% TIME OF CONTRACTION
Predicted RMS
RMS
FORCE

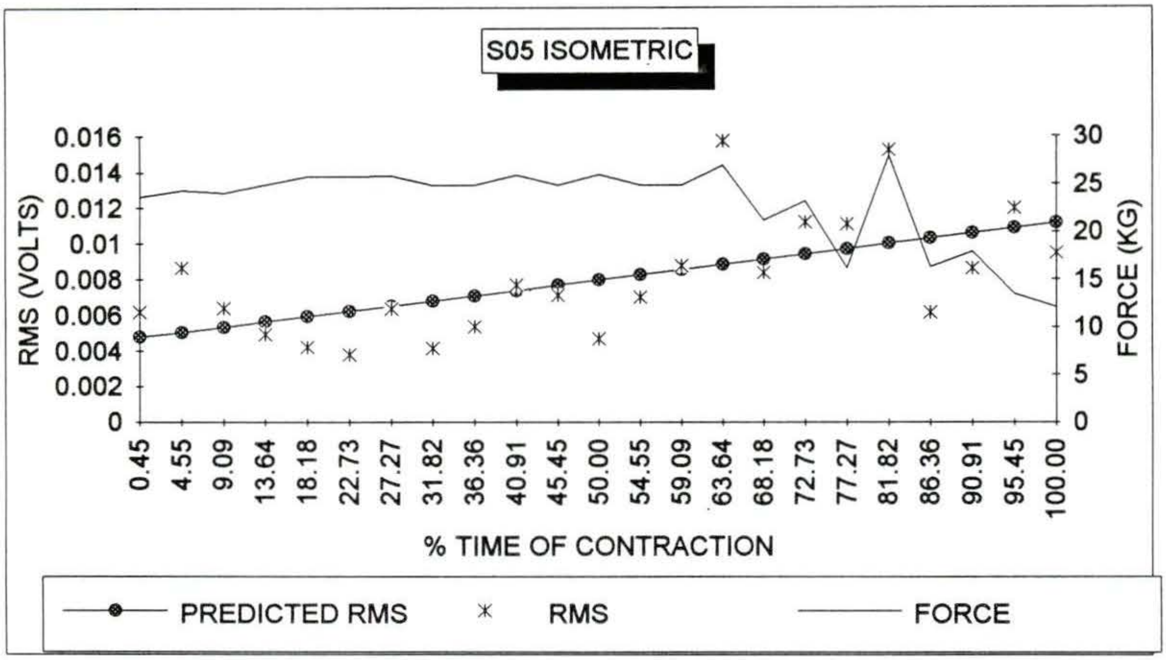

S04 PDS BAND WIDTH
124
122
120
118
116
114
112
HF-LF (Hz)
1
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
230
240
250
TIME (SECONDS)
S04 DAY 1
S04 DAY 2

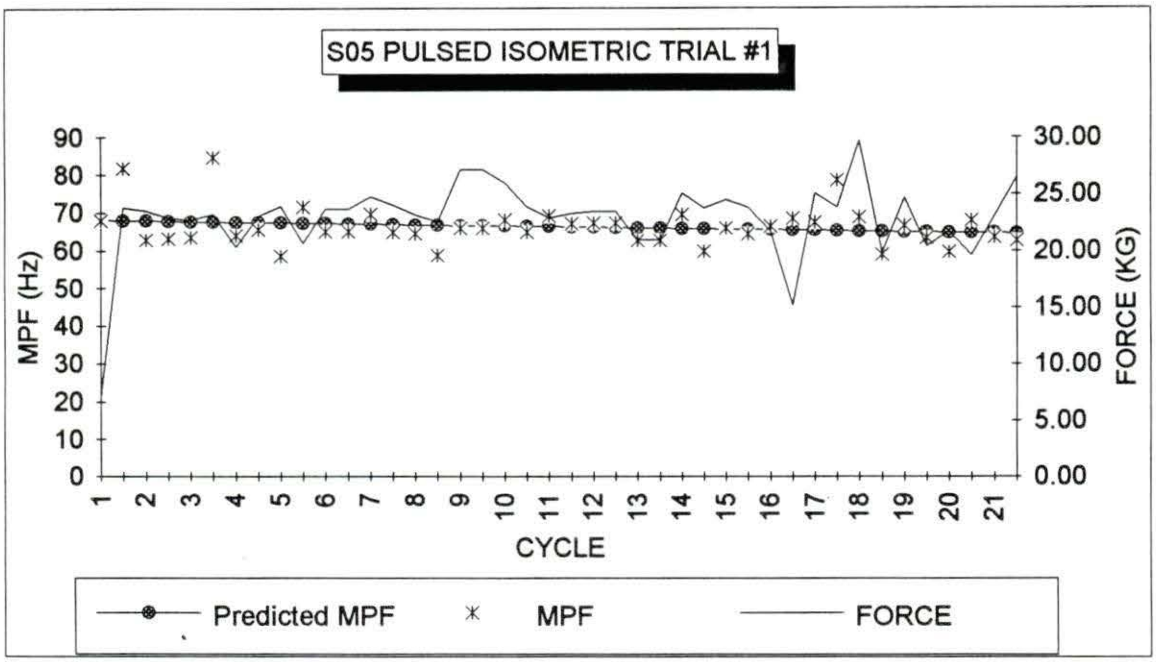

S05
80
70
60
50
40
30
20
10
0
MPF (Hz)
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
CYCLE (10 SEC/CYCLE)
TRIAL #1
TRIAL #2
TRIAL #3
ISO

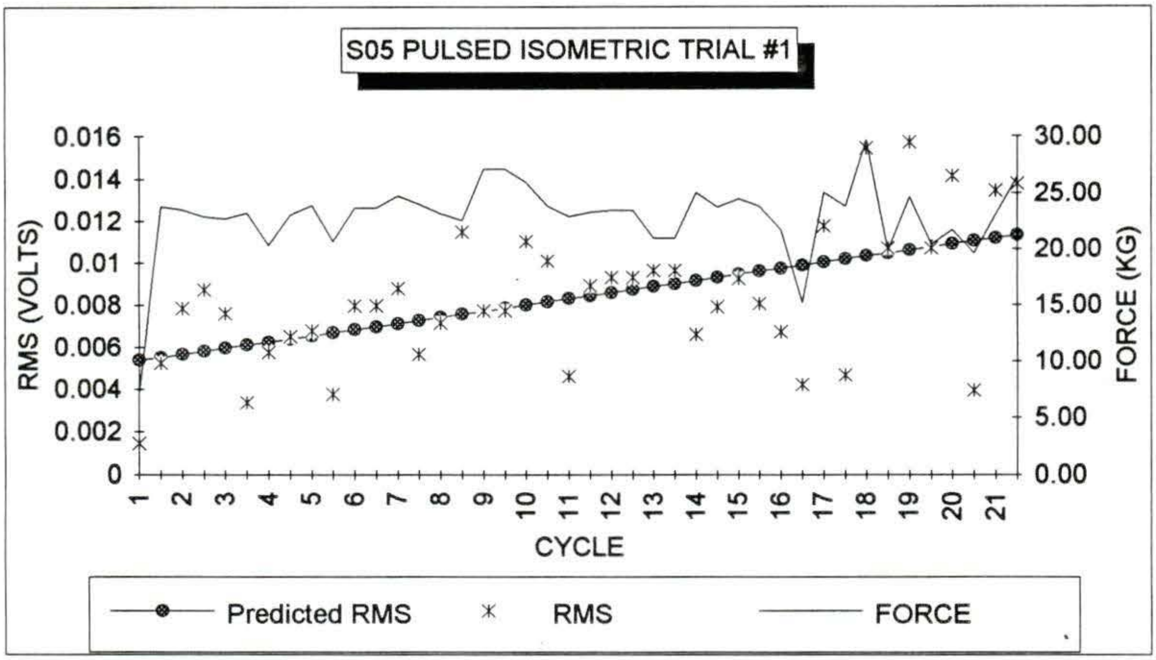

S05
0.014
0.012
0.01
0.008
0.006
0.004
0.002
0
RMS (VOLTS)
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
CYCLE (10 SEC/CYCLE)
TRIAL #1
TRIAL #2
TRIAL #3
ISO

