

X  
MFG: ENGINEERING TECH. INC.  
NAME: MOTION SIMULATOR  
TYPE: NON-KIDDIE

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**ENHANCED SIMULATION, L.L.C.**

**ES-360**

**OPERATION**

**AND**

**MAINTENANCE MANUAL**

# TABLE OF CONTENTS

<u>SECTION</u>	<u>PAGE</u>
1.0 SPECIFICATIONS.....	4
2.0 GENERAL INFORMATION.....	5
1.1 INTRODUCTION.....	5
1.2 WARRANTY.....	5
1.3 PARTS SUPPLIED.....	5
1.4 ABOUT THIS MANUAL.....	6
1.5 ABOUT SAFETY.....	6
3.0 PHYSICAL STRUCTURE AND MECHANICAL SYSTEMS.....	7
3.1 MOTION SYSTEM.....	7
A. Maintenance.....	
B. Troubleshooting.....	

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## SECTION

1.0

## 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: Engineering Technology, Inc.  
2975 South, 300 West  
Salt Lake City, UT 84115

Ride Speed: Heave (vertical) - 60" per second, or 12 degrees tilt per second  
Surge (forward and backward) - 30" per second  
Rotary - One revolution in 2.7 seconds (42 R.P.M.)

Passenger Capacity: 16 maximum

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

Ride Duration: 3 1/2 - 4 minutes (programmable)

Balance of Passenger Loading: Immaterial

Environmental Restrictions: Not recommended for operation during high winds

Passenger Restrictions: Minimum height requirement of 40"

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

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

	<u>Operational</u>	<u>Non-Operational</u>
<u>Height:</u>	16'	13'
<u>Width:</u>	10'9" (without ramps)	8 1/2'
<u>Weight:</u>	28,500 lb. (fully occupied)	26,000 lb.

Trailer (portable only): Height - 13 1/2' Width - 8' 6" Length - 52.2' Weight - 11,000 lb.

## GENERAL INFORMATION

### 2.1 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 a family amusement ride which provides a thrilling experience by combining screen-projected 3D 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.

ES produces their simulator adventures in-house through their production company, Multi-Dimensional Studios, L.L.C. They use a patent-pending 3D video system known as CineMajic™ and an optional AudioMajic™ 3D audio system in their productions. These systems greatly enhance the realism of the experiences. The simulator is available in either a fixed or portable configuration.

### 2.2 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 on 48 hours notice for on-site service for qualified warranty claims and under the terms of annual service contracts provided by ES after warranty expiration. Qualified technicians and specialists from independent service companies located throughout the world are also available for servicing ES components. ES can assist the operator in locating such service companies at the time of sale or installation.

### 2.3 PARTS SUPPLIED

All parts necessary for the initial operation of the system as contracted are supplied with each simulator. Also included with each system are the manufacturer's manual, and manuals provided by component part manufacturers to assist with operation and maintenance of parts and systems. A basic inventory of maintenance and spare parts for components is also maintained at the manufacturer's headquarters in Salt Lake City, UT, USA, for shipment worldwide.

## 2.4 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 prior to releasing the unit.

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 continued trouble free operation.

ES provides technical consulting during site planning, design and installation as well as at the time of system testing and training of on-site operating and maintenance personnel.

Although the manual should generally provide the answers necessary to solve most problems, it is equally important that the owner/operator thoroughly familiarize himself with the manuals provided by the manufacturers of all component parts of the ride. When needed, ES technicians and consultants are always available by phone, fax, or in person.

## 2.5 ABOUT SAFETY

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

### 3.0

## PHYSICAL STRUCTURE AND MECHANICAL SYSTEMS

### 3.1 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 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 1/2 feet. Fixed units have an optional additional heave capability of up to seven feet and surge of up to five feet. These combined motions make it possible to perform high banking and rolling maneuvers, thereby simulating air combat, river rafting, roller coasters, space flight, and other diverse activities more realistically than ever before possible.

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 ballscrew actuators which move the cabin up or down. Limit switches to prevent overtravel are built in. These switches kill power to the motors and apply dynamic braking in the event a command glitch 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 ballscrew 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 chain and sprocket mechanism. 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. There is a worm gear speed reducer used on this axis, located on the fore pivoting carriage.

Both ends of the capsule pivot and the rear shaft also slides <sup>back and fourth</sup> on lateral bearings.

*This design allows complete freedom of movement in every direction, and is unique to the ES-360 simulator.*

A. Maintenance

Refer to Sections 11.0 - Lubrication, 12.0 - Inspection and Tests, and 13.0 - Check Sheets.

B. Troubleshooting

Problem	Cause /Solution	
Rotational movements perform erratically and/or do not follow program.	Encoder sensor has moved, motor has lost its reference point. Sensor position must be readjusted. Call Company for support.	
Axis 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 E-Stop or over-travel switch.	Check circuit continuity for the E-Stop circuit, which connects to the 100 CR relay.
		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.

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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.

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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.

Faulty motor interface board and/or 5 VDC power supply.

Replace if faulty.

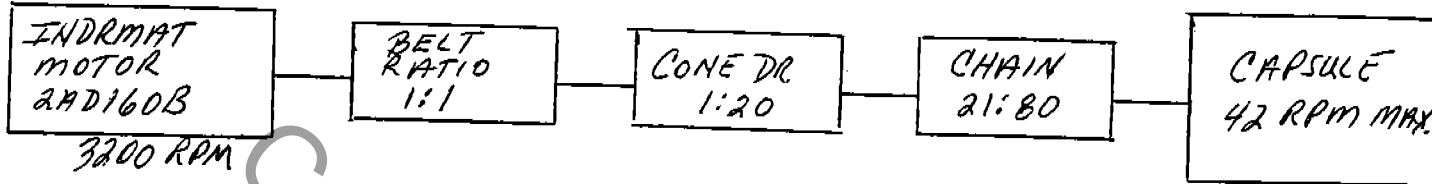
Faulty 24V power supply.

Replace if faulty.

