

Enhanced Simulation
"ES-360"
Non-Kiddie

mfr
ENHANCED SIMULATION, L.L.C.

Part name - **ES-360**
OPERATION
AND
MAINTENANCE MANUAL

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SPECIFICATIONS

Designer: Enhanced Simulation, L.L.C.
5181 W. Amelia Earhart Drive
Salt Lake City, UT 84116
(801) 530-1555 Fax (801) 530-0187

Manufacturer: McClean Anderson
Scofield, WI

Ride Speed: Heave (vertical) - 30" per second, or 12 degrees tilt
Surge (forward and backward) - 15" per second
Rotary - One revolution in 2.7 seconds (42 R.P.M.)

Passenger Capacity: 16 maximum

Max. Passenger Weight: 250 lb. per seat, 5000 lb. per ride

Ride Duration: 3 ½ - 4 minutes (programmable)

Balance of Pass. Loading: Immaterial

Environmental Restrictions: Not recommended for operation during high winds or precipitation

Passenger Restrictions: Minimum height requirement of 42" (must fit in seat)

Power Requirements: 480 volt, 180 amp (150 kW)

Horsepower: Heave - 40 to 60 Hp.; Surge - 50 to 70 Hp.; Rotary - 50 to 60 Hp.

Simulator Dimensions:

	<u>Operational</u>	<u>Non-Operational</u>
Height:	17'	13'4"
Width:	17' (with ramps)	8 ½' (without ramps)
Weight:	45,000 lb. (fully occupied)	40,000 lb.
Length:	30'/50' (fixed/mobil)	30'/50' (fixed/mobil)

Trailer Dimensions:

Height:	13 ½'
Width:	8' 6"
Length:	50'
Weight:	62,000 lb. (With Ramping)

Minimum Operating Crew: 2

General Information

Introduction

This manual provides basic operation and maintenance information for a motion simulator designed by Enhanced Simulation, L.L.C., hereafter referred to as ES. ES has designed a sixteen-seat motion simulator known as the ES-360. The ES-360 is an amusement ride which provides a thrilling experience by combining screen-projected 3-D adventures with synchronized motion and environmental effects, making the audience believe they are actually experiencing what they see and hear. The most dramatic feature of the ES-360 is its ability to execute full 360-degree rolls. The simulator is available in either a fixed or portable configuration.

Warranty

The ES-360 and its components are warranted for a period of one year from the date of delivery. Specific warranty conditions will be according to the contract. Normal wear parts such as motors, bearings, belts, etc. still carry component manufacturer's normal prorated warranty. Tractor-trailer is warranted according to manufacturer's standard warranty contract (portable only).

ES technicians and mechanics are available for on-site service for qualified warranty claims and under the terms of service contracts provided by ES after warranty expiration.

About this Manual

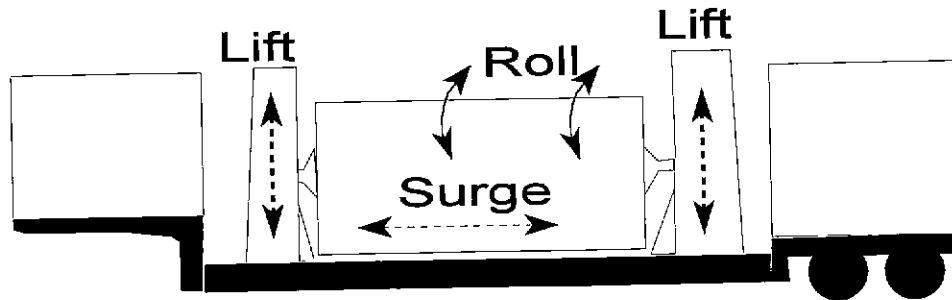
A thorough understanding of the operation and maintenance of the ES-360 simulator will be provided to key owner/operator personnel by this manual and by on-site ES technicians and safety personnel. This manual is designed to provide guidelines to assist the owner/operator with future operation, maintenance, and trouble shooting questions.

The manual is divided into chapters and appendixes. The user is urged to read through each of the chapters and get acquainted with the overall operation of the total system. The chapters are designed to address specific systems, procedures, or components of the simulator felt by ES to be important for low maintenance operation.

Although the manual will provide many answers necessary to solve operational problems, it is important that the owner/operator thoroughly familiarize himself with the manuals provided by the manufacturers of all component parts of the ride.

About Safety

The ES-360 is designed and constructed to provide the owner/operator with a ride that incorporates safety equipment and systems and meets or exceeds all applicable requirements of the ASTM Amusement Ride Safety Standards and specifically the ASTM-F-25 Committee Standards.. More detail on the safety systems is provided in a later section of this manual.



ES-360 Motions

Physical Structure and Mechanical Systems

Motion System

The patent-pending motion system of the ES-360 consists of four independently operated axes. Axis 0 (numbering consistent with computer references) provides *heave* (up and down) to the rear end of the capsule; Axis 1 provides *heave* motion to the front end of the capsule; Axis 2 provides *surge* (forward and backward) motion; and Axis 3 provides *rotary* motion capable of rotating the capsule in either direction. The standard ES-360 motion base allows positive and negative pitch of up to 12 degrees, roll of up to 360 degrees, heave of up to five feet, and surge of up to 2 ½ feet. Each motion axis is powered by its own Indramat three-phase, 480 volt electric induction motor.

The heave motion is accomplished when the two motors mounted on the outside of each tower rotate actuators which move the cabin up or down. Limit switches to prevent over-travel are built in. These switches kill power to the motors and apply dynamic braking in the event a command or mechanical failure should drive one or more of them too far.

The surge motion is accomplished when a motor mounted on an outside rail moves the capsule back and fourth on parallel I-beam rails, also through ball screw actuation. Two high-density polyurethane wheels on each of the four corners of the cradle (structure which holds the capsule) support the unit, while laterally-mounted wheels hold it captive on the beams. There are limit switches on this axis as well.

The rotary motion is accomplished by a direct drive gearing mechanism connected to an Indramat motor that rides in the vertical carriage. A sturdy, spoke-like framework called a "spider" is mounted on each end of the capsule. These structures connect to rotational shafts, one of which is turned by a motor mounted on the pivoting carriage on the aft end.

Both ends of the capsule pivot and the rear shaft also slides on lateral bearings. This design allows complete freedom of movement in every direction, and is unique to the ES-360 simulator.

Capsule

The ES-360's fully enclosed capsule is constructed as a composite structure by enveloping balsa wood inside fiberglass. The capsule is light weight and designed to withstand the rigors

and forces that will be applied. An FEA was performed on the design of the capsule in conjunction with the loads and velocities that it would be experiencing. Most interior structures of the capsule are bonded rather than bolted into place to reduce stress points. Items that needed reinforcing have been reinforced with bolts, steel or aluminum bracing. The axis is specifically placed off-center to assure that the centrifugal force generated during the revolution tends to hold the riders in their seats.

The capsule is air conditioned by a coolant being cooled externally and passed inside the capsule to a heat exchange unit which is then ducted throughout the cabin.

There are individual bucket seats for 16 customers. The seats are made of rigid, form-fitted resin and have vinyl seat covers, lap belts, and adjustable ratcheted shoulder restraints. Raised rows assures that each seat has optimal viewing.

