HORIZONS
INVENTORY SUMMARY

RIDE & SHOW
ENGINEERING

© DISNEY

Walt Disney World

HORIZONS

Date: May, 1992

GENERAL INFORMATION

LIST OF REVISIONS

PAGE	DATE
Title page	February 05, 1987
2-41	February 05, 1987
2-54	February 05, 1987

HORIZONS

MAINTENANCE MANUAL

VOLUME I
RIDE MECHANICAL

00026

Walt Disney World®
EPCOT CENTER

PRODUCED BY
WED/MAPO TECHNICAL PUBLICATIONS

Please address any questions or comments to:
Technical Publications, Dept. 525
WED Enterprises
1401 Flower Street, Glendale, CA 91201

PREFACE

This document is prepared as a ready referance and maintenance manual for the ride and show mechanical, special effects and ride control for EPCOT Center's Horizons Pavilion.

Pertinent drawings not included in this manual are available on request from the appropriate WED Engineering department.

This manual will be revised on a periodic or as-required basis. Any corrections or suggestions should be directed to the WED Technical Publications Department.

Monte Hoult, Manager
Technical Publications

INTRODUCTION

This maintenance manual contains procedures for maintenance personnel to use as a guide in the repair and maintenance of the Horizons Pavilion Ride and Show systems. The manual is divided into four volumes as follows:

VOLUME I	Section 1 - General Description	
	Section 2 - Ride System Mechanical	
VOLUME II	Section 3 - Show System Mechanical	
	Section 4 - Special Effects	
VOLUME III	Section 5 - Ride Control	

Each of the above sections contains information, illustrations and specifications which are based on the latest production information available at the time of publication approval.

Some of the material contained herein has been excerpted from applicable manufacturer documentation.

To ensure that this publication continues to remain a valid up-to-date reference, when change pages or revisions affecting this manual are received, immediately remove deleted pages as indicated and insert new pages where applicable. All changes are recorded on the List of Effective Pages.

Master Table of Contents

HORIZONS MAINTENANCE MANUAL TABLE of CONTENTS

VOLUME I

SECTION 1 INTRODUCTION and GENERAL DESCRIPTION

SECTION 2 RIDE MECHANICAL, VEHICLES and TRACKSIDE EQUIPMENT

TABLE OF CONTENTS (cont.)

SECTION 3 SHOW MECHANICAL, MOVING SCREENS and A-A FIGURES

TABLE OF CONTENTS

Volume II

SECTION 4 SPECIAL EFFECTS

PARAGRAPH PAGE

TABLE OF CONTENTS (cont)

TABLE OF CONTENTS (cont)

VOLUME III

SECTION 5 RIDE CONTROL

TABLE OF CONTENTS (Continued)

LIST OF ILLUSTRATIONS

VOLUME I

SECTION 1 GENERAL DESCRIPTION

FIGURE PAGE

SECTION 2 RIDE SYSTEM MECHANICAL

LIST OF ILLUSTRATIONS

VOLUME II

SECTION 3 SHOW SYSTEM MECHANICAL

FIGURE PAGE

TO BE SUPPLIED

SECTION 4 SPECIAL EFFECTS

LIST OF ILLUSTRATIONS (cont)

VOLUME III

SECTION 5 RIDE CONTROL

LIST OF TABLES

VOLUME I

SECTION 1 GENERAL DESCRIPTION

TABLE PAGE

NO TABLES IN SECTION 1

SECTION 2 RIDE MECHANICLAL

VOLUME II

SECTION 3 SHOW SYSTEM MECHANICAL

TO BE SUPPLIED

SECTION 4 SPECIAL EFFECTS

LIST OF TABLES

VOLUME III

SECTION 5

RIDE CONTROL

TABLE

PAGE

LIST OF EFFECTIVE PAGES

Page	Issue
Title Page	Origina
Copyright	Origina
Preface	Origina
Master Table of Contents	Origina
Table of Contents	AUG,198
Introduction	Origina
General Safety Precautions	Origina

Section 1

Page	Issue
1-1 thru 1-4	Origina

Section 2

Page	Issue
2-1 thru 2-98	Origina
Vendor Information	Origina

Section 3

TO BE SUPPLIED

Section 4

Page	Issue
4-1 thru 4-97	Origina

Section 5

Page	Issue
5-1 thru 5-98	Origina

GENERAL SAFETY PRECAUTIONS

The following general safety precautions are not related to any specific procedures and therefore do not appear elsewhere in this publication. These are precautions that personnel must understand and apply during many phases of operation and maintenance. Safe maintenance practices and qualified personnel are imperative. Refer to the pertinent EPCOT Standard Operating Procedure, available in the Maintenance, Operations and Safety Offices, or ask your supervisor for further information on matters of safety.

Read and heed all WARNING, CAUTION, and NOTE signs posted on equipment.

KEEP AWAY FROM LIVE CIRCUITS

Installation, operation, and maintenance should be performed only by qualified personnel.

Before initiating maintenance procedures on any electrical or electronic equipment, be sure all power sources are disconnected from the machine and accessories. Under certain conditions, dangerous potentials exist even when the power control is disconnected due to charges retained by capacitors. Always remove power and discharge a circuit to ground before touching it. Always provide an equipment ground when working with any electrical equipment installed on vibration-isolation pads, as it is isolated from ground.

If a high-potential insulation test is required, follow the procedures and precautions outlined in the appropriate NEMA Standards.

KEEP AWAY FROM ROTATING PARTS

Rotating parts of machinery can cause serious or fatal injury. When working around such machinery, avoid contact with moving parts. Wear appropriate clothing and use appropriate equipment as specified in the COMPANY SAFETY MANUAL. When attempting maintenance or repair to such machinery, disconnect all power sources and allow the unit to come to a complete stop before approaching it.

DO NOT SERVICE OR ADJUST ALONE

Whenever a potential for accident or injury exists, never attempt maintenance or adjustment except in the presence of someone who is capable of rendering aid. It is particularly important that such work not be performed after hours or in an area remote from other personnel.

BE FAMILIAR WITH RESUSCITATION TECHNIQUES

Personnel working with or near high voltages should be familiar with modern methods of resuscitation. CPR (cardio-pulmonary resuscitation) classes are available regularly at the Safety Department and the Reedy Creek Fire Department. Call the Safety Department, extension 4768, for information concerning these classes. Refresher courses should be taken at least once a year.

KNOW AND COMPLY WITH FEDERAL OSHA REQUIREMENTS

Your supervisor will familiarize you with OSHA standards, and can advise you about a continuing eight-hour course available at the Disney University.

GENERAL HYDRAULIC PROCEDURES

Precautions must be observed when starting up a hydraulic system to prevent accidents or damage. The following suggestions are applicable to most hydraulic systems but are not intended to be a substitute for good practice or judgment.

WARNING

Improper operation of a hydraulic system can cause injury to personnel or damage to equipment.

FLUID

Fill the reservoir to the operating level with a good grade of suitable hydraulic fluid or as indicated on the reservoir nameplate. If the unit has been purchased for fire-resistant service, do not use hydrocarbon-based fluids such as Mobile DTE. Special component seals are required for fire-resistant fluids. Check each pump on the unit for prefill requirements. Most piston type pumps require the "case" to be filled prior to startup.

CAUTION

During startup, be sure to monitor the fluid level in the reservoir. As the system fills, the oil level may drop below a safe operating point. If this occurs, shut down the system and add fluid as necessary.

VOLTAGE AND ROTATION

Check to be sure the unit is connected to the correct voltage. Units with internal wiring are shipped with a tag indicating whether the internal connections are for 230V or 460V. Make sure this tag agrees with plant-connected voltage.

If the voltages do not agree, it may be necessary for an electrician to make changes to transformer connections, motor leads, motor start coil or solenoid valve coils.

CAUTION

> Voltage on solenoid valves is indicated on the valve nameplate. Verify that this agrees with the connected circuit.

Motor rotation is indicated by the rotation arrow on the pump housing or motor endbell. Make sure rotation is correct by "bumping" (fast operation of ON-OFF pushbutton) the motor before allowing the motor to come up to speed. Some pumps can be damaged if operated in the wrong direction for even a very short period of time.

ACCUMULATORS

Accumulators are used on many hydraulic circuits to provide reserve power and for shock attenuation. If the system has an accumulator, be sure to check that it has been properly precharged with dry nitrogen before initial starting of the system. Starting a system containing an uncharged bag-type accumulator will result in bag rupture. Most accumulator type systems are shipped with the accumulator precharged and this will be indicated by a tag near the charging port.

WARNING

> Accumulator systems may have fluid stored under pressure even though the pump is not operating. If the controls are operated, unexpected movement of the machine members may occur leading to damage to the equipment or injury to personnel. Do not attempt maintenance on the machine or allow any unauthorized handling of the controls unless a qualified operator has verified that the stored energy has been bled down. Do not work on any piping or components of the hydraulic system unless the system has been bled down. Some accumulator systems contain gas back-up bottles. Do not remove any interconnecting piping or tubing until a qualified operator has verified that all gas pressure has been relieved.

STARTING

Before starting the system, look over the circuit and locate a bypass valve, a relief valve or relief valve vent valve that can be opened to start the system under zero pressure. After the system is in operation, gradually bring up the pressure, checking all adjustments, stops, feeds and other controls for setting and synchronization until it is established that the system is operating properly.

Equally important is to assure that the system is properly bled of trapped air. Some pumps will not prime if started against an air load and may be damaged if run dry for even short periods of time. On initial startup, open the air bleed valve at the pump outlet and utilize the open center configuration of free flow through the circuit that may be supplied on some circuits, or crack open a fitting downstream of the pump to permit escape of air until flow is initiated.

WARNING

> Ensure that bleeds or fittings are opened to permit escape of trapped air and that personnel and equipment are clear of any parts that might be subject to this movement.

Some circuits have an "overcenter" movement which would ordinarily be supported by hydraulic fluid. At startup, this support may not be supplied because of the presence of air, and some mechanical support or other means may be necessary to prevent dropping of the part until the air has been displaced. Where the installation of the machine is such that injury or damage cannot occur from trapped air, the operator may elect to merely displace the air by running the machine through a few cycles after the pump is primed. This frequently eliminates the need for further bleeding.

FILTERS

Since most hydraulic systems have residual scale, rust, dirt and cuttings in the piping at startup, ensure that filters and suction strainers are monitored during the first hours of operation. Check the suction strainer and other filters replaced at the end of an initial forty hours of operation and then monitor at longer intervals as necessary.

1.1 INTRODUCTION

The Horizons Pavilion, presented by General Electric, is an integral part of EPCOT Center; it is located in the area shown in Figure 1-1. It contains a major ride and show that is a synthesis of all the themes in Future World: contemporary man's relationship with the future. The show explores the technological advances in communications, transportation, agriculture, and energy which will enhance the lifestyles of future generations. Horizons' show and ride fills almost the entire facility. Extensive show elements are used: animation, sets and props, film/video, special effects, audio, and lighting.

1.2 SHOW/RIDE OVERVIEW

The Horizons show and ride is a journey into the many worlds of tomorrow. Styled as a transportation center called the FuturePort, the queue area is the guests' first experience of this future. As travelers, the guests are immersed in "tomorrow's environment" by PA announcements to board transports for exotic destinations. Further in the FuturePort, projected travel posters highlight the destinations of this future adventure: Sea Castle, a floating city; Villa del Sol, a desert farming community; and Brava Centauri, a space colony.

Having reached the load area, the guests step onto a moving conveyor to board the ride vehicle, an overhead-suspended gondola that can hold four passengers. The journey begins by "Looking Back at Tomorrow", a taste of what some people from the past thought the future might look like.

The vehicles then ascend to the Omni-Max theater to look at the miracles of today. From the vehicle path, the guests have an optimum view of the wonders of today's science and technology visible above, below, and to either side.

After passing through the theater, the guests begin an exploration of some of the possible future habitats. Members of an extended family provide the narrative link. The grandmother and grandfather of this clan, in an urban setting, are talking to their daughter via holographic telephone.

The next scene takes guests to visit this daughter, a farmer, working on a desert farming project that even has robotic fieldhands. Her husband, son, and daughter are in their living quarters. The husband and son are working on a birthday cake; they are assisted by electronic kitchen aids. The daughter is talking, via teleview, with her boyfriend. He is in a marine environment, a floating city which the vehicles descend into to take the guests. Various aspects of sea living are demonstrated: recreation, science, and industry.

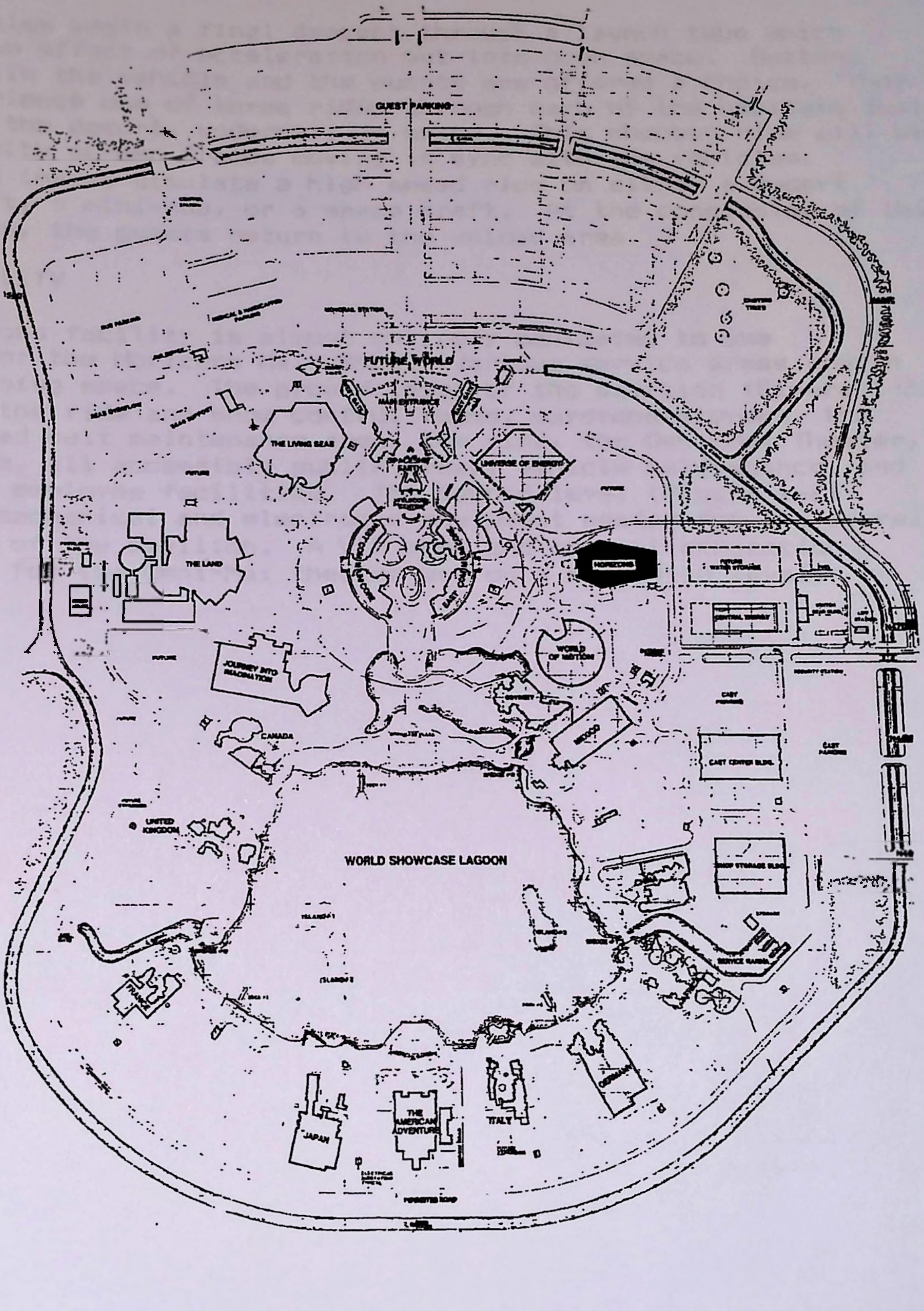


Figure 1-1 Horizons Pavilion Location

The vehicles begin another ascent, this time to a space colony. Again, the unique advantages of this environment for work and for play are highlighted. In the colony's communications center, guests see the final members of the family, another young couple and their baby, visiting with previously encountered relatives via a holographic partyline.

The vehicles begin a final descent through a launch tube which creates an effect of acceleration out into open space. Buttons light up in the vehicle and the guests are offered a choice. They may experience one of three rides through each of the habitats just visited: the desert, undersea, or space. This choosen ride will be created with screen frames moving in sync with the vehicles. Projected images simulate a high speed ride on either a desert hovercraft, a mini-sub, or a space craft. At the conclusion of this simulation, the guests return to the unload area.

1.3 FACILITY

The Horizons facility is almost entirely dedicated to one attraction: the Horizons Main Show. Various service areas are in the remaining space. The ground level of the pavilion (Figure 1-2) contains the ride and show control rooms, wardrobe storage, the load/unload belt maintenance area, the ride, the Omni-Max Theater, VIP lounge, all accessible public areas, vehicle maintenance, and backstage employee facilities. The second level (Figure 1-2) contains mechanical and electronic equipment needed for the overall operation of the pavilion. A VIP area and special projection equipment for the Omni-Max theater are on a mezzanine level.

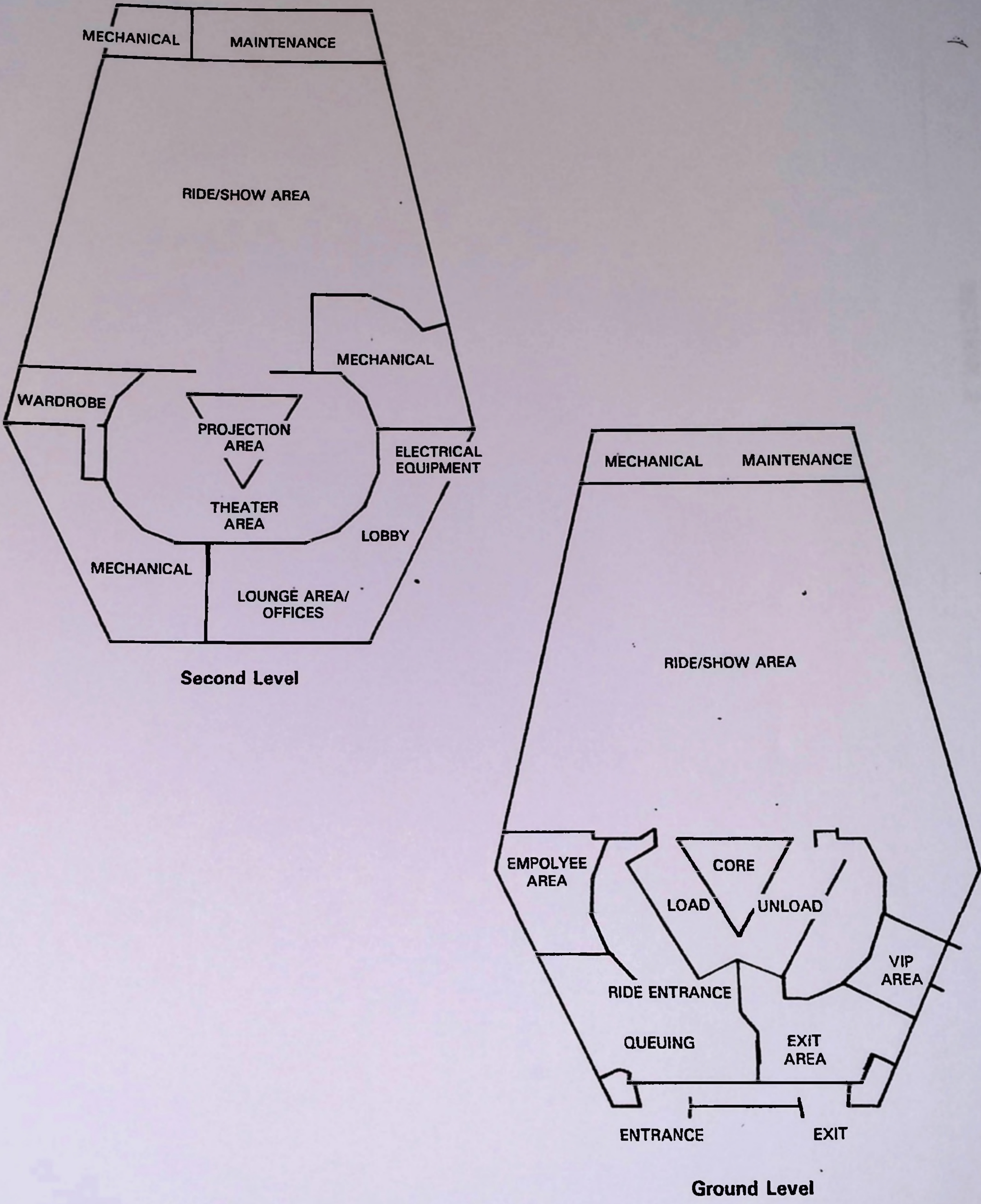


Figure 1-2 Horizons Pavilion Floor Plan

SECTION 2 RIDE SYSTEM MECHANICAL

2.1 INTRODUCTION

This section provides information required to maintain the Horizons Pavilion Ride System in operational condition. It includes description and operational requirements for the Vehicle/Track Monitoring System (VTMS). It also includes, as required, descriptions, theory of operation, preventive maintenance, corrective maintenance, and illustrated parts breakdowns for the ride vehicle and track. Safety rules and regulations, where required, are throughout this section. Table 2-1 is a summary of the ride elements in the Horizons Pavilion.

Table 2-1 Ride Elements Summary

OPERATING SYSTEM	PARAMETERS
Drive System	AC motor, 1 horsepower, 2 speeds normal and 1/2 speed for maintenance, custodial, and slow guest loading.
Maximum Pull Number of Units	1000 Pounds 174 + 10 Spares
Onboard Power	Brush pickup from bus bar. Onboard power is required to operate a guest voting panel and audio equipment.
Safety Devices	Overload cut-outs, incline and decline brakes.
Onboard Audio	Bus Bar The audio signal received by the car is controlled by their position in the show. There are four speakers on the back wall of each vehicle.
Load and Unload Stations	Two belt moving sidewalks, six feet wide with moving handrails. Guides to prevent swinging of the cars when loading and unloading are mounted on the floor.

2.2 VEHICLE/TRACK MONITORING SYSTEM (VTMS)

The VTMS is one of several monitoring systems installed in the Horizons Pavilion Ride System to prevent the vehicles, the track, or the support structure from being damaged because of the transmission of abnormally high forces through the train of vehicles. The VTMS operates independently of other protection systems that monitor the drive motor current levels and drive motor temperatures.

2.2.1 DESCRIPTION. The system is divided into three levels of complexity:

In Level 1, the system detects any excessive forces delivered through the chain (either in the vehicle chain or indirectly in the track structure). Depending on the level of overload detected, either a warning is issued at the control console or the ride is automatically shut down.

At Level 2, the VTMS functions as in Level 1 and also provides accurate measurement of the vehicle chain forces.

At Level 3, the VTMS works in conjunction with the vehicle system computer. In addition to force measurement and setpoint shutdown, the Level 3 system also shuts down the ride if the computer detects given combinations of above average loading.

Requirements of these levels are described below.

2.2.1.1 Level 1. The system detects high overloads either directly in the vehicle chain or indirectly in the track structure and shuts the ride system down before there is damage to the vehicles, the track, or the support structure. The Level 1 system incorporates dual setpoints for overload detection. If there is an overload and the first setpoint is tripped, a warning is displayed at the ride control console. This warning indicates the location at which the overload was detected.

2.2.1.2 Level 2. The Level 2 system meets all the requirements of the Level 1 system and provides, at the ride control console, vehicle chain load data from 25 locations around the course.

2.2.1.3 Level 3. The Level 3 system supplies, to the ride control computer, continuous vehicle chain load data from at least 30 locations around the course. If given combinations of above average forces are detected, the computer either issues a warning to the ride control console with diagnostics or it shuts the ride down with appropriate location and diagnostic information issued to the control console.

2.2.2 OPERATIONAL REQUIREMENTS. The ride system is capable of sustained operation for 14 hours a day, 365 days a year for the following minimum periods:

Conditioning devices and cabling:	15 years
Transducers:	8 years

The system operates within a temperature range of 45°-110°F. Maintenance operation of the ride and VTMS, therefore, is possible with the loss of the pavilion heating or air conditioning. The VTMS includes all equipment from the transducers at the monitored locations to the displays at the ride control console.

2.3 SCALED-DOWN MONITORING SYSTEM

There is a scaled-down monitoring system that provides only load measurement at a reduced number of track locations. This load data is used primarily to adjust the motor controls to balance the ride during installation and subsequent maintenance operations.

2.3.1 SYSTEM DESCRIPTION. The load measurement system consists of five pairs of transducers installed into the following five track curves: C-5, C-9, C-14, C-20, C-33. The pair of transducers in each curve is separated by half a vehicle pitch distance, with the object being to sum the signals to minimize wheel passing effects. Each transducer has a separate signal conditioner, for a total of ten each. The ten conditioned signals are gathered by the Ride Data Concentrator (RDC). The RDC is located in the maintenance tunnel, which is a boxed-in structure that encloses the upper vehicle assemblies and is continuous around the length of the track. The RDC multiplexes each channel and sends the information serially to the Ride Control Computer (RCC), which is located in the equipment room. In addition, output jacks are provided for each channel in the equipment room for the purpose of monitoring the analog data with a multi-channel recorder.

2.3.2 ELECTRICAL REQUIREMENTS. Electrical considerations for the VTMS includes operation under the following conditions:

Input voltage --- 115 VAC ± 15%
Ambient temperature --- 0°C (32°F) to 60°C (140°F)

Signal requirements are: 4-20 mA. analog current to represent ± 12,000 lb. chain load range. This is the conditioned signal to the A/D interface.

Accuracy is .5% of reading or better overall including, but not limited to, repeatability and absolute value, over a 10°C temperature change and input voltage change from min. to max.

Stability is .25% for 16 hours.
Frequency response is 0-5 Hz.

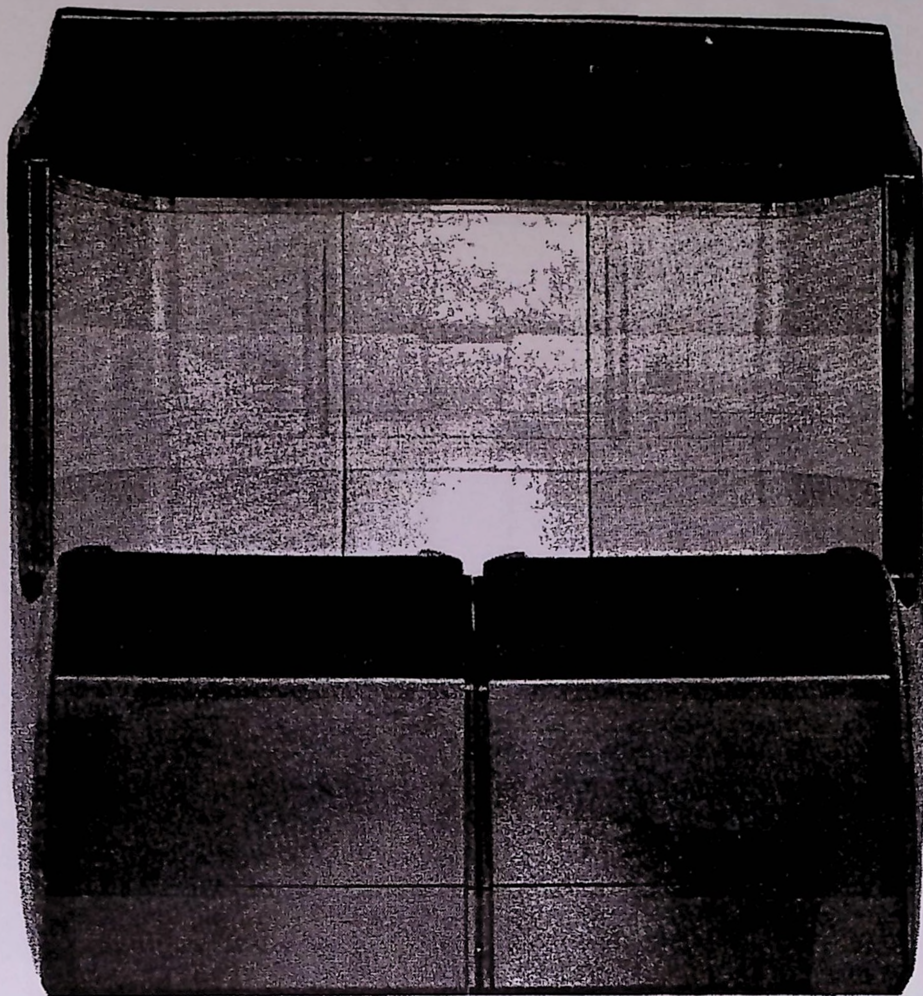


Figure 2-1 Ride Vehicle

2.4.1 DESCRIPTION. The ride consists of 174 four-passenger vehicles that are linked together and suspended from a support rail that follows a 1346 foot closed loop course. Each ride vehicle is an overhead gondola (Figure 2-1) consisting of an upper trolley unit with two bogies which are separately driven through a gearbox and pulley arrangement by a 1-HP AC induction motor (see Figure 2-2). Electrical power for transmitting motor power as well as audio power aboard the vehicle is obtained from a 4-conductor bus bar pickup system encased in an extruded plastic holder/rail and self-contained pickup box that rides on the rail. Zonal control of power levels for various grades is achieved by individual bus bar segments powered by off-board inverters. The trolley unit rides on the track assembly load rail and a reaction rail that runs parallel to the load rail around the entire track. Any lateral or radial forces that are generated are taken by the load rail through reaction arms that attach to the trolley assemblies.

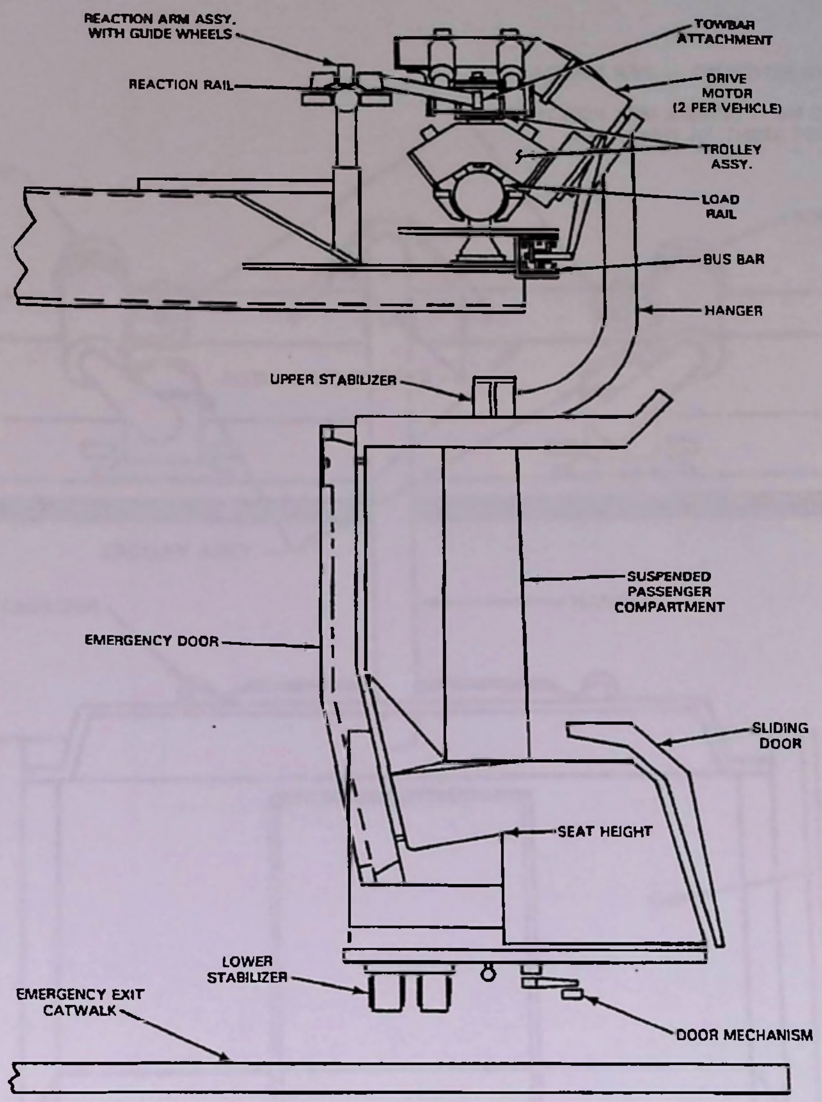


Figure 2-2 Side View of Vehicle and Track Support

The two bogies on each vehicle (Figure 2-3) are tied together with a load bar. Every bogie consists of two polyurethane load wheels approximately 5.5 inches in diameter and four guidewheels approximately four inches in diameter. The distance between the axis of the bogies is approximately 3 feet, 10-1/2 inches. Top linkage consists of load bars and tie bars connected with universal joints. Tie bars with shock absorbers are installed between vehicles to restrain them from swinging. The passenger compartment is carried below the trolley on a rigid hanger. The vehicle shell forms a window effect for viewing the show and also serves as a soundbox with narration and sound effects traveling in the vehicles with the guests.

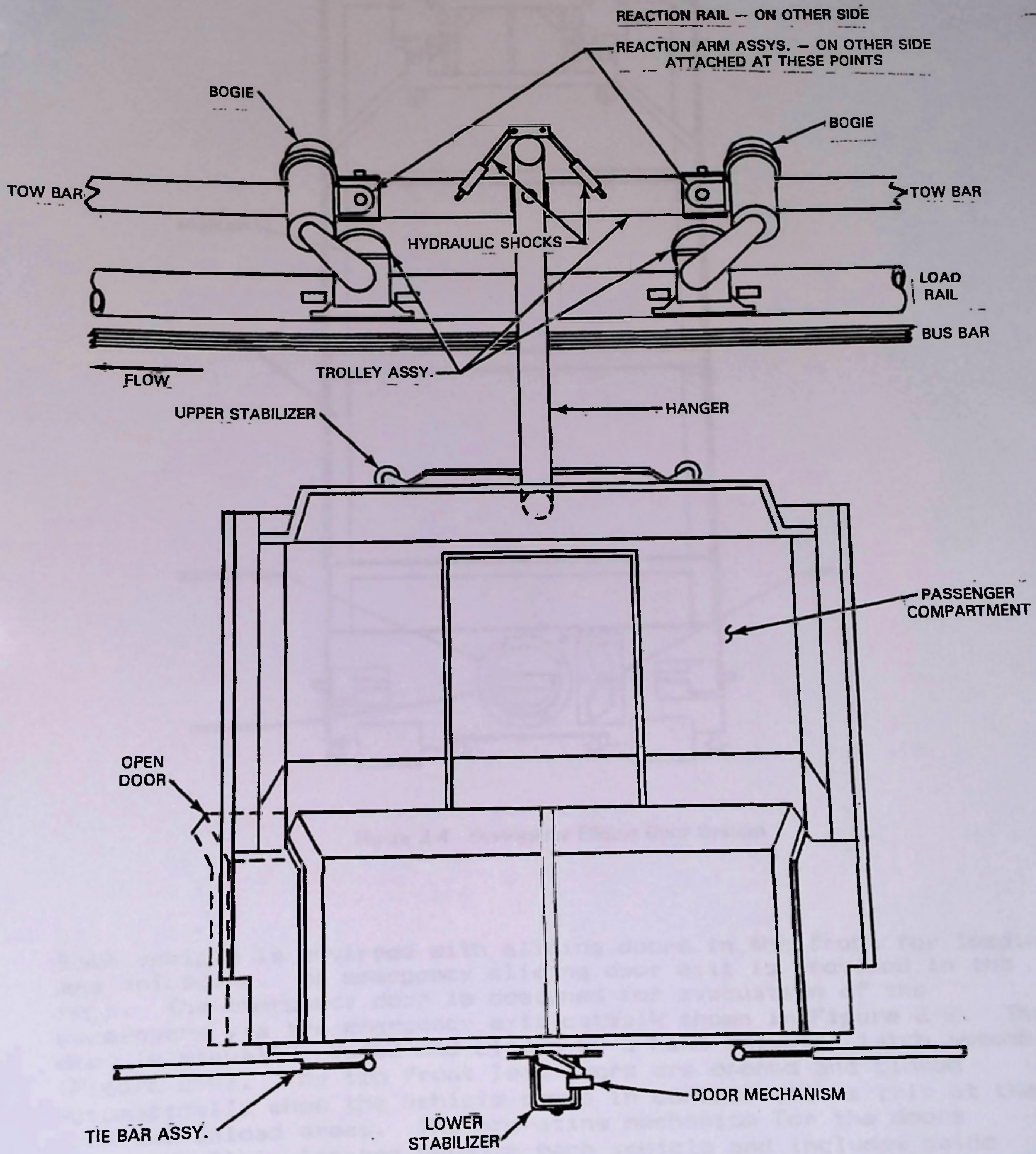


Figure 2-3 Front View of Vehicle and Track Support

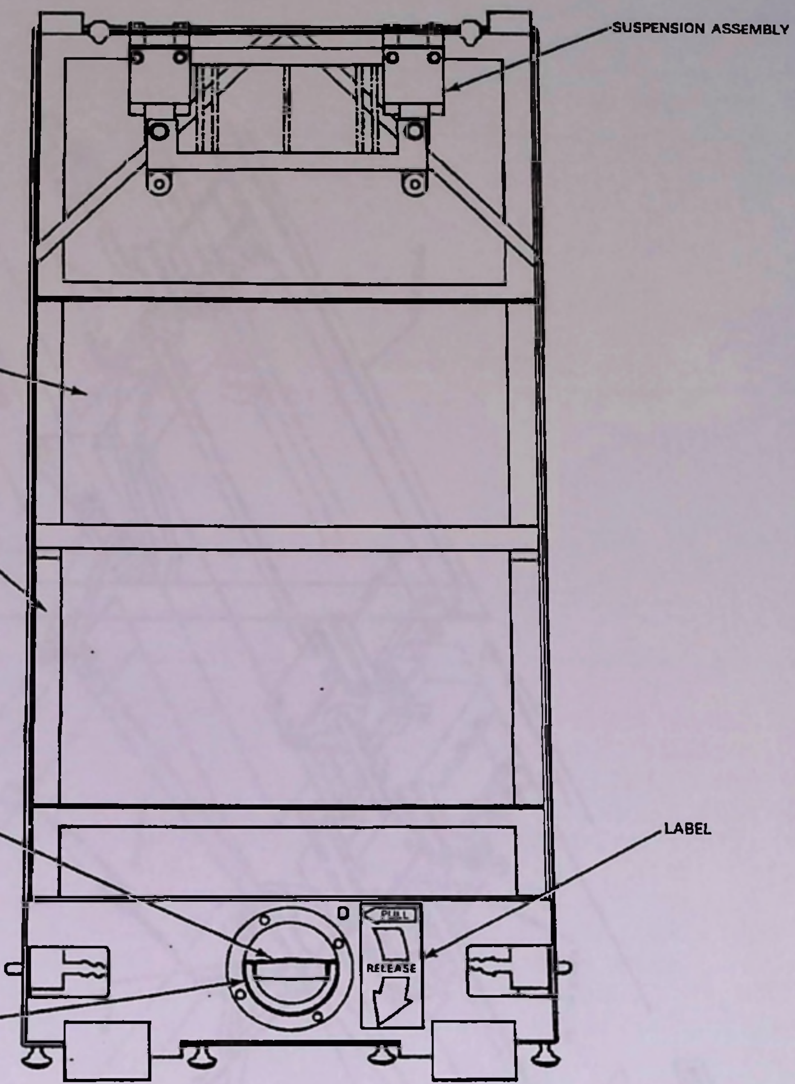


Figure 2-4 Emergency Sliding Door System

Each vehicle is equipped with sliding doors in the front for loading and unloading. An emergency sliding door exit is provided in the rear. The emergency door is designed for evacuation of the passengers via the emergency exit catwalk shown in Figure 2-2. The door is manually opened and closed by a hand actuated latch assembly (Figure 2-4). The two front load doors are opened and closed automatically when the vehicle comes in contact with a trip at the load and unload areas. The operating mechanism for the doors (Figure 2-5) is located beneath each vehicle and includes guide wheels which are utilized for stabilization during load and unload procedures. The doors are spring loaded to prevent injury to guests who may be obstructing the doorway. After an obstruction is cleared, the doors automatically close and lock. For maintenance procedures, refer to paragraph 2.4.4.

Major characteristics of the ride vehicle are listed in Table 2-2.

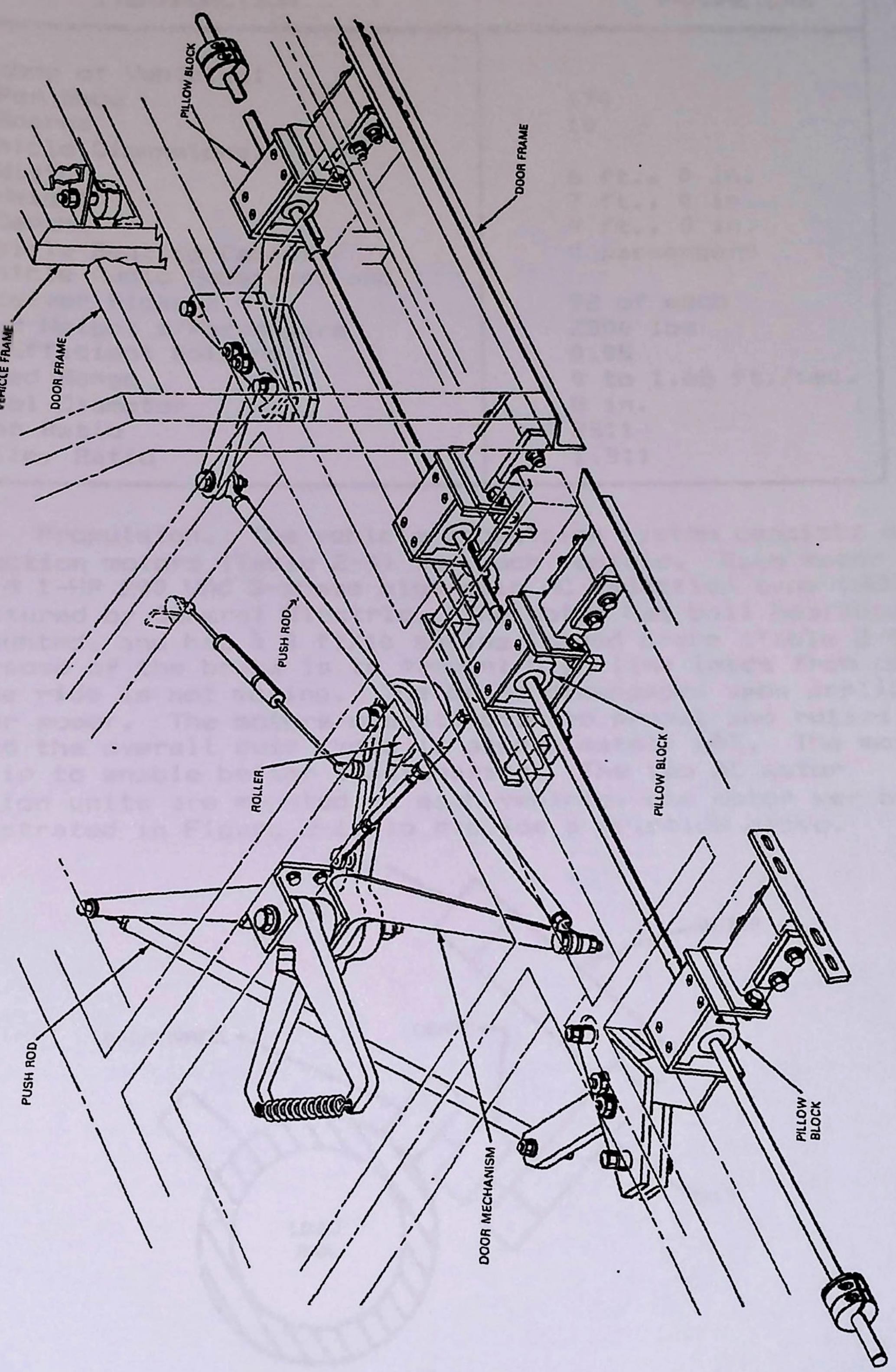


Figure 2-5 Sliding Doors Mechanism

Table 2-2 Vehicle Major Characteristics	
ITEM/FUNCTION	PARAMETERS
Number of Vehicles:	
Per Show	174
Spares	10
Vehicle Dimensions:	
Width	6 ft., 0 in.
Height	7 ft., 0 in.
Depth	4 ft., 0 in.
Vehicle Seating Capacity	4 passengers
Vehicle Audio Receivers and Receiver Pickups	92 of each
Load Weight w/Passengers	2300 lbs
Co-Efficient Rolling F	0.05
Speed Range	0 to 1.65 ft./sec.
Wheel Diameter	8 in.
Gear Ratio	25:1
Pulley Ratio	1.3:1

2.4.1.1 Propulsion. The vehicle propulsion system consists of two AC induction motors (Table 2-3) for each vehicle. Each motor is a standard 1-HP 240 VAC 3-phase high-slip AC induction type (NEMA D) manufactured by General Electric. The motor has ball bearings, is foot mounted, and has a 3 ft/lb spring-loaded brake (Table 2-4). The purpose of the brake is to prevent high link loads from occuring when the ride is not moving. The brake disengages upon application of motor power. The motors operate both to propel and retard the cars and the overall duty cycle is approximately 60%. The motor is high-slip to enable better load-sharing. The two AC motor propulsion units are mounted on each vehicle; one motor per bogie, as illustrated in Figure 2-6, to provide a friction drive.

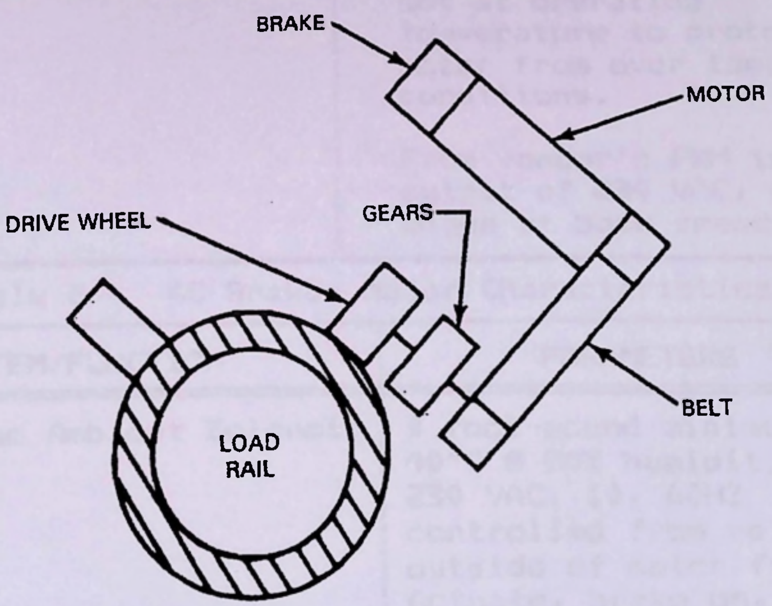


Figure 2-6 Dual AC Motor Unit

Table 2-3 AC Motor Major Characteristics

ITEM/FUNCTION	PARAMETERS
Model	5K48VG8050V 1HP, 230 VAC, 3 phase, hi-slip (10%) induction motor
Base Speed	1620 RPM at 10% slip
Ambient	40°C at 80% humidity
Duty Cycle	17 hours/day
Service Class	I to II
Frame	143T open drip proof (splash guard)
Mounting	Foot mount
Shaft	a. To accept sheave hub for timing belts with tapered hub. b. Capable of mounting hollow shaft standard torque brake on rear of motor.
Stator Voltage	Vendor's standard Wound stator with klixons set at operating temperature to protect the motor from over temp conditions.
Input	From vendor's PWM inverter output of 230 VAC, 60Hz, 3 phase at base speed.

Table 2-4 AC Brakes Major Characteristics

ITEM/FUNCTION	PARAMETERS
Torque Ambient Solenoid	3 foot-pound minimum 40°C @ 80% humidity 230 VAC, 1Ø, 60HZ controlled from relay outside of motor frame. Actuate, brake on, at no voltage.
Brake Release Noise	Manual release with easy access. The brake must not chatter in a manual release or normal pick up.

Disassembly of components should be considered only when repair or replacement of components is necessary and only to the extent needed to effect such repair or replacement. Before determining that disassembly is required, refer to the troubleshooting procedures in Table 2-10. Material required to clean component parts is listed in Table 2-11. Inspection procedures are required to verify the condition of disassembled components and will reveal defects that result from wear, damage, deterioration or other causes.

The following paragraphs provide corrective maintenance procedures for the vehicles. When possible, repairs are accomplished without removing the vehicle from the track. Troubleshooting procedures are contained in Table 2-10.

2.4.4.1 Disassembly. Disassembly procedures are described in the following paragraphs.

2.4.4.1.1 Chassis. No special procedures are required to remove components from the chassis. If removal of components is necessary, refer to Figure 2-11. To disassemble the hanger (4, Figure 2-11), refer to Figure 2-12. If the reaction link (5, Figure 2-11) requires disassembly, refer to Figure 2-13.

2.4.4.1.2 Bogies. No special procedures are required for disassembly of the bogies. If removal of bogie components is necessary, refer to Figure 2-14. Bearing races are press fit; remove using a hydraulic press in the maintenance area.

2.4.4.1.3 Sliding Doors Mechanism. No special procedures are required for disassembly of the sliding doors mechanism. If removal of components is necessary, refer to Figure 2-15.

2.4.4.2 Cleaning. Cleaning instructions for the ride vehicle are described in the following procedures. Material required to clean vehicle components is listed in Table 2-11.

WARNING

Use solvent only in well ventilated area away from energized electrical circuits and heated objects such as soldering irons, or open flames. Avoid excessive inhalation of solvent vapors or prolonged or repeated contact of solvent with skin. Solvent is toxic and flammable and can cause physical discomfort, injury, or death.

CAUTION

When cleaning bearings, heavy petroleum solvents such as kerosene should not be used unless absolutely necessary because they do not evaporate readily. Any small amount left in the bearing cavity will dissolve the new lubricant and change its properties. Refer to Table 2-6 for recommended solvent.

Table 2-10 Vehicle Troubleshooting Chart

PROBLEM/SYMPTOM	PROBABLE CAUSE	CORRECTIVE ACTION
Drive motor will not run.	1. No AC power to panel.	Restore power.
	2. Panel fuse blown.	Replace fuse.
	3. Overload cutout tripped.	a. Check if motor is overloaded and correct condition. b. Check for grounded or shorted motor or push button circuit. Replace as necessary.
	4. Defective SCR.	Replace SCR bridge.
	5. No reference voltage.	Check speed adjust potentiometer or check for defective wiring.
	6. Motor brushes worn or sticking.	Replace brushes.
Drive motor runs at high speed only, without control.	1. Defective speed adjust potentiometer or wiring.	Replace speed adjust potentiometer or defective wiring as necessary.
	2. Defective feedback circuit.	Replace defective circuit.
	3. Defective regulator card.	Replace regulator card.
Motor runs at low speed only.	1. Defective speed adjust potentiometer or wiring.	Replace speed adjust potentiometer or defective wiring as necessary.
	2. Brushes worn or improperly seated.	Replace worn brushes or ensure that brushes are seated properly.
	3. Defective regulator card.	Replace regulator card.
	4. Motor field circuit open.	Check field current.
	5. Motor overloaded.	Ensure that current limit does not hold down motor's speed.

Table 2-10 Vehicle Troubleshooting Chart (Cont.)		
PROBLEM/SYMPTOM	PROBABLE CAUSE	CORRECTIVE ACTION
Short SCR life.	1. Line voltage is not within range.	Check line voltage.
	2. Drive overloaded (a). Constant overload. (b). Peak overloads. (c). Excessive starting loads during acceleration due to high inertia load.	a. Check for overloads and correct as necessary. b. Replace SCR bridge if necessary.
	3. Ambient temperature is excessive.	Check ambient temperature and adjust as necessary.
	4. Grounded motor or push button wiring.	Replace as necessary.
Motor overheats and/or sparks excessively.	1. Motor overloaded.	Check if motor is overloaded and correct condition.
	2. Brushes worn or improperly seated.	Replace worn brushes or ensure that brushes are seated properly.
	3. Wrong grade of brushes.	Replace brushes with correct grade.
Motor speed oscillates.	1. Brushes worn, improperly seated or sticking in holders.	a. Replace worn brushes. b. Correct improperly seated or sticking brushes.
	2. Machine load oscillates.	Check motor speed with load decoupled.
	3. IR drop compensation adjusted too high.	Readjust as necessary.
	4. Defective SCR bridge.	Replace SCR bridge.
	5. Defective IR drop compensation potentiometer.	Clean or replace potentiometer.
	6. Defective regulator card.	Replace regulator card.
Motor runs in one direction only.	1. Defective regulator card.	Replace regulator card.

Table 2-10 Vehicle Troubleshooting Chart (Cont.)

PROBLEM/SYMPTOM	PROBABLE CAUSE	CORRECTIVE ACTION
	2. Defective or improperly wired push buttons, toggle switches or potentiometers.	Replace as necessary.
Frequent blowing of fuses.	1. Current limit adjusted too high.	Readjust current limit.
	2. Faulty SCR bridge.	Replace SCR bridge.
	3. Faulty regulator card.	Replace regulator card.
	4. Dirt or foreign matter in relay contacts.	Clean relay contacts or remove foreign matter.
	5. Line voltage too high.	Check line voltage.
	6. Grounded or shorted motor armature or wiring.	Repair or replace as necessary.
	7. Motor overloaded.	Check if motor is overloaded and correct condition.

Table 2-11 Cleaning Materials

MATERIAL	RECOMMENDED TYPE
Solvent	Federal Specification P-D-680 or equivalent.
Alcohol	1,1,1 Trichloroethylene or equivalent
Cloth, cleaning, low-lint	MIL-C-85043A or equivalent
Compound, Isoline	MIL-S-8660 or equivalent
Compound	MIL-C-16173 or equivalent
Brush, soft bristle	---------
Swab, Cotton	----------
Canvas (Motor)	----------
Sandpaper, very fine (Motor)	----------

> NOTE
>
> During cleaning procedures, ensure that solvent does not splatter or spill on surrounding equipment.

2.4.4.2.1 Vehicle. Proceed as follows:

a. Remove any surface grease on vehicle panels with a clean lint-free cloth moistened with solvent.

b. Blow dust from surfaces, holes and recesses using an air hose.

c. When dry, touch up any minor damage to finish.

d. On plastic parts, use an air hose to blow dust and dirt from surfaces, wipe clean with a lint-free cloth moistened with solvent, allow to dry and polish with a clean, dry, lint-free cloth.

2.4.4.2.2 Chassis Assembly. Proceed as follows:

a. Remove dust and dirt from all surfaces, including parts and wiring, using a soft-bristled brush and an air hose as necessary.

b. Wipe all finished surfaces including motor control box, with a clean, lint-free cloth moistened with solvent.

c. Dry all surfaces with a clean, dry lint-free cloth.

d. Clean wiring; connectors and electrical components with a stiff-bristled brush using solvent, Federal Specification P-D-680 or equivalent.

e. Wipe parts dry with a clean, dry lint-free cloth.

f. After cleaning, retouch or spot-paint surfaces whenever a scratch, mark or scar penetrates to bare metal.

g. When necessary, treat metals with corrosion preventive compound, Military Specification MIL-C-16173 or equivalent. Anodize or apply approved chemical film to aluminum alloy parts which are not grounded or bonded.

h. After cleaning electric connectors, apply a minimum amount of isoline compound, Military Specification MIL-S-8660 or equivalent, on threads of mating surfaces.

i. Clean all threaded fasteners with 1,1,1 trichloreothylene or approved cleaning agent that does not leave a film after evaporation.

2.4.4.2.3 Motors. Proceed as follows:

a. Remove dry dust from motors with power off using vacuum or low pressure clean air. Ensure that wet or oily dirt is removed from the panels and motors.

b. Clean motor commutator with canvas while running motor at low speed. If oil, grease or wet dirt is found, wipe out thoroughly and prevent further contamination. If the surface is very rough, it may be cleaned with a very fine sandpaper.

2.4.4.2.4 Bogies. Proceed as follows:

a. Remove dust and dirt from all surfaces using a stiff-bristled brush and wipe clean with a dry, lint-free cloth or blow dry with an air hose.

b. Clean load wheels and guide wheels with a lint-free cloth moistened with solvent and blow-dry with an air hose or allow to air dry.

2.4.4.2.5 Sliding Doors Mechanism. Proceed as follows:

a. Remove dust and dirt from all metal surfaces using a stiff-bristled brush and wipe clean with a dry, lint-free cloth or blow dry with an air hose.

b. Clean guide roller wheels of door mechanism assembly and upper and lower stabilizer guide wheels with a lint-free cloth moistened with solvent and blow dry with an air hose or allow to air dry.

2.4.4.3 Inspection. Inspection procedures are required to verify the condition of disassembled and cleaned components of the ride vehicle. Inspection will reveal defects resulting from wear, damage or deterioration. In general, perform a visual inspection of vehicle components. Inspect all parts for loose or missing hardware, foreign matter, damage, corrosion, dirt and film. Items to be inspected and their possible defects are described in the following paragraphs.

2.4.4.3.1 Chassis Assembly. Refer to Figure 2-11 and proceed as follows:

a. Observe travel, alignment and vehicle speed.

b. Ensure that bogie wheels and drive are in operating condition.

c. Inspect gearboxes for oil leaks.

d. Check for unusual noises.

e. Check load rail for shiny surfaces indicating wear or a sticking bogie wheel.

f. Check bogie stabilizing arm attached to reaction rail for wear, looseness or damage.

g. Inspect all bolts and fittings on drive for tightness.

h. Check condition of wheels and check for smoothness of operation.

i. Inspect all threaded surfaces for burrs, nicks or stripped threads.

j. Inspect shafts for burrs, nicks and scratches. Remove burrs, nicks and scratches as necessary or replace shafts.

k. Inspect hoses for leakage. Repair or replace as necessary.

l. Inspect bearings for leakage or damage. Replace as necessary.

2.4.4.3.2 Motors. Inspect motors at regular intervals as follows:

> WARNING
>
> Internal parts of the bogie motor may be at line voltage even when motor is not rotating. Before contacting any internal part disconnect all AC line connections.

a. Windings should be dry and free of dust, grease, oil, and dirt. Windings may be cleaned by suction cleaners or by wiping. Nozzles on suction type cleaners should be non-metallic. Gummy deposits of dirt and grease may be removed by using a commercially available low volatile solvent. Do not use gasoline or other inflammable solvents.

b. Terminal connections, assembly screws, bolts and nuts should be tight. They may loosen if motor is not securely bolted and tends to vibrate.

c. Inspect insulation resistance of motors at regular intervals and at approximately the same temperature and humidity conditions each time, to determine possible deterioration of the insulation. When measurements during these intervals indicate a wide variation, determine the cause. Recondition, rewind or reinsulate motors that have been subjected to excessive moisture.

d. Check timing belt for tension and wear every six months. Belts should be able to move approximately 1/2-inch up and down at midway between pulleys. Tighten or replace loose or worn belts.

e. Check any unusual vibration or noise.

f. Inspect for proper grounding.

g. Replace deteriorating wire and components.

h. Tighten loose connections and terminals.

i. Clean and inspect windings.

j. Validate equipment/circuitry.

k. Take amp load and compare with specification data. Record.

l. Inspect and lubricate motor bearings.

m. Megger motor load and line side. Record.

n. Inspect motor plate disc plate and lining.

o. Inspect motor commutator for sooty appearance. A commutator in good condition is dull and chocolate brown.

p. Inspect motor brushes for wear. Replace as necessary.

If problems develop in the operation of the motor, refer to the troubleshooting chart, Table 2-9, and ensure the following:

a. Bearings are in normal condition and have been properly lubricated with a high grade ball bearing lubricant, free of dirt or grit. If dirt enters bearing, flush and relubricate.

b. There is no mechanical misadjustment to prevent free rotation of moving parts of motor and drive.

c. All bolts and nuts are properly tightened.

d. Motor instructions have been carefully carried out.

e. The rated voltage is available at the motor terminals.

f. The voltage corresponds to the value stamped on the nameplate.

g. All connections are properly made in all circuits between motor and control.

h. The overload and low voltage devices in control equipment, fuses or other protective devices are in proper working order.

i. Brushes are in good condition and are making good contact with the commutator.

j. The commutator is clean and has smooth polished surface.

k. No excessive overload exists on the motor. Compare line amperes at full load with nameplate stamping.

2.4.4.3.3 Bogies. Refer to Figure 2-14 and proceed as follows:

a. Inspect for excess side or end play.

b. Inspect all threaded surfaces for burrs, nicks or stripped threads.

h. Tighten loose connections and terminals.

i. Clean and inspect windings.

j. Validate equipment/circuitry.

k. Take amp load and compare with specification data. Record.

l. Inspect and lubricate motor bearings.

m. Megger motor load and line side. Record.

n. Inspect motor plate disc plate and lining.

o. Inspect motor commutator for sooty appearance. A commutator in good condition is dull and chocolate brown.

p. Inspect motor brushes for wear. Replace as necessary.

If problems develop in the operation of the motor, refer to the troubleshooting chart, Table 2-9, and ensure the following:

a. Bearings are in normal condition and have been properly lubricated with a high grade ball bearing lubricant, free of dirt or grit. If dirt enters bearing, flush and relubricate.

b. There is no mechanical misadjustment to prevent free rotation of moving parts of motor and drive.

c. All bolts and nuts are properly tightened.

d. Motor instructions have been carefully carried out.

e. The rated voltage is available at the motor terminals.

f. The voltage corresponds to the value stamped on the nameplate.

g. All connections are properly made in all circuits between motor and control.

h. The overload and low voltage devices in control equipment, fuses or other protective devices are in proper working order.

i. Brushes are in good condition and are making good contact with the commutator.

j. The commutator is clean and has smooth polished surface.

k. No excessive overload exists on the motor. Compare line amperes at full load with nameplate stamping.

2.4.4.3.3 Bogies. Refer to Figure 2-14 and proceed as follows:

a. Inspect for excess side or end play.

b. Inspect all threaded surfaces for burrs, nicks or stripped threads.

c. Inspect shafts for burrs, nicks or scratches. Remove burrs, nicks or scratches as necessary or replace shaft.

d. Check idlers on power unit.

e. Inspect wheel bearings for wear, leaks or damage. Replace bearings as necessary.

f. Inspect outside diameter of load wheels and guide wheels for wear.

2.4.4.3.4 Bogie Wheels (Figure 2-14). A related problem to absolute wheel wear is relative wheel wear; the uniformity of wheel wear from vehicle to vehicle. This is significant because of the shape of the torque/speed curve for the AC induction motor, as shown in Figure 2-9, which results in large changes in torque for small changes in speed. Because all vehicles travel at the same speed, small differences in wheel diameter result in significant differences in motor speed and thus in delivered torque. A differential tread wear of 0.030 in. on the 6-inch diameter wheel results in only a 1% change in diameter and speed, but a 13% change in motor torque (8% slip motor). It is therefore important to ensure the following:

a. All wheel wear is relatively uniform.

b. A ride-speed feedback or control feature is provided so that the ride does not slow down as the wheels wear.

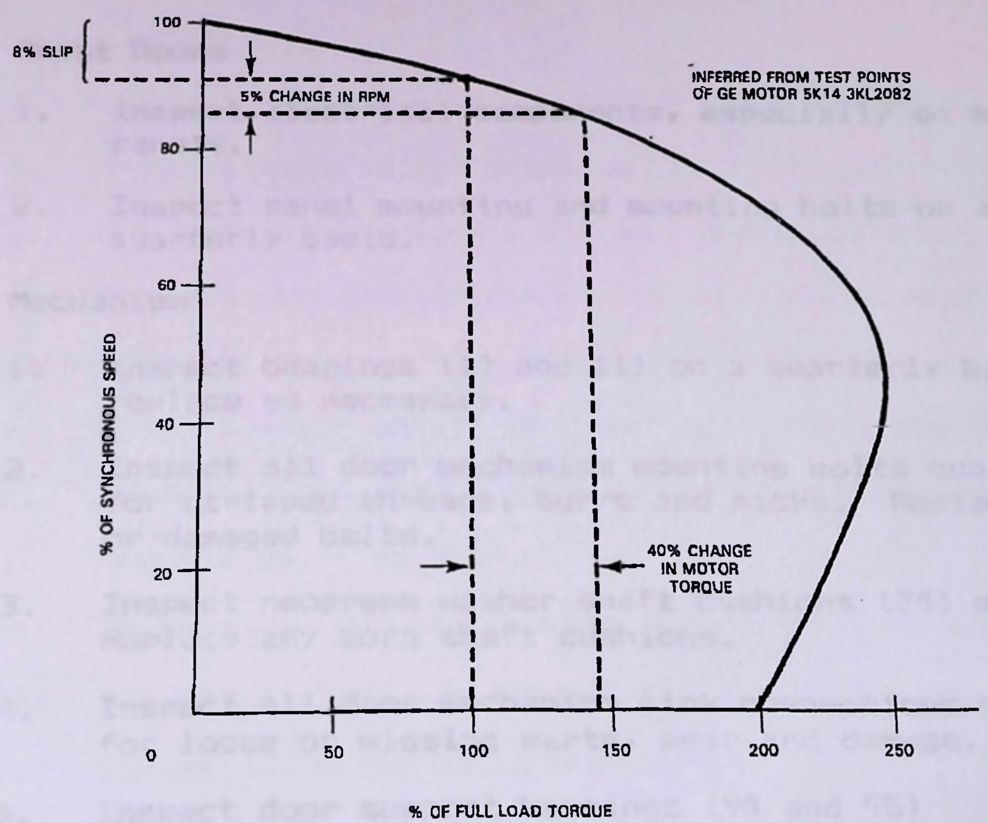


Figure 2-9 Motor Torque To Speed Curve

During some operational conditions, car tilt around the load rail axis while climbing the maximum grade may result in a reduction of the normal force on one drive wheel, resulting in wheel slippage. If this problem materializes, observe the following:

a. Do not permit unpowered vehicles to be loaded.

b. Do not load vehicles unevenly.

c. Sense wheel slippage electrically and remove or reduce power to the motor.

If large differences in wheel diameter occur, such as a very worn wheel being replaced by a new wheel with a larger diameter, the new wheel will turn substantially slower. If torque is 150% to 180% higher than the rated torque, it may cause wheel slippage on inclines, as well as overstress of the motors. To prevent this occurance, follow the procedures listed below:

1. Grind the new replacement wheel to the same diameter as the original wheel.

2. Use onboard controllers and simultaneously replace both wheels on the car.

2.4.4.3.5 Sliding Doors. Inspection of the sliding doors mechanism is accomplished from the access pit located between track supports DE 13.5-4 and DE 13.5-5. Refer to Figure 2-15 and proceed as follows:

a. Guest Doors

1. Inspect electrical components, especially on moving panels.

2. Inspect panel mounting and mounting bolts on a quarterly basis.

b. Mechanism

1. Inspect bearings (10 and 11) on a quarterly basis and replace as necessary.

2. Inspect all door mechanism mounting bolts quarterly for stripped threads, burrs and nicks. Replace worn or damaged bolts.

3. Inspect neoprene washer shaft cushions (74) monthly. Replace any worn shaft cushions.

4. Inspect all door mechanism link connections monthly for loose or missing parts, wear and damage.

5. Inspect door support bearings (94 and 95) semi-annually.

6. Inspect guide roller wheels (17) quarterly. Replace any worn or damaged wheel.

7. Inspect all pivot bearings and bolts quarterly. Replace any worn or damaged components.

8. Check spring (9) for tension. Replace as necessary.

c. Door Latch Assembly

1. Inspect latch and bearings (31 and 32) quarterly. Replace worn or damaged components.

2. Inspect capscrews (35, 36 and 53) quarterly.

3. Inspect pivot bushing (49) quarterly. Replace if worn.

d. Secondary Latch Assembly

1. Check mounting bolts quarterly.

2. Inspect pillow block (60). Replace as necessary.

e. Panel Assembly, Secondary Latch

1. Inspect panel bearing (62) semi-annually for wear. Replace bearing annually.

2. Check mounting bolts.

f. Lower Stabilizer

1. Inspect guide wheels quarterly for tread wear.

2. Inspect guide wheel bearings for wear quarterly.

3. Inspect all mounting bolts and wheel bolts quarterly.

4. Replace any worn or damaged components as necessary.

g. Upper Stabilizer

1. Inspect guide wheels semi-annually for tread wear.

2. Inspect guide wheel bearings for wear semi-annually.

3. Inspect mounting bolts.

4. Replace any worn or damaged components as necessary.

h. Tilt and Unload Soft Cam Entry

1. Inspect mounting bolts quarterly.

2. Inspect square center bonded point semi-annually. Replace as required.

3. Replace shock absorbers annually.

2.4.4.3.6 Emergency Door. Proceed as follows:

a. Inspect suspension assembly (Figure 2-10) for operation and worn or damaged components. Replace suspension assembly or components as required.

b. Inspect latch assembly for operation and worn or damaged components. Replace latch assembly or components as required.

c. Inspect safety lanyard on door latch for damage or deterioration. Replace worn or damaged lanyard.

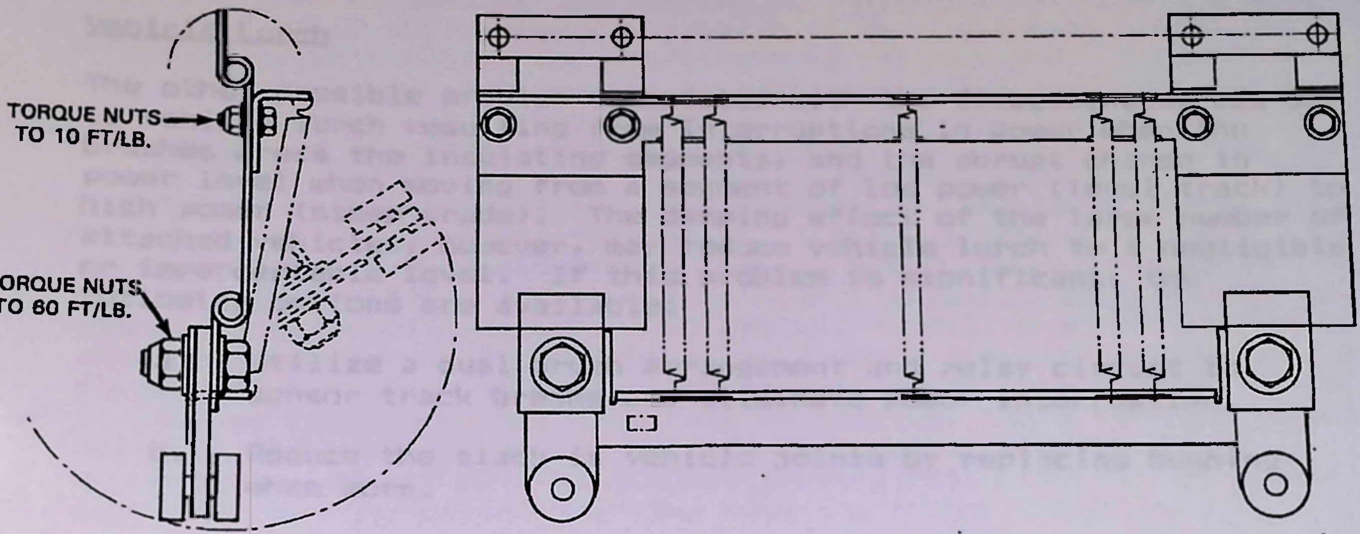


Figure 2-10 Emergency Door Suspension Assy.

2.4.4.3.7 Electrical Pickup System. Proceed as follows:

a. Inspect the pickup brushes for wear. Replace worn brushes.

b. Inspect the copper brush bar for wear. Replace brush bar as necessary.

c. Inspect the bus bar plastic housing for wear, cracks or other signs of damage. Replace worn or damaged housing.

Arcing

The zone control for the motors utilizes segments of the bus bar to provide various power levels. When the pickup brush leaves one segment to travel over an insulating segment to another segment, the inductive load will cause an arc. This sparking may present the following three problems:

a. Interference with audio.

b. Excessive brush wear or bus bar wear (at ends).

c. Visible flashes in dark areas of ride.

If these problems are evident, the following solutions are recommended:

a. Filter or shield audio circuits.

b. Use a solid state or mechanical relay circuit to disengage the motor prior to the brush breaking contact with the bar.

c. Shield against visible flashes.

d. Use onboard controller with continuous bus bar.

Vehicle Lurch

The other possible problem associated with the discontinuous bus bar is vehicle lurch resulting from interruptions in power when the brushes cross the insulating segments, and the abrupt change in power level when moving from a segment of low power (level track) to high power (steep grade). The damping effect of the large number of attached vehicles, however, may reduce vehicle lurch to a negligible or imperceptable level. If this problem is significant, the following options are available:

a. Utilize a dual brush arrangement and relay circuit to sensor track breaks and eliminate power interruption.

b. Reduce the slack in vehicle joints by replacing bushing when worn.

c. Utilize inductive coupling pickup with zone control in the primary circuit instead of bus bars.

d. Utilize onboard controller with automatic ramp-on ramp-off features between zones.

2.4.4.3.8 Vehicle Audio System. Proceed as follows:

a. Ensure that audio power is provided by the motor power conductors.

b. Ensure that the pickup box and bus bar conductor system is supporting the audio IR signal transmitter and receiver.

2.4.4.4 Lubrication. Lubrication procedures are described in the following paragraphs.

2.4.4.4.1 Sliding Doors Mechanism. Proceed as follows:

a. Pump two or three strokes of grease into appropriate grease fittings using bearing or a good multi-purpose chassis grease.

b. Lubricate all pivot points.

c. Apply a light grade oil to the door support shaft (23, Figure 2-15). Apply lubricant frequently to maintain the protective film on the shaft.

2.4.4.4.2 Bearings. The bogies contain fully sealed bearings which eliminate the need for continual lubrication. This simplifies maintenance procedures and assures that grease will not leak onto the load rail causing wheel slippage. The bearings have been selected for 98% reliability for a 3-year life and should be replaced every 3 years.

Lubricate bearings that are not self lubricated at regular intervals. The frequency and amount of lubrication is dependent upon the type of service the bearing is subjected to. Use a grease that is free of acid, alkali, abrasive filters and dirt. NLGI No. 2 consistency with a drop point of 150°F is recommended. A bearing not properly lubricated can run to destruction and cause damage to other components. Add grease slowly, as rapid application may blow the seals and allow the grease to escape.

2.4.4.4.3 Fasteners. Lubrication reduces the friction between mating flanks on threaded fasteners. Torsional forces on the threaded lubricated fastener are therefore much lower, making it possible to preload the fastener to higher values. The presence of grease or heavy oil requires a 40 percent reduction of torque. A 30 percent reduction in torque should be made if graphite is used and a 25 percent reduction if white lead is applied to the threads. When tightening fasteners that have been in service, use a reduced torque value if the exposed threads of a capscrew have received an accumulation of oil or grease while in service, since oil or grease will provide lubrication when the nuts are being retightened.

2.4.4.5 Reassembly. Reassembly procedures are described in the following paragraphs. Threaded fasteners used in metal to metal structural points conform to the following:

Hex Head Capscrews - Grade 8 per SAEJ429

Prevailing Torque Locknuts - Grade C per IFI-100

Hardened Washers - ASTM - A325 or F436

Procedures for the Grade 8 Primary Fastener System used in the Horizons ride vehicle are described in paragraph 2.4.3.1. Unless otherwise specified, the assembly torques listed in Table 2-8 are required for reassembly or installation of vehicle components.

WARNING

Improper application of a fastener could result in personal injury or damage to the equipment. For assistance on special and critical torquing problems contact the engineering department.

> **NOTE**
>
> Apply Loctite 242 to all threaded fasteners before installing.

2.4.4.5.1 Chassis Assembly. No special procedures are required to install components on the chassis. Refer to Figure 2-11 for reassembly. Before installing a hanger (4), refer to Figure 2-12 for reassembly. For reassembly of a reaction link (5), refer to Figure 2-13.

2.4.4.5.2 Bogie. Refer to Figure 2-14 and proceed as follows:

a. Guide Wheels (33, 34)

1. Insert support tube (39) and bushing (40) into guide wheel (37).

2. Position guide wheel assembly (33, 34) in housing (35) and secure with capscrew (43), washers (52) and locknut (50). Torque nut to 60 ft/lbs.

b. Load Wheels (57, 58)

1. Position load wheel shaft (55) into load wheel (55). Secure with studs (79), washers (95) and nuts (91). Torque nuts to 40 ft/lbs.

2. Install thrust washer (60), bearing (76), spacer (63) and bearing (75).

3. Secure to shaft (55) with lockwasher (81) and nut (80).

4. Install bearing (75), retainer (64) and spacer (61).

5. Secure to shaft (55) with nut (90). Torque nut to 200 ft/lbs and install cotter pin (82).

6. Position assembled wheel to bogie (1) and install bearing caps (3 and 4) on studs (5).

7. Install washer (7) and secure with nuts (6).

c. Bogies

1. Insert (56) into bogie and secure with washer (93) and nut (80). Torque nut to 400 ft/lbs.

d. Motors

1. Assemble mounting bracket (10 or 11) and upstop bracket (32). Secure with washers (96) and capscrews (85). Torque capscrews to 25 ft/lbs.

2. Secure motor to mounting plate (13) with washers (97), nuts (92) and capscrews (86). Torque capscrews to 15 ft/lbs.

2.4.4.5.3 Sliding Doors. No special procedures are required to install components on the sliding doors. Refer to Figure 2-15 to install a roller, pillow block or bearings, or to reassemble linkages, the door latch or secondary door latch. Replace worn bearings or shaft cushions. Torque nuts to values listed in Table 2-8.

2.4.4.5.4 Emergency Door. If an emergency door has been removed for maintenance or repair, ensure that the same door is reinstalled on the vehicle. Torque nuts as shown in Figure 2-10.

2.4.4.6 Illustrated Parts Breakdown. The illustrated parts breakdowns (IPB) provide listings and illustrations necessary for the disassembly and assembly of the vehicles and are intended to be used to facilitate requisitioning, storing and identifying vehicle parts.

2.4.4.6.1 Item Number. Item numbers are assigned to parts or groups of parts within each figure and correspond with the item numbers on the accompanying illustrations.

2.4.4.6.2 Dwg/Mfr No. Column. This column lists the manufacturer's drawing number assigned to each part as applicable.

2.4.4.6.3 WDP No. Column. This column lists the Walt Disney Productions part number assigned to each part.

2.4.4.6.4 Description/Mfr column. This column lists the noun name of each part plus descriptive modifiers which define the physical and functional characteristics of the part when necessary for identification. The description of parts other than those manufactured by Walt Disney Productions contain the manufacturer's name next to the description of the part.

