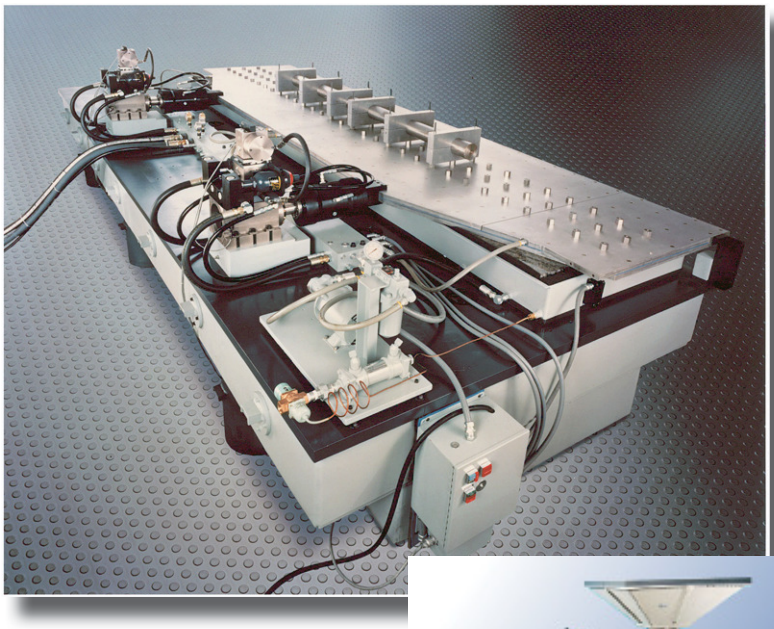
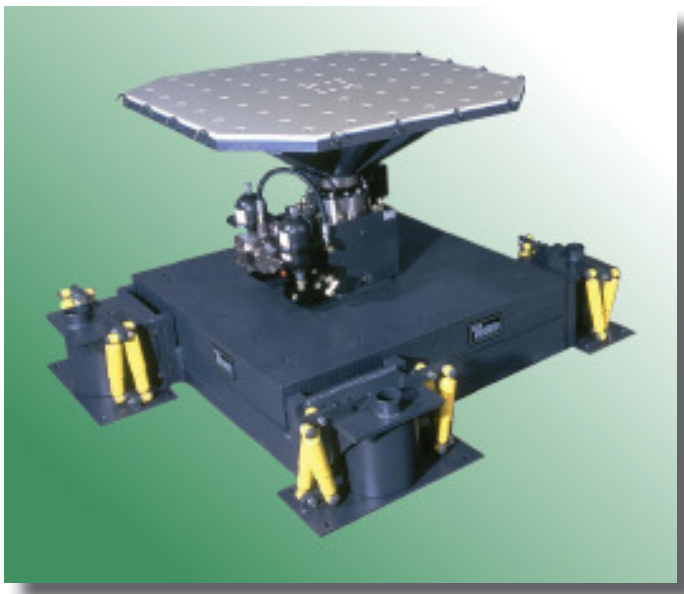
Vibration Testing Equipment

Single Axis
Vibration Test Systems

Systems & Solutions

Engineered vibration testing solutions for improved product quality.





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Team Corporation is the Undisputed Leader in Servohydraulic Linear Test Systems, Providing Unmatched Performance in the Widest Array of Standard and Purpose-Built Systems

Vibration testing is an established means for product development and validation. Linear excitation in a single axis is the primary technique, originally developed during World War II and remaining the predominant methodology in use today. Efficient utilization of laboratory time requires a proven test platform with the displacement, velocity, force and frequency response to reproduce demanding test profiles. *Team* Corporation produces the finest test systems available on the market, demonstrating durability and reliability in hundreds of applications.

Team Corporation is solely focused on the development of vibration test systems. Our heritage began in the 1950´s with the introduction of the HydraShaker, the first servohydraulic actuator designed specifically to meet the challenging requirements of high intensity linear vibration testing. The HydraShaker continues to set the standard for linear vibration systems, produced in a wide variety of models with a range of capabilities not equaled by any other vibration exciter.

Challenges in the development of advanced aircraft spurred by the advent of World War II served as the catalyst for vibration testing in aerospace and military industries. Engineers needed increasingly more sophisticated and capable test platforms to validate new aircraft designs prior to production. Current technology in vibration exciters was limited in force and frequency response, severely curtailing the size of test objects and the range of reproducible environmental conditions. The need for a linear vibration exciter with higher force and frequency response was evident.

Team Corporation´s founder, Vernon Tauscher, developed the HydraShaker to meet this need. Based on a revolutionary servovalve design and incorporating hydrostatic bearing technology, the HydraShaker could now provide the widest frequency band available in forces eclipsing the current state of technology for conventional shakers. With the ability to provide dynamic forces exceeding 40,000 pounds from DC through 1 kHz, the HydraShaker became the key element in test systems for massive objects. The power density afforded by servohydraulics resulted in a very compact actuator, allowing creative solutions to achieving complex test system designs. *Team* Corporation continues this legacy of innovation, providing industry with standard and customized test systems to meet the most demanding test requirements possible.

What can a test engineer expect from a typical HydraShaker system? Displacement to provide high accelerations at low frequencies is a challenge for most other exciters. The HydraShaker is available in dynamic stroke lengths up to 12 inches in standard models, with custom exciters of almost any stroke. Exciting a large payload can generate severe overturning moments that must be reacted by guidance bearings. HydraShakers have hydrostatic bearings that provide the highest reactive capacity of any guidance system, exceeding 50,000 in-lbs. on our standard designs without the need for any external mechanism. The addition of a T-Film® Slip Table for horizontal testing increases that overturning moment capacity to the millions of inch pounds. HydraShakers are available that have controllable frequency response to 2 kHz on smaller models, with larger models demonstrating frequency response over 500Hz on tables exceeding 60 inches square. Peak forces exceeding 60,000 force pounds are available in a HydraShaker little larger than a 2 drawer file cabinet. And with *Team* Corporation´s full line of servovalves, velocities exceeding 120 inches per second are commonplace.

The unique attributes of the HydraShaker make them the ideal exciter for test systems requiring an innovative approach. *Team* Corporation has a group of experienced engineers to design, manufacture and commission complex test systems able to meet almost any criteria. For example, HydraShakers have been incorporated into live firing automotive engines, driving intake and exhaust valves, permitting engineers to investigate fuel economy of variable valve timing. *Team* Corporation has supplied HydraShaker systems to investigate the dynamics of soil mechanics, simulating the effects of earthquakes on models subjected to elevated g-fields produced by geo-technical centrifuges. Combining *Team* Corporation´s hydrostatic angular couplings with the HydraShaker, systems producing torsional vibration to very high levels have been produced. *Team* Corporation is the acknowledged leader in producing multi-axis test systems using standard and customized designs of the HydraShaker. The versatility of the HydraShaker has been demonstrated in systems able to reproduce the most daunting test conditions, situations where no other vibration exciter can perform.

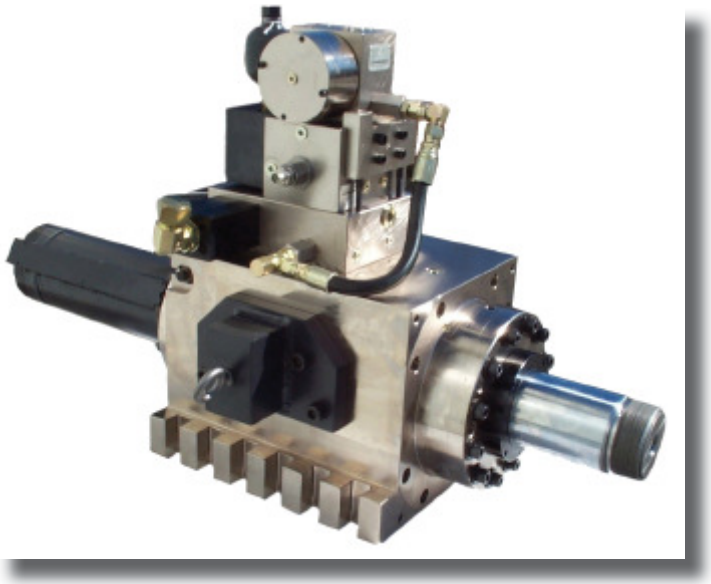


Figure 1. Team 81 Series actuator capable of 12 inches Pk-Pk displacement, 14,000 lb dynamic force output (21,000 lb stall force) and 500 Hz frequency response.