The four doors on each side are electrically actuated. Front doors are wider to accommodate the physically impaired.

The interior walls are covered with a special U.L. fire rated black carpeting.

The capsule and its electrical components are protected by an automatic fire suppression system which uses PFC-410 extinguishing agent.

Pneumatic Systems

Most of the weight of the capsule rests on two large pneumatic cylinders, one at each end of the cradle, with two air supply tanks mounted underneath. This system reduces the motor loads for the two lift motors. A sensor displays whether or not the ride has adequate compression to operate the ride and will not allow the ride to operate when air pressure is below safe standards.

Compressed air is passed inside the capsule to operate the door dead bolts and for ride environmental options (misting & direct air to passengers). All systems are serviced by a single industrial air compressor.

Shoulder Restraints

The shoulder restraints operate on a ratcheting principal. They are designed to allow each rider the ability to adjust the snugness according to his or her own comfort level and body.

When the riders enters the capsule and take their seats, the shoulder restraints are in the raised position. They are first instructed to buckle their seat belts, then they are instructed to first PUSH UP on the shoulder restraint to unlatch it, then PULL DOWN to a tight but comfortable fit. As the restraint is pulled down, it travels through ratchets which lock it in place wherever it stops. At the conclusion of the ride, the restraints are released by the Operator via a manual switch located on the side of the capsule. The rider must PULL DOWN on the restraint to unlatch it, then lift it back over his head to exit.

The restraint mechanism is designed so that the application of power provides the locking function, and the absence of power provides the release function so in the event of a power

failure, the riders are able to exit their seats. This lock/release function is accomplished by way of an electromagnetic solenoid. (Note: Since the restraints require a PULL DOWN motion to release, and since the seat belts are adequate by themselves to hold the riders in their seats, there is no danger of a power failure resulting in injury due to absence of passenger restraint).

Maintenance

(Refer to drawing # _____)

There are several points which must be checked monthly, or after any extended travel, on each shoulder restraint assembly. These are:

- 1) Four 3/4" bolts (2 each side) which hold on the bearing assembly. The bearing assembly is located on the top back of each chair. The bolts are held on with nylon lock nuts, and should be torqued down until they are snug against the frame..
- 2) Visually check to verify that the eight screws which hold the solenoid onto the ratchet assembly have not come loose. Note: The solenoid assemblies are pre-set at the factory and should not require further attention. They are nylocked into place, and should neither be tightened nor loosened.
- 3) Visually check to verify that the eight bolts which hold on the ratchet body are still tight. Note: These bolts are pre-set at the factory and should not require further attention. They are nylocked into place, and should neither be tightened nor loosened.
- 4) On each restraint assembly, there are six retaining rings holding in clevis pins. These rings must be visually checked to verify that they are still present, otherwise a pin could work its way out causing the restraint to fail. They are located: Two at the top of the ratchet bar; Two behind the ratchet assembly which hold the assembly to the chair; and; Two below the return spring.
- 5) At the top of the torsion bar, there are two set screws (left and right) which hold in a "key way" (square piece of metal). This key way lines up the outer diameter of the torsion bar with the inner diameter of the restraint bar bushing, and locks the two together. Check to verify tightness of the set screws and proper positioning of the key way.

Trailer

In its portable configuration, the ES-360 includes a 50-foot trailer with a built-in generator room, control room, storage space, and mountings for the motion base and capsule. The trailer is also equipped with support rigs and ingress/egress access ramps.

Electrical System

Power Source

Power requirements for the fixed and portable configurations are identical. In the portable configuration, the power source is an on-board Kohler Model 150ROZJ diesel generator, rated at 150 kW, 277 / 480 Volt, 3 Phase, 1800 RPM, and 60 cycles, silencer equipped. A 10 kVA transformer supplies the 208v and 110v circuits. The generator is battery-started.

The 480 volts power the motors and motor controllers via a switched solenoid-locked junction box. There is also a switched 208 volt junction box which power the components. The 480v and 208/110v circuits are segregated.

Internal Components

The following is a list of the electrical components located inside the capsule:

1. 2 - Sharp 850 video projectors
2. 3 - Smoke detectors
3. 1 - Fire System Control Panel
4. 1 - Infrared Video monitor camera
5. 1 - Audio Microphone
6. 16 - Seat belt fastened / rider detection switches
7. 16 - Solenoids for shoulder restraint latch/unlatch
8. Various switching relays
9. Interior lighting
10. Bose FreeSpace Sound System
11. 2 - 208v Door Motors
12. 1 - "Smart Terminal" Circuit Board

External Components

The following is a list of the electrical components located outside the capsule:

1. 4 - Indramat Motors
2. 1 - Rotation reference sensor
3. 1 - Surge reference sensor
4. 2 - Surge limit sensor
5. 2 - Heave reference sensors
6. 4 - Heave limit sensors
7. Low air pressure sensor
8. Generator Room
 - a. 480v Three Phase Generator
 - b. Capsule Cooling System
 - c. Air compressor
9. Control booth
 - a. Control booth air conditioner / heater
 - b. Motor Control Cabinet
 - i. 4 - Indramat Motor Controllers
 - ii. 4 - ES Motor Controller Boards
 - iii. 1 - 5v/24v Power Supply

- iv. Multiple Switch Relays
- c. lighting and 110 volt outlets
- d. Control Console, Computer & Monitors
- 10. 2 External Security Cameras
- 11. Various Lights for Night time operation

The Commutator

The commutator is a cylindrical device of about 18" in length, around which are 19 segregated and insulated slip rings. As the device rotates, each of these rings acts as a separate connecting point for one aspect of the simulator's electronic and electrical functions, i.e., video signal, audio signal, power to internal components, etc. The connections are made via 19 stationary "fingers" which press up against the rotating rings.

The ES-360 uses a single commutator located at the aft end of the capsule. The poles are assigned as follows:

- Video In Signal - 4 poles (Two Composite Signals)
- Audio In Signal - 3 poles (Left, Right, Ground)
- Control Signal - 3 poles (transmit, receive, ground).
- Infrared Video Out Signal - 2 poles
- Audio Out Signal - 2 poles
- A.C. Power - 5 poles (208 three phase service consisting 2 high, 2 low and ground)

Since so many of the ES-360's functions are transmitted through the commutator, the proper functioning of this component is critical. The commutator is designed and constructed to withstand the rigors of extended operation and travel, however, as in anything mechanical, it is not immune to failure. Commutator failure could manifest in any number of ways, i.e., loss of or diminished quality in video and/or audio, loss of control functions, loss of power to on-board components, etc.

Nonetheless, because of the inherently sturdy nature of the device, a commutator failure is normally a very unusual occurrence. It must, however, be cleaned and serviced regularly. The recommended maintenance schedule for the commutator is every three to four days for outside operation, and every month for indoor operation. This may vary according to actual operator experience.

Important: A common indication that the commutator is in need of cleaning is diminished video quality.

Important: Regular maintenance of the commutator is essential to continued trouble-free operation of the ride!

Audiovisual System

CineMajic™

CineMajic™ is a trade name for the process used by Multi-Dimensional Studios, L.L.C., of Salt Lake City, UT in their video productions. MDS is a sister company of

ES, and is the principal supplier of their simulator adventures. They have extensive experience in making videos that include live action footage and computer graphics in a 3-D. format.