2.4.4.6.5 Quantity Column. This column contains the number of items required for each listed part.

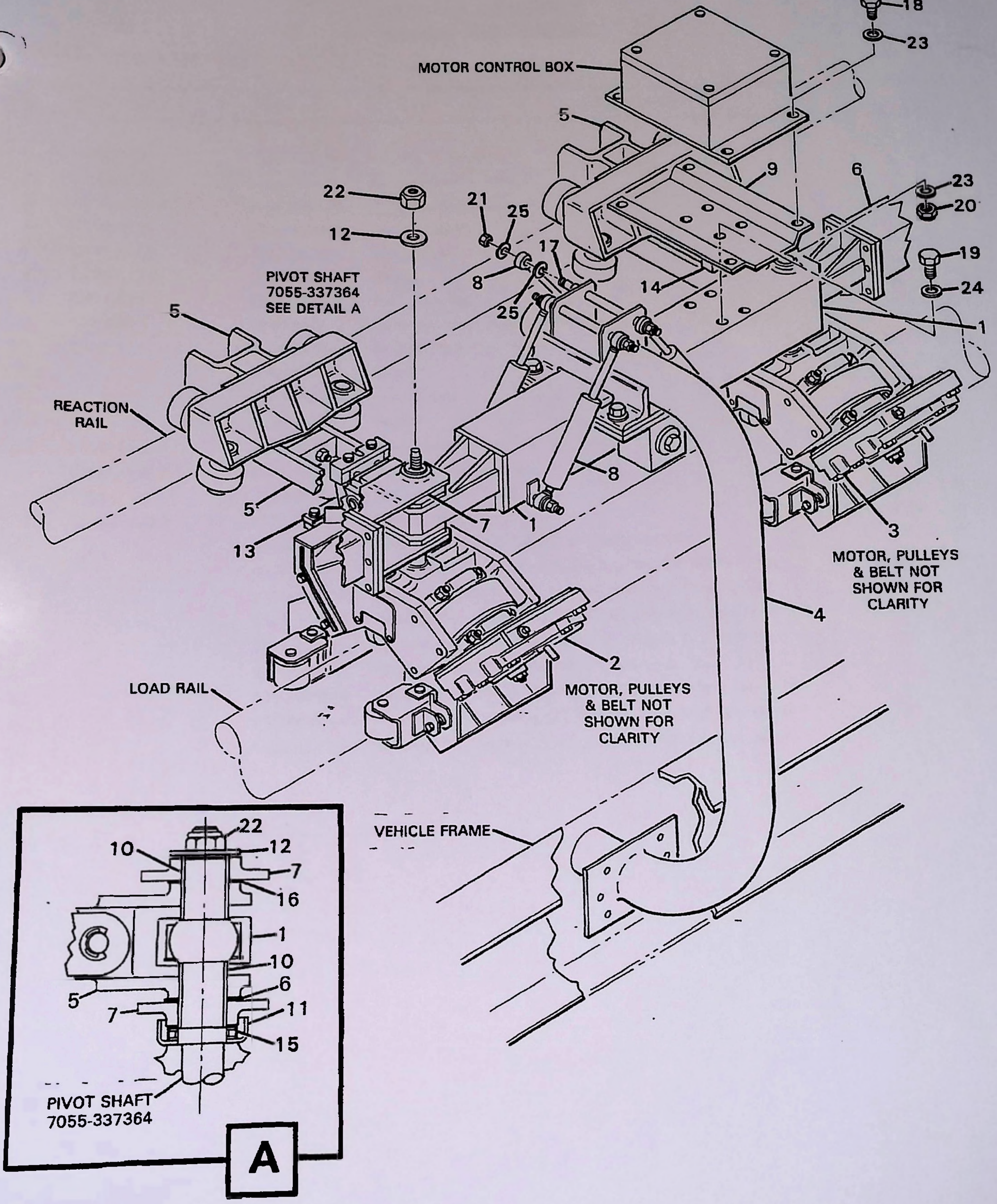


Figure 2-11 Chassis Assembly
Sheet 1 of 2

CHASSIS ASSEMBLY

WDP NO. 7055-335880

DWG NO. C3PM-A100 Rev.

ITEM	DWG/MFR NO.	WDP NO.	DESCRIPTION/MFR	QTY
1	C3PM-A101	7055-337434	Load Bar Assembly	1
2	C3PM-A102-1	7055-337442	Bogie Assembly, Front	1
3	C3PM-A102-2	7055-337443	Bogie Assembly, Rear	1
4	C3PM-A103	7055-337248	Hanger Assembly	1
5	C3PM-A105	7055-337503	Reaction Link Assembly	2
6	C3PM-112-2	7055-337346	Tongue	1
7	C3PM-113	7055-337426	Yoke, Tow Bar	1
8	C3PM-114	3040-337079	Shock Absorber, Spec Control Drawing	4
9	C3PM-115	7055-337441	Bracket, Motor Control Box	1
10	C3PM-116	5365-337676	Spacer	4
11	C3PM-118	4930-337708	Cup, Grease	2
12	C3PM-165	3310-337677	Washer	2
13	C3PM-A502-1	7055-337962	Safety Switch Assembly, Left Hand	1
14	C3PM-A502-2	7055-337963	Safety Switch Assembly, Right Hand	1
15	T199	3110-583243	Bearing Thrust, TTSP *TIMKEN*	2
16	CWW32E52-3	3120-583244	Washer, Thrust *DIXON*	4
17		5306-615961	Rod, Threaded, 1/2-13UNC × 12-1/2, Stl, Pltd	4
18		5306-812674	Screw, Cap 5/16-18UNC × 3/4, Hex Hd, Stl, Grade 8, Pltd	8
19		5306-575933	Screw, Cap 3/8-16UNC × 5/8, Hex Hd, Stl, Grade 8, Pltd	4
20		5310-002585	Locknut, Hex, P.T., 5/16-18UNC, IFI 100, Gr C, Zinc Pl Stl	4
21		5310-561935	Locknut, Hex, P.T., 1/2-13UNC, IFI 100, Gr C, Zinc Pl Stl	8
22		5310-569788	Locknut, Hex, P.T., 1-14UNF, IFI 100, Gr C, Znc Pl Stl	2
23		5310-565934	Washer, Flat, Hardened, 5/16" ASTM A325/F436, Zinc Pl Stl	12
24		5310-562353	Washer, Flat, Hardened, 3/8" ASTM A325/F436, Zinc Pl Stl	4
25		5310-593114	Washer Flat, Hardened, 1/2" ASTM A325/F436, Zinc Pl Stl	16

Figure 2-11 Chassis Assembly
Sheet 2 of 2

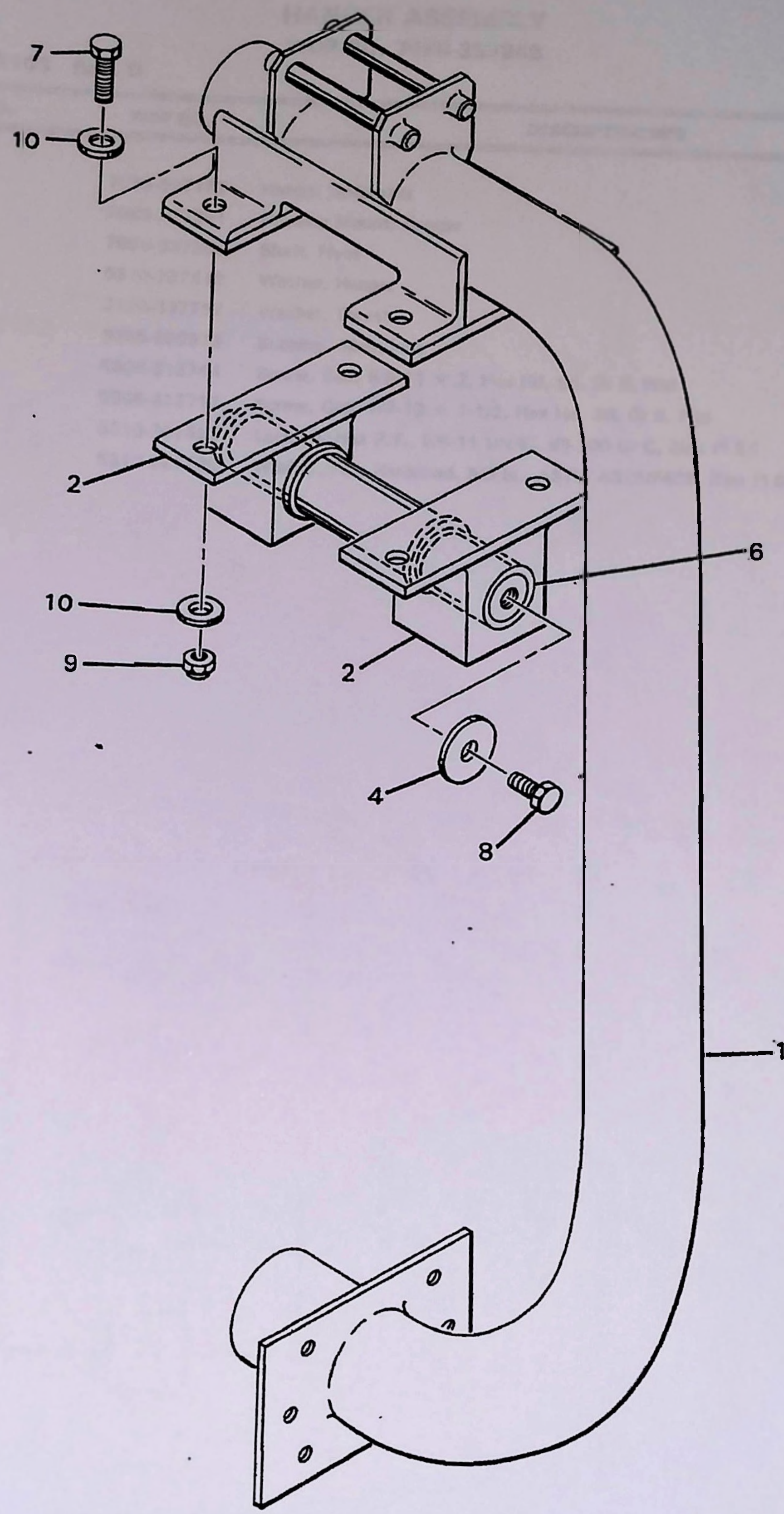


Figure 2-12 Hangar Assembly
Sheet 1 of 2

HANGER ASSEMBLY

WDP NO. 7055-337248

DWG NO. C3PM-A103 Rev. 0

ITEM	DWG/MFR NO.	WDP NO.	DESCRIPTION/MFR		QTY
1	C3PM-130	7055-337152	Hanger Weldment		1
2	C3PM-131	7055-337251	Housing Mount, Hanger		2
3	C3PM-132	7055-337250	Shaft, Pivot		1
4	C3PM-133	5310-337249	Washer, Hanger		2
5	C3PM-134	3120-337757	Washer, Thrust		2
6	3543	5365-580973	Bushing, Silent Line	*BUSHING INC.*	2
7		5306-812744	Screw, Cap, 5/8-11 × 2, Hex Hd, Stl, Gr 8, Pltd		4
8		5306-812717	Screw, Cap, 1/2-13 × 1-1/2, Hex Hd, Stl, Gr 8, Pltd		2
9		5310-561532	Locknut, Hex P.T., 5/8-11 UNRC, IFI-100 Gr C, Zinc Pl Stl		4
10		5310-561225	Washer, Flat, Hardened, 5/8 In., ASTM A325/F436, Zinc Pl Stl		8

Figure 2-12 Hangar Assembly
Sheet 2 of 2

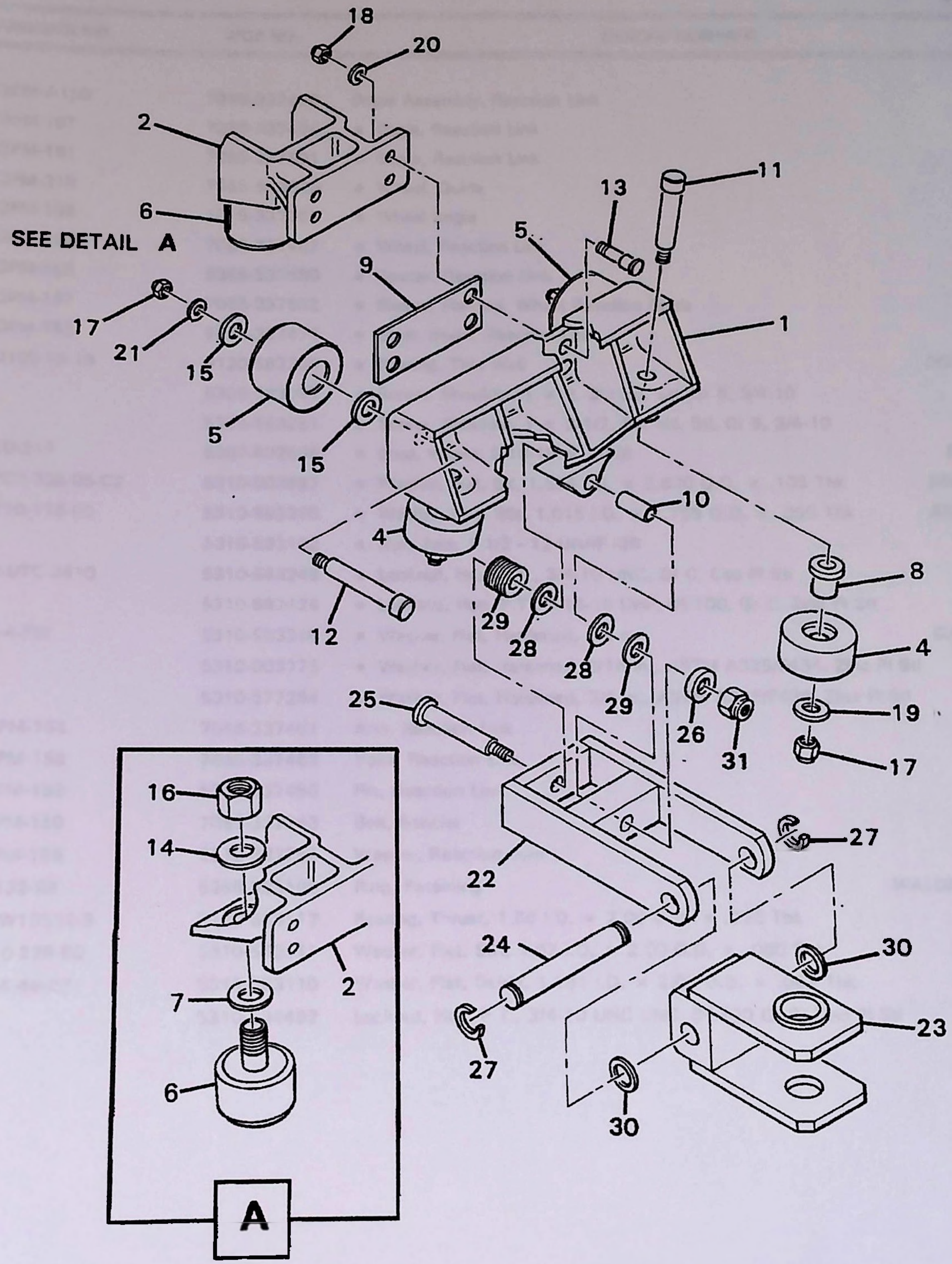


Figure 2-13 Reaction Link Assembly
Sheet 1 of 2

REACTION LINK ASSEMBLY

WDP NO. 7055-337503

DWG NO. C3PM-A105 Rev. **Sheet 1 of 1**

ITEM	DWG/MFR NO.	WDP NO.	DESCRIPTION/MFR		QTY
1	C3PM-A150	7055-337498	Bogie Assembly, Reaction Link		1
2	C3PM-197	7055-337484	• Bogie, Reaction Link		1
3	C3PM-151	7055-337501	• Bogie, Reaction Link		1
4	C3PM-318	7055-663523	• Wheel, Guide		2
5	C3PM-196	7055-337751	• Wheel Bogie		2
6	C3PM-152	7055-337487	• Wheel, Reaction Link		1
7	C3PM-155	5365-337480	• Spacer, Reaction Link		1
8	C3PM-157	7055-337502	• Sleeve, Flanged, Wheel Reaction Bogie		2
9	C3PM-153	5365-337479	• Shim, Bogie, Reaction Link		A/R
10	CJ16E-18-18	3120-583206	• Bearing, Thin Wall	*DIXON C.J.*	1
11		5305-583097	• Screw, Shoulder, 1 × 3, Skt Hd, Stl, Gr 8, 3/4-10		2
12		5305-583251	• Screw, Shoulder, 1 × 3-1/2, Skt Hd, Stl, Gr 8, 3/4-10		2
13	610-217	5307-602569	• Stud, Wheel, 9/16-18 × 2-1/8	*DORMAN*	4
14	5702-336-05-C2	5310-003997	• Washer, Flat, Stl, 1.504 I.D. × 2.820 O.D. × .105 Thk	*SEASTROM*	1
15	5710-116-90	5310-583250	• Washer, Flat, SSt, 1.015 I.D. × 1.755 O.D. × .090 Thk	*SEASTROM*	4
16		5310-583102	• Nut, Jam, 1-1/2 - 12 UNRF -2B		1
17	52-UTC-3410	5310-583249	• Locknut, Hex, P.T., 3/4-10 UNC, Gr C, Cad Pl Stl		4
18		5310-582424 •	• Locknut, Hex, P.T., 9/16-18 UNF, IFI-100, Gr C, Zinc Pl Stl		4
19	CL-4-FW	5310-583248	• Washer, Flat, Hardened, 3/4 In.	*CARR LANE*	2
20		5310-003775	• Washer, Flat, Hardened, 9/16 In., ASTM A325/F436, Zinc Pl Stl		4
21		5310-577284	• Washer, Flat, Hardened, 3/4 In., ASTM A325/F436, Zinc Pl Stl		2
22	C3PM-154	7055-337481	Arm, Reaction Link		1
23	C3PM-158	7055-337482	Yoke, Reaction Link		1
24	C3PM-159	5315-337486	Pin, Reaction Link		1
25	C3PM-156	7055-337743	Bolt, Special		1
26	C3PM-195	5310-337754	Washer, Reaction Arm		1
27	X5133-98	5365-583109	Ring, Retaining	*WALDES TRUARC*	2
28	CWW16532-3	3120-583112	Bearing, Thrust, 1.00 I.D. × 2.00 O.D. × .078 Thk	*DIXON*	2
29	5710-229-60	5310-583111	Washer, Flat, SSt, 1.02 I.D. × 2.00 O.D. × .060 Thk	*SEASTROM*	5
30	5614-44-62	5310-583110	Washer, Flat, Delrin, 1.161 I.D. × 2.00 O.D. × .062 Thk	*SEASTROM*	2
31		5310-594492	Locknut, Hex, P.T., 3/4-10 UNC UNC, IFI-100 Gr C, Zinc Pl Stl		1

Figure 2-13 Reaction Link Assembly
Sheet 2 of 2

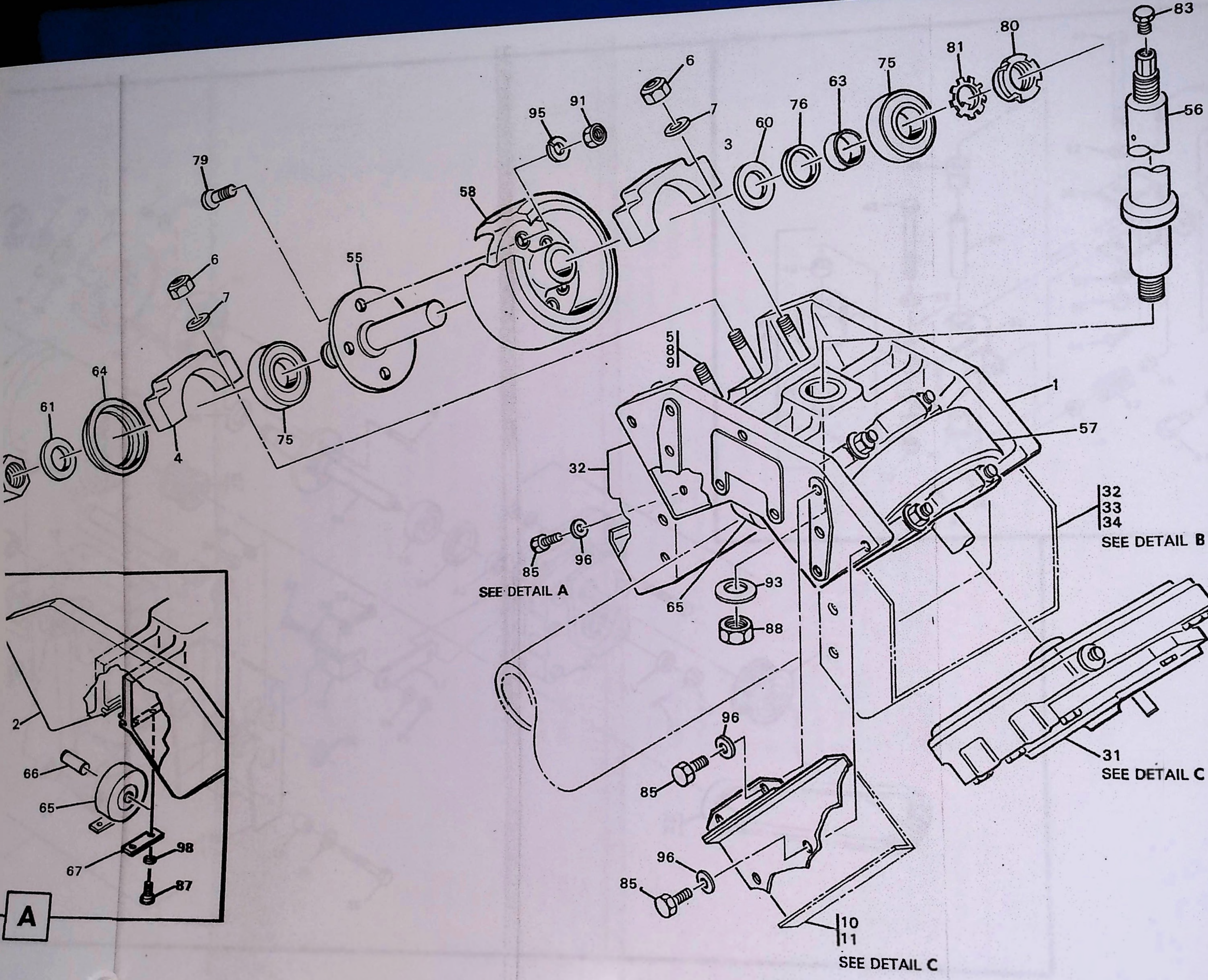
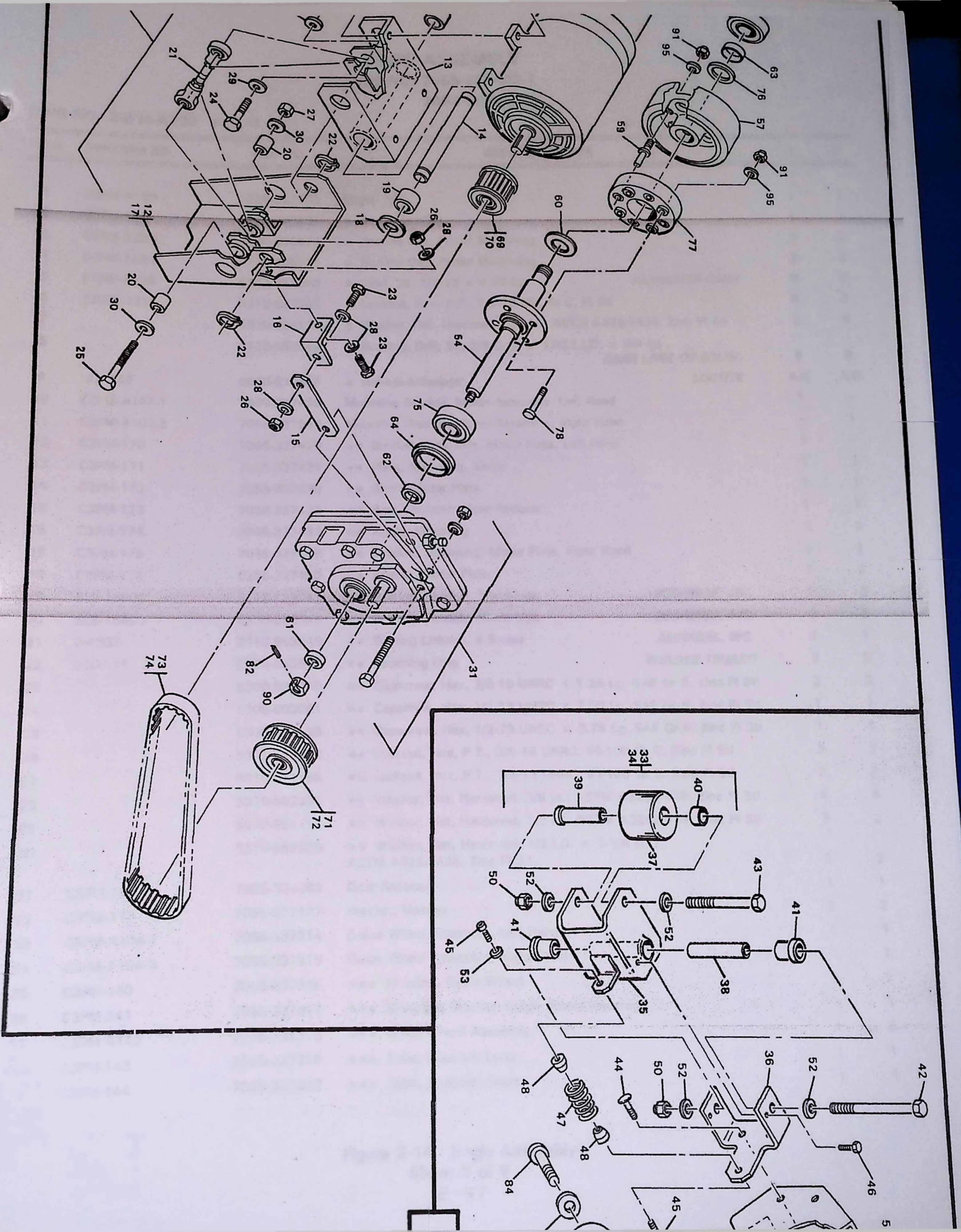


Figure 2-14
She



21
29
24
27
30
20
22
13
14
12
17
19
18
26
28
69
70
20
30
25
22
16
23
28
23
64
28
26
15
75
64
78
62
61
82
90
31
73
74
71
72
91
95
63
76
57
59
91
95
60
77
33
34
39
40
37
43
50
52
41
45
53
52
38
35
41
48
47
44
50
52
36
52
42
48
46
84
45

BOGIE ASSEMBLY
WDP NO. 7055-337442-1
7055-337443-2

DWG NO. C3PM-A102 Rev. 0

ITEM	DWG/MFR NO.	WDP NO.	DESCRIPTION/MFR	-1	-2
1	C3PM-A120	7055-337438	Bogie	1	1
2	C3PM-121	7055-337437	• Bogie Housing	1	1
3	C3PM-122-1	3120-335973	• Bearing Cap, Partial Machining	2	2
4	C3PM-122-2	3120-335974	• Bearing Cap, Partial Machining	2	2
5	91561A728	5307-583048	• Stud, Stl, 1/2-13 × 4.00 Lg *McMASTER-CARR*	8	8
6	52UTC1213	5310-583265	• Locknut, Hex, P.T., 1/2-13 UN, Gr C, Pl Stl	8	8
7		5310-593114	• Washer, Flat, Hardened, 1/2 In., ASTM A325/F436, Zinc Pl Stl	8	8
8		3120-583049	• Bushing, Drill, Stl, 3/4 O.D. × 17/32 I.D. × 3/4 Lg *CARR LANE OR EQUIV.*	8	8
9	NO. 242	8030-570605	• Adhesive/Sealant *LOCTITE*	A/R	A/R
10	C3PM-A107-1	7055-337439	Mounting Bracket, Motor Assembly, Left Hand	1	—
11	C3PM-A107-2	7055-337040	Mounting Bracket, Motor Assembly, Right Hand	—	1
12	C3PM-170	7055-337428	•• Bracket, Mounting, Motor Plate, Left Hand	1	—
13	C3PM-171	7055-337429	•• Plate, Mounting, Motor	1	1
14	C3PM-172	7055-337430	•• Shaft, Motor Plate	1	1
15	C3PM-173	7055-337432	•• Arm, Stiffener, Gear Reducer	1	1
16	C3PM-174	7055-337433	•• Angle, Mounting	1	1
17	C3PM-175	7055-337449	•• Bracket, Mounting, Motor Plate, Right Hand	—	1
18	C3PM-176	5365-337450	•• Spacer, Motor Plate	2	2
19	SLB-15600	3120-583047	•• Bearing, Flexible, Silent-Lign *BUSHINGS, INC.*	2	2
20	SLB-15400	3120-583046	•• Bearing, Flexible, Silent-Lign *BUSHINGS, INC.*	2	2
21	S-4393	3110-583045	•• Bearing Linkage, K Series *ALINABAL, INC.*	1	1
22	5100-75	5365-560651	•• Retaining Ring *WALDES TRUARC*	2	2
23		5306-590940	•• Capscrew, Hex, 3/8-16 UNRC × 1.25 Lg, SAE Gr 8, Zinc Pl Stl	2	2
24		5305-603061	•• Capscrew, Hex, 1/2-13 UNRC × 2.00 Lg, SAE Gr 8, Zinc Pl Stl	1	1
25		5305-583039	•• Capscrew, Hex, 1/2-13 UNRC × 3.75 Lg, SAE Gr 8, Zinc Pl Stl	1	1
26		5310-594493	•• Locknut, Hex, P.T., 3/8-16 UNRC, IFI-100 Gr C, Zinc Pl Stl	2	2
27		5310-571758	•• Locknut, Hex, P.T., 1/2-13 UNRC, IFI-100 Gr C, Zinc Pl Stl	2	2
28		5310-562353	•• Washer, Flat, Hardened, 3/8 In., ASTM A325/F436, Zinc Pl Stl	4	4
29		5310-593114	•• Washer, Flat, Hardened, 1/2 In., ASTM A325/F436, Zinc Pl Stl	2	2
30		5310-568680	•• Washer, Flat, Hardened, 1/2 I.D. × 1-1/4 O.D., ASTM A325/F436, Zinc Pl Stl	2	2
31	C3PM-190	7055-335883	Gear Reducer	1	1
32	C3PM-117	7055-337427	Bracket, Upstop	2	2
33	C3PM-A104-1	7055-337314	Guide Wheel Assembly, Left Hand	1	1
34	C3PM-A104-3	7055-337315	Guide Wheel Assembly, Right Hand	1	1
35	C3PM-140	7055-337316	••• Housing, Guide Wheel	1	1
36	C3PM-141	7055-337317	••• Mounting Bracket, Guide Wheel Housing	1	1
37	C3PM-A142	7055-337318	••• Guide Wheel Assembly	1	1
38	C3PM-143	7055-337319	••• Tube, Support, Long	1	1
39	C3PM-144	7055-337320	••• Tube, Support, Short	1	1

Figure 2-14 Bogie Assembly
Sheet 3 of 5

DWG NO. C3PM-A102 Rev. 0

ITEM	DWG/MFR NO.	WDP NO.	DESCRIPTION/MFR		-1	-2
40	C3PM-145	5365-337321	••• Spacer, Guide Wheel		1	1
41	35654 FB-1216-8	3120-577128	••• Bushing, Flanged, Bronze	***BOSTON GEAR***	2	2
42		5306-573987	••• Capscrew, Hex, 1/2-13 UNRC -2A × 5.50 Lg, Gr 8, Zinc Pl		1	1
43		5306-812726	••• Capscrew, Hex, 1/2-13 UNRC -2A × 4.50 Lg, Gr 8, Zinc Pl		1	1
44	610-102	5307-580977	••• Wheel Stud, 7/16-20 UNF -2A × 1-3/8 Lg	***DORMAN PROD.***	2	2
45		5305-562226	••• Capscrew, Socket Hd, 1/4-20 UNC -2A × .75 Lg, Gr 8, Zinc Pl		1	1
46		5306-812662	••• Capscrew, Hex, 1/4-20 UNRC × 3/4 Lg, Stl, Gr 8, Zinc Pl		2	2
47	C1100-135-2000	5360-580975	••• Spring, Compression	***ASSOCIATED SPRING***	1	1
48	C3PM-146	7055-337322	••• Stop, Guide Wheel		2	2
49		5310-580976	••• Locknut, Hex, P.T., 7/16-20 UNF -2B, IFI-100, Gr C, Zinc Pl		2	2
50		5310-571758	••• Locknut, Hex, P.T., 1/2-13 UNC -2B, IFI-100, Gr C, Zinc Pl		2	2
51		5310-576144	••• Washer, Flat, Hardened, 7/16 In., ASTM A325/F436, Zinc Pl Stl		2	2
52		5310-593114	••• Washer, Flat, Hardened, 1/2 In., ASTM A325/F436, Zinc Pl Stl		4	4
53		5310-562175	••• Washer, Flat, Hardened, 1/4 In., ASTM A325/F436, Zinc Pl Stl		1	1
54	C3PM-123-1	7055-337089	Shaft, Load Wheel		1	
55	C3PM-123-2	7055-337090	Shaft, Load Wheel		1	1
56	C3PM-124	7055-337364	Shaft, Vert. Pivot		1	1
57	C3PM-125-1	7055-337153	Load Wheel		1	2
58	C3PM-125-2	7055-337154	Load Wheel		1	—
59	C3PM-126	5315-337415	Pin, Drive		4	4
60	C3PM-127	5310-337420	Washer, Thrust		2	2
61	C3PM-128-1	5365-337416	Spacer		2	2
62	C3PM-128-2	5365-337417	Spacer		1	1
63	C3PM-128-3	5365-337418	Spacer		2	2
64	C3PM-129	7055-337419	Retainer, Bearing		2	2
65	C3PM-191	7055-337422	Roller		1	1
66	C3PM-192	7055-337421	Shaft, Roller		1	1
67	C3PM-193	7055-337423	Keeper Plate		2	2
68	SEV-173	7028-335487	Guide Wheel Assembly		2	2
69	TL18H200	3020-583050	Pulley, Dyna-Sync, Size 113704	***DODGE***	1	1
70	1215	3020-801779	Bushing, Taper-Lock, 7/8 Bore, 3/16 × 3/32 K.W.	***DODGE***	1	1
71	TL24H150	3020-583051	Pulley, Dyna-Sync, Size 113663	***DODGE***	1	1
72	2012	5365-583056	Bushing, Taper-Lock, 3/4 Bore, 3/16 × 3/32 K.W.	***DODGE***	1	1
73	360H075	3030-583055	Belt, Dyna-Sync, 1/2" Pitch × 3/4 Wide	***DODGE***	—	1
74	390H075	3030-583054	Belt, Dyna-Sync, 1/2" Pitch × 3/4 Wide	***DODGE***	1	—
75	307NPP	3110-582718	Bearing, Ball, Double-Sealed	***FAFNIR***	4	
76	TT-2008	3120-592746	Bearing, Thrust, 1.503 I.D. × 2.00 O.D. × 1/8	***OILITE***	2	2
77	LCR-400-800-115A	3010-582719	Coupling, Elastromeric	***LORD***	1	1

Figure 2-14 Bogie Assembly
Sheet 4 of 5

BOGIE ASSEMBLY

WDP NO. 7055-337442-1
7055-337443-2

DWG NO. C3PM-A102 Rev. 0

ITEM	DWG/MFR NO.	WDP NO.	DESCRIPTION/MFR		-1	-2
78	610-157	5307-583052	Stud, Wheel, 7/16-20 UNF -2A × 2-1/8 Lg	*DORMAN*	4	4
79	610-102	5307-583053	Stud, Wheel, 7/16-20 UNF -2A × 1-3/8 Lg	*DORMAN*	4	4
80	N-07	3110-568126	Nut, Bearing, 1-3/8 - 18	*AFBMA STANDARD*	2	2
81	W-07	3110-811509	Washer, Lock, Bearing	*AFBMA STANDARD*	2	2
82		5315-565548	Pin, Cotter, 1/8 × 1-1/2		2	2
83		4730-800138	Pipe Plug, 1/8-27 NPT		1	1
84		5305-567711	Screw, Shoulder, 1 × 1-3/4, Skt Hd, Stl, Gr 8, Plated, 3/4 I.D.		2	2
85		5306-590739	Capscrew, Hex, 3/8-16 UNRC × 1 Lg, SAE Gr 8, Zinc Pl Stl		12	12
86		5306-594473	Capscrew, Hex, 5/16-18 UNRC × 1 Lg, SAE Gr 8, Zinc Pl Stl		4	4
87	MS35207-263	5305-003423	Screw, Pan Hd, Cross Rec, 10-32 UNF × 1/2, Zinc Pl Stl		4	4
88		5310-582457	Nut, Lock, Hex, 1-12 UNF -2B, IFI-100 Gr C, Zinc Pl Stl		1	1
89	S2-UTC3410	5310-595184	Nut, Lock, Hex, P.T., 3/4-10 UNC -2B, IFI-100 Gr C, Plated		2	2
90		5310-583057	Nut, Hex, Slotted, 3/4-10 UNC -2B, Gr 5, Zinc Pl Stl		2	2
91		5310-002150	Nut, Lock, Hex, 7/16-20 UNF -2B, IFI-100 Gr C, Zinc Pl Stl		12	12
92		5310-002585	Nut, Lock, Hex, 5/16-18 UNF -2B, IFI-100 Gr C, Zinc Pl Stl		4	4
93		5310-562311	Washer, Flat, Hardened, 1 In., ASTM A325/F436, Zinc Pl Stl		3	3
94		5310-595280	Washer, Flat, Hardened, 3/4 In., ASTM A325/F436, Zinc Pl Stl		2	2
95		5310-576144	Washer, Flat, Hardened, 7/16 In., ASTM A325/F436, Zinc Pl Stl		12	12
96		5310-562353	Washer, Flat, Hardened, 3/8 In., ASTM A325/F436, Zinc Pl Stl		12	12
97		5310-565934	Washer, Flat, Hardened, 5/16 In., ASTM A325/F436, Zinc Pl Stl		8	8
98		5310-565548	Washer, Split-Lock, #10		4	4

Figure 2-14 Bogie Assembly
Sheet 5 of 5

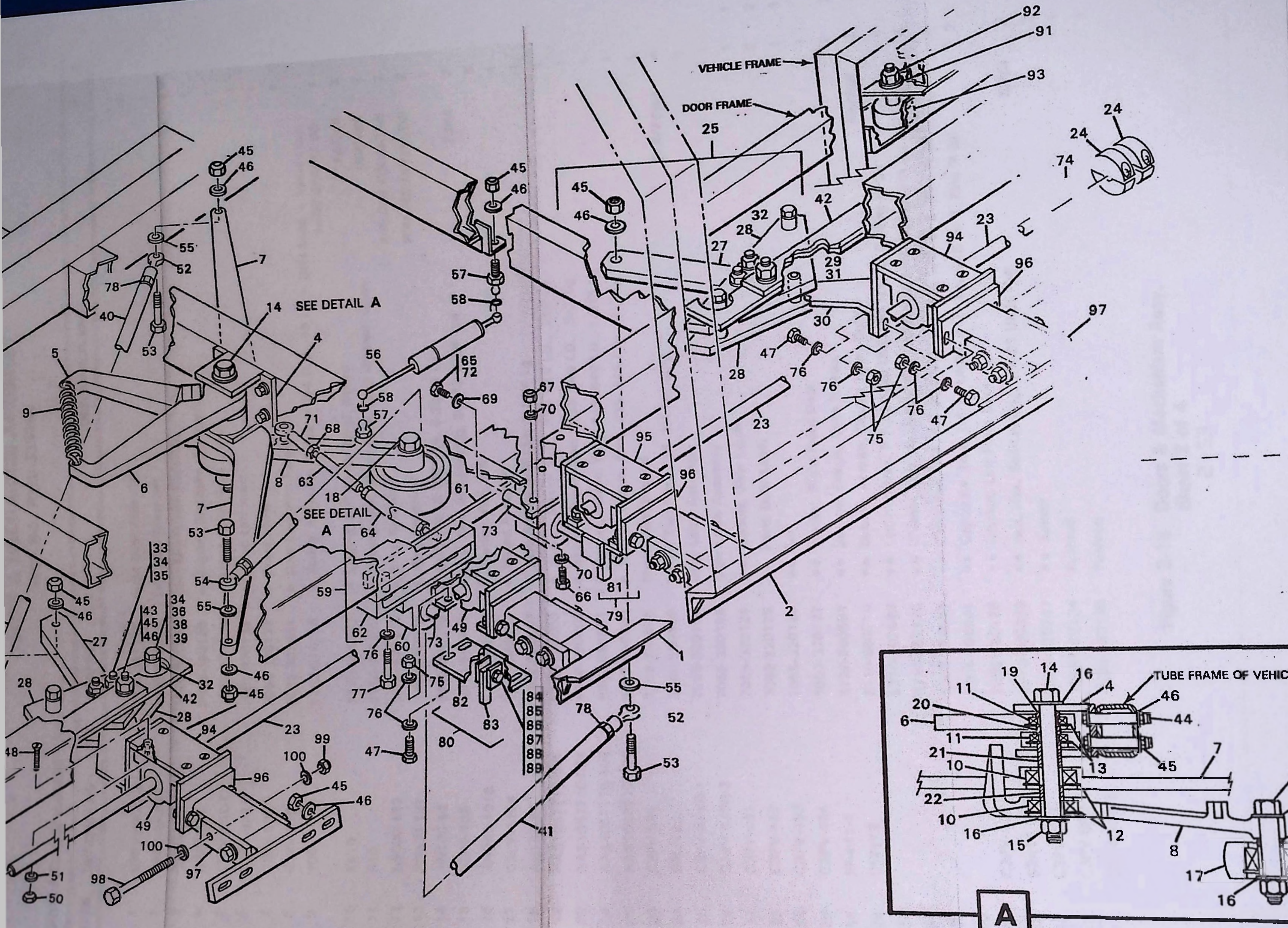


Figure 2-15 Doors & Mechanisı
Sheet 1 of 4

DOORS & MECHANISM ASSEMBLY

WDP NO. 7055-335784

DWG NO. C3PV-A400 Rev. 0

ITEM	DWG/MFR NO.	WDP NO.	DESCRIPTION/MFR		-1	2
1	C3PV-A420-2	7055-337354	Right Door Assembly		1	
2	C3PV-A420-1	7055-337353	Left Door Assembly		1	
3	C3PV-A500	7055-320123	Door Mechanism Assembly		1	
4	C3PV-501	7055-320129	• Bracket, Mounting, Mechanism		1	
5	C3PV-502-1	7055-320130	• Lever, Right Hand		1	
6	C3PV-502-2	7055-320131	• Lever, Left Hand		1	
7	C3PV-503	7055-320132	• Crank, Door		1	
8	C3PV-510	7055-335951	• Door Cam Arm Follower		1	
9	100	5360-616765	• Spring, Extension (6-1/2 × 3/4 O.D., 45 Lb = Safe Load + Initial Load)	*LANE SPRING CO.*	1	
10	KP10	3110-595333	• Bearing, Ball (Single Row), Sealed	*FAFNIR*	2	
11	R10	3110-580599	• Bearing, Ball (Single Row, Deep Groove), Open	*HOOVER*	2	
12	N5000-193	5365-806473	• Ring, Retaining	*WALDES KOHINOOR*	2	
13	N5000-137	5365-460573	• Ring, Retaining	*WALDES KOHINOOR*	2	
14	AN180-52	5306-580598	• Bolt, 5/8-18 UNF -3A, 5-25/64 Lg		1	
15	52NE-108	5310-560431	• Nut, Hex, Self-Locking, 5/8-18 UNJF -3B	*ESNA*	2	
16	AN960-1016	5310-002756	• Washer, Flat, 5/8		5	
17	C3PV-A154	7055-335362	• Wheel Assembly		1	
18	AN180-27	5306-580597	• Bolt, 5/8-18 UNF -3A, 3-1/64 Lg		1	
19	NAS1057T10-025	5365-580603	• Spacer, Sleeve, Bolt, .639-.649 I.D., .250 Lg		2	
20	NAS1057T10-034	5365-580602	• Spacer, Sleeve, Bolt, .639-.649 I.D., .343 Lg		1	
21	NAS1057T10-102	5365-580601	• Spacer, Sleeve, Bolt, .639-.649 I.D., 1.015 Lg		1	
22	NAS1057T10-081	5365-580600	• Spacer, Sleeve, Bolt, .639-.649 I.D., .812 Lg		1	
23	C3PV-581	7055-335808	Shaft, Door Support		1	
24	SPL-12 L	3040-580668	Collar, Two Piece, Stl, 3/4 Dia Bore	*STAFFORD*	4	
25	C3PV-A450-1	7055-320194	Door Latch Assembly		1	
26	C3PV-A450-2	7055-320195	Door Latch Assembly		1	
27	C3PV-451	7055-320124	•• Bracket, Door Latch		1	1
28	C3PV-452	7055-320125	•• Plate, Door Latch		2	2
29	C3PV-453	7055-320126	•• Bar		1	1
30	C3PV-454	7055-320127	•• Bracket, Right Front Door		1	
31	FF-411-1	3120-560691	•• Bearing, Flange, Oilite Bronze		2	2
32	DW4K2	3110-560710	•• Bearing, Aircraft, Double Row, Sealed	*FAFNIR*	2	2
33		5310-003996	•• Locknut, Hex, P.T., 1/4-20 UNC, IFI-100 Gr C, Zinc Pl Stl		2	2
34		5310-562175	•• Washer, Flat, Hardened, 1/4" ASTM-A325/F436, Zinc Pl Stl		6	6
35		5305-580688	•• Capscrew, Hex, 1/4-20 UNRC × 1-3/8, SAE Gr 8, Zinc Pl Stl		2	2
36		5305-602941	•• Capscrew, Hex, 1/4-28 UNRF × 2" Lg, SAE Gr 8, Zinc Pl Stl		2	2
37	C3PV-455	7055-320128	•• Bracket, Left Front Door			1
38	52NTE-048	5310-560839	•• Nut, Hex, Self-Locking, 1/4-28 UNJF -3B	*ESNA*	2	2
39	C3PV-456	5365-335747	•• Spacer		2	2
40	C3PV-580-1	7055-320134	Pushrod		1	
41	C3PV-580-2	7055-320135	Pushrod		1	

Figure 2-15 Doors & Mechanism Assy.
Sheet 2 of 4

ITEM	DWG/MFR NO.	WDP NO.	DESCRIPTION/MFR		-1	-2
42	C3PV-410	7055-335970	Latch Catch		2	
43		5305-002496	Screw, Flat Hd, 5/16-18 UNRC × 1.25 Lg, Gr 8, 82° C-Sink, Zinc Pl Stl		4	
44		5306-565930	Capscrew, Hex, 5/16-18 UNRC × 2-1/2 Lg, SAE Gr 8, Zinc Pl Stl		4	
45		5310-580662	Locknut, Hex P.T., 5/16-18 UNC, IFI-100 Gr C, Zinc Pl Stl		21	
46		5310-565934	Washer, Flat, Hardened, 5/16", ASTM A325/F436, Zinc Pl Stl		25	
47		5305-603015	Capscrew, Hex, 1/4-20 UNRC × 1" Lg, SAE Gr 8, Zinc Pl Stl		20	
48		5305-580664	Screw, Flat Hd, #8-32 UNC × 7/8 Lg, 82° C-Sink	***ALLEN***	16	
49	SPB-12	3130-565093	Pillow Block, Ball Bushing, 3/4" Dia Shaft	***THOMSON IND. INC.***	4	
50		5310-580661	Locknut, Hex, P.T., #8-32 UNC, IFI-100 Gr C, Zinc Pl Stl		16	
51	5702-76-030	5310-580658	Washer, Steel, #8, .384 O.D. × .190 I.D. × .030 Thk	***SEASTROM MFG. CO.***	16	
52	AM-5	3110-583013	Rod End, Male, 5/16-24 UNF, Right Hand Thread	***AURORA***	2	
53		5305-603028	Capscrew, Hex, 5/16-18 UNRC × 1-1/2 Lg, SAE Gr 8, Zinc Pl Stl		4	
54	AB-5	3110-583012	Rod End, Male, 5/16-24 UNF, Left Hand Thread	***AURORA***	2	
55	5714-79-063	5310-580657	Washer, Brass, .636 O.D. × .313 I.D. × .063 Thk	***SEASTROM MFG. CO.***	4	
56	See Description	2590-576505	Gas Spring, Part No. 16-2-172-100-A3A-B3A-236N	***SUSPA, INC.***	1	
57	P6700001	5307-663741	Ball Studs, 10mm Ball	***SUSPA, INC.***	2	
58	P6800011	5340-663740	Safety Clips	***SUSPA, INC.***	2	
59	C3PV-A560	7055-335733	Secondary Latch Assembly		1	
60	SPB-10	3130-577970	••• Pillow Block	***LINEAR INDUSTRIES LTD.***	2	
61	C3PV-562	7055-335735	••• Support, Slider		2	
62	C3PV-563	7055-335736	••• Support, Bearing		2	
63	C3PV-564	7055-335737	••• Bar, Secondary Latch		1	
64	C3PV-565	7055-335738	••• Universal Joint, Modified		1	
65		5306-594473	••• Capscrew, Hex, 5/16-18 UNRC × 1.0 Lg, SAE Gr 8, Zinc Pl Stl		2	
66	MS16997-35	5305-004212	••• Capscrew, Socket Hd, 8-32 UNC -3A × .750 Lg		8	
67	22NM-82	5310-560443	••• Locknut, Hex, Light, 8-32 UNJC -3B	***ESNA***	8	
68	MS35691-6	5310-580613	••• Nut, Hex, Jam, 1/4-28 UNF -2B		3	
69		5310-565934	••• Washer, Flat, Hardened, 5/16 ASTM-A325//F436, Zinc Pl Stl		2	
70	AN960-8	5310-011472	••• Washer, Flat, #8		8	
71	CW-45	3110-580615	••• Rod End, Female, 1/4-28 UNF -2B with Stud	***AURORA***	1	
72	No. 242	8030-570605	••• Adhesive/Sealant	***LOCTITE***	A/R	
73	C3PV-561	7055-335734	••• Slide Bar		2	
74	5613-67-93	5310-583429	Washer, Neoprene, 1.015 I.D. × 1.755 O.D. × .093 Thk	***SEASTROM***	2	
75		5310-570555	Locknut, Hex, P.T., 1/4-20 UNC, IFI-100 Gr C, Zinc Pl Stl		20	
76		5310-805855	Washer, Flat, Hardened, 1/4", ASTM A325/F436, Zinc Pl Stl		48	
77		5305-603016	Capscrew, Hex, 1/4-20 UNRC × 1-1/2 Lg, SAE Gr 8, Zinc Pl Stl		8	
78		5310-580663	Nut, Jam, 5/16-24 UNF-R.H., IFI-100 Gr C, Right Hand Thread, Zinc Pl Stl		2	
79	C3PV-A570-1	7055-335731	Pawl, Secondary Latch Assembly		1	
80	C3PV-A570-2	7055-335732	Pawl, Secondary Latch Assembly		1	
81	C3PV-571	7055-335729	•••• Frame, Pawl Support		1	
82	C3PV-573	7055-335730	•••• Frame, Pawl Support			

Figure 2-15 Doors & Mechanism Assy.
Sheet 3 of 4

ITEM	DWG/MFR NO.	WDP NO.	DESCRIPTION/MFR	-1	-2
83	C3PV-572	7055-335727	•••• Pawl, Secondary Latch	1	1
84	5614CHH	3110-580608	•••• Bearing, Ball *MINIATURE PRECISION BEARING CORP.*	1	1
85	N5000-37	5365-582900	•••• Ring, Retaining *WALDES KOHINOOR*	1	1
86	AN174-13	5305-580607	•••• Bolt, Hex Hd, 1/4-28 UNF -3A × 1-13/32 Lg	1	1
87	52NTE-048	5310-560839	•••• Nut, Hex, Self-Locking, 1/4-28 UNJF -3B *ESNA*	1	1
88	5714-63-040	5310-580606	•••• Washer, Flat, 1/4, Brass *SEASTROM*	2	2
89	5702-97-060	5310-580605	•••• Washer, Flat, 1/4, Steel *SEASTROM*	2	2
90		5310-001650	Nut, Jam, 5/16-ZA UNF-LH, IFI-100 Gr C, Left Hand Thread, Zinc Pl Stl	2	
91	5702-174	5310-580656	Washer, Steel, 1.132 O.D. × .632 I.D. × .030 Thk *SEASTROM MFG. CO.*	2	
92		5310-580660	Locknut, Hex, P.T., 5/8-18 UNF, IFI-100 Gr C, Zinc Pl Stl	2	
93	CRB-24	3110-580659	Cam Follower, 1.50 Dia × 7/8" Wide with 5/8 Dia Stud × 1-1/2 Lg *TORRINGTON BEARING*	2	
94	C3PV-480	7055-337200	Door Bearing Mount, Outside	2	
95	C3PV-481	7055-337201	Door Bearing Mount, Inside	2	
96	C3PV-482	7055-337202	Door Bearing Mount Connection	4	
97	C3PV-483	7055-337203	Door Connection, Outside	2	
98		5306-591168	Capscrew, Hex, 3/8-16 UNRC × 3" Lg, SAE Gr 8, Zinc Pl Stl	8	
99		5310-594493	Locknut, Hex, P.T., 3/8-16 UNC, IFI-100 Gr C, Zinc Pl Stl	8	
100		5310-562353	Washer, Flat, Hardened, 3/8", ASTM A325/F436, Zinc Pl Stl	16	

Figure 2-15 Doors & Mechanism Assy.
Sheet 4 of 4

2.5 TRACK SYSTEM

2.5.1 TRACK DESCRIPTION. The Horizons track system is laid out as shown in Figures 2-16. The track system consists of a 6-inch diameter main line load rail (Figure 2-17), a 3-inch diameter reaction rail and a maintenance track. The load rail is a single pipe section with leak type welds at the joints. The rail is separated into six pressurized zones which are monitored by crack detection sensors (Figure 2-18) so that if a pressure decay exists, there will be an indication that a crack is present within a defined zone. The rail is made up of straight pipe sections, flat horizontal curves, vertical curves, helical curves and a maintenance track as shown in Figure 2-19. Curve numbers on the main line track are identified by a "C" to indicate a curve, followed by a sequence number. Maintenance track curves are identified by "SC" followed by sequence numbers. The load rail has a maximum change in elevation of 37 feet, 7 inches and is mounted on structural steel supports with spans between supports at intervals of less than 12 feet each. The rail is supplied with anchor pads welded in position along the rail (Figure 2-20) to coincide with the structural support locations. There are no thermal expansion joints in the load rail or special anchorage hardware to provide support flexibility. The load rail and reaction rail are each 1346 feet long and the maintenance track, which is not pressurized, is a continuous pipe 210 feet long, broken at one location to provide a switch to the tunnel and maintenance area.

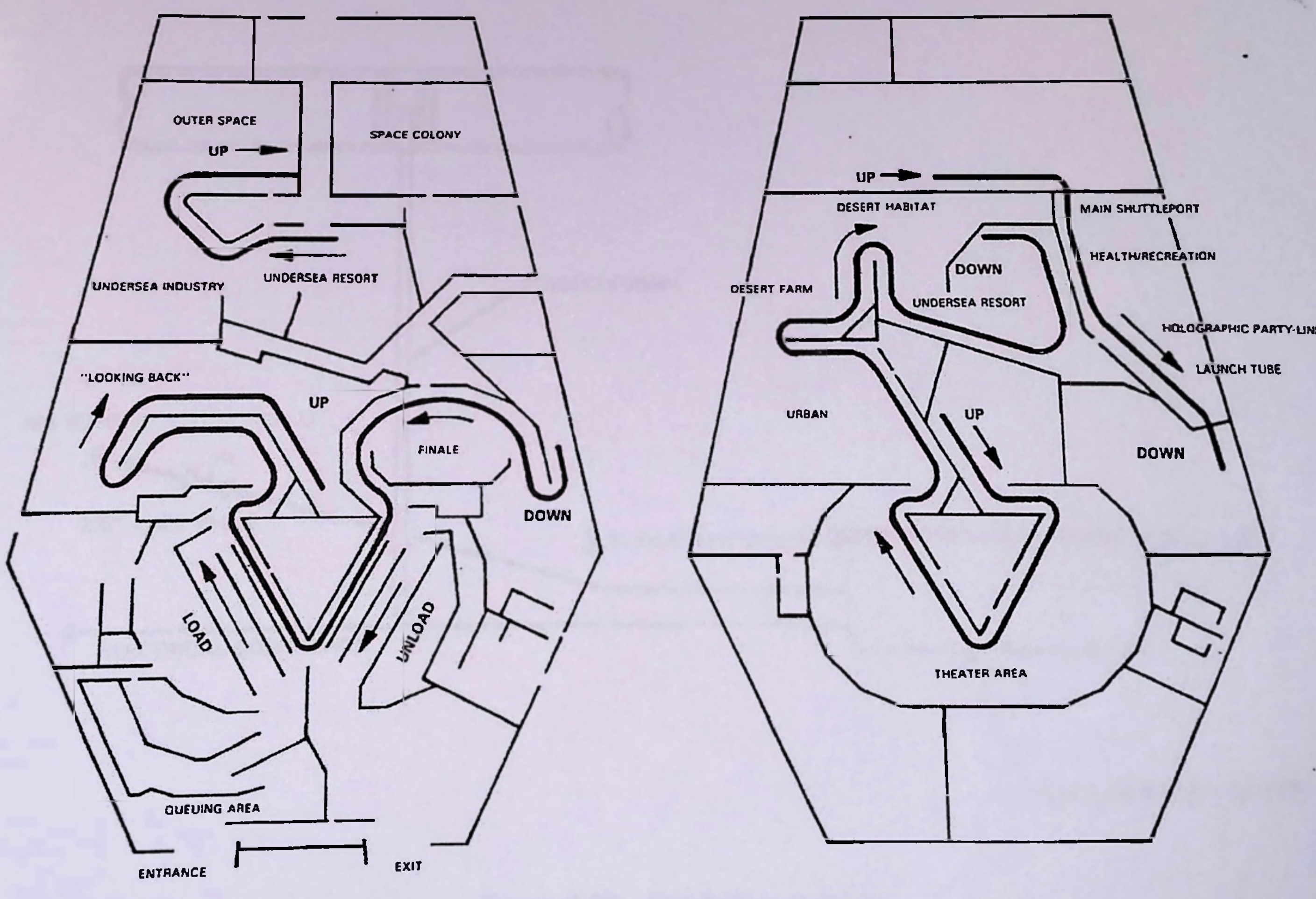


Figure 2-16 Track Layout

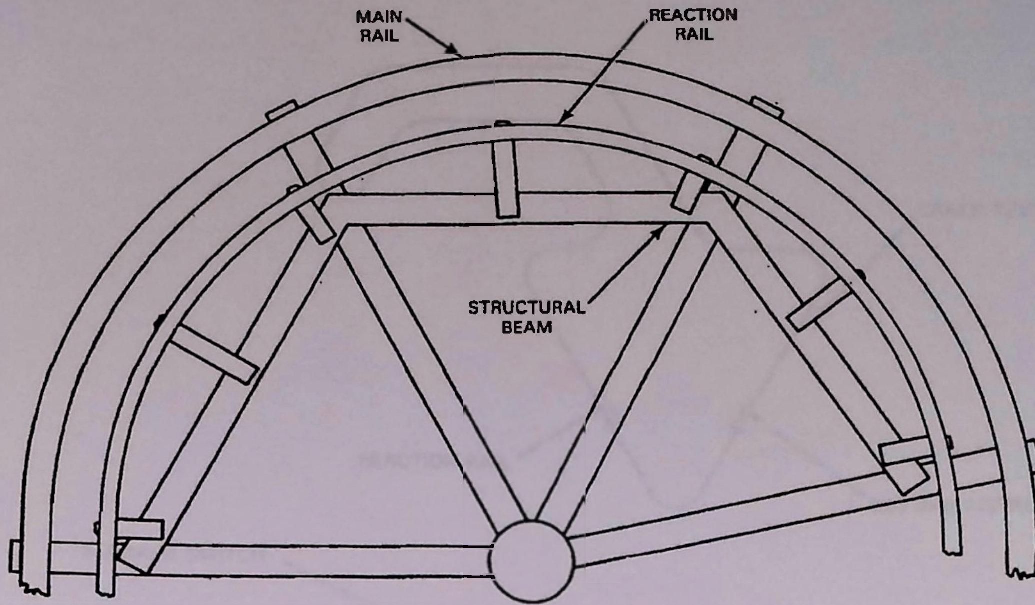


Figure 2-17 Track System

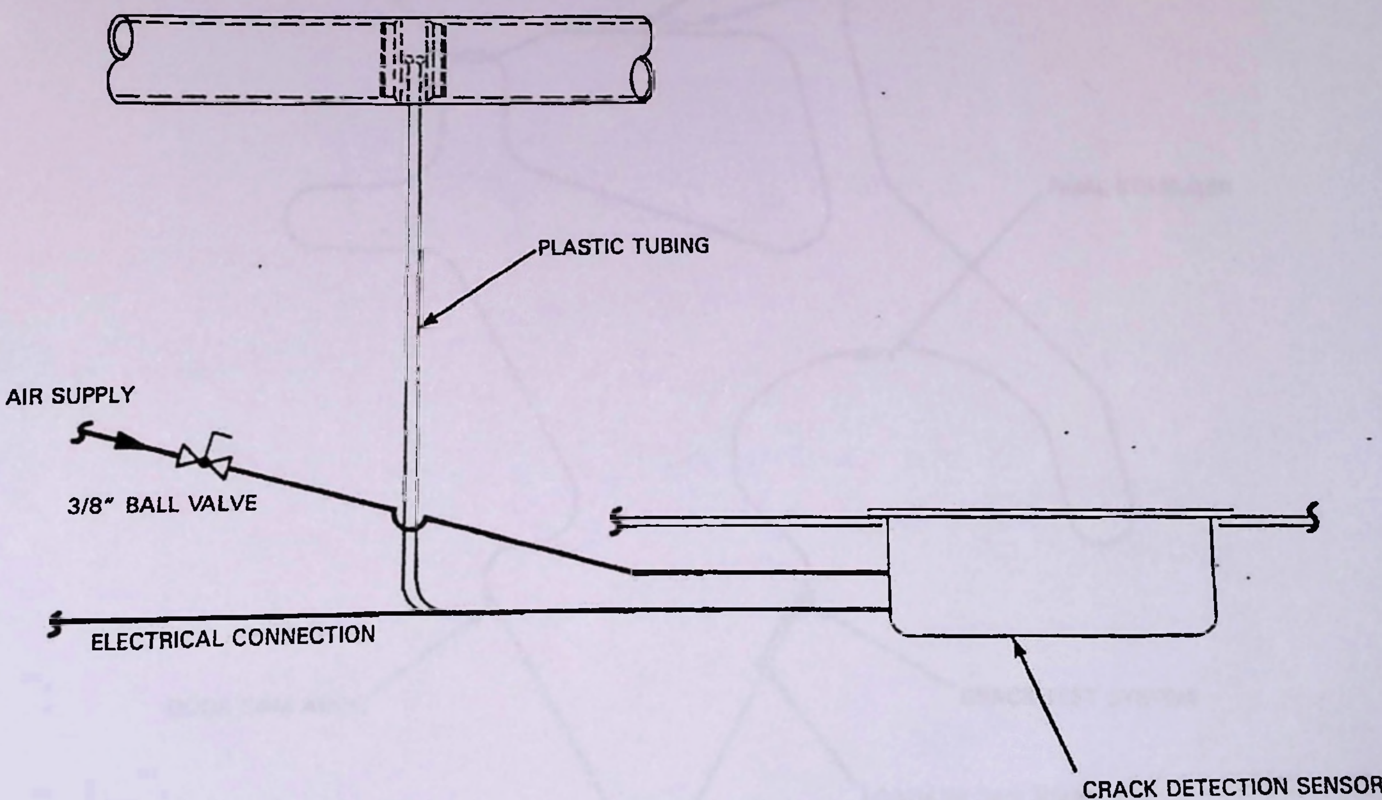


Figure 2-18 Crack Test System

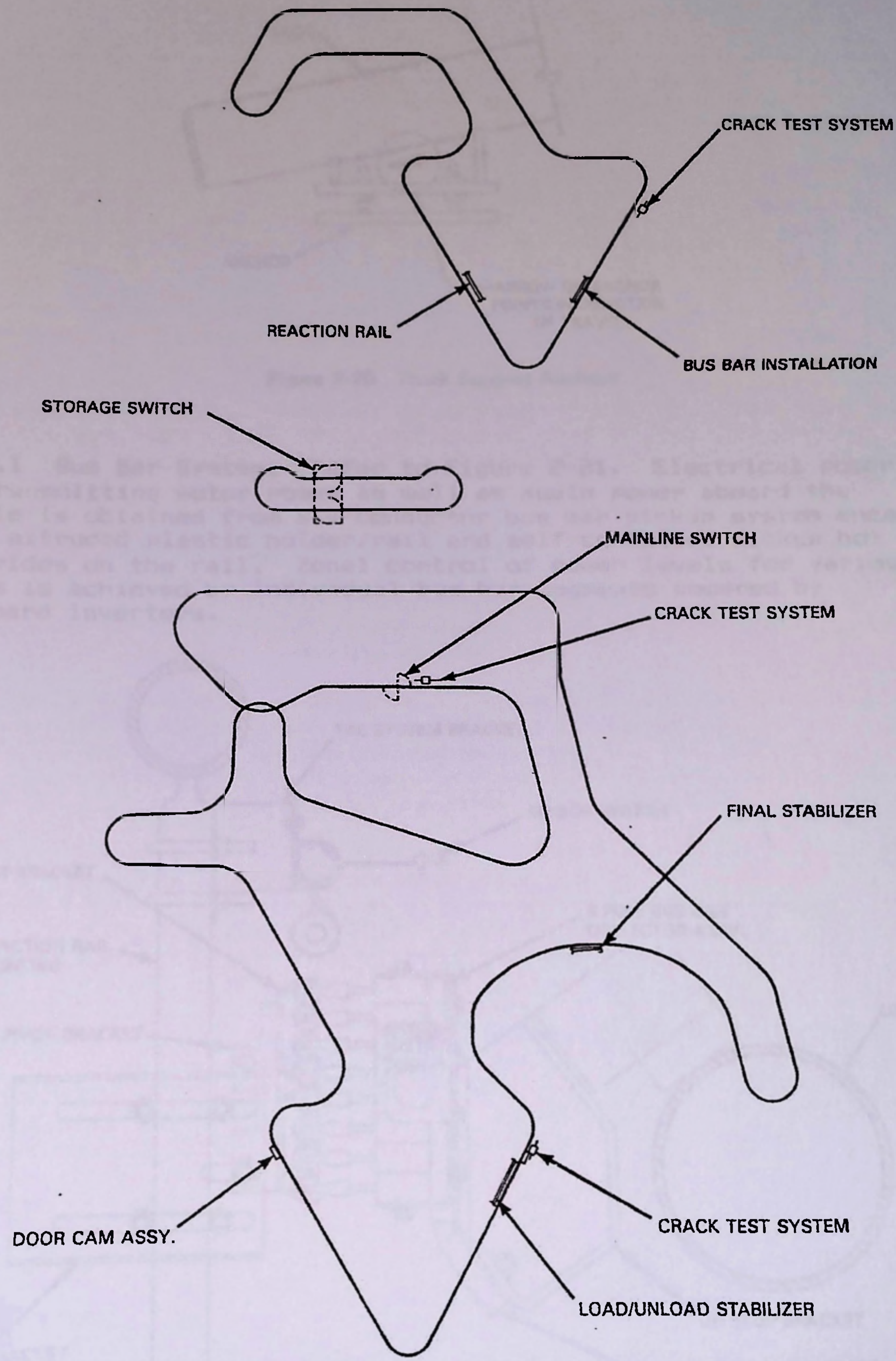


Figure 2-19 Track Curves & Trackside Equip.

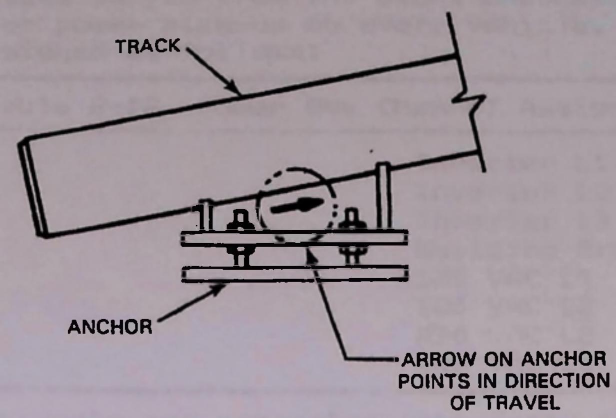


Figure 2-20 Track Support Anchors

2.5.1.1 Bus Bar System. Refer to Figure 2-21. Electrical power for transmitting motor power as well as audio power aboard the vehicle is obtained from a 4-conductor bus bar pickup system encased in an extruded plastic holder/rail and self-contained pickup box that rides on the rail. Zonal control of power levels for various grades is achieved by individual bus bar segments powered by off-board inverters.

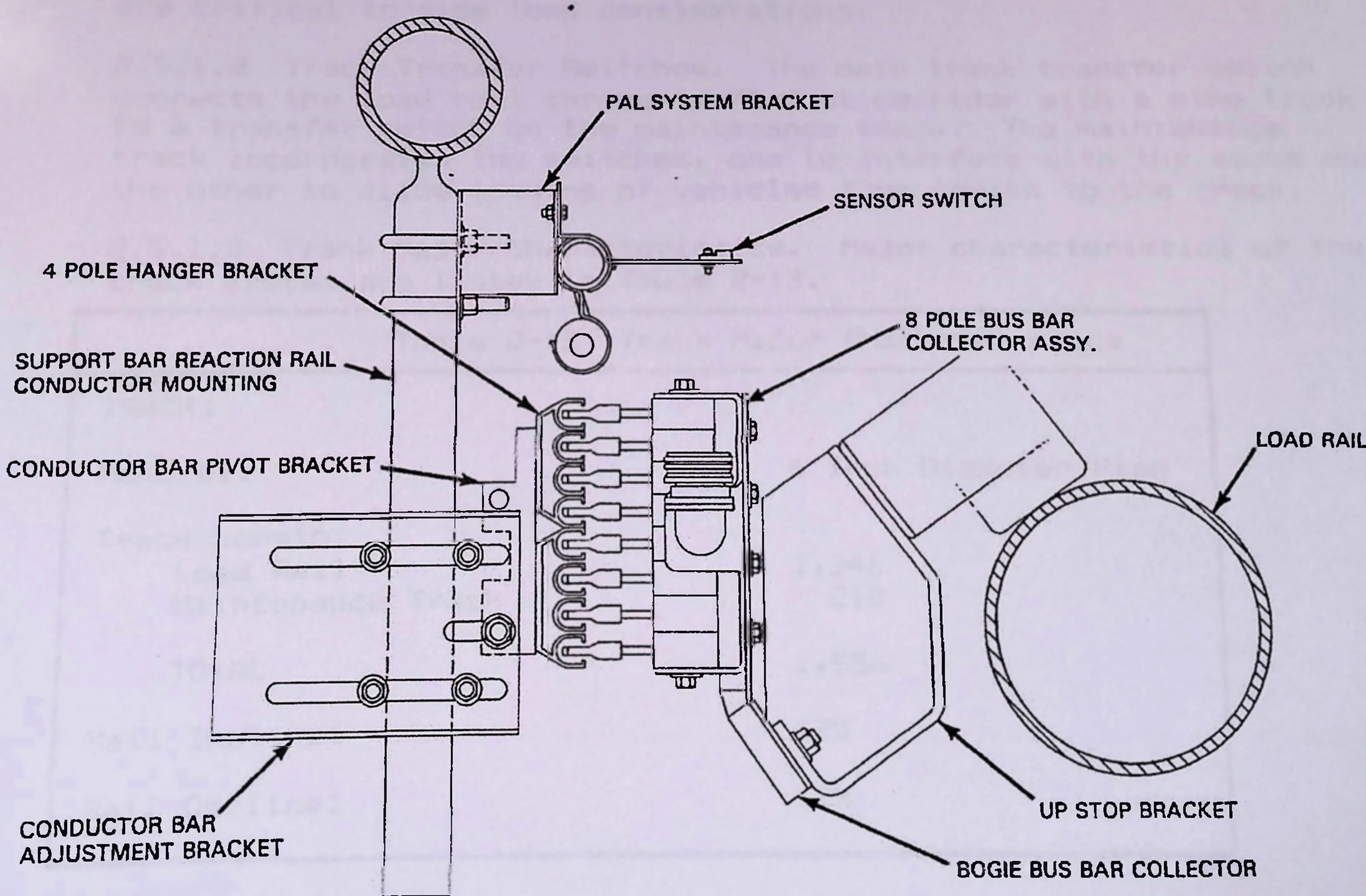


Figure 2-21 Bus Bar System

All vehicle voltage is fed from the eight channel bus bar through a vehicle collector power pick-up on every vehicle. Power bus channels are assigned as follows:

Table 2-12 Power Bus Channel Assignments

Channel 1	Inverter L1
Channel 2	Inverter L2
Channel 3	Inverter L3
Channel 4	Building Ground
Channel 5	120 VAC L1
Channel 6	120 VAC L2 (Neutral)
Channel 7	230 VAC L2 (Neutral)
Channel 8	230 VAC L1

Power bus bar channels are separated into forty isolated sections which are fed from eleven circuit breakers. The eleven 230 VAC circuit breakers are in the Facilities Electrical Cabinet in the ride equipment room. The circuit breakers for the three inverter channels are located in the Load Control Switch cabinet in the ride equipment room. Individual bus bar channels are rated at 100 Amps continuous service. Therefore, the Load Switch Control cabinet provides load distribution and protection as well as standby inverter switching capability. The 120 VAC bus bar feed is controlled from each of four maintenance stations by Electrical Facilities Engineering. Inverter isolation points are eight inches long to allow motor stator fields and currents to reduce to a negligible level at normal ride speed. The isolaton point location are critical to ride load considerations.

2.5.1.2 Track Transfer Switches. The main track transfer switch connects the load rail through a 75-foot corridor with a pipe track to a transfer switch on the maintenance track. The maintenance track incorporates two switches, one to interface with the above and the other to allow loading of vehicles from trucks to the track.

2.5.1.3 Track Major Characteristics. Major characteristics of the track system are listed in Table 2-13.

Table 2-13 Track Major Characteristics

TRACK:	
Monorail:	6 Inch Diameter Pipe
Track Length:	
Load Rail	1,346
Maintenance Track	210
TOTAL	1,556
Rail Incline:	12%
Rail Decline:	12%

Table 2-13 Track Major Characteristics (cont.)

Minimum Radius of Turns:	6' 0" with Guest facing out; 10' 0" with Guest facing in
Maximum Radius of Turns:	40'
Maximum Slope:	12 Degrees (Approximately)
Cam Rails:	
Upper Load Section	170 Linear Feet
Door Open	170 Linear Feet
Lower Load Section	170 Linear Feet
Show Section	100 Linear Feet
Switch Track:	3
Track Anchor Assembly:	250
Bus Bar Hangers:	625
Chill Rings:	195
Crack Test Plug:	7
Trackside Radiators:	550
B-Fold Dual Drivers:	60
Nominal Pitch Between Cars:	7' 9"
Vertical Pitch Between Cars:	12' 11" (Including one 18" thick catwalk)
Minimum Horizontal Pitch Between Cars:	7' 4"
Attachment to the Building:	Brackets to the ceiling, walls, or building floor
Catwalk:	7' 0" Wide (Approximately) 4' 0" Beneath Vehicle 3' 0" Behind Vehicle The catwalk runs all the way around for Guest evacuation and safety, and for maintenance. Maintenance zone with the switches will be provided.

2.5.2 PREVENTIVE MAINTENANCE. Preventive maintenance procedures for the track system are listed in the Scheduled Services System Manual. The facility contains four maintenance stations, three to provide for preventive maintenance and repair on the track and one located at the maintenance switch for removal and replacement of vehicles from spares maintained on the maintenance track.

2.5.2.1 Maintenance Equipment. Each maintenance station is equipped with the following ride control equipment:

a. Power On Indicator

b. Reset/Stop Switch

c. Low/High Speed Switch

d. Jog switch

e. E-Stop Switch

f. Vehicle Green Light Sensor

h. Momentary button

i. Off/On locked switch

j. Momentary button

k. Maintained button, enclosed in a padlock lockable enclosure

l. Optical offboard IR sensor to provide a "maintenance stop" function at any maintenance station

The following ride control equipment is provided for the maintenance corridor area:

a. Track Switch Controls
(120 VAC Pneumatic Valves)

b. Vehicle Control

c. Vehicle Power

d. E-Stop lockout switch
Trackswitch rotate to 0 Degrees
Trackswitch rotate to 90 Degrees

e. Momentary "GO" button
FWD - REV switch

f. 100-foot power cable reel
3-pole reversing motor contactor

2.5.3 CORRECTIVE MAINTENANCE. Corrective maintenance consists of recognizing a malfunction, isolating the cause and taking corrective action as described in the troubleshooting procedures, Table 2-14. The following paragraphs provide the procedures required to maintain the maintenance track and main track transfer switches in operational condition. For disassembly of switch components, refer to the appropriate illustrated parts breakdown (IPB) described in paragraph 2.5.4. Disassembly of components should be considered only when repair or replacement of components is necessary and only to the extent needed to effect such repair or replacement. Material required to clean component parts is listed in Table 2-15. Inspection procedures are required to verify the condition of disassembled components and will reveal defects that result from wear, damage, deterioration or other causes. The following paragraphs provide corrective maintenance procedures for the track switches.

2.5.3.1 General Maintenance Instructions. Inspect the underside of the transfer switches every three months for wear, deterioration or damage. Check platform, cables, pneumatic and electrical components. Lubricate as described in paragraph 2.5.3.5. Check switches for any loose bolts. Tighten all loose bolts to ensure quiet and smooth operation of the switches.

2.5.3.1.1 Air Cylinder. The use of strainers is recommended for the air cylinder to keep sand, grit or other foreign matter out of the air system. Keep the supply tank drained in order that the line remain as free from moisture as possible. Close the main shutoff valve in the air line when the equipment is not in use. The packing used in the cylinder is self-sealing (sealed by compressed air) and requires no adjustment.

Table 2-14 Transfer Switch Troubleshooting Chart		
PROBLEM/SYMPTOM	PROBABLE CAUSE	CORRECTIVE ACTION
Switch will not move.	1. Loss of tension on cable.	a. Restore cable tension.
		b. Replace stretched or broken cable.
	2. Tripped circuit.	Reset circuit breaker.
	3. Switch has encountered an obstruction to its travel.	a. Remove obstruction from track or wherever obstruction is.
		b. Reset circuit breaker if tripped.
Switch stopping rate is too fast.	Flow control valve out of adjustment.	Adjust valve.
Switch stopping rate is too slow.	Flow control valve out of adjustment.	Adjust valve.
Switch does not stop in desired location.	Flow control valve out of adjustment.	Adjust valve.
Switch acceleration rate is too slow.	Flow control valve out of adjustment.	Adjust valve.
Hissing sound in switch.	Leakage in air system.	Detect and correct leak.
Switch sticks or is erratic in travel.	1. Excessive dirt on track surface or casters.	Clean tracks or casters.
	2.Nicks or scratches on cable.	Replace cable.
	3. Slack in cable.	Restore cable tension.
Switch does not hold in position.	Locking mechanism not engaged.	Repair locking mechanism as required.
Cylinder travel is erratic.	Cylinder slipping (leaking).	Replace cylinder.
Cylinder does not move.	Pneumatic power off.	Restore pneumatic power.