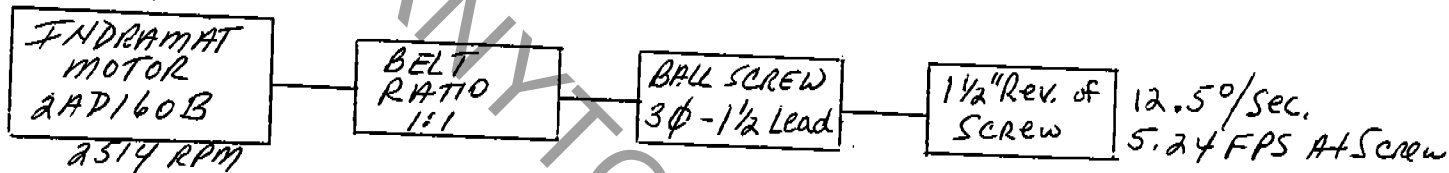
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# ES-360 Motion Schematic

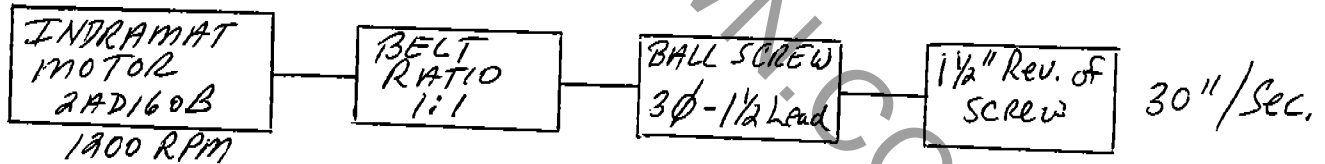
## Rotational Axis



## Heave Axis (2)



## Surge Axis



### 3.2 CAPSULE

The ES-360's fully enclosed capsule is constructed in one piece using a process known as Filament Winding. This space-age process involves wrapping or winding a resin-bathed filament in a computerized pattern around a turning mandrel, or mold, which is formed in the shape of the capsule. When the process is complete, the mandrel is removed, leaving a extremely sturdy shell that lighter than steel. This construction method is less expensive, faster and stronger than traditional methods of construction, and has never before been applied to an amusement device.

The interior structures of the capsule are bonded rather than bolted into place which virtually eliminates stress points. The only structural bolts used are to attach the spiders to each end of the capsule, to hold the projectors, and to hold the seat mounts. 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 unit located in the fore section behind the screen. It is also equipped with two powerful air fans which are used for environmental effects during the ride.

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, ~~with pneumatic hand holds~~. Staggered placement assures that each seat has optimal viewing.

The four doors on each side are pneumatically actuated. Rear doors are wider to accomodate the physically impaired.

The floor and 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 ~~410~~ PFC-410 extinguishing agent.

The exterior of the capsule can be customized or themed according to need or preference.

### 3.3 PNEUMATIC SYSTEMS

Most of the weight of the capsule rests on two large pneumatic cylinders, one at each end of the cradle, with two lift support tanks mounted underneath. This system counterbalances and cushions the motions of the ride, making the experience not only more realistic, but safer and more comfortable than other

simulator rides. It also serves to reduce the load on the motors and actuators, adding to their life and to the life of the unit in general.

Two additional pneumatic systems actuate and latch the doors, ~~and also release the shoulder restraint latches~~. All systems are serviced by a single air compressor and are equipped with pressure monitoring sensors which warn of leakage and automatically stop the ride if the pressure should drop too low.

For safety purposes, the door lift system can ~~also~~ be operated both from the control room and manually via a lever mounted outside the capsule.

Note: The door latches are designed to unlatch in the *absence* of air pressure. Therefore, in the event of pressure loss, the doors are able to be manually opened for evacuation.

A. Maintenance

Refer to Sections 11.0 - Lubrication, 12.0 - Inspection and Tests, and 13.0 - Check Sheets.

B. Troubleshooting

Problem	Causes	Solutions
Insufficient air pressure	Compressor not working	Check power to compressor. Repair compressor if necessary.
	Air leakage in system	Locate leak (usually found by locating hissing sound) and repair or tighten.
	Air regulators malfunctioning or are improperly set	Reset or repair as needed (Refer to Sections 8.5 & 13.7)

Motor is oscillating.

Motor feedback cable is  
in bad condition.

Replace cable or tighten  
connection.

Check the velocity command  
and verify it is not the cause  
of the instability.

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The motor does not reach  
the command speed.

Motor feedback cable is  
in bad condition.

Replace cable or tighten  
connection.

Check the motor power cable.

Set the LCD display to "M"  
and verify smooth and even  
number display.

Consult the Rexroth/Indramat  
manual for more detailed diagnostic  
information on the RAC motor drive.

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### 3.4 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 type.

When the rider enters the capsule and takes <sup>raised</sup> their seats, the shoulder restraints are in the ~~up~~ position. They are instructed to buckle their seat belts. They are then instructed to first PUSH UP on the shoulder restraint, 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 switch inside the Control Booth. 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 absense of power provides the release function so<sup>^</sup> 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 are locked down mechanically and require the PULL DOWN motion to release them, the restraints will not release and fly up in the event of a power failure).

#### A. Maintenance

(Refer to drawing # \_\_\_\_\_)

There are several ~~check~~ 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 Nylock nuts, and should be as tight as possible.
- 2) Visually check to verify that the four screws which hold the solenoid onto the ratchet assembly have not come loose. Note: The solenoid assemblys 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 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.

In addition, the bearings on each restraint assembly must be lubed quarterly with general purpose bearing grease. A zerk fitting is provided for this purpose.

Note: The recommended frequency of these checks is considered to be conservative, however actual operator experience may require them to be performed either more or less frequently.

### 3.5 TRAILER

In its portable configuration, the ES-360 includes a 52-foot trailer with a built-in generator room, control room, concession/ticket sales booth, storage space, and mountings for the motion base and capsule. The trailer is also equipped with hydraulic outboard support rigs and ingress/egress access ramps.

#### A. Maintenance

(to be supplied by Oceana)

B. Troubleshooting

Problem	Causes	Solutions
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(to be supplied by Oceana)

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## 4.0

### ELECTRICAL SYSTEM

#### 4.1 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 110 volt circuits. The generator is battery-started. Two separate batteries are used to power the interior lights, and can also be used to jump start the generator if necessary. *CR. this*

Further detail regarding power distribution, safety precautions, and a complete electrical schematic are provided in subsequent sections of this manual. Component information is provided in the owner's manuals.

#### A. Maintenance

Refer to Sections 12.0 - Inspection and Tests, and 13.0 - Check Sheets.

Also refer to Kohler Power Systems - Owner's Manual and Technical Information.