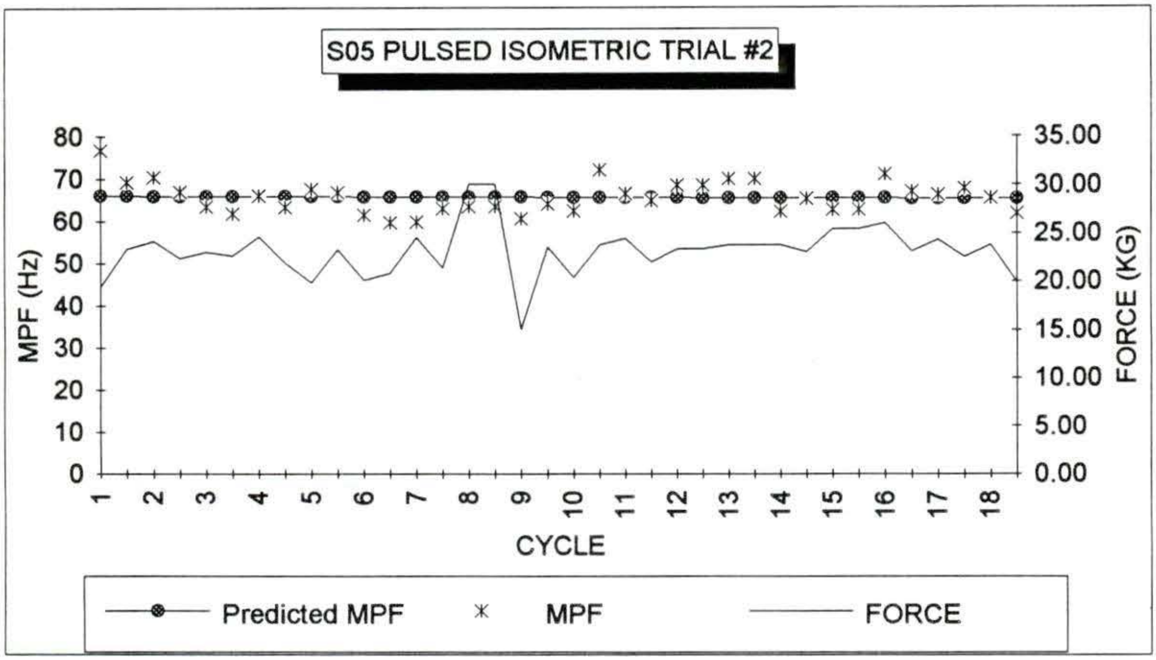


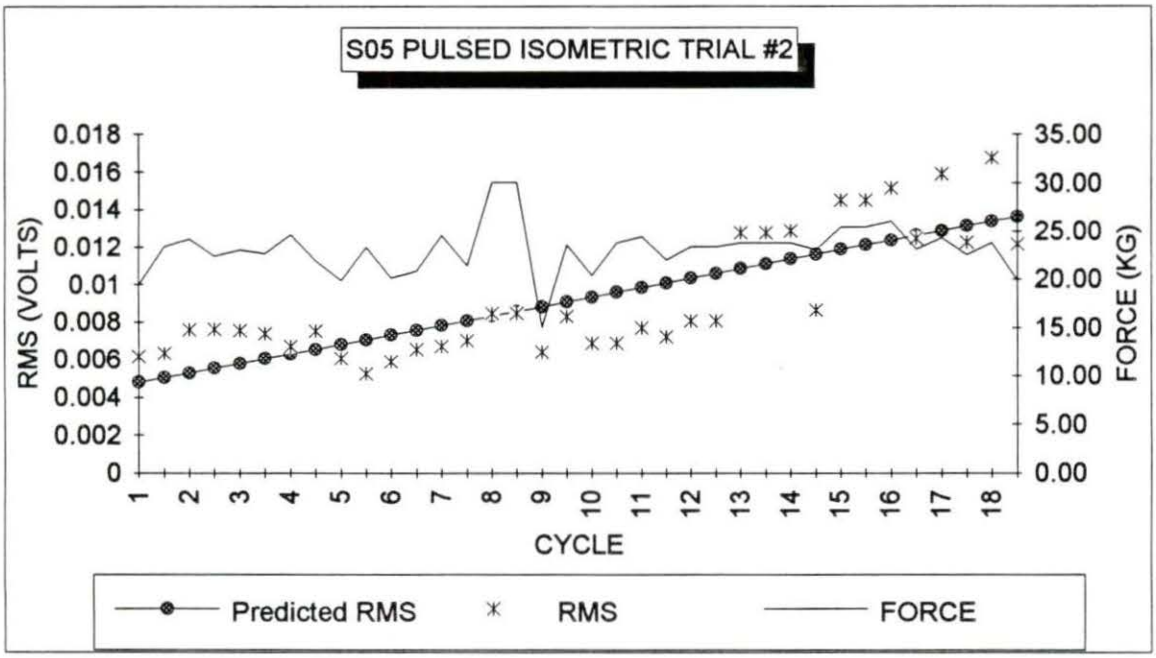
S05 ISOMETRIC
120
100
80
60
40
20
0
MPF (Hz)
30
25
20
15
10
5
0
FORCE (KG)
0.45
4.55
9.09
13.64
18.18
22.73
27.27
31.82
36.36
40.91
45.45
50.00
54.55
59.09
63.64
68.18
72.73
77.27
81.82
86.36
90.91
95.45
100.00
% TIME OF CONTRACTION
PREDICTED MPF
MPF
FORCE

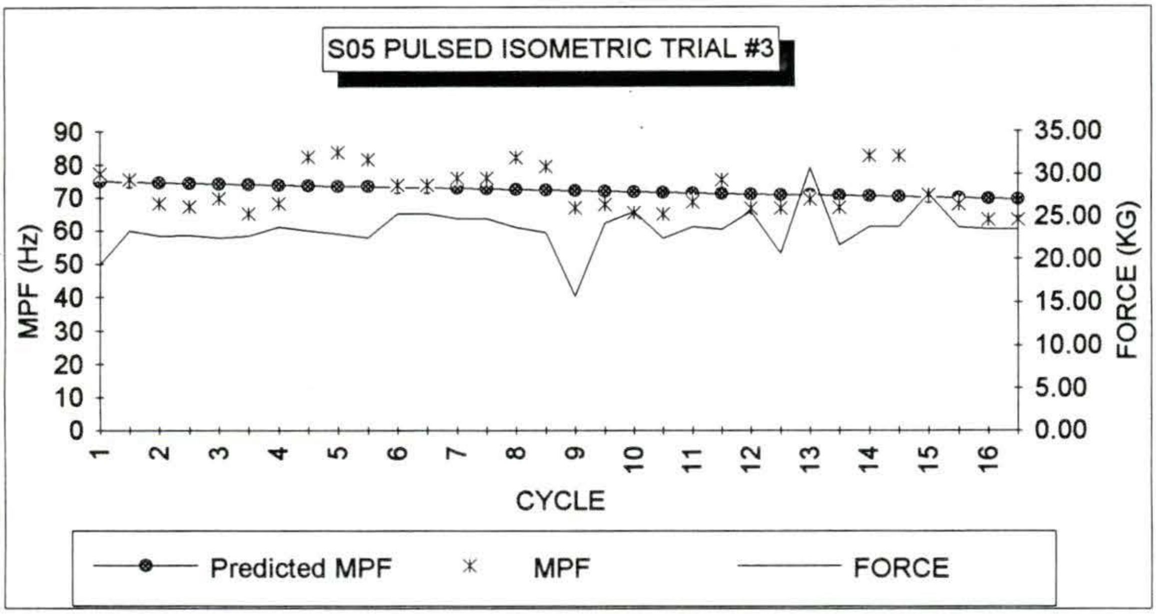

S05 ISOMETRIC
RMS (VOLTS)
0.016
0.014
0.012
0.01
0.008
0.006
0.004
0.002
0
FORCE (KG)
30
25
20
15
10
5
0
0.45
4.55
9.09
13.64
18.18
22.73
27.27
31.82
36.36
40.91
45.45
50.00
54.55
59.09
63.64
68.18
72.73
77.27
81.82
86.36
90.91
95.45
100.00
% TIME OF CONTRACTION
PREDICTED RMS
RMS
FORCE

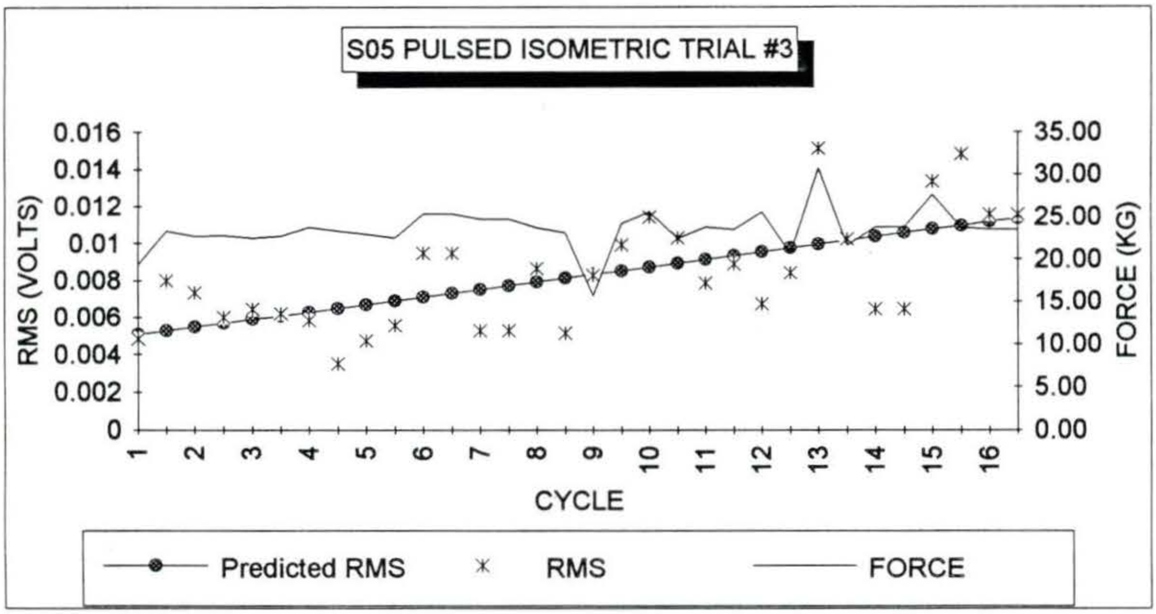

S05 PULSED ISOMETRIC TRIAL #1
MPF (Hz)
FORCE (KG)
CYCLE
90
80
70
60
50
40
30
20
10
0
30.00
25.00
20.00
15.00
10.00
5.00
0.00
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
Predicted MPF
MPF
FORCE