To check an air cylinder, remove tension from the cable and move the cylinder through full extended and retracted positions. Ensure that the cable sheaves are free and are not sticking. If sheave operation is unsatisfactory, replace the sheaves. If the cylinder sticks during travel, replace with new cylinder as described in paragraph 2.5.3.6.6.

2.5.3.1.2 Cables. Maintain a well-planned program of periodic inspection following the procedures described below. Abrasion, bending and crushing represent the common abuses of cables. The primary goal of good inspection practice is to discover such conditions early enough to make corrections or replace cables.

When a sudden degradation indicates a loss of original cable strength, the following must be observed in order to determine whether or not the cable can remain in service:

a. Details of equipment operation.

b. Frequency of inspection.

c. Maintenance history.

d. Consequences of failure.

e. Historical records of equipment operation.

Guidelines for the above procedures are as follows:

a. Maintain all inspection records and reports for an appropriate length of time.

b. Prior to each daily use:

    1. Check all equipment functions.

    2. During operation cycle, observe the cable, paying particular attention to any signs of kinking, twisting or other deformities.

    3. Check cables for visual signs of anything that can cause them to be unsafe to use, such as broken wires, excessive wear, kinking or twisting and marked corrosion. Pay particular attention to any new damage during operation.

2.5.3.2 Disassembly. Disassembly procedures are described in the following paragraphs.

2.5.3.2.1 Transfer Switches. No special procedures are required for disassembly of the maintenance track or main track transfer switches. If removal of components is necessary, refer to Figure 2-22, Maintenance Track Transfer Switch (to be supplied) or Figure 2-23, Main Track Transfer Switch (to be supplied). Untill these figures can be supplied, engineering drawings C3PT-A150, Main Track Switch and C3PT-A200 Maintenance Track Switch may be used.

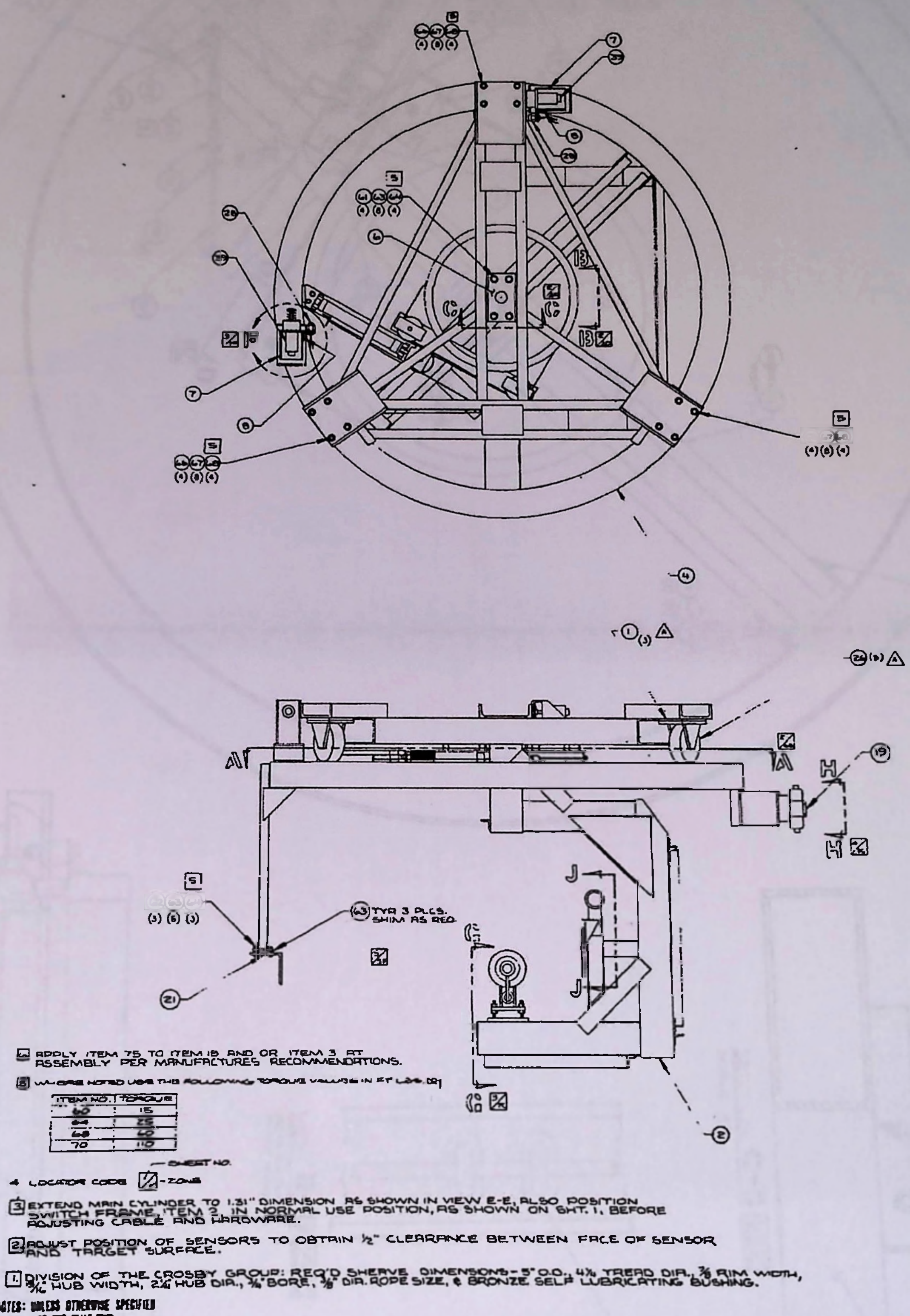


Figure 2-22 Maintenance Track Transfer Switch
Sheet 1 of 6

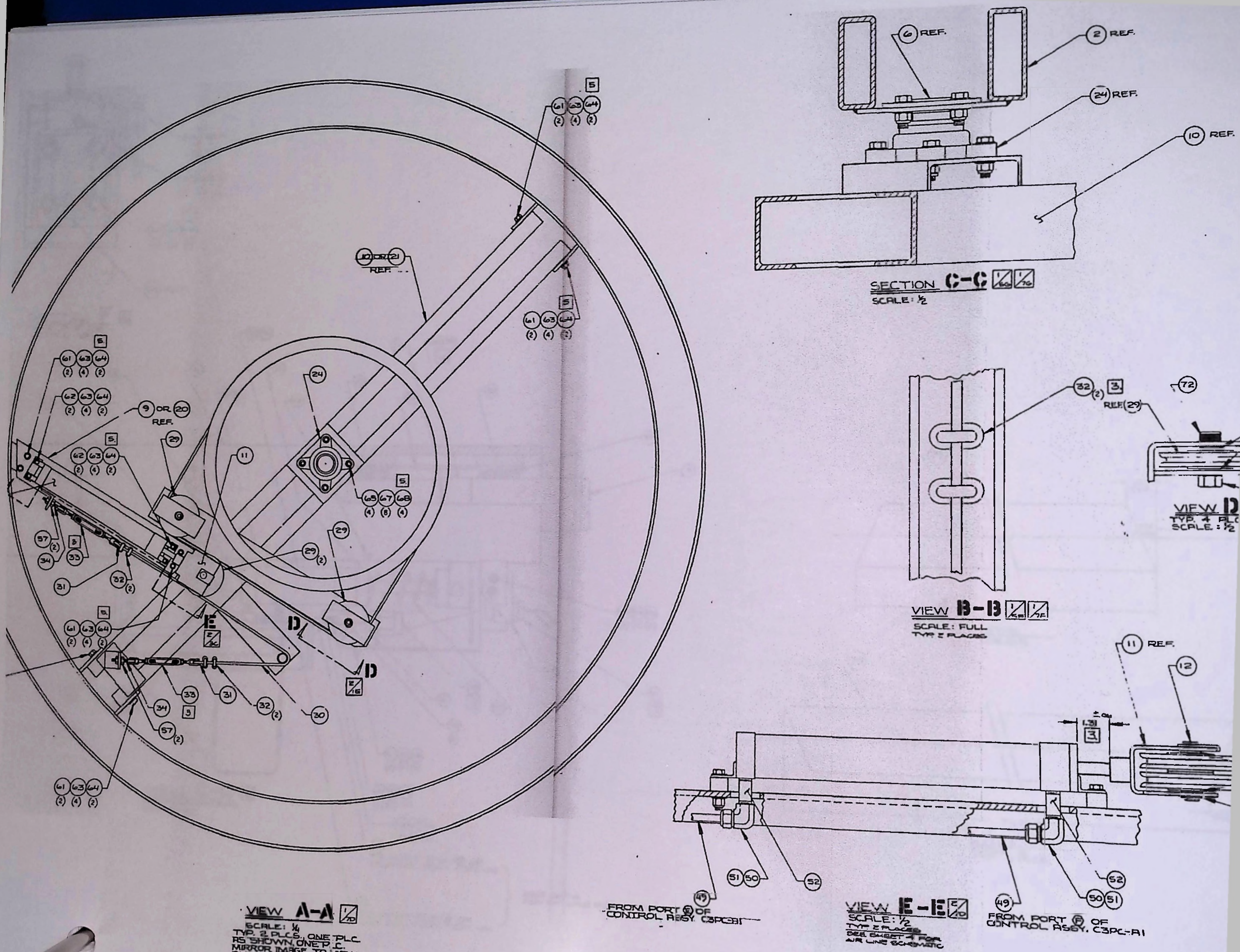


Figure 2 ... Maintenanc...
Sheet ...

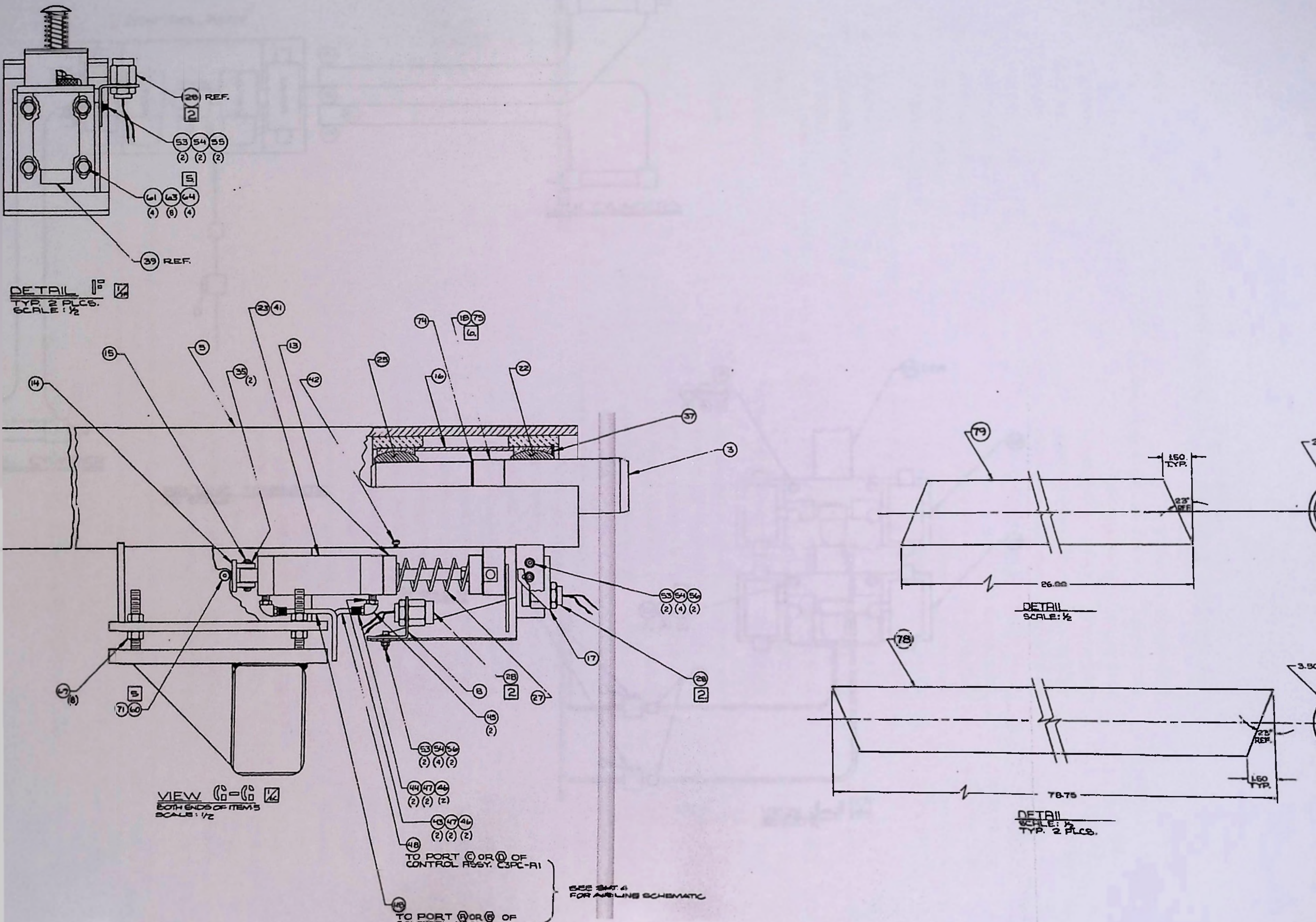


Figure Maintenance Track T
Sheet 3 of 6

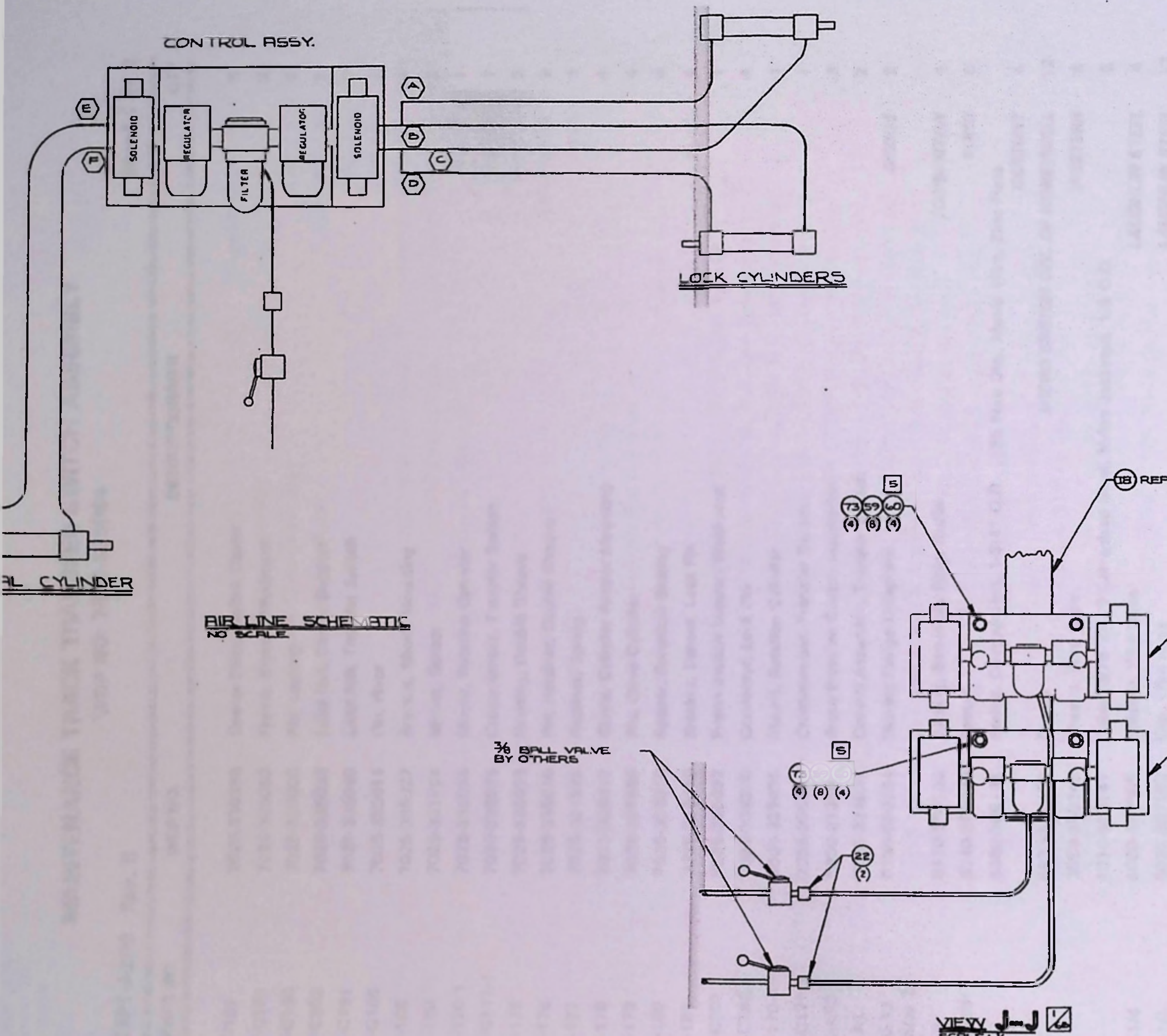


Figure 2-2 Maintenance Track Tra
Sheet 4 of 6

MAINTENANCE TRACK TRANSFER SWITCH ASSEMBLY

WDP NO. 7025-335064

DWG NO. C3PT-A200 Rev. B Sheet 1 of 2

ITEM	DWG/MFR NO.	WDP NO.	DESCRIPTION/MFR		QTY
1	C3PT-187	7025-335268	Spacer Plate, Switch Caster		6
2	C3PT-C151	7025-335063	Frame, Switch, Weldment		2
3	C3PT-C156	7025-335008	Pin, Locking		4
4	C3PT-C202	7025-335033	Load Rail, Center Support		1
5	C3PT-C161	7025-335040	Load Rail, Transfer Switch		2
6	C3PT-C166	7025-335011	Pin, Pivot		2
7	C3PT-168	7025-335027	Bracket, Shock Mounting		4
8	C3PT-169	7025-331994	Mount, Sensor		8
9	C3PT-170-1	7025-335034	Mount, Rotation Cylinder		1
10	C3PT-C171-1	7025-335028	Crossmember, Transfer Switch		1
11	C3PT-175	7025-335015	Housing, Double Sheave		2
12	C3PT-176	7025-335016	Pin, Retainer, Double Sheave		2
13	C3PT-177	7025-331995	Retainer, Spring		4
14	C3PT-178	7025-335017	Clevis, Cylinder Anchor Mounting		4
15	C3PT-179	7025-331993	Pin, Cleve Cylinder		4
16	C3PT-180	7025-335018	Spacer, Spherical Bearing		4
17	C3PT-181	7025-335019	Bracket, Sensor, Lock Pin		4
18	C3PT-C201	7025-335062	Frame Switch Support Weldment		1
19	C3PT-C182	7025-335020	Connector, Lock Pin		4
20	C3PT-170-2	7025-335036	Mount, Rotation Cylinder		1
21	C3PT-C171-2	7025-335029	Crossmember, Transfer Switch		1
22	SMDC-A19	5930-213882	Brake Pressure Switch Installation		2
23	C3PC-A1	7025-335037	Control Assembly, Transfer Switch		2
24	P.P. 10-78 Shaft Size 2"	3130-580134	Bearing Flange Unisphere	***DODGE***	2
25	27SF44	3110-580133	Bearing, Spherical, Plain, Radial	***TORRINGTON***	4
26	141-A6-MH	5340-580288	Caster	***BOND***	6
27	1783	5360-580131	Spring, Compression, 1-3/4" O.D., .135 Wire Dia., Music Wire, Zinc Plate	***CENTURY***	4
28	FMAS1	5930-580130	Sensor	***MICRO SWITCH DIV. OF HONEYWELL***	12
29	1173	3020-580146	Sheave, Wire Rope	***WESTERN***	8
30		4010-580141	Cable, 3/16-7×19 Galvanized Steel, Nylon Jacketed, 1/4 O.D.		8
31	G-411-1/4	4030-569805	Thimble, Wire Rope	***LAUGHLIN STEEL***	4
32	G-450-1/4	4030-803163	Clip, Wire Rope	***LAUGHLIN STEEL***	12
33	G-228-1/4 × 4	5340-580115	Turnbuckle, Jaw & Jaw	***LAUGHLIN STEEL***	4
34	G-291-1/4 × 2	5306-580116	Eye Bolt	***LAUGHLIN STEEL***	4
35	5133-37	5365-576284	Ring, Retaining External	***TRUARC***	8
36	×5133-74	5365-580166	Ring, Retaining, External	***TRUARC***	2
37	N5000-475	5365-812439	Ring, Retaining, Internal	***TRUARC***	4
38	NT1217	3120-591033	Washer, Thrust, Nylon	***BOSTON***	12
39	A 3/4 × 3	2540-580135	Shock Absorber	***ACE CONTROL***	4
40	2CB-2AS1414	3010-580117	Cylinder, Air Port Location Position No. 3	***PARKER***	2
41	313-DXP	3010-580136	Cylinder, Air	***BIMBA***	4

Figure 2-22 Maintenance Track Transfer Switch
Sheet 5 of 6

ITEM	DWG/MFR NO.	WDP NO.	DESCRIPTION/MFR		QTY
42	1610-BL	4730-576557	Fitting, Lubrication, 1/8 NPTF	*ALEMITE OR EQUIV.*	4
43	2206	4730-004545	Fitting, Male Gra-Tec to Male NPT	*GRA-TEC*	8
44	2609	4730-594227	Fitting, Male Gra-Tec to Plastic Tube	*GRA-TEC*	8
45	2802	4730-570906	Connector, 90° Gra-Tec Elbow	*GRA-TEC*	8
46	1902	5975-570990	Clip Fast	*GRA-TEC*	16
47	1311	5330-570987	'O' Ring	*GRA-TEC*	16
48	POL-4-BLACK	4720-580145	Tubing, Plastic, 1/4 O.D., 100 PSI Working Press	*PARKER OR EQUIV.*	A/R
49	POL-6-BLACK	4720-580144	Tubing, Plastic, 3/8 O.D., 100 PSI Working Press	*PARKER OR EQUIV.*	A/R
50	6-6-DBZ-S	4730-580118	Fitting, Tube, Female, Elbow, 90°, CPI to NPT	*PARKER*	4
51	6T23UIB	4730-580119	Insert, Tubing	*PARKER*	4
52	3/8 FF S2	4730-580140	Nipple, Hex, 3/8 NPT × 2"	*PARKER*	4
53	30SF48	3110-646092	Bearing, Spherical, Plain, Radial	*TORRINGTON*	4
54	D-231-3	5340-580129	Clevis, Piston Rod	*BIMBA*	4
55		5310-565548	Washer, Spring-Lock #10, Zinc Plate Steel		8
56		5310-002584	Locknut, Hex, #10-24 UNC, Zinc Plate Steel		16
57		5310-003996	Locknut, Hex P.T., 1/4-20 UNC, IFI-100 Gr. C, Zinc Plate Steel		8
58					
59		5310-565934	Washer, Flat, Hardened, 5/16" ASTM A325/F436, Zinc Plate Steel		16
60		5310-575796	Locknut, Hex P.T., 5/16-18 UNC, IFI-100 Gr. C, Zinc Plate Steel		
61		5305-002966	Capscrew, Hex, 3/8-16 UNRC × 1.50 Lg, SAE, Gr. 8, Zinc Plate Steel		40
62		5305-000079	Capscrew, Hex, 3/8-16 UNRC × 2.00 Lg, SAE, Gr. 8, Zinc Plate Steel		8
63		5310-594693	Washer, Flat, Hardened, 3/8" ASTM A325/F436, Zinc Plate Steel		96
64		5310-563718	Locknut, Hex, P.T., 3/8-16 UNC, IFI-100 Gr. C, Zinc Plate Steel		52
65		5306-002592	Capscrew, Hex, 1/2-13 UNRC × 2.00 Lg, SAE, Gr. 8, Zinc Plate Steel		8
66		5306-570244	Capscrew, Hex, 1/2-13 UNRC × 3.00 Lg, SAE, Gr. 8, Zinc Plate Steel		24
67		5310-594494	Washer, Flat, Hardened, 1/2" ASTM A325/F436, Zinc Plate		64
68		5310-563717	Locknut, Hex, P.T., 1/2-13 UNC, IFI-100, Gr. C, Zinc Plate Steel		32
69		5310-590826	Nut, Hex, 1/2-13 UNC, Zinc Plate Steel		40
70		5310-561532	Locknut, Hex, P.T., 5/8-11 UNC, IFI-100, Gr. C, Zinc Plate Steel		4
71		5305-580142	Screw, Shoulder, 3/8 Dia. × 3.00 Lg, Zinc Plate Steel		4
72		5305-580143	Screw, Shoulder, Nyloc, 3/4 Dia. × 1.50 Lg, Zinc Plate Steel		4
73		5305-569500	Capscrew, Hex, 5/16-18 UNRC × 1.25 Lg, SAE, Gr. 8, Zinc Plate Steel		8
74		5305-563462	Screw, Socket Hd, #10-24 UNC × .625, Zinc Plate Steel		24
75		5310-561455	Washer, Flat #10, Zinc Plate Steel		40
76	5100-275	5365-561101	Ring, Retaining, External	*TRUARC*	2
77	RC 601	8040-563655	Adhesive	*LOCTITE*	A/R
78		4710-002130	Pipe, Steel, B, 3 Dia., Sch 40, 78.75 Lg		2
79		4710-002130	Pipe, Steel, B, 3 Dia., Sch 40, 26.00 Lg		1

Figure 2-22 Maintenance Track Transfer Switch
Sheet 6 of 6

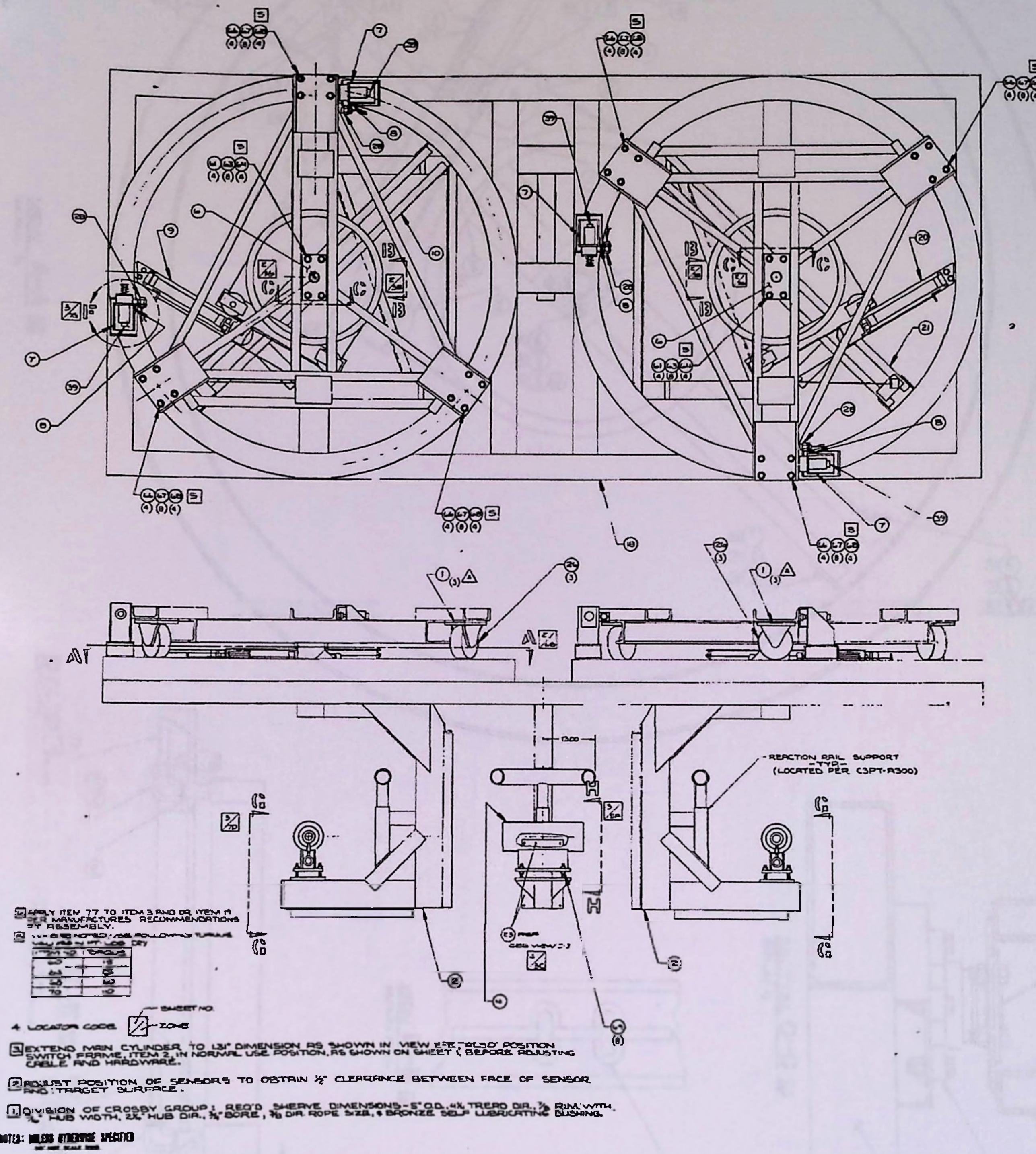
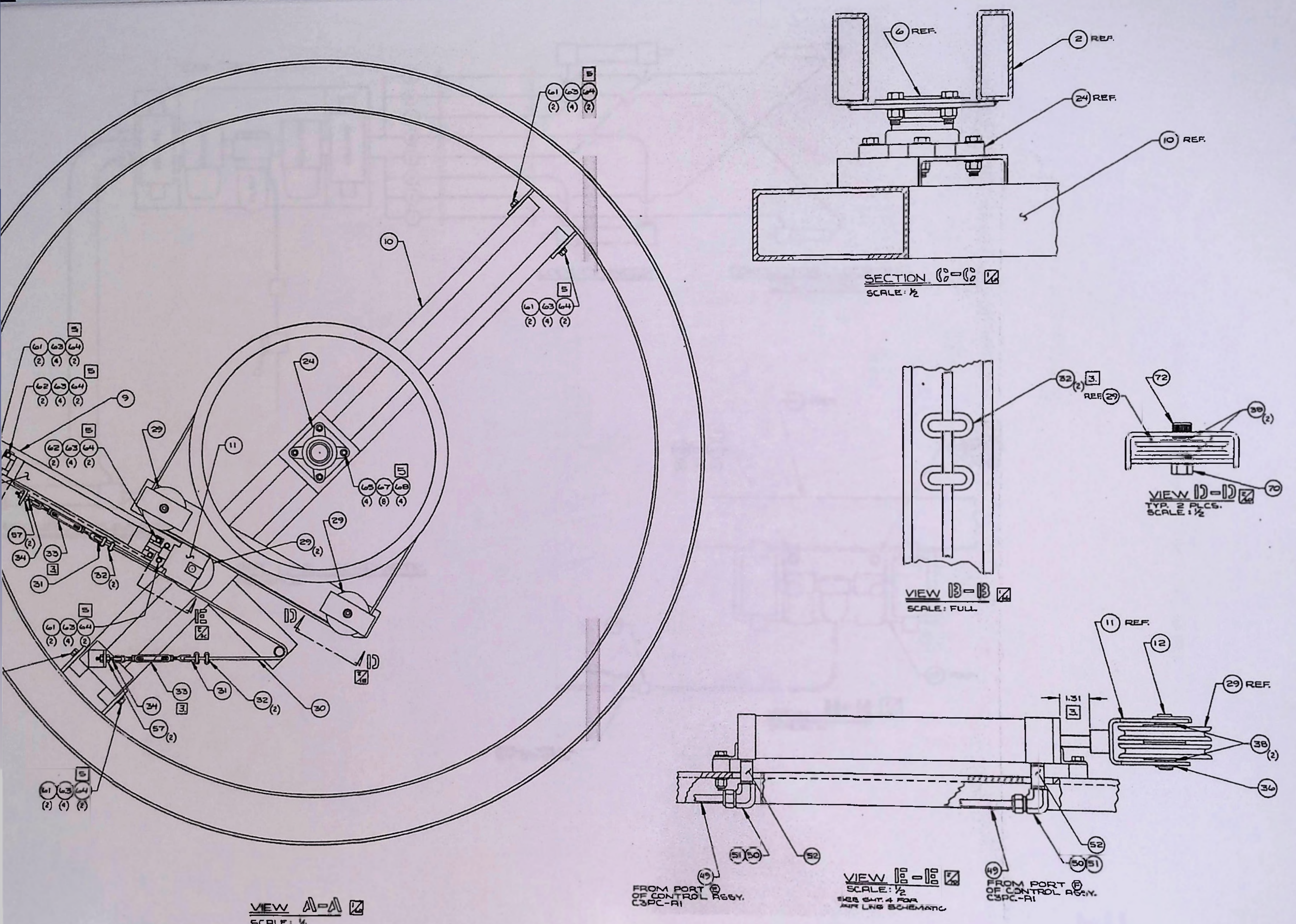
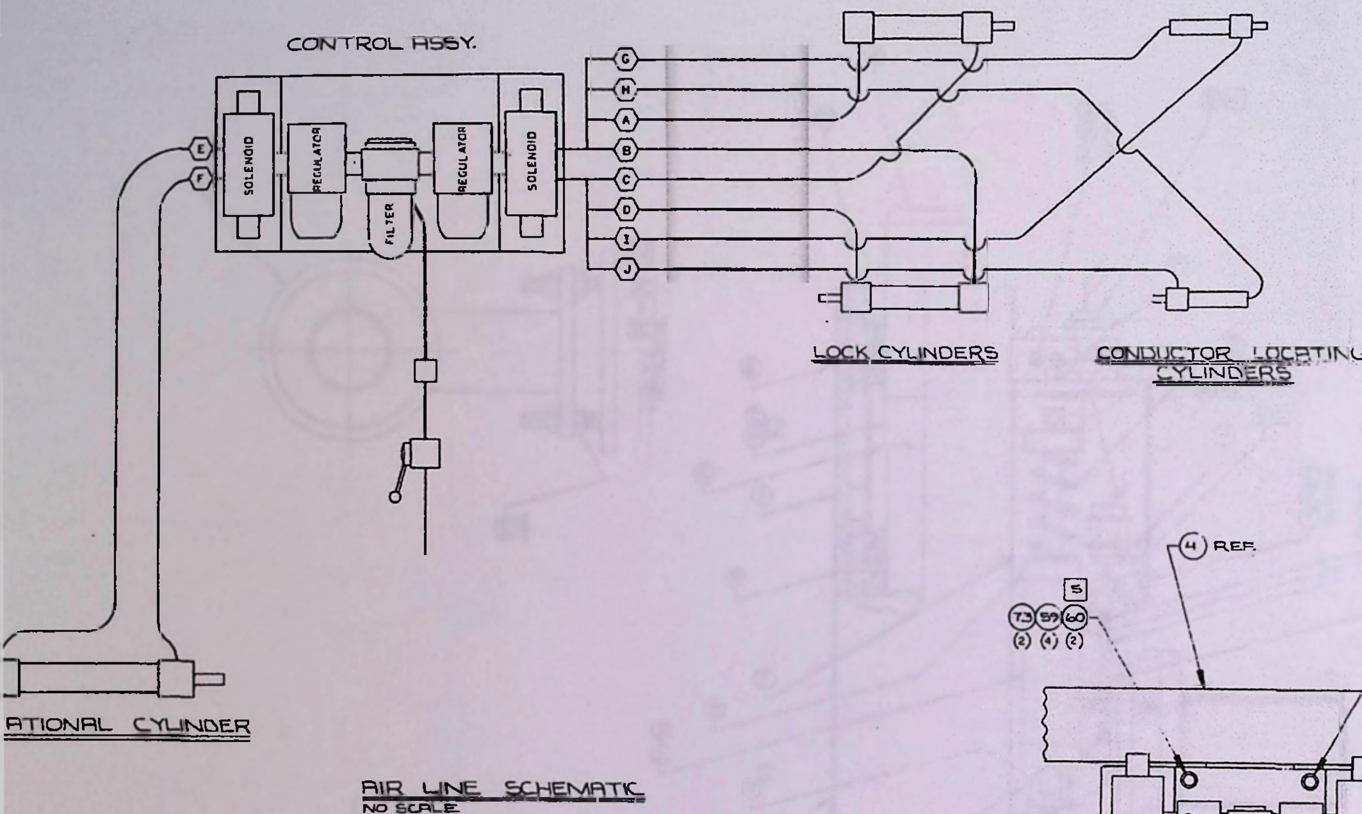


Figure 2-23 Main Track Transfer Switch
Sheet 1 of 8



re 2-23 Main Track Ti
Sheet 2 of 8



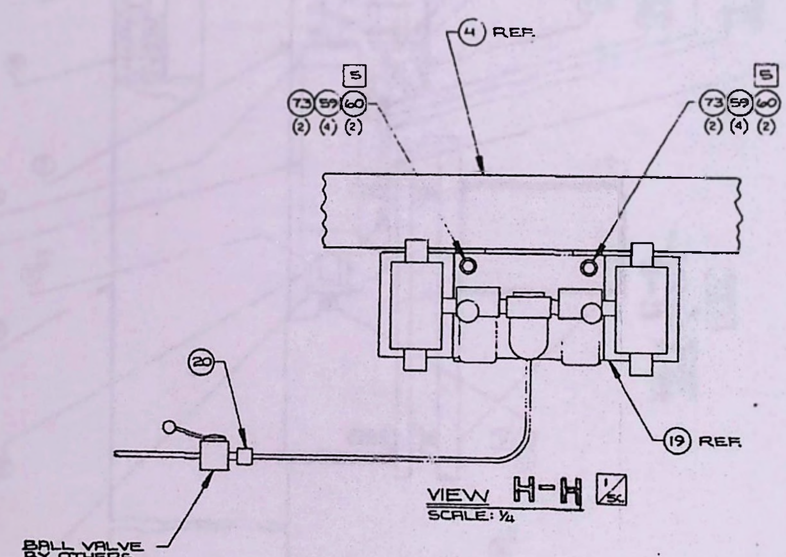


Figure 2-23 Main Track Transfer Sw
Sheet 3 of 8

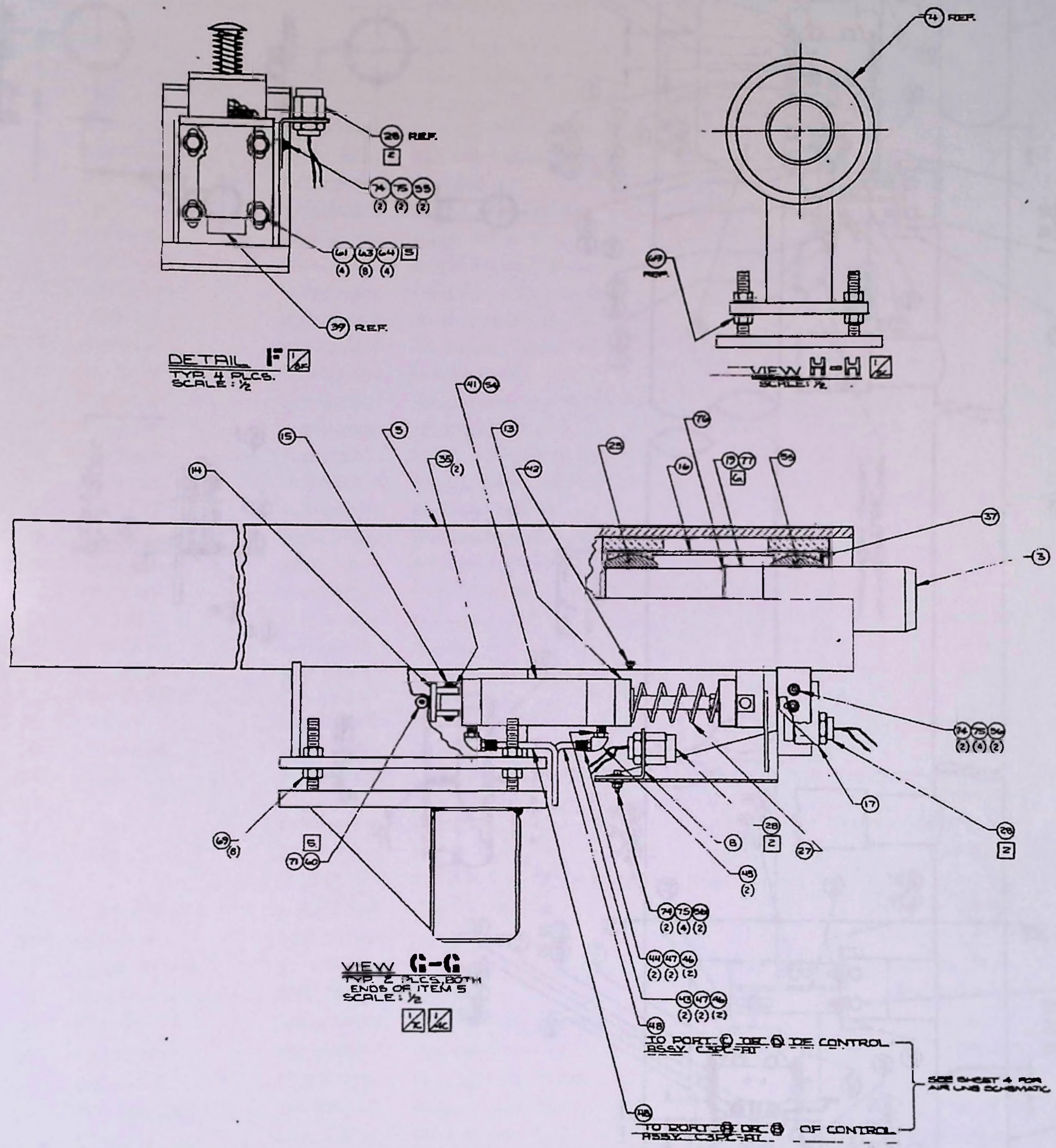
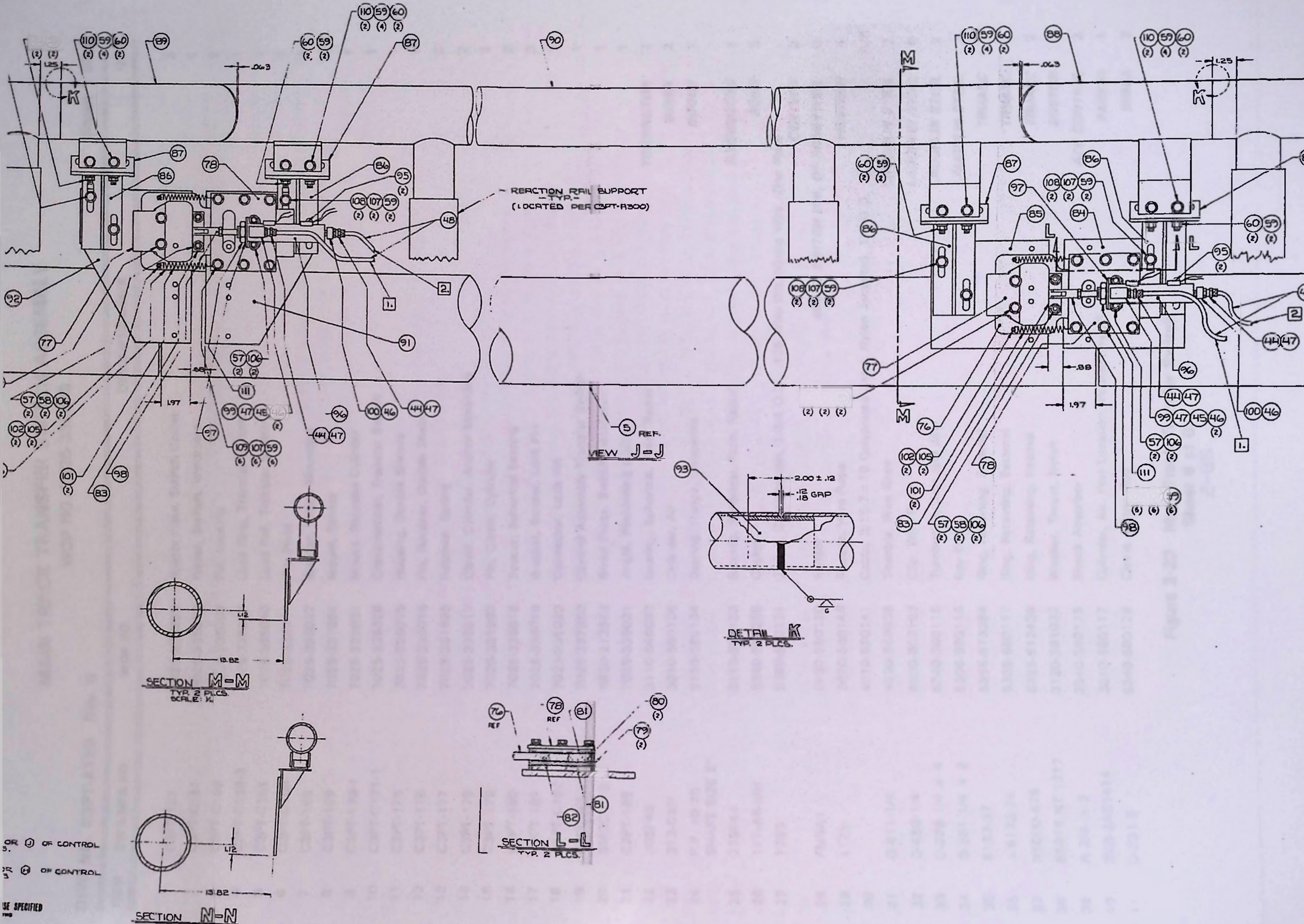


Figure 2-23 Main Track Transfer Switch
Sheet 4 of 8



F[illegible] 2-23 Main Track Trar
Sheet 5 of 8

MAIN TRACK TRANSFER SWITCH ASSEMBLY

WDP NO. 7025-335068

DWG NO. C3PT-A150 Rev. B **Sheet 1 of 3**

ITEM	DWG/MFR NO.	WDP NO.	DESCRIPTION/MFR		QTY
1	C3PT-187	7025-335268	Spacer Plate, Switch Caster		3
2	C3PT-C151	7025-335063	Frame, Switch, Weldment		1
3	C3PT-C156	7025-335008	Pin, Locking		2
4	C3PT-C158-3	7025-335067	Load Ring, Transfer Switch		1
5	C3PT-C161	7025-335040	Load Rail, Transfer Switch		1
6	C3PT-C166	7025-335011	Pin, Pivot		1
7	C3PT-168	7025-335027	Bracket, Shock Mounting		2
8	C3PT-169	7025-331994	Mount, Sensor		4
9	C3PT-170-1	7025-335034	Mount, Rotation Cylinder		1
10	C3PT-C171-1	7025-335028	Crossmember, Transfer Switch		1
11	C3PT-175	7025-335015	Housing, Double Sheave		1
12	C3PT-176	7025-335016	Pin, Retainer, Double Sheave		1
13	C3PT-177	7025-331995	Retainer, Spring		2
14	C3PT-178	7025-335017	Clevis, Cylinder, Anchor Mounting		2
15	C3PT-179	7025-331993	Pin, Clevis, Cylinder		2
16	C3PT-180	7025-335018	Spacer, Spherical Bearing		2
17	C3PT-181	7025-335019	Bracket, Sensor, Lock Pin		2
18	C3PT-C182	7025-335020	Connector, Lock Pin		2
19	C3PC-A3	7025-337850	Control Assembly Transfer Switch		1
20	SMDC-A19	5930-213882	Brake Press. Switch Installation		1
21	C3PT-186	7025-335021	Angle, Positioning Guide		1
22	30SF48	3110-646092	Bearing, Spherical, Plain, Radial	*TORRINGTON*	2
23	313-DXP	3010-580136	Cylinder, Air	*BIMBA*	2
24	P.P. 10-78 SHAFT SIZE 2"	3130-580134	Bearing, Flange, Unisphere	*DODGE*	1
25	27SF44	3110-580133	Bearing, Spherical, Plain, Radial	*TORRINGTON*	2
26	141-A6-MH	5340-580288	Caster	*BOND*	3
27	1783	5360-580131	Spring, Compression, 1-3/4 O.D.. .135 Wire Dia. Music Wire, Zinc Plate	*CENTURY*	2
28	FMSA1	5930-580130	Sensor	*MICRO SWITCH DIV. OF HONEYWELL*	6
29	1173	3020-580146	Sheave, Wire Rope	*WESTERN*	4
30		4010-580141	Cable, 3/16-7 × 19 Galvanized Steel, Nylon Jacketed, 1/4 O.D.		A/R
31	G-411-1/4	4030-569805	Thimble, Wire Rope	*LAUGHLIN STEEL*	2
32	G-450-1/4	4030-803163	Clip, Wire Rope	*LAUGHLIN STEEL*	6
33	G-228-1/4 × 4	5340-580115	Turnbuckle, Jaw and Jaw	*LAUGHLIN STEEL*	2
34	G-291-1/4 × 2	5306-580116	Eye Bolt	*LAUGHLIN STEEL*	2
35	5133-37	5365-576284	Ring, Retaining, External	*TRUARC*	4
36	× 5133-74	5365-580117	Ring, Retaining, External	*TRUARC*	1
37	N5000-475	5365-812439	Ring, Retaining, Internal	*TRUARC*	2
38	56916 NT 1217	3120-591033	Washer, Thrust, Nylon	*BOSTON*	6
39	A 3/4 × 3	2540-580135	Shock Absorber	*ACE CONTROL*	2
40	2CB-2AS1414	3010-580117	Cylinder, Air, Port Location, Position No. 3	*PARKER*	1
41	D-231-3	5340-580129	Clevis, Piston Rod	*BIMBA*	2

Figure 2-23 Main Track Transfer Switch
Sheet 6 of 8

MAIN TRACK TRANSFER SWITCH ASSEMBLY

WDP NO. 7025-335068

DWG NO. C3PT-A150 Rev. B Sheet 2 of 3

ITEM	DWG/MFR NO.	WDP NO.	DESCRIPTION/MFR		
42	1610-BL	4730-576557	Fitting, Lubrication, 1/8 NPTF	*ALEMITE OR EQUIV.*	2
43	2206	4730-004545	Male Gra-Tec to Male NPT	*GRA-TEC*	4
44	2609	4730-594227	Male Gra-Tec to Sleeveless Plastic Tube	*GRA-TEC*	8
45	2802	4730-570906	90° Gra-Tec Elbow Connector	*GRA-TEC*	6
46	1902	5975-570990	Clip, Fast	*GRA-TEC*	14
47	1311	5330-570987	'O' Ring	*GRA-TEC*	14
48	POL-4-BLACK	4720-580146	Tubing, Plastic, 1/4 O.D., 100 PSI, Working Press.	*PARKER OR EQUIV.*	A/R
49	POL-4-BLACK	4720-580144	Tubing, Plastic, 3/8 O.D., 100 PSI, Working Press.	*PARKER OR EQUIV.*	A/R
50	6-6-DBZ-S	4730-580118	Fitting, Tube, Female Elbow, 90°, CPI to NPT	*PARKER*	2
51	6T23UIB	4730-580119	Insert, Tubing	*PARKER*	2
52		4730-580140	Nipple, Pipe, 3/8 NPT × 2", Steel		2
53		5305-563462	Capscrew, Soc Hd, #10-24 UNC × .625 Lg, Zinc Plate Steel		12
54		5310-561455	Washer, Flat, #10, Zinc Plate Steel		20
55		5310-561455	Washer, Lock, #10, Zinc Plate Steel		4
56		5310-002584	Locknut, Hex, #10-24 UNC, Zinc Plate Steel		8
57		5310-003996	Locknut, Hex, P.T., 1/4-20 UNC, IFI-100, Gr. C, Zinc Plate Steel		12
58		5305-583297	Capscrew, Flat Hd, 1/4-20 × 1, SAE, Gr. 8, Zinc Plate Steel		4
59		5310-565934	Washer, Flat, Hardened, 5/16", ASTM A325/F436, Zinc Plate Steel		56
60		5310-575796	Locknut, Hex, P.T., 5/16-18 UNC, IFI-100, Gr. C, Zinc Plate Steel		[illegible]
61		5305-002966	Capscrew, Hex, 3/8-16 UNRC × 2.00 Lg, SAE, Gr. 8, Zinc Plate Steel		[illegible]
62		5305-000079	Capscrew, Hex, 3/8-16 UNRC × 2.00 Lg, SAE, Gr. 8, Zinc Plate Steel		[illegible]
63		5310-595693	Washer, Flat, Hardened, 3/8", ASTM A325/F436, Zinc Plate Steel		62
64		5310-563718	Locknut, Hex, P.T., 3/8-16 UNC, IFI-100, Gr. C, Zinc Plate Steel		31
65		5306-002592	Capscrew, Hex, 1/2-13 UNRC × 2.00 Lg, SAE, Gr. 8, Zinc Plate Steel		4
66		5305-580289	Capscrew, Hex, 1/2-13 UNRC × 3.00 Lg, SAE, Gr. 8, Zinc Plate Steel		12
67		5310-594494	Washer, Flat, Hardened, 1/2", ASTM A325/F436, Zinc Plate Steel		32
68		5310-563717	Locknut, Hex, P.T., 1/2-13 UNC, IFI-100, Gr. C, Zinc Plate Steel		16
69		5310-590826	Nut, Hex, 1/2-13 UNC, Zinc Plate Steel		16
70		5310-561532	Locknut, Hex, P.T., 5/8-11 UNRC, IFI-100, Gr. C, Zinc Plate Steel		2
71		5305-580142	Screw, Shoulder, 3/8 Dia. × 3.00 Lg, Zinc Plate Steel		2
72		5305-580143	Screw, Shoulder, Nyloc, 3/4 Dia. × 1.50 Lg, Zinc Plate Steel		2
73		5305-569500	Capscrew, Hex, 5/16-18 UNRC × 1.25 Lg, SAE, Gr. 8, Zinc Plate Steel		4
74	5100-275	5365-561101	Ring, Retaining, External	*TRUARC*	2
75	RC 601	8040-563655	Adhesive	*LOCTITE*	A/R
76	C3PT-189	7025-335953	Latch, Sliding, Conductor Lock		2
77	C3PT-190	7025-335905	Catch, Stationary, Conductor Lock		2
78	C3PT-191	7025-335888	Cover, Guide Rail		2
79	C3PT-192	7025-335889	Guide Rail		4
80	C3PT-193	7025-335890	Guide Strip		4
81	C3PT-194	7025-335891	Cover Strip		4
82	C3PT-195	7025-335892	Cover Spacer		
83	C3PT-196	7025-335893	Connector, Latch to Cylinder		

Figure 2-23 Main Track Transfer Switch
Sheet 7 of 8

MAIN TRACK TRANSFER SWITCH ASSEMBLY

WDP NO. 7025-335068

DWG NO. C3PT-A150 Rev. B **Sheet 3 of 3**

ITEM	DWG/MFR NO.	WDP NO.	DESCRIPTION/MFR		QTY
84	C3PT-197	7025-335894	Plate, Mounting, Sliding Latch		1
85	C3PT-198	7025-335895	Plate, Mounting, Stationary Catch		1
86	C3PT-199	7025-335896	Bracket, Mounting, Angle		4
87	C3PT-254	7025-337794	Bracket, Mounting Channel		4
88	C3PT-256-1	7025-337795	Reaction Rail End Tube		1
89	C3PT-256-2	7025-337796	Reaction Rail End Tube		1
90	C3PT-C257	7025-337797	Reaction Rail Transfer Switch		1
91	C3PT-258	7025-337830	Plate, Mounting, Offset, Sliding Latch		1
92	C3PT-259	7025-337831	Plate, Mounting, Offset, Stationary Catch		1
93	C3PT-309	7025-337370	Chill Ring, Sch. 40 Reaction Rail		2
94					
95	MRS 1.5	5930-583293	Switch, Magnetic Reed	*BIMBA*	4
96	MRS-092-DZ	3010-583292	Air Cylinder	*BIMBA*	2
97	D-8315	3010-583291	Foot Bracket	*BIMBA*	2
98	D-8309-A	3010-583290	Rod Clevis	*BIMBA*	2
99	2205	4730-560002	Male Gra-Tec to Male NPT	*GRA-TEC*	2
100	2757	4730-596128	Adapter, Female Gra-Tec to Male NPT	*GRA-TEC*	2
101	S-576	5360-583289	Extension Spring	*CENTURY*	4
102	CSA-60	5340-574188	Spring Anchor	*CENTURY*	4
103					
104					
105		5310-561940	Nut, Hex, 8-32		4
106		5310-562234	Washer, Flat, 1/4		8
107		5310-565550	Washer, Lock, 5/16		24
108		5306-812674	Screw, Cap, 5/16-18 × 3/4, Hex Hd, Steel, Gr. 8, Pltd		8
109		5305-002964	Screw, Cap, 5/16-18 × 2, Hex Hd, Steel, Gr. 8, Pltd		16
110		5305-603034	Screw, Cap, 5/16-18 × 3, Hex Hd, Steel, Gr. 8, Pltd		8
111		5310-562094	Nut, Jam, 3/4-16, Hex		2

Figure 2-23 Main Track Transfer Switch
Sheet 8 of 8

2.5.3.2.2 Cable Removal. Requirements for replacement of cables are indicated by a marked reduction in cable diameter, evidence of excessive abrasion on the outside wires, broken outside wires or indications of severe corrosion. These factors can all be determined by visual inspection of the outside of the cable. The marked reduction in cable diameter may be due to excessive abrasion or corrosion on the outside wires, but in some instances is due to excessive corrosion on the inside wires, which is not indicated by a surface examination of the cable. Excessive abrasion can be observed on the outside wires and can be allowed for in calculating the remaining strength of a cable.

The outside wires may be thoroughly protected by the lubricant used, but due to lack of penetration, the inside wires, as well as the core, may be damaged. In the event there is any doubt about the safety of the cable, it should be replaced. When corrosion is present, the remaining strength cannot be calculated with safety, so it is essential that corrosion be controlled. Sufficient lubrication is necessary to maintain safe cable service.

To remove a cable from the transfer switches, proceed as follows:

a. Release tension from cable (30) by loosening turnbuckle (33).

b. Remove wire rope clips (32) and remove cable from sheaves (29).

2.5.3.2.3 Caster Wheel Replacement. To replace a caster wheel from the switches, proceed as follows:

a. Removal:

   1. Place a jack beneath the nearest radial beam and raise the switch up just enough to relieve the wheel.

   2. Remove the axle and remove the wheel.

b. Installation:

   1. Position wheel, making sure that the high side of the wheel is toward the perimeter of the switch.

   2. Install axle.

   3. Tighten axle nut until the wheel can just be turned by hand.

   4. When ensured that the wheel is in place, lower the track down on the wheel.

2.5.3.2.4 Sensors. To remove sensors, proceed as follows:

a. Maintenance Track (Figure 2-22):

   1. To remove a sensor (28) from cylinder (41), remove locknut (56), screw (74) and washer (75) securing sensor mount (8 and remove sensor assembly.

   2. To remove sensor (28) from shock absorber (39), remove screw (74), flat washer (75) and lockwasher (55). Remove sensor assembly.

b. Main Track (Figure 2-23):

1. To remove a sensor (28) from cylinder (23), remove capscrew (53), flat washer (54) and locknut (56) securing sensor mount (8) and remove sensor assy.

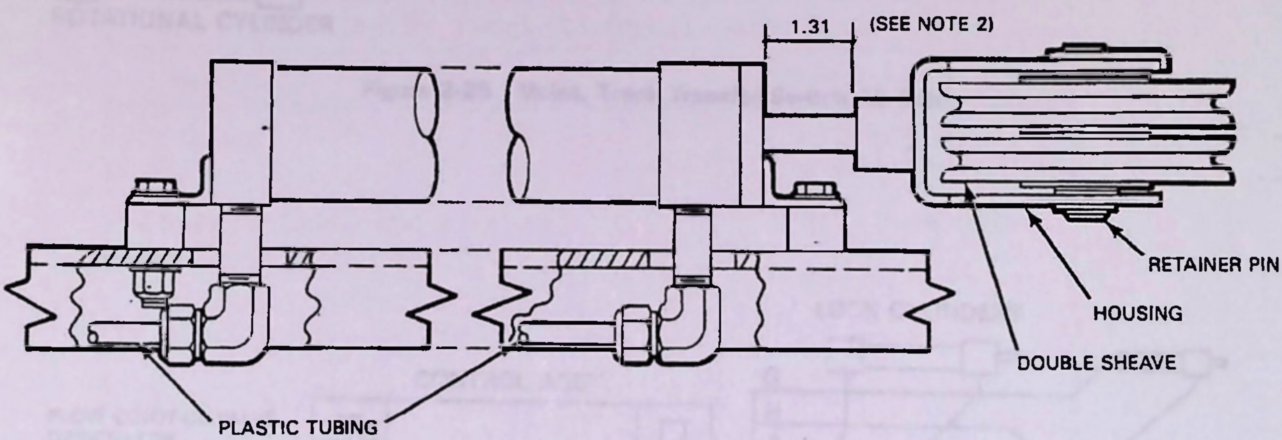
2. To remove sensor from shock absorber (39), remove capscrew (53), flat washer (54) and lockwasher (55).

2.5.3.2.5 Shock Absorber. To remove a shock absorber (39), remove capscrews (61), washers (63) and locknuts (64) and remove shock absorber from bracket (7).

2.5.3.2.6 Air Cylinder. To remove an air cylinder from a transfer switch, refer to illustrated parts breakdowns (23, Figure 2-22 or 41, Figure 2-23) and proceed as follows:

a. Turn electrical and pneumatic power off.

b. Disconnect pneumatic connections to cylinder (Figure 2-24) and plug cylinder ports. Refer to air line schematics, Figure 2-25, for maintenance track switch or Figure 2-26 for main track switch as necessary.



NOTE:
1. REFER TO THE FOLLOWING ILLUSTRATIONS:
   a. FIG. 2-25, MAINT. TRACK SWITCH AIR LINE SCHEM.
   b. FIG. 2-26, MAIN TRACK SWITCH AIR LINE SCHEM.
2. DURING INSTALLATION OF CYLINDER EXTEND TO DIMENSION SHOWN.

Figure 2-24 Transfer Switch Main Air Cylinder

c. Remove hardware (Figure 2-22 or 2-23) connecting clevis to switch frame.

d. Remove hardware connecting cylinder to cylinder mount..

e. Remove cylinder.

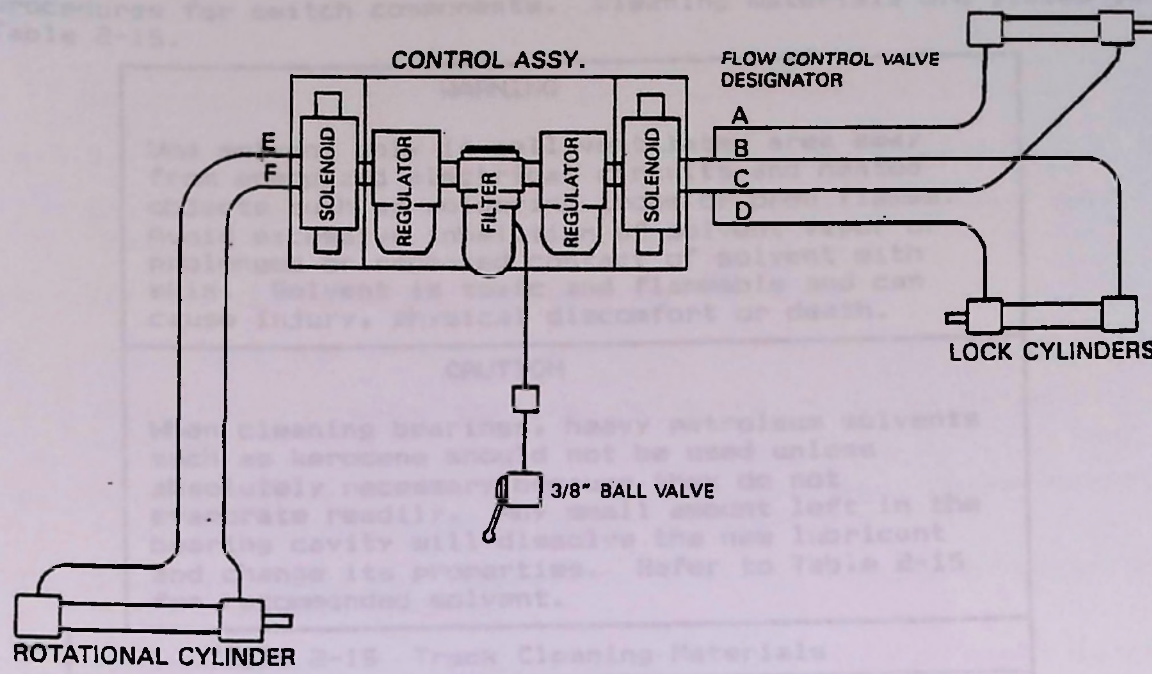


Figure 2-25 Maint. Track Transfer Switch Air Sch.

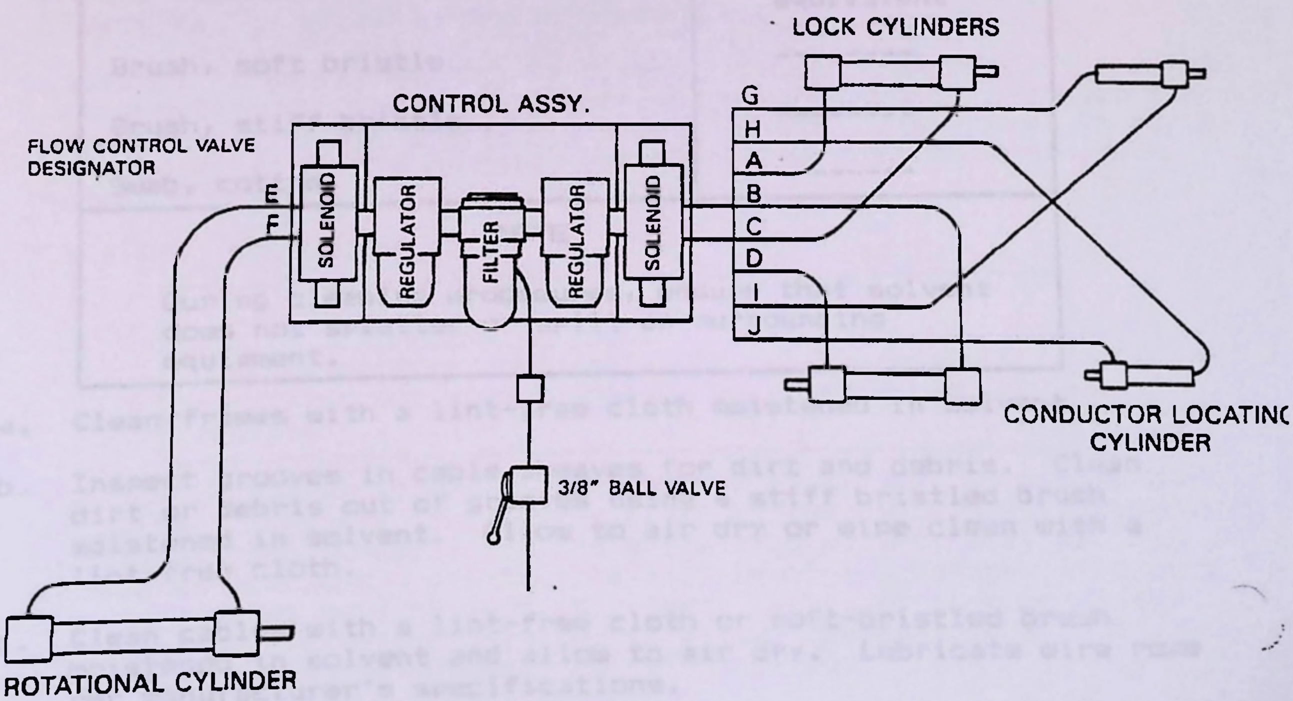


Figure 2-26 Main Track Transfer Switch Air Sch.

2.5.3.3 Cleaning. The following paragraphs provide cleaning procedures for switch components. Cleaning materials are listed in Table 2-15.

WARNING

Use solvent only in well ventilated area away from energized electrical circuits and heated objects such as soldering irons or open flames. Avoid excessive inhalation of solvent vapor or prolonged or repeated contact of solvent with skin. Solvent is toxic and flammable and can cause injury, physical discomfort or death.

CAUTION

When cleaning bearings, heavy petroleum solvents such as kerosene should not be used unless absolutely necessary because they do not evaporate readily. Any small amount left in the bearing cavity will dissolve the new lubricant and change its properties. Refer to Table 2-15 for recommended solvent.

Table 2-15 Track Cleaning Materials

MATERIAL	RECOMMENDED TYPE
Solvent	P-D-680 or equivalent
Cloth, cleaning, low-lint or	MIL-C-85043A equivalent
Brush, soft bristle	--------
Brush, stiff bristle	--------
Swab, cotton	--------

NOTE

During cleaning procedures, ensure that solvent does not splatter or spill on surrounding equipment.

a. Clean frames with a lint-free cloth moistened in solvent.

b. Inspect grooves in cable sheaves for dirt and debris. Clean dirt or debris out of grooves using a stiff bristled brush moistened in solvent. Allow to air dry or wipe clean with a lint-free cloth.

c. Clean cables with a lint-free cloth or soft-bristled brush moistened in solvent and allow to air dry. Lubricate wire rope per manufacturer's specifications.

d. Clean all switch track surfaces with a lint-free cloth moistened with solvent or use a brush moistened with solvent as necessary, and blow-dry with an air hose.

e. Clean caster wheels with a lint-free cloth or soft-bristled brush moistened wth solvent and blow dry with an air hose.

2.5.3.4 Inspection. Inspection procedures are as follows:

a. Check the underside of the transfer switches to ensure that casters are in operating condition.

b. Inspect all bolts and fittings for tightness.

c. Check condition of wheels and check for smoothness of operation.

d. Inspect all threaded surfaces for burrs, nicks or stripped threads.

e. Inspect shafts for burrs, nicks and scratches. Remove burrs, nicks and scratches as necessary or replace shafts.

f. Inspect sheaves for cracks, corrosion and freedom of rotation. Replace damaged sheaves.

g. Inspect cables for tension, stretch, corrosion or other damage. Replace as necessary.

h. Inspect cables for slack. Adjust tension as necessary.

i. Inspect cables and nylon jackets for nicks or scratches. Replace cables as necessary.

2.5.3.5 Lubrication. The following paragraphs provide lubrication procedures for transfer switch components.

2.5.3.5.1 Transfer Switch. Rotate the transfer switch and stop at each wheel. Pump two or three strokes of grease from a grease gun into the appropriate grease fittings. Do not allow grease to exude from the edges of the wheels. Use bearing or good multi-purpose chassis grease.

2.5.3.5.2 Cable Lubrication.

> NOTE
>
> Lubricate cables regularly not only to prevent corrosion but also to reduce wear of cables and equipment.

Lubrication guards against corrosion and abrasion. To ensure that the correct consistency is used, refer to the cable manufacturer's specifications. Usually a light grade (#10 weight) will be recommended because a light grade will penetrate before being wipe off or absorbed by surface dirt. Apply lubricant frequently to maintain the protective film and to allow lubricant to work into wire rope strands to combat internal friction.

2.5.3.5.3 Air Cylinders. Compressed air should be lubricated in order to prolong packing life. The lubricator should be piped into the line upstream from the operating valve in order to keep a film of oil on all moving parts in the air system. Lubricate air cylinders with "Never Wear," a specially formulated lubricant which is available only through the MAPO Hydraulics Shop. Proceed as follows:

a. Remove air lines from both cylinder ports.

b. Place cylinder in retracted position.

c. Place a small amount of "Never Wear" lubricant in the cylinder extend port.

d. Extend the cylinder fully, drawing the lubricant into the cylinder bore.

e. Place a small amount of "Never Wear" lubricant in the cylinder retract port.

f. Retract the cylinder fully, drawing the lubricant into the cylinder bore.

g. Reconnect all pneumatic lines and cycle the cylinder to distribute the lubricant.

h. Check the system for air leaks, correct as necessary, and place cylinder back in service.

2.5.3.6 Reassembly. Reassembly procedures are described in the following paragraphs.

2.5.3.6.1 Transfer Switches. No special procedures are required for reassembly of the maintenance track or main track transfer switches. When installing components, refer to Figure 2-22, Maintenance Track Transfer Switch or Figure 2-23, Main Track Transfer Switch. During reassembly of the transfer switches, refer to the above figures and use the torque values listed in Table 2-16.

Table 2-16 Transfer Switch Torque Values in Ft/Lbs Dry

ITEM NUMBER	TORQUE
60	15
64	25
68	60
70	110

2.5.3.6.2 Caster Wheels. To install a new caster wheel (26), refer to paragraph 2.5.3.2.3.

2.5.3.6.3 Cable Installation. A new cable requires careful installation and close adherence to following all appropriate procedures.

a. Thread new cable (30) through sheaves (29).

b. Thread cable through turnbuckle clevis (33) and secure with clips (32).

c. Position transfer switch frame in normal use position before adjusting cable and hardware.

d. Tighten turnbuckle until desired cable tension is reached. Cable should be taut.

After the cable has been installed and the ends secured in the correct manner, the mechanisms should be started carefully and then permitted to run through a cycle of operation at slow speed. During this trial operation, maintain a close watch on all working parts to make certain the cable runs freely and without possible obstructions as it makes its way through the system. If no problems appear during operation, provide several run-throughs of the normal operational cycle at reduced speed. This procedure allows the component parts of the new cable to make a gradual adjustment to the actual operating conditions.

2.5.3.6.4 Sensors. Install sensors in the reverse order of removal as described in paragraph 2.5.3.2.4. Apply Loctite Adhesive RC 601 to threaded surfaces prior to installation. After installation, adjust position of sensors to ensure 1/2-inch clearance between sensor face and target surfaces.

2.5.3.6.5 Shock Absorbers. Position new shock absorber (39) to bracket (7) and secure with capscrews (61), washers (63) and locknuts (64). Torque locknuts to 25 ft/lbs.

2.5.3.6.6 Air Cylinder Replacement. To install a new air cylinder on a transfer switch, refer to Figure 2-22 or, Figure 2-23 and proceed as follows:

a. Ensure that electrical and pneumatic power is off.

NOTE
Do not remove the shipping plugs in the cylinder ports of a new cylinder during installation until actual piping connections are ready to be made.

b. Align the cylinder carefully, keeping mounting surfaces square, parallel, concentric and true with the work direction.

c. Ensure that all connecting pipe ends are de-burred and that insides are cleaned of scale, rust and dirt.

d. Remove shipping plugs.

e. On main air cylinder, extend to 1.31" dimension as shown in Figure 2-24. Refer to air line schematics Figure 2-25 for maintenance track switch or Figure 2-26 for main track switch necessary.

f. Operate the cylinder several times to ensure that it is functioning properly.

g. Check piping for leakage.

> NOTE
>
> If installation is complete and cylinder does not function properly, check for: 1) poor alignment of the cylinder with its mating pieces, 2) insufficient pressure or leakage.

h. Restore electrical and pneumatic power to system.

2.5.4 LOAD/UNLOAD BELT DRIVE. The belt drive system used for passenger loading and unloading is a facility installation manufactured by Westmont Industries, Sante Fe Springs, CA 90670. The two drives are identical units integrated into the total ride system, with each drive incorporating relay logic that implements thermal protection, motor current overload, belt emergency stop and sequential logic. The load/unload belts are powered by 15 hp shunt wound DC motors and the load belt walkway utilizes a 1-1/2 hp shunt wound DC drive motor for the handrail.

The load belt drive, unload belt drive, handrail drive and belt system relay logic are installed in one cabinet located in the electrical equipment room. The belt drive systems are required to follow the master reference command so that all systems accelerate and decelerate at the same rate to the same linear velocity. Major characteristics are as follows:

a. Isolation Transformer:

460 to 230 VAC 3 Phase, 35KVA at 40°C ambient with $\pm$10% Taps in a NEMA I, floor mount enclosure.

b. Circuit Breaker:

460 three pole circuit breaker sized to protect the line from transformer faults - in a NEMA I - wall mount enclosure.

c. DC Drive System:

Input Voltage: 230 VAC $\pm$ 10%

Input Frequency: 60 Hz $\pm$ 3 Hz

Output:

Power - 15 KW at Base Speed

Speed Range - 0 to 1150

Speed regulation w/tachometer $\pm$ 1% of set speed from 500 to 1750 RPM

Torque - 45 ft/lbs continuous duty at 40° ambient over full speed range. Constant torque rating from zero speed to base speed with 17 hour duty cycle at service class I to II.

Adjustable separate accel & decel - 2 to 20 seconds. Non-regenerative type system, local manual operator panel required.

2.5.4.1 Maintenance Procedures. This paragraph contains basic information for maintaining the load/unload belt drives in operating condition. For detailed maintenance procedures, refer to the vendor's manual.

2.5.4.1.1 Preventive Maintenance. Preventive maintenance schedules for the load/unload belt drives are described in the following procedures.

a. Tighten all bolts on pulley hubs annually.

b. Check handrail lagging for abnormal wear bi-monthly.

c. Check handrail tension and proper handrail speed monthly.

d. Inspect emergency brake for proper alignment monthly.

e. Inspect emergency brake disc pads bi-monthly.

f. Check emergency brake solenoid for alignment and free motion monthly.

g. Lubricate all grease fittings semi-annually.

h. Check pulleys for any relative motion on shafts semi-annually.

i. Check main belt tension monthly.

j. Tighten bolts on pillow block bearings annually.

k. Check limit switches for proper function monthly.

l. Observe overall appearance for smoothness and quietness of operation monthly.

m. Clean pits of any major debris monthly.

2.5.4.1.2 Corrective Maintenance. Corrective maintenance for the load/unload belt drives consists of recognizing a malfunction, isolating the cause and taking corrective action as described in the troubleshooting procedures, Table 2-17.

Table 2-17 Load/Unload Belt Drive Troubleshooting Chart		
SYMPTOM	POSSIBLE CAUSE	SOLUTION
Unit will not start.	Main disconnect not on.	Push switch to on position.
	Blown fuses.	Replace fuses.
Unit will start but not remain operating.	Unit being started in wrong direction.	Start in proper direction.
	Mode selector not in proper position.	Turn mode selector switch to proper position.
	Speed sensor cards malfunctioning.	Replace cards.
Handrail traveling slower than main belt.	Insufficient tension.	Adjust tension so that handrail will have a pulling force of about 150#.
	Lagging on handrail drive sheave worn.	Replace lagging.
Head or tail pulley moved causing belt to shift.	Bolts loose on pulley hub.	Realign pulley and tighten bolts.
Abnormal wear/or noise of bearings at tail and head end curves.	Excessive handrail tension.	Reset handrail tension to develop about 150# pull.
Abnormal wear of canvas backing on inside of handrail.	Hold-down bolt for handrail guide projecting into handrail.	Tighten down bolt.

2.5.4.1.3 Cleaning.

WARNING

Do not use wax or polish when cleaning the treadway. These agents may cause the treadway to become slippery resulting in possible injuries to personnel or guests.

a. Treadway. The treadway should be cleaned by scrubbing with soap and water using a stiff bristled brush.

b. Handrail. The handrail may be cleaned with non-detergent soap and water. Commercial waxes may be used to maintain a clean, shiny appearance.

c. Stainless Steel Trim. The trim can be kept clean using a non-abrasive soap and water. A commercial polish can be used to maintain a shiny appearance.

2.5.4.1.4 Lubrication. Lubricate bearings at regular intervals. The frequency and amount of lubrication is dependent upon the type of service the bearing is subjected to. A bearing not properly lubricated can run to destruction and cause damage to other components. Add grease slowly, as rapid application may blow the seal and allow the grease to escape. The following lubricants are recommended by the manufacturer:

Shell Oil Company - Alvania No. 2 Lithium Grease

Mobil Oil Corp - Mobile Ux2

Texaco Inc. - Premium RB Grease.