ES chose 3-D digital component video over the alternatives for several reasons. Film can tear inside a moving capsule, plus it tends to wash out the bright colors and high contrast that video offers. (High-definition video can be used, however there is extra expense to the customer). Ordinary video is commonly used in simulators, but it does not provide the realism that 3-D. does. The combination of realistic video and 3-D. depth of field makes for an exciting and realistic visual experience.

The audience wears specially designed circular-polarized glasses which, unlike traditional 3-D. glasses, maintain the effect regardless of head movement. Circular polarization is critical for effective 3-D. in a simulator application. The illusion of depth of field is combined in some films with the effect of objects appearing to enter theater space, making the experience extremely convincing.

The hardware for the CineMajic™ video system consists of the following components:

- 1) 2-Panasonic laser videodisc players
- 2) 2-Sharp 850 LCD video projectors
- 3) Vinyl screen
- 4) Proprietary micro controller
- 5) 3-D. glasses

Note: In addition to video, the laserdiscs are also the source of the audio and motion information.

Fundamentals of 3D Viewing

In order to fully understand and preserve the video experience provided in the ES-360 simulator, it is important to become acquainted with the fundamentals of 3-D. viewing. The brain perceives depth by processing the slightly-offset view each of our eyes has of the world. (Point to an object with both eyes open, then alternately wink. Notice how the view shifts from side to side).

To create the illusion of depth of field on a flat surface, 3-D. filming artificially replicates the information delivered to the brain during normal sight. This is done by projecting two identical views slightly offset side to side, and then, through a filtering process, allowing only the left image to reach the left eye and the right image to reach the right eye. When this is done, the brain perceives depth, even though in reality there is only a flat screen.

CineMajic™ adventures are filmed using two cameras mounted side by side at a precise angle, or convergence. "Convergence" refers to the point at which the views of each of the cameras intersect. This is important during the filming process in order to achieve the desired effect. It is equally important, however, that the two *projected* images are adjusted to the proper convergence if the 3-D. effect is to come across without causing eye strain, ghosting, or double images.

Occasional adjustment of the projectors' convergence is one of the necessary routine maintenance procedures. Convergence should be checked at the beginning of each day, and at least once during the day if possible.

CineMajic™ Glasses

As discussed, a filtering process is necessary to permit only the desired image to reach the desired eye. The filtering process used in the ES-360 is called "polarization".

A piece of polarizing film is placed over the lense of each projector. Through an arcane scientific process, this special film is able to refract light at an angle in such a way so that when another piece of polarizing film is placed in front of the eye at a right angle in relation to the first, the view is occluded, or filtered out. In other words, depending upon the way the two pieces of polarizing film are turned in relation to each other, they will either permit light to pass through them or restrict it from doing so.

The polarizing film on the projectors and on the 3-D. glasses is configured so that each eye sees only its own image. The brain interprets this as normal sight, and the magic of 3-D. is created!

A special feature of our CineMajic™ glasses is that they are "circular polarized". This simply means that, unlike most other 3-D. applications, they hold their 3-D. image regardless of whether the head is moved or tilted.

Note: In the event that one of the projectors malfunctions and is unable to be readily repaired, it is still possible to run the ride in 2-D. using one projector, thereby preventing downtime.

Audio System

The ES-360's audio system is designed to deliver high-fidelity digital Surround Sound as well as vibrational effects. The Bose FreeSpace system is used. The control portion of this system is located in the front console of the capsule.

Monitoring System

The control booth operator is able to monitor the interior of the capsule during the ride by way of an infrared signal camera positioned inside. The operator also has two-way audio communications with the riders.

It is important that the operator closely monitors the passengers during ingress and egress and during the ride. He should watch for proper behavior, proper seating and restraining, and for any signs of distress during the ride. He may deliver a reprimand or instruction if necessary, or stop the ride. Should a ride stop take place, the operator should apologize to the passengers and explain the reason: "One of the riders lost their glasses", "One of the riders wants out", etc., and then resume the ride from the beginning.

Control System

Description

The ES-360's Control System is completely governed by state-of-the-art computer circuitry and software. Some functions are automatic, such as ride sequences, fire system operation, and emergency auto-abort functions. Others are totally dependent upon Operator command, such as ride homing, "computer stopping" of the ride, manual motor operation, fire discharge abort, and interior effect systems. All of the commands of the ES-360's control system are mouse executed, and/or mouse selected.

The Control System is designed to monitor and display feedback information concerning critical functions of the unit, such as possible air pressure leaks, seat belt fastened / unfastened, seat occupancy status, axis position, and warnings of certain mechanical and electrical malfunctions.

The Control System operates the following functions:

- Detect seat belt attachment
- Detect Door Status
- Begin Show
 - 1) Shut off interior lights
 - 2) Operate both projectors
 - 3) Operate sound system
 - 4) Operate each of four motors
- Terminate show (lock capsule in "home" position, turn on interior lights)
- Repeat cycle

On the left side of the screen, a flashing message box displays possible malfunctions or safety concerns. These messages are:

1. ESTOP - Indicates that one or more of the five ESTOP buttons have been pressed, or that the capsule is resting below one or more of its reference (overtravel) switches. The ride's "automatic" function is disabled in this mode. The ESTOP button must be pulled out and the capsule "homed" in order to operate the ride. Note: The ESTOP message will flash as a matter of course when the unit is first powered up because it rests below its reference switches. It must be "homed" prior to operation. (Section 8.5).
2. Fire Alert - Indicates that the fire system has detected smoke. This indication should be accompanied by a alarm. Immediately "Computer Stop" the ride and evacuate.
3. Comm. Errors 1-3

Console

The unit comes equipped with a Pentium 90 MHz. PC, a high-resolution monitor, a hard disk drive, and a powerful software package consisting of the following modules:

1. A motion program capable of simultaneously controlling and monitoring the position of four electric motors to provide one rotary axis, one surge axis, and two independent heave axes of movement.
2. One Master Controller Circuit Board which handles all communication from the PC and other circuitry
3. One Video Controller board which controls all laser disc players
4. One "Smart Terminal" located on-board the simulator capsule
5. Four Motor Controller located in the motor controller cabinet

During operation, each experience is constantly monitored and displayed on the color screen through simple graphic symbols and annunciators. The programs error checking reduces the chance for the operator to issue the wrong instruction or command.

The motors are programmed and their positions are monitored by way of a counting system. Through a device called an "encoder", each revolution of the motor is divided into a finite number of "counts" which are in turn read by magnetic sensors positioned nearby. The monitor displays a continuous numerical readout of the position of each axis.

There is a Laser Manual Control display, which allows the Operator to run just the movie without the motion. This function is used in adjusting picture quality, focus and convergence, sound volume and equalization, and other audiovisual tests which are best performed while the capsule is not in motion.

A separate display indicates whether seat belts are buckled, allowing the Operator to double check before starting the ride.

On/Off and Play/No Play toggles allow independent function of each motor for the purpose of programming. (This function, as well as the other programming indicator, are generally not used by the Operator).

Safety Features

Redundant self-monitoring and sequential event circuitry combined with a thorough operator training course help insure the safety of the ES-360. Also, all structural and mechanical aspects of the ride have been engineered with safety as the number one priority.