(Additional information to be supplied by EnTec)

#### 4.2 INTERNAL COMPONENTS

Following is a list of the electrical components located inside the capsule:

- 1) 2 - Sharp 850 video projectors
- 2) 1 - Air conditioner (115 VAC, 6.3 amp running)
- 5) 2 - Dayton Mdl.4C445A air blowers (115 VAC)
- 6) 2 - Audio power amps, with 12-band stereo equalizer
- 7) 3 - Smoke detectors
- 8) 1 - Extinguisher activation relay
- 9) 1 - Video monitor camera *Recommend ignored*
- 10) 16 - Seat belt fastened / rider count switches
- 11) 16 - Seat occupied switches ?
- 12) 16 - Solenoids for shoulder restraint latch/unlatch
- 13) 16 - Multi-Active™ switch circuits
- 14) 10 - 5-VDC to 115-VAC relays
- 15) Interior lighting
- 16) Solenoid valves for doors (115 VAC)
- 17) Fuses and breakers for 115 VAC componets

#### A. Maintenance

Maintenance of internal components should be conducted according to manufacturer's recommendations. Also refer to Section (13.0) - Check Sheets.

#### B. Troubleshooting

Note: In the event of a problem, the possibility of component malfunction should first be eliminated. The first course of action should be to refer to the appropriate owner's manual. This guide presumes that the component has been found to have no apparent internal malfunction.

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.


Problem

Causes

/ Solutions

(to be supplied by Entec, Loran, Bert, ~~Kyle~~)

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4.3   
28

**EXTERNAL COMPONENTS**

Following is a list of the electrical components located outside the capsule:

- 1) 4 - Motors
- 2) 1 - Rotation calibration switch
- 3) 1 - Surge calibration switch with optical isolator
- 4) 2 - Surge limit switches with relays
- 5) 2 - Heave calibration switches with optical isolators
- 6) 2 - Heave limit switches with relays
- 7) 4 - Low air pressure switches
- 8) 1 - Solenoid lock for high voltage compartment
- 9) 1 - 24 volt power supply
- 10) 1 - Control booth air conditioner / heater

- 11) Control booth lighting and 110 volt outlets
- 12) 1 - Air compressor, with low pressure and start / stop switches

A. Maintenance / Troubleshooting

The above components should require no maintenance under normal operating conditions, except in the event of malfunction. Malfunction of any of these components will manifest either in the form of a message on the control monitor, or in some form of equipment failure. Proper response to such failure or message is covered in other troubleshooting sections of this manual.

4.4 THE COMMUTATOR

Delivery of power and low-level (video, audio, control) signals to components located inside a rotating capsule presents an obvious mechanical problem. This problem is addressed through the use of a device known as a "commutator". A commutator is a cylindrical device with electrical poles at each end, constructed so that one end is able to rotate (see figure 1). The connections are maintained during rotation through segregated, gold plated slip rings inside the commutator's sealed housing.

The ES-360 uses a single 24-pole commutator, located at the aft end of the capsule, to deliver electrical signal to the capsule's interior. The poles are assigned as follows:


- update
- Video Signal - 6 poles (red, green and blue for each of two projectors).
  - Audio Signal - 2 poles (stereo).
  - Control Signal - 3 poles (transmit, receive, ground).
  - A.C. Power - 5 poles (two 30-amp / 110 volt circuits, plus common ground).

Note: Since so many of the ES-360's functions are transmitted through the commutator, the proper functioning of this component is obviously critical. The commutator is designed and constructed to withstand the rigors of extended operation and travel, however, as in any mechanical system, it is not necessarily immune to failure. Commutator failure could manifest in any number of ways. However, because of the inherently sturdy nature of the device and the care with which it has been installed, a commutator failure would be a very unusual occurrence. Therefore, every other possibility for a problem should be explored and eliminated prior to considering removal or replacement of the commutator.

Figure 1  
**24-POLE COMMUTATOR**  
**USED IN THE ES-360 SIMULATOR**

(INSERT DIAGRAM)

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4.5 

**THE UPS SYSTEM (UNINTERRUPTABLE POWER SUPPLY)**  
The Surge Pro™ UPS system is designed to last for many years, protecting your equipment from powerline dips, surges, spikes, and power outages.

(additional information to be supplied by Loran and/or manual)

A. Maintenance/Troubleshooting

Refer to Surge Pro™ owner's manual

**CAUTION: THIS SYSTEM CONTAINS POTENTIALLY HAZARDOUS VOLTAGES AND BATTERYS, SO THE OUTPUT MAY BE LIVE WHEN DISCONNECTED FROM THE POWER SUPPLY.**

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## AUDIOVISUAL SYSTEM

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

ES chose 3D 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 3D does. The combination of realistic video and 3D depth of field makes for an exciting and realistic visual experience.

The audience wears specially designed circular-polarized glasses which, unlike traditional 3D glasses, maintain the effect regardless of head movement. Circular polarization is critical for effective 3D 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-Sony CRV laser videodisk players
- 2) 2-Sharp 850 LCD video projectors
- 3) Compound Curved vinyl screen
- 4) Proprietary microcontroller
- 5) 3D glasses and sanitizer

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

## 5.2 FUNDAMENTALS OF 3D VIEWING

In order to fully understand and preserve the the video experience provided in the ES-360 simulator, it is important to become acquainted with the fundamentals of 3D 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, 3D 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 3D 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. The procedure for adjusting convergence is as follows:

(Loran to supply)

### 5.3 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 3D glasses is configured so that each eye sees only its own image. The brain interprets this as normal sight, and the magic of 3D is created!

A special feature of our CineMajic™ glasses is that they are "circular polarized". This simply means that, unlike most other 3D applications, they hold their 3D 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 2D using one projector, thereby  
← preventing downtime.

A. Maintenance (Refer to M4316. Manuals)

(Loran-what is status of sanitizing glasses?)

B. Troubleshooting

Problem	Causes	Solutions
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. Reposition on its gear and tighten screw.

(to be continued by Loran, Bert, EnTec)

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#### 5.4 AUDIO SYSTEM

The ES-360's audio system is designed to deliver high-fidelity digital Surround Sound as well as vibrational effects. There are four <sup>Bose</sup> ~~8" Festex~~ wall-mounted speakers, two in the fore section and two in the aft, plus two JBL sub-woofers mounted in the front which are used to accomplish this purpose. The system is powered by two Hafler power amps ~~delivering~~ <sup>which deliver</sup> a combined 7400 watts of power, and is enhanced by stereo 12-band equalization. ) CK.