SECTION 3 SHOW SYSTEM MECHANICAL

3.1 INTRODUCTION

Section 3 provides the procedures required to maintain the Horizons show in operational condition. This section describes the traveling video frames system and includes maintenance information on the traveling frames and their drive unit. It also describes the animated figures, animated props, and show action equipment and provides required preventive and corrective maintenance procedures and illustrated parts breakdowns (IPB).

3.2 SHOW DESCRIPTION

The following paragraphs describe the Horizons' show scenes.

3.2.1 SCENE 1 - FUTUREPORT. Orienting guests to the idea of taking a journey into tomorrow, the Horizons adventure begins in the FuturePort, a queue and load concourse area styled as a transportation center in a future community.

3.2.2 SCENE 2 - LOAD AREA. Upon leaving the FuturePort, the guests enter the main load concourse, where they can board ride vehicles which will transport them on their adventure.

3.2.3 SCENE 3 - TRANSITION TUNNEL ONE. The ride vehicles depart from the Load Area and pass through a Transition Area. The on-board narrator informs the guests that they are not the first to make the trip into the future -- people have been dreaming about it for centuries.

3.2.4 SCENE 4 - EARLY INVENTIONS. As the vehicles leave the transition tunnel, they pass through an area filled with moving clouds and projections of early inventions.

3.2.5 SCENE 5 - JULES VERNE. Jules Verne was one of the leading visionaries of his time. In this sequence, his view of space travel is illustrated as his renowned bullet rocket blasts off on its way to the moon, with Verne himself and two animals as passengers. The vehicles soon pass by the Man in the Moon with the rocket lodged in his eye.

3.2.6 SCENE 6 - ROBIDA. The scene features a look at a 19th century artist's conception of futuristic transportation systems. It is Robida's stylized view of rapid transit moving the masses from here to there and back again.

3.2.7 SCENE 7 - ART DECO. A salute to dreams and inventions of sci-fi enthusiasts from the 1930's, this scene is a three-dimensional environment, combining projection screens, dimensional sets, and audio-animatronic figures with optical, sound and special effects. Past dreams about future communities and life-styles will be demonstrated in a dimensional art deco setting, featuring a rather overburdened "housework" robot.

3.2.8 SCENE 8 - NEON CITY. Against a neon backdrop, three screens provide glimpses of the future world from classic science fiction films and TV programs.

3.2.9 SCENE 9 - FUTURE CITY. The 1950's conception of the future city is revealed. City lights twinkle on and off as a futuristic monorail glides along its guideway. In the sky above, helicopters, jet-packers, and rocket ships dominate the area.

3.2.10 SCENE 10. TRANSITION TUNNEL TWO. As the ride vehicles leave the Future City, the guests are taken through a transition area.

3.2.11 SCENE 11 - OMNISPHERE (OMNI-MAX THEATER). With the Omni-Max projection, guests visit micro and macro worlds, as well as the far reaches of inner and outer space, whose secrets open the doors to tomorrow.

3.2.12 SCENE 12 - TRANSITION TUNNEL THREE. Moving out of the Omni-Max theater, there is a transitional fade from the theater into a futuristic urban setting.

3.2.13 SCENE 13 - URBAN HABITAT. After making the transition from the theater, the ride vehicles glide past a three-dimensional urban set of the future at dusk. Advanced transportation systems and habitable megastructures are visible throughout the community. The vehicles then pass by the apartment of a mature married couple. The guests will recognize the man's voice as their vehicle narrator. The conversations and observations of this couple, grandparents in an extended family, are the vehicle narration for the rest of the trip. At the moment, the wife is conversing with a holographic view screen projection of her daughter at a desert farm community.

3.2.14 SCENE 14 - TRANSITION TUNNEL FOUR. The ride vehicles leave the urban habitat and pass through a transition area before entering the desert farm.

3.2.15 SCENE 15 - DESERT FARM. The desert represents the Earth's brightest potential for feeding the growing population. Moving past desert mesas, the ride vehicles come upon a future farm. In the distance a field of genetically engineered citrus trees are being harvested by robotic fieldhands. Overhead, silent helium filled airships are carrying their cargo across the skies. Standing by a large console in the main control room is a farmer giving voice commands to various mechanical harvesters. "Video" screens on the panel show closeup views of robots and their harvesting. An additional view screen shows a man in a kitchen setting. Further on, there is a hovercraft on its landing pad located near the farmer's house.

3.2.16 SCENE 16 - DESERT HABITAT KITCHEN/COMMUNICATIONS ROOM. The ride vehicles continue along the pathway overlooking the farm as they head toward the farmer's nearby house. Here, there is a lush garden with a three-tiered waterfall and tropical flowers tucked inside a natural rock landscape. Inside the house, dad is fixing a cake at an island counter. Nearby, the young son is playing with the voice-activated pantry. In the communications center of the house, a talking computer is giving a chemistry lesson to a teen-aged daughter. However, she is far more interested in talking to her boyfriend on the wall teleview screen.

3.2.17 SCENE 17 - TRANSITION TUNNEL FIVE. The ride vehicles leave the desert habitat and pass through a transition tunnel before entering the sub repair room.

3.2.18 SCENE 18 - SUB REPAIR ROOM. The ride vehicles enter a workroom where the young man seen on the teleview screen in the desert habitat continues his conversation with the farmer's daughter. As he chats, he works sporadically on a mini-sub, aided by an interactive diagnostic computer and a laser welding tool.

3.2.19 SCENE 19 - DIVE CHAMBER. The ride vehicles passes over a dive chamber where a submarine is awaiting its next expedition.

3.2.20 SCENE 20 - FLOATING CITY CLASSROOM. The vehicles drop down to a level where a class is in session. The teacher is instructing her pupils in preparation for an underwater dive.

3.2.21 SCENE 21 - UNDERSEA RESORT. The vehicles pass into and through an airlock to begin a tour of the ocean floor. In the foreground, an undersea restaurant can be seen where people are dining while watching a dolphin play just outside their port windows. The children from the classroom swim by with their instructor.

3.2.22 SCENE 22 - UNDERSEA FARMING. In this area there is a scenic kelp forest. A submarine takes samples from this cultivated farm. Further on, the ocean mining operation is visible where manganese nodules are being vacuumed from the sea floor.

3.2.23 SCENE 23 - TRANSITION AREA. As we rise, the boy's submarine appears, then suddenly dissolves into a spaceship that recedes behind a space colony.

3.2.24 SCENE 24 - OUTER SPACE. The underwater void now becomes space of a different nature. The dark ocean depths have suddenly become twinkling stars. The ride vehicles move past a construction site where an astronaut is maneuvering beams into position. A woman in a space manipulator vehicle lends him assistance. In the distance are three space colonies.

3.2.25 SCENE 25 - AIRLOCK. The vehicles enter an airlock chamber transition tube leading from outer space to the space colony. An intercolony transport is refueling.

3.2.26 SCENE 26 - SPACE COLONY. After passing through the airlock chamber, the vehicles enter an observation tube looking out to the city below.

3.2.27 SCENE 27 - HEALTH AND RECREATION. The zero gravity recreation center is brimming with the latest in healthful recreational equipment. A woman is cycling down a bike path from her hometown on Earth, courtesy of a simulation device. A body scan device, to receive medical information, is nearby. In the background of the recreation center there are the shadows cast by a group of athletes playing zero-gravity basketball.

3.2.28 SCENE 28 - MAIN SHUTTLE PORT. The ride vehicles pass the colony's main shuttle docking bay; a family of new arrivals are getting "carried away" with the zero-gravity setting. The boy and his dog are floating in the air while his parents are waiting nearby. Off in space past the shuttle there are two astronauts controlling the movement of an asteroid being readied for transportation to Earth.

3.2.29 SCENE 29 - CRYSTAL MANUFACTURING LAB. On the other side of the technical lab there is the manufacturing lab. Here, crystals are growing for use in a number of important applications back on Earth.

3.2.30 SCENE 30 - TRANSITION TUNNEL. The ride vehicles leave the Crystal Manufacturing area and pass through a transition tunnel before entering the "holographic party line" area.

3.2.31 SCENE 31 - HOLOGRAPHIC PARTY LINE. Passing through the lab, the vehicles enter a habitat in the colony's community area. Here, a family is in the midst of a holographic party line conversation. The couple is showing off their year-old child to friends and relatives. One screen features characters from the urban setting, another scene, the teenage girl at the desert home, and the third scene, the boy from the floating community.

3.2.32 SCENE 32 - LAUNCH TUBE/AERIAL IMAGES. As the ride vehicles leave the colony via a launch tube, the guests view three aerial images. These "tourism ads" are based on habitats presented throughout the "tomorrow's windows" sequences and re-acquaint guests with the transportation vehicles used in the finale.

3.2.33 SCENE 33 - CHOOSE YOUR TOMORROW SELECTIONS. Once in space, four sets of back-lit panels appear on the doors of the ride vehicle. Each set contains three selections which are "rides" based on transports they have already seen in the visited habitats. Guests are invited to make a choice. The majority rule in each vehicle determines which experience will be shown. If an agreement is not reached, the computer system automatically makes the decision for the vehicle.

3.2.34 SCENE 34 - SIMULATIONS. Guests now begin their chosen experience. It is a simulated ride on one of three different types of futuristic transport vehicles.

3.2.35 - SCENE 35 - TUNNEL TO UNLOAD. The ride vehicles leave the Choose Your Tomorrow simulations area and pass through a transition tunnel before entering the unload area.

3.2.36 - SCENE 36 - UNLOAD AREA. Having completed the unique experience of traveling through the future, the guests return to the FuturePort unload area to disembark from their ride vehicles.

3.2.37 - SCENE 37 - EXIT. Upon disembarking from the ride vehicles, the guests pass through an exit area with a vast mural.

3.3 TRAVELING VIDEO FRAMES

The final section of the show area features the Traveling Video Finale. As the ride vehicles pass through the area, a set of traveling frames move on a track; they are synchronized with the ride vehicles. Video projectors display images on the rear side of a screen behind the frames to provide a final show scenario.

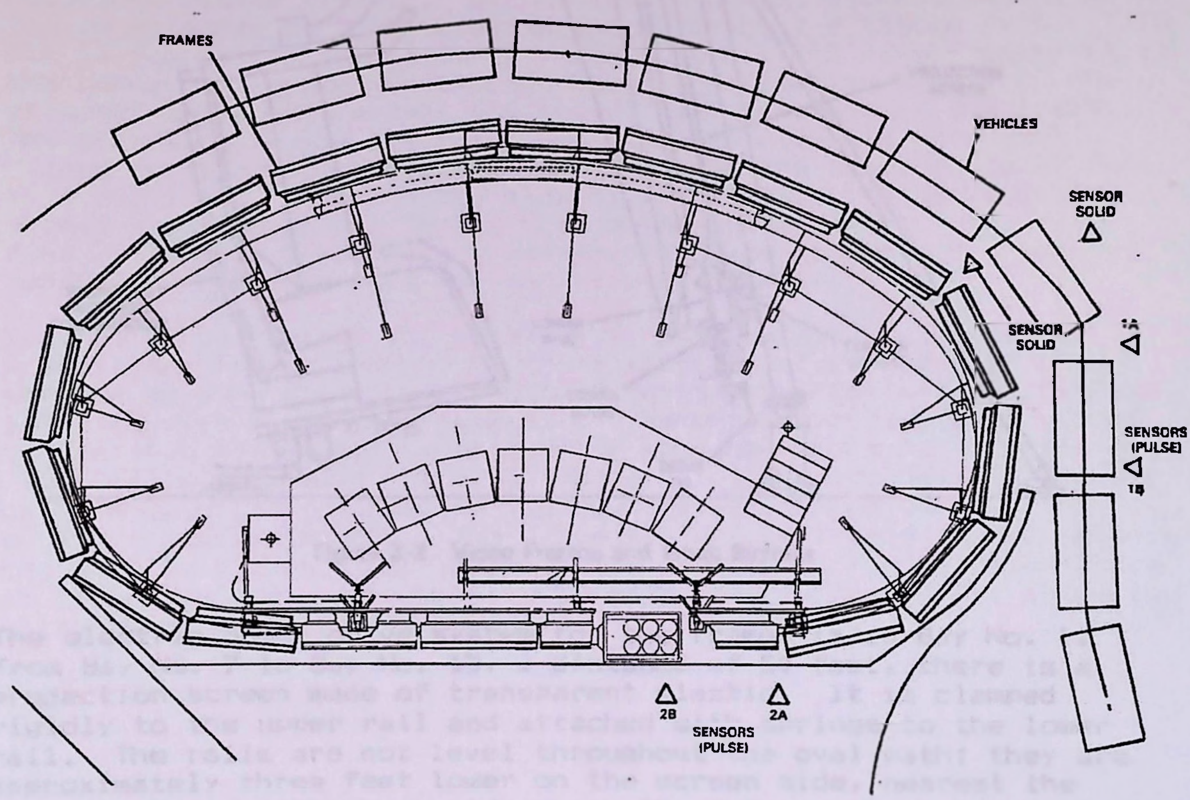


Figure 3-1 Traveling Video Frames and Viewing Area

3.3.1 DESCRIPTION. Figure 3-1 shows a plan view of the layout for the traveling video frames. The principal mechanical items in the traveling video frames installation are the track and its supporting structure, the projection screen attached to the track, the traveling frames, and the drive unit. The projection system and control system are covered in a Section 5.

3.3.1.1 Track System. The frames ride vertically on a track that is made with an upper rail and a lower rail that are spaced approximately 5-1/2 feet apart. The rails are formed from heavy wall tubing with a retangular cross section. They are held in place with standoffs from steel columns (Figure 3-2). Twenty steel columns, fixed to the floor and braced, are in an oval pattern as shown in Figure 3-1. The rails attach to the outward facing side of each column to form a continuous path for the traveling frames. The columns, spaced approximately equidistant, form twenty bays which are numbered counterclockwise from 1 to 20; number 1 starts at the back side which is furthest from the vehicle path.

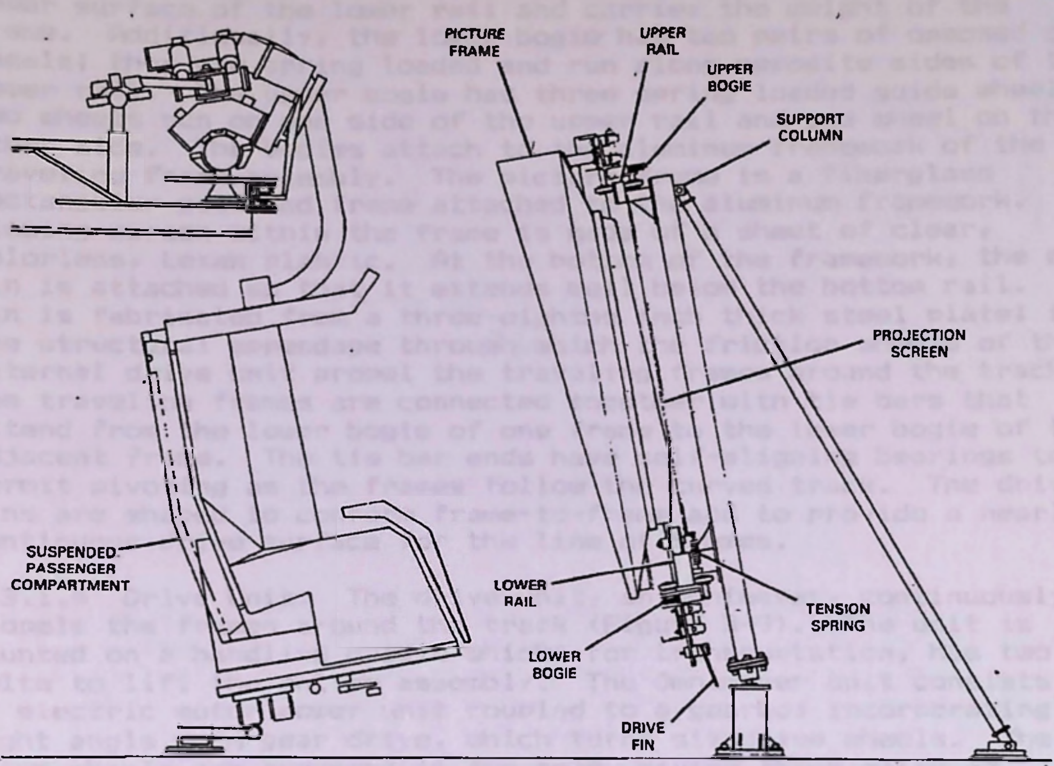


Figure 3-2 Video Frames and Track System

The electric motor drive system for the frames is in Bay No. 1. From Bay No. 7 to Bay No. 13, a distance of 50 feet, there is a projection screen made of transparent plastic. It is clamped rigidly to the upper rail and attached with springs to the lower rail. The rails are not level throughout the oval path; they are approximately three feet lower on the screen side, nearest the vehicles than on the back side where the drive unit is located. The columns are tilted to secure the proper frame orientation in the viewing area and in the drive area.

3.3.1.2 Projection Screen. The projection screen is a single sheet of clear, colorless, Lexan plastic. 216 holes are spaced along the edges for bolts so the sheet may be clamped between an angle and a brace placed on opposite sides along the sides and bottom of the screen. On the top, the screen is clamped between an angle and the upper rail of the track (Figure 3-2).

The bottom angle (to which the screen is clamped) is secured to the lower rail by a series of tension springs. The springs are attached to the angle by anchor bolts; the springs are attached to the lower rail by standoffs welded in place. There are two spring sizes, alternated along the length of the screen, to make the screen and spring system less sensitive to vibrations induced by the motion of the frames.

3.3.1.3 Traveling Frames. The traveling frames move along the track on two sets of bogies - two upper bogies and two lower bogies. The lower bogies each have a load wheel that rides on the upper surface of the lower rail and carries the weight of the frame. Additionally, the lower bogie has two pairs of opposed guide wheels; they are spring loaded and run along opposite sides of the lower rail. The upper bogie has three spring loaded guide wheels; two wheels run on one side of the upper rail and one wheel on the other side. The bogies attach to the aluminum framework of the traveling frame assembly. The picture frame is a fiberglass rectangular extended frame attached to the aluminum framework. The viewing screen within the frame is made of a sheet of clear, colorless, Lexan plastic. At the bottom of the framework, the drive fin is attached so that it extends well below the bottom rail. This fin is fabricated from a three-eighths inch thick steel plate; it is the structural appendage through which the friction wheels of the external drive unit propel the traveling frames around the track. The traveling frames are connected together with tie bars that extend from the lower bogie of one frame to the lower bogie of the adjacent frame. The tie bar ends have self-aligning bearings to permit pivoting as the frames follow the curved track. The drive fins are shaped to conform frame-to-frame and to provide a nearly continuous drive surface for the line of frames.

3.3.1.4 Drive Unit. The drive unit, an Omnimover, continuously propels the frames around the track (Figure 3-3). The unit is mounted on a handling cradle which, for transportation, has two eye bolts to lift the entire assembly. The Omnimover unit consists of an electric motor power unit coupled to a gearbox incorporating a right angle worm gear drive, which turns six drive wheels. The six drive wheels are arranged in two rows, giving three pairs of counter-rotating wheels. The drive fin of the frames passes between the resilient wheels and is propelled forward by the friction force at the drive wheel periphery. The plan view in Figure 3-1 shows the orientation of the drive wheels.

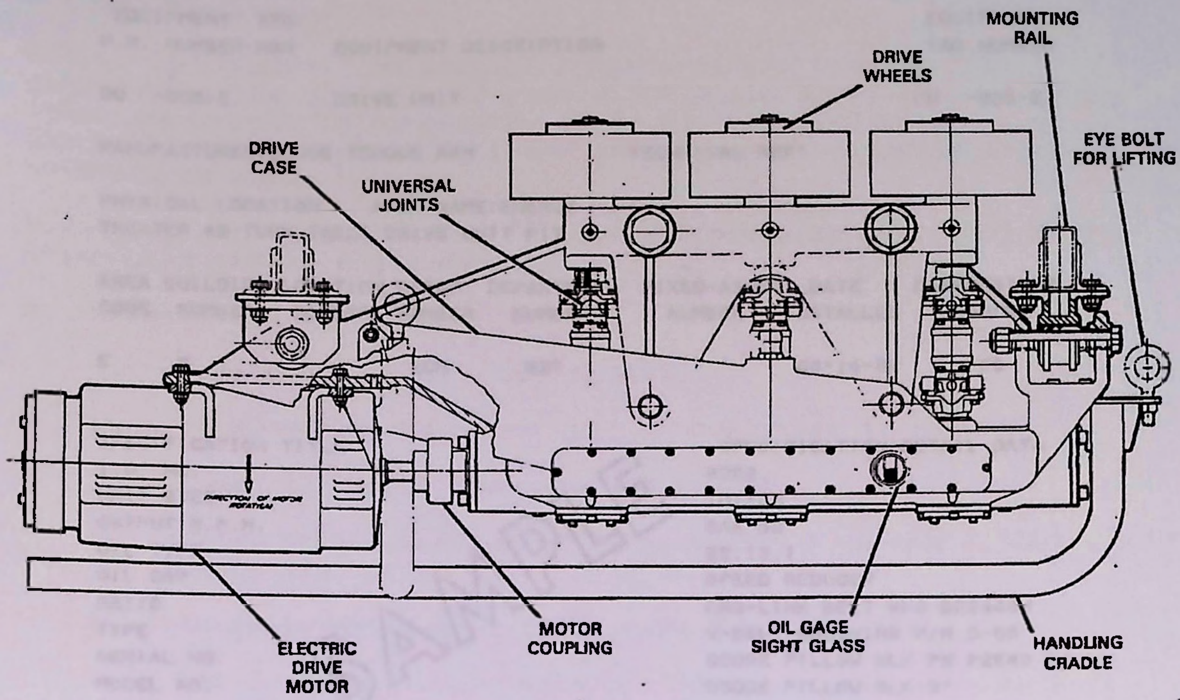


Figure 3-3 Drive Unit

3.3.2 THEORY OF OPERATION. Nineteen picture frames moving on a track are synchronized with the ride vehicles so that seven frames are aligned with the seven ride vehicles in the scene at any one time. Seven TV projectors are used to rear-project images on the fifty foot wide screen behind the moving frames. The pictures being projected are electronically wiped from projector to projector in synchronization with the moving frames. This system allows continuous viewing of a framed show scenario projected from the TV projectors while the vehicles are in motion. The control system utilizes infrared (IR) sensors for a continuous stream of pulses for position data on each frame and vehicle (relative to each other) in the curve of the finale show area. The pulses are produced when slotted fins, mounted on the vehicles and traveling video frames, interrupt the IR beams. The data is utilized by the Remote Data Concentrator (RDC) adjust the speed of the drive system for proper synchronizaiton.

3.3.3 PREVENTIVE MAINTENANCE. Perform preventive maintenance procedures on a regular basis to forestall malfunctions and to detect unsuspected failures. The components requiring preventive maintenance are the Omnimover drive unit and the bogies of the traveling frames. The other parts of the system should be inspected for possible damage. Maintenance schedules and procedures are listed in the Scheduled Service System Manual and are stored in a computer for ready reference. Figure 3-4 is a typical maintenance schedule for an Omnimover drive unit.

EQUIPMENT P.M. NUMBER	SEQ NBR	EQUIPMENT DESCRIPTION	EQUIPMENT TAG NUMBER
DU	-005-E	DRIVE UNIT	DU -005-E

MANUFACTURER: DODGE TORQUE ARM   TECHNICAL REF:

PHYSICAL LOCATION   AREA NAME: ENERGY
THEATER #2 TURN TABLE DRIVE UNIT PIT

AREA CODE	BUILDING NUMBER	LOCATION NUMBER	GROUP NUMBER	DEPARTMENT NUMBER	FIXED-ASSET NUMBER	DATE INSTALLED	RESPONSIBLE ORIGIN
E	E		ECM	82C		06-14-82	60

SPECIFICATION TITLE	SPECIFICATION DETAIL DATA
I.D. NO.	8252
UNIT SIZE	TDT-65
OUTPUT R.P.M.	SAE 50
OIL TYPE	25.13.1
OIL CAP	SPEED REDUCER
RATIO	BRG-LINK BELT #FC B22448H
TYPE	V-BELT BROWNING P/N D-68
SERIAL NO.	DODGE PILLOW BLK PN P2E48
MODEL NO.	DODGE PILLOW BLK 3"
P/N	
COUPLING TYPE	
DRIVE AND DRIVEN HALVES	
TYPE OF BELTS/QUANTITY	
CHAIN SIZE/TYPE/QTY	
SPROCKET SIZE/TYPE/QTY	
MISC INFO	

FREQUENCY: ANNUALLY
CRAFT: MECHANICAL

SEQUENCE	PROCEDURE TO BE PERFORMED	NUMBER
1	CHECK ALIGNMENT OF PUMP & MOTOR	852
2	CHANGE GEAR LUBRICANT	138
3	CLEAN SIGHT GLASS	722

FREQUENCY: BI-WEEKLY
CRAFT: MECHANICAL

SEQUENCE	PROCEDURE TO BE PERFORMED	NUMBER
1	INSPECT FOR LOOSE NUTS BOLTS & MISSING PARTS	1

Figure 3-4 Typical Maintenance Schedule

3.3.4 CORRECTIVE MAINTENANCE. The following paragraphs contain the procedures required to maintain the traveling video track system in operational condition, and include disassembly, cleaning, inspection, and reassembly procedures. For disassembly of system components, refer to the illustrated parts breakdowns (IPB) included in these paragraphs.

3.3.4.1 Disassembly. The following paragraphs describe the disassembly procedures.

3.3.4.1.1 Bogies. No special procedures are required to disassembly the bogies. If removal of bogie wheel assemblies or other components is necessary, refer to Figures 3-10 and 3-11. Bearing races are press fit; to remove, use a hydraulic press in the maintenance area.

3.3.4.1.2 Drive Unit. The following procedures are provided for drive unit repair and overhaul:

a. General

1. Remove drive unit from mount.

2. Disassemble the drive unit as described in step b.

3. Clean all parts (paragraph 3.3.4.2).

4. Order replacement parts as necessary from the illustrated parts list (Figure 3-9).

5. Assemble drive unit (Paragraph 3.3.4.5).

6. Lubricate all components of the drive unit (Figure 3-7).

b. Disassembly. To dismantle the drive unit for overhaul, refer to Figure 3-5 for part location and proceed as follows:

1. Disconnect the universal joint coupling yoke from the drive shafts by removing four screws (1) from each upper universal joint (six places).

2. Remove the four drive carrier shafts (2). Drive carrier assemblies may now be removed from gear case.

3. Remove upper and lower spider and bearing assemblies (3).

4. Remove end yoke (4) from drive wheel and shaft assembly (5) by removing bolt and washer from center of shaft end.

5. Pull lower seal (6). The drive wheel and shaft can now be pressed out through the top of the carrier.

c. Drive Unit Worm Gear. To remove the worm gear from the drive case, proceed as follows:

1. Drain gear case oil.

2. Remove the drive wheel carrier assembly following steps 1 thru 5 above.

3. Remove port covers from both sides of the gear case (7).

4. Remove collar shield and O-ring (8).

5. Remove collar (9) with top seal and bearing.

6. Remove lower housing cap (10).

7. Remove screw and washer (11) from center of gear shaft end.

8. Remove lower bearing housing (12) with bearings.

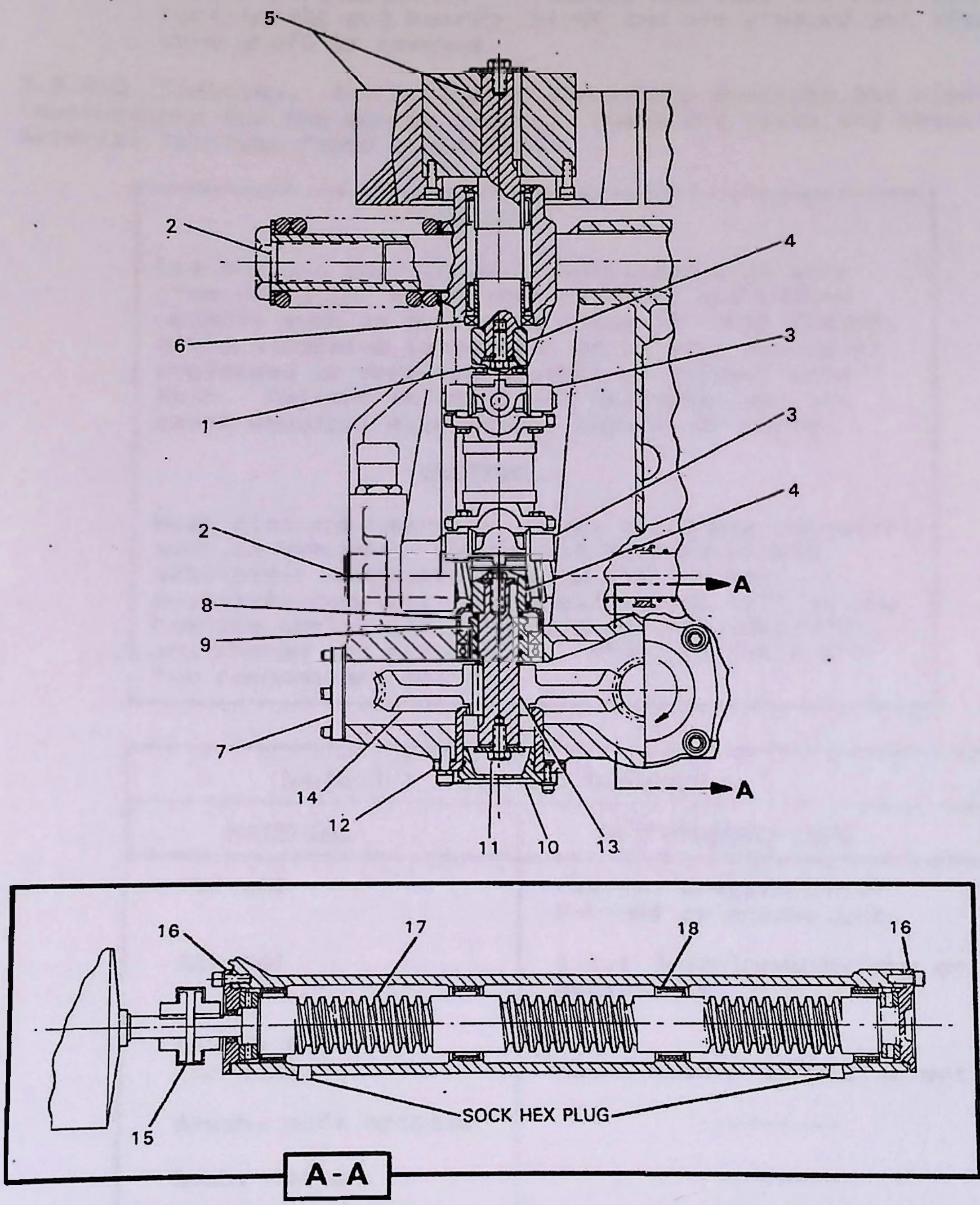


Figure 3-5 Drive Unit Disassembly Points

9. Press gear shaft (13) upward out of gear (14). Gear can now be removed through port in gear case.

10. Disconnect motor coupling (15) and remove motor (16) from drive assembly.

11. Remove both worm cap assemblies (16).

12. Remove worm shaft (17). Radial bearings are held with Loctite 242 and bearing rings and are pressed out after the worm shaft is removed.

3.3.4.2 Cleaning. The following paragraphs describe the cleaning instructions for the moving frames. Table 3-1 lists the required material to clean frame components.

WARNING

Use solvent only in well ventilated area away from energized electrical circuits and heated objects such as soldering irons, or open flames. Avoid excessive inhalation of solvent vapors or prolonged or repeated contact of solvent with skin. Solvent is toxic and flammable and can cause physical discomfort, injury, or death.

CAUTION

When cleaning bearings, heavy petroleum solvents, such as kerosene, should not be used unless absolutely necessary because they do not evaporate readily. Any small amount left in the bearing cavity will dissolve the new lubricant and change its properties. Refer to Table 3-1 for recommended solvent.

Table 3-1 Cleaning Materials

MATERIAL	RECOMMENDED TYPE
Solvent	Federal Specification P-D-680 or equivalent.
Alcohol	1,1,1 Trichloreothylene or equivalent
Cloth, cleaning, low-lint	MIL-C-85043A or equivalent
Brush, soft bristle	----------
Swab, Cotton	-----------

> **CAUTION**
>
> If oil or grease appears on fins, it must be cleaned away and the cause located and corrected.

3.3.4.2.1 Bogies. Proceed as follows:

a. Using a stiff-bristled brush, remove dust and dirt from all surfaces, and then wipe clean with a dry, lint-free cloth or blow-dry with an air hose.

b. Clean load wheels and guide wheels with a lint-free cloth moistened with solvent, and then blow-dry with an air hose or allow to air dry.

3.3.4.2.2 Drive Unit. If drive fins become dirty or greasy, they must be cleaned. Dirt and grease will cause the drives to slip and may close down the show. Fins should be cleaned with an approved dry cleaning solvent which will not leave a residue. Clean the drive unit as follows:

a. Remove dust and dirt from all surfaces using a soft-bristled brush and an air hose as necessary.

b. Dry all surfaces with a clean, dry lint-free cloth.

c. When necessary, treat metals with corrosion preventive compound, Military Specification MIL-C-16173 or equivalent. Anodize or apply approved chemical film to aluminum alloy parts which are not grounded or bonded.

d. Clean all threaded fasteners with 1,1,1 trichloreothylene or approved cleaning agent that does not leave a film after evaporation.

3.3.4.3 Inspection. Inspection procedures verify the condition of disassembled and cleaned components of the moving frames. Inspection will reveal defects resulting from wear, damage, or deterioration. In general, visually inspect vehicle components. Inspect all parts for loose or missing hardware, foreign matter, damage, corrosion, dirt, and film. The following paragraphs describe the items to be inspected and their possible defects.

3.3.4.3.1 Daily Inspection. The entire system should be put through one inspection performance cycle daily so that maintenance personnel can check proper tracking of bogies, check the drive system, and listen for suspicious sounds.

3.3.4.3.2 Projection Screen. Inspect the projection screen for nicks or cuts so that minor damage can be repaired before major tears develop. Inspect the springs for failures which could cause loss of uniform screen tension.

3.3.4.3.3 Track System. Inspect the track system for cracked welds or loose bolted joints which could cause track vibration when the frames are in motion.

3.3.4.3.4 Drive System. Check drive units for proper operation while in motion. Check for noisy bearings and drive couplings. Drive fins should pass through the drive wheels without binding. Inspect all seals, gaskets, and plugs for oil leaks. The oil level (see Figure 3-6) in the gearcase should be checked while the unit is not operating.

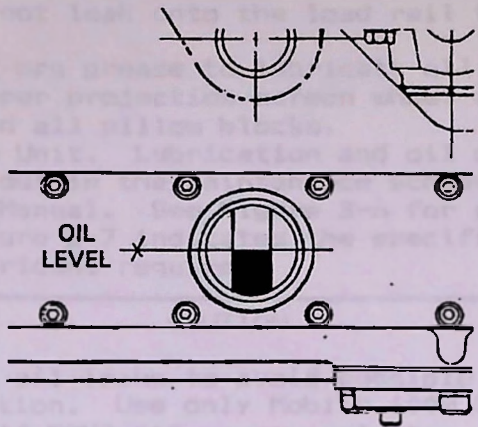


Figure 3-6 Oil Gauge Sight Glass

3.3.4.3.5 Bogies. Refer to Figures 3-10 and 3-11 and proceed as follows:

a. Inspect for excess side or end play.

b. Inspect all threaded surfaces for burrs, nicks or stripped threads.

c. Inspect shafts for burrs, nicks, or scratches. Remove burrs, nicks, or scratches as necessary or replace shaft.

d. Check idlers on power unit.

e. Inspect wheel bearings for wear, leaks, or damage. Replace bearings as necessary.

f. Inspect outside diameter of load wheels and guide wheels for wear.

3.3.4.3.6 Tie Bars. Check all tie bars for loose or missing fasteners. Tighten or replace as necessary. Check for signs of wear and deterioration and make any necessary corrections.

3.3.4.3.7 Drive Fins. Drive fins should be firmly supported in proper alignment under each frame. The flexible mount should be in good condition and the fin should be clean and not bent or warped. The fins should align one directly behind the next. Repair or replace items as necessary.

3.3.4.4 Lubrication. Lubrication procedures are described in the following paragraphs.

3.3.4.4.1 Bogies. Proceed as follows:

a. The traveling frame bogies contain fully sealed bearings to eliminate the need for continual lubrication. This ensures the grease will not leak onto the load rail to cause wheel slippage.

b. Use Slick 50 mpg grease to lubricate all wheel assemblies on lower and upper projection screen wheel assemblies (Figures 3-10 and 3-11) and all pillow blocks.

3.3.4.4.2 Drive Unit. Lubrication and oil changes for the drive unit are called out in the maintenance schedules in the Scheduled Services System Manual. See Figure 3-6 for proper oil level in the drive unit. Figure 3-7 indicates the specific lubrication points and types of lubricant required.

CAUTION

Correct oil leaks to avoid possible loss of lubrication. Use only Mobile 600W Super Cylinder Oil, Gulf EPHD 460 or equivalent.

Gear Case Oil Change. Gear case oil should be drained and refilled after the first two weeks of operation of a new or rebuilt unit. After this initial oil change, service intervals should be approximately once every 2500 hours of operation thereafter. Proceed as follows:

a. Drain oil from gear case by removing the two drain plugs located in the bottom of the gear case at each end. Refer to lube chart (Figure 3-7) for location.

NOTE

Approximately three gallons of oil is required to refill the gear case to its proper level.

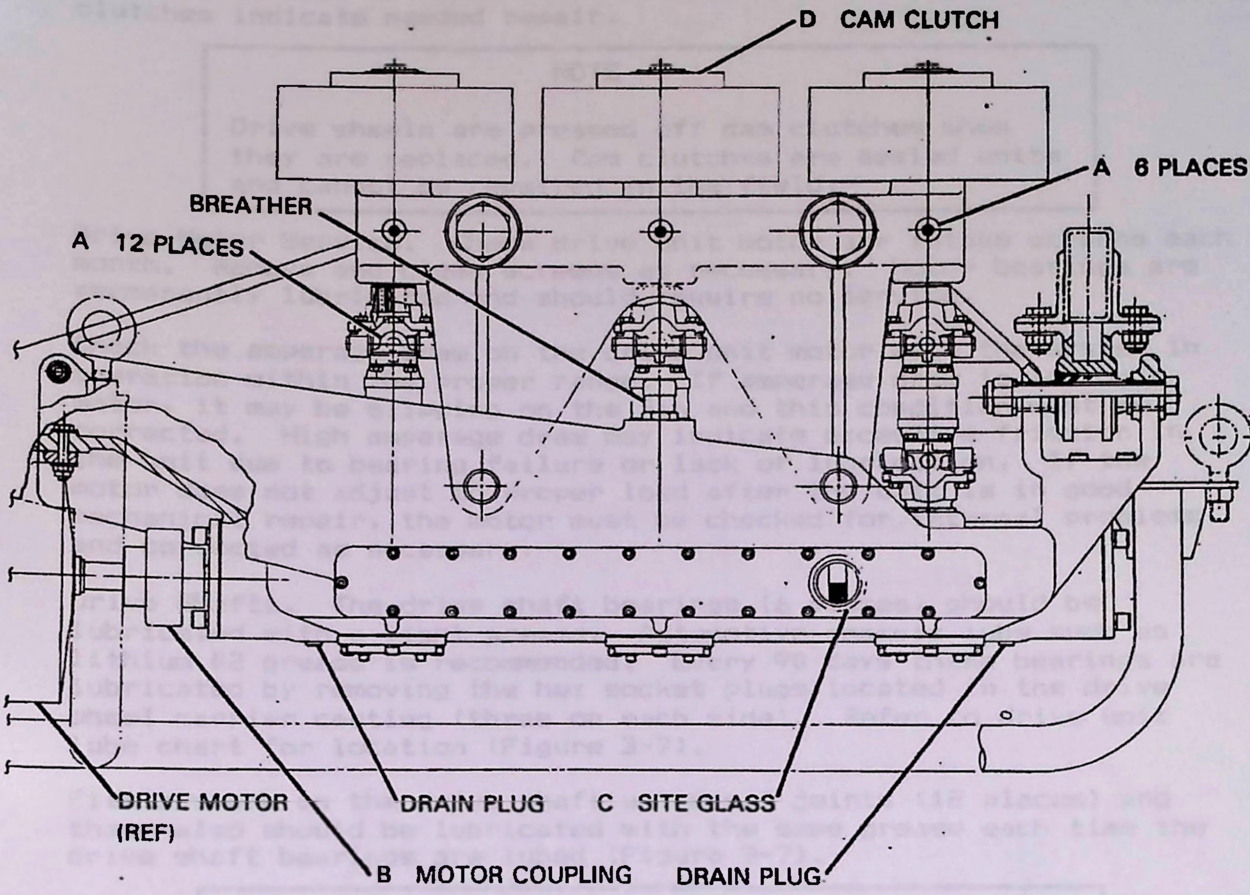
b. Replace drain plugs in bottom of gear case.

c. Remove one of the gearbox breather caps.

d. Refill gear case through this opening.

e. Check for proper oil level at sight glass. Oil should be at centerline of window (Figure 3-5).

f. Reinstall breather securely.



LUBE CHART		
ITEM	**RECOMMENDED LUBRICANT**	**FREQUENCY**
A	LITHIUM #2	90 DAYS
B	WHEEL BEARING GREASE #1200-2	90 DAYS
C	600 wt. SUPER CYLINDER OIL	ANNUALLY
D	SEALED	

Figure 3-7 Drive Unit Lubrication Diagram

Drive Wheels and Clutches. All drive wheels and cam clutches should be in good repair. Cracking or chunked drive wheels should be replaced as well as those excessively worn. Oil leaks in cam clutches indicate needed repair.

> NOTE
>
> Drive wheels are pressed off cam clutches when they are replaced. Cam clutches are sealed units and cannot be repaired in the field.

Drive Motor Service. Check drive unit motor air intake screens each month. Remove and clean screens as necessary. Motor bearings are permanently lubricated and should require no service.

Check the amperage draw on the drive unit motor with the system in operation within the proper range. If amperage draw is low on a motor, it may be slipping on the fin and this condition must be corrected. High amperage draw may indicate excessive friction in the unit due to bearing failure or lack of lubrication. If the motor does not adjust to proper load after the unit is in good mechanical repair, the motor must be checked for internal problems and corrected as necessary.

Drive Shafts. The drive shaft bearings (6 places) should be lubricated with a light grease. Automotive chassis lube such as lithium #2 grease is recommended. Every 90 days these bearings are lubricated by removing the hex socket plugs located in the drive wheel carrier casting (three on each side). Refer to drive unit lube chart for location (Figure 3-7).

Fittings are on the drive shaft universal joints (12 places) and these also should be lubricated with the same grease each time the drive shaft bearings are lubed (Figure 3-7).

> NOTE
>
> All plugs and caps must be reinstalled securely after lubrication.

Motor Coupling. The motor coupling should be cleaned and a fresh coating of heavy wheel bearing grease applied every 90 days.

Drip Pans. Drip pans should be cleaned quarterly after each drive unit oil change. Be sure all drip pans are in place after servicing.

3.3.4.5 Reassembly. The following paragraphs describe the reassembly procedures.

3.3.4.5.1 Drive Unit. Before assembly of the drive unit, thoroughly clean all parts. Inspect all parts, paying particular attention to wear areas and bearings. Check for signs of wear, stress, and deterioration. Repair or replace any worn, damaged, or questionable parts. Reassemble the drive unit using the following procedure (see Figure 3-8).

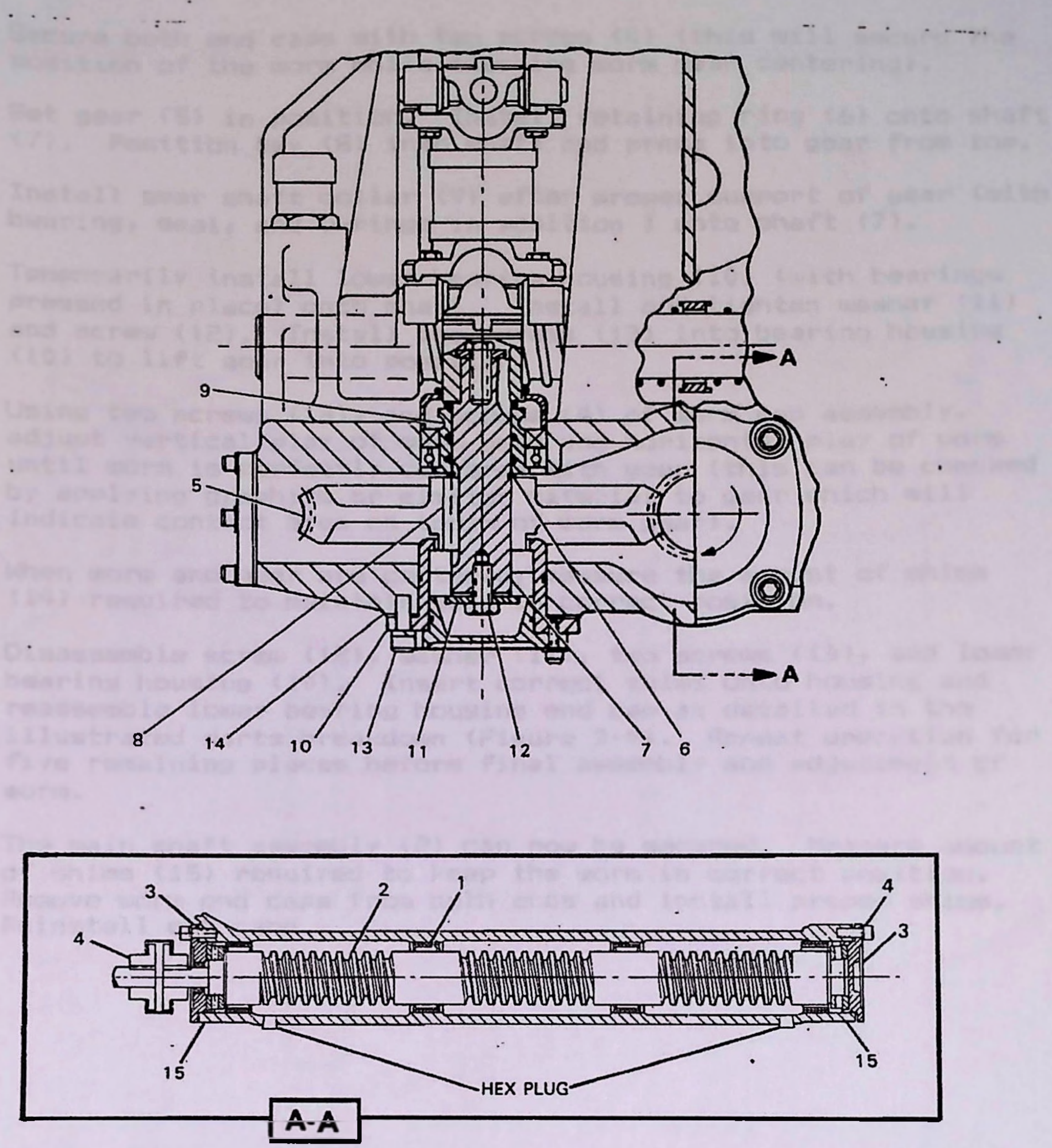


Figure 3-8 Drive Unit Assembly Points

> CAUTION
>
> This assembly procedure must be followed precisely. Improper alignment of worm gears will result in severe damage to the drive unit.

a. Position main shaft bearings (1) in gear case with bearing rings and Loctite 242.

b. Position main shaft (2) in case, temporarily installing both end caps (3) in case, omitting shims at this time.

c. Secure both end caps with two screws (4) (this will secure the position of the worm while checking worm gear centering).

d. Set gear (5) in position. Install retaining ring (6) onto shaft (7). Position key (8) into shaft and press into gear from top.

e. Install gear shaft collar (9) after proper support of gear (with bearing, seal, and O-rings in position) onto shaft (7).

f. Temporarily install lower bearing housing (10) (with bearings pressed in place) onto shaft. Install and tighten washer (11) and screw (12). Install two screws (13) into bearing housing (10) to lift gear into position.

g. Using two screws (13), and screws (4) of worm cap assembly, adjust vertical play of worm gear and horizontal play of worm until worm is perfectly centered with gear (this can be checked by applying graphite or similar material to gear which will indicate contact area on tooth of worm gear).

h. When worm and gear are centered, measure the amount of shims (14) required to maintain gear in correct position.

i. Disassemble screw (12), washer (11), two screws (13), and lower bearing housing (10). Insert correct shims onto housing and reassemble lower bearing housing end cap as detailed in the illustrated parts breakdown (Figure 3-9). Repeat operation for five remaining places before final assembly and adjustment of worm.

j. The main shaft assembly (2) can now be secured. Measure amount of shims (15) required to keep the worm in correct position. Remove worm end caps from both ends and install proper shims. Reinstall end caps.

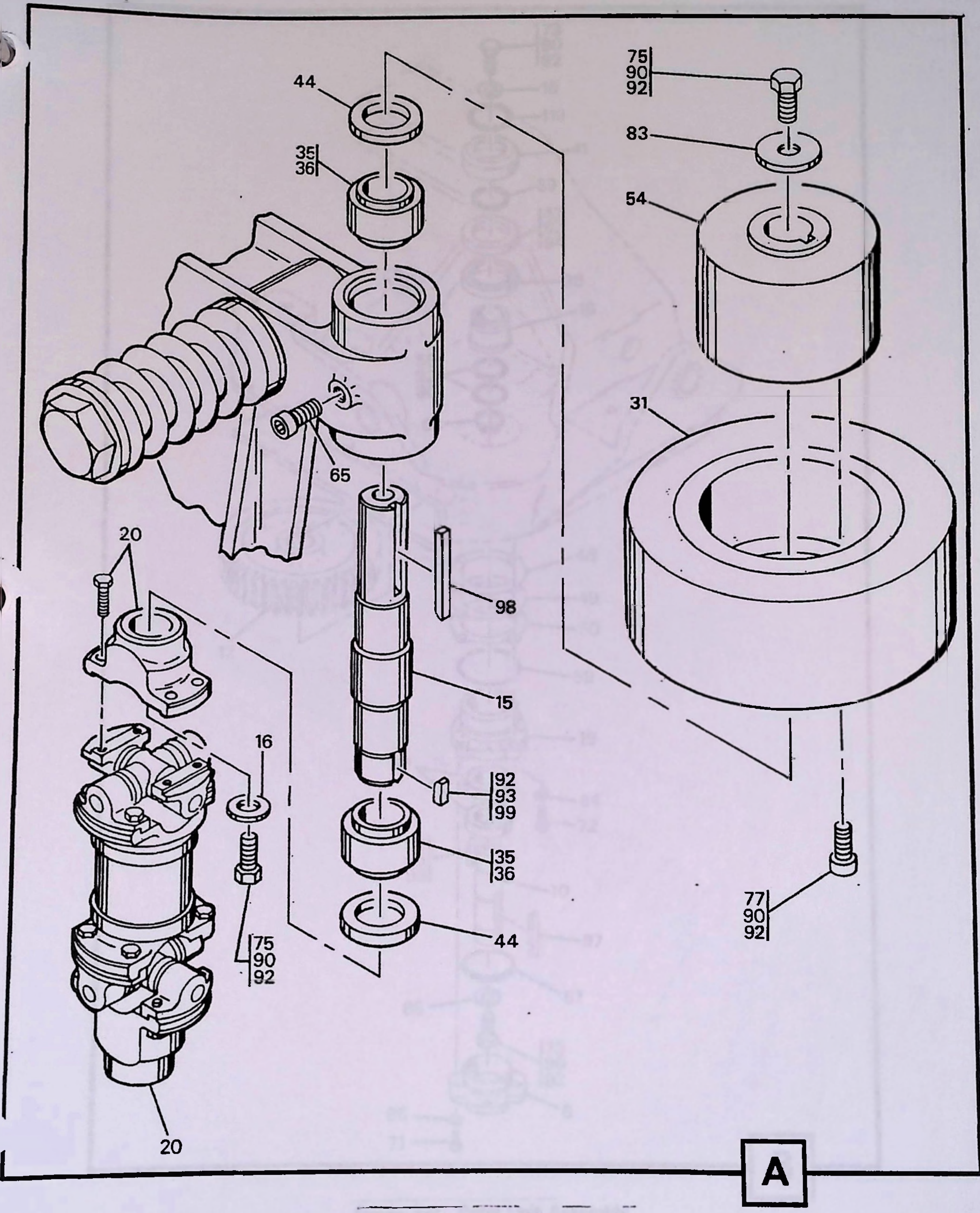


Figure 3-9 Drive Unit Assembly
Sheet 2 of 4

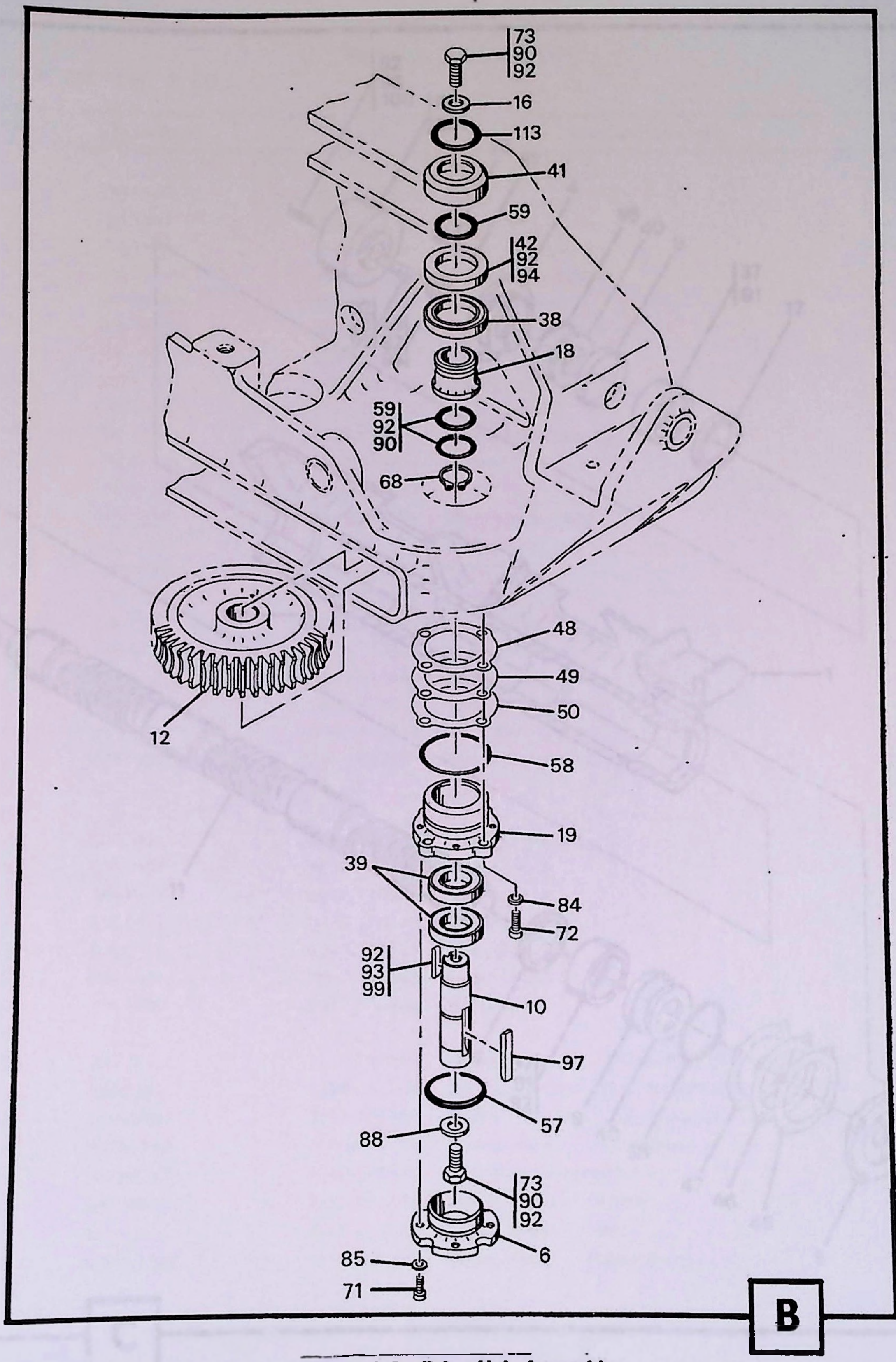


Figure 3-9 Drive Unit Assembly
Sheet 3 of 4

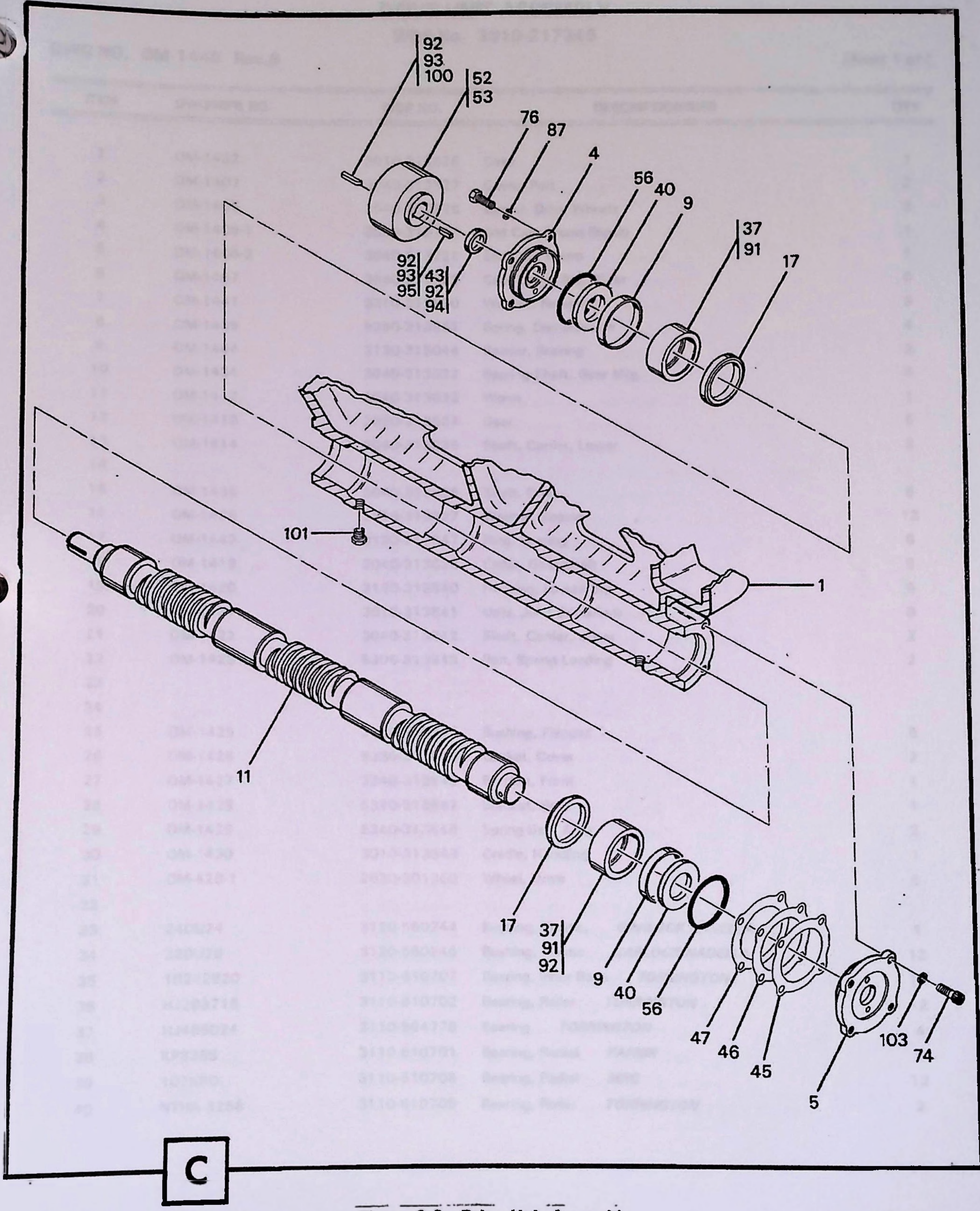


Figure 3-9 Drive Unit Assembly
Sheet 4 of 4

DRIVE UNIT ASSEMBLY

WDP No. 3010-217346

DWG NO. OM-1440 Rev.6 **Sheet 1 of 3**

ITEM	DWG/MFR NO.	WDP NO.	DESCRIPTION/MFR	QTY
1	OM-1402	3010-313826	Case	1
2	OM-1403	3040-313827	Cover, Port	2
3	OM-1405	3040-313828	Carrier, Drive Wheels	2
4	OM-1406-1	3040-313722	End Cap, Worm (Input)	1
5	OM-1406-2	3040-313721	End Cap, Worm	1
6	OM-1407	3040-313829	Cap, Lower Brg., Gear	6
7	OM-1441	5310-313830	Washer, Retaining	8
8	OM-1439	5360-313831	Spring, Compression	4
9	OM-1444	3130-315044	Spacer, Bearing	2
10	OM-1434	3040-313832	Bearing Shaft, Gear Mtg.	6
11	OM-1412	3040-313833	Worm	1
12	OM-1413	3020-313834	Gear	6
13	OM-1414	3040-313835	Shaft, Carrier, Lower	2
14				
15	OM-1435	3040-313836	Shaft, Drive	6
16	OM-1436	5310-313837	Washer, Special	12
17	OM-1443	3130-217347	Ring, Bearing	6
18	OM-1419	3040-313839	Collar, Gear Shaft	6
19	OM-1420	3130-313840	Housing, Lowee Brg	6
20	OM-1437	3010-313841	Univ. Joint (Modified)	6
21	OM-1422	3040-313842	Shaft, Carrier, Upper	2
22	OM-1423	5306-313843	Bolt, Spring Loading	2
23				
24				
25	OM-1425	3120-313844	Bushing, Flanged	6
26	OM-1426	5330-313845	Gasket, Cover	2
27	OM-1427	5340-313846	Bracket, Front	1
28	OM-1428	5340-313847	Bracket, Rear	1
29	OM-1429	5340-313848	Spring Seat Assy	2
30	OM-1430	3010-313849	Cradle, Handling	1
31	OM-428-1	2630-801360	Wheel, Drive	6
32				
33	24DU24	3120-560244	Bushing, Plastic, ***GARLOCK NADELLA***	4
34	32DU28	3120-560245	Bushing, Plastic ***GARLOCK NADELLA***	12
35	1R242820	3110-610707	Bearing, Inner Race ***TORRINGTON***	12
36	HJ283716	3110-610702	Bearing, Roller ***TORRINGTON***	12
37	HJ486024	3110-564778	Bearing ***TORRINGTON***	4
38	KP33BS	3110-610701	Bearing, Radial ***FAFNIR***	6
39	107KRD	3110-610708	Bearing, Radial ***MRC***	12
40	NTHA-3258	3110-610705	Bearing, Roller ***TORRINGTON***	2

ITEM	DWG/MFR NO.	WDP NO.	DESCRIPTION/MFR	QTY
41	OM-1433	3110-313748	Shield, Shaft Collar	6
42	50302S	5330-616376	Seal ***NATIONAL***	6
43	50045S	5330-616377	Seal ***NATIONAL***	1
44	40059	5330-616375	Seal ***NATIONAL***	12
45	K21620	3110-560240	Shim, .020 THK ***TIMKEN***	1
46	K21607	3110-560239	Shim, .007 THK ***TIMKEN***	3
47	K21605	3110-560238	Shum, .005 THK ***TIMKEN***	3
48	K21220	3110-560237	Shim, .020 THK ***TIMKEN***	6
49	K21207	3110-560236	Shim, .007 THK ***TIMKEN***	18
50	K21205	3110-560235	Shim, .005 THK ***TIMKEN***	18
51	H9004-1	5340-616497	Lord Mount ***LORD MFG***	3
52	5016	5340-560228	Cover, Joint ***DODGE***	1
53	FB5016	3020-610451	Coupling ***DODGE***	1
54	MG-600	3010-560229	Clutch, 1.250 Bore, 1/4 x 1/8 Keyway ***MORSE***	6
55	CD218AT	6105-593765	Motor (Drive) 7 1/2 HPDC	1
56	2-239C557-7	5330-560231	O'Ring ***PARKER***	2
57	2-139C557-7	5330-560232	O'Ring ***PARKER***	6
58	2-40C557-7	5330-560223	O'Ring ***PARKER***	6
59	2-220C557-7	5330-560234	O'Ring ***PARKER***	18
60	357	5360-560241	Spring ***CALIF. SPRING***	4
61	NO. 4112	6685-560289	Oil Gage, (Style DW-30) ***GITS BROS.***	2
62				
63				
64	A-854	2520-610079	Breather ***TEDECO***	2
65		4730-560270	Plug, Hex Soc, 1/8-27 Dryseal	6
66				
67				
68	5100-137H	5365-594834	Ring, Retaining ***TRUARC***	6
69	5100-200H	5365-560675	Ring, Retaining ***TRUARC***	2
70				
71		5305-561452	Bolt, Soc Hd, 1/4-20 x 7/8 Lg	68
72		5305-560295	Bolt, Soc Hd, 3/8-16 x 1 3/8 Lg	24
73		5306-577029	Bolt, Hex Hd, 7/16-20 x 1" Long, Full Thread	12
74		5305-564698	Bolt, Soc Hd, 1/2-13 x 1 1/2 Lg	4
75		5306-560251	Bolt, Hex Hd, 1/2-20 x 7/8 Lg, Full Thread	12
76			Bolt, Hex Hd, 1/2-13 x 1 1/2" Lg	4
77		5305-567643	Bolt, Soc Hd, 5/16-24 x 1" Lg	36
78	AN16-71A	5306-000329	Bolt, Hex Hd, 1"-14 x 6" Grip	3
79	AN6-17A	5306-000328	Bolt, Hex Hd, 3/8-24 x 1 5/16 Grip	4
80		5305-593763	Set Screw, Cone Pt, Hex Soc, 3/8-16 x 3/4 Lg	2

DRIVE UNIT ASSEMBLY

WDP No. 3010-217346

DWG NO. OM-1440 Rev.6 **Sheet 3 of 3**

ITEM	DWG/MFR NO.	WDP NO.	DESCRIPTION/MFR	QTY
81	AN365-164	5310-560434	Nut, Hex, S.L., 1"-14 ***ESNA NO. 52NE 164***	3
82	AN365-624	5310-000065	Nut, Hex, S.L., 3/8-24 ***ESNA NO. 52NE064***	4
83	AN970-8	5310-600304	Washer, Flat, Wood Size, 1/2 Dia	6
84		5310-560274	Washer, Split Lock, 3/8 Dia High Collar (For Soc. Hd)	24
85	AN936A416	5310-000240	Washer, Lock, Int. Tooth, 1/4 Dia	68
86	AN960-816	5310-002754	Washer, Flat, 1/2 Dia	36
87		5310-566033	Washer, Lock 1/2 Dia	4
88	AN970-7	5310-000169	Washer, Flat, Wood Size, 7/16 Dia	6
89	AN960-616	5310-002752	Washer, Flat, 3/8 Dia	8
90			Nut Lock ***LOCTITE***	AR
91			Bearing Mount ***LOCTITE***	AR
92	Grade N		Locquic Primer ***LOCTITE***	AR
93			Key Fit ***LOCTITE***	AR
94	Grade AV		Sealant ***LOCTITE***	AR
95		5315-572090	Key, Sq, 1/4 x 1.38 Lg, 4130 Stl	1
96				
97		5315-560257	Key, Sq, 3/8 x 1 11/16 Lg, 4130 Stl	6
98		5315-560258	Key, Sq, 1/4 x 3" Lg, 4130 Stl	6
99		5315-560259	Key, Sq 5/16 x 1.00 Lg, 4130 Stl	12
100		5315-560260	Key, Sq 5/16 x 1 3/4" Lg, 4130 Stl	1
101		4730-578977	Plug, Pipe, Hex Soc, 1/2-14 NPT	2
102				
103		5310-560266	Washer, Split Lock, 1/2 Dia High Collar (For Soc.Hd)	8
104		5310-560265	Washer, Shim; .38 I.D. x 2.00 O.D. x .010-.030 THK	AR
105				
106				
107	AN365-820	5310-002890	Nut, Hex, S.L., 1/2-20 Esna No. 52NE080	20
108				
109	No. 8	5306-560099	Eye Bolt ***WILLIAMS VULCAN***	3
110		5305-570613	Bolt, Soc Hd. 1/2-20 x 1 3/4 Lg	8
111	AN8-13A	5306-000492	Bolt, Hex Hd, 1/2-20 x 11/16 Grip	4
112	AN8-17A	5306-000496	Bolt, Hex Hd, 1/2-20 x 1 3/16 Grip	8
113	2-328C-557-7	5330-560267	O'Ring ***PARKER***	6
114	Mobil 600W	9150-564040	Super Cylinder Oil #8 Comp	3 Gal
115				

3.3.4.5.2 Lower Projection Screen Bogie. Refer to Figure 3-10 and proceed as follows:

a. Assemble load wheel (9).

b. Place shims (15) as needed on shaft (4).

c. Insert shaft (4) of assembled load wheel into bogie (3).

d. Install washer (25) and nut (22). Torque nut to 110 ft/lbs.

e. Assemble guide wheel (7).

f. Install washer (14) and spring (13) on bearing rod (1) and insert bearing rod into pillow block (10). Secure with washer (14) and nut (17).

g. Position guide wheel assembly (7) on bearing rod (1) and secure with nut (19).

h. Torque nuts (17 and 19) to 30 ft/lbs.

i. Position lower projection screen and secure the bogie with washer (27), nut (20), four washers (26), four capscrews (23), and four locknuts (21). Torque nut (20) to 120 ft/lbs and locknuts (21) to 40 ft/lbs.

3.3.4.5.3 Upper Projection Screen Bogie. Refer to Figure 3-11 and proceed as follows:

a. Assemble wheel (10) and secure wheel assembly with shoulder screw (10). Torque shoulder screw to 40 ft/lbs.

b. Install washer (12) and spring (11) on bearing rod (1). Insert bearing rod through pillow block (8). Secure with washer (12) and nut (14).

c. Slide wheel assembly mount (2) over bearing rod (1) and secure with nut (15).

d. Torque nuts (14 and 15) to 30 ft/lbs.

e. Position upper projection screen (4) and secure to bogie with washer (22) and nut (16). Torque nut to 120 ft/lbs.

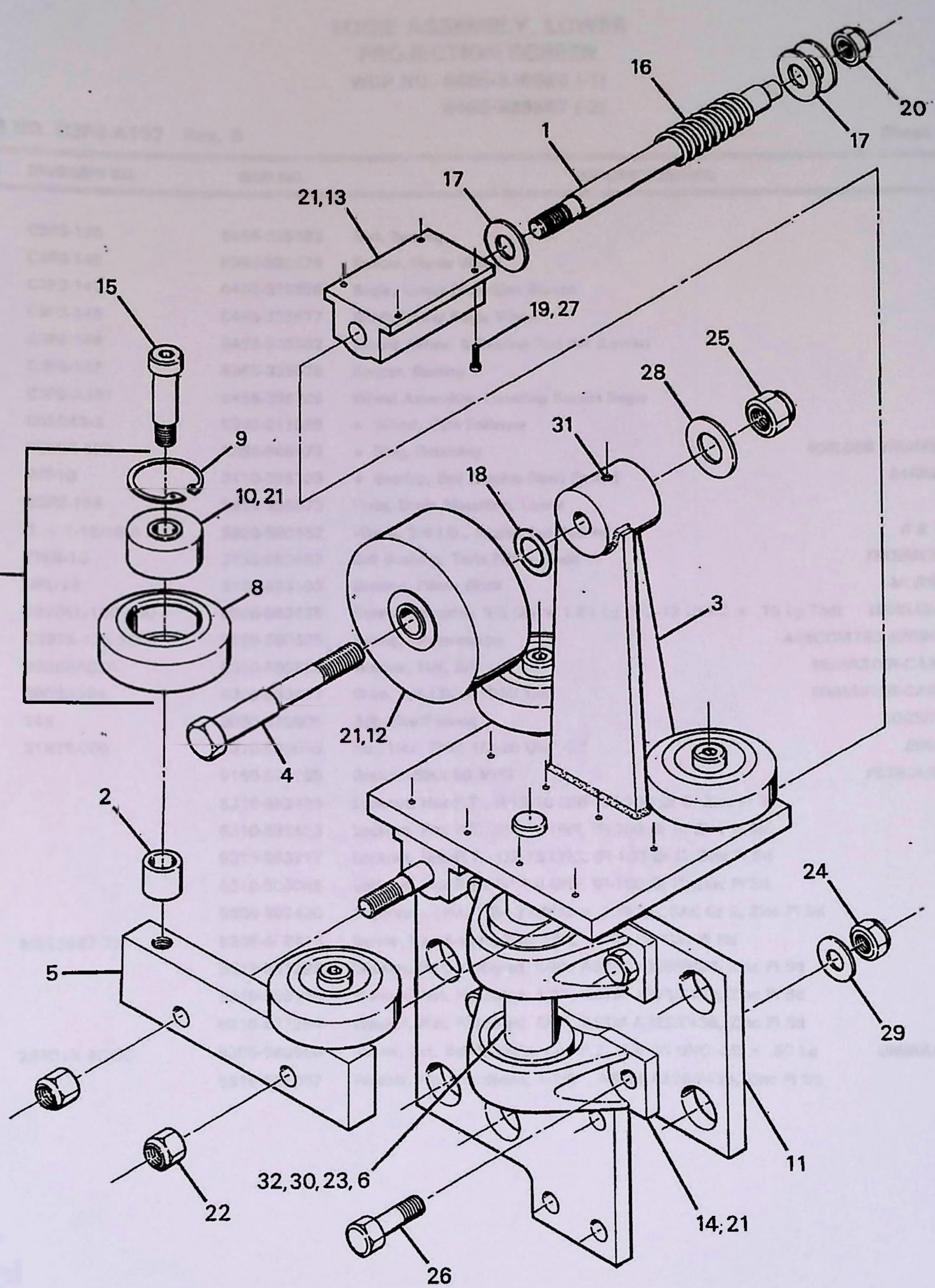


Figure 3-10 Lower Projection Screen Bogie

BOGIE ASSEMBLY, LOWER
PROJECTION SCREEN
WDP NO. 6455-335666 (-1)
6455-335667 (-2)

DWG NO. C3PS-A157 Rev. B **Sheet 1 of 1**

ITEM	DWG/MFR NO.	WDP NO.	DESCRIPTION/MFR		QTY
1	C3PS-136	6455-335583	Rod, Bearing		2
2	C3PS-140	5365-335574	Spacer, Guide Wheel		4
3	C3PS-142	6455-335586	Bogie, Lower Projection Screen		1
4	C3PS-145	6455-335577	Shaft, Lower Bogie Wheel		1
5	C3PS-146	6455-335582	Mount, Wheel & Bearing Rod Bar (Lower)		1
6	C3PS-147	5365-335578	Spacer, Bearing		1
7	C3PS-A161	6455-335709	Wheel Assembly, Traveling Screen Bogie		4
8	OM-842-3	5340-211635	• Wheel, Cam Follower		1
9	N5000-193	5365-806473	• Ring, Retaining	*WALDES TRUARC*	1
10	DPP10	3110-595383	• Bearing, Ball (Double Row) Sealed	*FAFNIR*	1
11	C3PS-156	6455-335575	Plate, Bogie Mounting, Lower		1
12	5 × 1-15/16 A	3920-580552	Wheel, 3/4 I.D., Sealed Ball Bearing	*R & K*	1
13	TWN-10	3130-580553	Ball Bushing, Twin Pillow Block	*THOMSON*	2
14	NPL-18	3130-583103	Bearing, Pillow Block	*MORSE*	2
15	12705L-10C-29D	5305-582425	Screw, Shoulder, 5/8 Dia × 1.81 Lg (1/2-13 UNRC × .75 Lg Thd)	*UNBRAKO*	4
16	C0975-125-3500	5360-580555	Spring, Compression	*ASSOCIATED SPRING*	2
17	93286A035	5310-580528	Washer, Flat, 5/8	*McMASTER-CARR*	5
18	3088A384	5365-582417	Shim, 3/4 I.D. × .020 Thk	*McMASTER-CARR*	A/R
19	242	8030-570605	Adhesive/Sealant	*LOCTITE*	A/R
20	21NTE-080	5310-580085	Nut, Hex, Thin, 1/2-20 UNF -3B	*ESNA*	2
21		9150-570785	Grease, Slick 50 MPG	*PETROLON*	A/R
22		5310-582424	Locknut, Hex P.T., 9/16-18 UNF, IFI-100 Gr C, Zinc Pl Stl		2
23		5310-582423	Locknut, Hex P.T., 3/4-16 UNF, IFI-100 Gr C, Zinc Pl Stl		1
24		5310-563717	Locknut, Hex P.T., 1/2-13 UNC, IFI-100 Gr C, Zinc Pl Stl		4
25		5310-003085	Locknut, Hex P.T., 5/8-18 UNF, IFI-100 Gr C, Zinc Pl Stl		1
26		5305-582420	Capscrew, Hex, 1/2-13 UNRC × 1.75 Lg, SAE Gr 8, Zinc Pl Stl		4
27	MS16997-33	5305-582416	Screw, Hex Socket, 8-32 UNC × .63 Lg, Cad Pl Stl		8
28		5310-561225	Washer, Flat, Hardened, 5/8", ASTM A325/F436, Zinc Pl Stl		1
29		5310-593114	Washer, Flat, Hardened, 1/2", ASTM A325/F436, Zinc Pl Stl		4
30		5310-577284	Washer, Flat, Hardened, 3/4", ASTM A325/F436, Zinc Pl Stl		1
31	28701N-4C-8C	5305-580565	Screw, Set, Self-Locking, Cup P.T., 1/4-20 UNC -2B × .50 Lg	*UNBRAKO*	1
32		5310-565667	Washer, Flat, Hardened, 1-1/8", ASTM A325/F436, Zinc Pl Stl		1

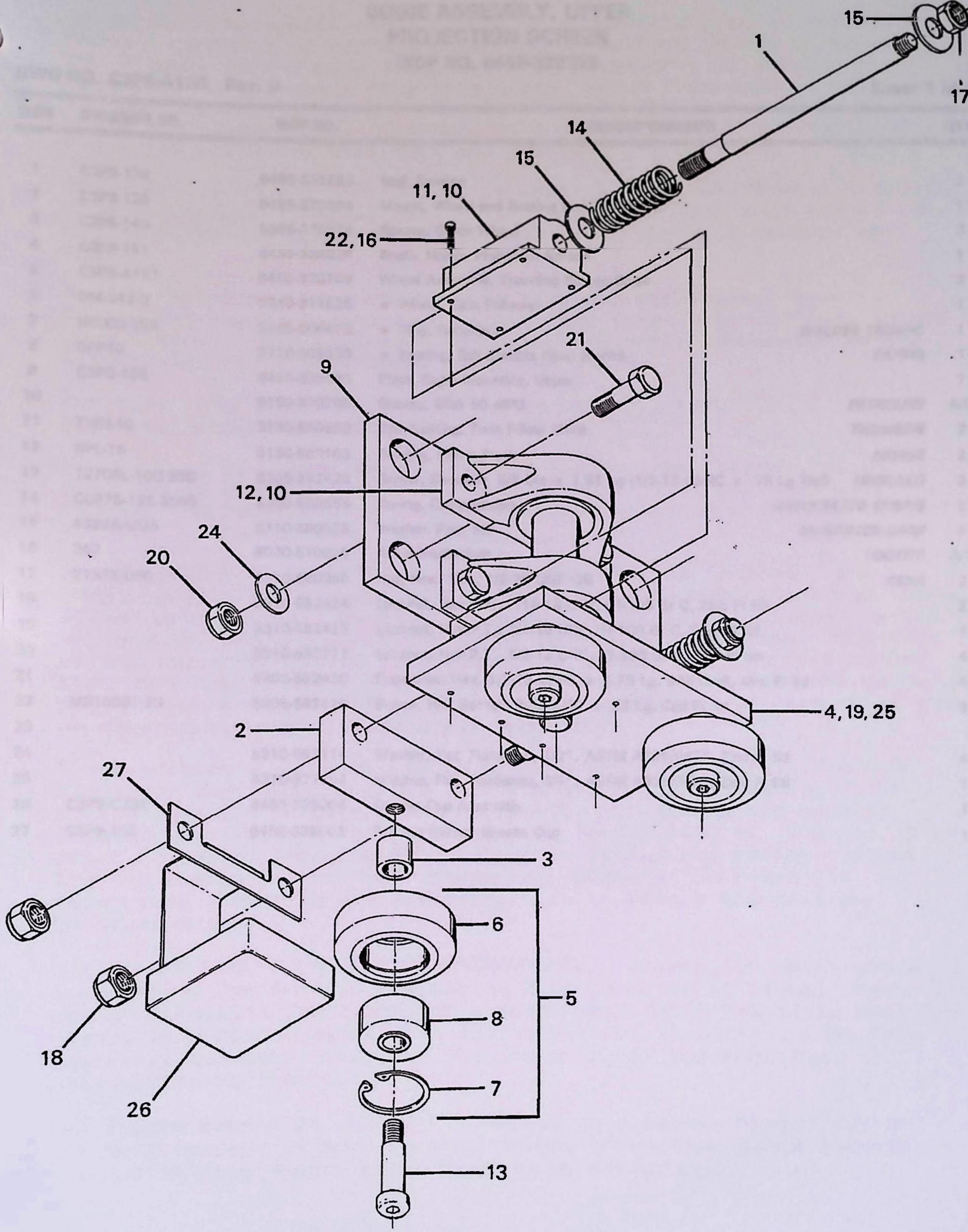


Figure 3-11 Upper Projection Screen Bogie

BOGIE ASSEMBLY, UPPER
PROJECTION SCREEN
WDP NO. 6455-328329

DWG NO. C3PS-A150 Rev. B **Sheet 1 of 1**

ITEM	DWG/MFR NO.	WDP NO.	DESCRIPTION/MFR		QTY
1	C3PS-136	6455-335583	Rod, Bearing		2
2	C3PS-139	6455-335684	Mount, Wheel and Bearing Rod Bar (Upper)		1
3	C3PS-140	5365-335574	Spacer, Guide Wheel		3
4	C3PS-151	6455-328326	*Bogie, Upper, Projection Screen*		1
5	C3PS-A161	6455-335709	Wheel Assembly, Traveling Screen Bogie		3
6	OM-842-3	5340-211635	• Wheel, Cam Follower		1
7	N5000-193	5365-806473	• Ring, Retaining	***WALDES TRUARC***	1
8	DPP10	3110-595383	• Bearing, Ball (Double Row) Sealed	***FAFNIR***	1
9	C3PS-155	6455-335585	Plate, Bogie Mounting, Upper		1
10		9150-570785	Grease, Slick 50 MPG	***PETROLON***	A/R
11	TWN-10	3130-580553	Ball Bushing, Twin Pillow Block	***THOMSON***	2
12	NPL-18	3130-583103	Bearing, Pillow Block	***MORSE***	2
13	12705L-10C-29D	5305-582425	Screw, Shoulder, 5/8 Dia × 1.81 Lg (1/2-13 UNRC × .75 Lg Thd)	***UNBRAKO***	3
14	C0975-125-3500	5360-580555	Spring, Compression	***ASSOCIATED SPRING***	2
15	93286A035	5310-580528	Washer, Flat, 5/8	***McMASTER-CARR***	4
16	242	8030-570605	Adhesive/Sealant	***LOCTITE***	A/R
17	21NTE-080	5310-580085	Nut, Hex, Thin, 1/2-20 UNF -3B	***ESNA***	2
18		5310-582424	Locknut, Hex P.T., 9/16-18 UNF, IFI-100 Gr C, Zinc Pl Stl		2
19		5310-582423	Locknut, Hex P.T., 3/4-16 UNF, IFI-100 Gr C, Zinc Pl Stl		1
20		5310-563717	Locknut, Hex P.T., 1/2-13 UNC, IFI-100 Gr C, Zinc Pl Stl		4
21		5305-582420	Capscrew, Hex, 1/2-13 UNRC × 1.75 Lg, SAE Gr 8, Zinc Pl Stl		4
22	MS16997-33	5305-582416	Screw, Hex Socket, 8-32 UNC × .63 Lg, Cad Pl Stl		8
23					
24		5310-593114	Washer, Flat, Hardened, 1/2", ASTM A325/F436, Zinc Pl Stl		4
25		5310-577284	Washer, Flat, Hardened, 3/4", ASTM A325/F436, Zinc Pl Stl		1
26	C3PS-C198	6455-339004	Grease Cup Assembly		1
27	C3PS-196	6455-339002	Bracket Hanger Grease Cup		1

3.4 ANIMATED FIGURES

An Audio-Animatronics (A-A) figure is a mechanical actor (person or animal) designed to perform an action or actions in a show scene. The figure, formed on a steel skeletal framework, is jointed as necessary to perform a role in a scene. This framework is designed and constructed to support the plastic body form and costume of the character it portrays. Movement of the figure is by pneumatic or hydraulic actuators that work the joints.