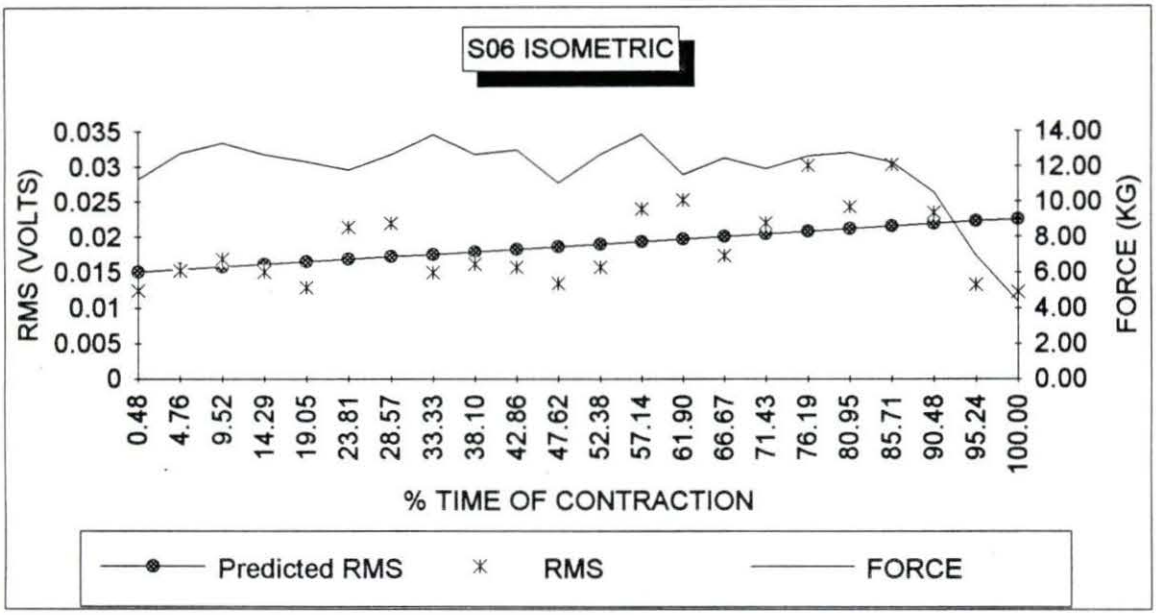

S05 PULSED ISOMETRIC TRIAL #1
RMS (VOLTS)
0.016
0.014
0.012
0.01
0.008
0.006
0.004
0.002
0
FORCE (KG)
30.00
25.00
20.00
15.00
10.00
5.00
0.00
CYCLE
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21
Predicted RMS
RMS
FORCE


S05 PULSED ISOMETRIC TRIAL #2
80
70
60
50
40
30
20
10
0
MPF (Hz)
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
FORCE (KG)
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18
CYCLE
Predicted MPF
MPF
FORCE

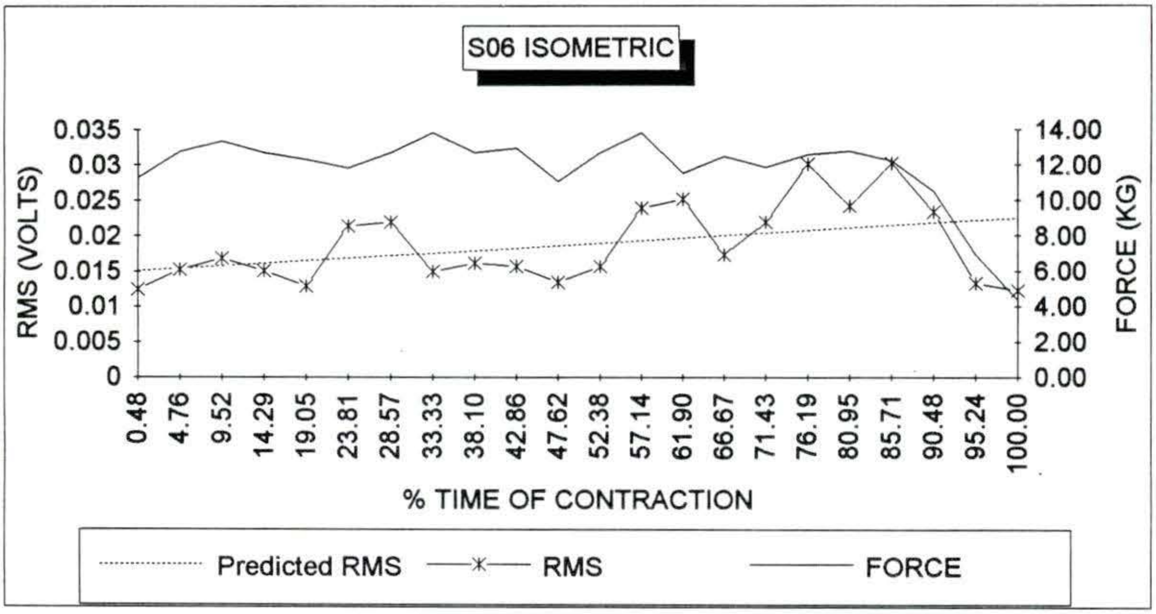

S05 PULSED ISOMETRIC TRIAL #2
RMS (VOLTS)
0.018
0.016
0.014
0.012
0.01
0.008
0.006
0.004
0.002
0
FORCE (KG)
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18
CYCLE
Predicted RMS
RMS
FORCE

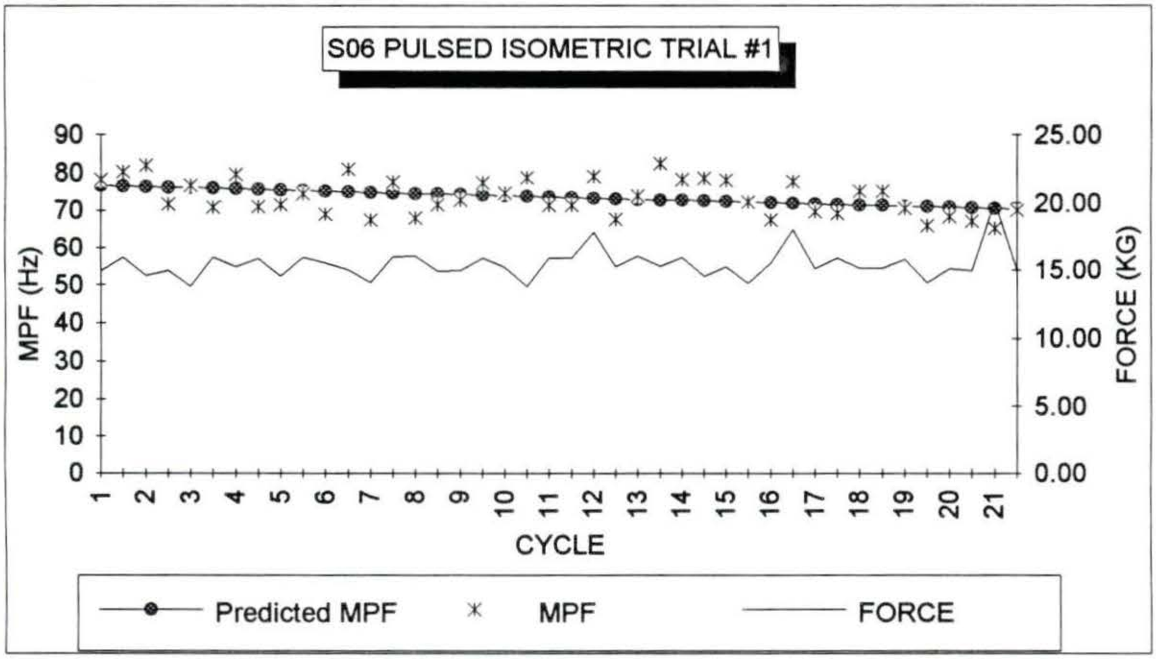

S05 PULSED ISOMETRIC TRIAL #3
MPF (Hz)
90
80
70
60
50
40
30
20
10
0
FORCE (KG)
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
CYCLE
Predicted MPF
MPF
FORCE

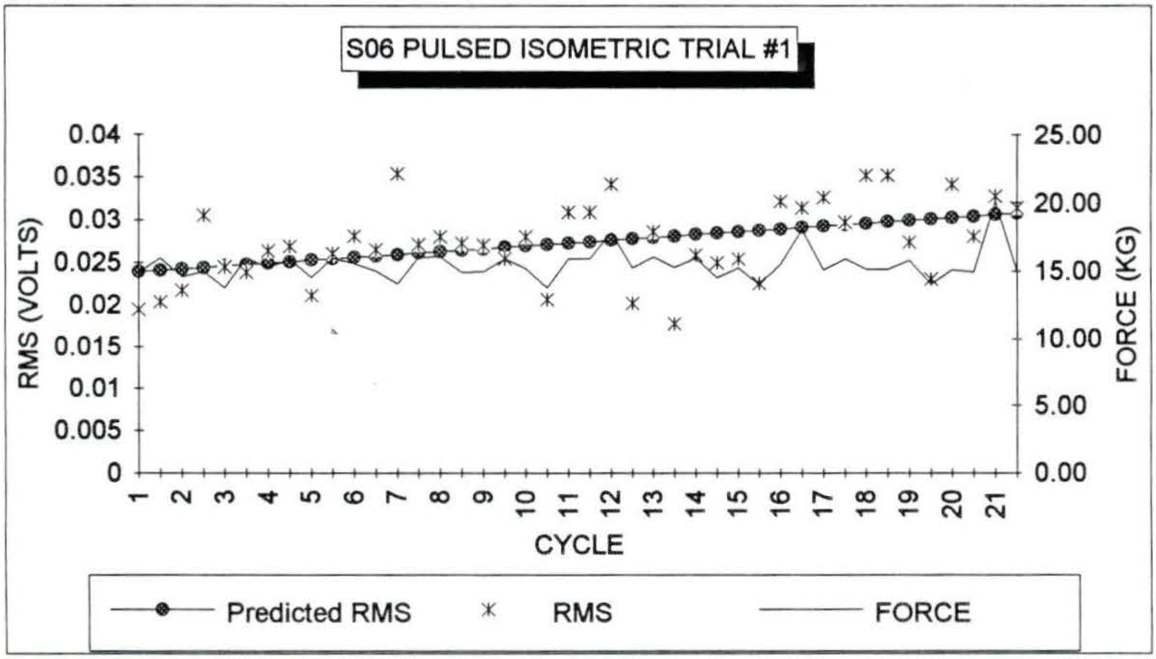

S05 PULSED ISOMETRIC TRIAL #3
RMS (VOLTS)
FORCE (KG)
0.016
0.014
0.012
0.01
0.008
0.006
0.004
0.002
0
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
CYCLE
Predicted RMS
RMS
FORCE