Figure 2. 81 Series actuator designed for use in an automotive 4 Poster with built-in load bias system capable of 14 inches Pk-Pk displacement, 7,000 lb dynamic force output (11,000 lb stall force) and 180 inches per second velocity response.

Engineered for Accuracy, Durability and Dependability Demanded by Test Professionals

System dynamics influence the performance of any vibration test system. Engineering a system that not only has the needed specifications of force, displacement, velocity and frequency response, but is also well damped and exhibits controllable behavior is a formidable challenge. *Team* Corporation has the tools and the experience gained from 50 years of system design to produce the system you, our customer, needs.

Any vibration test system is a combination of several important sub-assemblies. A successful system must have each component carefully selected to ensure not only the required performance, but also to minimize the system´s dynamic response and to maximize safety to the test object, test system and personnel. *Team* Corporation employs sophisticated finite element analysis tools to determine the dynamic characteristics of each system sub-assembly as well as proprietary hydrodynamic modeling tools to determine system performance parameters to a given test profile. This attention to system design details insure the customer of superior, predictable performance.

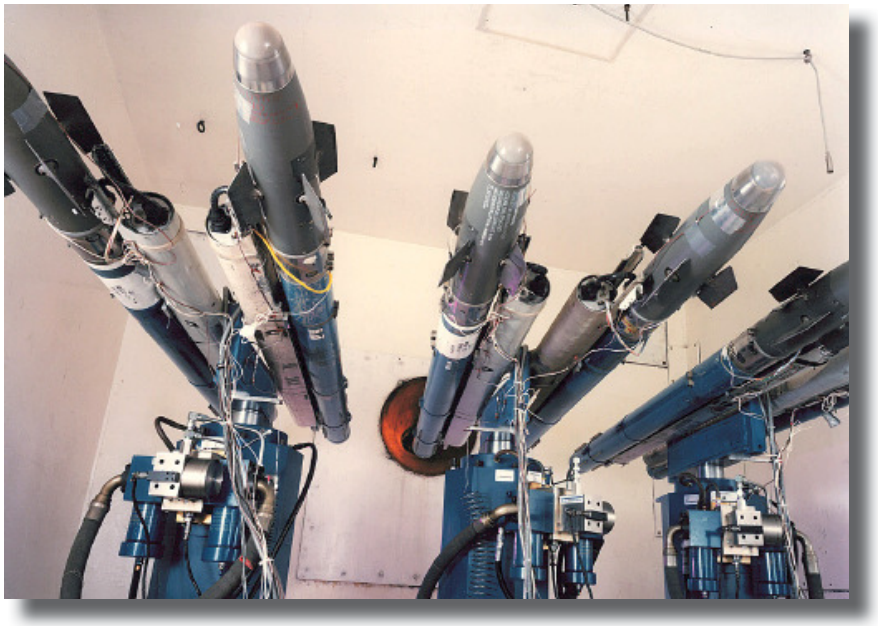
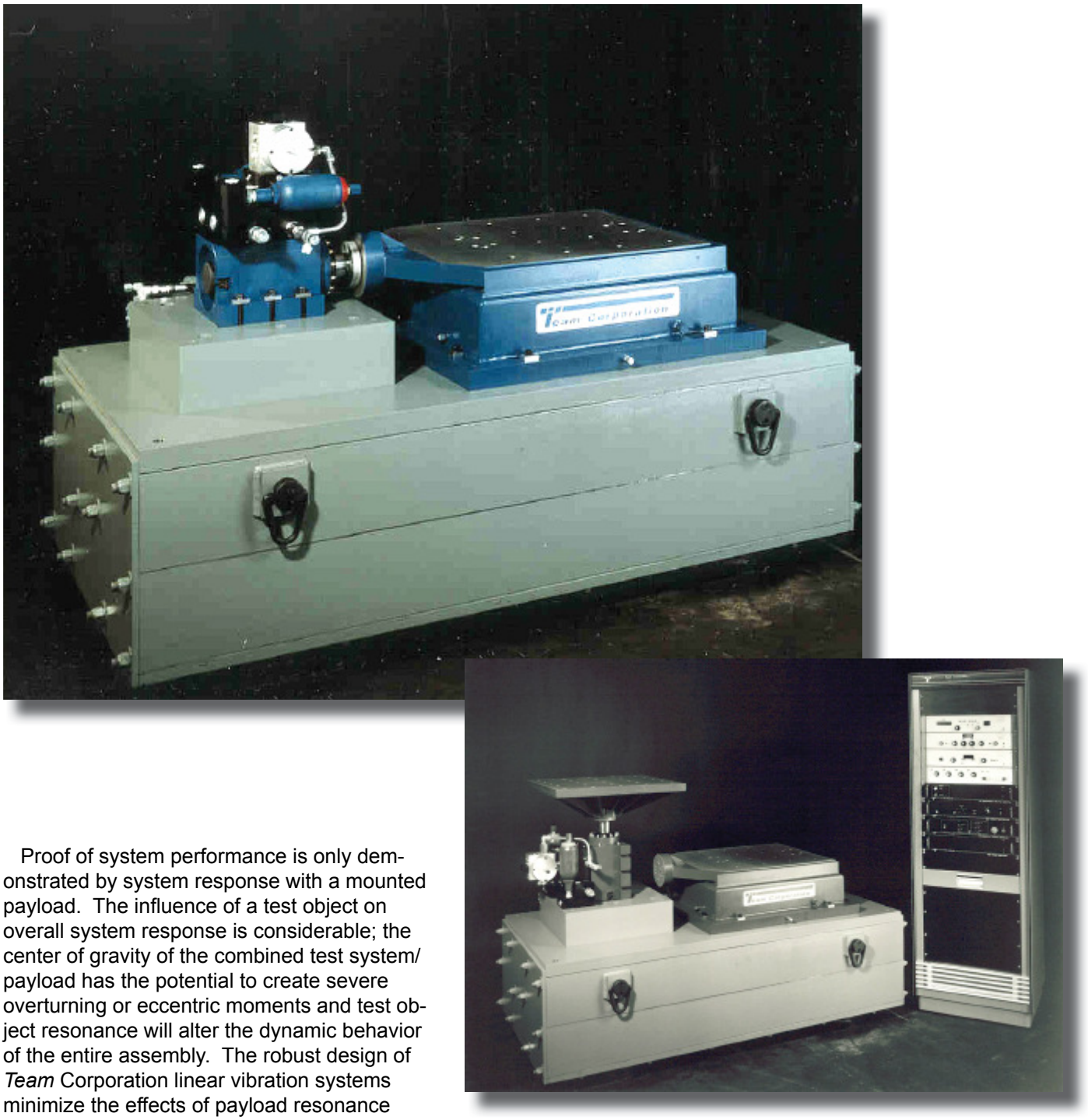


Figure 3. Multiple Team vertical actuators mounted in an acoustic reverberant chamber used to duplicate the acoustic and acceleration loading of under wing mounted munitions systems.