The activity of the A-A figures is controlled by electronic signals from the remote terminal unit (RTU) located at each show scene. The RTU receives its commands (SMACS data) from the show control unit (SCU).

An A-A figure may have one or more discrete pneumatic valves, mechanical feedback actuator, relays, and first stage valves, in any combination. This equipment is photographically documented in the Illustrated Parts Breakdown, paragraph 3.4.4.

For more information about A-A figure control, refer to <u>Audio-Animatronics Maintenance Manual</u>.

Figure 3-12 is a show area layout of the Horizons attraction and provides an overall map of the show layout. This map will assist in finding the locations of all A-A figures, animated props and special effects in the Horizons facility.

3.4.1 THEORY OF OPERATION. A-A figures are the "actors," the people and animal figures used in each scene to make the scene "come alive" with action. An A-A figure is a mechanical, jointed, "actor" designed to perform an action or actions in a show scene. Movement of the figure is caused by pneumatic actuators and electric motors that move the joints. These movements are, in turn, controlled by computer-programmed scripts that cause the figures to respond on cue or move continuously, acting out the scene.

These actuators and electric motors are contained within the A-A figure or the pedestal under the figure. Pneumatic valves for controlling the actuators and relays for the motors are usually located in a first stage rack adjacent to the figure. Control is by means of cables from the RTU. Flexible tubing and cables connect the A-A figure to the first stage rack where it receives its supporting pneumatic and electric power to effect the desired physical motion.

3.4.2 A-A FIGURE PREVENTIVE MAINTENANCE. Preventive maintenance inspections for A-A figures begins with an external visual check for proper animation functions and appearance. Table 3-3 lists each A-A figure in Horizons along with the animation activities. Use this checklist whenever reviewing the operation of the show for malfunctioning figures.

A-A figure operation should be checked on a weekly basis; correct all deficiencies as soon as they occur. Paragraph 3.4.2.3 contains preventive maintenance procedures to be performed.

SECTION 4 SPECIAL EFFECTS

This section contains useful information about the special effects in the Horizons Pavilion. Because the special effects add a sense of "reality/believability" to each scene and, therefore, heighten the experience of the guests, it is important that all special effects equipment, both optical and mechanical, work at all times.

All projected special effects are unacceptable if:

1. Color is faded from the gel or color transparency
2. Artwork is dirty or damaged
3. Distortion or diffusion missing
4. Focus incorrect
5. Brightness incorrect from set level
6. Aiming incorrect
7. Lamp burned out
8. Flash rate set wrong
9. Accessory motors inoperative or wrong speed

Each effect is assigned an "FX- " number for identification purposes. The special effects are discussed in show-scene order.

The projector set-up for a specific effect is provided in this Section. For detailed information about a specific projector (for example: a 5x5, or a 10x10) and its accessories, refer to the projector manual distributed by the WDP Studio Machine Shop. The Mini Fiber Optic Illuminators are made by MAPO and are covered in this Section.

See Figure 3-14 in Section 3 for an equipment location plan to help you find the projectors, fog box, and other special effects equipment.

For fast reference see the back of this section:

Table 4-1 Artwork Replacement
Table 4-2 Lamp Replacement
Table 4-3 Sources for Uncommon Parts
Table 4-4 List of WED Special Effects Drawings

4.1 FX-1: TRAVEL POSTERS; SCENE 1.

4.1.1 DESCRIPTION. Creating travel posters that look like giant geodesic, kalediOscopic spheres, images of futuristic living spaces are projected by HMI 5x5 (P-13, P-14, P-15) with accesories. Each "poster's" image is projected by a single projector and multiplied by mirrors: P-13 for the underwater poster, P-14 for the desert city poster, and P-15 for the outer space poster. All three projectors are located by the entrance/que area. The projectors are in show sync.

P-13 consists of:

MAIN ASSEMBLY:	6730-910661-1
ASSEMBLY: 5x5 Unit (HMI 1200) Front	6730-909208-2
LAMP: 1200 watts TYPE: HMI Quartz (5600)	DAYMAX#DMI 1200 OSRAM#HMI 1200W
LENS: 4.5" Buhl	#271-020
Lens Sleeve	6730-909784
Condenser 8 (6"x12" F.L.)	6730-907675-2
P.S. (Ballast) HMI (Modified)	6730-920839 Xetron#B1-1200/C
RP Screen: Size=7'5"w x 6'0"h; Throw=11'0"	Refer to Table 4-3.
ACCESSORIES:	
Stand (Projector)	6730-910708-4
Power Cord x 15' (PS to 5x5)	6730-920797-2
Fan Unit (Artwork Cooling) 2 reqd	6730-908932-2
(X-Y) Stage Assy (Program)	6730-910664
(X-Y) Stage - Elect Control Cab (4A)	6730-921428
Mode - (X-Y) Travel = 12"	
" Oper - (Rate) Horz=1.5"/sec (Const)	Ref.
" " (Rate) Vert=0-3"/sec (Var)	Ref.
" Cable Assy (Controls to Proj) x 11"	6730-921584
Mirror (RP) Assy (4'6"w x 4'6"h)	6730-910583
Electrical 'J' Box (Hubbell #7594)	6730-909526-1
ARTWORK/MASK/GEL: see Table 4-1	

P-14 consists of:

MAIN ASSEMBLY	6730-910661-2
ASSEMBLY: 5x5 Unit (HMI 1200) Front	6730-909208-2
LAMP: 1200 watts TYPE: HMI Quartz (5600)	DAYMAX#DMI 1200 OSRAM#HMI 1200W
LENS: 4.5" Buhl	#271-020
Lens Sleeve	6730-909784
Condenser 8 (6"x12" F.L.)	6730-907675-2
P.S. (Ballast) HMI (Modified)	6730-920839 Xetron#B1-1200/C
RP Screen: Size=7'5"w x 6'0"h; Throw=11'7"	Refer to Table 4-3.
ACCESSORIES:	
Stand (Projector)	6730-910708-2
Power Cord x 15' (PS to 5x5)	6730-920797-2
Fan Unit (Artwork Cooling) 2 reqd	6730-908932-2
(X-Y) Stage Assy (Program)	6730-910664
(X-Y) Stage - Elect Control Cab (4A)	6730-921428
Mode - (X-Y) Travel = 12"	
" Oper - (Rate) Horz=1.5"/sec (Const)	Ref.
" " (Rate) Vert=0-3"/sec (Var)	Ref.
" Cable Assy (Controls to Proj) x 11"	6730-921584
Mirror (RP) Assy (7'6"w x 6'6"h)	6730-910584-1
Electrical 'J' Box (Hubbell #7594)	6730-909526-1
ARTWORK/MASK/GEL: see Table 4-1	

P-15 consists of:

MAIN ASSEMBLY	6730-910661-3
ASSEMBLY: 5x5 Unit (HMI 1200) Front	6730-909208-2
LAMP: 1200 watts TYPE: HMI Quartz (5600)	DAYMAX#DMI 1200 OSRAM#HMI 1200W
LENS: 4.5" Buhl	#271-020
Lens Sleeve	6730-909784
Condenser B (6"x12" F.L.)	6730-907675-2
P.S. (Ballast) HMI (Modified)	6730-920839 Xetron#B1-1200/C
RP Screen: Size=7'5"w x 6'0"h; Throw=12'0"	Refer to Table 4-3.
ACCESSORIES:	
Stand (Projector)	6730-910708-5
Power Cord x 15' (PS to 5x5)	6730-920797-2
Fan Unit (Artwork Cooling) 2 reqd	6730-908932-2
(X-Y) Stage Assy (Program)	6730-910664
(X-Y) Stage - Elect Control Cab (4A)	6730-921428
Mode - (X-Y) Travel = 12"	
" Oper - (Rate) Horz=1.5"/sec (Const)	Ref.
" " (Rate) Vert=0-3"/sec (Var)	Ref.
" Cable Assy (Controls to Proj)	6730-921460
Mirror (RP) Assy (7'6"w x 6'6"h)	6730-910584-2
Electrical 'J' Box (Hubbell #7594)	6730-909526-1

ARTWORK/MASK/GEL: see Table 4-1

4.1.2 THEORY OF OPERATION. Refer to the projector manual.

4.1.3 PREVENTIVE MAINTENANCE. Refer to the projector manual.

4.1.4 CORRECTIVE MAINTENANCE. Refer to the projector manual.

4.2 FX-77: FIBER OPTIC WALL; SCENE 3.

4.2.1 DESCRIPTION. The fiber optic wall creates a visual interpretation of time travel. It is created by three Large Disc Fiber Optic Illuminators (P-16, P-17, P-18) with indexing disc, one Xenon Fiber Optic Illuminator (P-19), and fiber optic displays. P-16, P-17, and P-18 form the changing color/clouds and P-19 provides the lightning. All four illuminators are located by the load area. The large disc fiber optic illuminators' indexing is in show sync to maintain the color change coordination.

P-16, P-17, and P-18 consist of:

ASSEMBLY: Fiberoptics Illum Unit (Large Disc)	6730-908940-39
LAMP: 75 Watts TYPE: EYC (12 lamps)	
Electrical Panel	6730-920911-33
Spl Plug/Filter Panel	6730-920913-3
ACCESSORIES:	
20" Disc Drive Unit - Indexing (3D)	Ref.
20" Disc Drive Speed (0.25 RPM)	
20" Disc Mtr Speed (RPM)	Ref.
Floor Stand (Part of Unit)	
Backplate Fiber I/F	Ref.
Bushing (Fiber) - 6 reqd	Ref.
Lamp Control - 6 SSR (6D): see below	Ref.
Power I/F Panel Distribution	6730-921400
Power Cable:	
P-16: (12c-#16) x 20'	6730-921582
P-17 and P-18: (12c-#16) x 6'	6730-921401

This unit interfaces with multiple fiber bundles
ARTWORK/MASK/GEL: see Table 4-1

Dimmer Circuit Number:

P-16
- SSR#1 = DS1, 2 (LD01-301-1)
- SSR#2 = DS3, 4 (LD01-302-2)
- SSR#3 = DS5, 6 (LD01-401-3)
- SSR#4 = DS7, 8 (LD01-402-4)
- SSR#5 = DS9, 10 (LD01-501-5)
- SSR#6 = DS11, 12 (LD01-502-6)

P-17
- SSR#1 = DS1, 2 (LD01-303-1)
- SSR#2 = DS3, 4 (LD01-304-2)
- SSR#3 = DS5, 6 (LD01-403-3)
- SSR#4 = DS7, 8 (LD01-404-4)
- SSR#5 = DS9, 10 (LD01-503-5)
- SSR#6 = DS11, 12 (LD01-504-6)

P-18
- SSR#1 = DS1, 2 (LD01-305-1)
- SSR#2 = DS3, 4 (LD01-306-2)
- SSR#3 = DS5, 6 (LD01-405-3)
- SSR#4 = DS7, 8 (LD01-406-4)
- SSR#5 = DS9, 10 (LD01-505-5)
- SSR#6 = DS11, 12 (LD01-506-6)

P-19 consists of:

ASSEMBLY: Fiberoptics Unit (Xenon)	6730-908131-13
LAMP: 300 Watts TYPE: Xenon Lamp	ILC#LX300F
Lamp Holder	6730-905082
P.S. Unit (Xenon)	6730-906960
ACCESSORIES:	
Motor Drive Unit - Indexing (150 RPM)	6730-902867-149
Dual Optical Assy - (10.0 RPM)	6730-909773
" " Mirror Assy	Ref.
2 Fiber Mounting Rings: 6.0" D	6730-908168-3
8.0" D	6730-908168-4
Plate, Floor Mounting (Xen. Fib. Opt.)	6730-908501
Douser Assy. (Show Controls) - (1D)	Ref.

This Unit interfaces with Fiber Bundles
ARTWORK/MASK/GEL: none

4.2.2 THEORY OF OPERATION. Refer to the projector manual.

4.2.3 PREVENTIVE MAINTENANCE. Refer to the projector manual.

4.2.4 CORRECTIVE MAINTENANCE. Refer to the projector manual.

4.3 FX-3: PARADE OF INVENTIONS; SCENE 4.

4.3.1 DESCRIPTION. The parade of inventions are three zones projected on an RP screen which is behind the cloud-shaped cut-out. Each zone has images of inventions drawn to look like wood block prints. In each of the three zones there is always an image cross-fading with another. A couple of images are always on the screen at any one time.

On and around the invention images, there is projected "rippling" or clouds (see FX-68, paragraph 4.4).

The images of inventions are created with four Incandescent 10 x 10 Projectors (P-20, P-21, P-22, P-23) and two Incandescent 5 x 5 Projectors (P-24, P-25). All of the projectors run continuously during the show day.

P-20 is the bottom unit for the left screen, the large flying craft. P-21 is the top unit for the left screen, the man in the feather flying machine. P-22 is the bottom unit for the center screen, the cannon. P-23 is the top unit for the center screen, the Verne bullets. P-24 is the bottom unit for the right screen, the man with the balloon/parachute. P-25 is the top unit for the right screen, the man with the birds.

P-20, P-21, P-22, and P-23 consist of:

MAIN ASSEMBLY:	6730-910904
P-20 and P-21	6730-910905
P-22 and P-23	6730-910906
ASSEMBLY: 10 x 10 Unit (Front Throw) - MIII	6730-904676
LAMP: 2000 Watts TYPE: Tungsten Halogen	6240-594504
LENS:	
P-20 and P-21: 14" TYPE: Buhl	#834-140
P-22 and P-23: 12.5" TYPE: Buhl	#834-125
10 x 10 Lamp/ Blower Module - MIII	6730-904689
ACCESSORIES:	
Stand (Projector):	
P-20 and P-21 - Main Frame	6730-910905
P-22 and P-23 - Main Frame	6730-910906
*38"D Disc Assy - Constant w/ Ripple	6730-910927
" " - Speed (6.0 RPM) CW (@ Rear)	Ref.
" " - Drive (Coupled w/ Shaft)	Ref.
Mirror Assy.:	
P-20 and P-21 (10"w x 10"h) @45 degree	6730-907776
P-22 and P-23 - not required	
Man. Dimmer - MIII	6730-904670
Gel Holder	Ref.

*Disc Unit Loc. (8" - 10" Front of Proj (Used w/ P-20 and P-21)
ARTWORK/MASK/GEL: see Table 4-1

P-24 and P-25 consist of:

MAIN ASSEMBLY:	6730-910904
	6730-910907
ASSEMBLY: 5 x 5 Unit (Front Throw) - MIII	6730-907671
	6730-910109
LAMP: 2000 Watts TYPE: Tungsten Halogen	6730-594504
LENS: 6.5" TYPE: Beseler	#8S1.1-34 (SK)
Condenser A(6" x 9" F.L.	6730-907675-1
10 x 10 Lamp/ Blower Module - MIII	6730-904689
ACCESSORIES:	
Stand (Projector):	6730-910907
*38"D Disc Assy - Constant w/ Ripple	6730-910927
" " - Speed (6.0 RPM) CW (@ Rear)	Ref.
" " - Drive (Coupled w/ Shaft)	Ref.
" " - Drive Mtr.(1/12 HP-9.4 RPM)	Ref.
" " - Drive Mtr.(Elect. Term. Box)	Bodine (Ref.)
" " - w/HUbbell #7596 I/F	Ref.
Fan Unit (Artwork Cooling)	6730-908932-1
Electrical 'J' Box (Hubbell #7596)	6730-909526-1
Slide Holder (Dual)	6730-908618
Man. Dimmer - MIII	6730-904670
Gel Holder	6730-907889-1

*Disc Unit Loc. (8" - 10" Front of Proj (Used w/ P-24 and P-25)
ARTWORK/MASK/GEL: see Table 4-1

4.3.2 THEORY OF OPERATION. The projectors for each zone are paired. Each pair has a rotating disc in front of it which either blocks, distorts, or passes one of the projector's image so that one image fades in as the other fades out. All pairs are mechanically synced so that there will always be a couple of images visible at ony one time.

For information about the projectors and their accessories, refer to the projector manual.

4.3.3 PREVENTIVE MAINTENANCE. Refer to the projector manual.

4.3.4 CORRECTIVE MAINTENANCE. Refer to the projector manual.

4.4 FX-68: MOVING CLOUDS; SCENE 4.

4.4.1 DESCRIPTION. Also part of the parade of inventions (see FX-3), this effect provides the "clouds" or "ripples" that add to the visual interpretation of looking back in time. They are created with one Incandescent 5 x 5 Projector (P-26) and accessories. P-26 is the top unit for the center screen. It runs continuously during the show day.

P-26 consists of:

MAIN ASSEMBLY:	6730-910904
	6730-910906
ASSEMBLY: 5 x 5 Unit Front Throw	6730-907671
	6730-900110
LAMP: 2000 Watts TYPE: Tungsten Halogen	6240-594504
LENS: 8.5" TYPE: Buhl	#834-85
Condenser B(6"x9/12" F.L.)	6730-907675-2
10 x 10 Lamp/Blower Module-MIII	6730-904689
ACCESSORIES:	
Stand (Projector) - Main Frame	6730-910906
19" Rim Disc (Single)-Constant	6730-907840-18
" " " - Speed (.75 RPM) CW (Rear)	Ref.
Man. Dimmer Unit - MIII	6730-904670
Fan Unit (Artwork Cooling)	6730-908932-1
Electrical 'J' Box (Hubbell #7594)	6730-909526-1
Beam Diverting Mirror-Adj. for 45 degree	6730-909848-3
Mirror (9'6"w x 10'0"h)	by WED
Gel Holder	Ref.
ARTWORK/MASK/GEL: see Table 4-1	

4.4.2 THEORY OF OPERATION. Refer to the projector manual.

4.4.3 PREVENTIVE MAINTENANCE. Refer to the projector manual.

4.4.4 CORRECTIVE MAINTENANCE. Refer to the projector manual.

4.5 FX-5: MOVING CLOUDS; SCENE 5.

4.5.1 DESCRIPTION. This effect simulates movement of the space craft by projecting clouds rolling down the "wall." They are created with two 24" Cloud Drums (P-29, P-30). P-29 is located on the left side and P-30 is located on the right side. The cloud drums run continuously during the show day.

P-29 and P-30 consist of:

ASSEMBLY: Cloud Drum-24" D. (Spl)	6730-910751
Lamp Assembly	6730-910675
LAMP: 75 Watts TYPE: Quartz (28v)	G.E. #1982
ACCESSORIES:	
24" D. Drum-(Constant)w/Blower	Ref.
" " -Drum Speed (6.7 RPM)CCW	Ref.
" " -Mtr.(7.0 RPM)CCW	Ref.
" " -Elect. Control Box	6730-921499
" " -Cable Assy.-(1)Reqd(Lamp)	6730-921500-1
" " -Cable Assy.-(2)Reqd(Mtr/Fan)	6730-921500-2
Stand (Projector) - (Part of Assembly)	6730-910744
ARTWORK/MASK/GEL: see Table 4-1	

4.5.2 THEORY OF OPERATION. Refer to the projector manual.

4.5.3 PREVENTIVE MAINTENANCE. Refer to the projector manual.

4.5.4 CORRECTIVE MAINTENANCE. Refer to the projector manual.

4.6 FX-69: ROBOT FLASHES; SCENE 7.

4.6.1 DESCRIPTION. The flashes simulate electrical sparks around the head and eyes of the robot as if it had overloaded and short-circuited. They are created with one Xenon Fiber Optic Illuminator (P-31) and fiber optic displays. The illuminator is located beneath the set. It runs continuously during the show day.

P-31 consists of:

ASSEMBLY: Fiberoptics Unit (Xenon)	6730-908131-12
Lamp Holder	6730-905082
LAMP: 300 Watts TYPE: Xenon	ILC#LX300F
ACCESSORIES:	
(1) Motor Drive Unit - Constant (52 RPM)	6730-902867-112
Dual Optical Assy. - (4.0 RPM)	6730-909773
" " Mirror Assy.	Ref.
(2) Fiber Mounting Rings (4.0" D)	6730-908168-1
(5.0" D)	6730-908168-2
Plate, Floor Mounting (Xen. Fib. Opt.)	6730-908501

Note: This unit interfacs with fiber bundles
ARTWORK/MASK/GEL: none

4.6.2 THEORY OF OPERATION. Refer to the projector manual.

4.6.3 PREVENTIVE MAINTENANCE. Refer to the projector manual.

4.6.4 CORRECTIVE MAINTENANCE. Refer to the projector manual.

4.7 FX-12: LUMIA; SCENE 11.

4.7.1 DESCRIPTION. The lumia provides a transition area from one time period to another. It uses Mini-Moles with a motor, shaft, and two wheels on the shaft - one with radial stripes and one with colors (FXP11-1 thru FXP11-13).

Each unit also has a motor/lamp monitor that assumes if light is pulsating at a regular rate, the lamp is on and the motor is turning the wheels.

For more information, refer to Figure 4-1.

ARTWORK: see Table 4-1

4.8 FX-13: LUMIA; SCENE 13.

For information about FXP13-1 thru FXP13-14, see FX-12, paragraph 4.7.

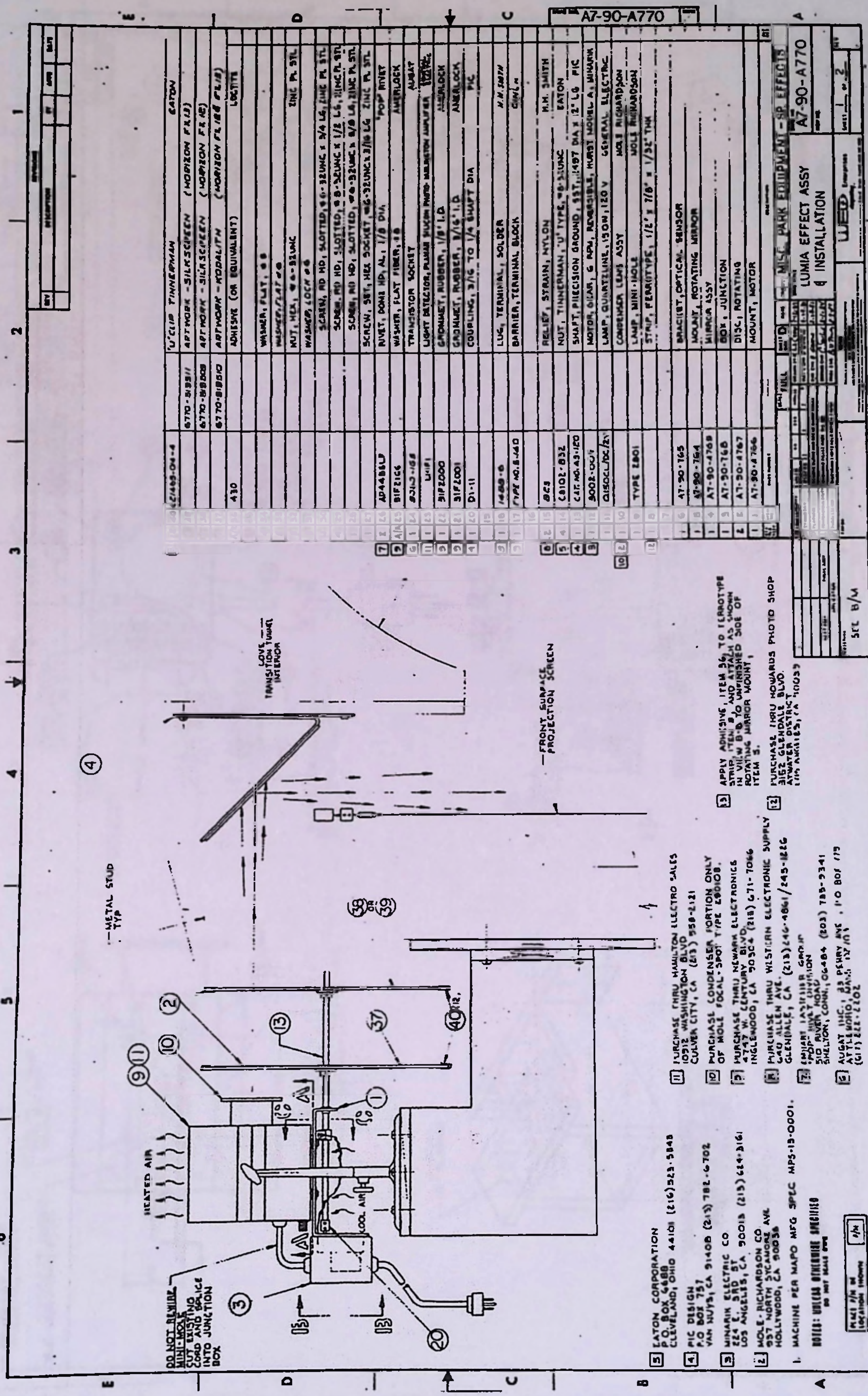


Figure 4-1   Lumia Effect Assembly & Installation
Sheet 1 of 2

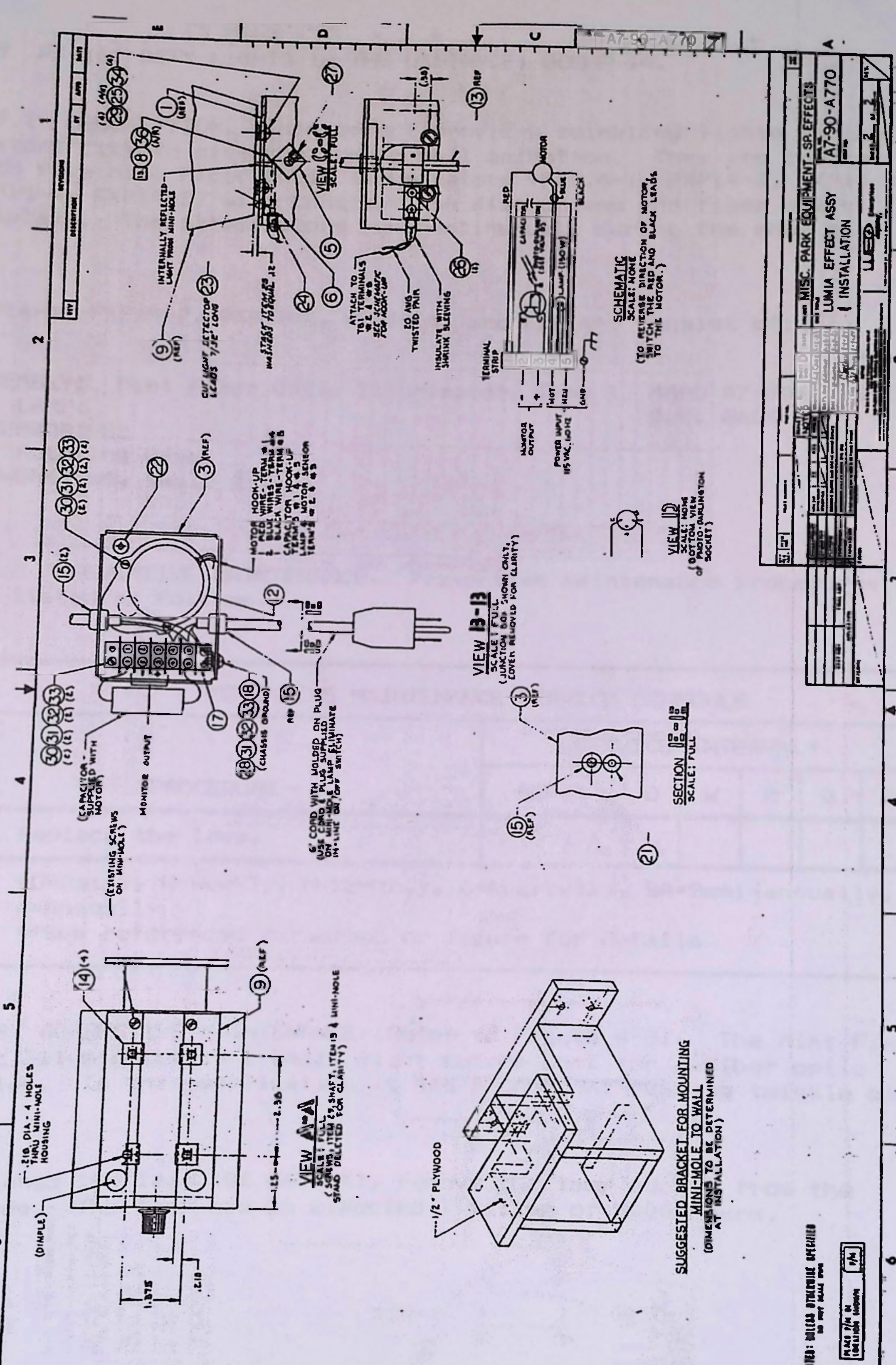


Figure 4-1 Lumia Effect Assembly & Installation
Sheet 2 of 2

4.9 FX-16: CITY LIGHTS IN THE DISTANCE; SCENE 14.

4.9.1 DESCRIPTION. This effect provides twinkling lights in the distant city to give the scenic wall animation. They are created with five Mini Fiber Optic Illuminators (FXP14-1, FXP14-2, FXP14-3, FXP14-4, FXP14-5) with constant run disc drives and fiber optic displays. The illuminators run continuously during the show day.

FXP14-1, FXP14-2, FXP14-3, FXP14-4, and FXP14-5 consist of:

ASSEMBLY: Mini Fiber Optic Illuminator, Type 1 MAPO A7-90-A598-2
LAMP: G.E. 2604-X
ACCESSORIES:
Rotating Disc
ARTWORK: see Table 4-1

4.9.2 PREVENTIVE MAINTENANCE. Preventive maintenance procedures are listed as follows.

PREVENTIVE MAINTENANCE SERVICE SCHEDULE								
	SERVICE INTERVAL*							
PROCEDURE	REF**	D	W	M	Q	SA	A
1. Replace the lamp.	Fig 4-2						X
*D=Daily, W=Weekly, M=Monthly, Q=Quarterly, SA=Semi-annually, A=Annually **See referenced paragraph or figure for details							

4.9.3 CORRECTIVE MAINTENANCE (Refer to Figure 4-2). The Mini Fiber Optic Illuminator is a small light source unit for a fiber optic display. In this application it has a constant running twinkle disc.

To change the lamp (GE 2604-X), remove the lamp socket from the outside. The lamp has an expected lifetime of 8000 hours.

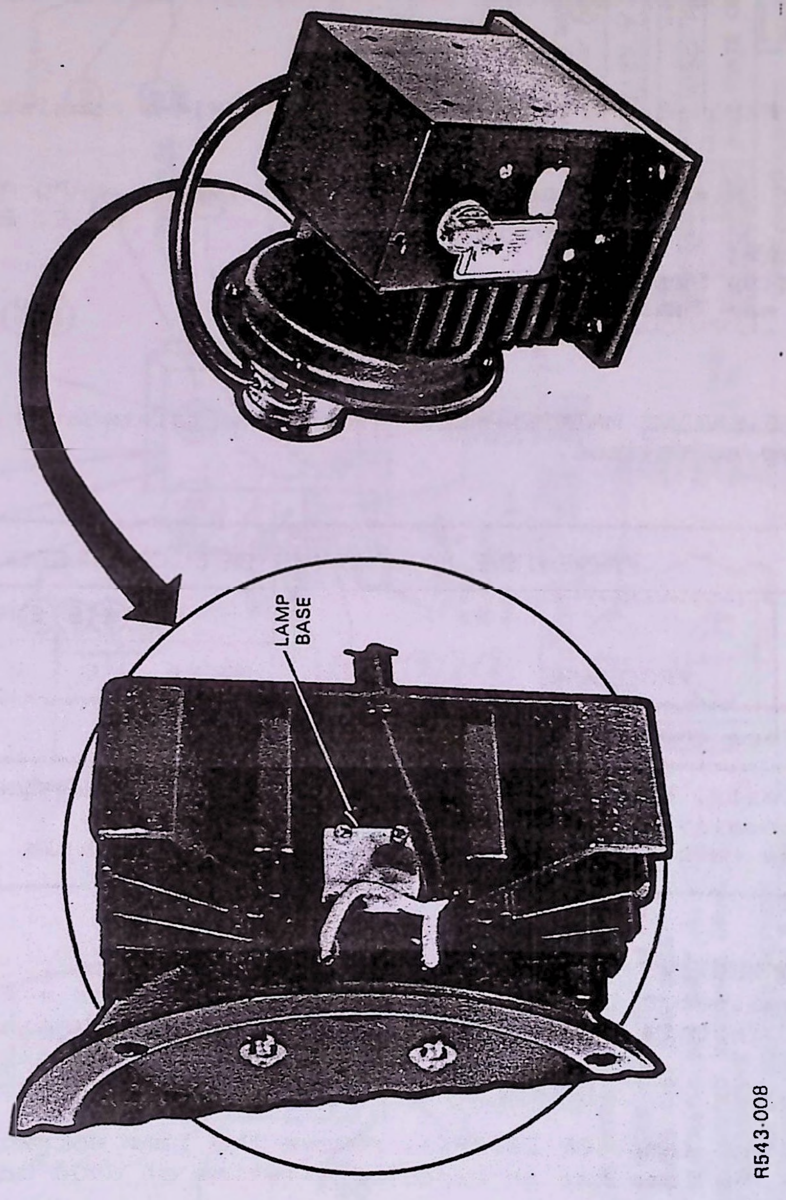


Figure 4-2 Mini Fiber Optic Illuminator
Sheet 1 of 8

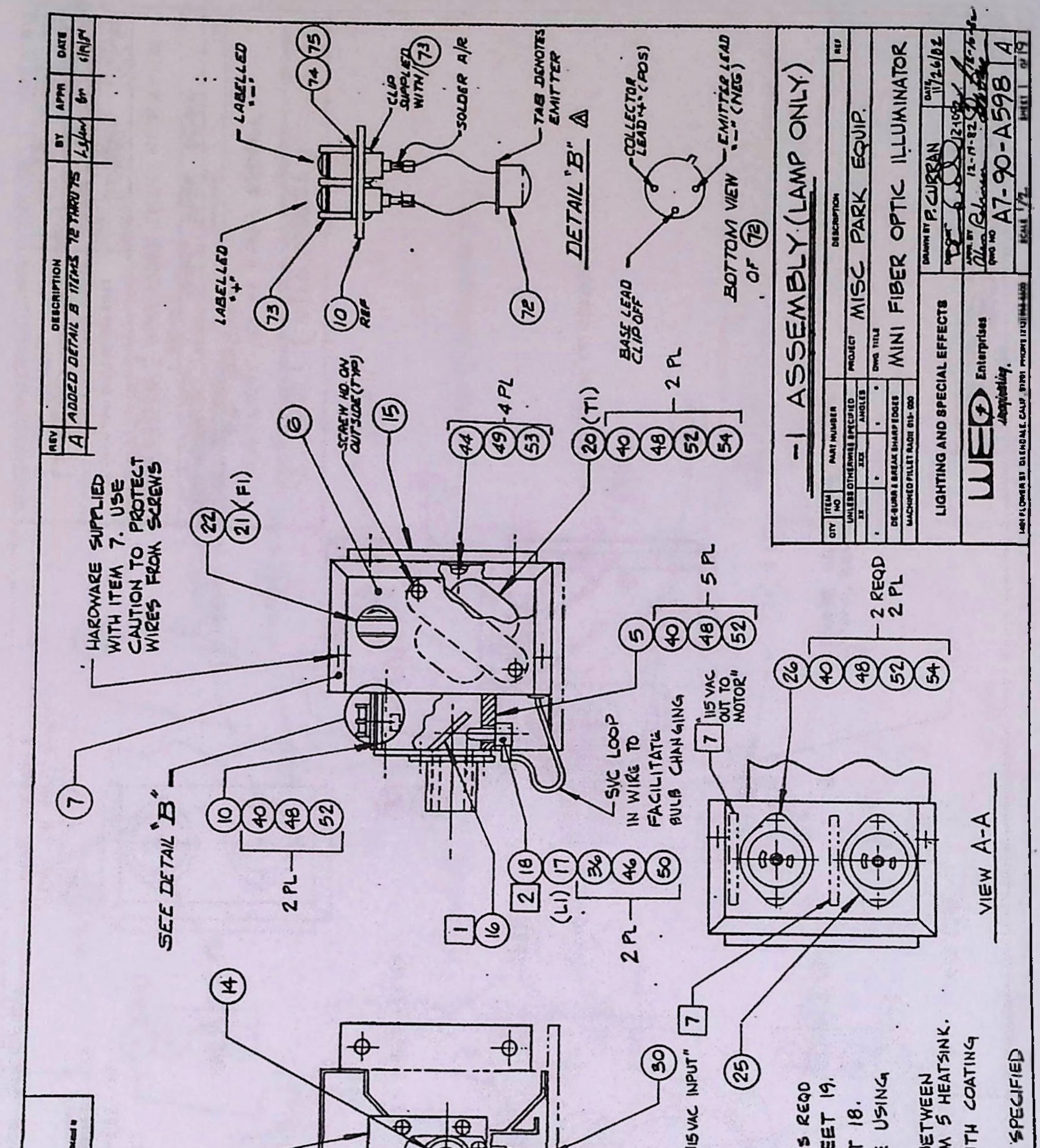


Figure 4-2 Mini Fiber Optic Illuminator
Sheet 2 of 8

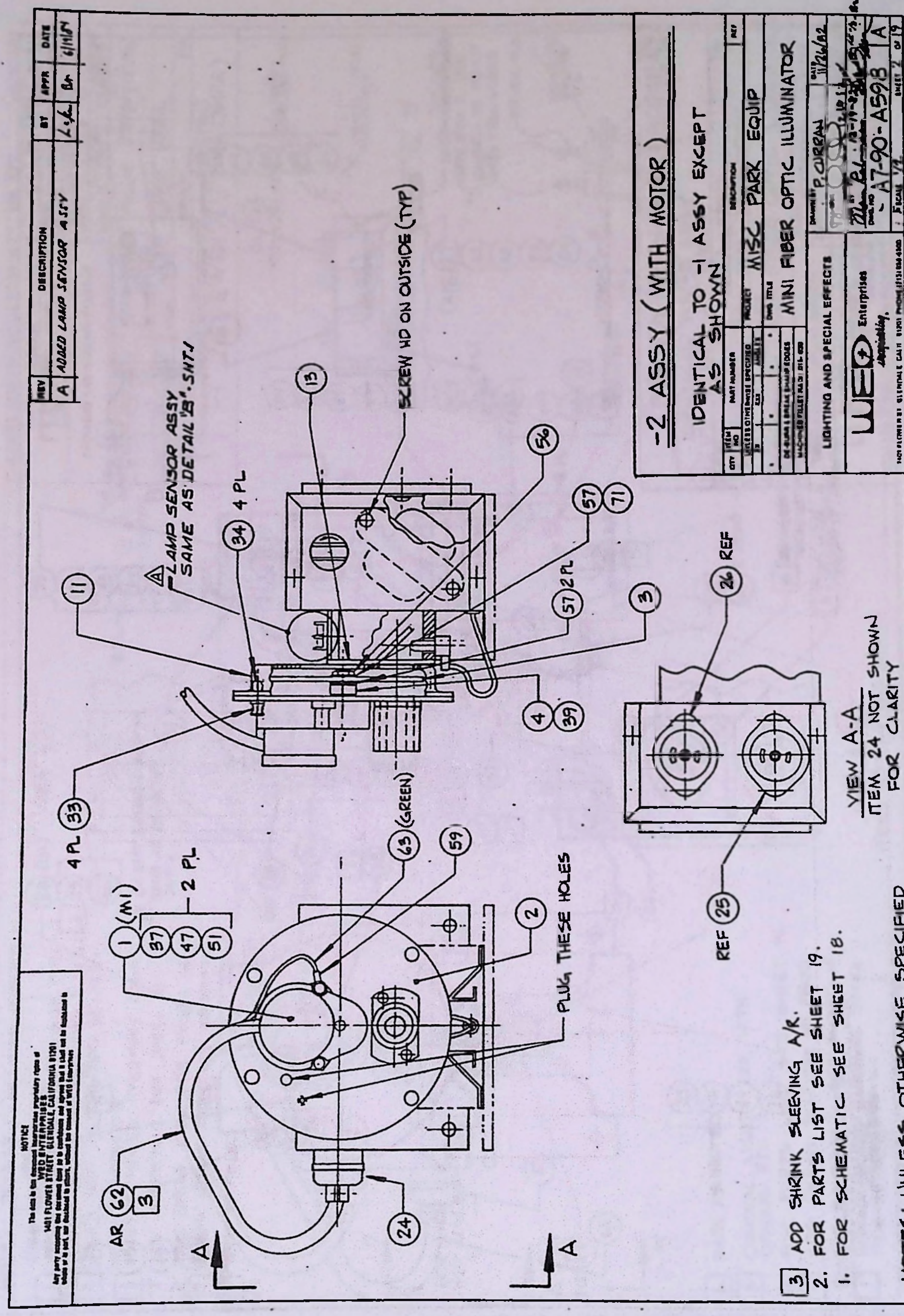


Figure 4-2 · Mini Fiber Optic Illuminator
Sheet 3 of 8

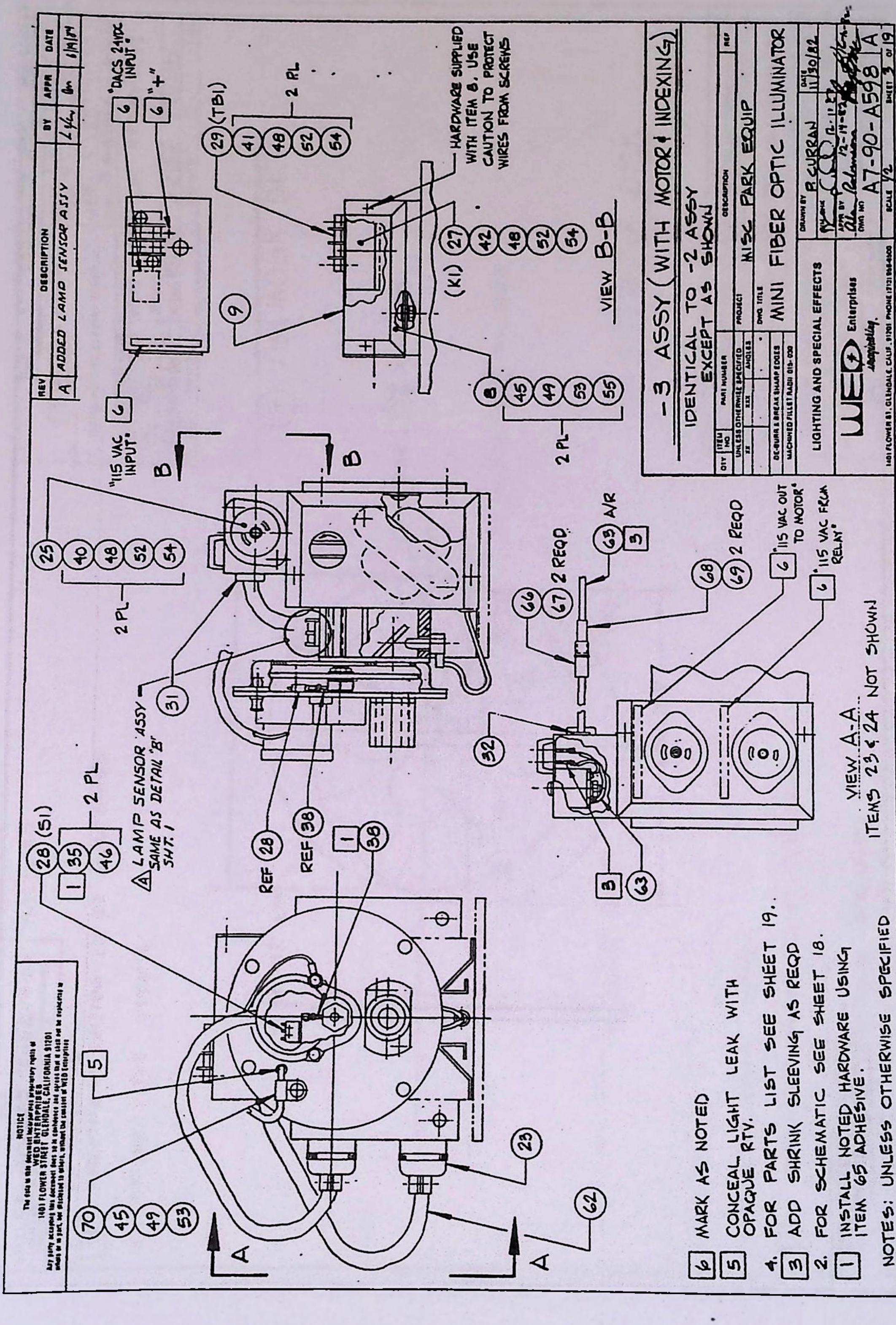


Figure 4-2 Mini Fiber Optic Illuminator
Sheet 4 of 8

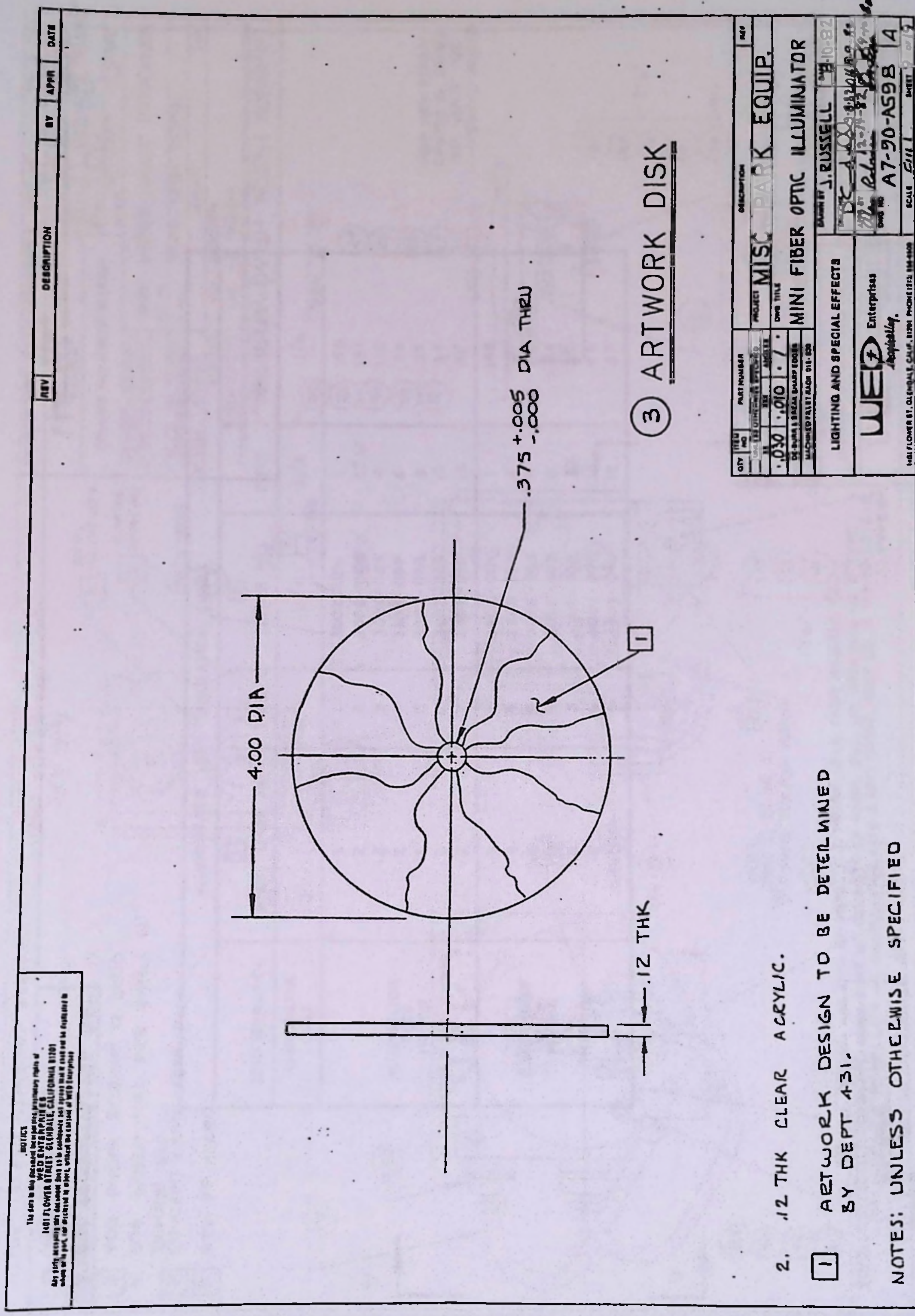


Figure 4-2 Mini Fiber Optic Illuminator
Sheet 5 of 8

NOTICE
The data in this document incorporates proprietary rights of WED ENTERPRISES, 1401 FLOWER STREET, GLENDALE, CALIFORNIA 91201. Any party accepting this document does so in confidence and agrees that it shall not be duplicated in whole or in part, nor disclosed to others, without the consent of WED Enterprises.

REV	DESCRIPTION	BY	APPR	DATE

ILLUMINATOR ASSY. TABULATION CHART

CONFIGURATION	[1] ASSY. DASH NO.	[1] TYPE	[2] MOTOR P/N	RPM	TORQUE (OZ IN)
ILLUMINATOR ONLY	-1	N/A	N/A	N/A	N/A
ILLUMINATOR WITH MOTOR	-2	1	3002-001	1	150
	-2	2	3002-003	2	131
	-2	3	3002-005	4	110
	-2	4	3002-007	6	74
	-2	5	3002-008	8	55
	-2	6	3002-009	10	44
	-2	7	3002-010	12	37
ILLUMINATOR WITH MOTOR & INDEXING	-3	1	3002-001	1	150
	-3	2	3002-003	2	131
	-3	3	3002-005	4	110
	-3	4	3002-007	6	74
	-3	5	3002-008	8	55
	-3	6	3002-009	10	44
	-3	7	3002-010	12	37

[2] ALL MOTORS ARE MFG. BY HURST AND PROCURABLE FROM MINARIK INC.

[1] COMPLETE ASSY PART NO. CONSISTS OF BASIC DWG. NO. WITH DASH NO. & TYPE: e.g. TO SPECIFY AN ILLUMINATOR WITH 2 RPM MOTOR, PART NO. IS "A7-90-A598-2, TYPE 2"

NOTES: UNLESS OTHERWISE SPECIFIED:

QTY	ITEM NO	PART NUMBER	DESCRIPTION	REF.

PROJECT: MISC PARK EQUIP.

DWG. TITLE: MINI FIBER OPTIC ILLUMINATOR

DE-BURR & BREAK SHARP EDGES

MACHINED FILLET RADII .015-.030

LIGHTING AND SPECIAL EFFECTS

WED Enterprises

1401 FLOWER ST., GLENDALE, CALIF. 91201

DATE 12-7-82

DWG NO A7-90-A598 A

SCALE NONE

F-3642

Figure 4-2 Mini Fiber Optic Illuminator
Sheet 6 of 8

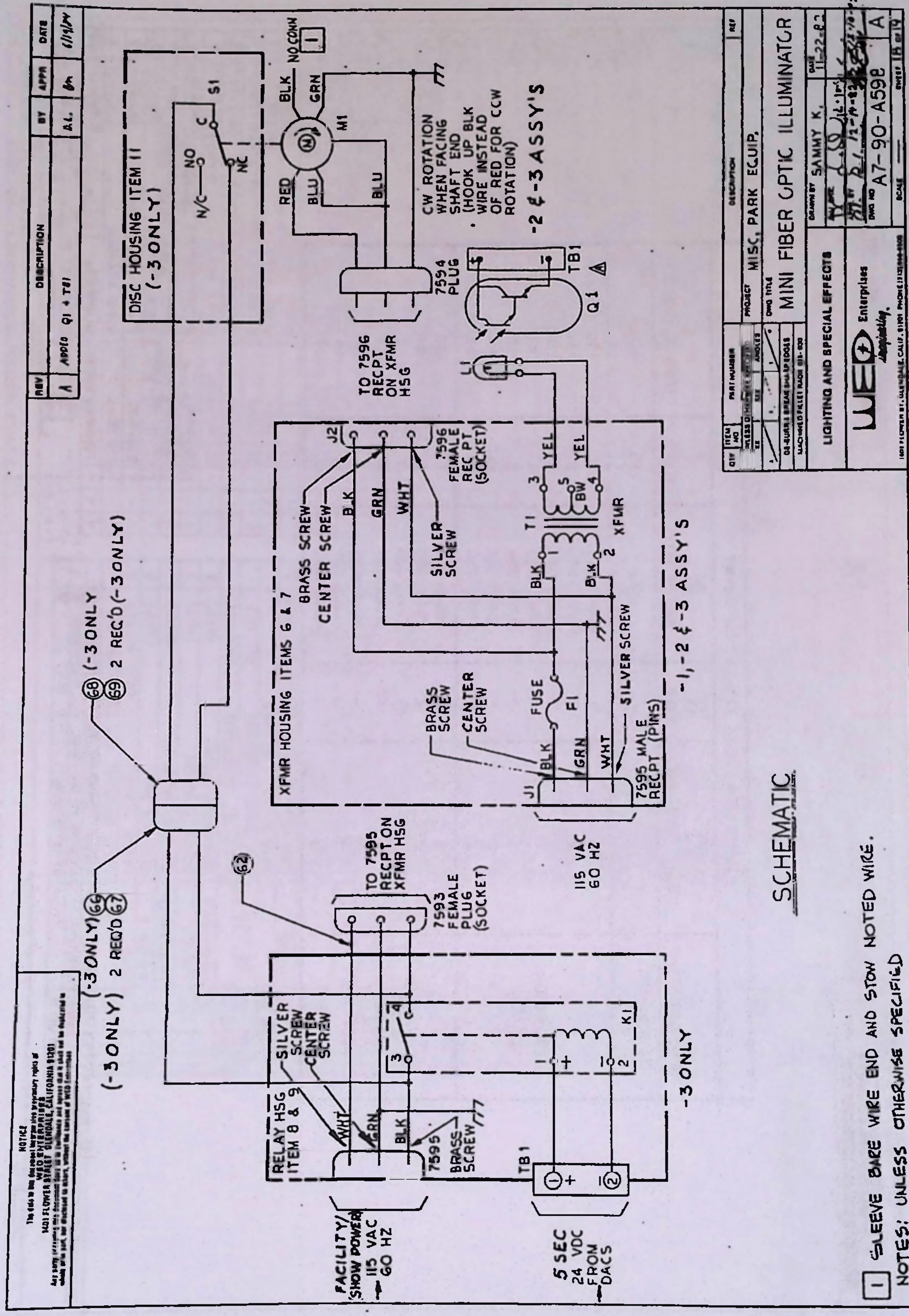


Figure 4-2 Mini Fiber Optic Illuminator
Sheet 7 of 8

NOTICE

The data in this drawing are proprietary to WED ENTERPRISES, 1401 FLOWER STREET, GLENDALE, CALIFORNIA. Any party accepting this document does so in confidence and agrees that it shall not be duplicated in whole or in part, nor disclosed to others, without the consent of WED Enterprises.

-3	-2	-1	ITEM NO.	PART NUMBER	DESCRIPTION	REF
A/R	A/R	A/R	74		GLUE, SUPER A	
1	1	1	73	1599-E	TERMINAL BOARD (KULKA) A	
1	1	1	72	L14F1	PHOTO - DARLINGTON (G.E) A	
1	1	–	71		LOCK WASHER, INT TOOTH, 3/8 DIA	
1	–	–	70	8941	CABLE CLAMP, (H.H. SMITH)	3
1	–	–	69	60618-1	CONTACT, PIN (AMP)	3
1	–	–	68	1-480319-0	CONNECTOR, PLUG (AMP)	3
1	–	–	67	60617-1	CONTACT, SOCKET (AMP)	3
1	–	–	66	1-480318-0	CONNECTOR, RECPT (AMP)	3
AR	AR	AR	65		"LOCTITE" COMPOUND (LOCTITE)	
AR	AR	AR	64	29 TYPE	HEAT SINK COMPOUND (GC CO.)	
AR	AR	AR	63		WIRE ELECT. 18 GAGE	
AR	–	–	62	19229	LINE CORD, SJO-3 COND, 18 GA (BELDEN)	3
2	1	1	61		TERM #8 RING, 18 AWG	
4	–	–	60		TERM #6 RING, INSUL, 18 AWG	
1	1	–	59		TERM #4 RING, INSUL, 18 AWG	
9	6	6	58		TERM, #4 FORK, INSUL, 18 AWG	
3	3	–	57		WASHER, FLAT THIN, 3/8"	
1	1	–	56		NUT, HEX, THIN ELECTR, 3/8"-24	
2	–	–	55		NUT, HEX, 8-32	
11	6	6	54		NUT, HEX, 6-32	
6	4	4	53		WASHER, LOCK, #8	
24	19	19	52		WASHER, LOCK, #6	
2	2	–	51		WASHER, LOCK, #4	
2	2	2	50		WASHER, LOCK, #2	
7	4	4	49		WASHER, FLAT, #8	
24	19	19	48		WASHER, FLAT, #6	
2	2	–	47		WASHER, FLAT, #4	
4	2	2	46		WASHER, FLAT, #2	
3	–	–	45		SCREW, BHSCS, 8-32 x .38 LG	
5	4	4	44		SCREW, BHSCS, 8 32 x .25 LG.	
2	2	2	43		SET SCREW, SOC. HD. 6-32 x .190 LG.	
1	–	–	42		SCREW, PAN HD, 6-32 x 1.25 LG.	
6	4	4	41		SCREW, BHSCS, 6-32 x .50 LG.	
15	13	13	40		SCREW, BHSCS, 6-32 x .38 LG	
1	1	–	39		SET SCREW, SOC HD 4-40 x .25 LG.	
1	–	–	38		SCREW, FIL HD, 4-40 x .38 LG.	
2	2	–	37		SCREW, BHSCS, 4-40 x .38 LG.	
2	2	2	36		SCREW, BHSCS, 2-56 x .62 LG.	
2	–	–	35		SCREW, PAN HD, 2-56 x .81 LG.	
4	4	–	34	HN4G-44-1	GROMMET "NYLATCH" (HARTWELL)	2,3

-3	-2	-1	ITEM NO.	PART NUMBER	DESCRIPTION	REF
4	4	–	33	HN4P-44-4-1	PLUNGER "NYLATCH" (HARTWELL)	2,3
1	–	–	32	2047	SNUB BUSHING (HEYCO)	3
1	–	–	31	1200	STRAIN RELIEF BUSHING (HEYCO)	3
1	1	1	30	8-312-250	SNAP BUSHING (HEYCO)	1,2,3
1	–	–	29	2-164-Y	TERMINAL BLOCK, 2 TERM (TB1) (CINCH)	3
1	–	–	28	MMW	SWITCH, MIN. (S1) W/INTEGRAL ROLLER (UNIMAX)	3
1	–	–	27	601-1401	RELAY, SOLID STATE, 5 AMP (K1) (TELEDYNE)	3
1	1	1	26	7596	RECEPTACLE, FEMALE (HUBBELL)	1,2,3
2	1	1	25	7595	RECEPTACLE, MALE RECESSED (HUBBELL)	1,2,3
1	1	–	24	7594	PLUG, MALE (HUBBELL)	2,3
1	–	–	23	7593	PLUG, FEMALE (HUBBELL)	3
1	1	1	22	344125	FUSE HOLDER (LITTLE FUSE)	1,2,3
1	1	1	21	313005	FUSE, 5AMP (3A6) (F1) (LITTLE FUSE)	1,2,3
1	1	1	20	P-6467	TRANSFORMER, 5V, 3AMP (T1) (STANCOR)	1,2,3
2	2	2	19	S-1189	TERM, .189 FEM (90°) FLAG, 18-14 GA (WALDON)	1,2,3
1	1	1	18	28-207	SOCKET (G4) (LEECRAFT)	1,2,3
1	1	1	17	2604-X	LAMP, 5V, 10W (L1) (GE)	1,2,3
1	1	1	16	MODIFY STOCK 5.00 x 5.00 x .12	MIRROR, 45° COLD/PYREX 1.00 x 1.25 x .12 (OCLI)	1,2,3
1	1	1	15		PLATE, MOUNTING	1,2,3,14
1	1	1	14	1	BUSHING, FIBER OPTIC	1,2,3,15
–	–	1	13		PLATE, BUSHING MOUNT	1,16
1	1	1	12		BUSHING, MTG (FIBER OPTIC)	1,2,3
1	1	–	11		HOUSING, DISC	2,3
1	1	1	10		COVER, TOP	
1	–	–	9		COVER, RELAY HOUSING	
1	–	–	8		BASE, RELAY HOUSING	
1	1	1	7		BASE, XFMR HOUSING	
1	1	1	6		COVER, XFMR HOUSING	
1	1	1	5		HEAT SINK	
1	1	–	4		BUSHING, DISC MTG	
1	1	–	3		DISC, ARTWORK	
1	1	–	2		PLATE, MOTOR MTG	
1	1	–	1	2	MOTOR 3W, 115VAC 60HZ, (M1) (HURST)	

QTY REQD PER ASSY-NO

REV	DESCRIPTION	BY	APPR	DATE
A	ADDED ITEMS 72 73 & 74			6/11/84

2. SEE TAB CHART, SHT 17, TO SELECT APPROPRIATE MOTOR SPEED.

1. SEE TAB BLOCK, SHT 15, TO SELECT PROPER BUSHING SIZE.

NOTES: UNLESS OTHERWISE SPECIFIED

UNLESS OTHERWISE SPECIFIED: .XXX ANGLES

DE-BURR & BREAK SHARP EDGES

MACHINED FILLET RADII .015-.030

PROJECT: MISC. PARK EQUIP.

DWG TITLE: MINI FIBER OPTIC ILLUMINATOR

LIGHTING AND SPECIAL EFFECTS

WED Enterprises imagineering

1401 FLOWER ST., GLENDALE, CALIF. 91201

DRAWN BY: SAMMY K. DATE: 11-22-82

DWG NO: A7-90-A598 A

SCALE: — SHEET 19 OF 19

Figure 4-2 Mini Fiber Optic Illuminator
Sheet 8 of 8

4.10 FX-17: ELEVATOR; SCENE 17.

4.10.1 DESCRIPTION. The purpose of this effect is to provide additional animation to scenic wall; for this effect, "elevators" move up and down the outside of buildings. Each elevator is created with a 10 x 10 Projectors (P-46, P-47, P-48). Each projector's light source is a 10 watt bulb mounted on a stage assembly. It is the light source moved by the stage assembly and projected by the objective lense that moves the "elevator." P-46 is located on the left side of the setpiece. P-47 is located in the center area in fornt of the setpiece. P-48 is located in the center area. The projectors are in show sync.

P-46, P-47, and P-48 consist of:

MAIN ASSEMBLY:	6730-910510
ASSEMBLY: 10 x 10 Unit (Front Throw) Spl	6730-904676
LAMP: 10 Watts TYPE: Quartz (5v)	#2604X
LENS: 14" TYPE: Buhl	#834-140
ACCESSORIES:	
Stand (Projector) Lens Hgt=38"; Tilting=8"h	6730-903424-7
(Y) Stage Assy. (Program)	6730-910511
" " -Elect. Control Box (1A)	6730-921464
" Mode - (Y) Travel=8"	Ref.
" Oper. - (Rate) Travel=0.5"/sec	Ref.
Cable Assy.(Control Box to Projector) x 30"	6730-921478
ARTWORK/MASK/GEL: none	

4.10.2 THEORY OF OPERATION. Refer to the projector manual.

4.10.3 PREVENTIVE MAINTENANCE. Refer to the projector manual.

4.10.4 CORRECTIVE MAINTENANCE. Refer to the projector manual.

4.11 FX-18: MAG LEV TRAINS; SCENE 14.

4.11.1 DESCRIPTION. This effect simulates magnetic levitation trains moving through tunnels behind the buildings in the "foreground" of the scene. They are created with two HMI 10 x 10 Projectors (P-49, P-50). P-49 is located on the left side by the setpiece. P-50 is located on the left side in front of the setpiece. The projectors run continuously during the show day.

P-49 consists of:

MAIN ASSEMBLY:	6730-911008
ASSEMBLY: 10 x 10 Unit (HMI-1200) - Vert.	6730-909205-2
LAMP: 1200 Watts TYPE: HMI Quartz (5600 K)	DAYMAX#DMI 1200
	OSRAM#HMI1200W
LENS: 10" TYPE: Buhl	#834-100
P.S. (Ballast) HMI	6730-920839
	Xetron#81-1200/c
ACCESSORIES:	
Stand (Projector) Lens Hgt=34";Tilting=8"h	6730-903424-7
Power Cord x 50' (P.S. to 10x10)	6730-920797-7
9-1/2" Film Loop Unit (Long) perfed	6730-905100-4
" " Artwork Speed (73"/min) (L to R)	Ref.
" " Motor Speed (25 RPM)	Ref.
Mirror Assy. (10"w x 10"h) @45 degrees	6730-907776
ARTWORK/MASK/GEL: see Table 4-1	

P-50 consists of:

MAIN ASSEMBLY:	6730-911008
ASSEMBLY: 10 x 10 Unit (HMI-1200) - Front	6730-909201-4
LAMP: 1200 Watts TYPE: HMI Quartz (5600 K)	DAYMAX#DMI 1200
	OSRAM#HMI1200W
LENS: 12-1/2" TYPE: Buhl	#834-125
P.S. (Ballast) HMI	6730-929839
	Xetron#81-1200/c
ACCESSORIES:	
Stand (Projector) Lens Hgt=39-1/2";Tilting=8"h	6730-903424-7
Power Cord x 30' (P.S. to 10x10)	6730-920797-3
9-1/2" Film Loop Unit (Long) perfed	6730-905100-5
" " Artwork Speed (?"/min) (L to R)	Ref.
" " Motor Speed (13 RPM)	Ref.
Mirror Assy. (10"w x 10"h) @45 degrees	6730-907776
ARTWORK/MASK/GEL: see Table 4-1	

4.11.2 THEORY OF OPERATION. Refer to the projector manual.

4.11.3 PREVENTIVE MAINTENANCE. Refer to the projector manual.

4.11.4 CORRECTIVE MAINTENANCE. Refer to the projector manual.

4.12 FX-70: STATION HIGHLIGHTS: SCENE 14.

4.12.1 DESCRIPTION. To further increase the depth and therefore, the realism of the scene, the station's lights are more intense than those painted on the wall. They seem to shine brightly from within. They are created with two aimed HMI 10 x 10 Projectors (P-52, P-53). Both projectors are located on the right side of the setpiece. They run continuously during the show day.

P-52 and P-53 consist of:

MAIN ASSEMBLY:	6730-911005
ASSEMBLY: 10 x 10 Unit (HMI-575) - Front	6730-909201-2
LAMP: 575 Watts TYPE: HMI Quartz (5600 K)	DAYMAX#DMI 575 OSRAM#HMI575W
LENS: 14" TYPE: Buhl	#834-140
P.S. (Ballast) HMI	6730-920838 Xetron#B1-575/c
ACCESSORIES:	
Stand (Projector) Lens Hgt=34";Tilting=8"h	6730-903424-7
Power Cord x 50' (P.S. to 10x10)	6730-920797-2
ARTWORK/MASK/GEL: see Table 4-1	

4.12.2 THEORY OF OPERATION. Refer to the projector manual.

4.12.3 PREVENTIVE MAINTENANCE. Refer to the projector manual.

4.12.4 CORRECTIVE MAINTENANCE. Refer to the projector manual.

4.13 FX-19: HOLOGRAM FLICKER; SCENE 14.

4.13.1 DESCRIPTION. To enhance the interpretation of a transmitting hologram (rather than just a poorly lit figure), the image is made to flicker. The flicker is created with a show controlled 2 x 2 Strobe (P-51). It is located in area #209.

P-51 consists of:

ASSEMBLY: 2 x 2 Strobe Unit (Constant) w/fan	6730-910686-1
LAMP: 300 Watts TYPE: Flashtube	Kemlite#S95B-9
Lamp Module	Strobex#274
LENS: 7.87" TYPE: Buhl	#206-060
Strobe P.S. Unit	Strobex#236-D
Modified (w/PCB)	#VC99-3482
ACCESSORIES:	
Floor Mounting (Projector)	6730-908500
Mirror Assy. (10"w x 8"h)	Ref.
ARTWORK/MASK/GEL: none	

4.13.2 THEORY OF OPERATION. Refer to the projector manual.

4.13.3 PREVENTIVE MAINTENANCE. Refer to the projector manual.

4.13.4 CORRECTIVE MAINTENANCE. Refer to the projector manual.

4.14 FX-28: CITRUS BLOSSOM SCENT; SCENE 16.

4.14.1 DESCRIPTION. This effect increases the guests' perception of the orchard at the desert farm. It is created with citrus blossom scent (R-2534) 'fired' from a scent cannon.

4.14.2 THEORY OF OPERATION. When signaled by show control, the scent cannon "shoots" a puff of scent to the middle of the tracks.

It shoots each time the "open" cylinder control valve receive the 24 vdc dispense scent command and filtered animation air extends the actuator cylinder which opens the tank cover. When the "close" cylinder control valve receives the 24 vdc signal, the actuator cylinder retracts which closes the tank cover.

The wick motor and the fan are on continuously during the show day.

Periodically, the metering pump is signaled to spray fresh scent on the wick. There is a time delayed relay to protect the liquid metering pump, see Figure 4-3.

4.14.3 PREVENTIVE MAINTENANCE. Preventive maintenance procedures are listed as follows.

PREVENTIVE MAINTENANCE SERVICE SCHEDULE								
		SERVICE INTERVAL*						
	PROCEDURE	REF**	D	W	M	Q	SA	A
1.	Check scent fluid level. Refill as needed.	4.14.4		X				
2.	Clean or replace foam filter.	Fig 4-4			X			
3.	Clean or replace animation air filter.	Fig 4-4				X		
4.	Clean or replace cannon air filter.	Fig 4-4				X		

*D=Daily, W=Weekly, M=Monthly, Q=Quarterly, SA=Semi-annually, A=Annually
**See referenced paragraph or figure for details

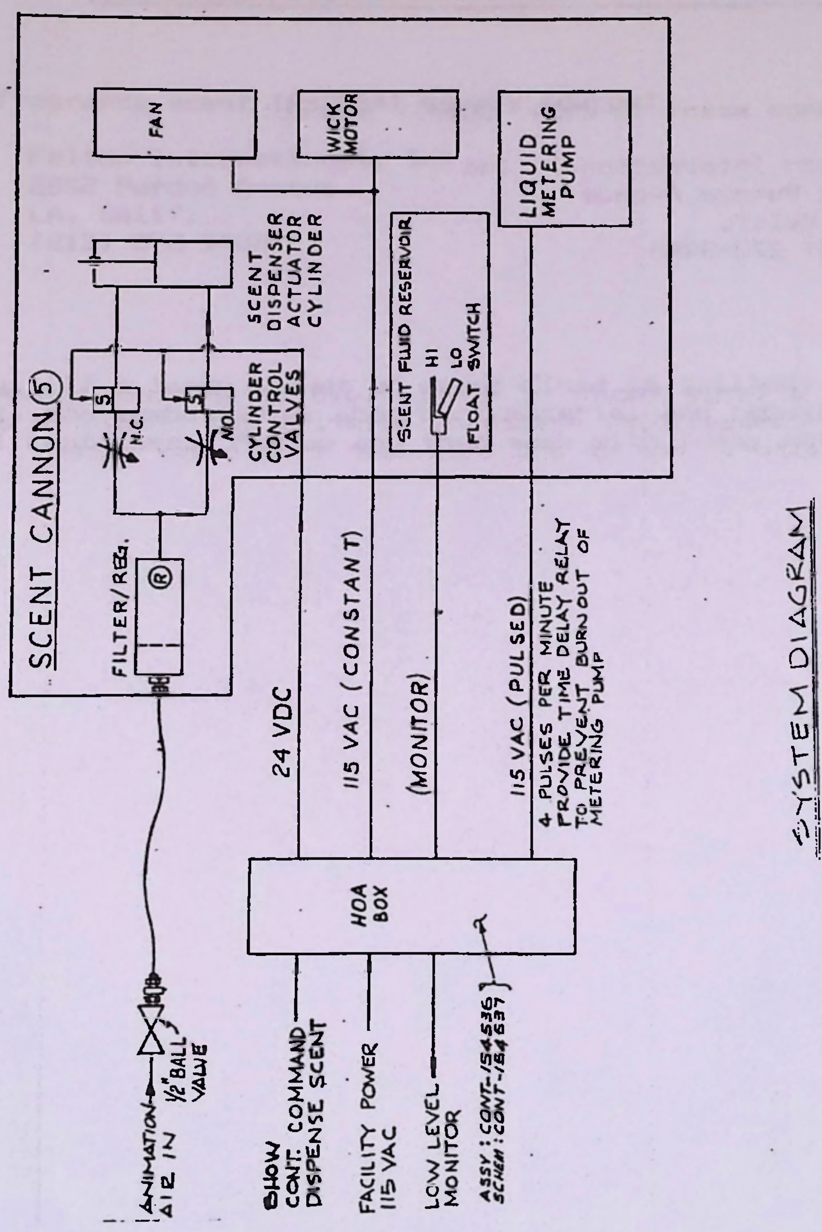


Figure 4-3 Scent System Diagram

4.14.4 SCENTS. Each scent refill canister should be color-coded to the correct scent cannon.

WARNING

If scent is swallowed, do not induce vomiting. Call a physician. In case of fire, use a chemical foam type fire extinguisher.

Orange fragrance scent (R-2534) supply source:

Felton International, Inc
2242 Purdue Avenue
LA, Calif.
(213) 272-3482.

Cleaning. If a large amount of scent fluid is spilled, cover with an inert, non-combustible, absorbant material and remove to a disposal container. Mop up and then wash with soapy water.