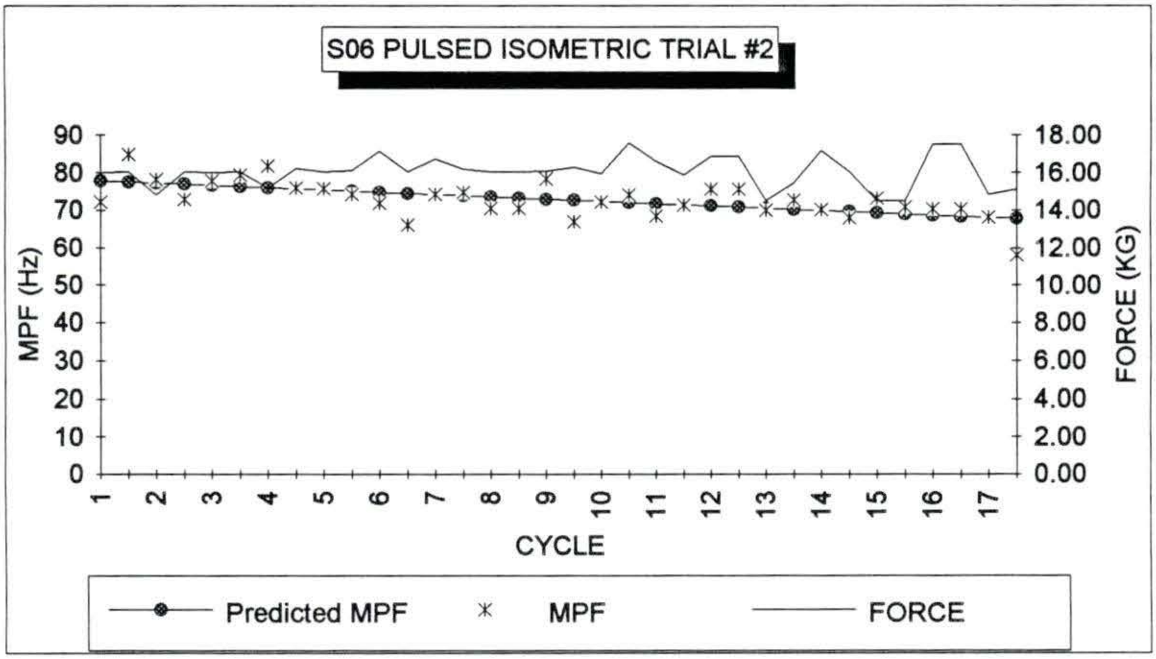


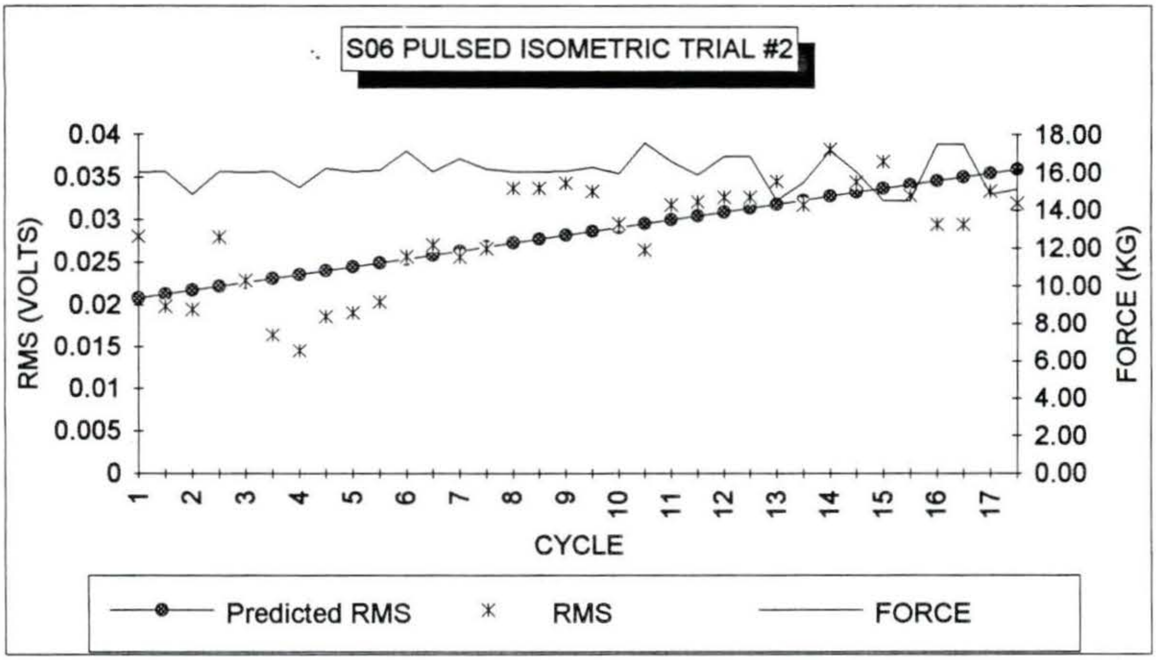
S06 ISOMETRIC
RMS (VOLTS)
0.035
0.03
0.025
0.02
0.015
0.01
0.005
0
FORCE (KG)
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
0.48
4.76
9.52
14.29
19.05
23.81
28.57
33.33
38.10
42.86
47.62
52.38
57.14
61.90
66.67
71.43
76.19
80.95
85.71
90.48
95.24
100.00
% TIME OF CONTRACTION
Predicted RMS
RMS
FORCE

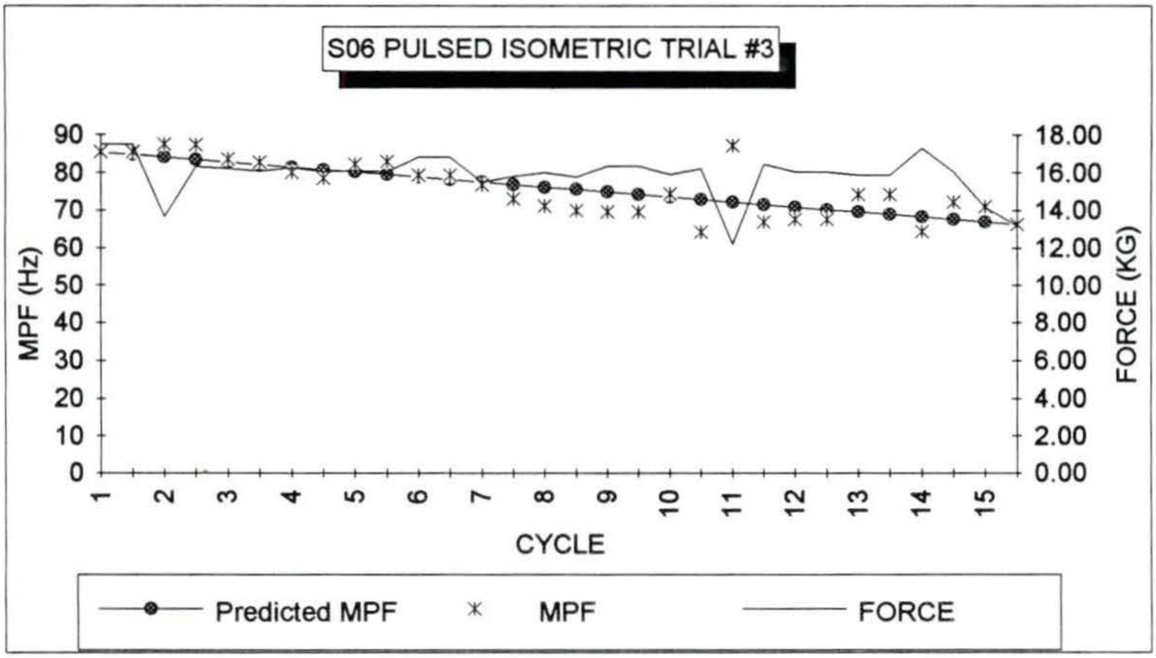

S06 ISOMETRIC
RMS (VOLTS)
0.035
0.03
0.025
0.02
0.015
0.01
0.005
0
FORCE (KG)
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
0.48
4.76
9.52
14.29
19.05
23.81
28.57
33.33
38.10
42.86
47.62
52.38
57.14
61.90
66.67
71.43
76.19
80.95
85.71
90.48
95.24
100.00
% TIME OF CONTRACTION
Predicted RMS
RMS
FORCE