Proof of system performance is only demonstrated by system response with a mounted payload. The influence of a test object on overall system response is considerable; the center of gravity of the combined test system/ payload has the potential to create severe overturning or eccentric moments and test object resonance will alter the dynamic behavior of the entire assembly. The robust design of *Team* Corporation linear vibration systems minimize the effects of payload resonance and our use of hydrostatic bearing technology ensures the ability to react even the most severe overturning moments. These integral design features provide the user with the best possible reproduction of desired test profiles. They also contribute to the broad frequency response demonstrated in actual test results.

Figure 4. These archival photos illustrate a common system configuration. The actuator is designed to mount both vertically for use with a Specimen Mounting Plate (SMP) and horizontally for use with Team´s patented T-Film slip table system. The actuator and slip table are mounted on a common reaction base which can be configured to meet customer needs - movable, airbag isolated or fixed.

Innovative Design, Meticulous Manufacturing and Attention to Detail are all Hallmarks of *Team* Corporation

The HydraShaker is an engineered system, comprised of a linear actuator driven by *Team* Corporation´s high performance servovalve. Other system components are equally important, including horizontal and vertical tables, power supplies, reaction mass designs and test controllers. *Team* Corporation takes full system responsibility to produce an entire system satisfying the most stringent requirements for performance and reliability.

HydraShaker

Team Corporation´s HydraShaker is a specialty actuator designed for high performance vibration testing. It is an extremely robust design, built to last a lifetime. Although simple in appearance, the HydraShaker incorporates sophisticated design features that make it the ideal actuator for exciting large payloads to high accelerations.

Stiffness is of utmost importance in a vibration exciter; dynamic response of the actuator itself during testing can compromise test results or even result in damage to system components. The HydraShaker was designed from the outset to be both mechanically and hydraulically stiff. This is achieved through the use of an extremely massive body, manufactured from a single billet of steel, with substantial cross-sectional dimensions to minimize deflection and resonance. The piston, or moving element in the actuator, is manufactured from a single piece of high strength steel, with an oversized rod diameter for increased bending moment capacity. Hydraulic stiffness is achieved through minimizing the trapped volume of oil between the servovalve and the piston.

The double ended design of the HydraShaker fully supports the piston with hydrostatic bearings on both ends of the rod as well as the circumference of the piston. Hydrostatic bearings are universally accepted as the optimum choice in vibration testing. Utilizing a thin film of pressurized oil to support adjacent surfaces, friction s eliminated since no metal-to-metal contact exists. Without friction, wear is virtually negligible. The stiffness of a hydrostatic bearing is a function of the volume of oil making up the separating film. The volume of oil in *Team* Corporation hydrostatic bearing design is extremely small, with an attendant increase in bearing stiffness. For example, a typical HydraShaker rod bearing can react dynamic loading that exceeds 1,000,000 in-lbs. applied radially. This design feature has the additional benefit of eliminating any high pressure dynamic seals, the most common source of periodic maintenance. To complete the design, the HydraShaker is fitted with a concentric LVDT (Linear Variable Displacement Transformer) to provide very accurate position feedback to the system controller.

HydraShakers are available in a wide variety of force and displacement options. Standard models are available is stroke lengths up to 12 inches and longer strokes are easily provided. Force generation in the HydraShaker is a function of hydraulic system pressure and the piston area where hydraulic pressure is applied. Standard models range from 2,000 pounds of dynamic force (3,000 pounds of peak force) through 40,000 pounds of dynamic force (50,000 pounds of peak force) operating with an industry standard hydraulic supply pressure of 3,000 psi. *Team* Corporation has manufactured models with peak force ratings exceeding one million pounds and has HydraShaker models capable of being operated at a hydraulic supply pressure of 5000 psi. With this wide array of options, a HydraShaker can be manufactured to meet virtually any system force and displacement requirement.

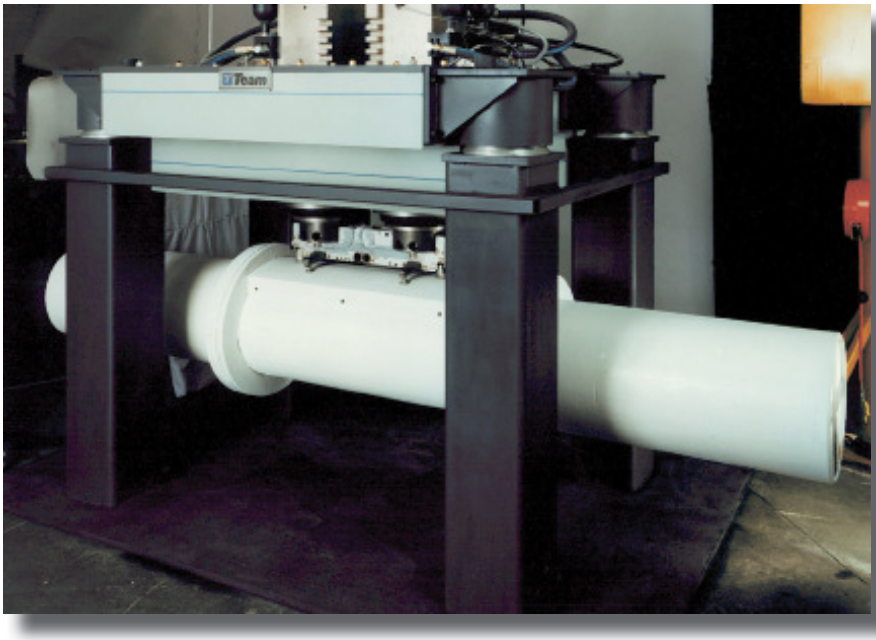


Figure 5. A bomb-rack mounted payload assembly hangs from two, single axis actuators. These actuators provided acceleration loading of a test article mounted inside an acoustic progressive wave tube which duplicated an under-wing acoustic environment.

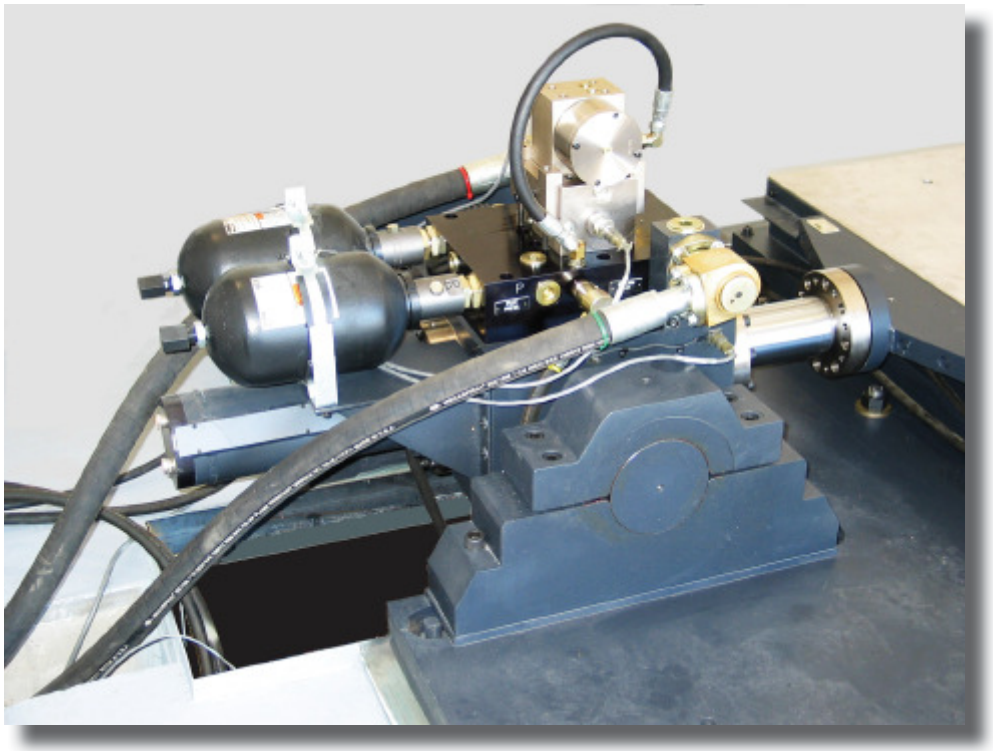


Figure 6. Trunnion mounted actuator assembly minimizes change over time from vertical operation with an SMP to horizontal operation with a slip table.