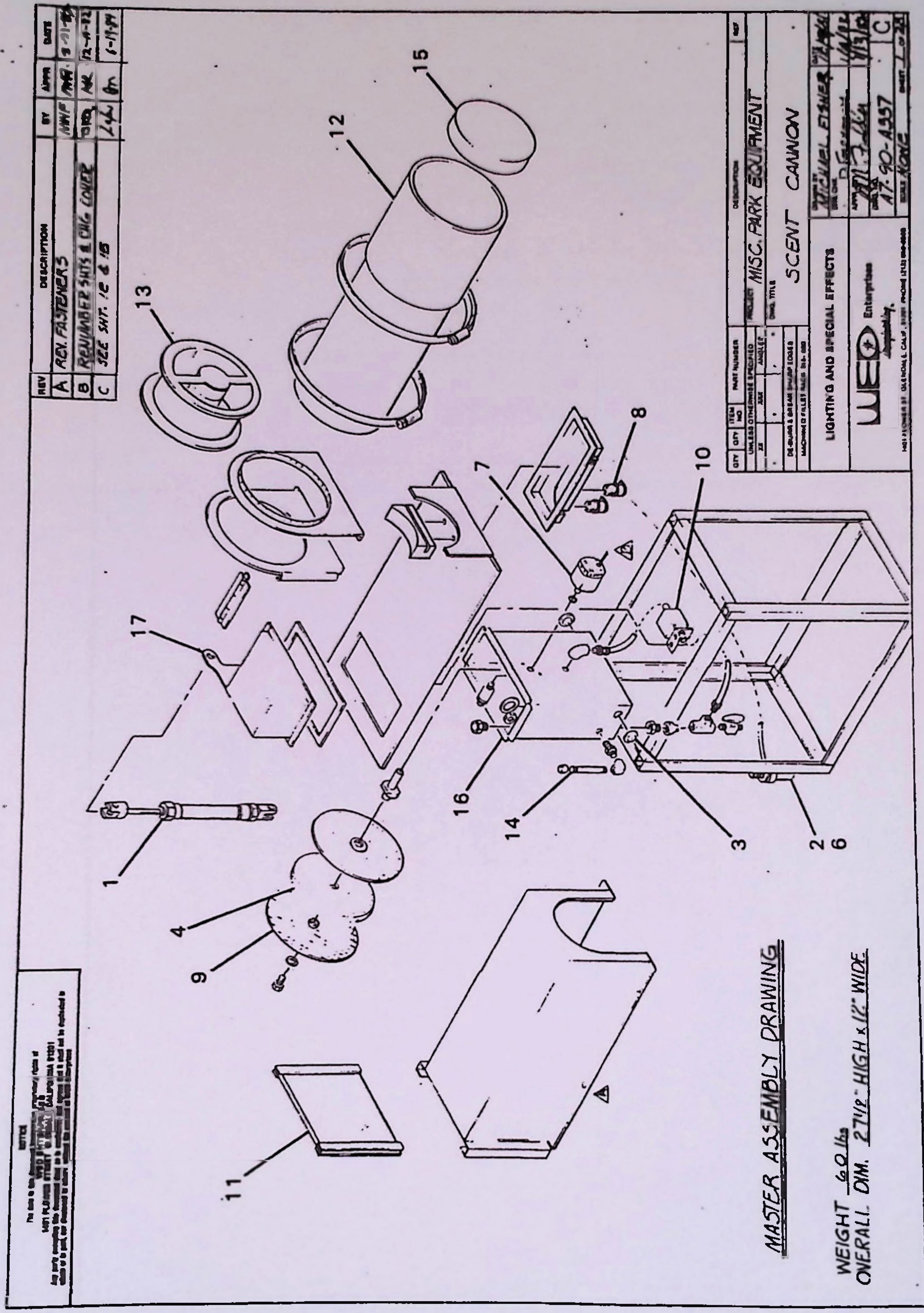


Figure 4-4 Scent Cannon
Sheet 1 of 2

Figure 4-
SCENT CANNON
PARTS LIST

DWG NO. A7-90-A337 **WDP NO. 6005-259705**

ITEM	DWG/MFR PART NO.	WDP NO.	DESCRIPTION		QTY
1	04DXDDE		Cylinder, Double Acting, 3/8" Bore × 3" Stroke	*BIMBA*	1
2	04E-0-5-B-13-F		Filter Regulator	*PARKER*	1
3	1128N21	6680-584883	Sight Glass	*McMASTER-CARR*	1
4	40 P.P.I.	9390-584821	Foam, Industrial, 3/8" Thk × 8" Dia	*WILSHIRE FOAM PROD.*	1
5	6910-050		Switch, Liquid Level (Not Shown)	*RYAN-HERCO*	1
6	7214-2 1/2-1/8-CM, 0-100		Gauge	*GEN.INST.*	1
7	742	6105-584925	Motor, Geared, 7.9 RPM	*BODINE*	1
8	9002-01	6005-646044	Valve, Miniature Type EVO-3 with Muffler Element	*CLIPPARD*	2
9	9238W12		Cloth, Wire, 6" × 6" × .028, 60% Open, SSt	*McMASTER-CARR*	2
10	SV500-2	4810-645244	Pump, Miniature Metering	*VALCOR*	1
11	A7-90-A337B	6005-259707	Air Filter — Same material as wick retainer		1
12			Barrel		1
13			Fan, Rotron "Karavel"	*WEATHERFORD*	1
14			Fillport		1
15			Insert, Phenolic, 4" Thk × 9" O.D. 3/8" Cell Type Hrp	*HEXCELL*	1
16			Liquid Storage Tank		1
17			Tank Cover		1

Figure 4-4 Scent Cannon
Sheet 2 of 2

4.15 FX-22: MOVING CLOUDS; SCENE 16.

4.15.1 DESCRIPTION. To give an otherwise static scenic wall animation, the effect provides a stormy sky with moving clouds. They are created with two HMI 10 x 10 Projectors (P-54, P-55). Both projectors are located on the left side of the rear catwalk. They run continuously during the show day.

P-54 and P-55 consist of:

MAIN ASSEMBLY:	6730-911006
ASSEMBLY: 10 x 10 Unit (HMI-1200) - Front	6730-909201-5
LAMP: 1200 Watts TYPE: HMI Quartz (5600 K)	DAYMAX#DMI 1200 OSRAM#HMI1200W
LENS: 14" TYPE: Buhl	#834-140
P.S. (Ballast) HMI	6730-920839 Xetron#B1-1200/C
ACCESSORIES:	
Stand (Projector) Lens Hgt=33-1/2";Tilting=8"h	6730-903424-7
Power Cord x 15' (P.S. to 10x10)	6730-920797-2
9-1/2" Film Loop Unit (Long) perfed	6730-905100-
" " Artwork Speed (7.9"/min) (L to R)	Ref.
" " Motor Speed (35 RPM)	Ref.
Gel Holder (Lens Mtd)	Ref.
ARTWORK/MASK/GEL: see Table 4-1	

4.15.2 THEORY OF OPERATION. Refer to the projector manual.

4.15.3 PREVENTIVE MAINTENANCE. Refer to the projector manual.

4.15.4 CORRECTIVE MAINTENANCE. Refer to the projector manual.

4.16 FX-23: LIGHTNING; SCENE 16.

4.16.1 DESCRIPTION. The lightning appears to flash from the stormy clouds (FX-22). It is created with a 2 x 2 Strobe (P-56). P-56 is located on the shelf of the rear catwalk. The strobe is in show sync.

P-56 consists of:

MAIN ASSEMBLY:		6730-910687
ASSEMBLY: 2 x 2 Strobe Unit (Spl. 10-200 FPS)		Chadwick#236D
LAMP: 300 Watts	TYPE: Flashtube	Kemlite#S95B-9
	Lamp Module	Strobex#274
LENS: 18"	TYPE: Buhl	#834-180
Strobe P.S. Unit		Strobex#236-D
Modified (w/PCB)		#VC99-3482
ACCESSORIES:		
Floor Mounting (Projector)		6730-908500
Mirror Assy. (10"w x 8"h)		Ref.
ARTWORK/MASK/GEL: see Table 4-1		

4.16.2 THEORY OF OPERATION. Refer to the projector manual.

4.16.3 PREVENTIVE MAINTENANCE. Refer to the projector manual.

4.16.4 CORRECTIVE MAINTENANCE. Refer to the projector manual.

4.17 FX-25: SIMULATED MONITORS; SCENE 16.

4.17.1 DESCRIPTION. In addition to the real video monitor, three monitors are simulated: a farm aerial grid, a harvester, and a weather map. Their images move slowly as if a camera was panning. The video is simulated by three Incandescent 2 x 2 Projectors (P-57, P-58, P-59). They are located underneath the setpiece. The Video Monitor Screens are 18" wide x 14" high; with 60 degree mirror 8-1/2" x 8-1/2" which are also part of the prop. The projectors run continuously during the show day.

P-57, P-58, and P-59 consist of:

MAIN ASSEMBLY:	6730-910503
ASSEMBLY: 2 x 2 Unit - MIII	6730-905190-8
LAMP: 500 Watts TYPE: Quartz (BCK)	
LENS: 3" TYPE: Buhl	#813-060
Lamp/Blower Module - MIII	6730-905152
ACCESSORIES:	
Stand (Projector) - Std Yoke	Ref.
Plate, Floor Mounting (2x2)	6730-908500
(X-Y) Slide Assy. - Constant (Osc.)	6730-910489
X " Mtr. Speed (0.9 RPM) CW	Ref.
Y " Mtr. Speed (1.3 RPM) CW	Ref.
" I/F (Hubbell 7594) - (2) Plcs.	Ref.
Man. Dimmer Unit - MIII	6730-904670
ARTWORK/MASK/GEL: see Table 4-1	

4.17.2 THEORY OF OPERATION. Refer to the projector manual.

4.17.3 PREVENTIVE MAINTENANCE. Refer to the projector manual.

4.17.4 CORRECTIVE MAINTENANCE. Refer to the projector manual.

4.18 FX-26: FLYING CRAFT; SCENE 16.

4.18.1 DESCRIPTION. To add animation to the scenic wall, flying craft move across it. They are created with two HMI 2 x 2 Projectors (P-60, P-61). P-60 and P-61 are located in front of the setpiece. The projectors run continuously during the show day.

P-60 and P-61 consist of:

MAIN ASSEMBLY:	6730-910903
ASSEMBLY: 2 x 2 Unit (HMI-575) - Front	6730-909115
LAMP: 575 Watts TYPE: HMI Quartz (5600 K)	DAYMAX#DMI575 OSRAM#HMI 575W
LENS: 36" F.L. TYPE: Objective lens=14", Buhl	#830-140 6730-908683-3
Neg Lens= -50mm Assy	6730-910902
P.S. (Ballast) HMI (Modified)	6730-920838 Xetron#B1-575/C
ACCESSORIES:	
Stand (Projector) - Std Yoke/Base	6730-901884
Plate, Floor Mounting (2x2)	6730-908500
Power Cord x 6' (P.S. to 2x2)	6730-920797-1
Osc. Mirror Unit (10"w x 6"h) - Constant	6730-909999-3
" " " Speed (1.0 RPM) CW	Ref.
" " " 'J' Box (Hubbell #7974)	6730-906983-2
ARTWORK/MASK/GEL: see Table 4-1	

4.18.2 THEORY OF OPERATION. Refer to the projector manual.

4.18.3 PREVENTIVE MAINTENANCE. Refer to the projector manual.

4.18.4 CORRECTIVE MAINTENANCE. Refer to the projector manual.

4.19 FX-27: LIGHTS ON HELIUM CLOUD COVERS; SCENE 16.

4.19.1 DESCRIPTION. This effect provides the blinking warning lights on the helium cloud covers. They are created with a Mini Fiber Optic Illuminator (FXP16-1) with constant run disc drives (made by MAPO) and fiber optic display. The illuminator runs continuously during the show day. It is located behind the painted scenic wall.

FXP16-1 consists of:

ASSEMBLY: Mini Fiber Optic Illuminator, Type 1	MAPO A7-90-A598-2
LAMP: 10 watt	G.E. 2604-X
ACCESSORIES:	
Rotating Disc	
ARTWORK: see Table 4-1	

For more information, refer to paragraph 4.9, FX-16.

4.20 FX-71: PANTRY FREEZER; SCENE 17.

4.20.1 DESCRIPTION (refer to Figure 4-5). The illusion of the pantry freezer's coldness is enhanced by escaping "frosty air" from the drawer while opened. It is generated by a Type 1 Solid State Fog Box. The fog is produced continuously during the show day. Mineral-free water is supplied by the DI water cartridges. A PAR lamp behind the freezer drawer highlights the fog. The lamp is lit only when the drawer is open. The drawer's opening and closing are show controlled.

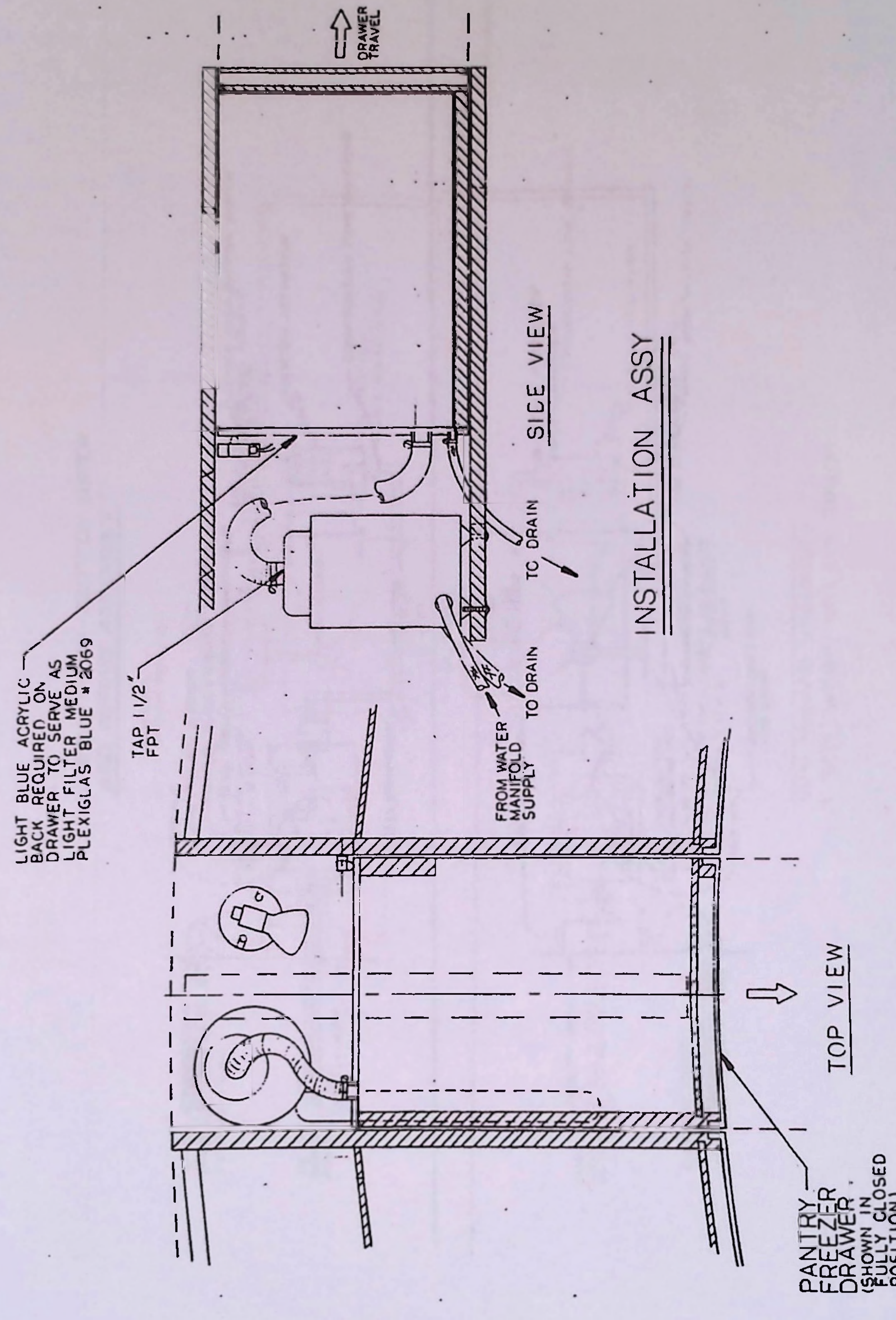


Figure 4-5 Pantry Freezer
Sheet 1 of 2

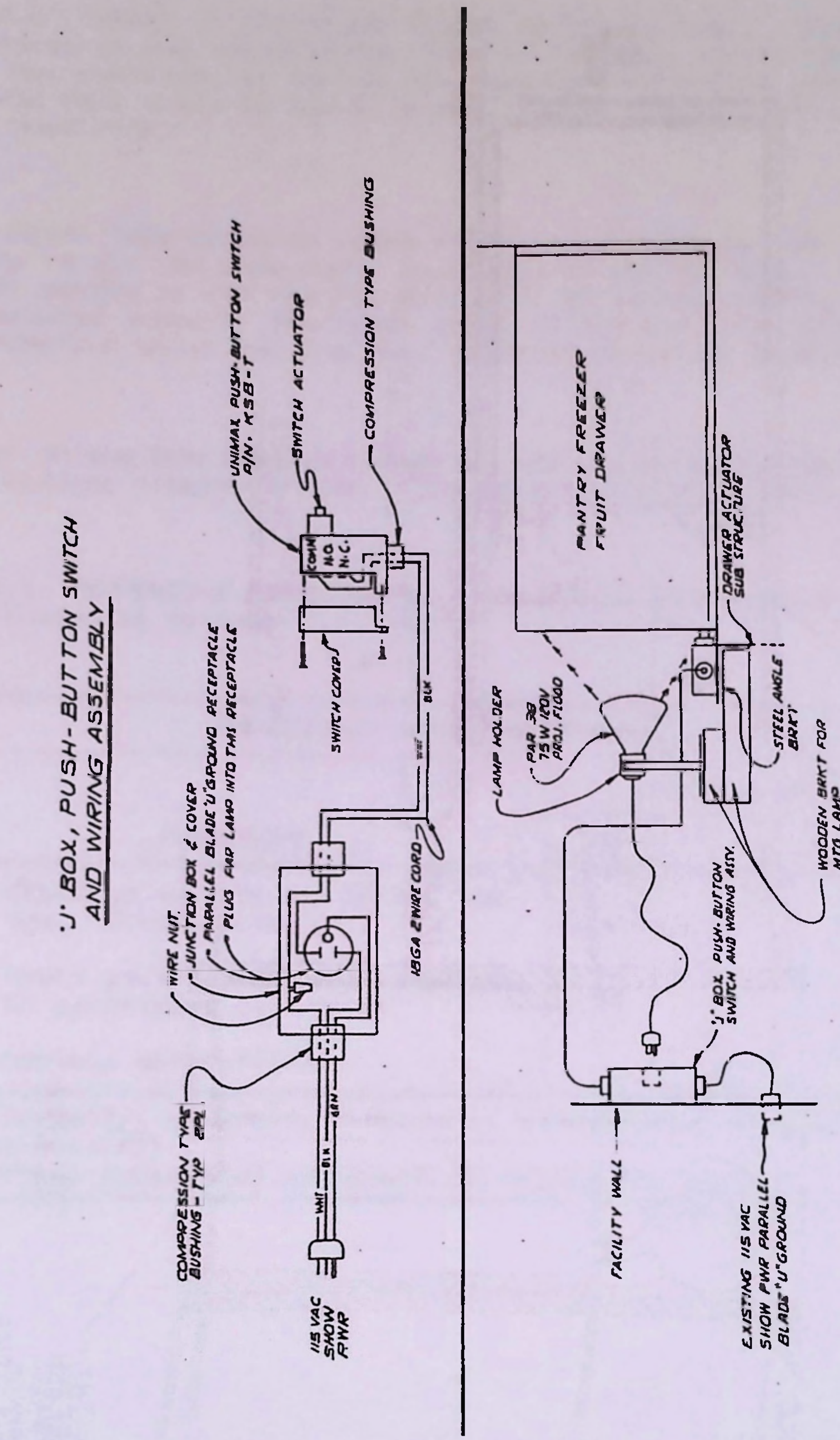


Figure 4-5 Pantry Freezer
Sheet 2 of 2

4.20.2 THEORY OF OPERATION (refer to Figure 4-6). "Frosty air" is produced by one Solid State, Type 1, Fog Box. Water flows to the fog box continuously during the show day. The flow rate is adjusted by the ball valve to about .1 gph. Water pressure is adjusted at the regulator.

The water feed solenoid valve (normally closed) is open as long as there is 115 vac show power available to the HOA box. A "water low" float switch in the fog box shuts off 48 vac to protect the transducer whenever the water level is too low. For more information about the fog box, refer to paragraph 4.20.4.

Power to the PAR lamp is turned on and off by a microswitch behind the sliding freezer drawer. The lamp is lit when the drawer is open.

4.20.3 PREVENTIVE MAINTENANCE. Preventive maintenance procedures are listed as follows.

PREVENTIVE MAINTENANCE SERVICE SCHEDULE

PROCEDURE	SERVICE INTERVAL*						
	REF**	D	W	M	Q	SA	A
1. Check water flow in Type 1 fog box. Clean as needed.	4.20.4.2			X			
2. Check purity indicator; replace DI cartridges as needed.				X			
3. Replace water filter.					X		

*D=Daily, W=Weekly, M=Monthly, Q=Quarterly, SA=Semi-annually, A=Annually
**See referenced paragraph or figure for details

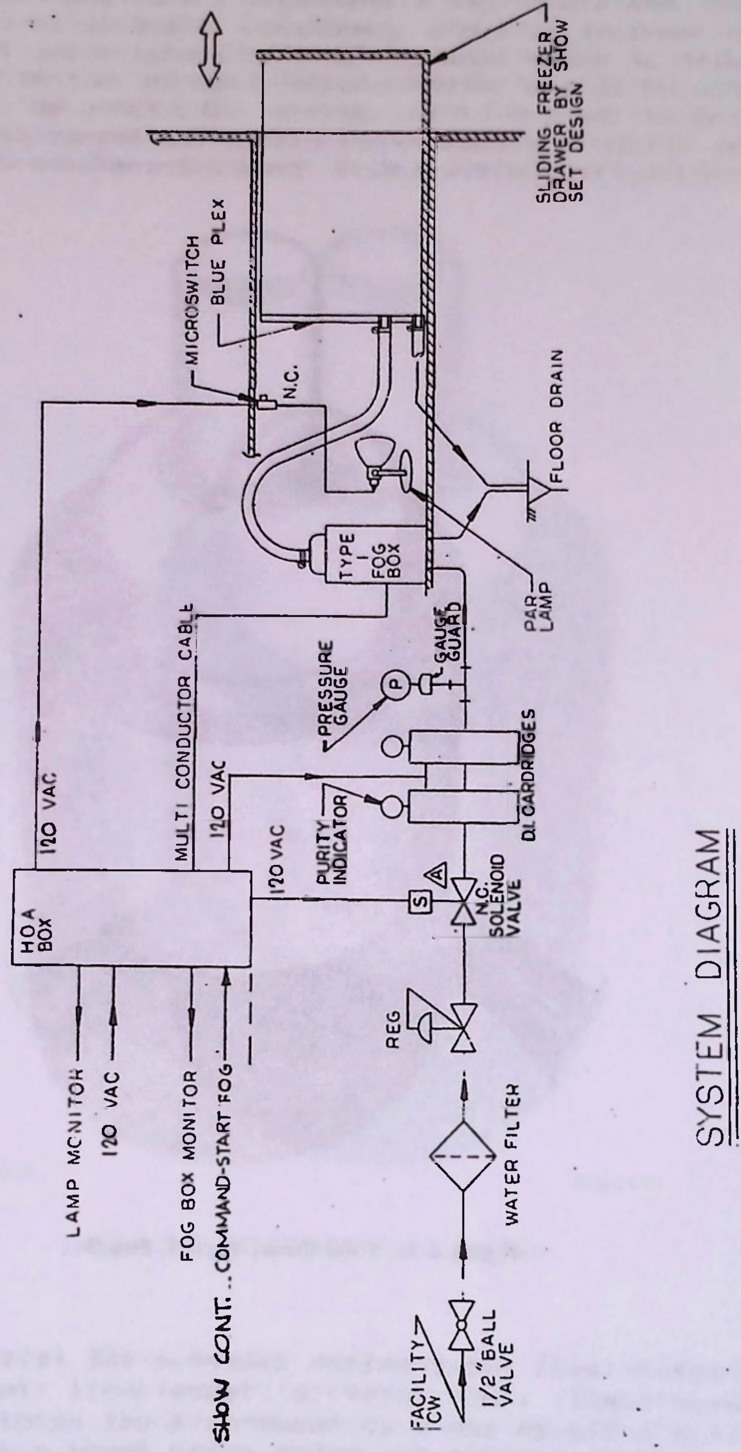
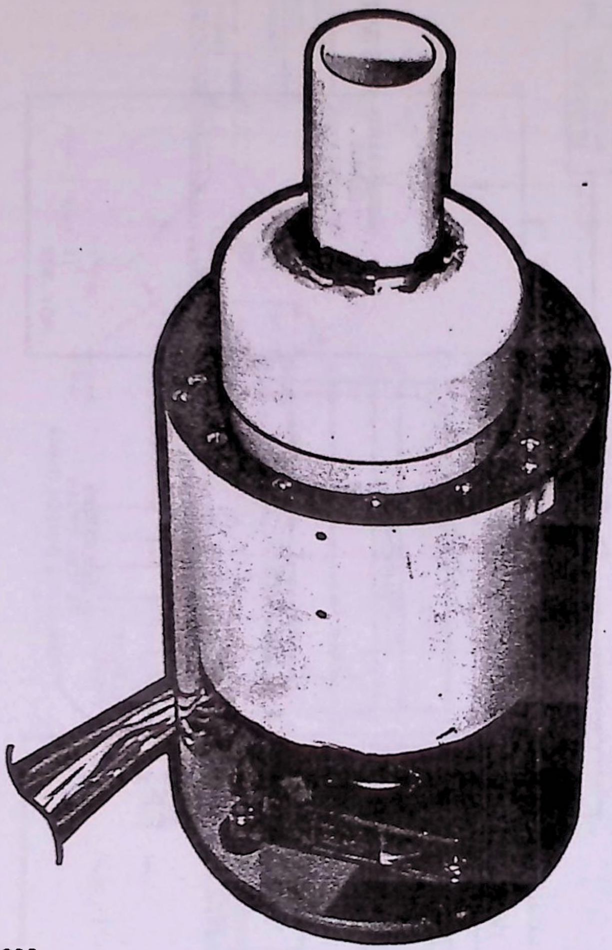


Figure 4-6 System Diagram

4.20.4 SOLID STATE TYPE 1 FOG BOX MAINTENANCE (refer to Figure 4-7). The Type 1 fog box is the smallest of the solid-state fog boxes. It consists of one transducer, a fan, two float switches (high and low level), and a standpipe. The body is made of clear acrylic with an inner tube of PVC that contains the transducer. The fan is mounted on the bottom blowing upwards to channel the fog out the opening at the top of the device. The fan also cools the transducer which is necessary to extend the transducer's life. 48 vac is supplied to the transducer from a transformer at the HOA box.



R543-026

Figure 4-7 Solid State, Type 1, Fog Box

The high water level float switch operates the fill solenoid valve in the water supply line (refer to Figure 4-8). The low water level float switch protects the transducer by shutting off the transistor (TR) when the water level drops below the minimum depth in the fog box's water chamber.

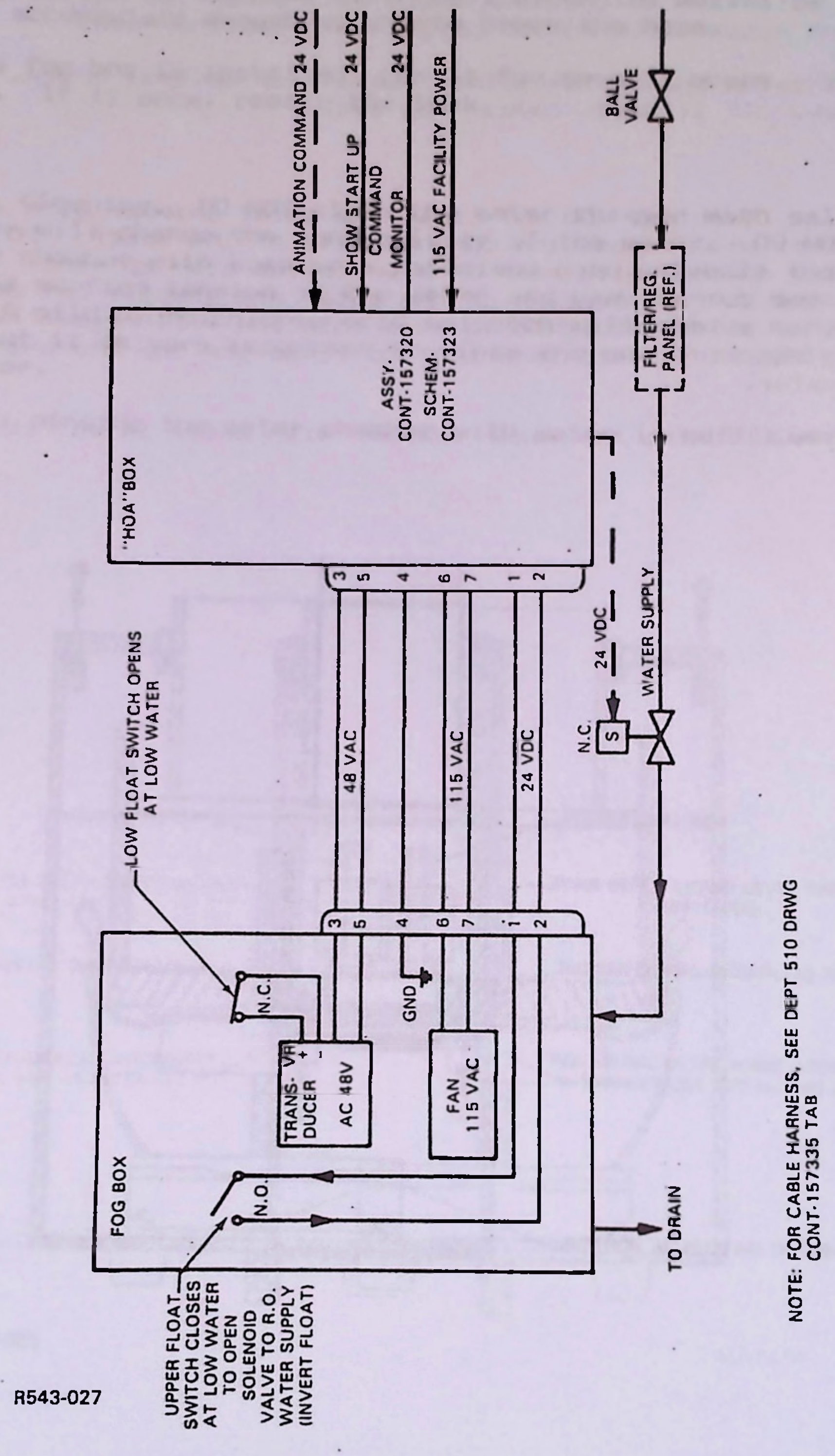


Figure 4-8 Type 1 System Diagram

4.20.4.1 Installation. The flexadux hose used to supply fog to the show area must not sag. If any sags or low spots are present, a puddle will form in the hose which will block the outlet of fog. It may also accummulate enough weight to break the hose.

After the fog box is installed, run it for several hours. It should not leak. If it does, repair the leak.

4.20.4.2 Cleaning. DO NOT clean the water chamber with salt or acid; they will change the conductivity of the water. DO NOT clean the water chamber with soap or a petroleum base solvent; they will change the surface tension of the water and greatly cut down the fog output. A mild hydrolchloric acid solution will remove hard water stains, but it is very important to rinse the box thoroughly with fresh water.

Generally, rinsing the water chamber with water is sufficient.

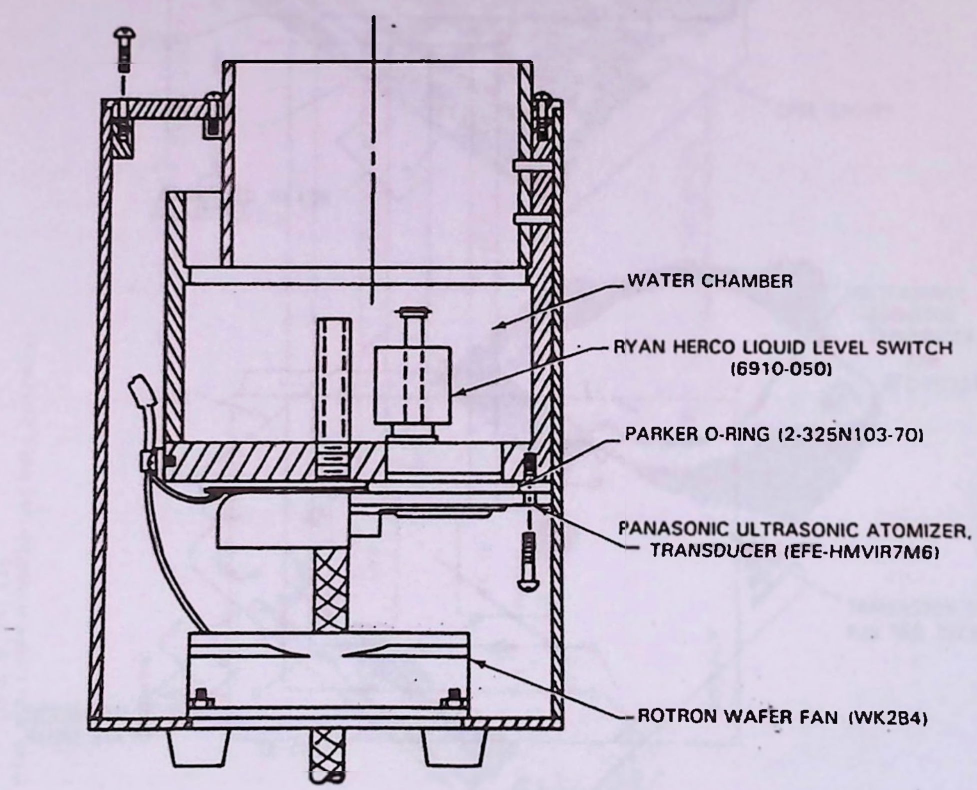


Figure 4-9 Type 1 Cut-a-way

4.20.4.3 Transducer Unit (PART NO. EFE-HMVIR7M6E). Refer to Figure 4-10.

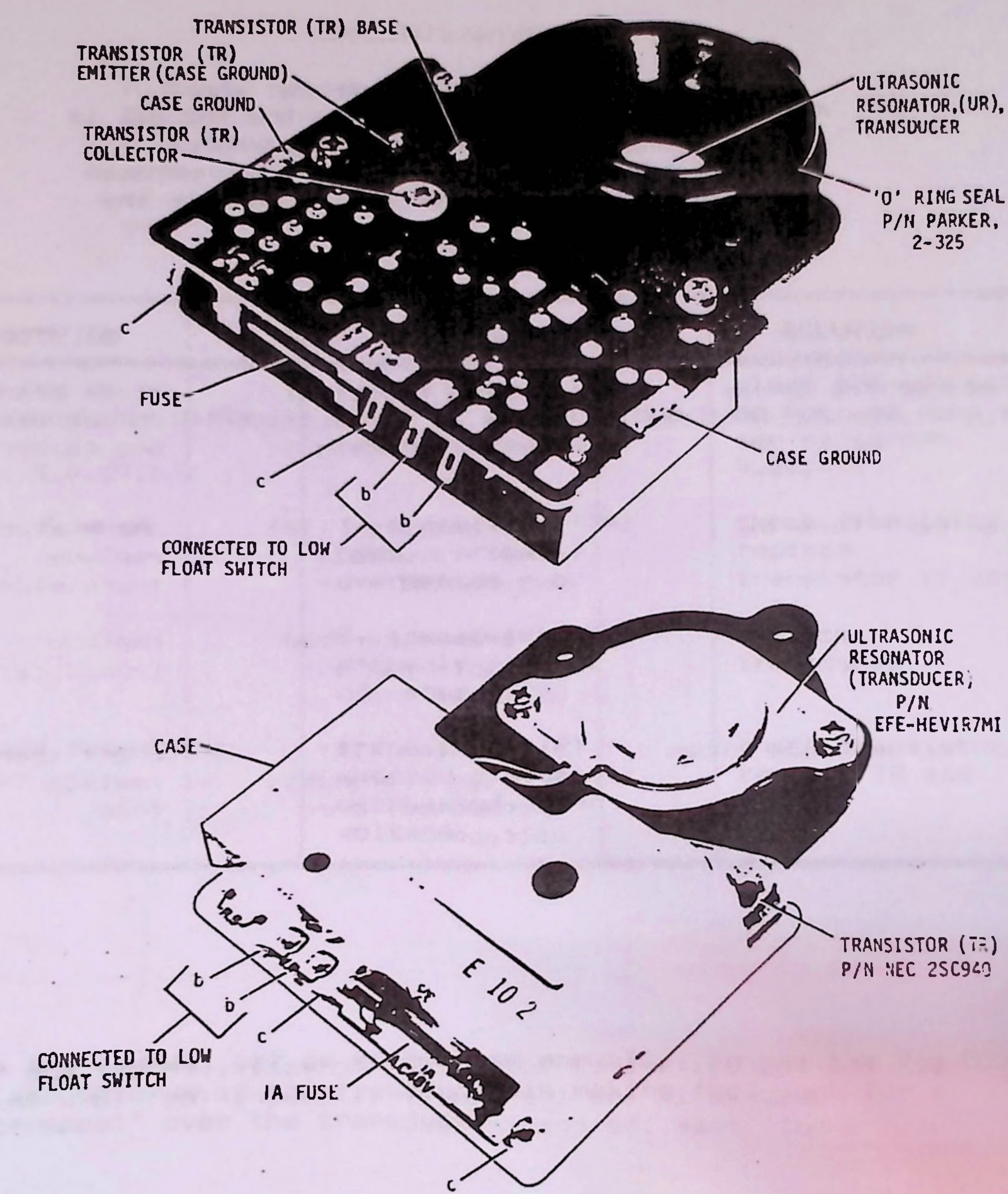


Figure 4-10 Transducer Unit

4.20.4.3.1 Troubleshooting Procedure. Refer to the troubleshooting chart, the steps that follow it, and Figure 4-11.

Troubleshooting Chart

WARNING:

Although it isn't an electrical shock, touching the tank water when the fog box is operating will give you an unpleasant sensation and may burn your finger because of the ultrasonic energy flux through the water.

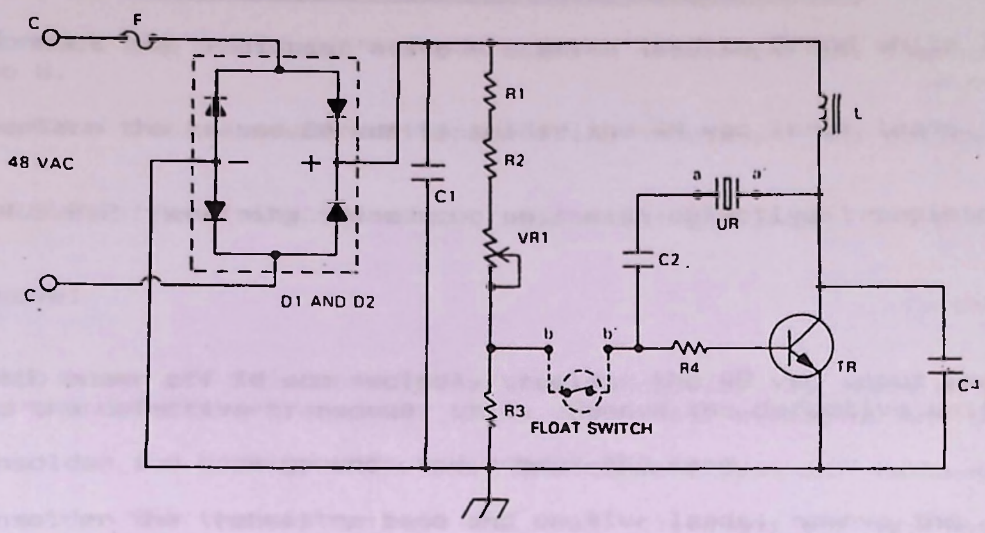
SYMPTOM	POSSIBLE CAUSE	SOLUTION
reduced fog or no fog - transducer dirty	mineral deposits; check if DI cartridge needs replacing	clean transducer: do not use soap - see paragraph 4.20.4.2
no fog - fuse ok	1. transistor (TR) open - probably overheated - or	check transistor replace transistor if bad
	2. transducer bad - probably ran out of water	replace transducer
no fog and fuse blown	transistor (TR) shorted - probably overheated, over voltage	check transistor replace TR and fuse

a. With the fog box set up to operate normally, remove the fog box lid and observe if the transducer is making fog: look for a "waterspout" over the transducer.

b. First, try cleaning the transducer. Remove power from the box. Then wipe the transducer with tissue in a circular fashion. Reapply power to the box and again note if the transducer is still not making fog.

c. Again, remove power from the box. Drain the water from the box. Check the transducer's fuse. If the fuse is ok, check for an open transistor. This will happen if overheated. To check for an open transistor, check the emitter, base, and collector resistance. This procedure can be done with the transistor in the circuit.

However, if the fuse is blown, the transistor will usually be shorted. To confirm that the transistor is bad, check the resistance between its emitter and collector. If resistence is low in both directions, replace the transistor.



C1: .22 μF
C2: .22 μF
C3: .03 μF
C4: .001 μF

R1: 1.5kΩ
R2: 1.5kΩ
R3: 470Ω
R4: 3.9Ω

D1 AND D2: FULL WAVE RECTIFIER, 2A
F: 1A
L: 64 μH
TR: NEC 2SC940

UR: ULTRASONIC RESONATOR (TRANSDUCER), EFE-HEVIR7MI
VR1: 500Ω
VR2: CONNECTED TO LOW FLOAT SWITCH

R543-038

Figure 4-11 Transducer Unit Schematic

4.20.4.3.2 Repair. Most of the time it will be effective to remove the defective transducer unit and replace it with a good one. Then repair the bad one at the shop.

4.20.4.3.2.1 Repairing transducer unit with defective transducer.

To Remove (NOTE: it is not necessary to remove the transducer unit from the fog box to replace a defective transducer):

a. With power off (disconnected), unsolder the 48 vac input leads to the defective transducer unit. Remove the defective unit.

b. Disconnect the transducer leads; remove the defective transducer.

To Replace:

a. Replace transducer.

> **WARNING:**
>
> ELECTRICAL SHOCK HAZARD. Failure to reconnect the transducer (UR) leads correctly as marked will place 150 volts peak-to-peak at the tank water.

b. Connect the transducer's leads - green lead to G and white lead to W.

c. Replace the transducer unit; solder the 48 vac input leads.

4.20.4.3.2.2 Repairing transducer unit with defective transistor.

To Remove:

a. With power off (disconnected), unsolder the 48 vac input leads to the defective transducer unit. Remove the defective unit.

b. Unsolder the case grounds and remove the case.

c. Unsolder the transistor base and emitter leads; remove the defective transistor.

To Replace:

a. Sparingly coat the bottom of a good transistor with heat sink compound. With the transistor's insulator in place, seat the transistor on the circuit board.

b. Solder the transistor's leads and clip.

c. Replace the transducer unit's case and solder it in place.

d. Replace the transducer unit; solder the 48 vac input leads.

4.21 FX-33: WELDING; SCENE 19.

4.21.1 DESCRIPTION. Welding sparks fly off the "laser welding" torch held by the boy repairing the submarine. It is created with a Xenon Fiber Optic Illuminator (P-62) and fiber optic displays. P-62 is located at the rear of the setpiece. The illuminator is in show sync.

P-62 consists of:

ASSEMBLY: Fiberoptics Unit (Xenon)	6730-908131-11
LAMP: 300 Watts TYPE: Xenon Lamp	ILC#LX300F
Lamp Holder	6730-905082
P.S. Unit (Xenon)	6730-906960
ACCESSORIES:	
Motor Drive Unit - Indexing (52 RPM)	6730-902867-112
Dual Optical Assy - (4.0 RPM)	6730-909773
" " Mirror Assy	Ref.
2 Fiber Mounting Ring: 10.0" D	6730-908168-5
Plate, Floor Mounting (Xen. Fib. Opt.)	6730-908501

This Unit interfaces with Fiber Bundles
ARTWORK/MASK/GEL: none

4.21.2 THEORY OF OPERATION. Refer to the projector manual.

4.21.3 PREVENTIVE MAINTENANCE. Refer to the projector manual.

4.21.4 CORRECTIVE MAINTENANCE. Refer to the projector manual.

4.22 FX-36: WATER RIPPLES; SCENE 19.

4.22.1 DESCRIPTION. The painted senic is animated with the projected water ripples. They are created with two Incandescent 5 x 5 Projectors (P-63, P-64). Both are located by the setpiece: P-63 on the right side and P-64 on the left side. The projectors run continuously during the show day.

P-63 and P-64 consist of:

MAIN ASSEMBLY:	6730-911000
ASSEMBLY: 5 x 5 Unit - Front Throw	6730-907671
LAMP: 2000 Watts TYPE: Tungsten Halogen	6240-594504
LENS: 8.5" TYPE: Buhl	#834-85
Condenser B(6" x 12" F.L.)	6730-907675-2
(10x10) Lamp/Blower Module - MIII	6730-904689
ACCESSORIES:	
Stand (Projector) - Tilting 3" h	6730-909320
Triple Plate Osc. Unit - Constant	6730-908601-1
" " " - Mtr Spd (3.0 RPM) CW	Ref.
Fan Unit (Artwork Cooling)	6730-908932-1
ARTWORK/MASK/GEL: see Table 4-1	

4.22.2 THEORY OF OPERATION. Refer to the projector manual.

4.22.3 PREVENTIVE MAINTENANCE. Refer to the projector manual.

4.22.4 CORRECTIVE MAINTENANCE. Refer to the projector manual.

4.23 FX-72: MYLAR WATER RIPPLE/REFLECTIONS; SCENE 20.

4.23.1 DESCRIPTION. It runs continuously during the show day.

P-65 and P-115 consist of:

ASSEMBLY: Water Ripple Unit (w/Mon.)	6730-910703-2
LAMP: 150 Watts TYPE: PAR (Blue Dichroic)	GE #150PAR/FL/B
ACCESSORIES:	
Baseplate (Part of Unit)	Ref.
Mon. Box Unit (5W)	6730-921312
" " Cable Assy. (5W) x 6'	6730-920995
Mylar w/Frame (by MAPO) 22"w x 20"h	Ref.
Fan Unit (by MAPO) -3W U Gnd.	Ref.
ARTWORK/MASK/GEL: none	

4.23.2 THEORY OF OPERATION. Refer to the projector manual.

4.23.3 PREVENTIVE MAINTENANCE. Refer to the projector manual.

4.23.4 CORRECTIVE MAINTENANCE. Refer to the projector manual.

4.24 FX-41: WATER RIPPLE; SCENE 22.

4.24.1 DESCRIPTION. To give an underwater look, water ripples are projected onto the sets and floor. They are created with eight HMI 5 x 5 Projectors(P-66, P-67, P-68, P-69, P-70, P-71, P-72, P-116). P-66, P-67, P-68, P-69, and P-116 are located in area #128. P-70, P-71, and P-71 are suspended in the under sea area. All of the projectors run continuously during the show day.

P-66, P-67, P-68, P-69, P-70, P-71, and P-72 consist of:

MAIN ASSEMBLY:	6730-911001
ASSEMBLY: 5x5 Unit (HMI 1200) Front	6730-909208-2
LAMP: 1200 watts TYPE: HMI Quartz (5600)	DAYMAX#DMI 1200
	OSRAM#HMI 1200W
LENS:	
P-66 - P-69: 8.5" Buhl	#834-85
P-70 - P-72: 4.5" Buhl	#271-020
Lens Sleeve	6730-909784
P-116: 14" Buhl	#834-140
Condenser B (6" x 9"/12" F.L.)	6730-907675-2
P.S. (Ballast) HMI (Modified)	6730-920839
	Xetron#B1-1200/C
ACCESSORIES:	
Stand (Projector)	6730-910708-3
Power Cord x 15' (PS to 5x5)	6730-920797-2
Fan Unit (Artwork Cooling)	6730-908932-1
19" Rim Disc (Dual) - Constant	6730-908777-6
" " " A (F)-(0.5 RPM) CW (Mtr.=2.8 RPM)	Ref.
" " " B (R)-(1.5 RPM) CCW (Mtr.=9.0 RPM)	Ref.
" " " I/F - (Hubbell 7974) - 2 Placs.	Ref.
Electrical 'J' Box (Hubbell #7594) - 1 Reqd.	6730-909526-1
10"x10" @ 45 degree Beam Diverter Mirror w/ Gimble Adj.	6730-909848-1
Gel Holder (Lens Mtd.)	Ref.
ARTWORK/MASK/GEL: see Table 4-1	

4.24.2 THEORY OF OPERATION. Refer to the projector manual.

4.24.3 PREVENTIVE MAINTENANCE. Refer to the projector manual.

4.24.4 CORRECTIVE MAINTENANCE. Refer to the projector manual.

4.25 FX-42: RESTAURANT DOME WINDOWS; SCENE 22.

4.25.1 DESCRIPTION. Each window has two concave acrylic domes with resin sandwiched between them for a little bit of lensing action as if you're looking through water at the people in the restaurant.

4.25.2 CLEANING INSTRUCTIONS. Clean with Type A-57 Plexiglass Cleaner (or equivalent) available from Orco Plastics. Follow instructions on the label.

Many transparent or mirrored surfaces use Plexiglass brand acrylic or Lexan brand polycarbonate sheeting. These surfaces should NOT be treated as glass; cleaning these surfaces too frequently or with the wrong solvent will leave the material scratched or cloudy.

To clean the acrylic or polycarbonate material, the surface should first be dusted very lighty (NOT WIPED) with a soft, clean cloth. Then the surface can be rinsed with water or a solution of mild non-abrasive detergent and water. A soft, grit-free cloth, sponge, or chamois may be used, but only as a means of carrying water to the plastic -- do NOT rub or "squeegee" the surface.

Grease, oil, food, and chewing gum may be removed with kerosene, VMP grade naptha, or isopropyl alcohol. To remove paint splatters from acrylic, use a 50/50 mixture of VMP grade naptha and Lacryl 205-T or solvent 100, or use a 10 - 20% solution of caustic soda or trisodium phosphate. To remove paint or caked-on substances on polycarbonate sheeting, use butyl cellosolde. The household cleaner "Formula 409" cantains a small amount of butyl cellosolde and works well to clean Lexan. Rinse any solutions off with water to prevent film deposits on the surface.

Do NOT use solvents such as acetone, benzine, carbon tetrachloride, fire extinguisher fluid, dry cleaning fluid, hexane, gasoline, lacquer thinner, window sprays, or scouring compounds.

Clean the acrylic/polycarbonate surfaces only "on an as needed" basis - when dust or stains appear. Cleaning too frequently will result in a cloudy surface.

4.26 FX-43: DISTANT SUBS; SCENE 23.

4.26.1 DESCRIPTION. This effect enhances the scene by adding the animation of the moving submarines to the painted scenic wall. They are created with two HMI 2 x 2 Projectors (P-73, P-74). The projectors are in show sync.

P-73 and P-74 consist of:

MAIN ASSEMBLY:		6730-9109501
ASSEMBLY:	2 x 2 Unit (HMI-575) - Front	6730-909115
LAMP:	575 Watts TYPE: HMI Quartz (5600 K)	DAYMAX#DMI575 OSRAM#HMI 575W
LENS:	14" TYPE: Buhl	#834-140
P.S. (Ballast) HMI (Modified)		6730-920838 Xetron#81-575/C
ACCESSORIES:		
Stand (Projector) - Std Yoke/Base		6730-905157-5 6730-901884
Plate, Floor Mounting (2x2)		6730-908500
Power Cord x 6' (P.S. to 2x2)		6730-920797-1
'Cam Driven'	Mirror Assy (12"w x 6"h)	6730-910951-1
	Cam Dr. Mir./Douser	
" "	Elect. Control Assy. (1D)	6730-921481
" "	Mode Oper.:	
	P-73: 90 degree sweep in 52.5 Sec.	Ref.
	P-74: 90 degree sweep in 63 Sec.	Ref.
" "	Cable I/F (Pwr)	6730-906980
" "	Cable I/F (Douser)	6730-921492
Douser Assy.		6730-910983-2
ARTWORK/MASK/GEL: see Table 4-1		

4.26.2 THEORY OF OPERATION. Refer to the projector manual.

4.26.3 PREVENTIVE MAINTENANCE. Refer to the projector manual.

4.26.4 CORRECTIVE MAINTENANCE. Refer to the projector manual.

4.27 FX-46: RIPPLES ON ROCKWORK; SCENE 23.

4.27.1 DESCRIPTION. To give an underwater look, water ripples are projected onto the sets and floor. They are created with four HMI 5 x 5 Projectors (P-75, P-76, P-77, P-78). The projectors run continuously during the show day.

P-75, P-76, P-77, and P-78 consist of:

MAIN ASSEMBLY:	6730-911003-1
ASSEMBLY: 5x5 Unit (HMI 1200) Front	6730-909208-2
LAMP: 1200 watts TYPE: HMI Quartz (5600)	DAYMAX#DMI 1200 OSRAM#HMI 1200W
LENS: 8.5" Buhl	#834-85
Condenser B (6" x 9"/12" F.L.)	6730-907675-2
P.S. (Ballast) HMI (Modified)	6730-920839 Xetron#B1-1200/C
ACCESSORIES:	
Stand (Projector)	6730-910708-1
Power Cord x 15' (PS to 5x5)	6730-920797-2
Fan Unit (Artwork Cooling)	6730-908932-1
19" Rim Disc (Dual) - Constant	6730-908777-6
" " " A (F)-(0.5 RPM) CW (Mtr.=2.8 RPM)	Ref.
" " " B (R)-(1.5 RPM) CCW (Mtr.=9.0 RPM)	Ref.
" " " I/F - (Hubbell 7974) - 2 Placs.	Ref.
Electrical 'J' Box (Hubbell #7594) - 1 Reqd.	6730-909526-1
10"x10" @ 45 degree Beam Diverter Mirror w/ Gimble Adj.	6730-909848-1
Gel Holder (Lens Mtd.)	Ref.
ARTWORK/MASK/GEL: see Table 4-1	

4.27.2 THEORY OF OPERATION. Refer to the projector manual.

4.27.3 PREVENTIVE MAINTENANCE. Refer to the projector manual.

4.27.4 CORRECTIVE MAINTENANCE. Refer to the projector manual.

4.28 FX-47: RED WARNING LIGHTS IN KELP; SCENE 23.

4.28.1 DESCRIPTION. The senic is animated by the blinking red warning lights in the kelp. They are created with two Mini Fiber Optic Illuminators (FXP23-1, FXP23-2) with constant run disc drives (made by MAPO) and fiber optic displays. The are located behind the scenic wall. The illuminators run continuoulsy during the show day.

FXP23-1 and FXP23-2 consist of:

ASSEMBLY: Mini Fiber Optic Illuminator, Type 1	MAPO A7-90-A598-2
LAMP: 10 watt	G.E. 2604-X
ACCESSORIES:	
Rotating Disc	
ARTWORK: see Table 4-1	

For more information, refer to paragraph 4.9, FX-16.

4.29 FX-73: WATER RIPPLES; SCENE 24.

4.29.1 DESCRIPTION. To give an underwater look, water ripples are projected onto the sets and floor. They are created by an HMI 5 x 5 (P-82). P-82 runs continuously during the show day.

P-82 consists of:

MAIN ASSEMBLY:	6730-911003-2
ASSEMBLY: 5x5 Unit (HMI 1200) Front	6730-909208-2
LAMP: 1200 watts TYPE: HMI Quartz (5600)	DAYMAX#DMI 1200
	OSRAM#HMI 1200W
LENS: 8.5" Buhl	#834-85
Condenser B (6" x 9"/12" F.L.)	6730-907675-2
P.S. (Ballast) HMI (Modified)	6730-920839
	Xetron#81-1200/C
ACCESSORIES:	
Stand (Projector)	6730-910708-3
Power Cord x 15' (PS to 5x5)	6730-920797-2
Fan Unit (Artwork Cooling)	6730-908932-1
19" Rim Disc (Dual) - Constant	6730-908777-6
" " " A (F)-(0.5 RPM) CW (Mtr.=2.8 RPM)	Ref.
" " " B (R)-(1.5 RPM) CCW (Mtr.=9.0 RPM)	Ref.
" " " I/F - (Hubbell 7974) - 2 Placs.	Ref.
Electrical 'J' Box (Hubbell #7594) - 1 Reqd.	6730-909526-1
Slide Holder (6")	Ref.
ARTWORK/MASK/GEL: see Table 4-1	

4.29.2 THEORY OF OPERATION. Refer to the projector manual.

4.29.3 PREVENTIVE MAINTENANCE. Refer to the projector manual.

4.29.4 CORRECTIVE MAINTENANCE. Refer to the projector manual.

4.30 FX-49: BEAM BUILDER; SCENE 25.

4.30.1 DESCRIPTION. At the partially built space station, prefabbed "panels" are being generated and continuously move from the space ship to the station for assembly. They are created by an HMI 10 x 10 Projector (P-83) which is located at the top of the catwalk. P-83 runs continuously during the show day.

P-83 consists of:

MAIN ASSEMBLY:	6730-911007
ASSEMBLY: 10 x 10 Unit (HMI-1200) - Front	6730-909201-5
LAMP: 1200 Watts TYPE: HMI Quartz (5600 K)	DAYMAX#DMI 1200 OSRAM#HMI1200W
LENS: 14" TYPE: Buhl	#834-140
P.S. (Ballast) HMI	6730-920839 Xetron#81-1200/C
ACCESSORIES:	
Stand (Projector)	6730-903424-8
Power Cord x 15' (P.S. to 10x10)	6730-920797-2
9-1/2" Film Loop Unit (Long) perfed	6730-905100-
" " Artwork Speed (13"/min)	Ref.
" " Motor Speed (3 RPM)	Ref.
Gel Holder (Lens Mtd)	Ref.
ARTWORK/MASK/GEL: see Table 4-1	

4.30.2 THEORY OF OPERATION. Refer to the projector manual.

4.30.3 PREVENTIVE MAINTENANCE. Refer to the projector manual.

4.30.4 CORRECTIVE MAINTENANCE. Refer to the projector manual.

4.31 FX-51: STARFIELD; SCENE 25.

4.31.1 DESCRIPTION. Because the view is from space, the starfields do not blink or twinkle. They are created by eight Standard Fiber Optic Illuminators without disc motors (P-84, P-85, P-86, P-87, P-90, P-91, P-92, P-93) and fiber optic displays. P-84, P-85, P-86, and P-87 are located on the left side behind the scrim. P-90, P-91, P-92, and P-93 are located on the right side behind the scrim. The illuminators run continuously during the show day.

P-84, P-85, P-86, P-87, P-90, P-91, P-92, and P-93 consist of:

ASSEMBLY: Fiberoptics Illum. Unit	6730-905905-8
LAMP: 42 Watts TYPE: ENL	
Illum Unit	6730-905889
ACCESSORIES:	
No Motor Unit	6730-905994-1
Floor Mounting Assy. (Full Base)	6730-907661
Fiber Housing (1.0" D.) Bushing	6730-905910-1
GEL: see Table 4-1	

4.31.2 THEORY OF OPERATION. Refer to the projector manual.

4.31.3 PREVENTIVE MAINTENANCE. Refer to the projector manual.

4.31.4 CORRECTIVE MAINTENANCE. To service, loosen four allen head screws, lift the projector from the fiber optic plate. It is not necessary to disturb the fiber optic bushing. The fiber bundles are fragile, and, if damaged, are difficult to replace.

If further maintenance information is required, refer to the appropriate section of the projector manual.

4.32 FX-52: FLIGHT THRUSTERS, SCENE 25.

4.32.1 DESCRIPTION. At the incomplete space station, a construction worker moves a girder into position by using the propulsion from the thrusters of the "jet pack." The propulsion is visually enhanced by fog nozzle assemblies each with a lamp assembly. The thrusters are show controlled and in sync with the show action of the girder.

4.32.2 THEORY OF OPERATION. Fog is produced by the nozzle assemblies. Each thruster has one assembly. The nozzle requires air at about 80 psi and water at about 50 psi. Both the air and water lines to the "up" or "down" thrusters have show controlled solenoid valves. The production of fog begins once both the air and water solenoids are energized and air and water are present at the nozzles.

The up sequence is programmed as follows:

To start:

activate air to the lower nozzles
short delay
activate water to the lower nozzles
short delay
activate the lower ring lights
short delay
activate girder movement (up)

To stop:

deactivate lights
short delay
deactivate water to the lower nozzles
short delay
deactivate air to the lower nozzles
short delay
deactivate girder movement

The down movement is the same, except that the upper nozzles and associated lamps are activated and deactivated.

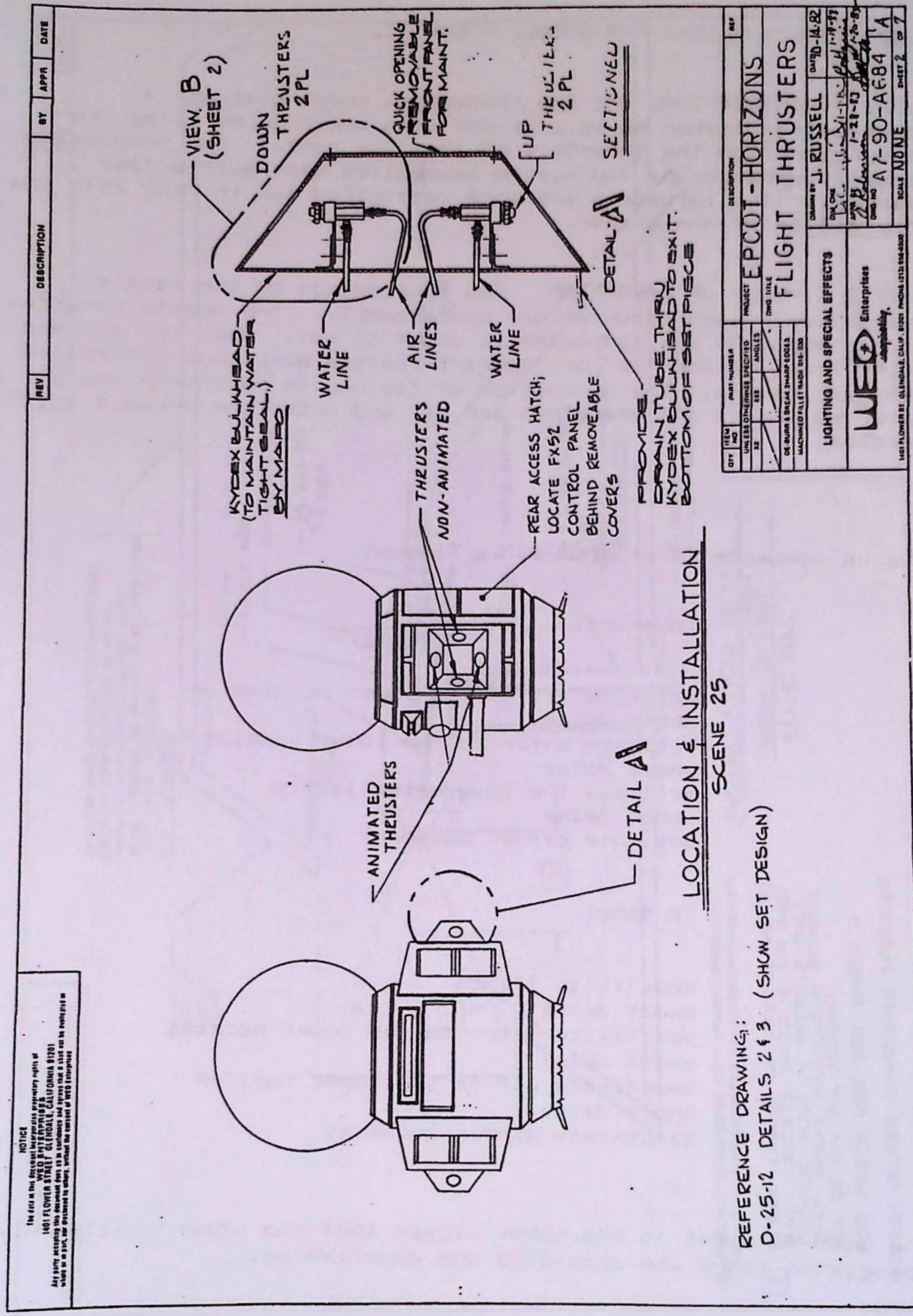


Figure 4-12 Flight Thrusters
Sheet 1 of 6

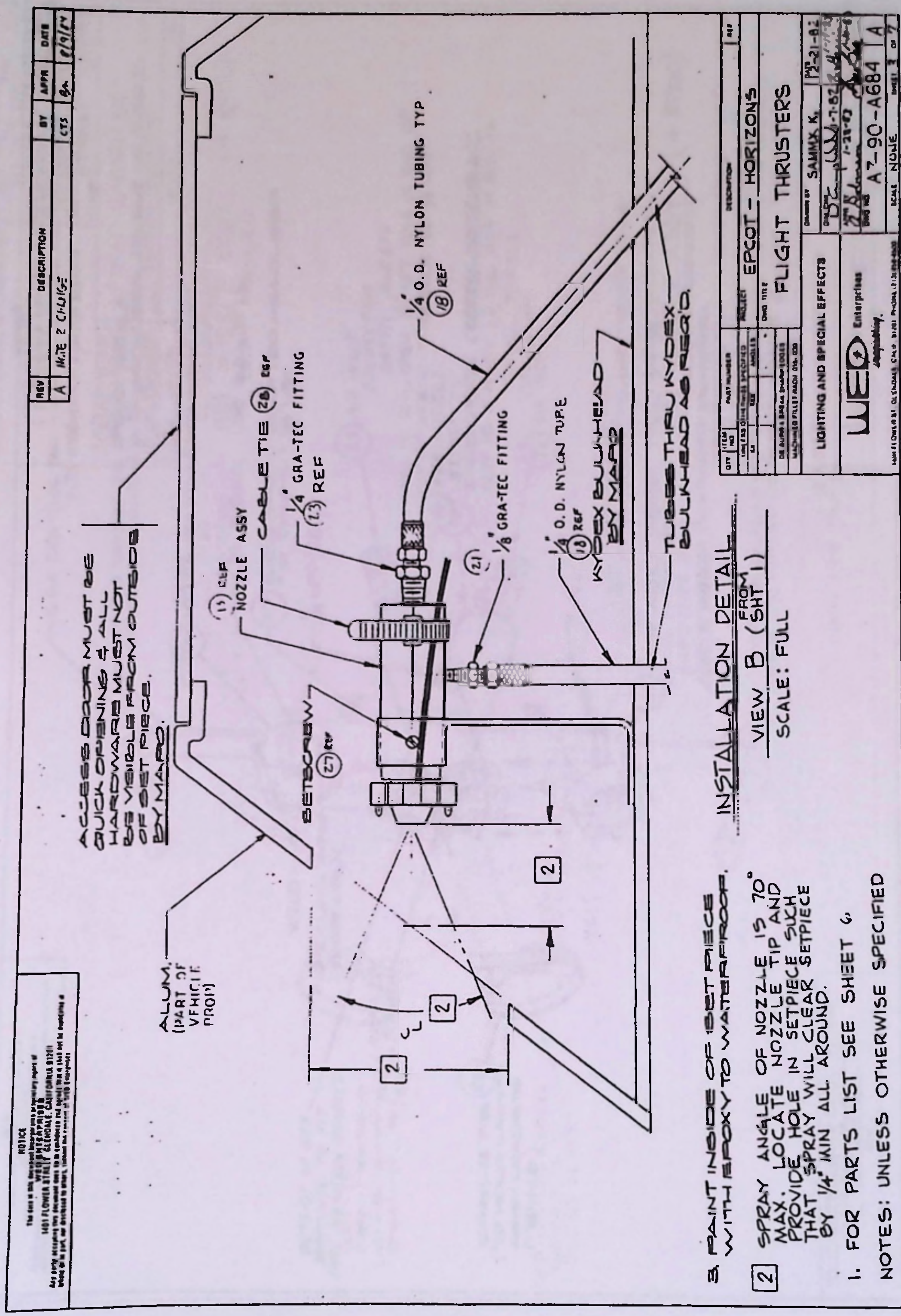


Figure 4-12 Flight Thrusters
Sheet 2 of 6

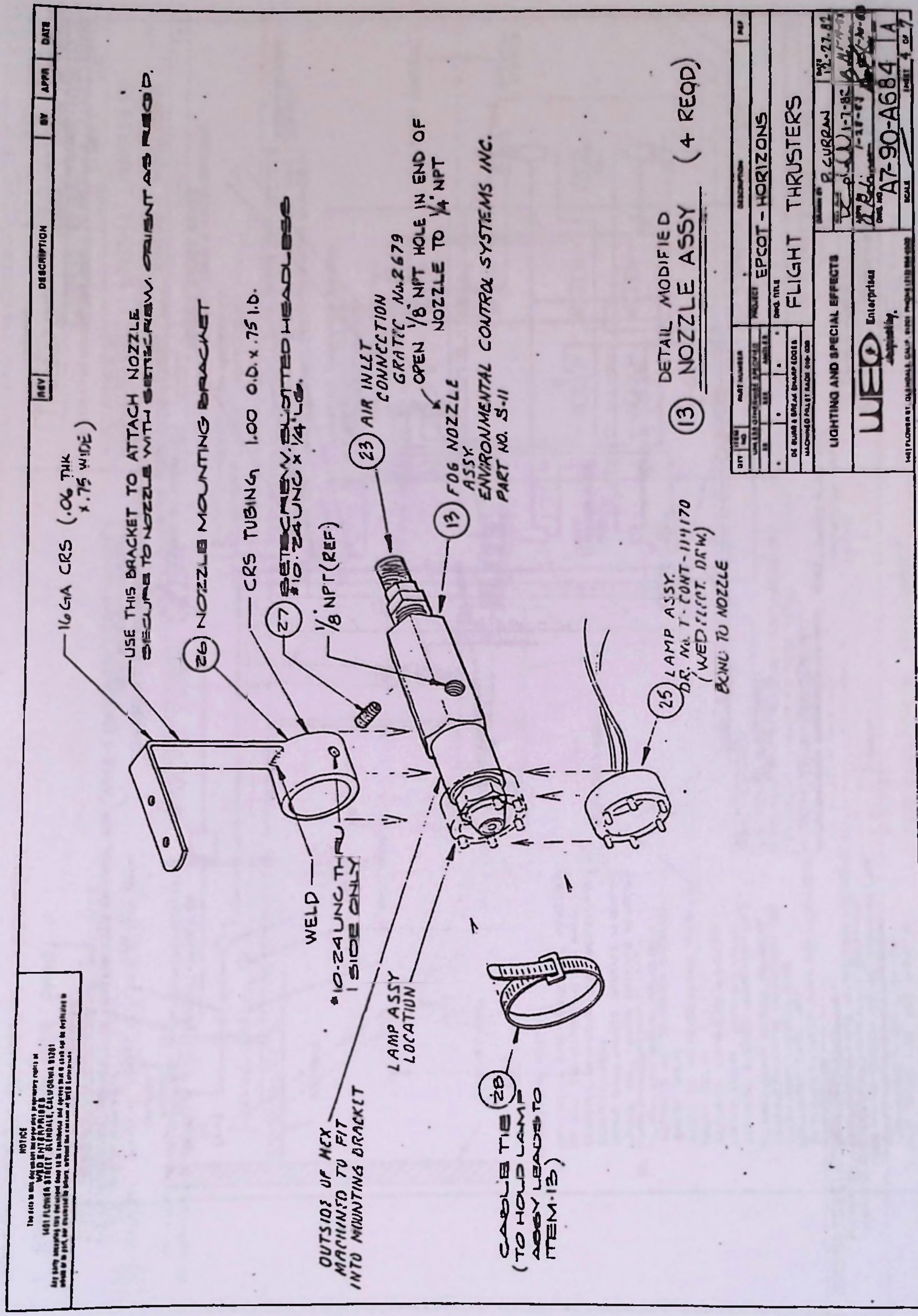


Figure 4-12 Flight Thrusters
Sheet 3 of 6

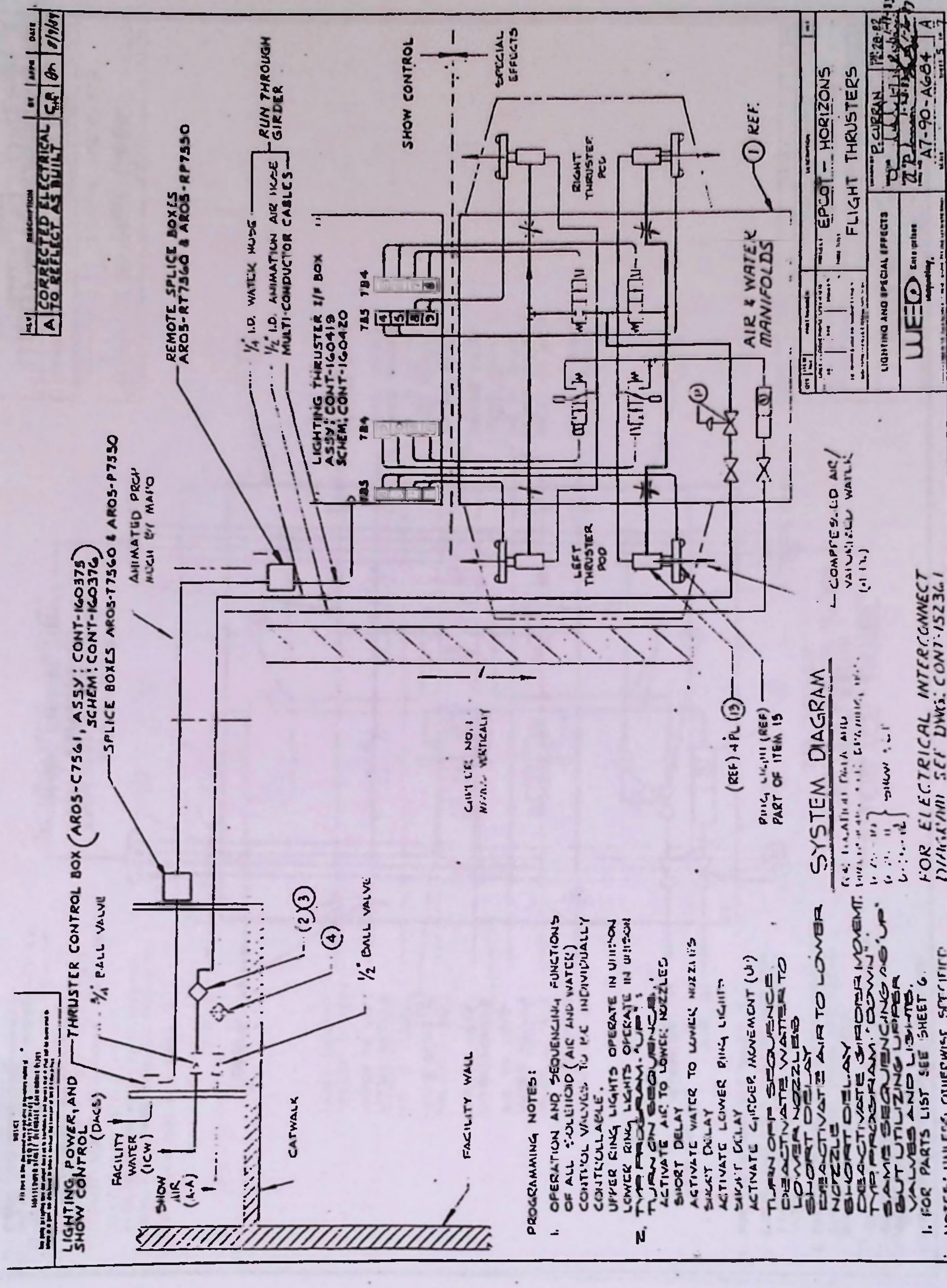


Figure 4-12 Flight Thrusters
Sheet 4 of 6

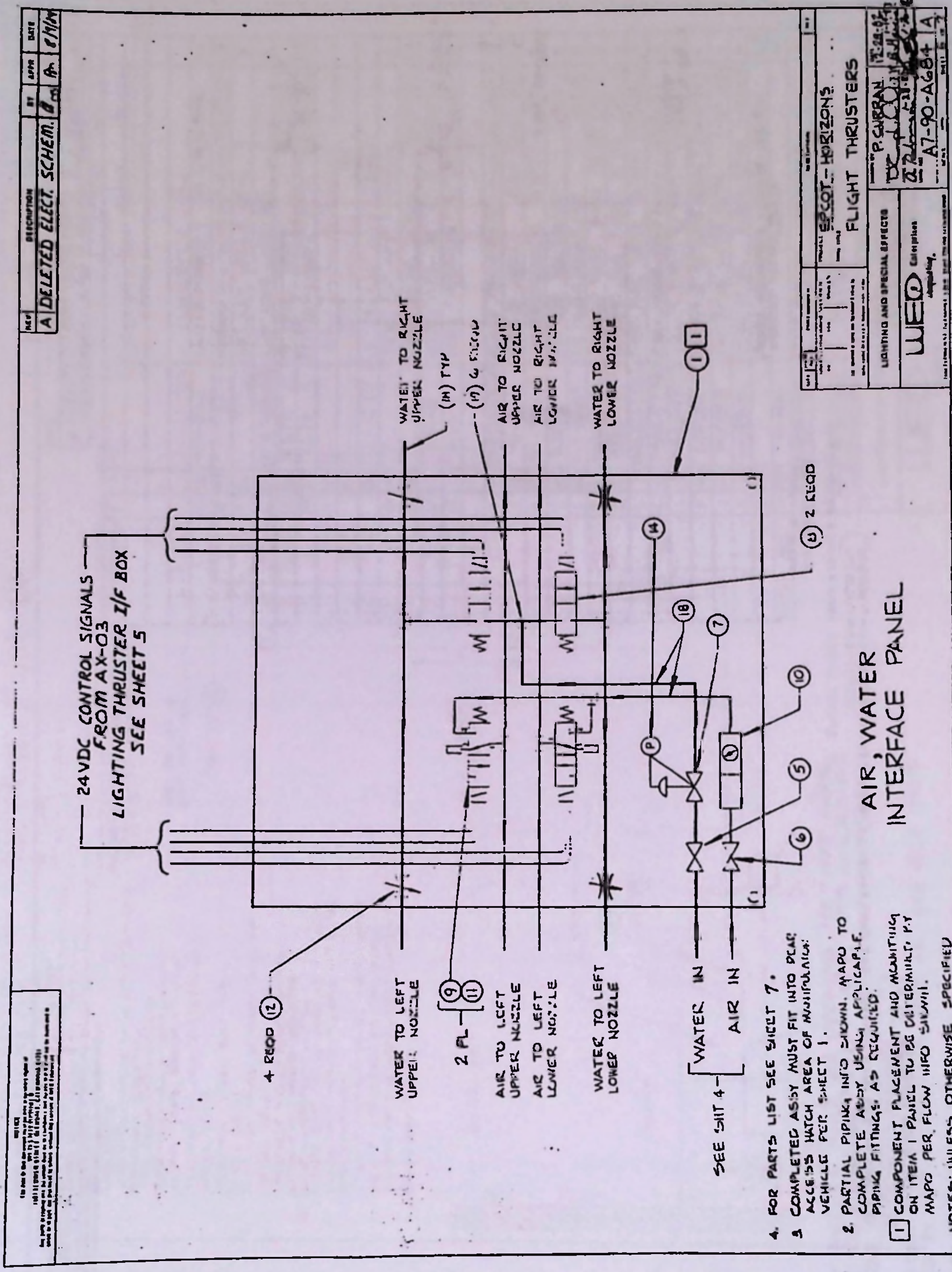


Figure 4-12 Flight Thrusters
Sheet 5 of 6

NOTICE
The data in this document incorporate proprietary rights of WED ENTERPRISES, 1401 FLOWER STREET, GLENDALE, CALIFORNIA 91201. Any party accepting this document does so in confidence and agrees that it shall not be duplicated in whole or in part, nor disclosed to others, without the consent of WED Enterprises.