1. Seats are equipped with electrically controlled, ratcheted shoulder restraints similar to those found on modern roller coasters. Restraints are lowered by the rider to their own comfort level, and released by the Attendant at the conclusion of the ride. Lap belts are wired with switches so that the Control Operator can verify that seat belts are buckled. Attendant also confirms this visually. Lap belt switches also count the riders.
2. Operator has a view of the cabin interior via an infrared camera mounted inside the capsule, as well as two-way audio communication.
3. If a belt is unbuckled during the ride, the seat location appears on screen in the control booth, allowing the operator to visually check and stop the ride. (Note: Unbuckling

- presents no danger to the riders, as the shoulder restraints will hold them in their seats, however established safety protocol requires that the ride be stopped nonetheless).
4. Door closure and latching is executed by the attendant, not automatically, allowing the operator to visually verify that no one is in a position to be struck by lowering doors.
 5. When the cabin comes to rest after each ride cycle, the motor drives are automatically disabled and an electronic friction brake is applied. This prevents movement of the cabin during passenger ingress and egress.
 6. The ride is always operated by a minimum of two people. There are five ESTOP buttons, one located inside the control booth and one on each corner of the exterior structure. There is also a manual fire system pull stations, located on the end of the capsule. The control booth operator has camera-monitored viewing of each side of the ride's exterior. Two attendants usually assist with passenger ingress and egress.
 7. A pressure monitoring sensor is displayed inside the control room and disables the ride if pressure falls below the safety level. (Note: Even if a pneumatic line were to be completely severed, it takes 15 to 20 seconds for the pressure to completely bleed off. The return of the cabin to the "home" position takes only 3 to 4 seconds.
 8. An automatic fire extinguishing system protects both the cabin interior as well as the electrical compartment in the front of the capsule. It is equipped with photoelectric smoke detectors, an alarm, a manual pull station, a manual abort station, and it utilizes the latest and safest extinguishing agent available. The Fire Control system console is located in the on-board console. Two hand extinguishers are also supplied.
 9. The on-board computer control system, and the fire system are all battery-backed.
 10. The cabin structure is designed and built with high safety/low stress factors. An FEA was performed on the composite structure to assure that it would exceed the loads and stresses applied during operation.
 11. The off-center axis, seat construction, and speed of revolution are calculated so that during the revolution, the centrifugal force tends to hold the riders in their seats.
 12. The linear actuators which drive the motion of the simulator are equipped with overtravel kill switches. These switches mechanically cut power to the motors and apply dynamic braking in the event an electronic malfunction, thereby assuring that the capsule cannot be driven too far in any direction.
 13. The door to the high voltage electrical compartment is protected by a solenoid lock which permits entry only if power is shut off.
 14. The weight of the cabin is supported by a pneumatic counterbalancing system rather than by the motors and actuators themselves. The cabin rests on two air cylinders, one at each end, which are pneumatically connected to two large accumulators (air tanks) mounted underneath the structure. This system cushions the starts, stops and other movements of the ride. It also protects the motors and overall structure from physical stress.
 15. Barrier height and placement, ramp width, and all other physical, mechanical and electrical components comply with or exceed ASTM Standards. Interior wiring is run through conduit, and meets national electrical codes. A minimum height requirement of 42" is required to ride. The cabin is illuminated during passenger loading and unloading. It automatically returns to the "home" position in the event of any power loss.
 16. R.C. Fussner & Associates, Inc., the recognized industry leader in amusement ride safety engineering and loss prevention, has been involved as design consultants. They are dispatched to each location prior to the unit's release to provide consultation on

final installation.

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Start-up and Operation

Personnel

There are four ride personnel designations: Operator, Senior Operator, Operator's Assistant, and Attendant. Their duties and functions are as follows:

Operator - A person trained in the skills, procedures, and precautions associated with the operation of the ride. "Operation" consists of set-up, pre-operation testing, ride operation, routine maintenance, routine troubleshooting, safety precautions, and emergency procedures. An operator must have successfully completed the manufacturer's training course. His responsibilities also include signing off on the daily check sheets.

Senior Operator - The overall ride supervisor. Skills are the same as those of the Operator, however the Senior Operator is also qualified and authorized to train others, and is responsible for their performance. In the case of portable units, the Senior Operator, Operator, and truck driver will often be the same person.

Operator's Assistant - A person qualified to conduct set-up, pre-operation testing, maintenance, troubleshooting, safety and emergency procedures, attendant's duties, and all other functions associated with the ride with the exception of actual ride operation. In portable units where there will generally be only two people accompanying the ride, both should be trained as operators.

Attendant - A person who participates in the routine tasks associated with the operation of the ride, such as set-up, ramp assembly (portable), assistance with ingress and egress, crowd control, ticket sales and collection, glasses distribution and collection, and other miscellaneous duties as required. Attendants for portable units will be hired and trained at each location, and may or may not be the same people who are hired to assist with ramp assembly. In addition to the Operator and Operator's Assistant, it is recommended that two Attendants be on duty during ride operation.

Qualifications for Employment

Persons being considered for employment as Operators and Operator's Assistants must have computer experience in the Windows operating system. Mechanical, electrical, and/or electronics experience is also highly desirable.

Attendants duties are far less responsible, and therefore do not have strict employment guidelines.

Of paramount importance is that all employees who have direct contact with the public be cheerful, upbeat and enthusiastic at all times. This condition would not necessarily apply to an Operator who is hired to work exclusively in the control booth, but it would definitely apply to Operators' Assistants and Attendants.

Power up

After all daily Mechanical and Electrical checks have been completed (Sections 14.1 & 2), power up the simulator either by switching on the master switch on the generator control unit (portable) or by turning on the main power switch (fixed). This will supply power to the junction boxes in the Control Booth.

Turn on the 208v junction box and all related 110v breakers. Turn on the 480 volt power to the motors via the large junction box.

You are now ready to execute the "homing" procedure which is necessary prior to operating the ride in the automatic mode (Section 8.5).

Manual Motor Operation

The motors can be operated either automatically or manually. In the manual mode, the individual motors are mouse selected, and then operated by pressing a specific key on the keyboard. They are pre-set to operate at a very slow speed in the manual mode.

It is necessary that the motors be operated manually on several specific occasions. These occasions are for startup the first of a new day and for positioning the roll motor to the zero position.

Following is a list of the various motor functions and their key controllers:

<u>Motor (Axis #)</u>	<u>Function</u>	<u>Key</u>
<u>Back (Axis 1)</u>	Up	Q
	Down	A
<u>Front (Axis 0)</u>	Up	W
	Down	S
<u>Surge (Axis 2)</u>	Out	E
	In	D
<u>Rotation (Axis 3)</u>	Clockwise	R
	Counterclockwise	F

The left side of the Control screen displays four green horizontal boxes corresponding to each of the four motors. Clicking on these boxes toggles between the automatic and manual modes. When in manual, the box also displays the correct key controllers for operating the motors, per above. *Note: When in manual mode, the motor in question will not operate during a "ride" nor for a motor command entered via the motor command dialog in the upper left corner of the control program window.*

In order to activate the motors after powering up, the large green enable button on the control console must be pressed. When the light stays lit, the motors will respond to command. If it does not stay lit, it is an indication that either there is an ESTOP button pressed somewhere, and/or, that the vertical carriage is resting below its

ESTOP switches and/or there is not sufficient air pressure to operate the ride. This situation must be corrected before the ride will operate in the automatic mode.