The recording process used on some of the ES-360 experiences is known as Audiomajic™, which is a trade name for Multi-Dimensional Studios' patent-pending technique of spacially-precise 3D recording.

Original music and/or scripted voice-over accompanies each simulator adventure.

#### A. Maintenance / Troubleshooting

No routine maintenance is required. See Section 3.2C - Internal Components Troubleshooting.

#### 5.5 MONITORING SYSTEM

The control booth operator is able to monitor the interior of the capsule during the ride by way of a broadcast signal from a camera positioned inside. The operator also has two-way 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~~ or before the ride. He may deliver a reprimand or instruction if necessary, or abort the ride. Should a ride abort 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.

#### A. Maintenance

No routine maintenance is required.

#### B. Troubleshooting

(Loran) / J. B.

CONTROL SYSTEM

## 6.1 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 door operation, shoulder restraint latch and release, ride commence, manual abort, manual axis operation, and fire discharge abort. Still other functions may operate either automatically *or* manually, such as ride abort, fire system discharge, and independent motor operation.

The Control System is also 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, axis position, and warnings of certain mechanical and electrical malfunctions.

In addition to the automatic functions, the main mechanical and electrical functions of the ES-360 can be operated manually from the keypad and/or mouse. This is important for testing the functions prior to operation, for examining, repairing or adjusting functions independently, for charging the pneumatic system ~~(Section 8.4)~~ (Section 8.4), and for maintaining Operator control in the event of unscheduled ride cessations or emergencies.

6.2 CONSOLE

The unit comes equipped with a Pentium 90 mhz. PC, a 17" high-resolution monitor, an input/output board, 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) A proprietary microcontroller capable of organizing and executing the sequence of      (#)      discrete events.
- 3) (?) etc.

These      modules provide the user with the means of precisely controlling the ES-360 experience, as well as automatically monitoring and executing its safety functions. As an option, the open architecture of the program and its associated hardware permits the expansion of its control capabilities to      additional discrete events.

*Is this language appropriate?*

Designed to be operated through a logically arranged screen menu, the operation of the ES-360 is a fast and simple procedure. The ES-360 comes with factory-installed programs which perform their complex functions almost automatically. During operation, their progress is constantly monitored and displayed on the color screen through simple graphic symbols and annunciators. The programs' comprehensive error checking prevents the operator from issuing the wrong instruction or command.

The control program performs lightning fast, real-time routines that insure precise synchronization with the predetermined motion and event programs.

The motors are controlled and their positions monitored by way of a counting system. Through a device called an "encoder", each revolution of the motor is divided into a certain number of "counts" which are in turn read by magnetic sensors positioned nearby. Based upon a "zero" reference point, this provides the feedback information needed to properly position the capsule during programming. The counts for each motor are displayed on the monitor, giving a continuous numerical readout of the position of each axis. They will be seen to be rapidly and continuously changing throughout the ride.

(more detail from Amber and J.B.)

↑  
on the  
monitor

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6.3  
2

## Functions

The control system operates the following functions:

- Open ingress doors (operator executes)
- Detect filled seats
- Detect seat belt attachment
- Latch shoulder restraints (operator executes)
- Close ingress doors (operator executes)
- Begin Show
  - 1) Shut off air compressors and interior lights
  - 2) Operate both projectors
  - 3) Operate sound system
  - 4) Operate each of four motors
- Terminate show (lock cabin in "~~home~~" <sup>home</sup> position, turn on interior lights)
- Start air compressors
- Unlatch shoulder restraints (operator executes)
- Open egress doors (operator executes)
- Close egress doors (operator executes)
- Repeat cycle

The system also monitors door closure, <sup>↖?</sup> fire system functions, and pneumatic pressure, disables the keypad control of the doors during the ride cycle, and operates the fans and air conditioner.

A message box <sup>on the Control Booth monitor</sup> flashes ~~amber~~ indications of possible malfunctions or safety concerns. These messages are:

- 1) Pressure Low? - Indicates that pressure may be low in the pneumatic system, ~~which actuates the doors and/or door latches~~. Check the gauges to confirm, and suspend the ride if one or more of them reads low. Check for air leak (Section 3.3 C).
- 2) (To be supplied by Amber)

3) etc.

6.4  
~~6~~

#### Multi-Active™ Interface

The ES-360 is the first truly interactive multi-seat simulator in the world. Its control system is designed to allow riders to interact with the Multi-Active™ show by prompting each rider to make a decision using a button on his or her harness as to which of two "places" (ie., planets, tunnels, islands, etc.) the ride will take them next. If no selection is made, the computer chooses a default. This optional feature immerses the rider in the experience and increases repeat ridership since the adventures will virtually never be the same twice.

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SAFETY FEATURES

Redundant self-monitoring and sequential event circuitry combined with a thorough operator training course insure the complete 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 pneumatically 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 pneumatically by the operator. Lap belt switches are wired with seat switches so that occupied seats must have their belts buckled before the ride will start. Lap belt switches also count the riders.

2) Operator has full view of the cabin interior at all times, as well as two-way communications.

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 if necessary (unbuckling presents no danger to the riders, as the shoulder restraints are more than adequate to hold them in their seats).

4) The ride cannot be started until the doors are closed. The pressure used to close the doors is not sufficient to injure a rider's fingers. Pneumatic door closure and latching is executed by the operator, not automatically. Keypad control of the door and shoulder restraint release functions is electronically disabled while the ride is in motion to prevent accidental release. Both the restraints and the doors can be manually released by way of valves located outside the cabin. Door latches are designed so that application of air pressure latches them and absence of air pressure unlatches them. This prevents trapping riders inside in the event of a loss of pressure.

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 any possibility of movement of the cabin during passenger loading and unloading. To start each ride, the operator must re-enable the motor drives via a manual switch. Note: The "start" command is subject to the conditions described in 3) and 4) above. In the event of a situation where the friction brake has been rendered inoperable (ex. power failure), a backup manual braking mechanism is engaged to lock the cabin into place for evacuation.

6) The ride is always operated by two people. There are five E-stop buttons, one located inside the control booth and one on each corner of the exterior structure. There are also two manual fire pull stations located on either end of the capsule. The control booth operator has mirrored viewing of the ride's exterior. Two additional attendants assist with passenger ingress and egress.