REV	DESCRIPTION	BY	APPR	DATE
A	DELETED ITEMS 15, 20, 21, & 22 ADDED NOTE 2 & REF 5 TO ITEM 1	CP	Gn	3/9/84

WDP NO.	QTY	ITEM NO	PART NUMBER	DESCRIPTION	REF
	4	28	RTH 830	CABLE TIES ALL STATIONS	2,3
	4	27		SETSCREW, SLOT, HDLESS. #10-24 UNC x 1/4" LG	2,3
	1	26		BRACKET, NOZZLE MTG	3
[1]	AR	25	WDP NO. T-CONT-141120	LAMP ASSY (MODIFIED)	3
	AR	24	2673	FITTING, 1/8 NPT (GRA-TEC)	2
	AR	23	2679	FITTING, 1/4 NPT (GRA-TEC)	2,3
		22			
		21			
		20			
	6	19		TEE, 1/4" FPT	5
	AR	18		TUBING, NYLON, 1/4" O.D. (GRA-TEC)	2,5
	AR	17	831-8	HOSE, "PUSH-LOK" 1/2" I.D. (PARKER)	5
	AR	16	B31-4	HOSE, "PUSH-LOK" 1/4" I.D. (PARKER)	5
		15			
	1	14	[illegible]	GUAGE, PRESSURE, 1/4", 0-100 (GEN INST)	5
[2]	4	13	S-11	NOZZLE ASSY (ENV. CONT. SYS)	2,3,4
	4	12	SS-2MG4	METERING VALVE, 1/8" FPT (NUPRO)	5
	2	11	ASP-2	MUFFLER, AIR EXHAUST [illegible]	5
	1	10	04E11B18F	AIR FILTER/REGULATOR (PARKER)	5
	2	9	8300D58F	SOLENOID VALVE, 3-WAY 1/4" FPT (ASCO)	5
	2	8	8262C15	SOLENOID VALVE, 2-WAY, 1/8" FPT (ASCO)	5
	1	7	R43-201-NNLA	PRESS./REG, WATER 1/4" FPT (NORGREN)	5
	1	6	T-585-Y (3/8")	BALL VALVE, 3/8" FPT (NIBCO)	5
	1	5	T-585-Y (1/4")	BALL VALVE, 1/4" FPT (NIBCO)	5
	1	4	07F35A	AIR FILTER W/ AUTO DRAIN (PARKER)	4
	1	3	D-CCPB	CARTRIDGE, WATER FILTER (AMF-CUNO)	4
	1	2	44153-01	WATER FILTER MODEL CT-101 (AMF-CUNO)	4
	1	1		PANEL, MOUNTING, AL ALY .25 THK	4,5

UNLESS OTHERWISE SPECIFIED — .XX / .XXX / ANGLES
DE-BURR & BREAK SHARP EDGES
MACHINED FILLET RADII .015-.030

PROJECT: EPCOT- HORIZONS
DWG TITLE: FLIGHT THRUSTERS

LIGHTING AND SPECIAL EFFECTS
WED Enterprises imagineering
1401 FLOWER ST. GLENDALE, CALIF. 91201

DRAWN BY P. CURRAN 12/27/82
CHK 1-7-83
APPR 1-28-83
DWG. NO. A7-90-A684 A
SCALE — SHEET 7 OF 7

[2] MODIFY NOZZLE ASSY BY OPENING 1/8" NPT HOLE IN END OF NOZZLE TO 1/4" NPT, AND MACHINING OUTSIDE OF HEX TO FIT INTO MOUNTING BRACKET.

[1] MODIFICATION DETAILS OF ITEM 25 TO BE SPECIFIED BY WED SPCL EFFECTS DEPT 431. SEE ECF 31000

NOTES: UNLESS OTHERWISE SPECIFIED

Figure 4-12 Flight Thrusters
Sheet 6 of 6

4.32.3 PREVENTIVE MAINTENANCE. Preventive maintenance procedures are listed as follows.

PREVENTIVE MAINTENANCE SERVICE SCHEDULE							
	SERVICE INTERVAL*						
PROCEDURE	REF**	D	W	M	Q	SA	A
1. Replace filter cartridges				X			
2. Clean or replace air manifold filter					X		
3. Clean nozzles							X
a. Disassemble nozzles							
b. Clean in ultrasonic cleaning unit with a 6:1 solution of water and metal etching							

*D=Daily, W=Weekly, M=Monthly, Q=Quarterly, SA=Semi-annually, A=Annually
**See referenced paragraph or figure for details

4.32.4 CORRECTIVE MAINTENANCE. The fog nozzle is an efficient atomizer that uses soundwaves to explode liquids into a fine mist. It uses a resonator cup supported by wire legs to reflect the air stream shockwave exiting from the main body of the nozzle.

If the resonator cup is bent out of alignment or broken off, the nozzle should be replaced. In an emergency, the cup can be re-aligned by passing the nearest sized drill bit through the nozzle and lining up the cup with the drill.

Truobleshooting the nozzle:

If the nozzle pulses at low flow rates, there could be a loose fitting between the nozzle and the adapter or a leak in the water line or connection before it enters the nozzle.

If the nozzle dribbles or fails to atomize the water completely, it is either not getting enough air or the water is being delivered to it at too great of a rate. Check for restrictions in the air line and increase the air and/or valve down the liquid.

If the nozzle creates too much fog, it is either receiving too much air or being delivered too little water.

4.33 FX-54: BODY SCAN; SCENE 27.

4.33.1 DESCRIPTION. This effect simulates a patient's digitized body scan. The figure wipes on and off the screen. It is created with an HMI 5 x 5 Projector (P-94) with a static digital screen. P-94 runs continuously during the show day.

P-94 consists of:

MAIN ASSEMBLY:	6730-910546
ASSEMBLY: 5x5 Unit (HMI 1200) Front	6730-909208-2
LAMP: 1200 watts TYPE: HMI Quartz (5600)	DAYMAX#DMI 1200 OSRAM#HMI 1200W
LENS: 8.5" Buhl	#834-85
Condenser B (6" x 9"/12" F.L.)	6730-907675-2
P.S. (Ballast) HMI (Modified)	6730-920839 Xetron#B1-1200/C
ACCESSORIES:	
Stand (Projector)	6730-909320
Power Cord x 15' (PS to 5x5)	6730-920797-2
Fan Unit (Artwork Cooling)	6730-908932-1
6" Film Loop Unit (Short)	6730-910260-1
" " " - Speed (20.0"/Min.)	Ref.
" " Mtr. - Speed (60.0 RPM)	
ARTWORK/MASK/GEL: see Table 4-1	

4.33.2 THEORY OF OPERATION. Refer to the projector manual.

4.33.3 PREVENTIVE MAINTENANCE. Refer to the projector manual.

4.33.4 CORRECTIVE MAINTENANCE. Refer to the projector manual.

4.34 FX-55: BASKETBALL PLAYERS SHADOWS; SCENE 27.

4.34.1 DESCRIPTION. This effect projects the shadows of several players in a zero gravity basketball game. It is basically a point source light linebach projector (FXP27-1). For its "artwork" it uses floating figures and a ball moved about in a mixture of water and ethylene glycol. The figures move about continuously during the show day.

4.34.2 THEORY OF OPERATION. To move the basketball player figures, the fluid mixture (1.140 gallons of water and 1.0 gallons of ethylene glycol) is circulated by the centrifugal pump. Power to the pump, lamp, and fan is available thoughout the show day.

A float switch in the tank provides a low fluid level monitor. The lamp also has a monitor.

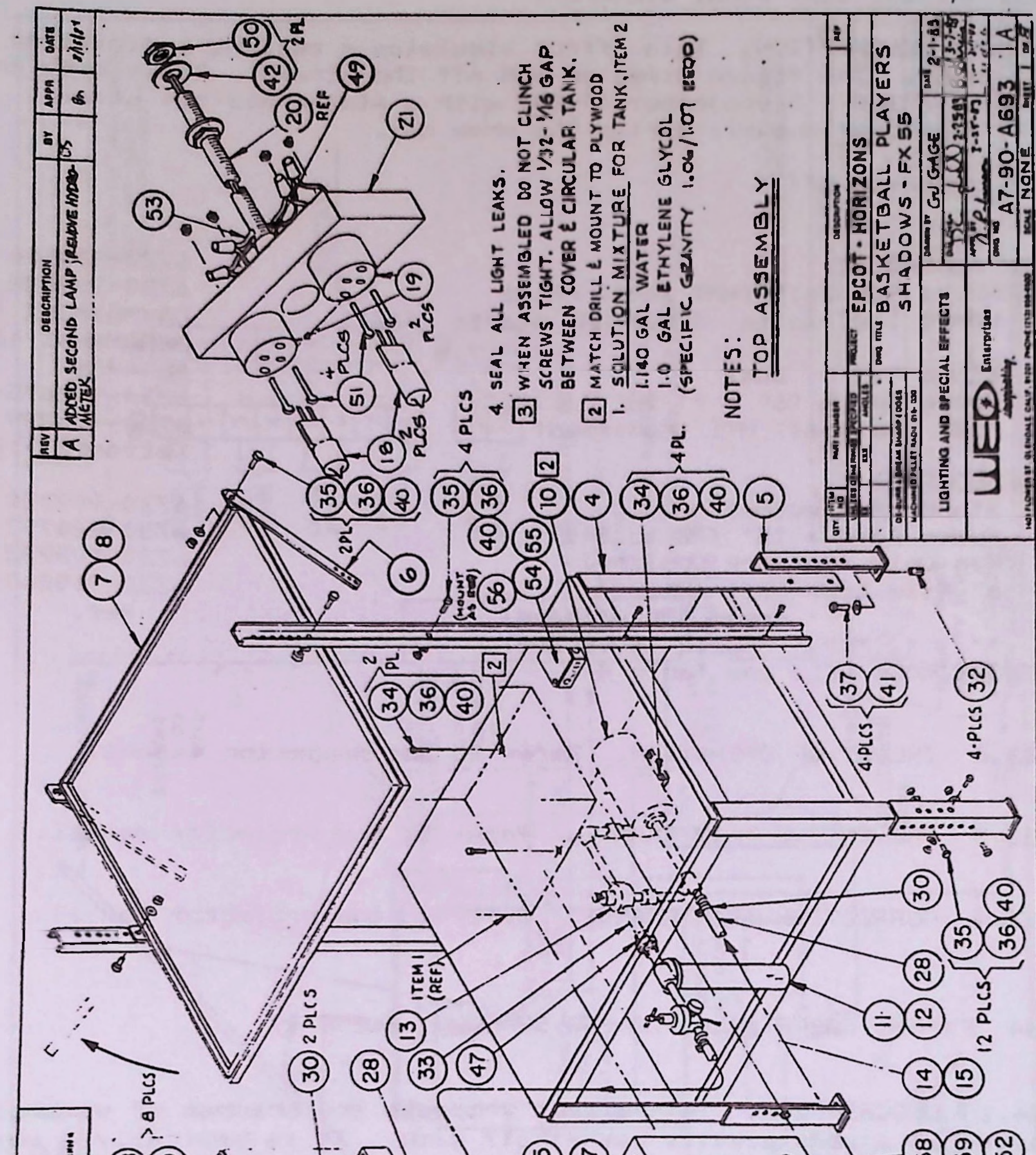


Figure 4-13 Basketball Players
Sheet 1 of 3

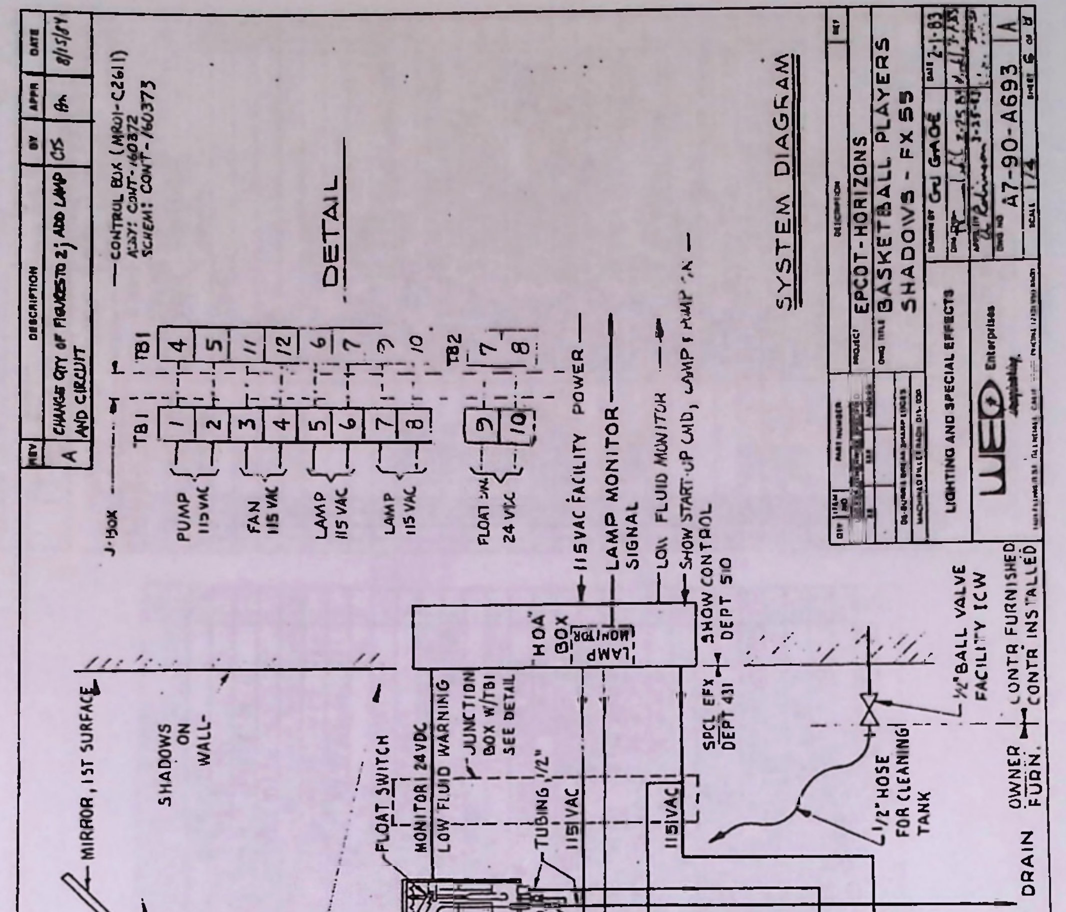


Figure 4-13 Basketball Players
Sheet 2 of 3

NOTICE
The idea in this document incorporates proprietary rights of
WED ENTERPRISES
1401 FLOWER STREET GLENDALE, CALIFORNIA 91201
Any party accepting this document does so in confidence and agrees that it shall not be duplicated in whole or in part, nor disclosed to others, without the consent of WED Enterprises.

REV	DESCRIPTION	BY	APPR	DATE
A	REMOVED ITEM 25; ADD NOTE 5; CHANGE QTY ON ITEMS 18,19,39,45(?) ADD ITEMS 9,17,23,27,29,31,33,44,48,&60	GTS	Bm	8/24/84

NOTE	QTY	ITEM NO	PART NUMBER	DESCRIPTION	REF
3. 2.	1	62		BASKETBALL SCULPTED	6
3. 2.	4	61		BASKETBALL PLAYER FIGURE,SCULPTED	6
	8	60		LOCKWASHER #10 SST	
	4	59		SPACER, 5/16 O.D.X #10 I.D.X 1"LG, ALUM.	4,1
	1	58		LIGHT SHIELD PL, FAN, 6" SQ.	4,1
	1	57		LIGHT SHIELD PLATE	4,1
	1	56	625-B	TERM. STRIP BUCHANAN FL BASE(OR EQUIV)	1,6
	1	55		COVER, "J" BOX, GALV.	1
	1	54		"J" BOX W/ KO'S, 4" SQ X 1 1/2 DP. GALV.	1
	A/R	53		WIRE, 14 GA	1
	4	52		SCREW, RD.HD # 8-32 X 1 1/4 LG W/NUT	4,1
	4	51		SCREW RD.HD # 5-40 X 1 LG W/ NUT	1
	2	50	NO. K0010	LOCKNUT, BRASS, 1/8 IPS, CRYSTAL LAMP	1
	1	49	NO. K0148	FLANGE, BRASS, 1/8 F, CRYSTAL LAMP	1
	2	48	37-20-101-20	TRAY FASTENER SOUTHCO INC.	1
		47	3858-005	UNION. 1/2" PVC RYAN-HERCO	1
	2	46		FITTING, BRASS, 1/2 MPT X 1/2" HOSE BARB	1
	1	45	0716-025	TEE, BARBED 1/2 X 1/2 X 1/2 RYAN-HERCO	1
	8	44		HEXNUT #10-32 SST	
	1	43	5309-102	LAB COCK VALVE, 1/4" THD X HOSE, RYAN-HERCO	1
4	2	42	91090A115	WASHER, FENDER, 3/8 X 1 1/2 O.D, ZINC PL.	1
	4	41		WASHER, FLAT, 3/8, GALV.	1
	28	40		WASHER, FLAT, 1/4, GALV.	1
	24	39		WASHER, FLAT # 10 SST	1
	8	38		SCREW, MACHINE, RD.HD, #10-24 SST	1
	4	37		BOLT, HEX HD, 3/8-24 X 1 1/4 LG SST	1
	28	36		LOCKNUT, 1/4-20	1
	22	35		SCREW, MACHINE, HEX. HD, 1/4-20 X 1" LG	1
	6	34		SCREW, HEX.HD, 1/4-20 X 1 1/4 LG	1
	A/R	33		PIPE. PVC SCHED. 40. 1/2"	1

NOTE	QTY	ITEM NO	PART NUMBER	DESCRIPTION	REF
	4	32	S 38	ANCHOR SNAP-OFF 3/8-24 "RED-HEAD"	1
	8	31		SCREW PAN HD. MACH. #10-32 x 1/2 SST	
	5	30	0950-008	HOSE CLAMP, SST, RYAN-HERCO (1/2)	1
	6	29		LOCKWASHER #4 SST	
	A/R	28	0512-080	TUBING, HERCO-BRAID, 1/2	1,2
	6	27		WASHER FLAT #4 SST	
	1	26	7000-002	TANK ADAPTER 1/4, RYAN-HERCO	1
	1	25	5309-202	LAB COCK VALVE, HOSE X HOSE, 1/4" RYAN-HERCO	1
	1	24	6905-100	FLOAT SWITCH, RYAN-HERCO	1
	6	23		HEXNUT 4-40 SST	
	A/R	22		SCOTT SAFETY FOAM, WILSHIRE FOAM, 40PPI	5
	2	21		LAMP HOLDER	1,7
	1	20	NO. H0500	PIPE, ALL-THRD, BRASS, 1/8 IPS, CRYSTAL LAMP	1
5	2	19	7039	LAMP SOCKET OSRAM	1
5	2	18	JCD	BULB, 110VAC, 250 WATT, SUNRAY LIGHTING	1
	6	17		SCREW FLAT HD. MACH. 82° #4-40 x 1/4 SST	
	1	16	W5-2107F-110	FAN, SUPER BOXER, 115VAC, .24AMPS [illegible]	1
	1	15	7214-2 1/2-14CB	PRESSURE GAUGE 0-40 GEN'L INSTR. CORP.	1
	1	14	11-009-057	PRESSURE REGULATOR NORGREN	1
	1	13	5414-005	PRESSURE BY-PASS VALVE, RYAN-HERCO	1
	1	12	D-CCPF	MICRO-WYND II, FILTER, CARTRIDGE, 5 MICR.	1
	1	11	44153-01	FILTER HOUSE, CT-101, AMF-CUNO	1
	1	10	6306-200	PUMP, 1/15 HP, 115/230 VAC. RYAN-HERCO	1
	1	9	1584A61	PIANO HINGE SST	4
1	1	8		MIRROR, 36" X 36" X 1/4 THK, 1ST SURFACE	3,1
	1	7		MIRROR FRAME	3,1
	2	6		BRACE	3,1
	4	5		EXTENSION LEG	3,1
	1	4		STAND	3,1
	1	3		COVER	5,1
	1	2		TANK	5,1
	1	1		LAMP BOX	4,1

UNLESS OTHERWISE SPECIFIED: XX . XXX . ANGLES .
DE-BURR & BREAK SHARP EDGES
MACHINED FILLET RADII .015-.030

PROJECT: EPCOT - HORIZONS
DWG TITLE: BASKETBALL PLAYERS SHADOWS - FX 55

LIGHTING AND SPECIAL EFFECTS
WED Enterprises
1401 FLOWER ST. GLENDALE, CALIF. 91201 PHONE (213) 956-6300

DRAWN BY: GJ GAGE DATE 2-1-83
CHECKED: 2-25-83
APPD BY: A. Robinson 3-25-83
DWG NO: A7-90-A693 REV A
SCALE
SHEET 8 OF 8

5. SUNRAY LIGHTING INC.
3120 CROODY WAY
SANTA ANA, CA 92704
PH. (213) 870-8628
(714) 556-3630

4. McMASTER CARR

3. SCULPTING MATERIAL:
BORDEN LIQUID RUBBER,
CASCOREZ CV-833 WITH
GE. SILICONE RUBBER
CURING AGENT BETA 4.
CARVE FIGURES FROM
CURED RUBBER. FIGURES
TO BE NEUTRALLY BUOYANT
IN SOLUTION SPECIFIED IN
NOTE 1 OF SHEET 1.

2. FIGURES TO BE SCULPTED
BY SHOW PRODUCTION DEPT 443.
SEE ECF

1. SUGGESTED SOURCE:
KEIM PRECISION MIRRORS CORP
2117 EMPIRE AV, BURBANK, CA.
PHONE (213) 842-4543

NOTES: UNLESS OTHERWISE SPECIFIED

Figure 4-13 Basketball Players
Sheet 3 of 3

4.35 FX-56: SIMULATED OSCILLOSCOPE; SCENE 27.

4.35.1 DESCRIPTION. The sweep of the oscilloscope is created with a Large Disc Fiber Optic Illuminator (P-96) and fiber optic displays. Fuorescent tubes with associated circuitry side lights the plex to create the screen's graticule. The illuminator runs continuously during the show day.

P-96 consists of:

ASSEMBLY: Fiberoptics Illum Unit (Large Disc) 6730-908940-40
    LAMP: 75 Watts TYPE: EYC (3 lamps)
    Electrical Panel 6730-
ACCESSORIES:
    20" Disc Drive Unit - Constant Ref.
    20" Disc Drive Speed (2.25 RPM)
    20" Disc Mtr Speed (RPM) Ref.
    Floor Stand (Part of Unit)
    Backplate Fiber I/F Ref.
    Bushing (Fiber) - 2 reqd Ref.
This unit interfaces with multiple fiber bundles
ARTWORK/MASK/GEL: see Table 4-1

4.35.2 THEORY OF OPERATION. Refer to the projector manual.

4.35.3 PREVENTIVE MAINTENANCE. Refer to the projector manual.

4.35.4 CORRECTIVE MAINTENANCE. Refer to the projector manual.

4.36 FX-57: STARFIELD; SCENE 28.

4.36.1 DESCRIPTION. Because the view is from space, the starfields do not blink or twinkle. They are created with three Standard Fiber Optic Illuminators without disc motors (P-97, P-98, P-99) and fiber optic displays. The illuminators run continuously during the show day.

P-97, P-98, and P-99 consist of:

ASSEMBLY: Fiberoptics Illum. Unit	6730-905905-8
LAMP: 42 Watts TYPE: ENL	
Illum Unit	6730-905889
ACCESSORIES:	
No Motor Unit	6730-905994-1
Floor Mounting Assy. (Full Base)	6730-907661
Fiber Housing (1.0" D.) Bushing	6730-905910-1
GEL: see Table 4-1	

4.36.2 THEORY OF OPERATION. Refer to the projector manual.

4.36.3 PREVENTIVE MAINTENANCE. Refer to the projector manual.

4.36.4 CORRECTIVE MAINTENANCE. To service, loosen four allen head screws, lift the projector from the fiber optic plate. It is not necessary to disturb the fiber optic bushing. The fiber bundles are fragile, and, if damaged, are difficult to replace.

If further maintenance information is required, refer to the appropriate section of the projector manual.

4.37 FX-58: CRYSTAL SCAN; SCENE 28.

4.37.1 DESCRIPTION. The rotating color ring of a crystal micrograph is rear projected on a screen. It is created with an HMI 5 x 5 Projector (P-100). P-100 runs continuously during the show day.

P-100 consists of:

MAIN ASSEMBLY:	6730-909208-2
ASSEMBLY: 5x5 Unit (HMI 1200) Front	6730-909208-2
LAMP: 1200 watts TYPE: HMI Quartz (5600)	DAYMAX#DMI 1200 OSRAM#HMI 1200W
LENS: 6.5" TYPE: Beseler	#BS1-1-34
Condenser B (6"x9" F.L.)	6730-907675-1
P.S. (Ballast) HMI	6730-920839 Xetron#B1-1200/C
PS/Ballast modified	
RP Screen: Size=7'5"w x 6'0"h; Throw=11'0"	
ACCESSORIES:	
Stand (Projector)	6730-910708-4
Power Cord x 15' (PS to 5x5)	6730-920797-2
Fan Unit (Artwork Cooling) 2 reqd	6730-908932-2
8"D. Disc - Constant	6730-907840-19
" " Speed (1.25 RPM) CW	Ref.
" " Motor (3.0 RPM) CW	Ref.
" " I/F - (Hubbell 7574)	Ref.
Beam Diverter Mirror Assy (10"x10") @ 45 degrees	6730-909848-1
Mirror Assy. (6'w x 4'h) @ 45 degrees	6730-911040
ARTWORK/MASK/GEL: see Table 4-1	

4.37.2 THEORY OF OPERATION. Refer to the projector manual.

4.37.3 PREVENTIVE MAINTENANCE. Refer to the projector manual.

4.37.4 CORRECTIVE MAINTENANCE. Refer to the projector manual.

4.38 FX-59: CRYSTAL LIGHTING: SCENE 28.

Colors slowly shift through the internally illuminated crystal. The neon lamp is on continuously during the show day.

For more information, refer to Figure 4-14.

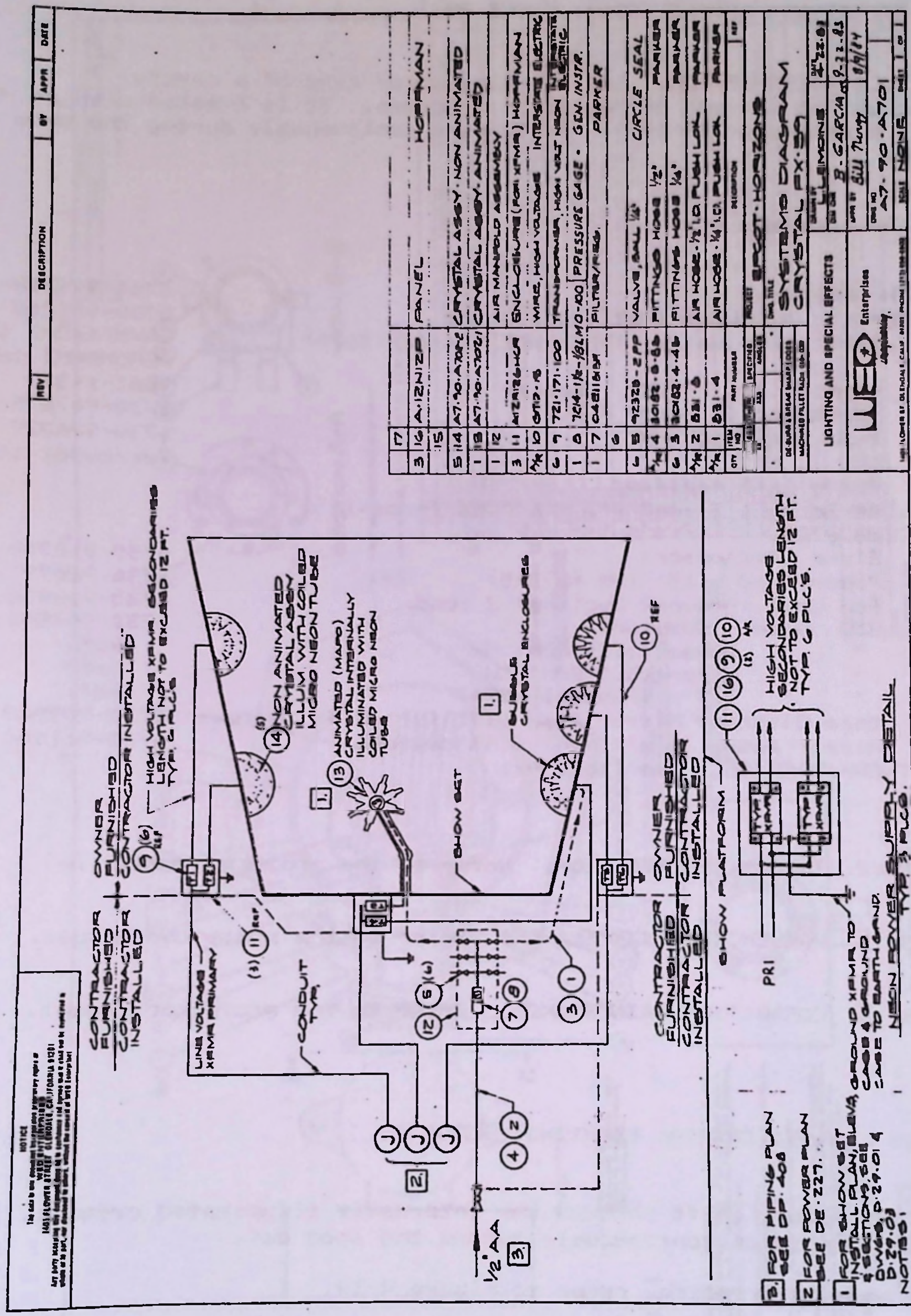


Figure 4-14 Neon Crystal Lamp
Sheet 1 of 3

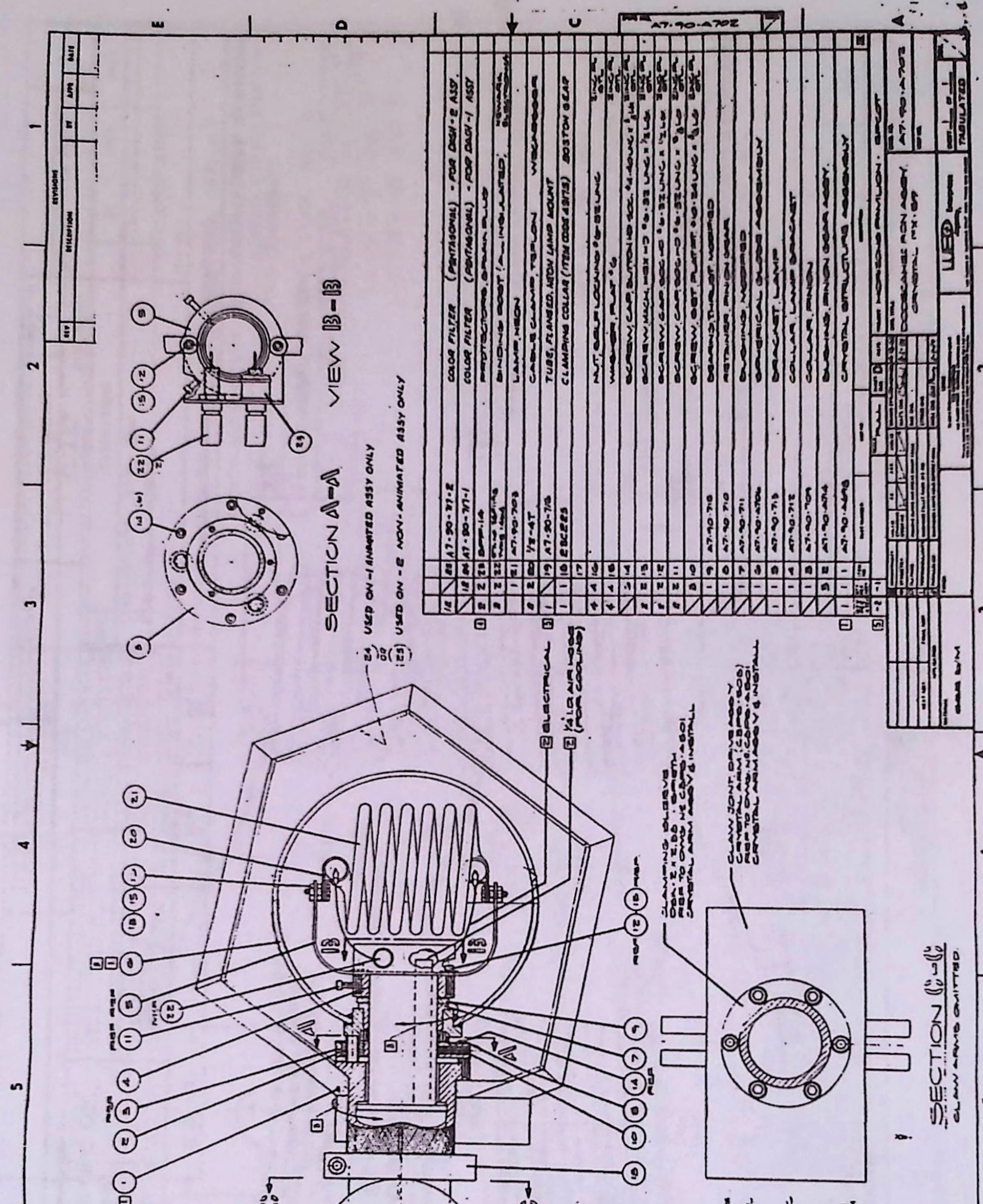


Figure 4-14 Neon Crystal Lamp
Sheet 2 of 3

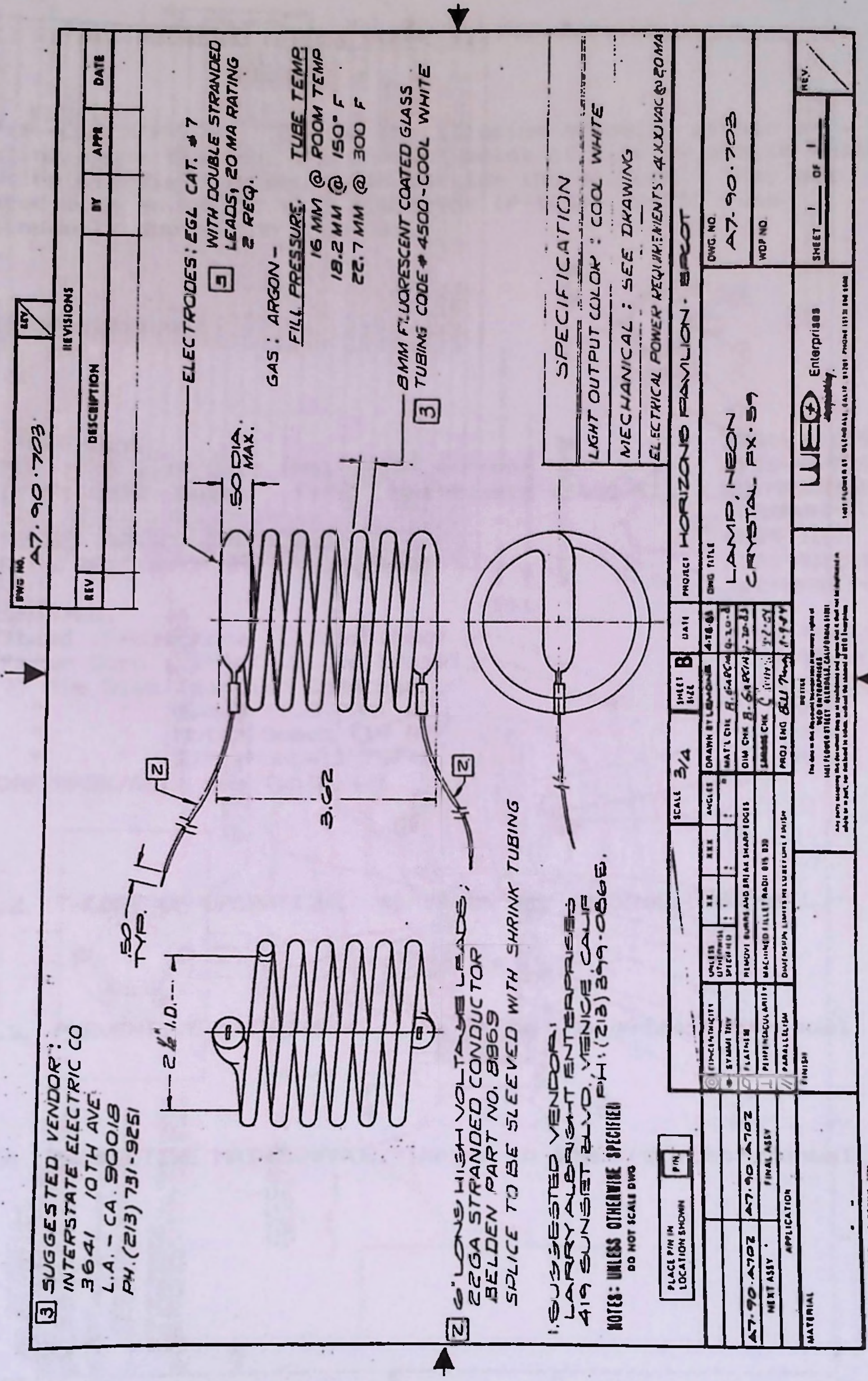


Figure 4-14 Neon Crystal Lamp
Sheet 3 of 3

4.39 FX-61: ROTATING STARS; SCENE 31.

4.39.1 DESCRIPTION. To give the illusion of being within a rotating space station, the guests' point of view is static while a rotating starfield is projected outside the windows. They are created with an HMI 10 x 10 Projector (P-105). P-105 runs continuously during the show day.

P-105 consists of:

MAIN ASSEMBLY:	6730-911004
ASSEMBLY: 10 x 10 Unit (HMI-1200) - Front	6730-909201-4
LAMP: 1200 Watts TYPE: HMI Quartz (5600 K)	DAYMAX#DMI 1200
	OSRAM#HMI1200W
LENS: 12.5" TYPE: Buhl	#834-125
P.S. (Ballast) HMI (Modified)	6730-920839
	Xetron#81-1200/C
ACCESSORIES:	
Stand (Projector) Tilting (Low)	6730-904070-7
Power Cord x 15' (P.S. to 10x10)	6730-920797-2
9" Rim Disc (Single) Constant	6730-903884
" " Speed (1.5 RPM) CCW	Ref.
" " Motor Speed (19 RPM) CCW	Ref.
" " I/F (Hubbell 7574)	Ref.
ARTWORK/MASK/GEL: see Table 4-1	

4.39.2 THEORY OF OPERATION. Refer to the projector manual.

4.39.3 PREVENTIVE MAINTENANCE. Refer to the projector manual.

4.39.4 CORRECTIVE MAINTENANCE. Refer to the projector manual.

4.40 FX-62: HOLOGRAM FLICKER; SCENE 31.

4.40.1 DESCRIPTION. To enhance the interpretation of a transmitting holographic party line (rather than just poorly lit figures), the images appear to flicker. The flicker is created with three show controlled 2 x 2 Strobes (P-106, P-107, P-108).

P-106, 107, and P-108 consist of:

ASSEMBLY: 2 x 2 Strobe Unit (Constant) w/fan	6730-910686-1
LAMP: 300 Watts TYPE: Flashtube	Kemlite#S958-9
Lamp Module	Strobex#274
LENS: 7.87" TYPE: Buhl	#206-060
Strobe P.S. Unit	Strobex#236-D
Modified (w/PCB)	#VC99-3482
ACCESSORIES:	
Floor Mounting (Projector)	6730-908500
ARTWORK/MASK/GEL: none	

4.40.2 THEORY OF OPERATION. Refer to the projector manual.

4.40.3 PREVENTIVE MAINTENANCE. Refer to the projector manual.

4.40.4 CORRECTIVE MAINTENANCE. Refer to the projector manual.

4.41 FX-63: AERIAL IMAGES; SCENE 33.

As the guests are instructed in the "choose your tomorrow" voting scenes of the of the three transport vehicles float by as if from three dimensional travel posters. The effect is created with three static spherical mirrors.

4.42 FX-65: STARFIELD; SCENE 33.

4.42.1 DESCRIPTION. Because the view is from space, the starfields do not blink or twinkle. They are created with four Standard Fiber Optic Illuminators without disc motors (P-88, P-89, P-109, P-110) and fiber optic displays. The illuminators run continuously during the show day.

P-88, P-89, P-109, and P-110 consist of:

ASSEMBLY: Fiberoptics Illum. Unit	6730-905905-8
LAMP: 42 Watts TYPE: ENL	
Illum Unit	6730-905889
ACCESSORIES:	
No Motor Unit	6730-905994-1
Floor Mounting Assy. (Full Base)	6730-907661
Fiber Housing (1.0" D.) Bushing	6730-905910-1
GEL: see Table 4-1	

4.42.2 THEORY OF OPERATION. Refer to the projector manual.

4.42.3 PREVENTIVE MAINTENANCE. Refer to the projector manual.

4.42.4 CORRECTIVE MAINTENANCE. To service, loosen four allen head screws, lift the projector from the fiber optic plate. It is not necessary to disturb the fiber optic bushing. The fiber bundles are fragile, and, if damaged, are difficult to replace.

If further maintenance information is required, refer to the appropriate section of the projector manual.

4.43 FX-66: STARFIELD; SCENE 34.

4.43.1 DESCRIPTION. Because the view is from space, the starfields do not blink or twinkle. They are created with two Standard Fiber Optic Illuminators without disc motors (P-112, P-113) and fiber optic displays. The illuminators run continuously during the shwow day.

P-112 and P-113 consist of:

ASSEMBLY: Fiberoptics Illum. Unit	6730-905905-8
LAMP: 42 Watts TYPE: ENL	
Illum Unit	6730-905889
ACCESSORIES:	
No Motor Unit	6730-905994-1
Floor Mounting Assy. (Full Base)	6730-907661
Fiber Housing (1.0" D.) Bushing	6730-905910-1
GEL: see Table 4-1	

4.43.2 THEORY OF OPERATION. Refer to the projector manual.

4.43.3 PREVENTIVE MAINTENANCE. Refer to the projector manual.

4.43.4 CORRECTIVE MAINTENANCE. To service, loosen four allen head screws, lift the projector from the fiber optic plate. It is not necessary to disturb the fiber optic bushing. The fiber bundles are fragile, and, if damaged, are difficult to replace.

If further maintenance information is required, refer to the appropriate section of the projector manual.

Table 4-1 Artwork Replacement

PROJECTED SPECIAL EFFECTS STILL FILM LOG

WED/SPECIAL EFFECTS/DEPARTMENT 431

The purpose of this log is to provide tracking information and facilitate the retrieval of both the original artwork at the studio and related WED-maintained transparencies. This log also establishes production requirements for each Special Effects projector's still film usage.

LEGEND:
WDP: WALT DISNEY PRODUCTIONS
CIBA: CIBACHROME
SILK: SILKSCREENED
KODA: KODALITH

MOST RECENT UPDATE: 07-25-84 REVISION NO: 3 DOCUMENT ID# 0085F PAGE 1 OF 10

PROJECT: HORIZONS LOCATION: FUTURE WORLD - EPCOT NO. OF EFFECT PROJECTORS 114 NO. OF FILM PROJECTORS 12

AREA/ SCENE	PROJECTOR NUMBER	SLIDES (QTY.)	SUBJECT/DESCRIPTION AND PROJECTOR TYPE	PRODUCTION RESPONSIBILITY	FILM BASE	PROCESS LAB	COMPL DATE	STUDIO REFERENCE NUMBER	COMMENTS
#1 FUTURE PORT	P13	1	1200W. HMI 5 X 5 COLOR STILL "TRAVEL POSTER" (UNDERWATER) McCALL PAINTINGS FX-1	WDP	CIBA			ARTWORK REF. #: 6770-919452 ROSCO GEL #66	5 X 7 COLOR STILL TRAVEL POSTER (1) LAYER COOL BLUE
	P14	1	1200W. HMI 5 X 5 COLOR STILL "TRAVEL POSTER" (DESERT CITY) McCALL PAINTINGS FX-1	WDP	CIBA			ARTWORK REF. #: 6770-919453	5 X 7 COLOR STILL TRAVEL POSTER
	P15	1	1200W. HMI 5 X 5 COLOR STILL "TRAVEL POSTER" (OUTER SPACE) McCALL PAINTINGS FX-1	WDP	CIBA			ARTWORK REF. #: 6770-919454	5 X 7 COLOR STILL TRAVEL POSTER
#3 TRANS TUNNEL #1	P16	1	LARGE DISC F.O.I. 20" DIA. COLOR STILL WITH LAMINATION "FIBER OPTIC WALL" FX-77	WDP	SILK			ARTWORK REF. #: 6770-919455	20" DIA. SILK SCREEN, LAMINATED
	P17	1	LARGE DISC F.O.I. 20" DIA. COLOR STILL WITH LAMINATION "FIBER OPTIC WALL" FX-77	WDP	SILK			ARTWORK REF. #: 6770-919456	20" DIA. SILK SCREEN, LAMINATED
	P18	1	LARGE DISC F.O.I. 20" DIA. COLOR STILL WITH LAMINATION "FIBER OPTIC WALL" FX-77	WDP	SILK			ARTWORK REF. #: 6770-919457	20" DIA. SILK SCREEN, LAMINATED
	P19	0	XENON FIBER OPTIC ILLUMINATOR "LIGHTNING FOR F.O. WALL" FX-77	NO ARTWORK					

Table 4-1 Artwork Replacement

PROJECT: HORIZONS LOCATION: FUTURE WORLD - EPCOT NO. OF EFFECT PROJECTORS 114 NO. OF FILM PROJECTORS 12

AREA/ SCENE	PROJECTOR NUMBER	SLIDES (QTY.)	SUBJECT/DESCRIPTION AND PROJECTOR TYPE	PRODUCTION RESPONSIBILITY	FILM BASE	PROCESS LAB	COMPL DATE	STUDIO REFERENCE NUMBER	COMMENTS
#4 EARLY INVENTIONS	P20	1	INCANDESCENT 10 X 10 FX-3 "PARADE OF INVENTIONS" B&W STILL (LARGE FLYING CRAFT)	WDP	KODA			ARTWORK REF. #: 6770-919458 ROSCO GEL #10	 (1) LAYER MED YELLOW
	P21	1	INCANDESCENT 10 X 10 FX-3 "PARADE OF INVENTIONS" B&W STILL (MAN IN FEATHER FLYING MACHINE)	WDP	KODA			ARTWORK REF. #: 6770-919459 ROSCO GEL #30	 (1) LT. SALMON PINK
	P22	1	INCANDESCENT 10 X 10 FX-3 "PARADE OF INVENTIONS" B&W STILL (CANNON)	WDP	KODA			ARTWORK REF. #: 6770-919460 ROSCO GEL #70	 (1) NILE BLUE
	P23	1	INCANDESCENT 10 X 10 FX-3 "PARADE OF INVENTIONS" B&W STILL (VERNE BULLETS)	WDP	KODA			ARTWORK REF. #: 6770-919461 ROSCO GEL #12 ROSCO GEL #16	 (1) STRAW (1) LT. AMBER
	P24	1	INCANDESCENT 5 x 5 FX-3 "PARADE OF INVENTIONS" B&W STILL (MAN W/BALLOON/PARACHUTE)	WDP	KODA			ARTWORK REF. #: 6770-919462 ROSCO GEL #10	 (1) MED YELLOW
	P25	1	INCANDESCENT 5 x 5 FX-3 "PARADE OF INVENTIONS" B&W STILL (MAN WITH BIRDS)	WDP	KODA			ARTWORK REF. #: 6770-919463 ROSCO GEL #52	 (1) LT. LAVENDER
	P26	1	INCANDESCENT 5 x 5 FX-6B "PARADE OF INVENTIONS" (MOVING CLOUDS) B&W 19" DISC	WDP	KODA			ARTWORK REF. #: 6770-919464 6730-911043 ROSCO GEL #67	 BLK & WHT KODA. GLASS DISC (1) LT. SKY BLUE
#5 JULES VERNE SPACESHIP	P29,30	1 ea	CLOUD DRUM - "MOVING CLOUDS" B&W 24" DIA. DRUM/76" LOOP FX-5	WDP	KODA			ARTWORK REF. #: 6770-919465	

Table 4-1 Artwork Replacement

MOST RECENT UPDATE: 07-25-84

PROJECT: HORIZONS | REVISION NO: 3 | DOCUMENT ID# 0085F | PAGE 3 OF 10

LOCATION: FUTURE WORLD - EPCOT | NO. OF EFFECT PROJECTORS 114 | NO. OF FILM PROJECTORS 12

AREA/ SCENE	PROJECTOR NUMBER	SLIDES (QTY.)	SUBJECT/DESCRIPTION AND PROJECTOR TYPE	PRODUCTION RESPONSIBILITY	FILM BASE	PROCESS LAB	COMPL DATE	STUDIO REFERENCE NUMBER	COMMENTS
#6 JULES VERNE SPACESHIP, (CON'T.)	P1	1	35mm 1-MIN. BLK & WHT FILM LOOP "MAN IN MOON"	WDP	ESTAR			ARTWORK REF. #: 6770-919441	
#7 ART DECO	P31	1	F.O. XENON ILLUMINATOR "ROBOT FLASHES" FX-69	NO ARTWORK					
#8 NEON CITY	P2	1	35mm 1-MIN BLK&WHT FILM LOOP "MOVIE MARQUEE" (CLIPS OF OLD TV)	WDP	ESTAR			ARTWORK REF. #: 6770-919442	
	P3	1	35mm 1-MIN BLK&WHT FILM LOOP "MOVIE MARQUEE" (CLIPS OF OLD TV)	WDP	ESTAR			ARTWORK REF. #: 6770-919443	
#11 TRANSITION TUNNEL #2	FXP-11-1 THRU FXP-11-13	2 ea	MINI-MOLE MODIFIED FX-12 "LUMIA" 12" DIA. COLOR DISK 12" DIA. B & W KODA	WDP WDP	SILK KODA			ARTWORK REF. #: 6770-919509 COLOR SILKSCREEN 12" DIA 6770-919510 BLK&WHT KODALITH 12" DIA	
#12 OMNIMAX	P4,5	1 ea	70mm OMNIMAX 12 MIN. COLOR FILM LOOP "MICRO/MACRO WORLDS"	WDP	ESTAR			ARTWORK REF. #: 6770-919444	
#13 TRANSITION TUNNEL #3	FXP-13-1 THRU FXP-13-14	2 ea	MINI-MOLE, MODIFIED FX-13 "LUMIA" 12' DIA. COLOR DISK 12' DIA. B & W DISK	WDP WDP	SILK KODA			ARTWORK REF. #: 6770-919511 COLOR SILKSCREEN 12" DIA 6770-919510 BLK&WHT KODALITH 12" DIA	

Table 4-1 Artwork Replacement

MOST RECENT UPDATE: 07-25-84
PROJECT: HORIZONS

REVISION NO: 3 | DOCUMENT ID# 0085F | PAGE 4 OF 10

LOCATION: FUTURE WORLD - EPCOT | NO. OF EFFECT PROJECTORS 114 | NO. OF FILM PROJECTORS 12

AREA/ SCENE	PROJECTOR NUMBER	SLIDES (QTY.)	SUBJECT/DESCRIPTION AND PROJECTOR TYPE	PRODUCTION RESPONSIBILITY	FILM BASE	PROCESS LAB	COMPL DATE	STUDIO REFERENCE NUMBER COMMENTS
#14 URBAN HABITAT	P46	2	10 X 10 SPECIAL MOVING LAMP "ELEVATOR" FX-17	NO ARTWORK				LAMP ONLY GE 2604X
	P47	2	10 X 10 SPECIAL MOVING LAMP "ELEVATOR" FX-17	NO ARTWORK				LAMP ONLY GE 2604X
	P48	2	10 X 10 SPECIAL MOVING LAMP "ELEVATOR" FX-17	NO ARTWORK				LAMP ONLY GE 2604X
	P49	2	1200W. HMI 10 X 10 FX-18 "MAG-LEV TRAINS" B&W LONG LOOP B&W MASK	WDP WDP	KODA KODA			ARTWORK REF. #: 6770-919472 B&W LONG LOOP 6770-919473 B&W MASK
	P50	2	1200W. HMI 10 X 10 FX-18 "MAG LEV TRAINS" B&W LONG LOOP B&W MASK	WDP WDP	KODA KODA			ARTWORK REF. #: 6770-919472 B&W LONG LOOP 6770-919475 B&W MASK LEE FILTER #209 (LT.NEUTRAL DENSITY)
	FXP14-1 THRU FXP14-5	1	F.O. MINI-ILLUMINATOR (4" DISC) "BLINKING LIGHTS" FX-16	WDP	KODA			ARTWORK REF. #: 6770-919471 B & W LAMINATED
	P51	0	2 X 2 STROBE FX-19 "HOLOGRAM FLICKER"	NO ARTWORK				
	P52	1	575W. HMI 10 X 10 FX-70 "STATION HIGHLIGHTS" BLK&WHT	WDP	KODA			ARTWORK REF. #: 6770-919476 10 X 10 KODALITH LEE FILTER #211 (DK.NEUTRAL DENSITY)
	P53	1	575W. HMI 10 X 10 FX-70 "STATION HIGHLIGHTS" BLK&WHT	WDP	KODA			ARTWORK REF. #: 6770-919477 10 X 10 KODALITH LEE FILTER #211 (DK.NEUTRAL DENSITY)

Table 4-1 Artwork Replacement

MOST RECENT UPDATE: 07-25-84

PROJECT: HORIZONS

REVISION NO: 3 | LOCATION: FUTURE WORLD - EPCOT | DOCUMENT ID# 0085F | NO. OF EFFECT PROJECTORS 114 | PAGE 5 OF 10 | NO. OF FILM PROJECTORS 12

AREA/ SCENE	PROJECTOR NUMBER	SLIDES (QTY.)	SUBJECT/DESCRIPTION AND PROJECTOR TYPE	PRODUCTION RESPONSIBILITY	FILM BASE	PROCESS LAB	COMPL DATE	STUDIO REFERENCE NUMBER	COMMENTS
#16 DESERT FARM	P54	2	1200W. HMI 10 X 10 FX-22					ARTWORK REF. #:	
			"MOVING CLOUDS" B&W LONG LOOP	WDP	KODA			6770-919478	B&W LONG LOOP CONT. TONE
			B&W MASK	WDP	KODA			6770-919479	B&W MASK
	P55	2	1200W. HMI 10 X 10 FX-22					ARTWORK REF. #:	
			"MOVING CLOUDS" B&W LONG LOOP	WDP	KODA			6770-919478	B&W LONG LOOP CONT. TONE
			B&W MASK	WDP	KODA			6770-919470	B&W MASK
	P56	1	2 X 2 STROBE FX-23					ARTWORK REF. #:	
			"LIGHTNING" 9" DIA. B&W DISC	WDP	KODA			6770-919480	9" KODALITH DISC
	P57	1	INCANDESCENT 2 X 2					ARTWORK REF. #:	
			"FARM AERIAL GRID" 4" X 4" COLOR	WDP	CIBA			6770-919481	COLOR TRANSP.
			(SIMULATED MONITORS) FX-25						
	P58	1	INCANDESCENT 2 X 2					ARTWORK REF. #:	
			"HARVESTER" 4" X 4" COLOR	WDP	CIBA			6770-919482	COLOR TRANSP.
			(SIMULATED MONITORS) FX-25						
	P59	1	INCANDESCENT 2 X 2					ARTWORK REF. #:	
			"WEATHER MAP" 4" X 4" COLOR	WDP	CIBA			6770-919483	COLOR TRANSP.
			(SIMULATED MONITORS) FX-25						
	P60,61	2 ea	HMI 2 X 2 FX-26					ARTWORK REF. #:	
			"FLYING CRAFT" COLOR 2 X 2 SLIDE	WDP	CIBA			6770-919484	35mm COLOR TRANSP
			B & W 2 X 2 MASK	WDP	KODA			6770-919485	& KODA MASK
								ROSCO GEL #18 - FLAME	
	FXP16-1	0	F.O. MINI-ILLUMINATOR (4" DISC)	NO ARTWORK	GEL			ROSCO GEL #26 - LT. RED	
			"BLIMP LIGHTS" FX-27						

Table 4-1 Artwork Replacement

MOST RECENT UPDATE: 07-25-84

PROJECT: HORIZONS

REVISION NO: 3 | DOCUMENT ID# 0085F | PAGE 6 OF 10

LOCATION: FUTURE WORLD - EPCOT | NO. OF EFFECT PROJECTORS 114 | NO. OF FILM PROJECTORS 12

AREA/ SCENE	PROJECTOR NUMBER	SLIDES (QTY.)	SUBJECT/DESCRIPTION AND PROJECTOR TYPE	PRODUCTION RESPONSIBILITY	FILM BASE	PROCESS LAB	COMPL DATE	STUDIO REFERENCE NUMBER	COMMENTS
#17 DESERT HABITAT	P114	0	MYLAR WATER RIPPLE FX-72	NO ARTWORK				BLUE PAR LAMP MOVED TO SC. 20, RENUMBERED P115	!!! DELETED !!!
	P6	1	35mm 1-MIN. COLOR FILM LOOP "COMMO. ROOM" (BOY WITH GIRL)	WDP	ESTAR			ARTWORK REF. #: 6770-919445	
#19 SUB REPAIR ROOM	P62	0	XENON FIBER OPTIC ILLUMINATOR "LASER WELDING" FX-33	NO ARTWORK					
	P63	4	INCANDESCENT 5 X 5 FX-36 "WATER RIPPLE" BLK & WHT	WDP WDP	KODA KODA			ARTWORK REF. #: 6770-919487 6770-919488	KODA MASK (TRIPLE PLATE OSCILLATOR) (3)
	P64	4	INCANDESCENT 5 X 5 FX-36 "WATER RIPPLE" BLK & WHT	WDP WDP	KODA KODA			ARTWORK REF. #: 6770-919489 6770-919488	KODA MASK (TRIPLE PLATE OSCILLATOR) (3)
	P7	1	35mm 1-MIN. COLOR FILM LOOP "VIDEO SCREEN" (SIMULATED)	WDP	ESTAR			ARTWORK REF. #: 6770-919446	
#20 DIVE CHAMBER	P65, P115	0	MYLAR WATER RIPPLE FX-72	NO ARTWORK				BLUE PAR LAMP	
#22 UNDERSEA RESORT	P66-69	1	1200W. HMI 5 X 5 FX-41 "RIPPLE REFLECTIONS" B & W	WDP	KODA			ARTWORK REF. #: 6770-919491 6730-911289 LEE FILTER #209 (1) LAYER LIGHT N.D. LEE FILTER #211 (2/3) LAYER DARK ND ROSCO GEL #70 (1) NILE BLUE #71 (1) SEA BLUE WITH 1-1/4" HOLE IN CENTER	19" KODA DISC, TEXTURED DISC

MOST RECENT UPDATE: 07-25-84

PROJECT: HORIZONS | REVISION NO: 3 | DOCUMENT ID# 0085F | PAGE 7 OF 10

LOCATION: FUTURE WORLD - EPCOT | NO. OF EFFECT PROJECTORS 114 | NO. OF FILM PROJECTORS 12

Table 4-1 Artwork Replacement

AREA/ SCENE	PROJECTOR NUMBER	SLIDES (QTY.)	SUBJECT/DESCRIPTION AND PROJECTOR TYPE	PRODUCTION RESPONSIBILITY	FILM BASE	PROCESS LAB	COMPL DATE	STUDIO REFERENCE NUMBER	COMMENTS
#22 UNDERSEA RESORT (CONT.)	P70-72,116	1	1200W. HMI 5 X 5 FX-41 "RIPPLE REFLECTIONS"	WDP	KODA			ARTWORK REF. #: 6770-919491 6730-911289 LEE FILTER #211 (1) LAYER DARK N.D. ROSCO GEL #70 (1) LAYER NILE BLUE #71 (1) SEA BLUE WITH 1-1/4" HOLE IN CENTER	 19" KODA DISC, TEXTURED DISC
	P8	1	35mm, 50 SEC. COLOR FILM LOOP "FLOATING CITY" (WITH SUB AND DIVERS)	WDP	ESTAR			ARTWORK REF. #: 6770-919447	
#23 UNDERSEA INDUSTRY	P73	2	575W. HMI 2 X 2 FX-43 "DISTANT SUBS" COLOR 2 X 2 B & W 2 X 2	 WDP WDP	 CIBA KODA			ARTWORK REF. #: 6770-919492 6770-919493	 35mm COLOR TRANSP KODA MASK
	P74	2	575W. HMI 2 X 2 FX-43 "DISTANT SUBS" COLOR 2 X 2 B & W 2 X 2	 WDP WDP	 CIBA KODA			ARTWORK REF. #: 6770-919494 6770-919495	 35mm COLOR TRANSP KODA MASK
	P75-78	1	1200W. HMI 5 X 5 FX-46 "RIPPLES ON ROCKWORK" B & W	WDP	KODA			ARTWORK REF. #: 6770-919491 6730-911289 LEE FILTER #211 (2) LAYERS DARK N.D. ROSCO GEL #70 (1) LAYER NILE BLUE #71 (1) SEA BLUE WITH 1-1/4" HOLE IN CENTER	 19" KODA DISC TEXTURED DISC
	FXP23-1,2	0	F.O. MINI-ILLUMINATOR (4" DISC) "KELP WARNING LIGHTS" FX-47	NO ARTWORK	GEL			ROSCO GEL #26 (1) LT. RED LEE FILTER #211 (1) DARK NEUTRAL DENSITY	

Table 4-1 Artwork Replacement

MOST RECENT UPDATE: 07-25-84
PROJECT: HORIZONS

REVISION NO: 3 DOCUMENT ID# 0085F PAGE 8 OF 10

LOCATION: FUTURE WORLD - EPCOT NO. OF EFFECT PROJECTORS 114 NO. OF FILM PROJECTORS 12

AREA/ SCENE	PROJECTOR NUMBER	SLIDES (QTY.)	SUBJECT/DESCRIPTION AND PROJECTOR TYPE	PRODUCTION RESPONSIBILITY	FILM BASE	PROCESS LAB	COMPL DATE	STUDIO REFERENCE NUMBER	COMMENTS
#24 TRANSITION	P79	2	575W. HMI 2 X 2 FX-48					ARTWORK REF. #:	
AREA	NOT INSTALLED		"SUBMARINE" COLOR 2 X 2	WDP	CIBA			6770-919496	35mm COLOR TRANSP
			B & W 2 X 2	WDP	KODA			6770-919497	KODA MASK
	P80	2	575W. HMI 2 X 2 FX-48					ARTWORK REF. #:	
	NOT INSTALLED		"SPACECRAFT" COLOR 2 X 2	WDP	CIBA			6770-919498	35mm COLOR TRANSP
			B & W 2 X 2	WDP	KODA			6770-919499	KODA MASK
	P81	2	575W. HMI 2 X 2 FX-74					ARTWORK REF. #:	
	NOT INSTALLED		"BUBBLES FOR SUB"	WDP	KODA			6770-919500	4 X 5 KODALITH
				WDP	KODA			6770-919501	(SOFT EDGE MASK)
	P82	2	1200W. HMI 5 X 5 FX-73					ARTWORK REF. #:	
			"WATER RIPPLES" B & W 19" DISC	WDP	KODA			6770-919491	19" KODA DISC
			B & W 5X5 MASK	WDP	KODA			6770-919486	MASK
								6730-911289	TEXTURED DISC
								ROSCO GEL #70 (1)	NILE BLUE
								ROSCO GEL #71 (1)	SEA BLUE WITH 1-1/4" HOLE IN CENTER
#25 OUTERSPACE	P83	2	1200W. HMI 10 X 10 FX-49					ARTWORK REF. #:	
			"BEAM BUILDER" 10 X 10 B&W MASK	WDP	KODA			6770-919502	10 X 10 KODA
			B&W LONG LOOP	WDP	KODA			6770-919503	LONG LOOP (KODA)
								ROSCO GEL #66 (1)	COOL BLUE
	P84,85,86,87, 90,91,92,93		42 WATT FIBER OPTIC ILLUMINATOR	NO ARTWORK	GEL			6730-	P-5 PLEX 2" X 2"
			"STARFIELD" FX-51					ROSCO GEL #60 (1)	NO COLOR BLUE
	P9	1	70mm, 1-MIN. COLOR FILM LOOP					ARTWORK REF. #:	
			"SPACE COLONY" (OUTSIDE)	WDP	ESTAR			6770-919448	

Table 4-1 Artwork Replacement

MOST RECENT UPDATE: 07-25-84

PROJECT: HORIZONS | REVISION NO: 3 | DOCUMENT ID# 0085F | PAGE 9 OF 10

LOCATION: FUTURE WORLD - EPCOT | NO. OF EFFECT PROJECTORS 114 | NO. OF FILM PROJECTORS 12

AREA/ SCENE	PROJECTOR NUMBER	SLIDES (QTY.)	SUBJECT/DESCRIPTION AND PROJECTOR TYPE	PRODUCTION RESPONSIBILITY	FILM BASE	PROCESS LAB	COMPL DATE	STUDIO REFERENCE NUMBER COMMENTS
#26 SPACE COLONY	P10	1	70mm, 1-MIN. COLOR FILM LOOP "ROTATING COLONY" (SPACE COLONY INSIDE)	WDP	ESTAR			ARTWORK REF. #: 6770-919449
#27 HEALTH AND RECREATION	P11	1	35mm, 1-MIN. COLOR FILM LOOP "SPORT SIMULATOR" (ROWING, TOP BUBBLE)	WDP	ESTAR			ARTWORK REF. #: 6770-919450
	P12	1	35mm, 1-MIN. COLOR FILM LOOP "SPORT SIMULATOR" (BICYCLE MACHINE, BOTTOM BUBBLE)	WDP	ESTAR			ARTWORK REF. #: 6770-919451
	P94	2	1200W. HMI 5 X 5 FX-54 "BODY SCAN" COLOR 5 X 5 STILL 5 X 5 SHORT LOOP	WDP WDP	SILK KODA			ARTWORK REF. #: 6770-919504 5 X 5 SILKSCREEN STILL 6770-919505 5 X 5 SHORT LOOP (KODA) (B&W LOOP WITH ROSCODYE RED HANDPAINTED ON IT.)
	FXP27-1	0	(MAPO) LINEBACH PROJECTOR "BASKETBALL PLAYERS" FX-55	NO ARTWORK	GEL			ROSCO GEL #71 (1) SEA BLUE SEE SPECIAL EFFECTS DWG A7-90-A693
	P96	1	LARGE DISC FIBER OPTIC ILLUM. "SIMULATED OSCILLOSCOPE" FX-56	WDP	SILK			ARTWORK REF. #: 6770-919506 20" SILK. DISC
#28 MAIN SHUTTLE PORT	P97, 98	0	42 WATT FIBER OPTIC ILLUMINATOR "STARFIELD" FX-57	NO ARTWORK	GEL			MECHANICAL REF. #: 6730-911290 (1) P-5 PLEX 2" X 2" ROSCO GEL #60 (1) NO COLOR BLUE
	P99	0	42 WATT FIBER OPTIC ILLUMINATOR "STARFIELD" FX-57	NO ARTWORK	GEL			ROSCO GEL #60 (1) NO COLOR BLUE

Table 4-1 Artwork Replacement

MOST RECENT UPDATE: 07-25-84 REVISION NO: 3 DOCUMENT ID# 0085F PAGE 10 OF 10

PROJECT: HORIZONS LOCATION: FUTURE WORLD - EPCOT NO. OF EFFECT PROJECTORS 114 NO. OF FILM PROJECTORS 12

AREA/ SCENE	PROJECTOR NUMBER	SLIDES (QTY.)	SUBJECT/DESCRIPTION AND PROJECTOR TYPE	PRODUCTION RESPONSIBILITY	FILM BASE	PROCESS LAB	COMPL DATE	STUDIO REFERENCE NUMBER	COMMENTS
#29 CRYSTAL MANUFACTURING	P100	1	1200W. HMI 5 X 5 FX-58					ARTWORK REF. #:	
			"CRYSTAL SCAN" 6" DIA. COLOR DISC	WDP	CIBA			6770-919507	COLOR TRANSPAREN.
								ROSCO GEL #65	(1) DK. STRAW
								ROSCO GEL #37	(3) PALE ROSE PINK
									(1) ACETATE DIFFUSER
#31 HOLOGRAPHIC PARTY LINE	P105	2	1200W. HMI 10 X 10 FX-61					ARTWORK REF. #:	
			"ROTATING STARS" 10" DIA B&W DISC	WDP	KODA			6770-919508	10" KODA. DISC
			10 X 10 B&W MASK	WDP	KODA			6770-919512	10 X 10 MASK
	P106,107,108	0	2 X 2 STROBE FX-62 "HOLOGRAM FLICKER"	NO ARTWORK					
#33 CHOOSE YOUR TOMORROW SELECTIONS	P88,89,109, 110	0	42 WATT FIBER OPTIC ILLUMINATOR "STARFIELD" FX-65	NO ARTWORK	GEL			6730-911290	(1) P-5 PLEX 2" X 2"
								ROSCO GEL #60	(2) LAYERS NO COLOR BLUE
#34 CHOOSE YOUR TOMORROW SIMULATIONS	P112,113	0	42 WATT FIBER OPTIC ILLUMINATOR "STARFIELD" FX-66	NO ARTWORK	GEL			6730-911290	(1) P-5 PLEX 2" X 2"
								ROSCO GEL #60	(1) LAYER NO COLOR BLUE

ADDITIONAL INFO.:

HORIZON 10-DIGIT NUMBERS: 6770-919452 THRU' 6770-919551

UNUSED WATER RIPPLE NUMBERS: 6770-919490 (LGE. SPOTS)
6770-919469 (SML. SPOTS)

USABLE NUMBERS AVAILABLE: 6770-919466 THRU' 6770-919468 ,6770-919474
6770-919513 THRU' 6770-919551

Table 4-2 Lamp Replacement				
FX NO	DEVICE NUMBER	EQUIPMENT	LAMP TYPE	PART NUMBER
FX-1	P-13	HMI 5x5 Projector	1200 watt HMI Quartz 5600 K	DAYMAX#DMI1200 OSRAM#HMI1200W
	P-14	"	"	"
	P-15	"	"	"
FX-77	P-16	Lg Disc FOI	(12) 75 watt EYC	
	P-17	"	"	---
	P-18	"	"	---
	P-19	Xenon FOI	300 watt Xenon	ILC#LX300F
FX-3	P-20	10x10 Projector	2000 watt tungsten halogen	6240-594504
	P-21	"	"	"
	P-22	"	"	"
	P-23	"	"	"
	P-24	5x5 Projector	2000 watt tungsten halogen	6240-594504
	P-25	"	"	"
FX-68	P-26	5x5 Projector	"	"
FX-5	P-29	24" Cloud Drum	75 watt Quartz (28v)	GE #1982
	P-30	"	"	"
FX-69	P-31	Xenon FOI	300 watt Xenon	ILC#LX300F
FX-12		Lumia	Mini Mole Lamp Quartzline	GE Q150CL/DC/2V
FX-13		Lumia	"	"
FX-16	FXP14-1	Mini FOI	Mini Lamp	GE 2504x
	FXP14-2	"	"	"
	FXP14-3	"	"	"
	FXP14-4	"	"	"
	FXP14-5	"	"	"
FX-17	P-46	10x10 Projector	10 watt Quartz (5v)	GE 2604X
	P-47	"	"	"
	P-48	"	"	"
FX-18	P-49	HMI 10x10 Projector	1200 watt HMI Quartz 5600 K	DAYMAX#DMI1200 OSRAM#HMI1200W
	P-50	"	"	"

FX NO	DEVICE NUMBER	EQUIPMENT	LAMP TYPE	PART NUMBER
Table 4-2 Lamp Replacement (Continued)				
FX-19	P-51	2x2 Strobe	300 watt flashtube	Kemlite #S598-9
FX-70	P-52	HMI 5x5 Projector	575 watt HMI Quartz 5600 K	DAYMAX#DMI575 OSRAM#HMI575W
	P-53	"	"	"
FX-22	P-54	HMI 10x10 Projector	1200 watt HMI Quartz 5600 K	DAYMAX#DMI1200 OSRAM#HMI1200W
	P-55	"	"	"
FX-23	P-56	2x2 Strobe	300 watt flashtube	Kemlite #S598-9
FX-25	P-57	2x2 Projector	500 watt Quartz (BCK)	---
	P-58	"	"	---
	P-59	"	"	---
FX-26	P-60	HMI 2x2 Projector	575 watt HMI Quartz 5600 K	DAYMAX#DMI575 OSRAM#HMI575W
	P-61	"	"	"
FX-27	FXP16-1	Mini FOI	Mini Lamp	GE 2504x
FX-71		Pantry Freezer	75 watt PAR flood lamp	---
FX-33	P-62	Xenon FOI	300 watt Xenon	ILC#LX300F
FX-36	P-63	5x5 Projector	2000 watt tungsten halogen	6240-594504
	P-64	"	"	"
FX-72	P-65	Water Ripple Unit	150 watt PAR flood	GE #150PAR/FL/B
	P-115	"	"	"
FX-41	P-66	HMI 5x5 Projector	1200 watt HMI Quartz 5600 K	DAYMAX#DMI1200 OSRAM#HMI1200W
	P-67	"	"	"
	P-68	"	"	"
	P-69	"	"	"
	P-70	"	"	"
	P-71	"	"	"
	P-72	"	"	"

FX NO	DEVICE NUMBER	EQUIPMENT	LAMP TYPE	PART NUMBER
Table 4-2 Lamp Replacement (Continued)				
FX-43	P-73	HMI 2x2 Projector	575 watt HMI Quartz 5600 K	DAYMAX#DMI575 OSRAM#HMI575W
	P-74	"	"	"
FX-46	P-75	HMI 5x5 Projector	1200 watt HMI Quartz 5600 K	DAYMAX#DMI1200 OSRAM#HMI1200W
	P-76	"	"	"
	P-77	"	"	"
	P-78	"	"	"
FX-47	FXP23-1 FXP23-2	Mini FOI	Mini lamp	?
FX-73	P-82	HMI 5x5 Projector	1200 watt HMI Quartz 5600 K	DAYMAX#DMI1200 OSRAM#HMI1200W
FX-49	P-83	10x10 Projector	2000 watt tungsten halogen	6240-594504
FX-51	P-84	Std FOI	42 watt ENL	---
	P-85	"	"	---
	P-86	"	"	---
	P-87	"	"	---
	P-90	"	"	---
	P-91	"	"	---
	P-92	"	"	---
	P-93	"	"	---
FX-54	P-94	HMI 5x5 Projector	1200 watt HMI Quartz 5600 K	DAYMAX#DMI1200 OSRAM#HMI1200W
FX-56	P-96	Lg Disc FOI	(3) 75 watt EYC	---
		Fluorescent Fixture	(4) 4 watt tubes	GE F4TS
FX-57	P-97	Std FOI	42 watt ENL	---
	P-98	"	"	---
	P-99	"	"	---
FX-58	P-100	HMI 5x5 Projector	1200 watt HMI Quartz 5600 K	DAYMAX#DMI1200 OSRAM#HMI1200W
FX-59		"	"	"
FX-61	P-105	HMI 10x10 Projector	1200 watt HMI Quartz 5600 K	DAYMAX#DMI1200 OSRAM#HMI1200W

Table 4-2 Lamp Replacement (Continued)				
FX NO	DEVICE NUMBER	EQUIPMENT	LAMP TYPE	PART NUMBER
FX-62	P-106	2x2 Strobe	300 watt flashtube	Kemlite #S598-9
	P-107	"	"	"
	P-108	"	"	"
FX-65	P-88	Std FOI	42 watt ENL	---
	P-89	"	"	---
	P-109	"	"	---
	P-110	"	"	---
FX-66	P-112	Std FOI	42 watt ENL	---
	P-113	"	"	---

Table 4-3 Sources for Uncommon Parts		
SCENE/FX #	DESCRIPTION	SOURCE
1/FX-1	Lumiflex 130 Rear Projection Screen; 99-1/2" x 80"; material only (no grommets, etc)	Stewart Film Screen Corp 1161 W. Sepulveda Blvd Torrance, CA 90592 (213) 326-1422
11/FX-12	Hurst Gearmotor (6 RPM) Reversable 3002-007 (Model A)	Distributor: Minarik Electric Co LA, CA (213) 624-3161
	Light Detector, General Electric L14F1	Distributor: Hamilton Electric Sales Culver City, CA (213) 558-2121
	Transistor Socket, Augat Incorp 8060-1G5	Distributor: ERIK-A Electronics 2640 S. Myrtle #1 Monrovia, CA 91016 (213) 574-1020
13/FX-13	see 11/FX-12	
16/FX-28	Orange fragrance scent (R-2534)	Felton International, Inc 2242 Purdue Ave. LA, CA (213) 272-3482.
17/FX-71	Transducer unit for fog box - complete PC board Panasonic Ultrasonic Humidifier (EFE-HMVIR7M6E)	Matsushima Electric Components Co, Ltd.
	Ultrasonic resonator for transducer unit - Ceramic Transducer (EFE-HEVIR7MI)	"
	Transistor for transducer unit (NEC 2SC940)	
	DI Cartridge D0803	Mfg: Syborn/Barnstead
	Puralite-Water Purity Indicator light E3450	"
	Microswitch 20 Amp, KSB-T	Mfg: Unimax

Table 4-3 Sources for Uncommon Parts (Continued)		
SCENE/FX #	DESCRIPTION	SOURCE
25/FX-52	Fog nozzle assemblies (S-11)	Environmental Control Systems, Inc. PO BOX 5 Glendora, CA 91740 (818) 963-8712
27/FX-55	Mirror, 36"x36"x1/4" 1st surface	Keim Precision Mirror Corp 2117 Empire Ave. Burbank, CA (818) 842-4543
28/FX-59	All plastic components for cyrstals	Reynolds and Taylor, Inc 2109 S. Wright St. Santa Ana, CA 92705 (714) 540-4850
	Neon lamp	Larry Albright Enterprises 419 Sunset Blvd. Venice, CA (213) 399-0865
	High Voltage Neon Transformer 721-171-100	Mfr: Jefferson Electric Dist: Interstate Electric
33/FX-63	Spherical mirrors	Reynolds and Taylor, Inc 2109 S. Wright St. Santa Ana, CA 92705 (714) 540-4850

Table 4-4 List of WED Special Effects Drawings

SCENE/FX #	DWG NO.	TITLE
11/FX-12	A7-90-A770	Lumia Effect Assy and Installation
13/FX-13	A7-90-A770	"
14/FX-16	A7-90-A598	Mini Fiber Optic Illuminator
16/FX-27	A7-90-A598	"
16/FX-28	A7-90-A337	Scent Cannon
	A7-90-A659	Citrus Scent Installation
17/FX-30	A7-90-A679	Mylar Water Ripple/Reflections
	A7-90-A229	Small Blower
17/FX-71	A7-90-A663	Pantry Freezer
	A7-90-A146	Fog Box, Ultrasonic, Type 1
20/FX-72	A7-90-A679	Mylar Water Ripple/Reflections
	A7-90-A229	Small Blower
23/FX-47	A7-90-A598	Mini Fiber Optic Illuminator
25/FX-52	A7-90-A684	Flight Thrusters
27/FX-55	A7-90-A693	Basketball Players Shadows
28/FX-59	A7-90-A698	Crystal Structure Assy, Crystal FX-59
	A7-90-A701	Systems Diagram, Crystal FX-59
	A7-90-A702	Dodecahedron Assy, Crystal FX-59
	A7-90- 703	Lamp, Neon, Crystal FX-59
	A7-90-A704	Hub, Dodecahdrn Assy, Crystal FX-59
	A7-90- 705	Internal Gear, Modified, Crystal FX-59
	A7-90-A706	Globe, Spherical Assy, Crystal FX-59
	A7-90-A707	Collar, Spherical Globe Assy Crystal FX-59
	A7-90- 708	Spur Gear, Modified, Crystal FX-59
	A7-90- 709	Collar, Pinion, Crystal FX-59
	A7-90- 710	Retainer, Pinion Gear, Crystal FX-59
	A7-90- 711	Bushing, Modified, Crystal FX-59
	A7-90- 712	Collar, Lamp Bracket, Crystal FX-59
	A7-90- 713	Bracket, Lamp, Crystal FX-59
	A7-90-A714	Bushing, Pinion Gear Assy, Crystal FX-59
	A7-90- 715	Bearing, Thrust Mod, Crystal FX-59
	A7-90- 716	Tube, Flanged, Crystal FX-59
	A7-90- 717	Color Filter - Pentagonal, Crystal FX-59
33/FX-63	A7-90-A681	Aerial Images

SECTION 5 RIDE CONTROL

This section provides information required to maintain the Horizons Ride Control System (see Figure 5-1 for the GPRCS Block Diagram). Included is a general description, operating information, functional description, and maintenance procedures for the Ride Control System. Also contained in this section is information about the Horizons Finale Video Request System (HFVRS), which consists of the electronics used in conjunction with the finale scenes in the Horizons Pavilion. Table 5-1 is a list of abbreviations used throughout this section.