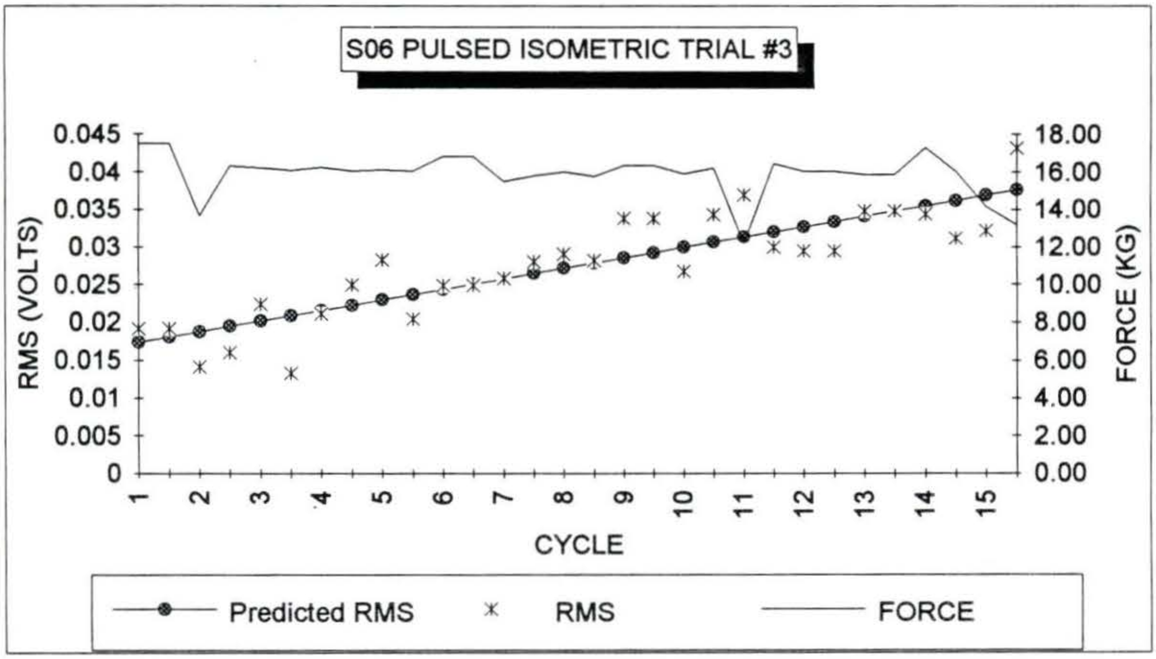

S06 PULSED ISOMETRIC TRIAL #1
MPF (Hz)
FORCE (KG)
CYCLE
90
80
70
60
50
40
30
20
10
0
25.00
20.00
15.00
10.00
5.00
0.00
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21
Predicted MPF
MPF
FORCE

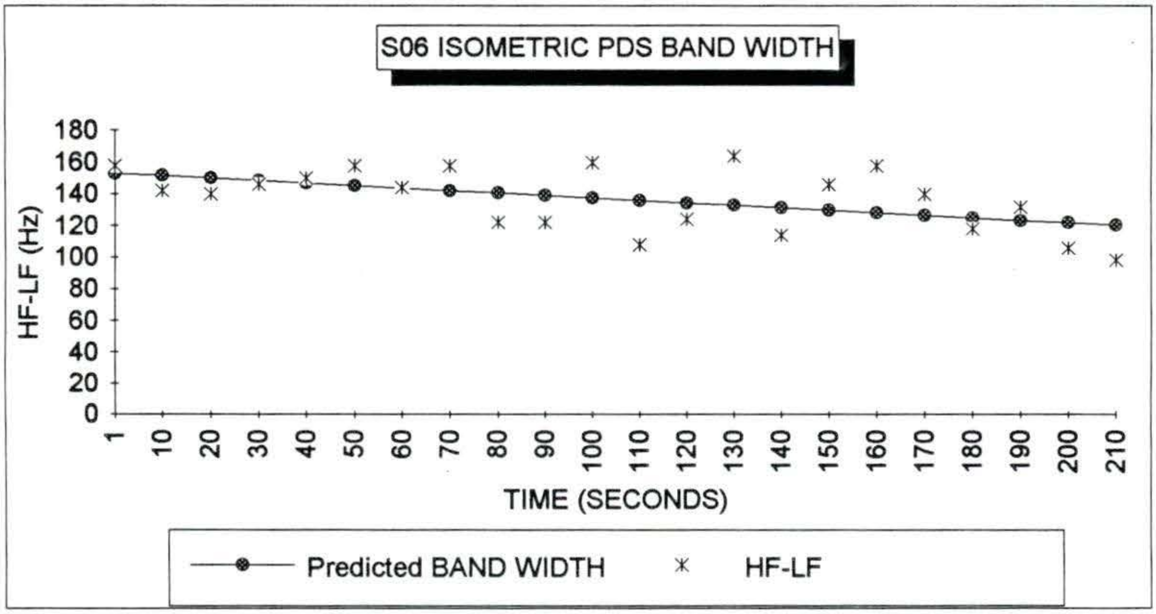

S06 PULSED ISOMETRIC TRIAL #1
RMS (VOLTS)
0.04
0.035
0.03
0.025
0.02
0.015
0.01
0.005
0
FORCE (KG)
25.00
20.00
15.00
10.00
5.00
0.00
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
CYCLE
Predicted RMS
RMS
FORCE

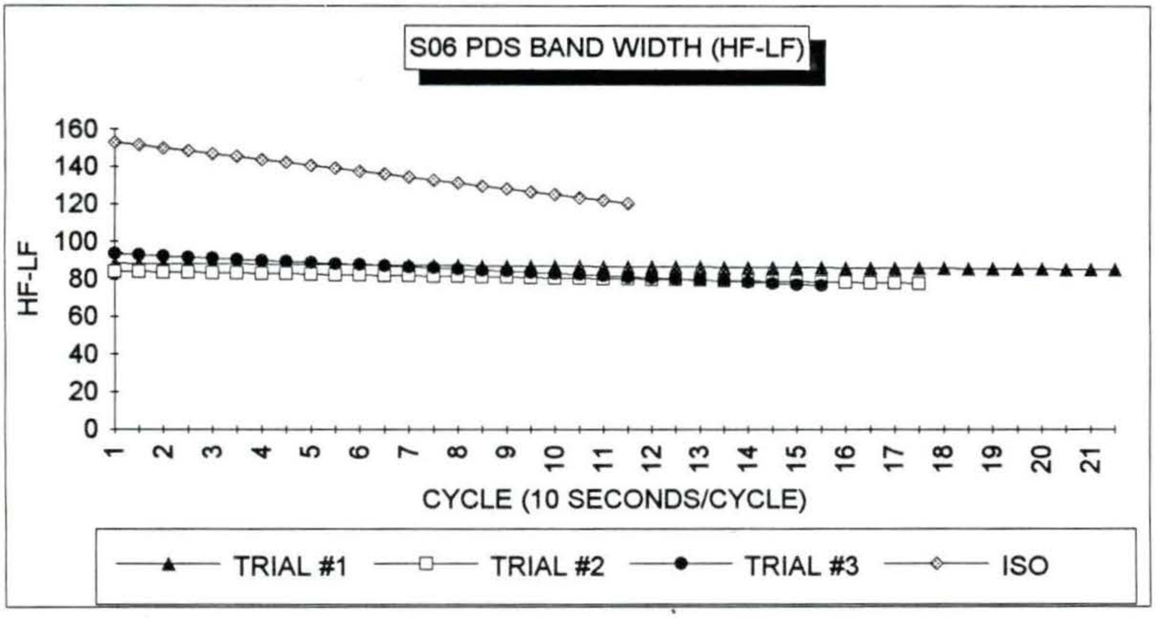

S06 PULSED ISOMETRIC TRIAL #2
MPF (Hz)
FORCE (KG)
CYCLE
0
10
20
30
40
50
60
70
80
90
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
18.00
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
Predicted MPF
MPF
FORCE

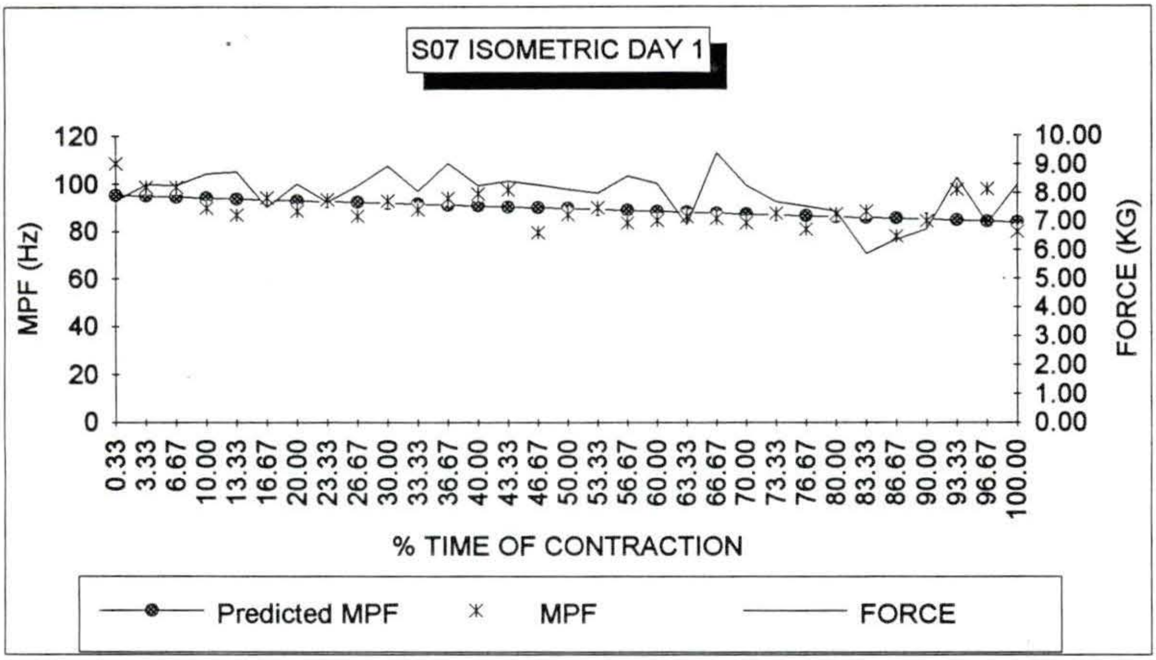

S06 PULSED ISOMETRIC TRIAL #2
RMS (VOLTS)
0.04
0.035
0.03
0.025
0.02
0.015
0.01
0.005
0
FORCE (KG)
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17
CYCLE
Predicted RMS
RMS
FORCE