- 7) Pressure monitoring sensors are installed at both ends of the door pneumatic system. If pressure drops on this system while the ride is in motion, the compressor automatically turns on. If pressure falls below a predetermined threshold of safety, a message appears on the control booth monitor and the ride automatically terminates. The cabin returns to the "home" position. Note: Even if a pneumatic line were to be completely severed, it takes 15 to 20 seconds for the pressure to bleed off. The return of the cabin to the "home" position takes only 3 to 4 seconds. Visual pressure monitoring gauges for the systems are also built in, and are routinely checked as a part of the daily protocol.
- 8) An automatic fire extinguishing system protects both the cabin interior as well as the two electrical compartments. It is equipped with photoelectric smoke detectors, dual horn/strobe alarms, two manual pull stations, and it utilizes the latest and safest extinguishing agent available. Two hand extinguishers are also supplied.
- 9) Both the computer control system and the fire system are battery-backed.
- 10) The cabin structure is designed and built with high safety/low stress factors. The filament winding system produces a unibody structure that is extremely sturdy yet lighter than steel. The interior structures are bonded rather than bolted into place using 4000 p.s.i. adhesive. All internal materials are either nonflammable or U.L. fire rated.
- 11) The off-center axis, seat construction, and speed of revolution were precisely calculated so that during the revolution, the centrifugal force tends to hold the riders in their seats.
- 12) The ballscrew 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 of a command glitch, thereby assuring that the cabin 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, thus lessening the possibility of neck and back strain. 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,

and is also equipped with emergency lighting. It automatically returns to the "home" position in the event of any unscheduled cessation of the ride.

16) A training course in the operation of the ES-360 simulator, complete with drills in emergency procedures, pre-operation systems check, inspections, maintenance, and trouble shooting is provided on-site by qualified company personnel prior to the release of the unit. In addition, R.C. Fussner & Associates, Inc., the recognized industry leaders in amusement ride safety engineering and loss prevention, have been intensively involved as design consultants. They are dispatched to each location prior to the unit's release to assure safety of installation.

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## START-UP AND OPERATION

### 8.1 RIDE PERSONELL

There are four ride personell designations: Operator, Chief 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.

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

### 8.2 POWER UP

After all daily Mechanical and Electrical checks have been completed (Sections 13.1 & 2), power up the simulator either by switching the master switch on the generator control unit to "RUN" (portable) or by turning on the main power switch (fixed). This will supply power to all electrical components and outlets in the simulator, and will automatically turn on the air compressor.

After the unit has been powered up, you will immediately turn on the Control System computer. The computer automatically "boots up" to the Control program. At the same time, you will turn on the laser disk players, video monitors,

sound systems, UPS system, and all other control booth components. Power to the Control components is fed by power strips so that they can all be turned on with two or three switches.

When the Control System is turned on, you will be looking at the screen pictured below.

(Printout of screen, with arrows and descriptions of graphics/functions)

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### 8.3 MANUAL OPERATION

The functions of the ride which can be manually actuated by keypad and/or mouse commands are:

<u>Function</u>	<u>Key</u>	<u>Mouse (Y or N)</u>
-----------------	------------	-----------------------

Acquaint yourself with each function of the ride by executing them manually one by one and observing the machine's response. (Your Trainer will be present for this orientation). These manual tests are also performed as part of the daily system checks.

A. Motors

(instructions)

B. Doors

(instructions)

C. Shoulder Restraints  
(instructions)

D. Interior Lights  
(instructions)

E. Laserdisk Players  
(instructions)

(etc. ?)

#### 8.4 PNEUMATIC PRESSURE

After the unit has been powered up, the air pressure in the pneumatic system must be allowed to build to its proper level prior to automatic operation of the ride. This is accomplished as follows:

- 1) Raise both ends of the capsule to their full vertical height via the appropriate manual motor control function keys.
- 2) Allow the system to pressureize while you continue your other daily checks (Sections 13.3-6 & 13.8-14). When you observe that the pressure in the lift support tanks has reached 120 p.s.i. (guage located on deck at aft end next to tank), lower the capsule to the "home" position. This will force air back into the tanks, raising the pressure in them to around 150-160 p.s.i. **This is the proper level for operation.**

- ENTEC
- 3) At this time, you will check the air pressure guages regulating the other systems, i.e., the door latching guage and the door lift guage located in the aft end of the capsule under disk-covered "peepholes" (See drawing         ), and the          guage located on the deck, kitty-cornered from the tanks guage. You will as also complete the other pneumatic systems checks at this time (Section 13.7).

**Important:** Refer to Pneumatic Schematics, Dwg. # 700-X-007-0, 1.

#### 8.5 AUTOMATIC OPERATION

Upon proper completion of all pre-operation procedures and checks, you will then run a test ride cycle as follows:

- 1) Insert both laserdisks into the laserdisk players
- 2) Select the desired ride experience by.....(etc.)
- 3) Verify that all functions are in the "Automatic" mode

(to be continued by J.B. and Amber)

## 8.6 SPECIAL INSTRUCTIONS

(J.B. Amber, Loran, etc.)

**Important** - The system should be fully checked out before any customers are allowed to ride. Refer to **Section 13.0 - Check Sheets**. All daily and/or interim checks must be performed and the ride operated through at least one satisfactory cycle prior to opening to the public.

## 8.7 SHUT-DOWN

(proper order/protocol to follow in shutting down ride? Loran)

## 8.8 TROUBLESHOOTING

Problem	Causes	Solutions
---------	--------	-----------

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

**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 hydraulically powered outriggers which are used to stabilize the unit. It is also equipped with a dropfoot jack and sand shoe, also hydraulically powered. 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. It is not advisable to apply too much pressure to these supports.

After the unit is supported, release the air from the rear axel air bags at the petcock near the left rear tires. **Important:** Be sure to do this before you have lowered and pinned the rear steps into place.

**9.2 TRAVEL BRACES**

There are three braces which must be removed prior to operation and replaced prior to transportation. Two support the capsule vertically and are designed to fit over the rubber bumpers at either end. One is designed to prevent lateral movement and fits between the front of the trailer and the rear of the carriage.

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 lateral brace. Then, the fore and aft vertical braces are installed as follows:

- 1) Raise the capsule high enough to insert the pin lock. This will prevent any possibility of the capsule accidentally dropping while the brace is being installed. Note: This is only a concern while installing the fore brace, as installing the aft brace does not place the individual underneath the capsule.

- 2) Fit the hollow legs of the braces over the two rubber bumpers at each end.

3) Lower the capsule one end at a time until it makes contact with each brace. Important: Be sure stop lowering the capsule as soon as it has made contact with the brace. Do not apply pressure from the motors.