“Homing” the Capsule

After the daily checks have been completed, the final step in preparation of the ride for automatic operation is called “homing”.

As explained in Section 6.2, a numerical counting system is used to program and monitor the position of each motor. In order for the motors to respond each time according to the motion programming, they must start from the same correct place each time. The motors are able to “know where they are” via feedback from fixed electromagnetic reference devices which are physically attached to the frame in various places.

If the ride is run with the capsule having started from its correct “home” position, the motors will move the capsule in the correct manner. If the ride is run with the capsule having started in something *other* than its “home” position, the motors will respond identically to the data, but the capsule will not move in the correct manner. Depending upon the position in which the capsule started, the motions could be erratic, or even violent. While there is little risk to any riders who may be inside the capsule if this happens, ***serious damage to the equipment could result***. In order to prevent this from happening, the Operator must be aware of this situation, and ***never start a ride with the capsule resting in anything but the “home” position.***

When the ride is idle, its vertical carriage rests on four high-density rubber bumpers, two at each end. In this position, it is sitting *below* its two vertical ESTOP switches. This means that the two vertical motors will not respond to either manual or automatic commands until both ends have been raised above the ESTOPS.

The procedure for raising the capsule prior to “homing” is as follows:

1. Click the two vertical motors to manual mode.
2. Press and HOLD IN the green enable button on the control console. You should hear a solid “Click” behind the motor controller panel when the button is pressed. This indicates that the motors are engaged.
3. Press the “Q” key while holding in the yellow button. This will slowly raise the back vertical carriage. You will know that you have passed the ESTOP switch by watching the Encoder counter as it moves up from zero, and then suddenly starts over at zero again. You may release the key at this point.
4. Press the “W” key while holding in the yellow button. This will raise the front vertical carriage. You will know that you have passed the ESTOP switch by watching the Encoder counter as it moves up from zero, and then suddenly starts over at zero again. You may release the key at this point.
5. Set the roll to zero by turning the roll motor to manual mode and manually rotating the unit until the Attendant indicates that you are at the zero position, or level and then click the Zero Roll button to set the zero position. *This operation may need to be redone once or twice during the day during long hours of operation.*

You have now passed the two vertical carriage ESTOPS. The green enable light will remain

lit, indicating that the motors will respond to the "Home" command. Proceed as follows:

1. Be certain that the doors are CLOSED and that they are LATCHED.
WARNING! SERIOUS DAMAGE TO THE EQUIPMENT MAY RESULT IF THE DOORS ARE NOT CLOSED AND LATCHED BEFORE MOVING! Therefore, always visually verify that the doors are closed prior to moving the capsule.
2. Visually inspect the horizontal position of the carriage for approximate center. If it is too far to one end, move the carriage to approximate center via the manual Surge motor.
3. Check the side monitors for clear, and click on "HOME". The capsule will now begin to adjust itself to the correct home position at a slow speed.
It is necessary to home the capsule on each occasion before the first show, after an ESTOP or Computer Stop, and occasionally during the day, preferably during a shift change.

Automatic Operation

Upon completion of all pre-operation checks and the "homing" procedure, you will run a test ride cycle as follows:

1. Turn on the On-Board Smart Terminal
2. Insert both laserdisks into the laserdisk players.
3. Select the desired ride experience by pressing the appropriate key.
4. Verify that all motors are in the "ON" and "AUTOMATIC" modes.
5. Verify that both projectors are operating
6. Verify that your Audio system is working by manually playing the beginning of a ride (Operate Laser players only - no motion) and listening to your monitor to see if sound from the movie is reaching the capsule.
7. Verify that your 2-way communications system is working by speaking through the microphone and listening to see if your voice is reaching the capsule. You must move the top switch on the mixer from the center to the right position to do this. (Be sure to move it back, otherwise the audience will hear the control booth rather than the movie).
8. Complete the remainder of the Pre-Operation checklist provided with this manual.
MAKE SURE THE DOORS ARE CLOSED AND LATCHED AND THAT ANYONE ON-BOARD IS SECURED
9. Click on START.
The ride will now begin. You or an assistant should ride to verify proper audiovisuals and motion. If all is well, you are ready to open the ride to the public.

Special Instructions

Important - The system should be fully checked out before any customers are allowed to ride. Refer to **Section 14.0 - Check Sheets, and the Pre-Operation**

checklist provided with this manual. All appropriate checks must be performed and the ride operated through at least one satisfactory cycle prior to opening to the public.

Special Section - Portable Only

There are a number of procedures which must be followed in order to prepare the portable ES-360 for travel and for operation once it arrives at the location.

9.1 OUTRIGGERS

The trailer for the ES-360 comes equipped with four trailer pads which are used to stabilize the unit. The wooden disks which come with the unit are to be used under the outriggers and dropfoot jack, stacked to an appropriate height. The disks may not be necessary if the surface is concrete.

Upon selecting a level spot, jack up the trailer and decouple the tractor. Then place one or two disks under each outrigger and lower to a firm pressure. Important: The outriggers are not intended to lift the trailer, only to stabilize it.

Travel Braces

There are two braces which must be removed prior to operation and replaced prior to transportation. One restrains the linear movement and the other restrains the roll movement.

Prior to travel, the capsule must be moved as far forward as possible with the surge motor, which will provide just enough room at the rear to install the linear brace. Then, the roll brace should be installed.

WARNING! NEVER TRANSPORT THE UNIT WITHOUT THE BRACES INSTALLED. SEVERE DAMAGE TO EQUIPMENT WILL RESULT.

Ramps

The ramps are custom designed to travel underneath the capsule. As part of your training, you will be shown the proper manner of assembling, disassembling and packing the ramps for travel. Important: The ramps are heavy, and require two men to assemble.

General Safety and Emergency Procedures

Operator

The following information relates to the Operator's responsibilities. The Operator must:

1. Verify that the minimum daily checks have been completed.
2. Insure that the Attendants have properly assisted all riders safely into the capsule and shut and latched the doors before ride operation.
3. Monitor the capsule during each ride, staying alert for unsafe or improper behavior,

- signs of distress, lost glasses, or projector malfunction. Operating the ride must never become routine to the point inattention.
4. Be prepared at all times to stop the ride, and to execute emergency procedures if necessary.
 5. Be alert to seat belt indicators before and during ride.
 6. Be alert to any unusual noise or vibration during ride.

Senior Operator

The Senior Operator is responsible for seeing that all ride personnel are properly trained in the execution of their duties and safety procedures. He must be fastidious in insisting that all duties be executed in strict accordance with manufacturer's recommended safety protocol.

Operator's Assistant

The Operator's Assistant's duties consist of:

1. Making sure that all riders enter and exit the capsule safely, warning them to watch their step and their heads.
2. Making sure that all shoulder restraints are locked into position, and all seat belts are buckled.
3. Making sure that no observers are too near the ride, especially the moving parts.
4. Signaling the Operator when it is clear to start.
5. Being prepared at all times to ESTOP the ride, and to execute emergency procedures if necessary.

Attendant

The attendant's duties concerning rider safety are the same as those of the Operator's Assistant, with the exception that he or she may not E-Stop the ride, execute emergency procedures, or signal clear to start.