S06 PULSED ISOMETRIC TRIAL #3
MPF (Hz)
90
80
70
60
50
40
30
20
10
0
FORCE (KG)
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
CYCLE
Predicted MPF
MPF
FORCE

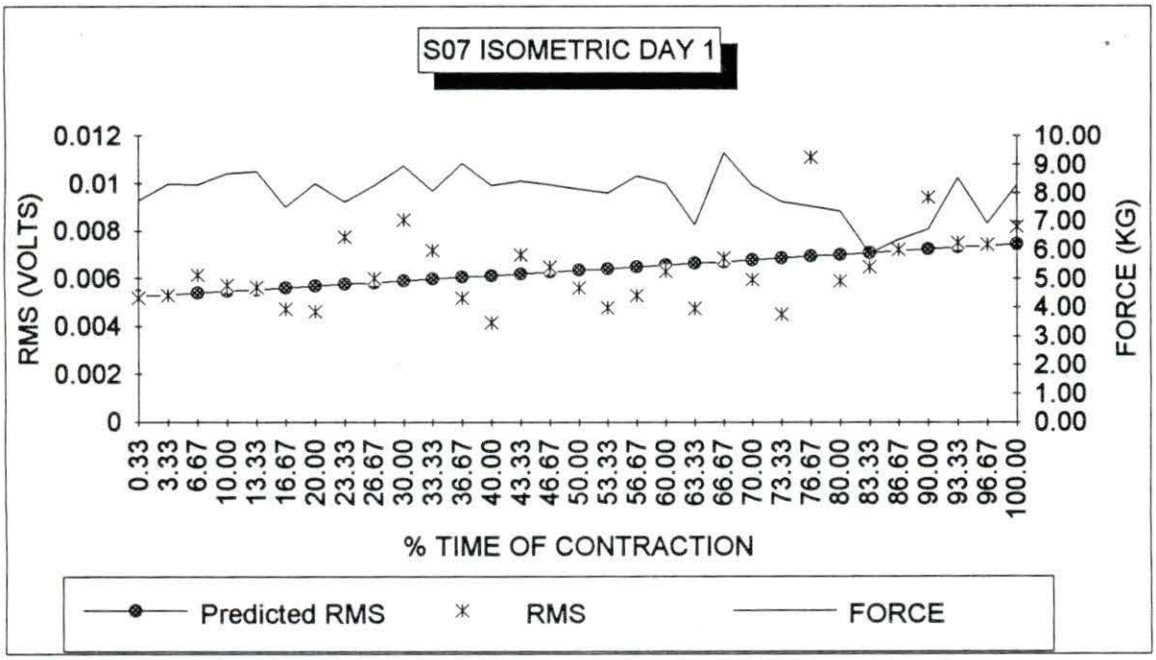

S06 PULSED ISOMETRIC TRIAL #3
RMS (VOLTS)
0.045
0.04
0.035
0.03
0.025
0.02
0.015
0.01
0.005
0
FORCE (KG)
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
CYCLE
Predicted RMS
RMS
FORCE

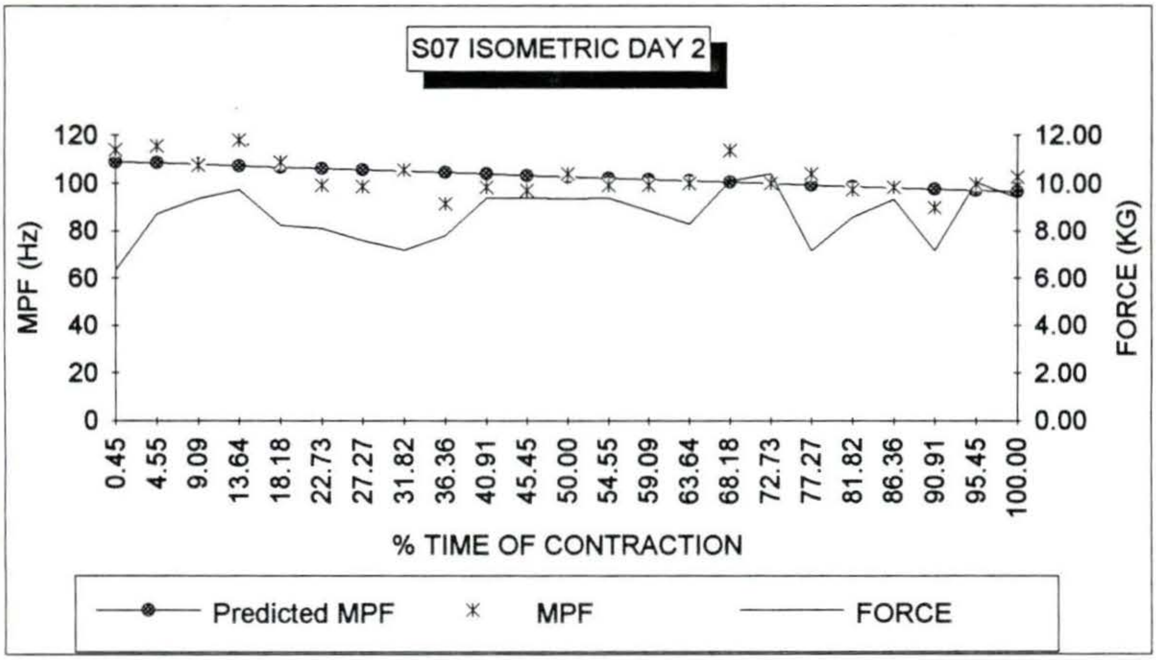

S06 ISOMETRIC PDS BAND WIDTH
HF-LF (Hz)
180
160
140
120
100
80
60
40
20
0
1
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
TIME (SECONDS)
Predicted BAND WIDTH
HF-LF

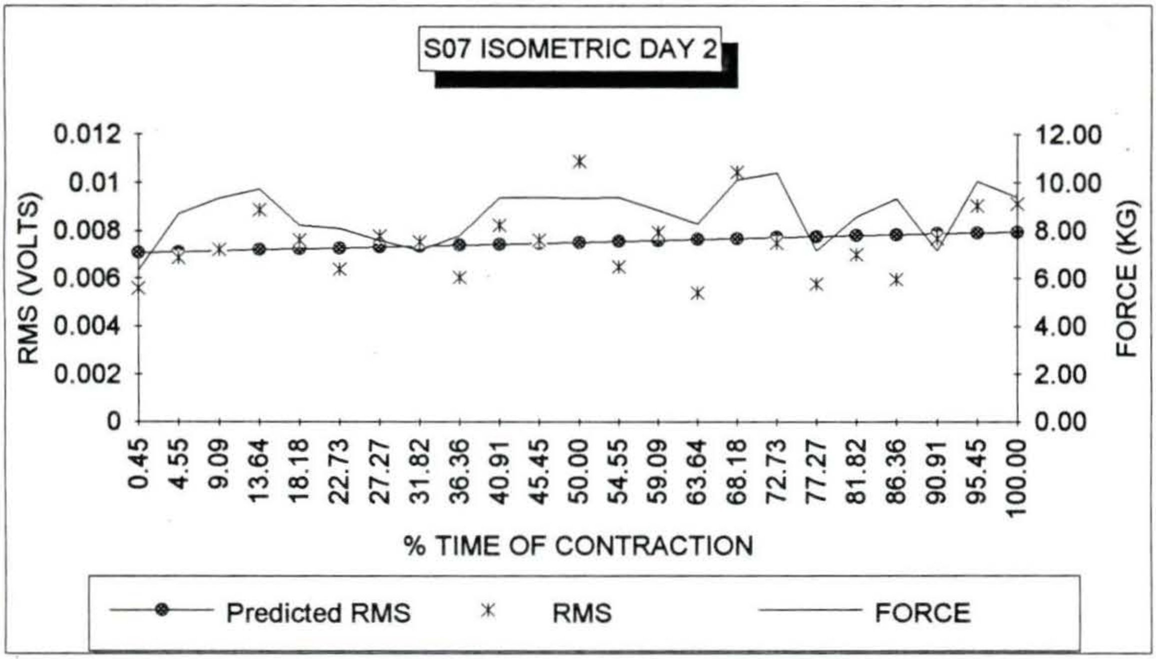

S06 PDS BAND WIDTH (HF-LF)
HF-LF
160
140
120
100
80
60
40
20
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21
CYCLE (10 SECONDS/CYCLE)
TRIAL #1
TRIAL #2
TRIAL #3
ISO