Servovalve

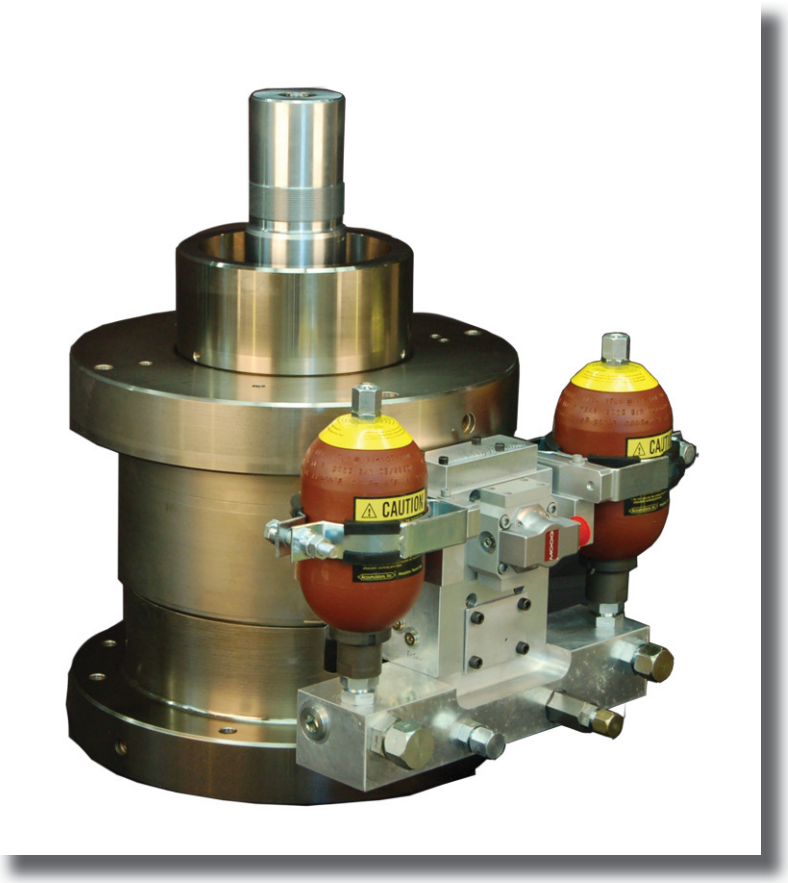
The key to high frequency response in a servohydraulic vibration system is the ability to supply the needed volume of pressurized hydraulic oil to and from the HydraShaker piston. This ability is governed by fluid dynamics and frequency response of the fluid control valve, or servovalve. *Team* Corporation designs and manufactures the highest performing servovalves in the world, specifically optimized for vibration test system conditions.

A typical servovalve assembly mounted directly to the HydraShaker is composed of two separate valves, the Voice Coil Pilot Valve and the Slave Valve. The Voice Coil Pilot Valve accepts the low level drive signal from the test controller and converts it to a proportional valve spool movement.

This results in a proportional flow of hydraulic fluid. The Voice Coil Pilot Valve has a very small spool with low mass and inertia, driven directly by a high power voice coil. Providing a very responsive system with wide dynamic range, the Voice Coil Pilot Valve is able to resolve small differences in drive voltage into correspondingly small differences in spool movement. This high resolution provides the sensitivity to achieve superior test results. For example, the V-20 Voice Coil Pilot Valve can provide full flow to over 600 Hz, rolling off as a second order system but continuing to provide useable, controllable flow to 2 kHz.

The flow from the Voice Coil Pilot Valve is used to control the Slave Valve. A Slave Valve has a much larger spool with a correspondingly high flow capacity. The Slave Valve controls the hydraulic flow entering and leaving the HydraShaker annulus. With a larger spool and greater inertia, the Slave Valve cannot match

Figure 7. Team 60 Series Vertical Only shaker fitted with a commercially available Moog servo valve and accumulators. Extended piston end to fit up into the vertical table / fixture.



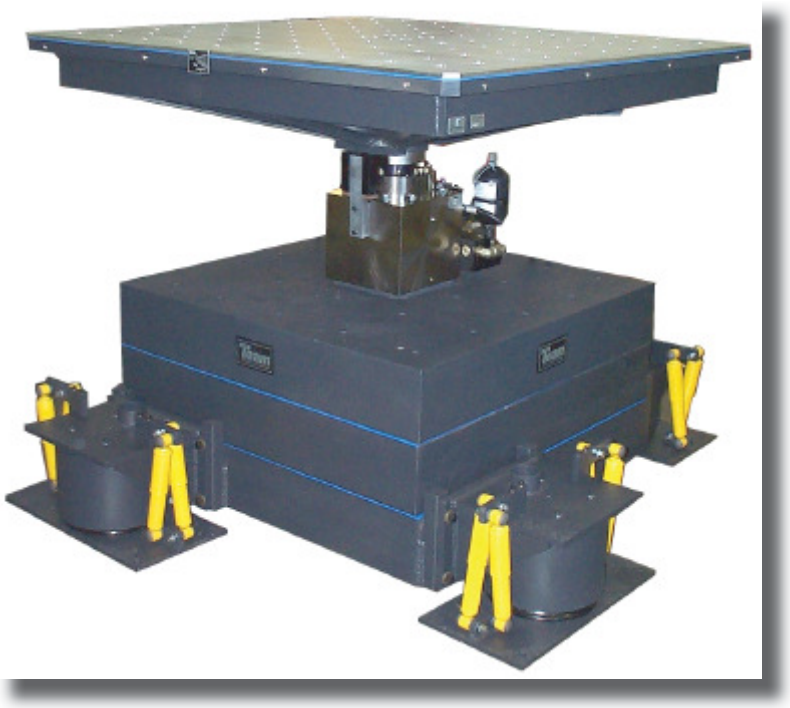


Figure 8. A selfcontained, vertical-only, shaker system features a 1200mm, square SMP, large reaction mass and airbag isolation. This system can be moved directly into the test laboratory without extensive facilities work.

the superlative performance of the Voice Coil Pilot Valve; however *Team* Corporation Servovalves have a flow versus frequency that is several times higher than any competing valve. For example, the V-140 Slave Valve and V-20 Voice Coil Pilot Valve can provide a full 36 gallons per minute of flow at 300 Hz.

As with our HydraShakers, *Team* Corporation Servovalves are available in a variety of sizes, ranging in flow capacity from 5 gallons per minute through 500 gallons per minute. Designed for optimum operation at 3,000 psi, valves are available for operation to 5,000 psi. Included with the servovalve assembly is the *Team* Corporation Servovalve Driver. The function of this electronic module is to provide the closed loop control needed to perform complex test profiles. The Servovalve Driver accepts position feedback from both the HydraShaker and the Slave Valve. An error signal, correcting the position response of the system, is generated, amplified then used to drive the servovalve. Calibrated and set by the factory, the Servovalve Driver is transparent to the user, yet provides a convenient means to manually manipulate the HydraShaker assembly for test set-up purposes.