WARNING! UNDER NO CIRCUMSTANCES ARE RIDE PERSONNEL TO ENTER THE MOVING AREAS OF THE RIDE (LOADING PLATFORMS AND EITHER END) WHILE THE RIDE IS IN MOTION.

E - Stop

The ESTOP buttons are to be used at the Operator's or Operator's Assistant's discretion. Following are some, but not all, of the circumstances where ESTOP should be executed:

1. "Runaway" motion on any axis
2. Failure of any structural component
3. When life or limb may be endangered due to motion
4. When any unusual sound or vibration is detected

5. In an event where safety requires immediate cessation of the ride

Upon execution of the ESTOP function, power is cut to all motors. The capsule swings free. The vertical carriages do not drop, provided there is pressure in the pneumatic system. If the capsule is occupied, you must immediately turn on the lights and speak to the riders. In order to regain computer control, the ESTOP button must be pulled out, and the capsule must be "homed".

Note: The Operator's first option for stopping the ride should be the Computer-Stop. This is because in a Computer-Stop, the Operator retains control of the ride, whereas in an ESTOP, he does not. In a Computer-Stop, rebooting is not necessary, however the movie must still be stopped manually, the lights turned on, and the capsule must immediately be homed as soon as the motor counters stop.

Fire System

The components and structures of the ES-360 have been designed and installed to be extremely fire resistant. However, as an added precaution, the ES-360 has been equipped with the latest automatic fire suppression system available. It uses the PFC-410 extinguishing agent, which is the same agent used by NASA on the Space Shuttle. PFC-410 is noted for its extremely high safety factor and speed of extinguishing (approx. two times that of Halon, the most commonly used agent). **UNDER ALL FIRE ALARM CIRCUMSTANCES, THE CAPSULE IS TO BE EVACUATED (Section 10.7).**

The fire system is equipped with the following components:

- 3 - Photoelectric smoke detectors, two located inside the capsule and one located in each of the two electrical compartments at either end of the simulator
- 2 - 20 lb. tanks, specially designed to operate upside down, located in the aft spider section
- 4 - Flooding nozzles, located same as smoke detectors
- 1 - Manual pull station, located at the aft end of the unit
- 1 - Manual abort circuitry, actuated from the control booth computer
- 1 - Audio alarm
- 1 - Control panel with battery back-up, located inside the capsule console
- 2 - Hand extinguishers

The system is an automatic, dual-alarm system which is designed to allow manual discharge and/or manual abort. It operates as follows:

- 1) When one smoke detector is activated, the horn alarm sounds, the Operator is signaled on the control monitor, the ride stops, and the capsule returns to home. ***At this time, you must unlatch and open the doors for immediate evacuation.***

If a fire is present, the Operator's Assistant may manually discharge the system or control it with a hand extinguisher.

Important: If a major fire is detected inside the capsule, the doors must be closed prior to discharging the system to prevent escape of the extinguishing agent. ***Use a hand extinguisher rather than discharging the system whenever possible.***

- 2) When two smoke detectors activate, the system enters the automatic discharge mode. The alarm sounds, and a 30-second countdown to discharge begins. The ride stops and returns to home. As in a one-detector alarm, the capsule should be evacuated. (Note: It is anticipated that a two-detector fire would be a very rare occurrence. The automatic discharge function is designed primarily to take over in the event of a catastrophic fire, or in the event that a fire occurs while the unit is unattended).

Should the system enter the automatic discharge mode while in operation, you will have 30 seconds to evaluate whether to abort the discharge.

The ABORT function is executed by the Operator via the computer. (See Section 6.0 - Control System), and should ***ONLY*** be executed when:

- a) People are still evacuating the capsule
- b) Fire is located inside the capsule and the doors are open
- c) The situation can be controlled with a hand extinguisher

PFC-410 will normally extinguish a fire in 15-20 seconds. In the unlikely event that the system has discharged with riders inside the capsule, you should open the doors as soon as possible to ventilate, *but only after allowing 20 to 30 seconds for the agent to have extinguished a potential fire.* There is no danger in exposure to PFC-410 for this amount of time.

After an alarm, the system must be reset. To return the system to normal after an alarm:

- 1) Remove the square control panel cover located on the fore end of the capsule.
- 2) Press the RESET switch.

If the system has discharged, it must be re-charged prior to operation of the ride. Consult the list of service representatives supplied with this manual for recharging.

WARNING! NEVER OPERATE THE RIDE WITHOUT A PROPERLY CHARGED AND FUNCTIONING FIRE SUPPRESSION SYSTEM.

Maintenance of the system consists of:

- 1) Monthly checking of standby batteries for full charge (25.5 to 26V).
- 2) Monthly checking of pressure gauges of both tanks (gauges located under disk

covers on the aft end of the capsule). Indicator should be in the green. If it is not, contact the nearest service representative.

- 3) Inspection of smoke detectors every six months for dust accumulation (cleaning if necessary) and testing for sensitivity.

The two monthly checks may be performed by staff maintenance personnel. For liability purposes, the semi-annual check must be performed and tagged off by an authorized service representative. Consult the list supplied.

Important: In order to acquire a thorough understanding (including troubleshooting) of the fire suppression system, it is important that the Chemtronics™ Installation and Operation Manual, along with the appropriate supplemental material, be thoroughly digested by ride Operators and Operator's Assistants. This material has been supplied with this manual.

Evacuation

In the event that the capsule must be evacuated for any reason, immediately inform the passengers that the ride has terminated and that there will be an evacuation. Request that they stay calm, remain seated, and wait a few moments for instructions. If the capsule is in the "home position, the procedure is as follows:

- 1) Open doors using normal doors open switch. If doors do not respond, the electrical system has failed, so you use the emergency door, release crank located in the control room to remove the control pin from the doors allowing them to open freely. Inform passengers that the shoulder restraints are about to be released. Release restraints, and instruct passengers on how to raise them
- 2) Assist each passenger with their egress.

In the unlikely event that the capsule is jammed, one side's doors may be blocked closed. In this event:

- 1) Open the available doors.
- 2) Inform passengers that the shoulder restraints are about to be released, and that their belts will hold them. Release restraints, and instruct them on how to raise them.
- 3) Beginning with the rear door, instruct the passenger nearest the door to release his or her belt, and assist them in climbing out. Continue one by one until the row is empty. (The rear door is now open for a stretcher if needed). Repeat the procedure for the other rows.
- 4) Depending upon the steepness of the angle, a ladder may be required to evacuate passengers. One should be carried with portable units or stored nearby with fixed units.

If the capsule is jammed in an awkward position, or upside-down, special care and attention must be given to calming and evacuating the passengers.

- 1) Follow instructions 1,2, and 3 above.
- 2) Two attending personnel must enter the capsule, one being an Operator or Operator's Assistant, the other being one of the Assistants. They must support each passenger one by one while they unbuckle their seat belt. Once the passenger has gained his footing, he will be assisted in exiting the capsule by the two who remained outside. Repeat the process for each passenger.

Throughout the evacuation procedure, reassurances to allay feelings of panic or distress should be spoken.

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11.0

LUBRICATION

11.1 MOTORS

The four drive motors are totally enclosed and fan cooled. The bearings in the motors are sealed and require no routine maintenance.