**WARNING! SEVERE DAMAGE TO UNIT WILL RESULT IF TRANSPORTED WITHOUT BRACES INSTALLED.**

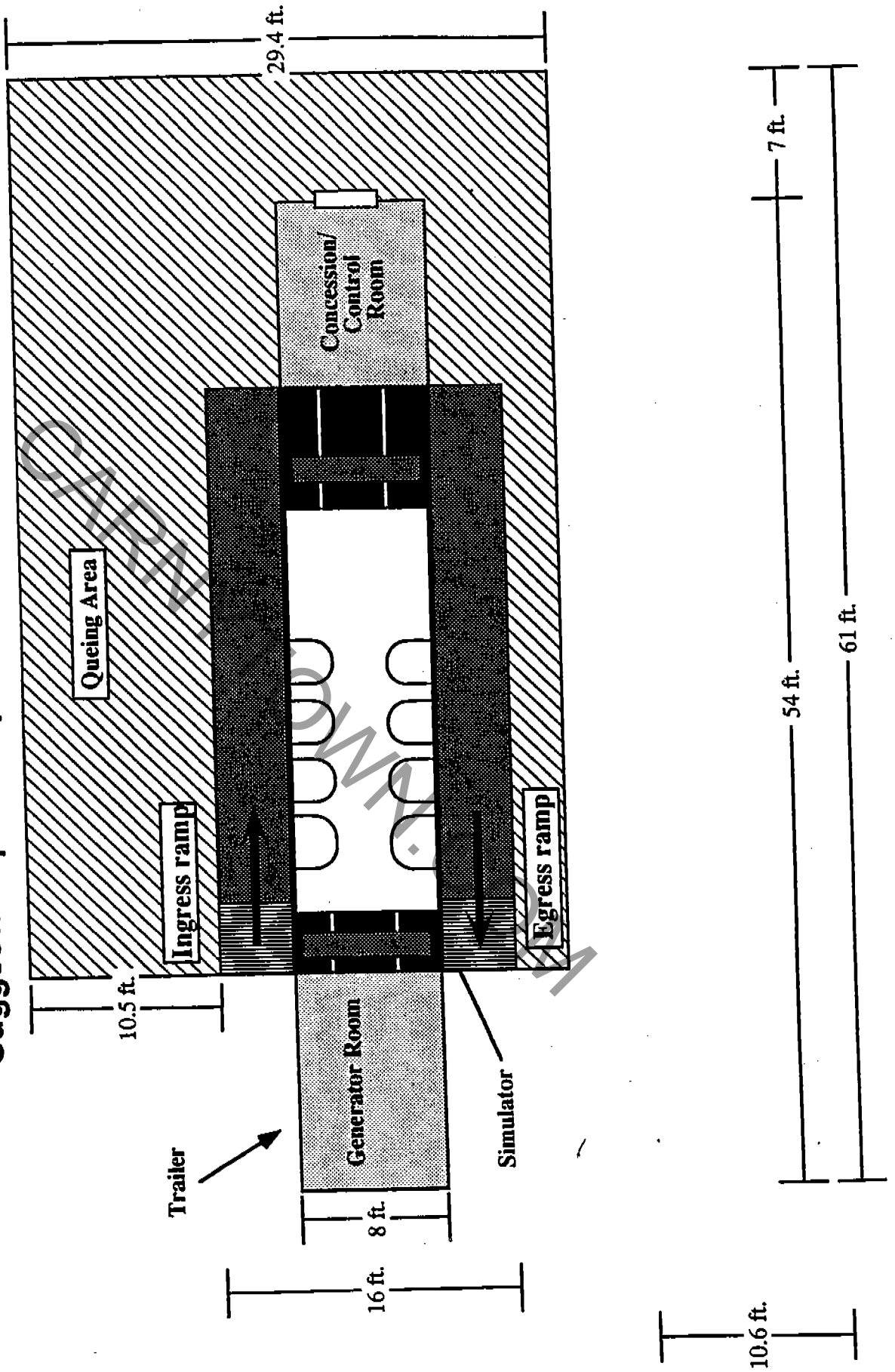
9.3 TRAVEL COVERS

There are two custom fitted weather covers on top of each vertical column, held in place with pins. These covers must be removed prior to operating the unit, and replaced prior to travel. Note: While operating the heavy axes with the covers on will cause no serious damage to the simulator, it will destroy the covers.

9.4 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 more than two men to assemble. Your scheduler should arrange for two local helpers who can be present to assist with this job. These helpers may or may not also be your two Attendants (see below).

**Enhanced Simulation  
Portable ES-360  
Suggested space requirements (top view)**



## GENERAL SAFETY AND EMERGENCY PROCEDURES

### 10.1 OPERATOR

The following information relates to the Operator's responsibilities in conducting his duties in a safe manner. The Operator must:

- 1) Be continually alert to the proper timing in opening and closing of doors so as not to injure riders.
- 2) Be continually alert to the signals from his or her Assistant, i.e., the "thumbs up" (ride clear to start) and "thumbs down" (ride not clear to start) signals.
- 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 of even momentary inattention.
- 4) Be prepared at all times to E-Stop the ride, and to execute emergency procedures if necessary.
- 5) Verify that there is sufficient fuel to operate the generator for an extended period, and that the door to the generator room is locked.
- 6) Be alert to any unusual noise or vibration during operation.

### 10.2 CHIEF OPERATOR

The Chief Operator is responsible for seeing that all ride personell are properly trained in their duties and safety procedures. He must be fastidious, insisting that all duties be executed strictly ~~according to~~ *in accordance with* safety protocol.

### 10.3 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, the generator room, or other ride components.

4) Signaling the Operator when it is clear to start.

5) Being prepared at all times to E-Stop the ride, and to execute emergency procedures if necessary.

#### 10.4 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.

#### 10.5 E - STOP

The E-Stop 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 E-Stop 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 any event where safety requires immediate cessation of the ride

Upon execution of the E-Stop function, power is cut to all motors and the capsule automatically returns to the home position.

Note: There are certain occasions where it may be more appropriate to execute an unscheduled cessation of the ride via the Control System rather than using the E-Stop, i.e., non-emergency situations such as lost glasses, misbehavior inside the capsule, false starts, etc.

#### 10.6 FIRE SYSTEM

The components and structures of the ES-360 have been designed and installed to be virtually fireproof. 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).