Reaction Mass

All vibration test systems require an inertial mass for excitation of a payload. The inertial, or reaction mass is often discounted in system design, considered simply something to “push against”. However, a poorly conceived reaction mass can have dynamic response that makes it impossible to achieve test oil film and journal bearing tables. Correctly designed and executed, the reaction mass will ensure the majority of the force produced by the exciter will be used to accelerate the test object and the surrounding environment will be protected from an unacceptable level of excitation.

Team Corporation offers reaction mass designs optimized for the user´s location and vibration test system specifications. A reaction mass of laminated steel plates with constrained layers of visco-elastic damping material is the most common design.

Effective damping of the reaction mass attenuates the response of the mass when it is excited at its own natural frequency. This is an important consideration in the system design since an undamped reaction mass can make control difficult or even prevent the system from reaching predicted levels of acceleration at a given frequency.

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The addition of air isolators permits testing to very low frequencies, below 1 Hz in many cases. They have the added benefit of requiring minimal facility modification prior to installation as the entire system can be placed directly on a typical concrete slab floor. If system considerations dictate, *Team* Corporation provides the design drawings and a component kit for a competent local contractor to pour in place an isolated reinforced concrete mass embedded in the laboratory floor. Regardless of construction technique, each mass is carefully analyzed for dynamic response to ensure successful and trouble-free system operation.

T-Film® Slip Table

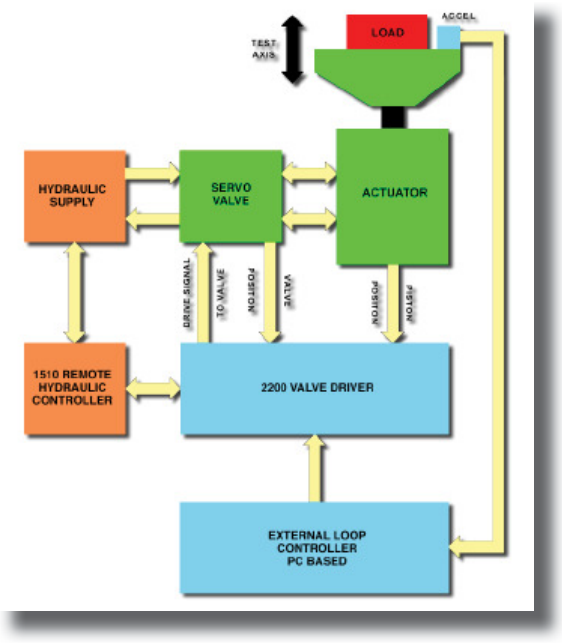
Team Corporation offers a variety of sizes of the patented the T-Film® Slip Table to provide exceptional performance in a horizontal vibration system. The T-Film® Slip Table, introduced in 1985, has earned an enviable reputation as the standard by which all others are measured. *Team* Corporation developed the T-Film® Slip Table to address the deficiencies of other designs, most notably standard oil film and journal bearing tables.

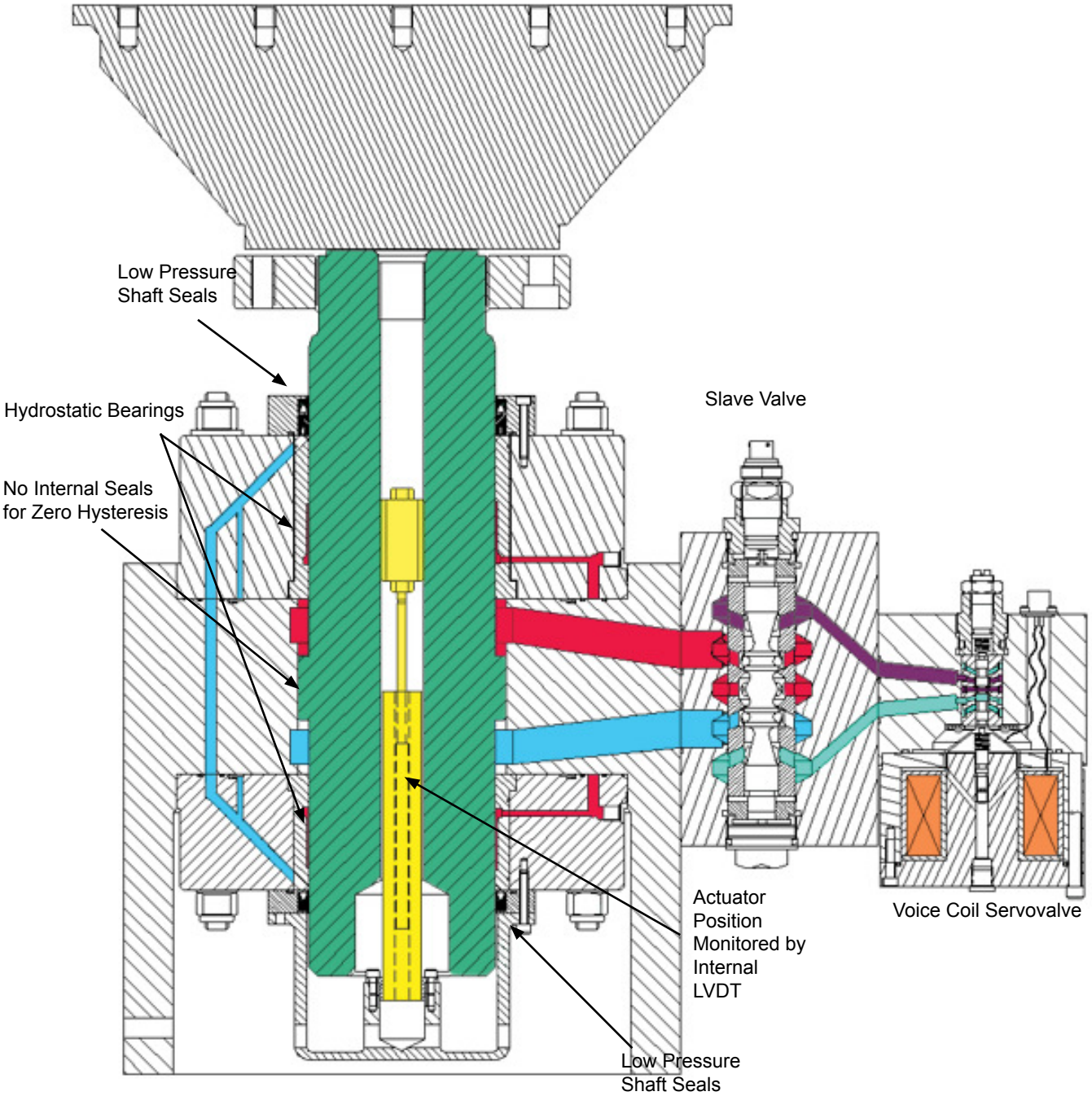
The T-Film® Slip Table uses an array of linear hydrostatic bearings, located on 12 inch centers both laterally and longitudinally, to fully support and guide the slip plate. This provides an extraordinary degree of stiffness in all degrees of freedom other than the line of motion. Oil film tables have no guidance bearings, depending on the guidance mechanism of the exciter to react any yaw motion generated during testing and atmospheric pressure to react pitching moments. Journal bearing tables have a single line of bearings, limiting the overturning moment capacity of the table and resulting in a much higher level of vertical cross-axis motion. In a T-Film® Slip Table, hydrostatic bearings are located throughout the specimen mounting area, ensuring the test project is fully supported and providing extremely high levels of overturning moment capacity. The design of the a T-Film® Slip Table also results in an oil film area about 25% larger than the slip plate, improving stiffness, damping and cross-axis motion control. The oil supply to the T-Film® Slip Table is only 600 psi, reducing heat generation, cost and eliminating any high pressure oil seals. Finally, all oil porting to the bearings is through the base plate, not through the slip plate. This provides considerable flexibility in the placement of threaded inserts for mounting payloads and eliminates any hoses leading to the slip plate from the hydraulic supply.