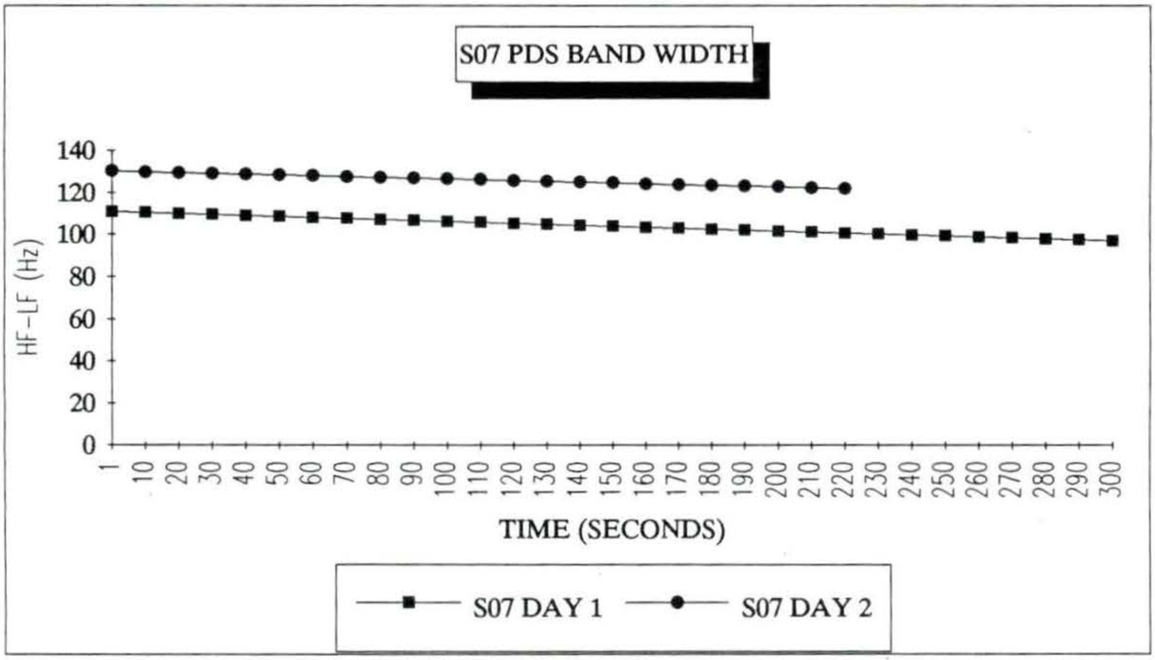
S07 ISOMETRIC DAY 1
MPF (Hz)
120
100
80
60
40
20
0
FORCE (KG)
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
0.33
3.33
6.67
10.00
13.33
16.67
20.00
23.33
26.67
30.00
33.33
36.67
40.00
43.33
46.67
50.00
53.33
56.67
60.00
63.33
66.67
70.00
73.33
76.67
80.00
83.33
86.67
90.00
93.33
96.67
100.00
% TIME OF CONTRACTION
Predicted MPF
MPF
FORCE

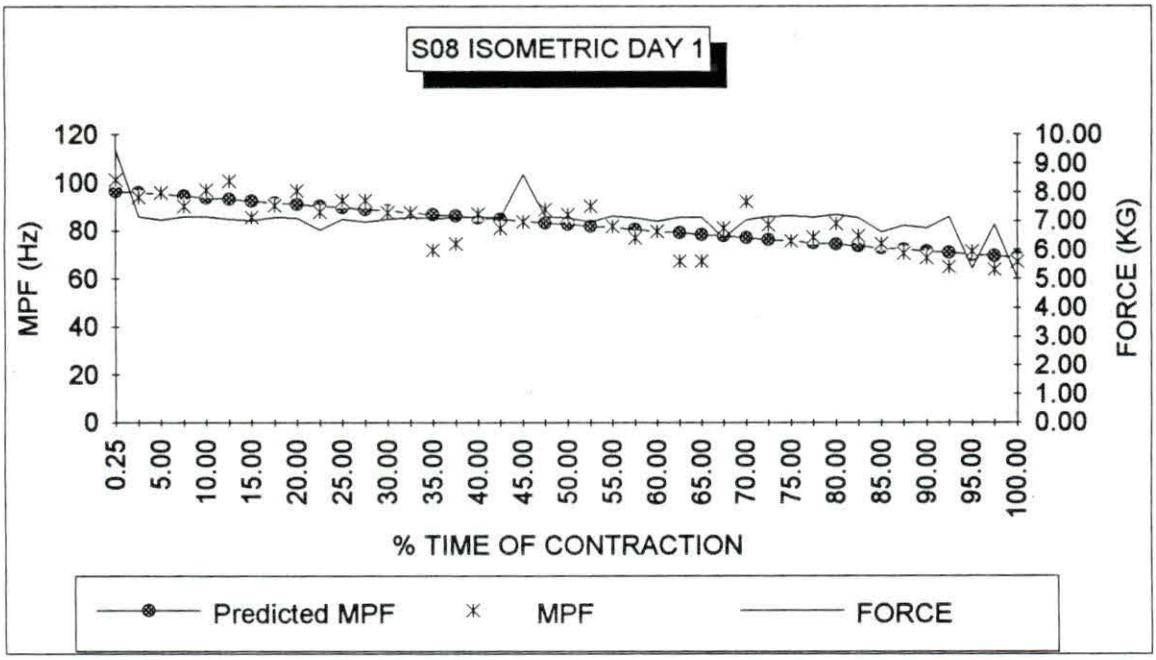

S07 ISOMETRIC DAY 1
RMS (VOLTS)
0.012
0.01
0.008
0.006
0.004
0.002
0
FORCE (KG)
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
0.33
3.33
6.67
10.00
13.33
16.67
20.00
23.33
26.67
30.00
33.33
36.67
40.00
43.33
46.67
50.00
53.33
56.67
60.00
63.33
66.67
70.00
73.33
76.67
80.00
83.33
86.67
90.00
93.33
96.67
100.00
% TIME OF CONTRACTION
Predicted RMS
RMS
FORCE

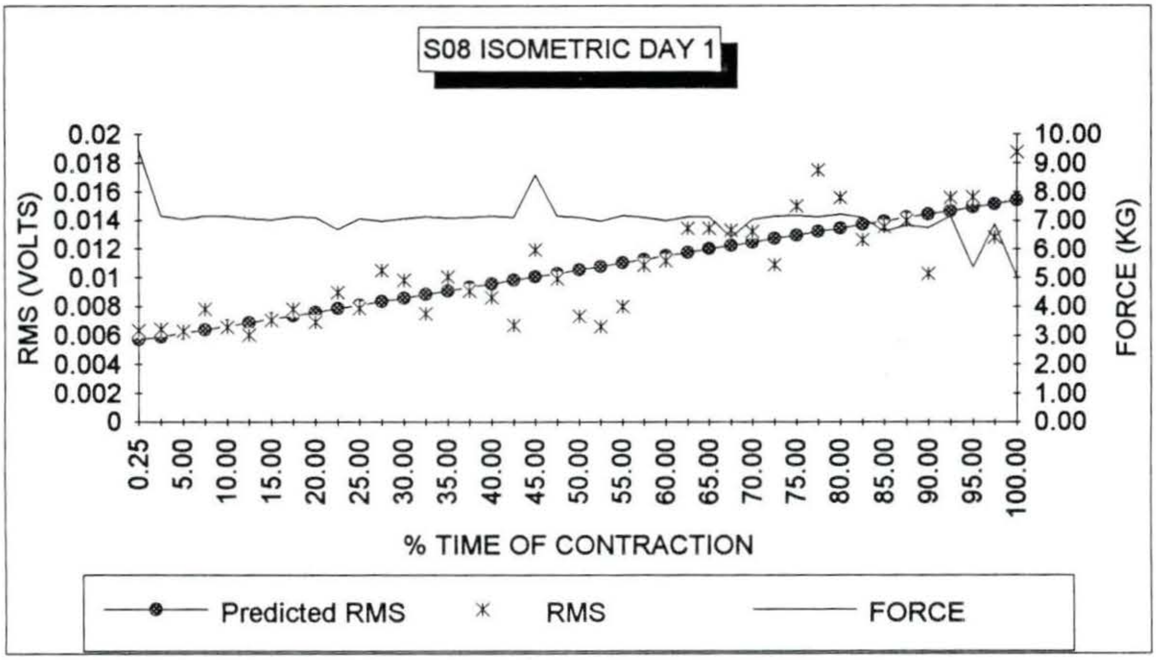

S07 ISOMETRIC DAY 2
120
100
80
60
40
20
0
MPF (Hz)
12.00
10.00
8.00
6.00
4.00
2.00
0.00
FORCE (KG)
0.45
4.55
9.09
13.64
18.18
22.73
27.27
31.82
36.36
40.91
45.45
50.00
54.55
59.09
63.64
68.18
72.73
77.27
81.82
86.36
90.91
95.45
100.00
% TIME OF CONTRACTION
Predicted MPF
MPF
FORCE