The fire system is equipped with the following components:

- 4 - 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 - Horn / strobe alarm
- 1 - Control panel with battery back-up, located on the fore end of the capsule
- 2 - Hand extinguishers

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

- 1) When one smoke detector is activated, the horn alarm sounds, the Operator is signaled on the control monitor, and the ride aborts. The capsule returns to the home position. ***At this time, you must ~~manually discharge~~ open the doors for immediate evacuation.*** A rapid investigation into the cause of the alarm is then performed. Depending upon the outcome of this investigation, you will have two options:
  - a) Upon discovering a fire or smelling smoke, the Operator's Assistant may manually discharge the system or control it with a hand extinguisher.
  - b) If no sign of a fire is discovered (false alarm), you may reset the system and continue operating the ride. If false alarms continue to sound, the function may be silenced via the SILENCE ALARM switch on the control panel (see below for instructions on accessing the control panel). A system check should be scheduled for the earliest possible date. Contact the nearest service representative via the list provided.

**Important:** If a fire is inside the capsule, the doors must be closed prior to discharge 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 strobe alarm flashes, and a 30-second countdown to discharge begins. The ride aborts 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, (indicated by horn plus flashing strobe), you will have 30 seconds to evaluate whether to abort or to allow automatic discharge.

### **ABORT**

The Abort function is executed by the Operator via the computer. (See Section 6.0 - Control System for instructions). Abort should be immediately executed when:

- a) No fire is detected or smoke smelled (false alarm). Note: This information may be relayed to the Operator by the Operator's Assistant who is working outside, as he may be in a better position to evaluate the situation.
- b) People are still evacuating the capsule
- c) Fire is located inside the capsule and the doors are open
- d) The situation can be controlled with a hand extinguisher
- e) More time is needed to evaluate the situation

**ALLOW** (or execute) discharge if:

- a) Capsule is in a position which prevents the doors from opening
- b) A serious fire is apparent which is unable to be contained by hand extinguishers

**Important:** Given the necessity of down time if the fire system discharges, the Operator should prepare to execute the abort function immediately after a two-detector alarm occurs. It is important to remember that the system may be manually discharged at any time, even after t<sub>1</sub>: automatic discharge

*function has been aborted, and, even prior to the 30-second countdown having elapsed, or, with no alarm having sounded (i.e., if a fire is discovered prior to an alarm sounding). Aborting the automatic discharge would be plainly appropriate and highly recommended where it is evident that a little more time is needed to determine the validity or seriousness of an alarm.*

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. *It is outside of Company safety standards to operate the ride without a fully-charged extinguishing system.*

Maintenance of the system consists of:

- 1) Monthly checking of standby battery 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.**

## 10.7 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 either the control command or the manual lever. If doors do not respond, the pneumatic system has failed, so you must manually lift each door and hold or prop them open. Inform passengers that the shoulder restraints are about to be released. Release restraints, and instruct passengers on how to raise them (Section 3.4).
- 2) Assist each passenger with their egress.

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

- ~~1) Apply the manual brake pin (located ✓ Entec) to prevent capsule from moving during evacuation. This is very important.~~
- 2) Open doors.
- 3) 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.
- 4) Beginning with the rear door, instruct the passenger nearest the door to release his belt, and assist him 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 all other rows.
- 5) 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 <sup>should become</sup> jammed upside-down or nearly so, special care and attention must be given to calming and evacuating the passengers.

1) Follow instructions 1,2, and 3 above.

2) Two attending personell must enter the capsule, on 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. Words such as, "No problem here, just stay calm"; and, "This is just a glitch, we'll have you out of here in no time"; and, "Please be patient, we'll be around to help each and every one of you", will help quiet your passengers and assure them that you are in control of the situation.

## 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).

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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INSPECTION AND TESTS

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INSPECTION AND TESTS

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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.

CHECK SHEETS

The following items should be considered by the owner operator when developing the actual daily, weekly, monthly, bi-monthly, semi-annual and annual checks that will be used to maintain and safely operate the ES-360. Any specific items required by component part manufacturers must also be included.

## 13.1 DAILY MECHANICAL CHECKPOINTS

- \_\_\_ Check ball screws, chain, and linear guides for dirt and rust. Wipe clean and oil or grease if needed.
- \_\_\_ Inspect fasteners. Be certain that none are missing or need tightening. Re-torque fasteners after any extended travel (portable). (Section 12.2).
- \_\_\_ Check function of each motor (Section 8.4).
- \_\_\_ First day after extended travel, check shoulder restraint assemblies (Section 3.4 A).

## 13.2 DAILY ELECTRICAL CHECKPOINTS

- \_\_\_ Check generator before starting (portable).
- \_\_\_ a. Check oil level. Level should be at or near the full mark, but not over.
- \_\_\_ b. Make sure there is an adequate supply of fuel for extended operation.
- \_\_\_ c. Check battery connections and level of battery electrolyte.
- \_\_\_ d. Be sure air filter is clean and properly installed.
- \_\_\_ e. Be sure rags, tools and debris are not left on or near generator.
- \_\_\_ f. Coolant level should be 3/4 to 1 1/2 in. below the radiator filler neck seat when cold. (Note: Do not add coolant to an overheated engine).
- \_\_\_ g. Check for spilled diesel fuel and clean up before operating.
- \_\_\_ h. Close and lock door to generator room.
- \_\_\_ Turn on generator or master power.
- \_\_\_ Turn on Control Booth components

**- Perform other daily checks now while pneumatic system builds pressure -**

## 13.3 DAILY STRUCTURE CHECKPOINTS

- \_\_\_ Visually scan structure for missing, loose or damaged fasteners.
- \_\_\_ Check to make sure all maintenance debris and tools have been removed.
- \_\_\_ Check to see that outriggers have not subsided or washed out (portable).

13.4

#### DAILY CAPSULE CHECKPOINTS

- \_\_\_ Check capsule interior for tools or debris. Vacuum if necessary. Be sure seats are free of grease or dirt that might soil clothing.
- \_\_\_ Check upholstery for tears or damage.
- \_\_\_ Check that all doors are latching properly.
- \_\_\_ Verify that all shoulder restraint lock and release mechanisms are functioning.
- \_\_\_ Check that all lap belts are working properly. Be sure that none are jammed or twisted inside their rollers.
- \_\_\_ Check interior lighting. Replace any burned out bulbs.