T-Film® Slip Tables have been manufactured with up to 100 square feet of specimen mount area and can be configured in any dimension on one foot increments, for example 4 feet by 6 feet. Smaller slip plates can be substituted for the full-sized plate when test parameters require a reduction in moving mass. Incorporating a T-Film® Slip Table into a combined environment system is easily accomplished by the addition of a simple cladding of phenolic epoxy insulation material on the slip plate. Long stroke versions are available, with dynamic displacement up to 12 inches. With overturning moments measured in the millions of inch-pounds, T-Film® Slip Tables can test extremely heavy or dense payloads with eccentric centers of gravity. As a fully realized design with hundreds of operating installations, the T-Film® Slip Table represents the finest example of engineered vibration test equipment available anywhere in the world.

Anatomy of a HydraShaker:

High frquency performance is a result of Team´s high performance, voice coil driven servovalve. The cutaway drawing shows the relative physical relationship between individual components. The flow diagram above shows the operational relationship of the HydraShaker (green), hydraulic system (orange) and the control system (blue).




Low Pressure
Shaft Seals
Hydrostatic Bearings
No Internal Seals
for Zero Hysteresis
Slave Valve
Actuator
Position
Monitored by
Internal
LVDT
Voice Coil Servovalve
Low Pressure
Shaft Seals

Vertical Specimen Mounting Plate (SMP)

To accomplish testing in the vertical orientation, the HydraShaker is rotated and a specimen mount table or SMP is bolted to the rod end through the use of a unique, pre-loaded union. This pre-loaded connection is designed to provide a backlash free connection, ensuring high transmissibility of force without introducing spurious noise to test results. *Team* Corporation´s Vertical Tables are designed with very high stiffness and well-damped dynamic behavior to improve the ability to perform severe testing profiles.

Team Corporation offers a wide variety of standard and custom designs to meet virtually any requirement for test object size. The large bending moment capacity of the HydraShaker means a very large vertical table can be used without any additional support. *Team* Corporation has provided vertical tables up to six feet square with a payload capacity of 6,000 lbs. wholly supported by only the HydraShaker rod.

Hydraulic Power Supply (HPS)

Every servohydraulic linear vibration system requires a continuous supply of clean, conditioned hydraulic oil at the proper temperature and pressure. Oil condition is critical for trouble-free operation. Servovalves and hydrostatic bearings have very tight mechanical tolerances and any contaminants in the oil supply can cause parts to malfunction. Hydraulic oil viscosity varies as a function of temperature; proper viscosity is essential to ensure predictable system behavior. Maintaining the required flow of pressurized hydraulic fluid is essential to achieving maximum system performance in velocity and force. *Team* Corporation is skilled in the design and manufacture of the required HPS to ensure long-term, trouble-free system performance.

Each HPS is carefully matched to complement the actuator and servovalve selected for optimum performance of the customer´s test profiles. *Team* Corporation has standard designs created to provide the continuous flow rate and pressure for maximizing servovalve flow rate and actuator force. These designs are available with an optional Noise Abatement feature to reduce the impact of generated noise into the laboratory. Options are also available for either water or air cooling.

Certain types of test profiles do not require a continuous flow, but rather peak flows to reach occasional high velocity transients. An example of this application would be the reproduction of a deterministic acceleration time-history measured during a seismic event. In this case, it may be more economical to provide a lower constant flow rate coupled with a stored volume of pressurized hydraulic fluid in an accumulator. *Team* Corporation uses a proprietary modeling program, called HydroSim, to calculate the best combination of continuous versus stored oil supply. An advantage of *Team* Corporation´s approach to linear vibration systems is our ability to tailor the entire system to the customer's needs, not merely selecting a system from a limited variety of sizes.

Many test facilities have an existing hydraulic power supply available for use. In this case, *Team* Corporation provides a Hydraulic Conditioning Manifold (HCM) to interface with the existing oil supply. The HCM provides the required filtration, pressure control and safety interlocks to ensure high performance and safe operation of the *Team*-supplied equipment. Regardless of which type of installation is best suited for customer needs, *Team* Corporation has remote control units located at the test engineer's station to allow convenient operation and monitoring of HPS and HCM status.

Test Controller

The final piece of any linear vibration test system is the operator interface, or test controller. Generally based on a PC, the test controller has the needed software packages to perform the required tests, such as swept sine, random, reproducing recorded field data, classical shock and so on. It also generates the drive signal to compensate for system non-linearities and updates the drive to converge on desired response.

Team Corporation can offer its customers the best option in test controller selection. *Team* Corporation has its own single axis test controller system, powered by Vibration Research, called VibeSuite. Offering a full array of software packages, exceptional dynamic range and sensitivity, VibeSuite is an effective and economical solution. However, many test labs have an installed base of test controllers, at times utilizing a site license for additional systems. In these cases, *Team* Corporation will supply the test controller of choice for the customer. Our systems are currently operated on virtually every test controller manufactured in the world. No longer is a customer constrained in their choice of test controller; *Team* Corporation works directly with the customer to provide the system desired.

Figure 9. This shaker system, which can perform pseudo two-axis vibration at any angle between 30 and 60 degrees from horizontal, illustrates the versatility of Team´s HydraShaker systems.

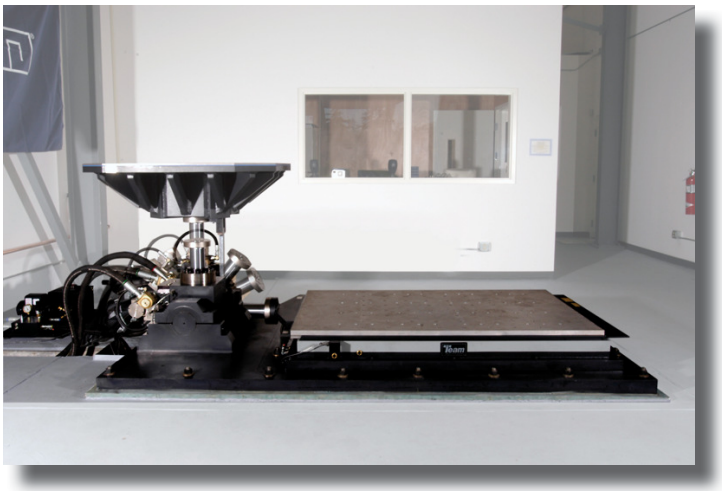


Figure 10. Stop action photography shows the transition of a trunnion mounted HydraShaker as it is moved from its horizontal attachment to a Team T-Film® slip table to its vertical orientation with a 48 inch square SMP.

Exceptional Performance in Tough Applications is the Measure of System Value

System value can only be determined by the ability to perform test requirements with assurance and reliability. *Team* Corporation Linear Vibration Test Systems offer the highest level of system capability coupled with robust component design, providing a combination of performance and reliability unmatched by any other supplier.

Determining a system´s suitability to a set to test conditions is more than just reviewing force and frequency response. The dynamics of a system configuration has significant influence on test performance, as does the response of a given payload. Minimizing the dynamic response of the test equipment is critical; however other factors are difficult or impossible to control. In servohydraulic test systems, the nature of hydraulic fluid serves to limit the overall acceleration levels at high frequencies. *Team* Corporation, through the development of our Voice Coil Servovalve and the HydraShaker, has greatly extended the frequency response of our servohydraulic test systems, to levels approaching those of electrodynamic shakers. This broadening of bandwidth in exciters with exceptional long stroke can provide the ideal solution to maximize test equipment utility.