11.2 WORM GEAR SPEED REDUCER

The worm gear speed reducer (blue box located on the fore pivoting carriage) is lubricated by the splash method. This requires that the oil level be strictly maintained as shown in the sight glass. The oil level should be inspected at least once monthly, and should always be examined with the unit stopped and in a level position.

Oil should be changed after the first two weeks of operation. Thereafter, it should be changed every 2500 hours of operation or every six months, whichever occurs first. In normal use, the six months will generally occur first.

Draining should be done after the speed reducer has been operating and the oil is fully warmed up and impurities thoroughly agitated. The drain plug should be removed promptly after the reducer is stopped so that foreign matter does not settle out. *Note: Never operate the reducer when there is no oil in the housing.*

Refill with AGMA-2EP ISO-VG-68 compound such as Chevron NL Gear Compound 68 oil (Dwg. # 700-X-011-0, Item 14).

11.3 PILLOW BLOCK BEARINGS

The rotation shaft is supported at each end in pillow block bearings. These bearings are lubricated by packing with grease. They should be re-lubricated every six to twelve months with a lithium base NLGE-2 grease (Dwgs. # 700-X-011-0, Item 10; and # 700-X-011-1, Item 8).

11.4 LINEAR SLIDE CARRIAGES

The vertical carriage runs on four (4) linear bearing carriages which must be lubricated with lithium base NLGI-2 grease every 60 days. There is a grease fitting on each carriage for this purpose (Dwgs. # 700-X-010-0, Item 13; and, # 700-X-010-1, Item 13).

11.5 CAM ROLLERS

There are three sets of cam rollers which must be lubricated:

- 1) The opposite sides of the vertical carriages are supported on cam rollers. They should be lubricated with a lithium base NLGI-1 grease through the fittings

provided every 60 days. (Dwgs. # 700-X-010-0, Item 30; and # 700-X-010-1, Item 30).

- 2) The pivot carriages pivot on large cam rollers which should be lubricated every 120 days with the same grease (Dwgs. # 700-X-010-0, Item 14; and # 700-X-011-1, Item 6).
- 3) There are two shaft support cam rollers on the drive end of the rotation shaft which should be lubricated every 60 days with the same grease (Dwg. # 700-X-011-0, Item 32).

11.6 BALL SCREW BEARING CARTRIDGE

The two vertical ball screws and the horizontal ball screw are supported on their drive end by ball bearings in a bearing cartridge. The cap end of the cartridge has a grease fitting and the opposite end of the cartridge has a relief fitting. Grease should be pumped in until it comes out of the relief fitting. These bearings should be greased every 60 to 90 days with lithium base NLGI-2 grease (Dwg. # 700-X-009-0, Items 16 sheets 1 & 2).

11.7 BALL SCREW SUPPORT BEARINGS

The other end of the ball screws is supported with either a flange bearing or a pillow block bearing. These are also lubricated with the same grease and schedule as the drive end of the ball screws (Dwg. # 700-X-009-0, Items 94 & 95).

11.8 BALL SCREWS

Important: The ball screws *must* be kept clean and rust free at all times. They should be wiped clean daily if required and should be kept oiled or greased at all times (Dwg. # 700-X-009-0, Items 19 & 22).

11.9 WAYS AND LINEAR GUIDES

Important: The ways and linear guides that the vertical carriages run on *must* be kept clean and rust free at all times. They should be oiled or greased as required (Dwg. # 700-X-009-0, Items 20 & 89).

11.10 SHOULDER RESTRAINT BEARINGS

The bearings on each shoulder restraint mechanism must be lubricated with general purpose bearing grease every three months via the fitting provided.

11.11 WHEELS

The horizontal motion of the simulator runs on a set of wheels on each corner of the

frame. These wheels are accessible through holes under removable covers on the sides of the rails. Each set consists of two large wheels supporting the vertical load, a side wheel and a top wheel. Each of the wheels has a grease fitting which should be lubricated every 60 to 90 days with lithium base NLGI-2 grease. There are sixteen (16) wheels total for all of the four corners. Also, the roller path on the I-beam bed must be kept clean and unobstructed at all times (Dwg. # 700-X-009-0, Items 96, 97, & 98).

11.13 CHAIN DRIVE - ROTATION AXIS

The final drive for the rotation is chain and sprocket. The chain should be oiled as required and should be kept clean and rust free (Dwg. # 700-X-011-0, Item 18).

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12.0

INSPECTION AND TESTS

12.1 WELDS

The following weld areas should be inspected monthly for cracking or other problems:

- 1) Cabin flange to main shaft - both ends.
- 2) Corner welds on vertical carriages.
- 3) Plate welds on pivot carriages.
- 4) Corner welds on pivot carriages.
- 5) Cabin spider structural welds

12.2 FASTENERS

The following fasteners should be inspected daily to be sure none are missing and to make sure they are tight. They should be re-torqued at least every six months or on each occurrence after an extended trip (portable):

<u>Drawing</u>	<u>Description</u>	<u>Size</u>	<u>Torque (ft-lbs)</u>
700-X-011-0	Gearbox bolts	7/8	580
"	Forward bearing bolts	1"	860
"	Motor bolts	1/2	108
"	Sm. sprocket bushing	M10	50
700-X-011-1	Aft bearing bolts	1"	860
700-XX-009-0	Cabin flange bolts	1"	860
"	Lg. sprocket bushing	M14	90
"	Ball scr. brng. block mount	5/8	210
"	Ball scr. brng. cap plate	1/2	108
"	Vert. motor bolts	1/2	108
"	Vert. scr. bearing block	1/2	108
"	Ball nut flg. and bracket	1" (shldr. bolt)	360
700-X-010-0,1	Vert. ball nut flange	3/4	360
"	Vert. ball nut bracket	1/2	108

12.3 BELTS

Each of the four motors drives a toothed belt. These belts should be inspected every 90 days for cracks or unusual wear, and to see if tightening is needed.

12.4 WIRE

The electrical wires going through the wireways or in exposed areas should be inspected every 90 days for frayed insulation or breaks due to abrasion or fatigue.

12.5 FLOW RESTRICTOR (DAMPING) VALVES

There are flow restrictors built into the pneumatic system (items 31 on drawing 700-X-007-0) which provide cushion for vertical E-Stop. They should be locked open at 3/4 of a turn from full closed. This should be checked every three months, or after any travel (portable).

12.6 DRAINING WATER

The main filter should drain automatically, however it should be checked each day to be sure it is working by noticing water on the deck. The two main tanks should be drained daily of any residual water that may have accumulated. Also, there are two petcock drain valves located at the aft bottom of the capsule which should be opened daily to allow all water in the system to drain.

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MOTION SYSTEM TROUBLESHOOTING

Problem	Cause	Solution
Rotational movements perform erratically and/or program.	Encoder sensor has moved, or has lost its reference point	Sensor position must be readjusted. Call company for support.
Axes motor not working.	Main power fuses blown.	Check and replace faulty fuses.
	RAC circuit breaker tripped.	Reset circuit breaker.
	24 VDC power supply is bad.	Check and replace if voltage is out of tolerance (Wire #'s 24 & 25).
	Faulty Emergency Stop Relay 100 CR	Check and replace if bad. Relay contact must be closed for motor to be enabled.
	Spindle brake energized.	Release brake.
	Defective drive	Repair or replace.
	Faulty ESTOP or over-travel switch	Check circuit continuity for the ESTOP circuit, which connects to the 100 CR relay.
	Faulty Indramat power supply circuit board.	Replace board (see *below).