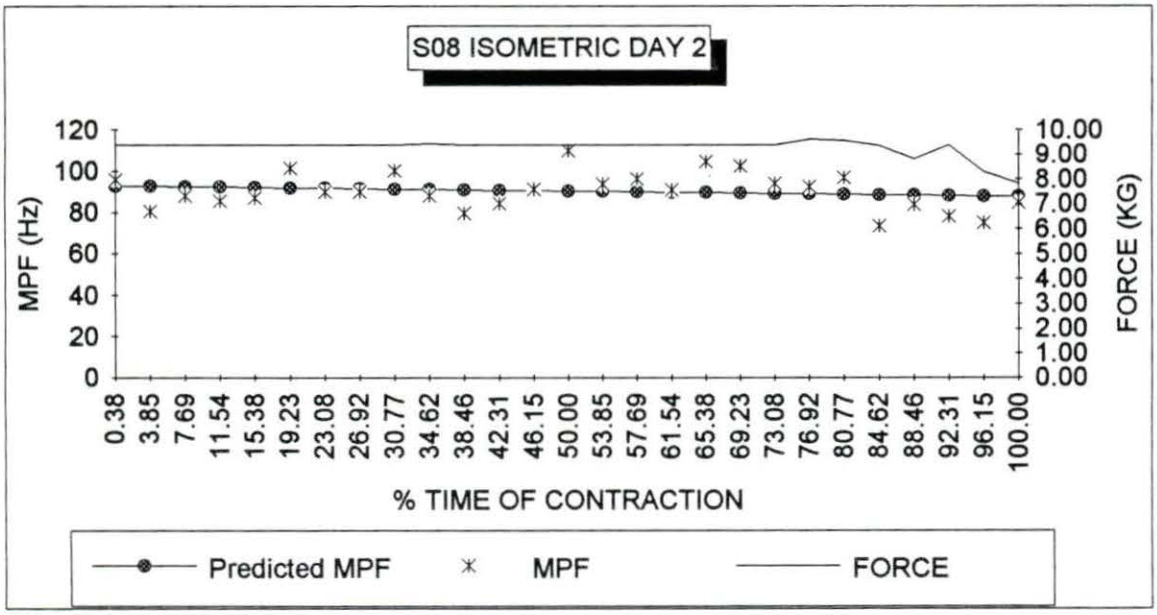


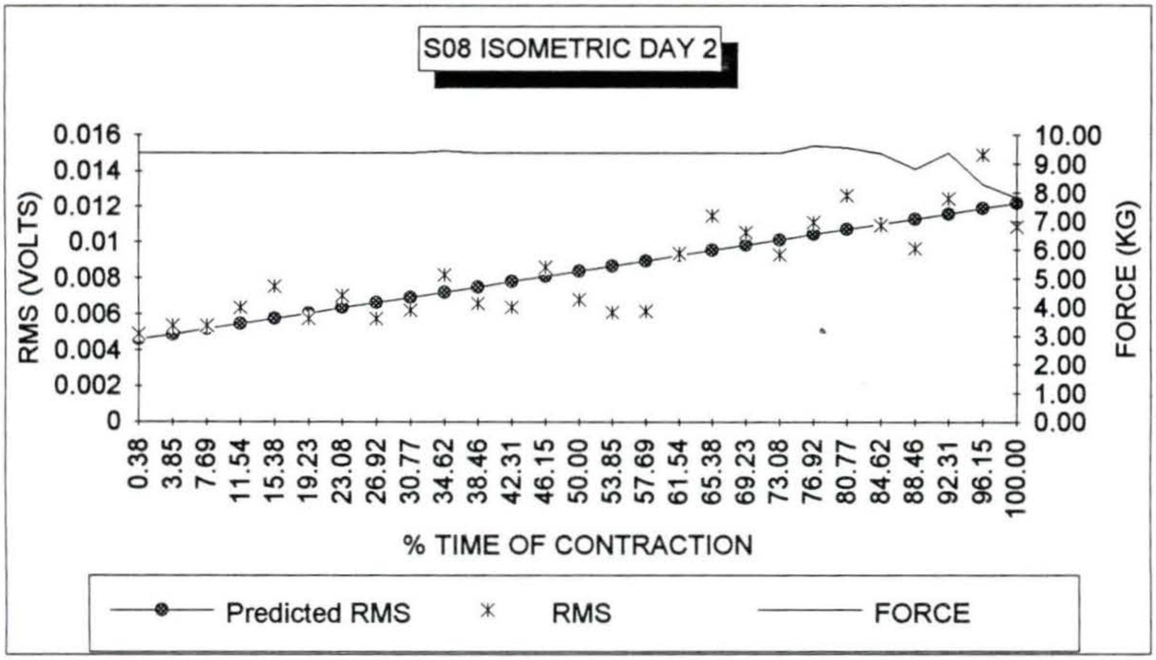
S07 ISOMETRIC DAY 2
0.012
0.01
0.008
0.006
0.004
0.002
0
RMS (VOLTS)
12.00
10.00
8.00
6.00
4.00
2.00
0.00
FORCE (KG)
0.45
4.55
9.09
13.64
18.18
22.73
27.27
31.82
36.36
40.91
45.45
50.00
54.55
59.09
63.64
68.18
72.73
77.27
81.82
86.36
90.91
95.45
100.00
% TIME OF CONTRACTION
Predicted RMS
RMS
FORCE


S07 PDS BAND WIDTH
140
120
100
80
60
40
20
0
HF-LF (Hz)
1
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
230
240
250
260
270
280
290
300
TIME (SECONDS)
S07 DAY 1
S07 DAY 2

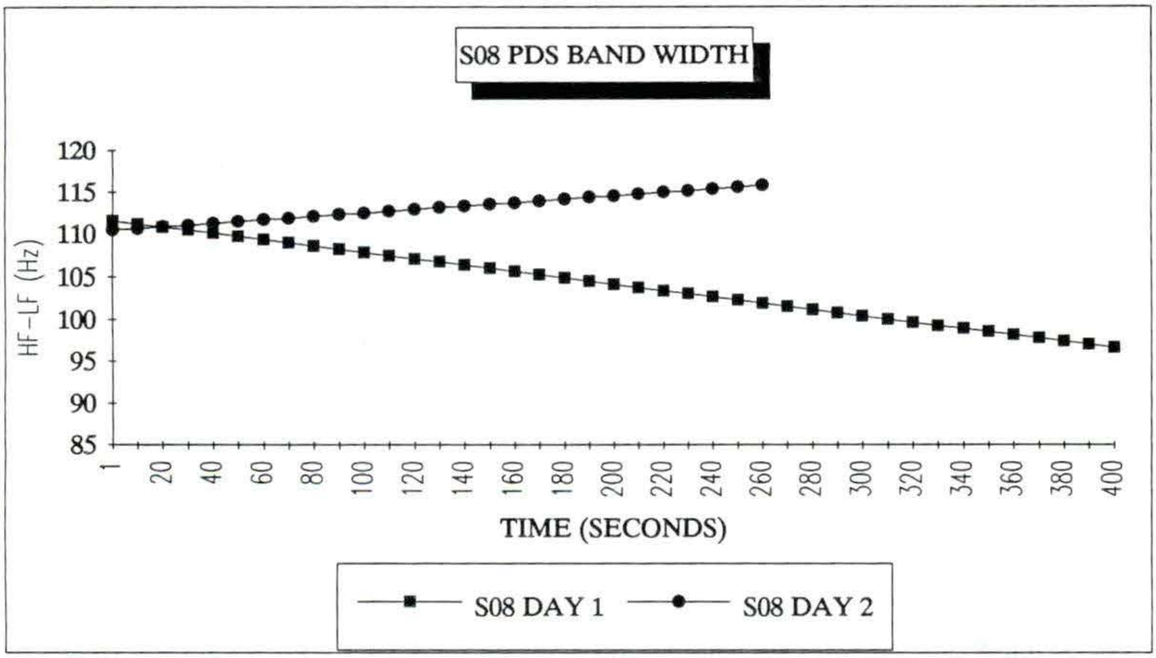

S08 ISOMETRIC DAY 1
MPF (Hz)
120
100
80
60
40
20
0
FORCE (KG)
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
0.25
5.00
10.00
15.00
20.00
25.00
30.00
35.00
40.00
45.00
50.00
55.00
60.00
65.00
70.00
75.00
80.00
85.00
90.00
95.00
100.00
% TIME OF CONTRACTION
Predicted MPF
MPF
FORCE


S08 ISOMETRIC DAY 1
RMS (VOLTS)
0.02
0.018
0.016
0.014
0.012
0.01
0.008
0.006
0.004
0.002
0
FORCE (KG)
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
0.25
5.00
10.00
15.00
20.00
25.00
30.00
35.00
40.00
45.00
50.00
55.00
60.00
65.00
70.00
75.00
80.00
85.00
90.00
95.00
100.00
% TIME OF CONTRACTION
Predicted RMS
RMS
FORCE


S08 ISOMETRIC DAY 2
MPF (Hz)
120
100
80
60
40
20
0
FORCE (KG)
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
0.38
3.85
7.69
11.54
15.38
19.23
23.08
26.92
30.77
34.62
38.46
42.31
46.15
50.00
53.85
57.69
61.54
65.38
69.23
73.08
76.92
80.77
84.62
88.46
92.31
96.15
100.00
% TIME OF CONTRACTION
Predicted MPF
MPF
FORCE



S08 ISOMETRIC DAY 2
RMS (VOLTS)
0.016
0.014
0.012
0.01
0.008
0.006
0.004
0.002
0
FORCE (KG)
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
0.38
3.85
7.69
11.54
15.38
19.23
23.08
26.92
30.77
34.62
38.46
42.31
46.15
50.00
53.85
57.69
61.54
65.38
69.23
73.08
76.92
80.77
84.62
88.46
92.31
96.15
100.00
% TIME OF CONTRACTION
Predicted RMS
RMS
FORCE


S08 PDS BAND WIDTH
120
115
110
105
100
95
90
85
HF-LF (Hz)
1
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
360
380
400
TIME (SECONDS)
S08 DAY 1
S08 DAY 2