Every evaluation of a particular test system should include a plot of acceleration against frequency. Displacement, velocity and force all serve to limit the possible acceleration for a given frequency. The same limitations exist for all vibration exciters; the relationship between the three variables is a long-establish physical fact. A typical performance plot has three separate slopes. At low frequencies, maximum acceleration is limited by dynamic displacement of the actuator. Long stroke HydraShakers can provide much higher acceleration at these low frequencies, greatly exceeding the capability of shakers constrained to 2 inches or less of displacement. Velocity serves to limit the maximum acceleration in the mid-frequency range; with the ability to produce velocities up to 120 inches per second, *Team* Corporation systems can produce accelerations to levels as much as twice as high as competing systems. Finally, dynamic force limits acceleration in the higher frequency range. With HydraShakers capable of over 50,000 dynamic force pounds, *Team* Corporation vibration systems can produce extremely high accelerations, with a device approximately one tenth the size of a comparable electrically powered device.

The perceived limitation in servohydraulic test systems is the lack of acceleration at high frequency. Oil column resonance, due to the compressibility of trapped hydraulic fluid within the actuator, has the resulting affect of requiring high flow rates at high frequencies, even though the required actuator velocity may be quite modest. Conventional servovalves, with limited frequency response, are unable to move the valve spool far enough, fast enough, to provide this increase in flow. Consequently, system acceleration performance rolls off rapidly at some level above the oil column resonance. *Team* Corporation proprietary valve technology has resulted in systems with exceptional frequency range, maintaining higher acceleration levels than any other servohydraulic system in the world.

Team Corporation has produced linear vibration test systems able to reproduce the NAVMAT test profile, a 20 to 2 kHz, 6 Grms random profile. Albeit a specialized system, this is an example of the exceptional performance *Team* Corporation has been able to produce in a system generally considered to have an upper frequency limit of 50 Hz. As system force increases, this upper frequency limit decreases, however *Team* Corporation standard systems can fully function to at least a 1 kHz in swept sine and 1.5 kHz in random with a 10,000 force pound HydraShaker, 24 inch specimen mounting table and 300 pound payload. The performance curve shown on the facing page demonstrates this capability. Once table sizes exceed 36 inches square, the system dynamics begin to limit upper frequency response for any system. With our optimized system design, *Team* Corporation vibration systems can provide a combination of high acceleration over a broad frequency band that is unmatched in the industry.

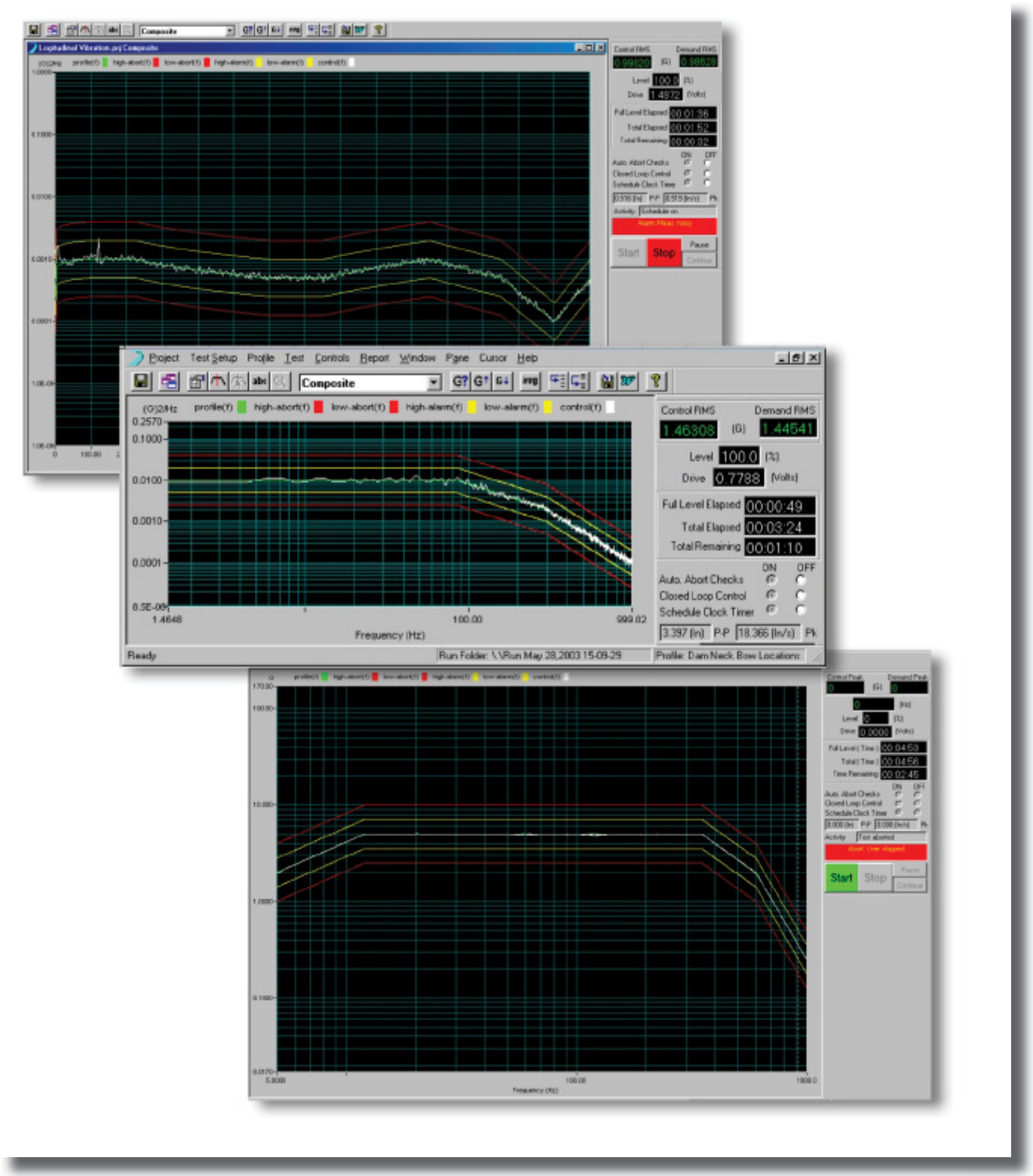
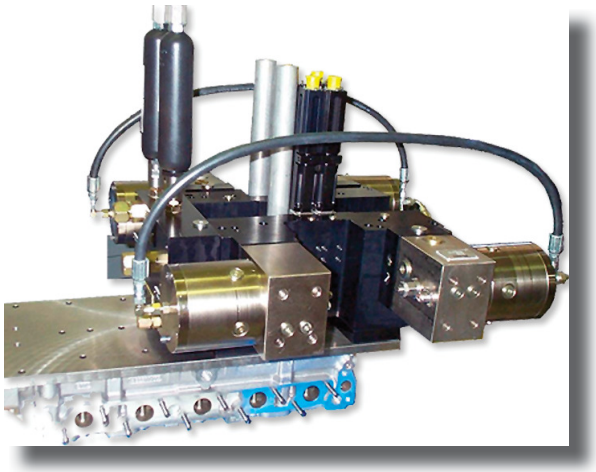


Figure 11. Actual performance plots of HydraShaker high frequency capability. In these examples, HydraShaker has 4 inch stroke and 24 inch square head expander.

Ranging from Conventional through Innovative, *Team* Corporation Linear Vibration Systems can be Custom-designed in an Almost Inifinite Array of Configurations

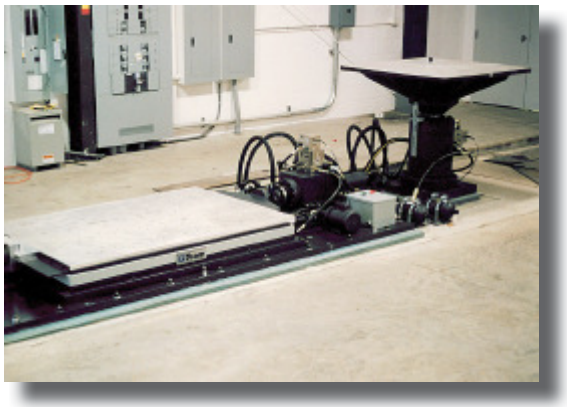
From a simple, single axis unit to very complex test systems combining different orientations of actuators, *Team* Corporation is skilled in the conception and execution of system designs. For over 50 years, *Team* Corporation has supplied both standard and customized arrangements of actuators, ranging from extremely small through incredibly large systems. Let your imagination be your guide and partner with *Team* Corporation to solve your most complex or daunting test requirements.