13.5

#### DAILY AUDIOVISUAL SYSTEM CHECK POINTS

- \_\_\_ Check that both projectors are working properly.
- \_\_\_ Check the convergence of the projectors and adjust if necessary (Section 5.2)
- \_\_\_ Check that the sound system is working properly and is at the correct volume.
- \_\_\_ Check the quality of the picture for resolution, color, contrast and 3D.

13.6

#### DAILY CONTROL SYSTEM CHECKPOINTS

- \_\_\_ Check to see that the control monitor is reading properly.
  - \_\_\_ a. Are all seat indicators reading vacant?
  - \_\_\_ b. Are there any messages flashing? (Note: "Pressure Low?" message will probably be normal at this point).
  - \_\_\_ c.
  - \_\_\_ d.
  - \_\_\_ e.
- \_\_\_ Check all cables, plugs, etc., to insure tight connection and proper condition.
- \_\_\_ Check the capsule monitoring system.
  - \_\_\_ a. Make sure you have a clear view of all seats. Check with doors closed, interior lights out and projectors on.
  - \_\_\_ b. Check that the two-way communications system is working and is at the proper volume.

## 13.7

## DAILY PNEUMATIC SYSTEMS CHECKPOINTS

**Important: The compressor may need to run for 1/2 hour to 45 minutes to build up sufficient pressure in the lift support tanks in order to operate the ride. To avoid stressing and possibly damaging the motors and actuators, never operate the ride without sufficient pressure (Refer to Section 8.5).**

- \_\_\_ Check the pressure gauges (read black indicators, not red):
  - \_\_\_ a. The main pressure regulator gauge at the compressor should read 120 p.s.i.
  - \_\_\_ b. The door lift and door latch pressure gauges (located in the aft end viewable through "peekholes") should read 90-100 p.s.i., determined by proper door support and latching.
  - \_\_\_ c. The lift support tanks gauge (located on the deck) should read 120 p.s.i. with the capsule raised, and 150 - 160 psi. when lowered. It should never exceed 160 p.s.i. *EWCC*
  - \_\_\_ d. The (function?) gauge (located on the deck, kitty-cornered from the support tank gauge should read 100 p.s.i.
- \_\_\_ Pull the door manual release lever on the capsule exterior to verify that it is functioning properly. Return it to its original position.
- \_\_\_ Open the two petcocks on capsule exterior to drain condensation from the capsule air tanks (system must be pressurized).
- \_\_\_ Verify that the main filter is draining automatically by noticing water on the deck (Section 12.6).
- \_\_\_ Drain the main tanks of residual water (valves located on the bottom of each lift support tank).
- \_\_\_ First day after extended travel, check flow restrictor (damping) valves on the pneumatic system. Be sure that they are locked open at 3/4 turn from full closed. (Section 12.5).

## 13.8

## DAILY PRE-OPERATION CHECK POINTS

- \_\_\_ Engage motors by pressing yellow lighted button in control booth.
- \_\_\_ Operate each motor manually to see that they are responding. Test all five E-stops to verify that they are functioning (capsule should return to "home" position after each E-stop). Note: Reset the E-stops by pulling up on the E-stop push buttons.
- \_\_\_ Check the other manual console functions to verify that they respond to command.

After all maintenance and operational checks have been completed and the ride released to operate, the ride should be operated for at least one satisfactory complete cycle before customers are permitted to ride. Listen for any abnormal sounds during the test run while monitoring the console. One operator or assistant should ride in order to verify that the audiovisuals are working properly.

### 13.9 WEEKLY LUBRICATION CHECK POINTS

- \_\_\_ Check oil level on compressor.
- \_\_\_ Check compressor belt for proper tension.
- \_\_\_ Change oil in worm gear box after second week of operation. (Section 11.0)

### 13.10 MONTHLY CHECK AND LUBRICATION POINTS

- \_\_\_ Check generator and compressor oil level. Change if dirty.
- \_\_\_ Check worm gear box oil level. Oil level must be strictly maintained. (Section 11.0)
- \_\_\_ Inspect weld areas for cracks or other problems (Section 12.1).
- \_\_\_ Check fire system standby batteries for full charge (25.5 to 26V)
- \_\_\_ Check pressure gauges of fire system tanks located under disk covers on aft end of capsule. Be sure they read in the green. Call for service if they do not.
- \_\_\_ Check shoulder restraint assemblies (Section 3.4 A).

### 13.11 BI-MONTHLY CHECK AND LUBRICATION POINTS

- \_\_\_ Check generator and compressor oil level. Change if dirty.
- \_\_\_ Lubricate vertical carriage linear bearings, vertical carriage cam rollers, and cam rollers on drive end of rotation shaft. (Section 11.0).
- \_\_\_ Check vertical axis and horizontal axis ball screw bearing cartridges, flange bearings and pillow block bearings. Grease if needed. (Section 11.0).
- \_\_\_ Check wheels. Grease if needed. (Section 11.0).

### 13.12 QUARTERLY CHECK AND LUBRICATION POINTS

- \_\_\_ Lubricate large pivot carriage cam rollers. (Section 11.0).
- \_\_\_ Check vertical axis and horizontal axis ball screw bearing cartridges, flange bearings and pillow block bearings. Grease if needed. (Section 11.0).

- \_\_\_ Check wheels. Grease if needed. (Section 11.0).
- \_\_\_ Check belts for cracks or unusual wear.
- \_\_\_ Check wires in wireways and exposed areas for frayed insulation or breaks.
- \_\_\_ Check flow restrictor (damping) valves on the pneumatic system. Be sure that they are locked open at 3/4 turn from full closed. (Section 12.5).
- \_\_\_ Lubricate shoulder restraint bearings (Section 3.4 A).

### 13.13 SEMI-ANNUAL CHECK POINTS

- \_\_\_ Change oil in worm gear box (Section 11.0).
- \_\_\_ Grease pillow block bearings on each end of rotation shaft (Section 11.0).
- \_\_\_ Re-torque all fasteners (fixed unit).
- \_\_\_ Contact nearest fire system service representative for semi-annual check (Section 10.6 A).

### 13.14 ANNUAL CHECK POINTS

- \_\_\_ Check all electrical contacts and connections.
- \_\_\_ Clean air compressor filter and blow out all lines.
- \_\_\_ Service generator as required by the manufacturer.
- \_\_\_ Repair or replace all loose or damaged structural members.

### 13.15 CHECK POINTS NOTE

Remember that the above list of check points is to be used as a guide only for developing in-house check sheets. Once again, items that are specified by component manufacturers should be included along with those items that are determined by the owner operator through actual experience.