Check for mechanical binding condition.

Check connector X15, pins 1, 2, 3, & 4 referenced to pin 9 and verify that the 24 VDC is present.

Check connector X2, pins 19, 23, 24, & 25 referenced to pin 1 and verify that 24 VDC is present.

Verify that the Mode Select switch is in the Parameter Mode position.

Check for correct incoming main 3-Phase power.

* **Important:** It is possible to temporarily operate the ride for the public without the Surge function. Should one of the motors other than the Surge motor go down during a business day as a result of a faulty motor controller power supply board, you may replace the faulty board with the functional one from the Surge motor controller and continue operating the ride for a short time until a new board arrives from Indramat (Delta Dash or other airline counter-to-counter service is the fastest means of shipment).

The power supply board is the uppermost circuit board you see when the front cover of the motor controller is removed. If the other troubleshooting tests have not isolated the problem, contact the Company for instructions on how to test this board for defect.

Problem	Cause	Solution
The motor is enabled, but does not respond to the velocity command.	Faulty motor interface board or cable.	Check board and verify cable connection.
	Faulty feedback cable.	Check feedback cable for a good connection.
		Set RAC's LCD display to "C" mode and check for a good connection.
		Check for any mechanical binding, including the holding-brake being energized.
The axis does not complete a "home" cycle.	Faulty OPTO22 IDC5 module.	Check and replace if faulty.
	Axis cam is not actuating the switch.	Check for correct alignment

Problem	Cause	Solution
	Faulty motor interface board and/or 5 VDC power supply.	Replace if faulty.
	Faulty 24V power supply.	Replace if faulty.
Motor is oscillating.	Motor feedback cable is in bad condition.	<p>Replace cable or tighten connection.</p> <p>Check the velocity command and verify it is not the cause of the instability.</p>
The motor does not reach the command speed.	Motor feedback cable is in bad condition.	<p>Replace cable or tighten connection.</p> <p>Check the motor power cable.</p> <p>Set the LCD display to "M" and verify smooth and even number display.</p> <p>Consult the Rexroth/Indramat manual for more detailed diagnostic information on the RAC motor drive.</p>

PNEUMATIC SYSTEM TROUBLESHOOTING

Insufficient air pressure .	Compressor not working.	Check power to compressor. Repair compressor if needed.
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Problem	Cause	Solution
	Air leakage in system.	Locate leak (usually found by locating hissing sound) and repair or tighten.
	Air regulators mal-functioning or are improperly set.	Reset or repair as needed (Refer to Sections 8.5 & 14.7).

TRAILER TROUBLESHOOTING

(to be supplied by Oceana)

ELECTRICAL SYSTEM TROUBLESHOOTING

If an electrical malfunction is indicated, the system electrical schematic should be referred to. A few quick checks at the pertinent terminal strip with a meter will normally identify any problem.

Generator does not start.	Batteries low	Jump start from other batteries.
	Battery Cable(s) loose	Tighten cable(s)

Problem	Cause	Solution
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AUDIOVISUAL SYSTEM TROUBLESHOOTING

In the event of a problem, the first course of action is to determine whether it is stemming from a component malfunction, or if the problem lies within the specific system to which the component is applied in the ES-360. This is not always immediately evident. It can be generally assumed, however, that unless a problem is clearly coming from an internal component malfunction, or from a simple loose connection, its source probably lies in the wiring, communications network, commutator, or other specific design characteristics of the simulator. This guide presumes that the component has been found to have no apparent internal malfunction, and that loose or frayed connections and wires have been eliminated as the potential source of the problem.

Laserdisk player will not accept disk.	Small plastic hooks inside unit have come loose.	Remove front cover, look for two white hooks on either side of unit. One may have slipped from its gear. Re-position on it's gear and tighten screw.
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(to be continued by Loran, Bert, JB)

CONTROL SYSTEM TROUBLESHOOTING

Describe problems such as failure of unit or component to respond to a command, etc. - J.B., Amber, Loran)

Monthly Maintenance #1	Date						
Generator							
Change oil, oil filter and fuel filter (200-250 hrs.)							
Cabin							
Check shoulder restraint assemblies, solenoids, pins and clips							
Check seatbelts, cables and fasteners							
Check that seatbelts register on computer monitor							
Check door pneumatic cylinders, clips and pins							
Check upper fans in front of cabin							
Check that floor bolts to seats are tight							
Front Tower							
Check welds on vertical carriage							
Check plate welds on pivot carriage							
Check corner welds on pivot carriage							
Check oil level blue speed reducer gear box							
Rear Tower							
Check welds on vertical carriage							
Check plate welds on pivot carriage							
Check corner welds on pivot carriage							

Monthly Maintenance #2	Date

Bi Monthly #1							
Front Tower							
Lube slide bearings (2 top, 2 bottom)							
Lube roller bearings (2 top, 2 bottom)							
Lube vertical ball screw bearing							
Lube vertical ball screw cap bearing							
Lube horizontal (surge) ball screw bearing							
Horizontal ball screw cap sealed. No need to lube							
Lube pivot bearings (1 left, 1 right)							
Lube shaft support cam roller bearing on rotational shaft (behind large rotational gear)							
Check oil level big blue speed reducer gear box							
Oil rotational chain							
Oil rotational gears (1 top, 1 bottom)							
Check big blue pneumatic cylinder							
Check blue pneumatic flow restrictor valve (3/4 turn from full closed)							
Check all welds front tower							
Check rubber bumpers (3 top, 4 bottom)							
Check motors (3) and mounts (3) (rotational, vertical, horizontal)							
Check motor belts (3)							
Check all wires and wireways front tower							
Clean and oil vertical ball screw surface							
Clean and oil horizontal (surge) ball screw surface							
Clean and oil slide surfaces (2)							
Clean and oil roller path surfaces (2)							
Check vertical over travel and reference switches							
Check horizontal overtravel and references switches							

Bi Monthly #1							
Bi monthly #2		Date					
<i>Rear Tower</i>							
Lube slide bearings (2 top, 2 bottom)							
Lube roller bearings (2 top, 2 bottom)							
Lube vertical ball screw bearing							
Lube vertical ball screw cap							
Lube pivot bearings (2)							
Check big blue pneumatic cylinder							
Check all welds rear tower							
Check rubber bumpers (3 top, 4 bottom)							
Check vertical motor and mount							
Check vertical motor belt							
Check all wires and wireways rear tower							
Check commutator							
Clean and oil vertical ball screw surface							
Clean and oil slide surfaces (2)							
Clean and oil roller path surfaces (2)							
Check vertical overtravel and reference switches							
<i>Travel wheels</i>							
Grease travel wheels right front (4)							
Clean travel wheels and wheel paths right front							
Grease travel wheels right rear (4)							
Clean travel wheels and paths right rear							
Grease travel wheels left front (4)							
Clean travel wheels and wheel paths left front							
Grease travel wheels left rear (4)							
Clean travel wheels and wheel paths left rear							

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Quarterly	Date					

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