Test systems should be governed by the test object and field environment to be replicated, not by test equipment limitations. Embracing this philosophy since our inception, *Team* Corporation is constantly innovating, tailoring our system designs to customer requirements. The resulting legacy of linear vibration test solutions is comprehensive and evolving as requirements dictate. On the following pages are examples of conventional system designs as well as some of *Team* Corporation´s accomplishments in custom solutions to extreme test requirements. While no means inclusive, this compendium of systems is intended to serve as a stimulus for your imagination. Contact *Team* Corporation´s engineering staff to discuss your needs, your conditions and your constraints.



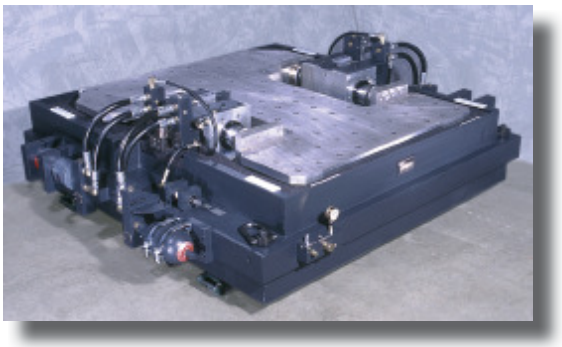
Engine Valve Actuator

Taking the place of the camshaft and rocker arm, *Team´s* Engine Valve Simulator permits full control of exhaust and intake valve lift and dwell on operating automotive engines. This has proven useful in studies of fuel economy and enhanced engine perfomrance.



NEBS GR63 Vibration Test Systems

Team offers a complete vibration test system capable of performing the seismic, office vibration and transportation tests as defined in the Telcordia NEBS document, GR-63-CORE with a frequency bandwidth of 0.1 through 500 Hz, a test payload with fixturing of approximately 500 lbs., maximum acceleration level of 2.0-g vertical for the maximum payload, 10 inches peak-to-peak dynamic displacement and a maximum velocity of at least 40 inches per second.



ComputaLog Horizontal System

The dedicated horizontal system shown can perform a 20 Grms random profile, flat from 5 Hz through 500 Hz on payloads up to 6 feet long. Typical system tests require 8 hours of continuous operation. The combination of *Team* Corporation´s HydraShaker design and T-Film® Bearings has proven to provide the ideal solution to this tough requirement.

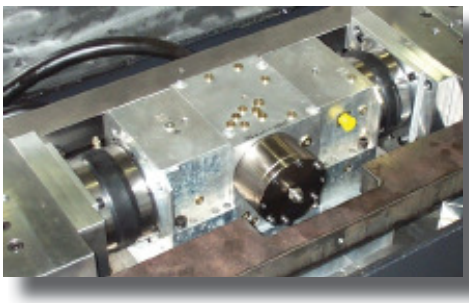
Honeywell System

This particular system reproduces extremely pure linear sinusoidal response at low frequency, high accelerations. With a stroke length of 12 inches, an added feature is the precise dashpots, ensuring the test object can never experience damaging levels of deceleration.

Typical Vertical System

A typical dedicated vertical system, *Team* Corporation has a wide variety of choices in force, displacement and table size. Able to achieve controllable excitation exceeding 1kHz in smaller sizes, large tables, 48 inches square and above, can easily be driven to 500 Hz with flat acceleration response.

Applications

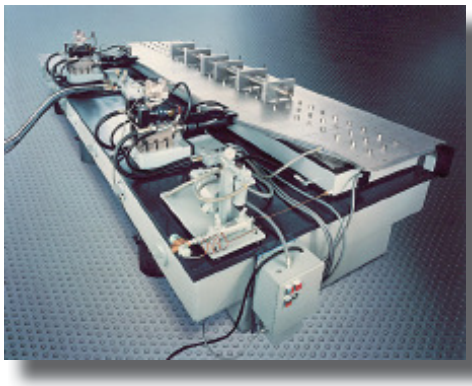


Centrifuge Shaker

Geo-technical soil mechanics uses the elevated g-field produced by a centrifuge to create scaled models emulating large earthen structures. *Team* Corporation´s unique actuator designs are the only choice to reproduce the frequency and force levels needed by premiere research institutes to study the effects of earthquakes.

Dayton T Brown System

Another dedicated vertical system, this unit has 300 Hz flat acceleration response on a 6,000 lbs payload mounted to a 72 inch square table. No external support mechanism is required to react bending moments on the actuator rod.



Schlumberger Dual Actuator System

High acceleration requirements sometimes dictate the need for multiple exciters. In this system two HydraShakers are driving a dedicated horizontal system to 60 g's peak. The system is capable not only of pure linear motion but can also produce yaw, or rotational motion of the slip plate. The use of *Team* Corporation´s Hydrostatic Spherical Couplings connecting the HydraShakers to the slip plate is the key element in multiple degree of freedom system design.

UC Irvine System

Reproducing the horizontal and vertical ground motions of severe seismic events on large payloads requires actuators with very long stroke and extremely high forces. This system is able to reproduce the 20 inch displacement and high velocities measured during the Kobe earthquake of 1995 on payloads of 10,000 pounds. Both vertical and horizontal motions can be produced simultaneously on this system.

Team Corporation´s Service and Support Group Ensures System Availability

Testing programs can be severely affected by downtime due to system maintenance or repair. The HydraShaker, with friction-free hydrostatic bearings and no periodic mechanical adjustment, provides the customer with unmatched reliability. In the event of a breakdown, *Team´s* dedicated service engineers are able to provide effective support in a timely and cost effective manner

A test system is only effective if it can be used when needed. Periodic maintenance must be anticipated and carefully planned to minimize program interruptions. *Team* Corporation´s Linear Vibration Systems, with hydrostatic bearing design and lack of dynamic seals, eliminates the most common sources of periodic maintenance. No longer is it necessary to rebuild actuators to replace leaking piston seals. What has been a regular service requirement on typical servohydraulic systems is now fully eliminated.

Team servo valve spool and sleeve assemblies.

First and foremost, *Team* Corporation offers annual maintenance contracts to ensure a consistent level of system availability. In the event of unanticipated service requirements, we can dispatch service engineers to provide more extensive maintenance as needed. To augment our customer support function, fully capable service is available locally at select sites.

The only regular maintenance consists of hydraulic filter element and low pressure rod seal replacement. *Team* Corporation has established a policy to provide filter element model numbers as defined by the filter manufacturer, allowing the customer to procure these items locally. Of course, we also maintains an inventory of these items to ensure continual availability for the customer's convenience.

L to R: Bill Woyski, VP of Research & Development; Doug Lund, VP of Engineering; Bob Tauscher, CEO; Bruce Huntley, General Manager.

Tell *Team* Corporation Your Needs

Personal and confidential service is the cornerstone of *Team* Corporation´s commitment to systems excellence. Contact *Team* Corporation directly to see if one of our standard Linear Vibration System designs is right for your application. Your system needs will be reviewed by our staff of engineering experts. With over 50 years of experience dealing with linear vibration test system solutions. *Team* brings a wealth of knowledge to the discussion, suggesting alternative design options to maximize your system capabilities. Let *Team* become your partner in system solutions.

Team
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