Table 5-1 List of Abbreviations

AX01	Floor-mounted IR Transmitter (finale show start beacon)
AX02	Floor-mounted IR receiver (show)
CTS	Track Crack Detector
DCM	Display Control Module (part of ROC)
GIR	Green Light IR Sensor (transmissive)
GLSS	Green Light Sensor System
GSPE	Guest Selection Processing Electronics
GSPR	Floor-mounted IR receiver (maintenance)
GVP	Guest Voting Panel
HFVRS	Horizons Finale Video Request System
LSC	Load Switch Control
MCC	Master Control Center
MTP	Maintenance Test Panel
PWM	Pulse Width Modulation
PRT	Data Logger (printer)
PVAA	PALS Vehicle Audio Amplifier
RBS	Sensor Breakout Box
RMC	Motor Control Cabinet
RCC	Ride Control Computer
RDC	Remote Data Concentrator
RFPS	Frame Present Fin
RFSS	Frame Speed Fin
RGS	Green Light Signal Conditioner
RIR	Slotted Fin IR Sensor (transmissive)
RMP	Maintenance Pendant Pushbutton Station
RMS	Maintenance Station Control Box
RMT	Maintenance Area Motor Controller
ROC	Ride Operator Console
RPB	Ride Parallel (Breakout) Box
RSS	Solid Fin IR Sensor (retro-reflective)
RT	Ride Terminal
RTS	Track Switch Control Station
RVPS	Vehicle Present Fin
RVSS	Vehicle Speed Fin
SIMM	Self-Incriminating Maintenance Mode
VSRP	Floor-mounted IR receiver (general nomenclature)
VAM	Vehicle Address Module
VTMS	Vehicle Track Monitor System
VTSS	Vehicle Tilt Shutdown System

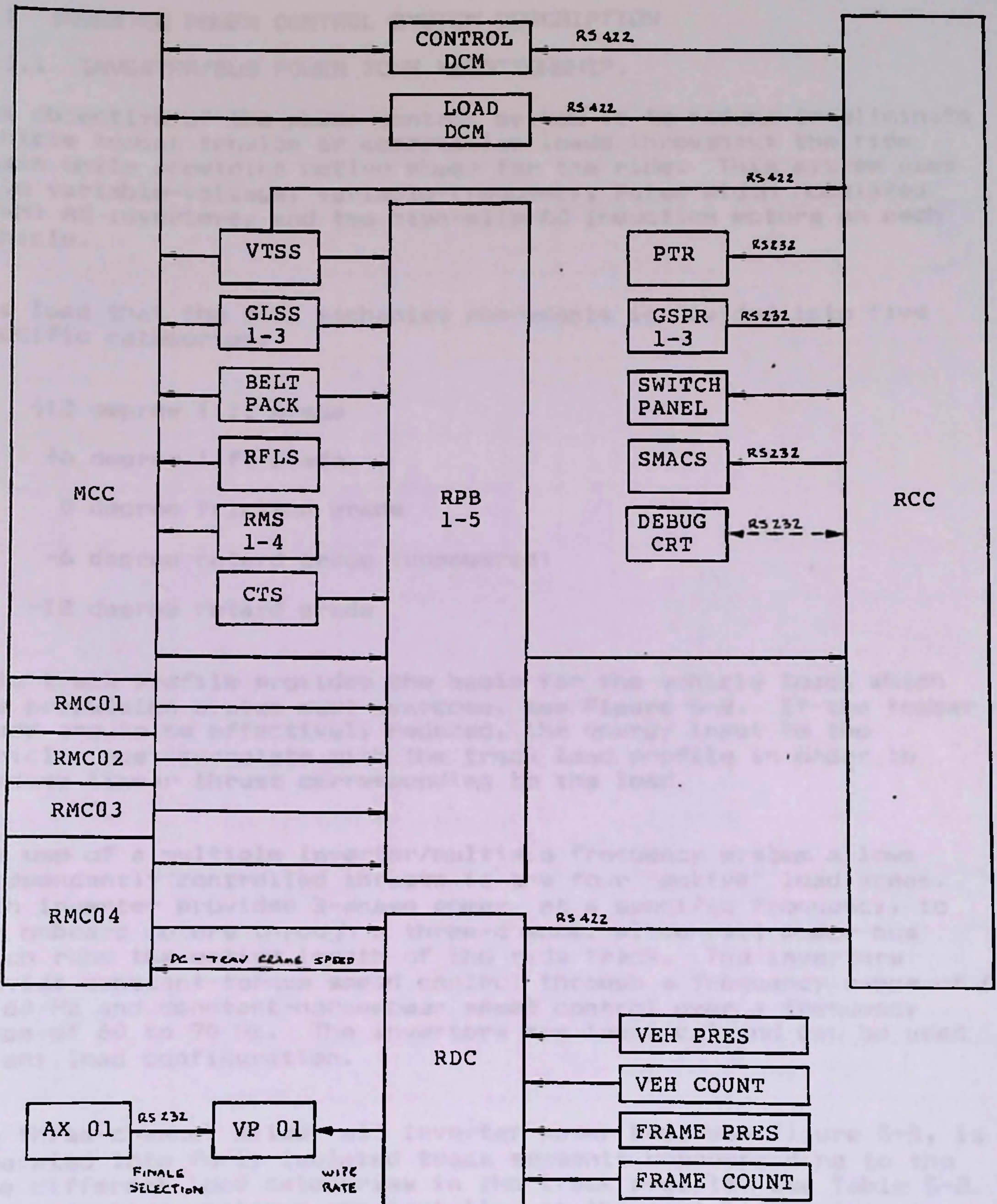


Figure 5-1 GPRCS Block Diagram

5.1 INVERTER POWER CONTROL SYSTEM DESCRIPTION

5.1.1 INVERTER/BUS POWER ZONE RELATIONSHIP.

The objective of the power control system is to reduce or eliminate vehicle towbar tension or compression loads throughout the ride chain while providing motive power for the ride. This system uses five variable-voltage, variable-frequency, Pulse Width Modulated (PWM) AC inverters, and two high-slip AC induction motors on each vehicle.

The load that the ride mechanism represents is divided into five specific categories:

a. +12 degree lift grade

b. +6 degree lift grade

c. 0 degree friction grade

d. -6 degree retard grade (unpowered)

e. -12 degree retard grade

This track profile provides the basis for the vehicle loads which the propulsion system must overcome, see Figure 5-2. If the towbar loads are to be effectively reduced, the energy input to the vehicles must correlate with the track load profile in order to produce linear thrust corresponding to the load.

The use of a multiple inverter/multiple frequency system allows independently controlled thrusts in the four "active" load areas. Each inverter provides 3-phase power, at a specific frequency, to the onboard motors through a three-channel slide-rail power bus which runs the entire length of the ride track. The inverters provide constant-torque speed control through a frequency range of 0 to 60 Hz and constant-horsepower speed control over a frequency range of 60 to 90 Hz. The inverters are identical and can be used in any load configuration.

The three-channel slide-rail inverter power bus, see Figure 5-3, is separated into forty isolated track segments corresponding to the five different load categories in the track profile, see Table 5-2. Non-conductive sections are installed at the isolation points in each of the three channels to insulate the inverter power feeds. The insulators are eight inches long to allow motor stator fields and currents to reduce to a negligible level at normal ride speed. The isolation point locations are selected for optimum towbar load reduction.

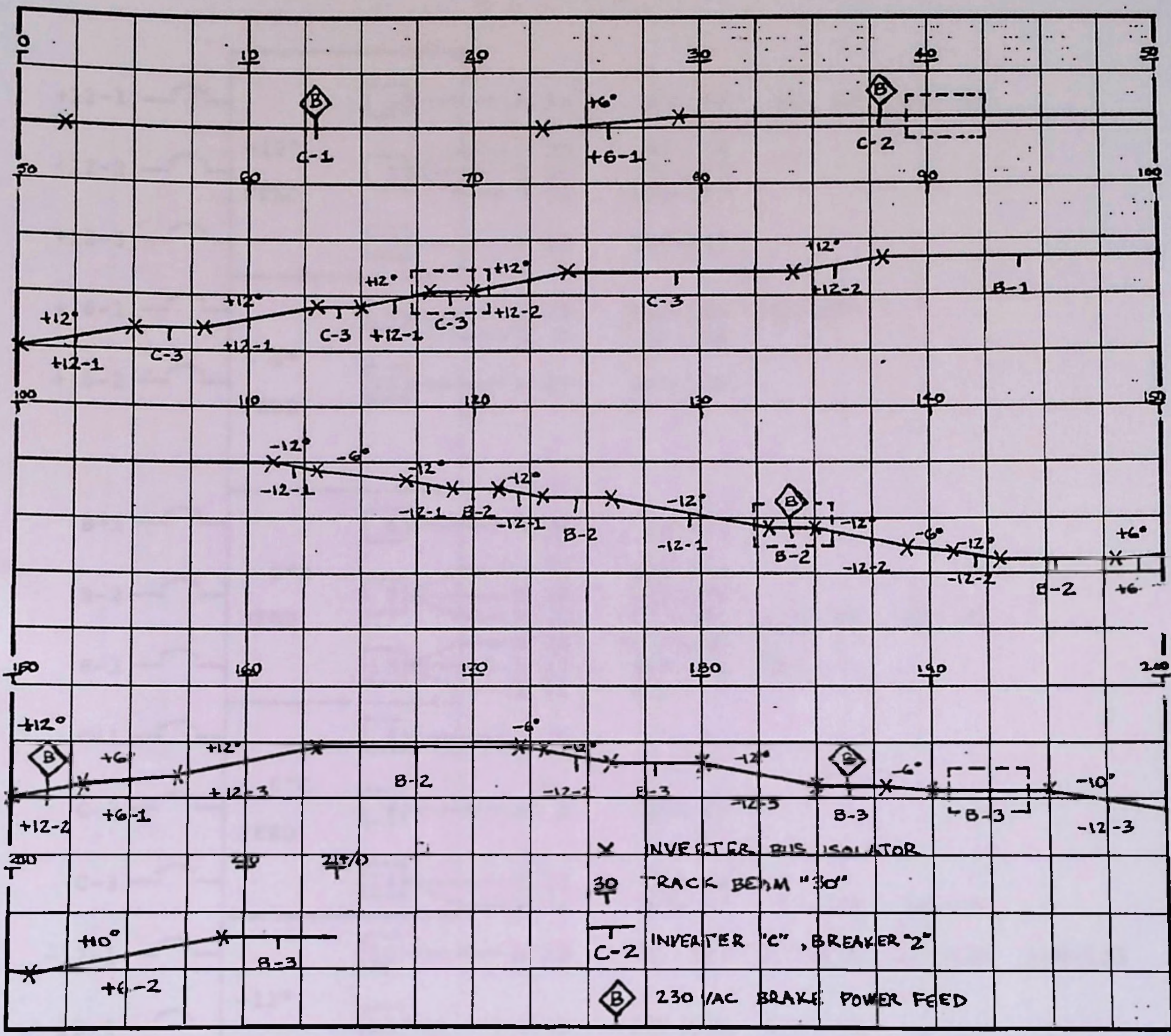


Figure 5-2 Track Profile Power Distribution System

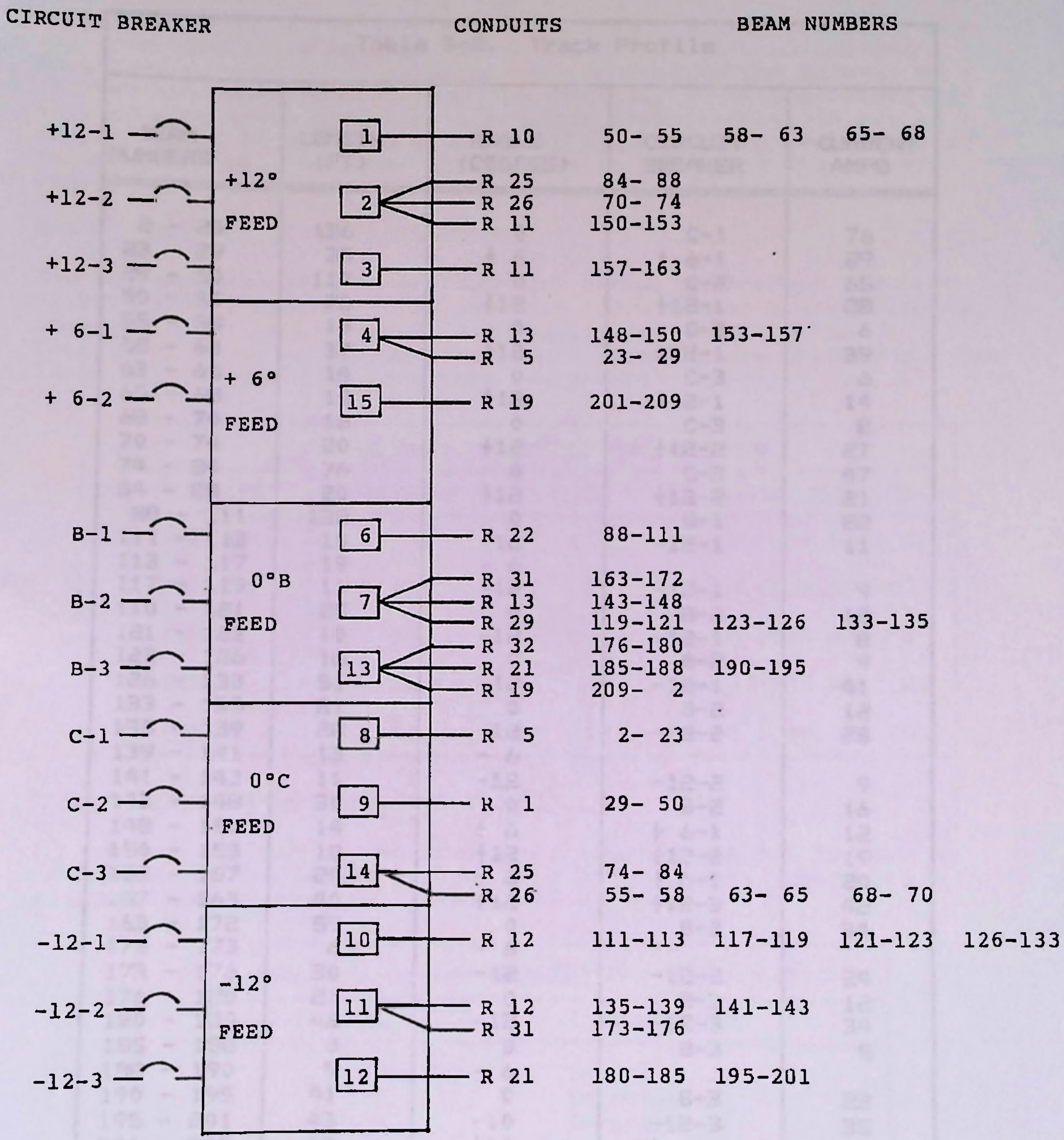


Figure 5-3 Bus Bar Power Interconnect

Table 5-2. Track Profile				
BEAM NUMBERS	LENGTH (FT)	ANGLE (DEGREE)	CIRCUIT BREAKER	CURRENT AMPS
2 - 23	136	0	C-1	76
23 - 29	35	+6	+6-1	29
29 - 50	114	0	C-2	65
50 - 55	26	+12	+12-1	28
55 - 58	14	0	C-3	6
58 - 63	37	+12	+12-1	39
63 - 65	14	0	C-3	6
65 - 68	15	+12	+12-1	14
68 - 70	16	0	C-3	8
70 - 74	20	+12	+12-2	27
74 - 84	76	0	C-3	47
84 - 88	20	+12	+12-2	21
88 - 111	138	0	B-1	82
111 - 113	14	-12	-12-1	11
113 - 117	19	- 6		
117 - 119	11	-12	-12-1	9
110 - 121	25	0	B-2	12
121 - 123	10	-12	-12-1	8
123 - 126	16	0	B-2	9
126 - 133	51	-12	-12-1	41
133 - 135	21	0	B-2	12
135 - 139	28	-12	-12-2	23
139 - 141	13	- 6		
141 - 143	11	-12	-12-2	9
143 - 148	30	0	B-2	16
148 - 150	14	+6	+6-1	12
150 - 153	18	+12	+12-2	19
153 - 157	24	+6	+6-1	20
157 - 163	40	+12	+12-3	42
163 - 172	59	0	B-2	34
172 - 173	6	- 6		
173 - 176	30	-12	-12-2	24
176 - 180	21	0	B-3	12
180 - 185	42	-12	-12-3	34
185 - 188	0	0	B-3	5
188 - 190	9	- 6		
190 - 195	41	0	B-3	23
195 - 201	43	-10	-12-3	35
201 - 209	43	+10	+6-2	42
209 - 2	37	0	B-3	21

The inverter power system uses 3-phase 460 VAC, which is transformed to 3-phase 230 VAC, then rectified to 310 VDC with a static diode rectifier. The DC bus is shared as a common energy source by the six inverters (five active and one standby). This allows the inverters to perform in a thrust mode (energy to the motors) or a regeneration mode (energy from the motors). Thus, the motors can provide a positive thrust or a negative thrust (drag) to act as a dynamic brake load. This allows a certain amount of energy to be regenerated into the power control system to reduce the overall energy required to operate the ride.

5.1.2 INVERTER/GRADE ASSIGNMENTS.

The fourteen isolated power feeds are connected through the load switch control cabinet to 36 separate track segments according to load and power requirements, which calls for five 100 KVA inverters. Four -6 degree grade track segments are unpowered. See Table 5-3 for the five inverters assignments.

Table 5-3. Inverter Assignments

INVERTER	FREQUENCY	LOAD	TRACK SECTIONS
PWM 01	Hi	+12	3 (100 AMP CB)
PWM 02	Med	+6	2 (100 AMP CB)
PWM 03	Med	0-B	3 (100 AMP CB)
PWM 04	Med	0-C	3 (100 AMP CB)
PWM 05	Lo	-12	3 (100 AMP CB)

5.1.3 BUS BAR POWER ASSIGNMENTS.

All vehicle voltage is fed from the 8-channel bus bar through a vehicle collector (power pickup) on every vehicle. Power bus channels are assigned as listed in Table 5-4.

Table 5-4. Power Bus Channel Assignments

CHANNEL	ASSIGNMENT
1	Inverter L1
2	Inverter L2
3	Inverter L3
4	Building Ground
5	120 VAC L1
6	120 VAC L2 (Neutral)
7	230 VAC L2 (Neutral)
8	230 VAC L1

5.1.4 SLIDE-RAIL BUS BAR POWER FEED.

5.1.4.1 230 VAC Inverter Bus Bar Feed (refer to Table 5-5).

Table 5-5. 230 VAC Inverter Bus Bar Feed

CIRCUIT	CONDUIT	BEAM NUMBERS			
1	R10	50- 55	58- 63	65- 68	
2	R25	84- 88			
2	R26	70- 74			
2	R11	150-153			
3	R11	157-163			
4	R13	148-150	153-157		
4	R05	23- 29			
15	R19	201-209			
6	R22	88-111			
7	R31	163-172			
7	R13	143-148			
7	R29	119-121	123-126	133-135	
13	R32	176-180			
13	R21	185-188	190-195		
8	R05	2- 23			
9	R01	29- 50			
14	R25	74- 84			
14	R26	55- 58	63- 65	68- 70	
10	R12	111-113	117-119	121-123	126-133
11	R12	135-139	141-143		
11	R31	173-176			
12	R21	180-185	195-201		

5.1.4.2 120 VAC Control Voltage Bus Bar Feed.

The 120 VAC bus bar feed contactor is controlled by switches in each of the four maintenance stations. Refer to Table 5-6.

Table 5-6. 120 VAC Control Voltage Bus Bar Feed

CIRCUIT	CONDUIT	BEAM NUMBER
1	R01	38
2	R05	16
3	R11	152
4	R21	189
5	R12	132
6- 7	R10	57
8- 9	R26	68
10-11	R25	81
12-13	R22	104
14-15	R13	146
16-17	R31	169
18-19	R19	202
20-21	R32	180

5.1.4.3 230 VAC Brake Voltage Bus Bar Feed.

The 1-phase 230 VAC brake voltage is fed from one phase of the 3-phase 500 KVA ride transformer in the ride equipment room. The brake load is distributed through five 20 amp circuit breakers, located in the facilities electrical cabinet in the ride equipment room, to individual trackside disconnect switches. Refer to Table 5-7.

Table 5-7. 230 VAC Brake Voltage Bus Bar Feed

CIRCUIT	BEAM NUMBER
1	13
2	38
3	134
4	153
5	186

5.2 INVERTER CONFIGURATION AND OPERATION

The proper configuration of the inverter power control system requires the analysis of many parameters of the track structure, vehicle chain, and power feed system. Measurements and calculations provide data which will result in a properly designed and installed ride facility and ride control system.

This section documents the parameters of this ride which relate to the proper setup and operation of the inverter power/control system.

5.2.1 TRACK PROFILE CALCULATIONS.

Refer to drawing CONT-157861, which provides curve and elevation data from the circled reference points and beam numbers on the drawing.

Total Grade Length:	+12 Grades:	176 feet
	+6 Grades:	116 feet
	Level Grades:	767 feet
	-6 Grades:	47 feet
	-12 Grades:	240 feet
Total Track Length:		1346 feet

+12 degree grades:

Beam Numbers	Feet
50 - 55	26
58 - 63	37
65 - 68	15
70 - 74	20
84 - 88	20
150 - 153	18
157 - 163	40
Total	176

$$F = \frac{790\ \text{lbs}}{\text{car}} \times \frac{\text{car}}{7.75\ \text{feet}} \times \frac{176\ \text{feet}}{\text{track}} = 17{,}941\ \text{lbs}$$

$$HP = F\ (\text{lbs}) \times \frac{V\ (\text{ft})}{(\text{sec})} \times \frac{\text{sec}}{e\ (\%)\ 550\ \text{ft-lbs}}$$

$$HP = \frac{17{,}941 \times 1.65}{0.90 \times 550} = 60\ \text{HP (maximum)}$$

+ 6 degree grades:

Beam Numbers	Feet
23 - 29	35
148 - 150	14
153 - 157	24
201 - 209	43
Total	116

$$F = \frac{462\ \text{lbs}}{\text{car}} \times \frac{\text{car}}{7.75\ \text{feet}} \times \frac{116\ \text{feet}}{\text{track}} = 6{,}915\ \text{lbs}$$

$$HP = \frac{6{,}915 \times 1.65}{0.90 \times 550} = 23\ \text{HP (maximum)}$$

0 degree B grades:

Beam Numbers	Feet
88 - 111	138
119 - 121	25
123 - 126	16
133 - 135	21
143 - 148	30
163 - 172	59
176 - 180	21
185 - 188	9
190 - 195	41
209 - 2	37
Total	397

$$F = \frac{128 \text{ lbs}}{\text{car}} \times \frac{\text{car}}{7.75 \text{ feet}} \times \frac{397 \text{ feet}}{\text{track}} = 6{,}557 \text{ lbs}$$

$$HP = \frac{6{,}557 \times 1.65}{0.90 \times 550} = 22 \text{ HP (maximum)}$$

0 degree C grades:

Beam Numbers	Feet
2 - 23	136
29 - 50	114
55 - 58	14
63 - 65	14
68 - 70	16
74 - 84	76
Total	370

$$F = \frac{128 \text{ lbs}}{\text{car}} \times \frac{\text{car}}{7.75 \text{ feet}} \times \frac{370 \text{ feet}}{\text{track}} = 6{,}111 \text{ lbs}$$

$$HP = \frac{6{,}111 \times 1.65}{0.90 \times 550} = 20 \text{ HP (maximum)}$$

-12 degree grades:

Beam Numbers	Feet
111 - 113	14
117 - 119	11
121 - 123	10
126 - 133	51
135 - 139	28
141 - 143	11
173 - 176	30
180 - 185	42
195 - 201	43
Total	240

$$F = \frac{-540 \text{ lbs}}{\text{car}} \times \frac{\text{car}}{7.75 \text{ feet}} \times \frac{240 \text{ feet}}{\text{track}} = -16{,}722 \text{ lbs}$$

$$HP = \frac{-16.722 \times 1.65}{0.90 \times 550} = -56 \text{ HP (maximum)}$$

- 6 degree grades (unpowered zones):

Beam Numbers	Feet
113 - 117	19
139 - 141	13
172 - 173	6
188 - 190	9
Total	47

5.2.2 INVERTER OUTPUT POWER.

(Assume 50% Electrical Losses)

$$P = \text{HP} \times \frac{760\ \text{Watts}}{\text{HP}} \times 150\ \% = \text{Watts}$$

+12 degree grades inverter:

$$P = 60\ \text{HP} \times \frac{760\ \text{Watts}}{\text{HP}} \times 1.5 = 68.4\ \text{KW}$$

+ 6 degree grades inverter:

$$P = 23\ \text{HP} \times \frac{760\ \text{Watts}}{\text{HP}} \times 1.5 = 26.2\ \text{KW}$$

0 degree B grades inverter:

$$P = 21\ \text{HP} \times \frac{760\ \text{Watts}}{\text{HP}} \times 1.5 = 23.9\ \text{KW}$$

0 degree C grades inverter:

$$P = 20\ \text{HP} \times \frac{760\ \text{Watts}}{\text{HP}} \times 1.5 = 22.8\ \text{KW}$$

-12 degree grades inverter:

$$P = 56\ \text{HP} \times \frac{760\ \text{Watts}}{\text{HP}} \times 1.5 = 63.8\ \text{KW}$$

5.2.3 INVERTER LOADS WITH OPTIMAL TOWBAR STRESS.

+12 Degree Track Load:

Beams	Phase Current	Circuit Breaker
50 - 68	80 Amps Per Leg	+12-1
70 - 153	67 Amps Per Leg	+12-2
157 - 163	42 Amps Per Leg	+12-3

+ 6 Degree Track Load:

Beams	Phase Current	Circuit Breaker
23 - 29	60 Amps Per Leg	+6-1
201 - 209	42 Amps Per Leg	+6-2

0 Degree B Track Load:

Beams	Phase Current	Circuit Breaker
88 - 111	82 Amps Per Leg	B-1
119 - 172	84 Amps Per Leg	B-2
176 - 2	62 Amps Per Leg	B-3

0 Degree C Track Load:

Beams	Phase Current	Circuit Breaker
2 - 23	76 Amps Per Leg	C-1
29 - 50	65 Amps Per Leg	C-2
55 - 84	66 Amps Per Leg	C-3

-12 Degree Track Load (does not account for inverter losses):

Beams	Phase Current	Circuit Breaker
111 - 133	69 Amps Per Leg	-12-1
135 - 176	56 Amps Per Leg	-12-2
180 - 201	68 Amps Per Leg	-12-3

5.2.4 VEHICLE LOAD CALCULATIONS.

Vehicle Length	L = 7.75 feet
Vehicle Weight	W = 3200 lbs (w/live load)
Rolling Friction	u = 0.04
Number of Vehicles	= 175
Velocity	V = 0 to 1.65 ft/sec
Propulsion System Efficiency	e = 90%
Horsepower (constant)	HP = 550 ft-lbs/sec

+12 degree grades:

$$\text{Force (F)} = (\text{Sin } 12° \times W) + (\text{Cos } 12° \times u \times W)$$

$$F = (0.21 \times 3200) + (0.98 \times 0.04 \times 3200)$$

$$= 665 \text{ lbs} + 125 \text{ lbs}$$

$$= 790 \text{ lbs} \quad \text{(force required to move vehicle)}$$

+ 6 degree grades:

$$\text{Force (F)} = (\text{Sin } 6° \times W) + (\text{Cos } 6° \times u \times W)$$

$$F = (0.10 \times 3200) + (0.99 \times 0.04 \times 3200)$$

$$= 334 \text{ lbs} + 127 \text{ lbs}$$

$$= 462 \text{ lbs}$$

0 degree grades:

$$\text{Force (F)} = \text{Cos } 0° \times u \times W$$

$$F = 1.00 \times 0.04 \times 3200$$

$$= 128 \text{ lbs}$$

-12 degree grades:

$$\text{Force (F)} = (-\text{Sin } 12° \times W) + (\text{Cos } 12° \times u \times W)$$

$$F = (-0.21 \times 3200) + (0.98 \times 0.04 \times 3200)$$

$$= -665 \text{ lbs} + 125 \text{ lbs}$$

$$= -540 \text{ lbs} \quad \text{(regenerative force for braking)}$$

5.2.5 VEHICLE MOTOR WORK CYCLE.

$$\frac{176 \text{ ft}}{1.5 \text{ ft/sec}} = 117 \text{ seconds on } +12 \text{ degree grade}$$

$$\frac{116 \text{ ft}}{1.5 \text{ ft/sec}} = 77 \text{ seconds on } +6 \text{ degree grade}$$

$$\frac{767 \text{ ft}}{1.5 \text{ ft/sec}} = 511 \text{ seconds on } 0 \text{ degree grade}$$

$$\frac{47 \text{ ft}}{1.5 \text{ ft/sec}} = 31 \text{ seconds on } -6 \text{ degree grade}$$

$$\frac{240 \text{ ft}}{1.5 \text{ ft/sec}} = 160 \text{ seconds on } -12 \text{ degree grade}$$

Total Time = 896 seconds

$$F_{rms} = \left[\frac{F^2(+12°) \times t + F^2(+6°) \times t + F^2(+0°) \times t + F^2(-12°) \times t}{896} \right]^{1/2}$$

$$= \left[\frac{(790^2 \times 117) + (462^2 \times 77) + (128^2 \times 511) + (-540^2 \times 195)}{896} \right]^{1/2}$$

= 415 lbs per vehicle

$$HP = F \text{ (lbs)} \times \frac{V \text{ (ft)}}{\text{(sec)}} \times \frac{\text{sec}}{e \text{ (\%) } 550 \text{ ft-lbs}}$$

$$HP_{rms} = \frac{415 \times 1.50}{0.90 \times 550}$$

= 1.26 HP per vehicle

5.2.6 VEHICLE THRUST

The vector diagram (Figure 5-4) illustrates the thrusts that the vehicle must produce in order to reduce towbar tension or compression during constant speed or constant acceleration. To understand this method of open loop control, it is necessary to understand the operation of the high-slip AC induction motor.

An induction motor develops torque (thrust) as a function of slip speed, in reference to synchronous (no load) speed. The design of this motor calls for a synchronous speed of 1800 RPM, with a 10% slip at full load. Therefore, this motor is rated to continuously develop 3 pound-feet of torque at 1620 RPM.

For this application it is necessary to relate linear ride speed, rotational motor speed, and thrust, in terms of frequency, so that each term may be referenced to the other variables. The following transfer functions are established:

Fv =	vehicle propulsion thrust	(lbs)
Tm =	motor torque	(lb-ft)
Ma =	drive wheel moment arm	(feet)
e =	efficiency ratio	(%)
2 =	number of motors sharing load	
Nr =	gear box ratio times pulley ratio	(25:1 x 1.3:1)
Km =	vehicle constant	

$$Fv = \frac{Tm}{Ma} \times Nr \times 2 \times e$$

$$Fv = \frac{3\ \text{lb-ft}}{0.33\ \text{ft}} \times 32.5 \times 2 \times 90\ \%$$

$$= 532\ \text{lbs}\ \ \text{(thrust available from each vehicle)}$$

The vehicles can be pictured as linear thrusters, and related directly to the track profile loads, which allows quantification of the vehicle force necessary to cancel the towbar loads.

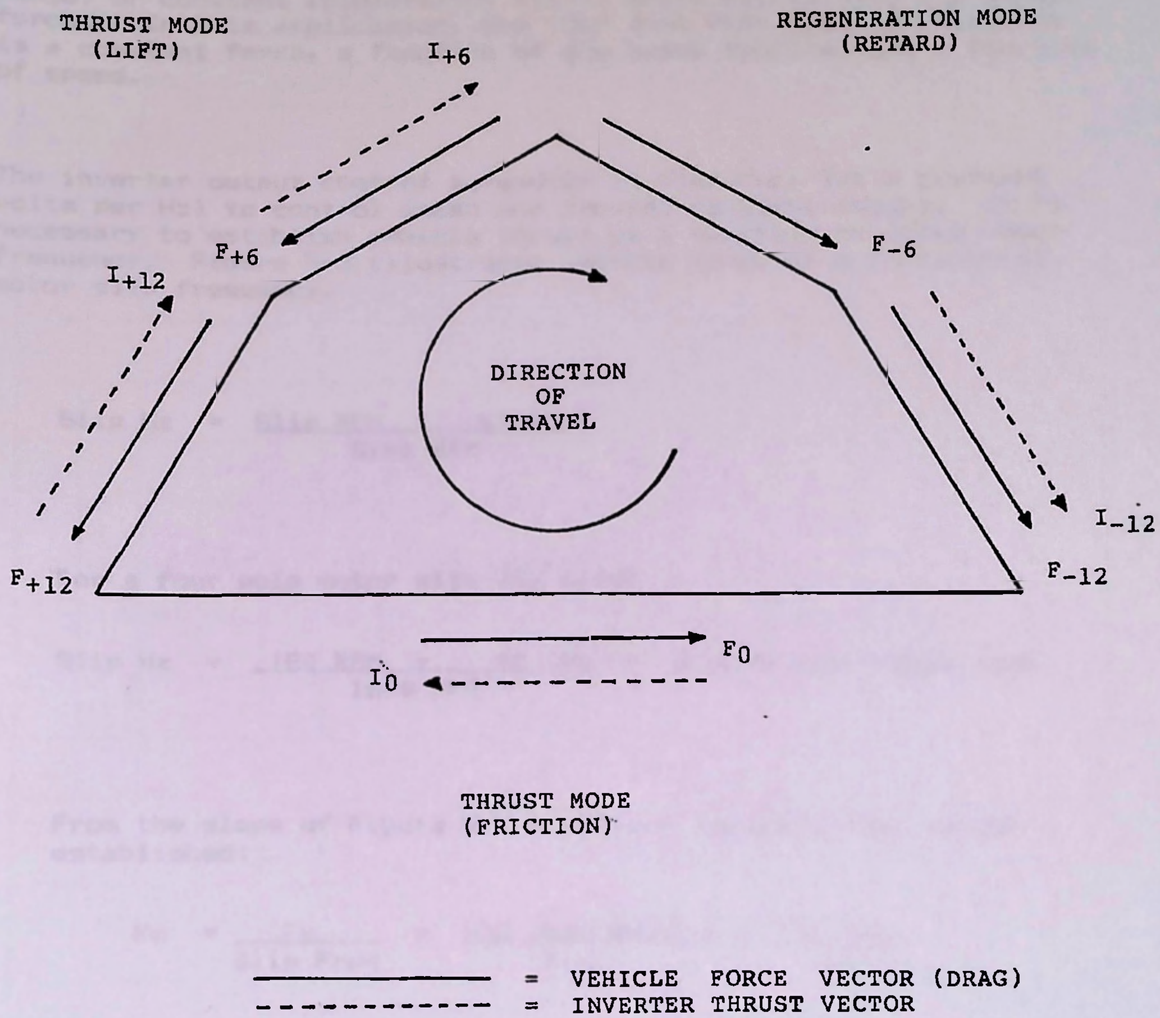


Figure 5-4 Thrust Vectors

5.2.6.1 Vehicle Thrust/Motor Slip Relationship.

The control system must maintain constant speed (over a 2:1 speed range) or constant acceleration (+/-), while maintaining low towbar forces. In this application, the load that each inverter supports is a constant force, a function of the track profile, not a function of speed.

The inverter output control parameter is frequency (at a constant volts per Hz) to control speed and provide constant torque. It is necessary to establish vehicle thrust as a function of input power frequency. Figure 5-5 illustrates vehicle force as a function of motor slip frequency.

$$\text{Slip Hz} = \frac{\text{Slip RPM} \times \text{Line Hz}}{\text{Sync RPM}}$$

For a four pole motor with 10% slip:

$$\text{Slip Hz} = \frac{180 \text{ RPM} \times 60 \text{ Hz}}{1800 \text{ RPM}} = 6 \text{ Hz @ full rated load}$$

From the slope of Figure 5-5 a vehicle constant (Km) can be established:

$$\text{Km} = \frac{\text{Ev}}{\text{Slip Freq}} = \frac{532 \text{ lbs/vehicle}}{6 \text{ Hz}} = \frac{83 \text{ lbs}}{\text{Hz}}$$

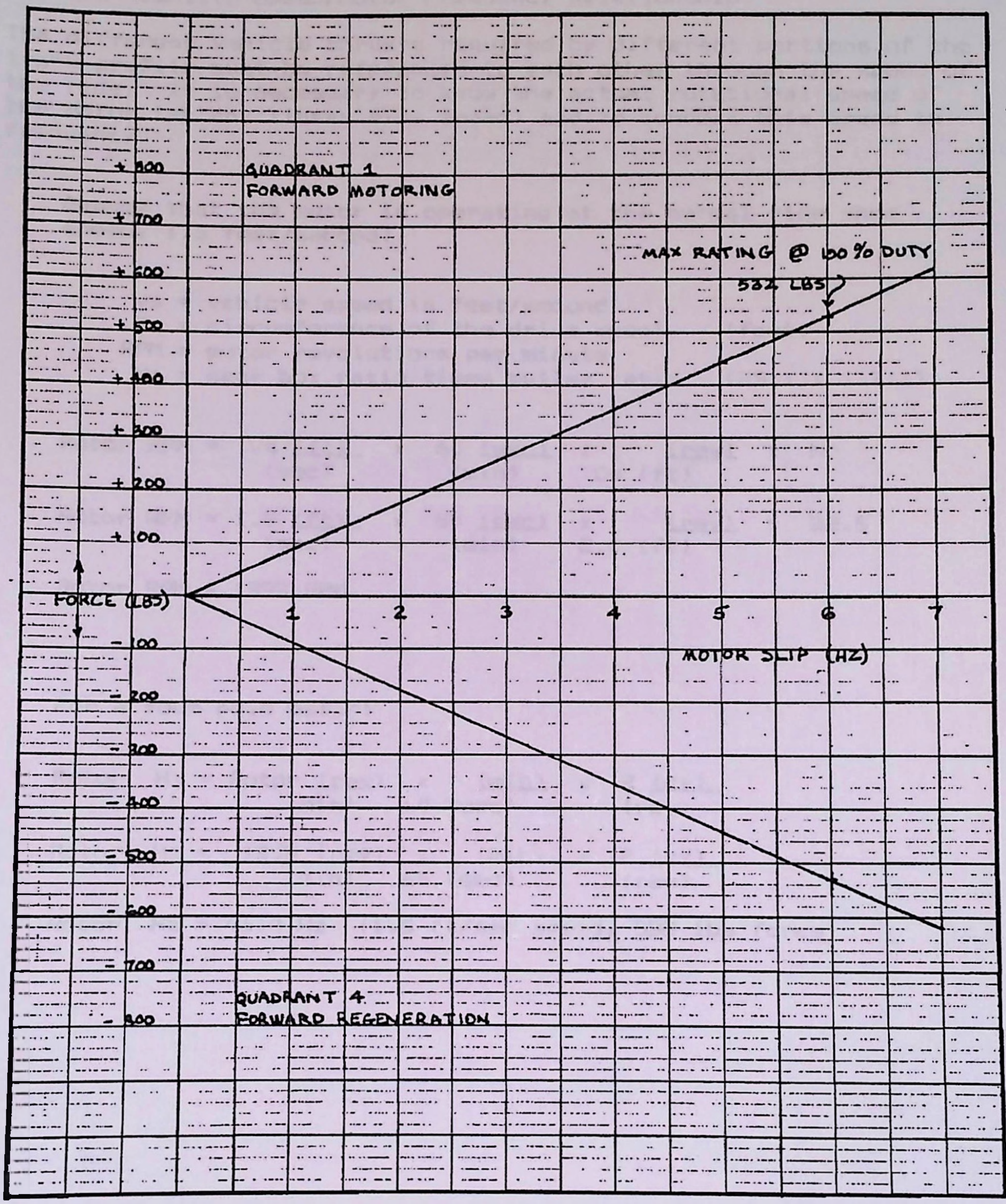


Figure 5-5 Vehicle Force (lbs) vs Motor Slip (Hz)

5.2.6.2 Vehicle Speed/Motor Frequency Relationship.

The different vehicle thrusts required by different portions of the track profile must be referenced to each other through the speed of the ride. It is necessary to know the actual rotational speed of the motor (at any linear ride speed) and to convert this speed to frequency.

Assume that the motor is operating at the normal ride show speed, 1.5 feet/second:

Vs = vehicle speed in feet/second
Cw = circumference of the drive wheel (feet)
RPM = motor revolutions per minute
Nr = gear box ratio times pulley ratio (25:1 x 1.3:1)

$$\text{Rotor RPM} = Vs\ \frac{(ft)}{(sec)} \times 60\ \frac{(sec)}{(min)} \times \frac{(rev)}{Cw\ (ft)} \times Nr$$

$$\text{Rotor RPM} = 1.5\ \frac{(ft)}{(sec)} \times 60\ \frac{(sec)}{(min)} \times \frac{(rev)}{2.1\ (ft)} \times 32.5$$

Rotor RPM = 1393 RPM

For a four pole motor:

$$\text{Rotor Hz} = \text{Rotor}\ \frac{(rev)}{(min)} \times \frac{(min)}{60\ (sec)} \times 2\ \frac{(cy)}{(rev)}$$

$$\text{Rotor Hz} = 1393\ \frac{(rev)}{(min)} \times \frac{(min)}{60\ (sec)} \times 2\ \frac{(cy)}{(rev)}$$

Rotor Hz = 46.4 Hz (1.5 ft/sec speed, 532 lbs force)

5.2.7 INVERTER FREQUENCY VALUES.

The following inverter settings are for reference only, and do not represent the final empirically derived values attained during the test and adjust period. They are important because the calculated values account for all the predictable variables that affect ride forces.

Inv	Type Load	Thrust	Slip Hz	Inverter Hz
	(Normal)	+532 lbs	+6.0 Hz	46.4 Hz
1	+12 degree	+790 lbs	+9.5 Hz	55.9 Hz
2	+6 degree	+462 lbs	+5.5 Hz	51.9 Hz
3	B-0 degree	+128 lbs	+1.5 Hz	47.9 Hz
4	C-0 degree	+128 lbs	+1.5 Hz	47.9 Hz
5	-12 degree	-540 lbs	-6.5 Hz	39.9 Hz

5.2.8 INVERTER SPEED CONTROL SYSTEM.

The inverter system speed command is an analog voltage output from the master reference control circuit. This signal is wired to the inputs of all six inverters and the belt drive systems. Each inverter has a frequency offset potentiometer which provides a constant bias voltage that is summed with the master reference signal. This bias voltage provides an additional "fine tuning" component to the inverter output frequency, with a range of 0 to 20 Hz. Figure 5-6 illustrates the master reference and offset method used to set the output frequencies of the inverter system.

Figure 5-7, Inverter Hz vs Ride Speed, illustrates the design concept of this control system. The slope for each of the inverters is exactly parallel to the others. This is necessary if the control system is to provide constant thrust at all speeds and during + or - accelerations.

Note that the -12 degree inverter must operate entirely in the first quadrant of the graph since the inverter cannot deliver negative Hz. In addition, this inverter must operate at some minimum frequency above zero in order to develop neutral torque at ride speed.

5.2.9 CONTROL SEQUENCING.

When the ride is commanded to start, the inverters supply energy to the vehicle motors in a "ramp" fashion, as shown in Figure 5-7, until normal ride speed is reached. The reverse sequence occurs during a normal stop.

During the ride start sequence, the vehicle brakes are released shortly after the motors begin developing thrust. During the ride stop sequence, the vehicle brakes are applied shortly before the motors stop producing thrust. This prevents the vehicle chain from "settling" into a condition where high static towbar tension loads occur at the high point of the ride track, and high static towbar compression loads occur at the low point of the ride track.

The point at which the brakes actuate is determined by a "threshold" control circuit, which activates the 1-phase 230 VAC brake bus at a selected inverter speed command control voltage, as the control voltage ramps up or down during acceleration or deceleration.

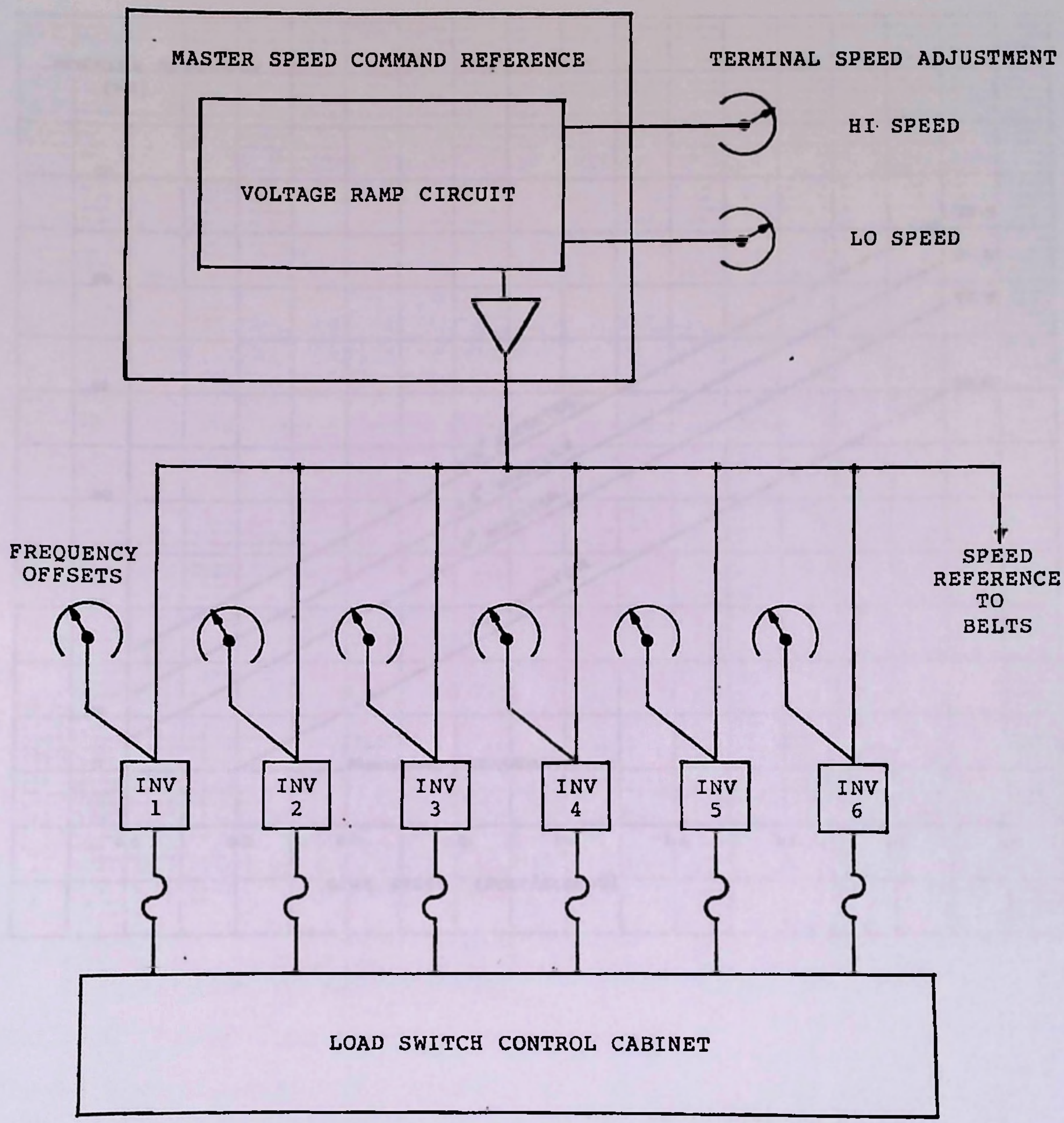


Figure 5-6 Speed Command Voltage Control

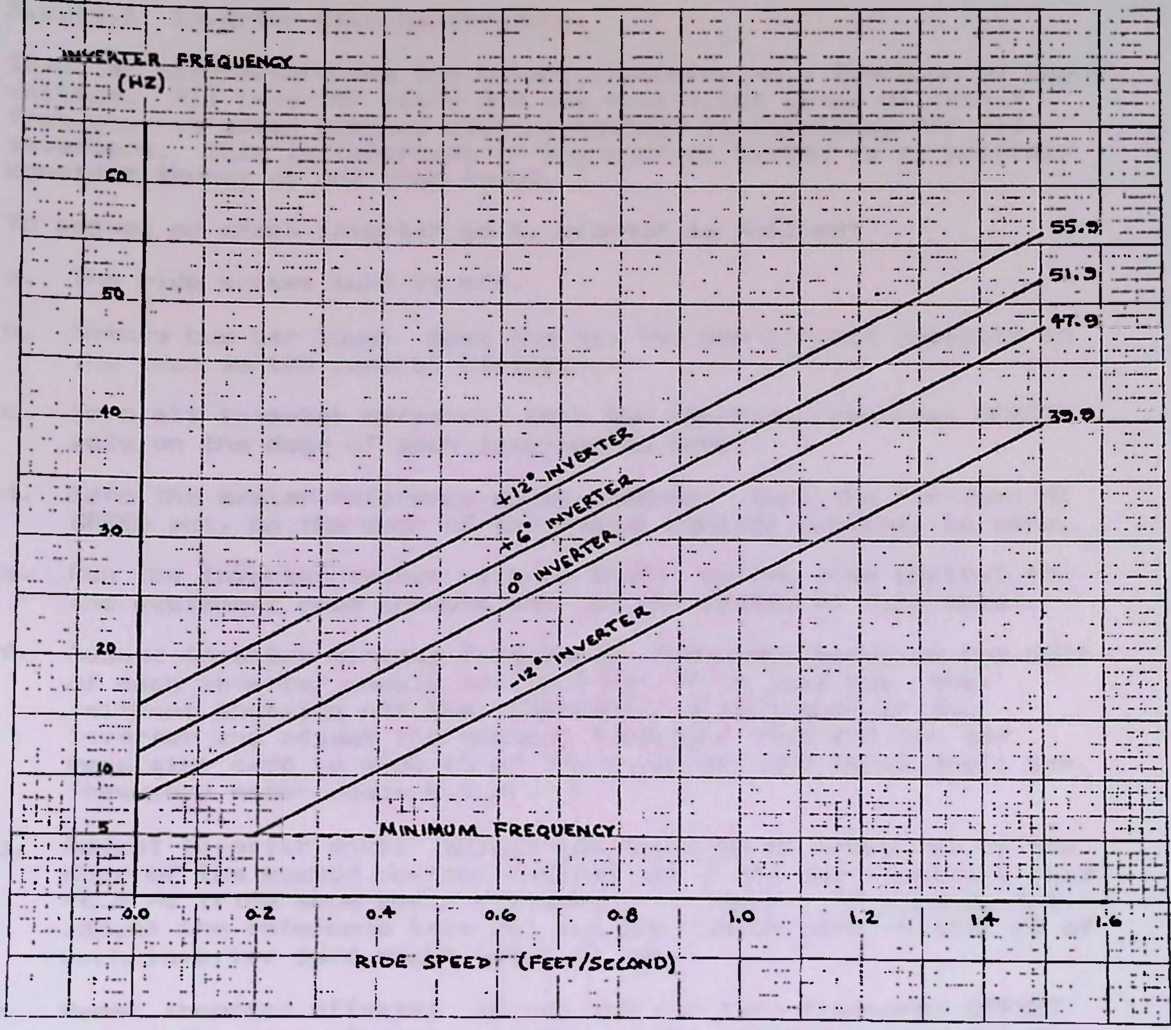


Figure 5-7 Inverter Hz vs Ride Speed

5.2.10 INVERTER ADJUSTMENT.

Adjustment of the inverter system requires that a number of items be checked, adjusted, or installed.

5.2.10.1 Inverter Gain Calibration.

Inverter gain determines the output frequency as a function of input voltage. All inverter gains are set equal; the slope of output frequency vs speed command control voltage is identical for all inverters. This is important if the control system is to maintain constant thrust at any ride speed.

To adjust or check inverter gain, proceed as follows:

a. The ride system must be off.

b. Remove bus bar load: open the six 300 amp circuit breakers in the load switch control cabinet.

c. Zero all inverter offsets: turn the ten-turn frequency OFFSET pots on the door of each inverter to zero.

d. Zero the master reference speed command: turn the ten-turn HI SPEED pot, on the door of the master control cabinet, to zero.

e. Run the inverter system with no load: switch ride control to the equipment room console and run the system at full speed.

f. Adjust inverter minimum frequency: frequency meter on the door of each inverter should read 5.0 Hz; if it does not, open (without shutting off the inverter) the left door of the inverter and adjust the minimum frequency trim pot (on the regulator card in slot 15 of the inverter card rack) until the frequency meter reads 5.0 Hz.

g. Adjust inverter gain: adjust the ten-turn HI SPEED pot on the door of the master control cabinet until all the inverters read 46.4 Hz (ride show speed frequency, no load). If some do not, adjust the reference trim pot (on the custom card in slot 21 of each inverter card rack) until it does.

h. Reset inverter offsets: adjust the ten-turn frequency OFFSET pot on the door of each inverter to the value required for the load assigned to that inverter.

5.2.10.2 Towbar Load Cell and Instrumentation.

Figure 5-8 illustrates the installation method for the load cell and associated instrumentation. The strain gauge conditioner should be calibrated such that 1 millivolt equals 10 pounds of tension or compression. The chart recorder should be set at 10 mv/division and 2mm/second chart speed, and should be zeroed so that at "no load" the pen is at the center of the graph on the chart paper. To ensure that the readings are accurate, the vehicle with the load cell, and five adjacent vehicles in either direction, should be operational.

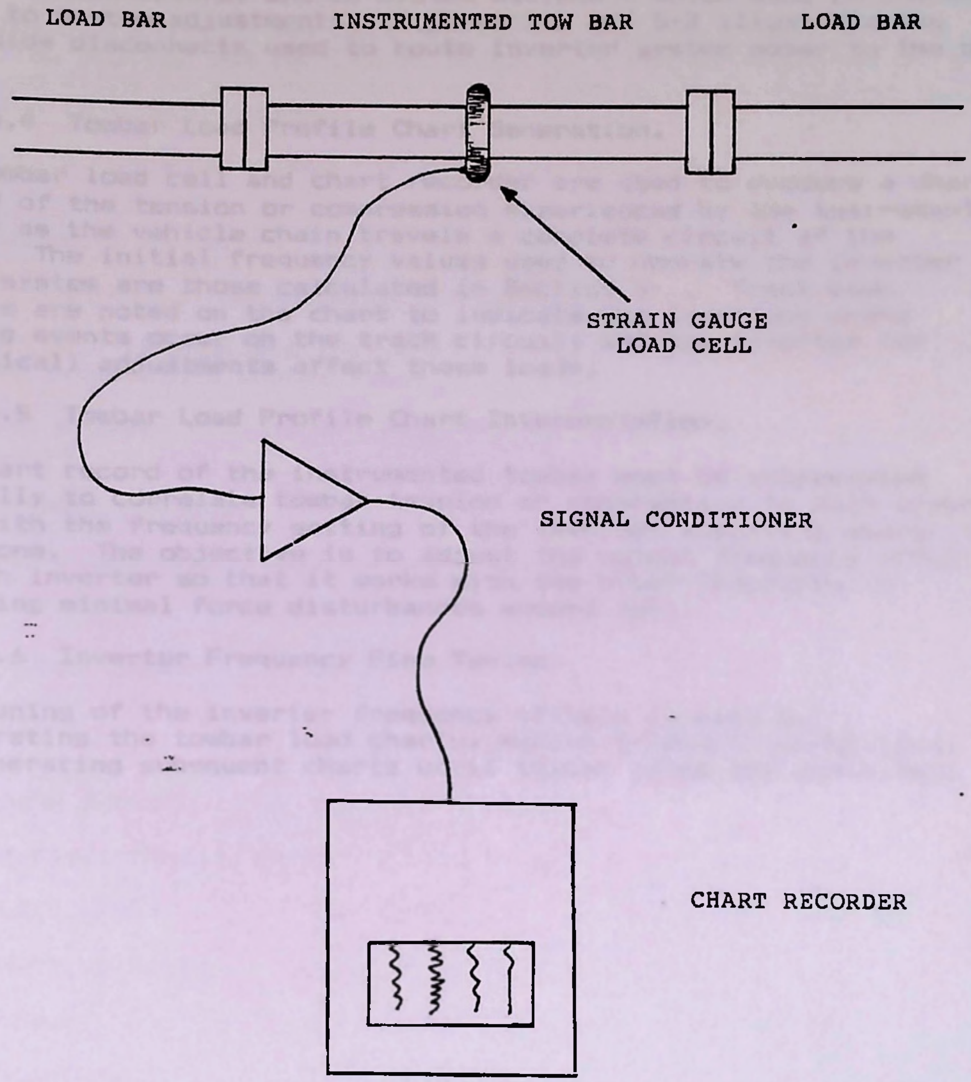


Figure 5-8 Load Cell Installation

5.2.10.3 Circuit Breakers and Disconnects.

All circuit breakers and disconnects should be closed to perform the inverter setup procedure. Figure 5-9 illustrates the circuit breakers, connectors, and GE system equipment which must be checked prior to system adjustments. Figures 5-2 and 5-3 illustrate the trackside disconnects used to route inverter system power to the bus bar.

5.2.10.4 Towbar Load Profile Chart Generation.

The towbar load cell and chart recorder are used to produce a chart record of the tension or compression experienced by the instrumented towbar as the vehicle chain travels a complete circuit of the track. The initial frequency values used to operate the inverter power system are those calculated in Section 5-.. Track beam numbers are noted on the chart to indicate the locations where loading events occur on the track circuit, and how inverter (or mechanical) adjustments affect these loads.

5.2.10.5 Towbar Load Profile Chart Interpretation.

The chart record of the instrumented towbar must be interpreted carefully to correlate towbar tension or compression in each power zone with the frequency setting of the inverter supplying energy to that zone. The objective is to adjust the output frequency offset of each inverter so that it works with the other inverters in producing minimal force disturbances around zero.

5.2.10.6 Inverter Frequency Fine Tuning.

Fine tuning of the inverter frequency offsets is done by interpreting the towbar load charts, making inverter corrections, and generating subsquent charts until towbar loads are minimized.

5.3 VEHICLE PROPULSION

5.3.1 PROPULSION DESCRIPTION (refer to Figure 5-9).

The propulsion system for each underslung vehicle consists of two AC induction motors, one per bogie, which turn two wheels, providing a friction drive on a round track pipe. Each motor is supplied with a standard rear mount brake.

This drive system provides the following features:

a. High-slip AC motors

b. Overcurrent circuit breakers with manual reset

c. Bi-metal thermostats (klixons) in the stators to provide case overtemperature protection

d. Disc brakes, with manual release, to provide static (zero-speed) braking

e. A 3-pole contactor

f. Gear boxes with a 25:1 ratio, and a 1.3:1 pulley ratio

5.3.2 MOTOR:

Model Number	5K48VG8050V
Type	1 HP, 230 VAC, 3-phase; hi-slip (10%), induction motor
Base Speed	1620 RPM @ 10% slip
Ambient Conditions	40° C @ 80% humidity
Duty Cycle	continuous, 17 hours/day
Service Class	I to II
Frame	143T open, drip proof (splash guard)
Mounting	foot mount
Shaft	to accept sheave hub for timing belts with tapered hub; capable of mounting hollow shaft standard torque brake on rear of motor
Stator	vendor's standard-wound stator with klixons set at operating temperature to protect the motor from overtemp
Input	from vendor's PWM inverter output of 230 VAC, 3-phase, 60Hz at base speed

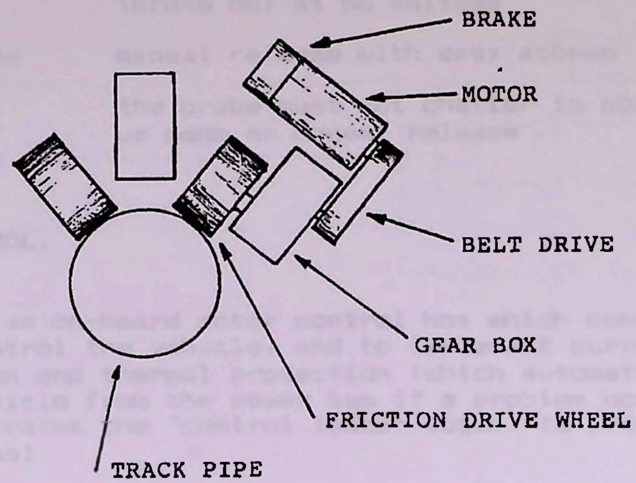


Figure 5-9 Vehicle Propulsion Unit Configuration

5.3.3 BRAKE (to mount on the rear of the AC motor).

Torque	3 foot-pounds minimum
Ambient Conditions	40° C @ 80% humidity
Solenoid	230 VAC, 1-phase, 60 Hz, controlled from relay outside of motor frame, actuate (brake on) at no voltage
Brake Release	manual release with easy access
Noise	the brake must not chatter in normal pick up mode or manual release

5.3.4 MOTOR CONTROL.

Each vehicle uses an on-board motor control box which contains the relay logic to control the vehicle, and to implement current overload protection and thermal protection (which automatically disconnect the vehicle from the power bus if a problem occurs). Figure 5-10 illustrates the "control ladder logic" to provide the following functions:

a. Connect inverter power bus

b. Disconnect vehicle motors due to: motor overtemp (K1, K2)
: current overload (OL)
: manual switch (S1)

c. Engage motor brakes B1 and B2 through bus bar power control

A green lamp is provided on each vehicle as a visual indication for maintenance personnel that the vehicle's motor system is operational. An associated infrared LED is also read automatically at the three maintenance stations; this "Green Light Detector" will initiate a normal ride stop command if the LED beacon is not recognized (see section 5.6).

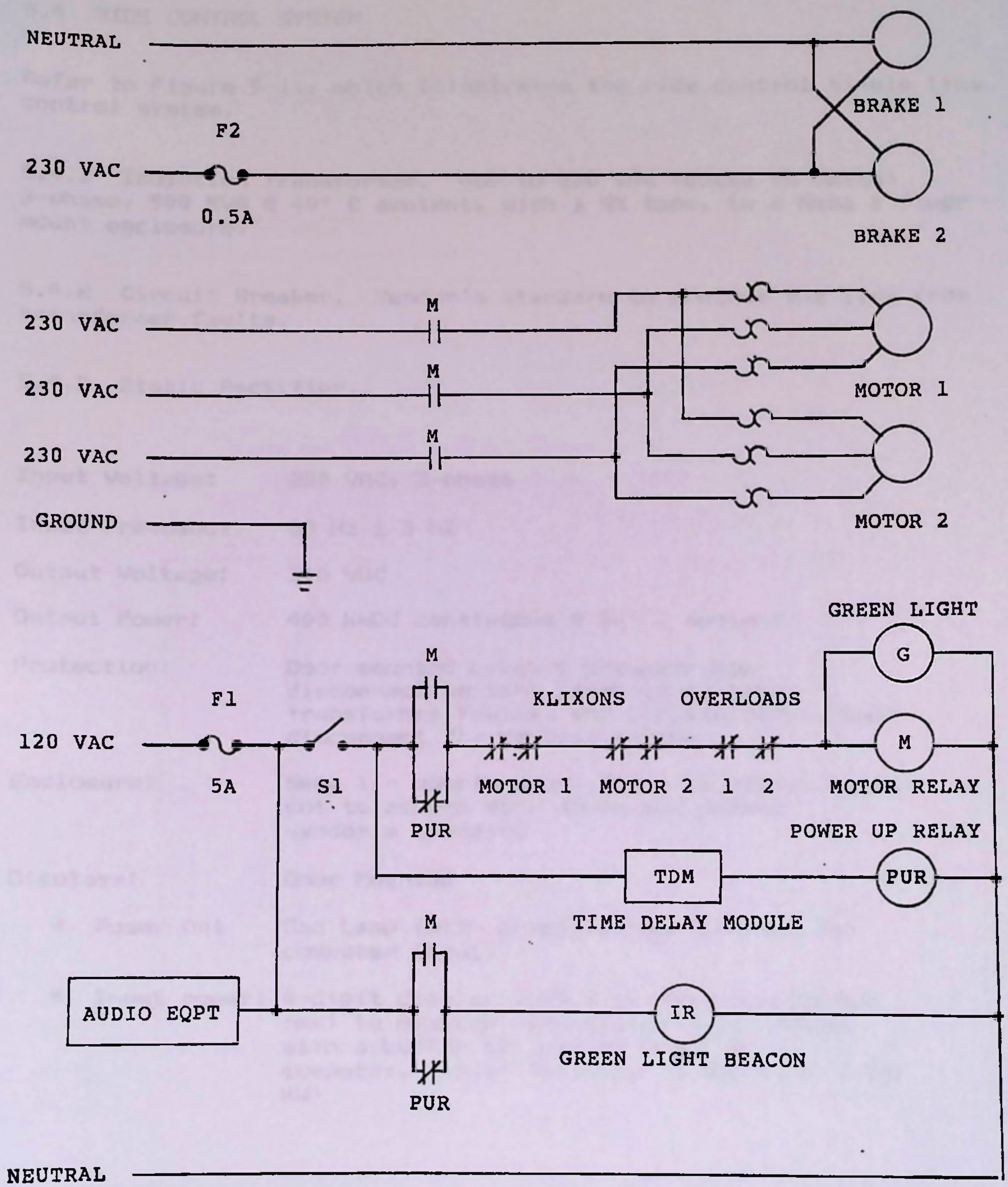


Figure 5-10 Vehicle Motor Control Box Wiring

5.4 RIDE CONTROL SYSTEM

Refer to Figure 5-11, which illustrates the ride control single line control system.

5.4.1 Isolation Transformer. 460 to 230 VAC (delta to delta) 3-phase, 500 KVA @ 40° C ambient, with ± 5% taps, in a Nema 1 floor mount enclosure.

5.4.2 Circuit Breaker. Vendor's standard to protect the line from transformer faults.

5.4.3 Static Rectifier.

Input Voltage:	230 VAC, 3-phase
Input Frequency:	60 Hz ± 3 HZ
Output Voltage:	310 VDC
Output Power:	400 KWDC continuous @ 40° C ambient
Protection:	Door mounted circuit breaker/power disconnect switch: sized to protect transformer faults, and provide total power disconnect for control system
Enclosure:	Nema 1 - double door, floor standing, height not to exceed 90", depth and width: vendor's standard
Displays:	Door Mounted
* Power On:	Red Lamp (with normally-open contact for computer input)
* Input power:	4-digit display (000.0 to 999.9 kilowatts, rms) to measure ride system input power, with a buffer for analog input to a computer, scaled for 0 to 10 VDC (1 V = 100 KW)

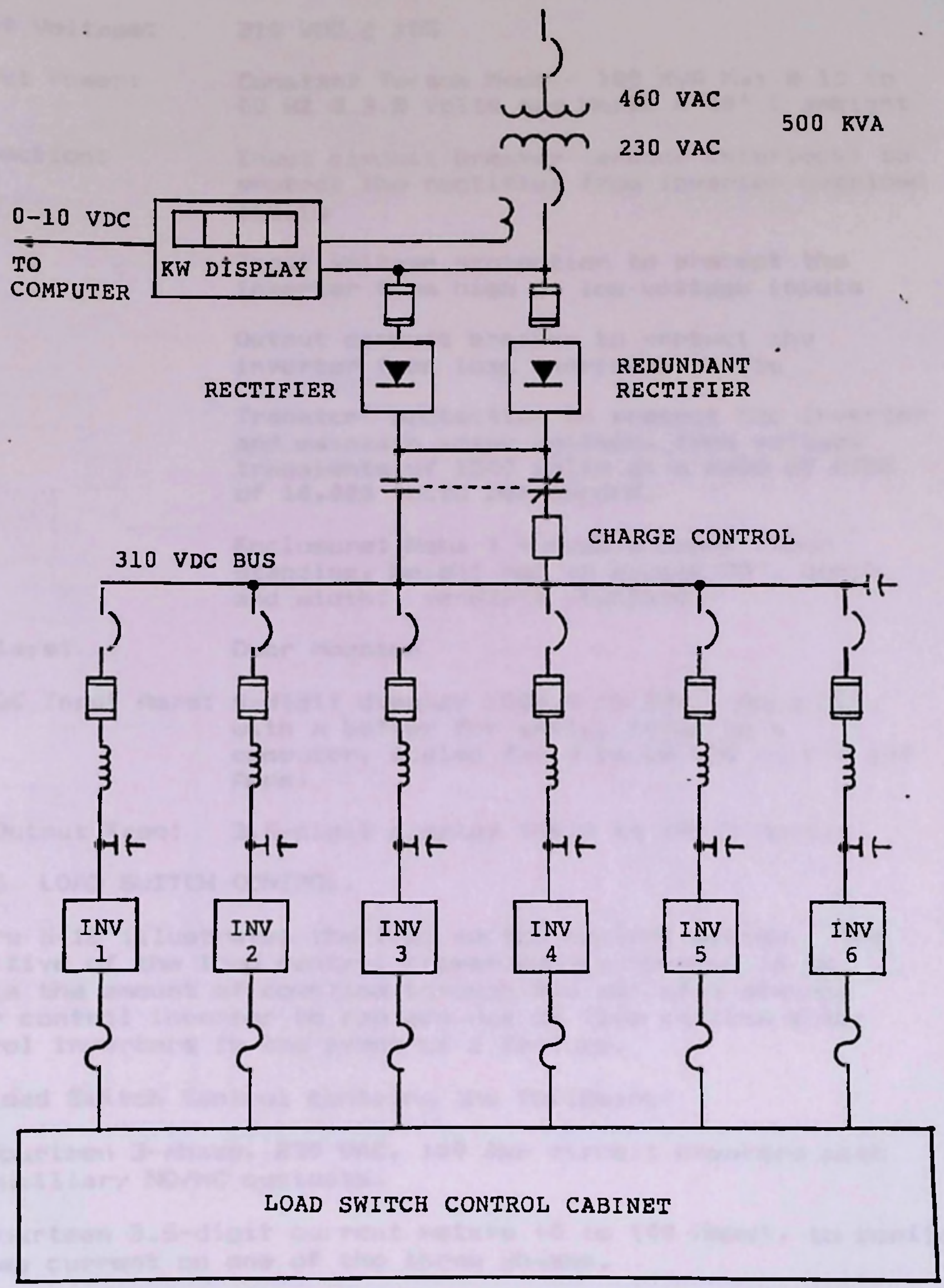


Figure 5-11 Single Line Inverter Control System

5.4.4 PWM INVERTERS.

Input Voltage:	310 VDC ± 10%
Output Power:	Constant Torque Mode - 100 KVA Max @ 10 to 60 HZ @ 3.8 volts per Hertz @ 40° C ambient
Protection:	Input circuit breaker (w/door interlock) to protect the rectifier from inverter overload faults
	Input voltage protection to protect the inverter from high or low voltage inputs
	Output circuit breaker to protect the inverter from load shorts or faults
	Transient protection to protect the inverter and maintain motor voltage, from voltage transients of 1500 volts at a rate of RTSE of 10,000 volts per second.
	Enclosure: Nema 1 - double door, floor standing, height not to exceed 90", depth and width: vendor's standard
Displays:	Door Mounted
* DC Input Amps:	4-digit display (000.0 to 999.0 Amps DC), with a buffer for analog input to a computer, scaled for 0 to 10 VDC (1 V = 100 Amps)
* Output Freq:	3.5-digit display (00.0 to 199.9 Hertz)

5.4.5 LOAD SWITCH CONTROL.

Figure 5-12 illustrates the load switch control system. The objective of the load control cross-connect concept is to reduce the amount of downtime through the use of a standby motor control inverter to replace one of five on-line motor control inverters in the event of a failure.

The Load Switch Control contains the following:

a. Fourteen 3-phase, 230 VAC, 100 Amp circuit breakers with auxiliary NO/NC contacts.

b. Fourteen 3.5-digit current meters (0 to 100 Amps), to monitor leg current on one of the three phases.

c. Door mounted panel display to indicate which power circuit is in operation.

d. Tabular display to illustrate which PWM is on line and which load it is servicing.

e. Cross Connect - the mechanism for cross connecting inverter outputs to the loads.

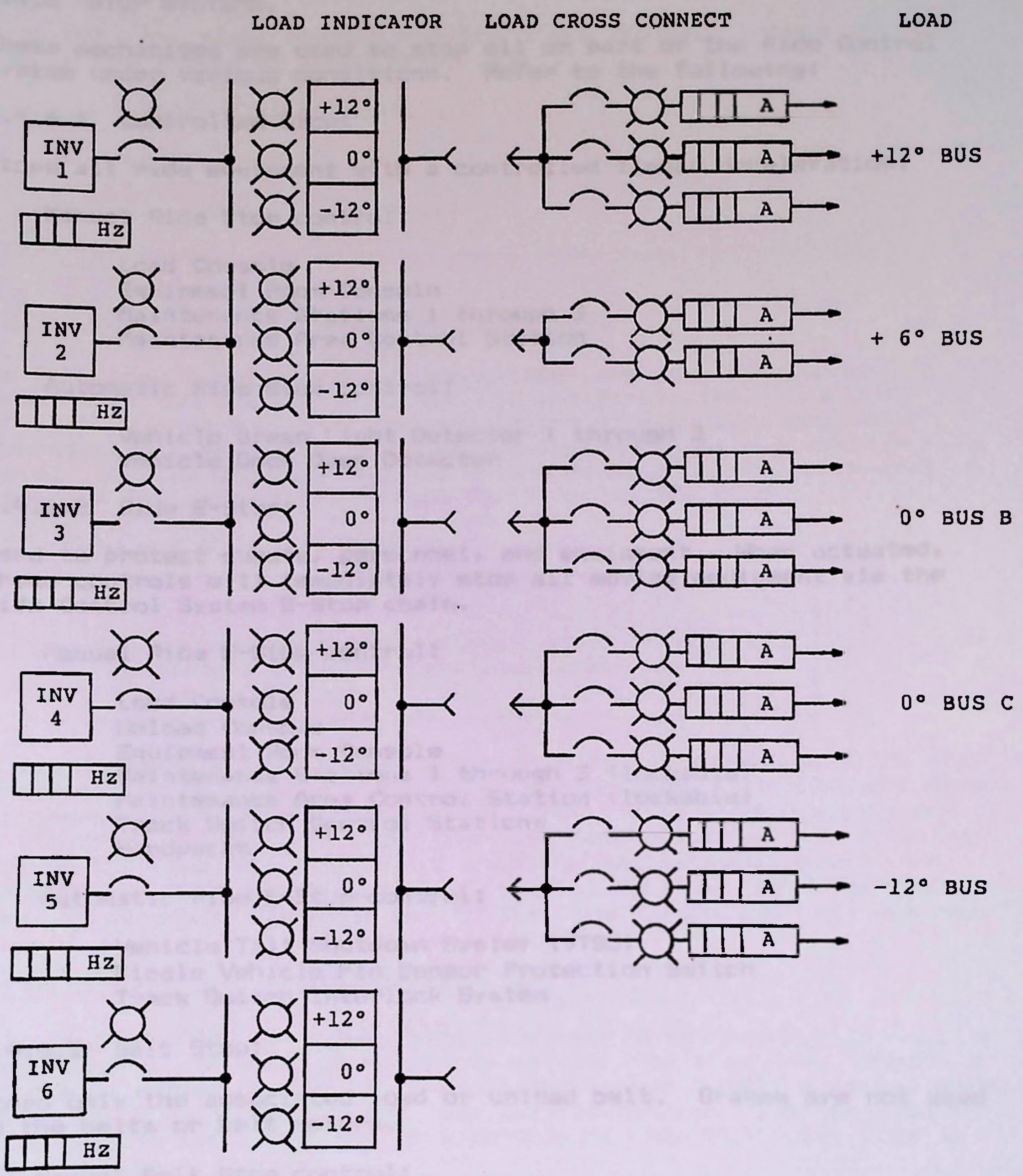


Figure 5-12 Load Switch Control System

5.4.6 STOP SYSTEMS.

These mechanisms are used to stop all or part of the Ride Control System under various conditions. Refer to the following:

5.4.6.1 Controlled Stop:

Stops all ride equipment with a controlled linear deceleration.

Manual Ride Stop control:

Load Console
Equipment Room Console
Maintenance Stations 1 through 3
Maintenance Area Control Station

Automatic Ride Stop control:

Vehicle Green Light Detector 1 through 3
Vehicle Door Open Detector

5.4.6.2 Ride E-Stop:

Used to protect guests, personnel, and equipment. When actuated, these controls will immediately stop all moving equipment via the Ride Control System E-Stop chain.

Manual Ride E-Stop control:

Load Console
Unload Console
Equipment Room Console
Maintenance Stations 1 through 3 (lockable)
Maintenance Area Control Station (lockable)
Track Switch Control Stations
Handpacks

Automatic Ride E-Stop control:

Vehicle Tilt Shutdown System (VTSS)
Finale Vehicle Fin Sensor Protection Switch
Track Switch Interlock System

5.4.6.3 Belt Stop:

Stops only the associated load or unload belt. Brakes are not used on the belts or belt motors.

Manual Belt Stop control:

Load Belt: ROC 01 & ROC 02 (DCM control)
Unload Belt: ROC 03 (mechanical start/stop switch)

Automatic Belt Stop control:

Both Belts : Belt Limit Switches

5.4.6.4 Traveling Frame Stop:

Stops only the final scene traveling video frames. Brakes are not used on the frames or frame drive unit.

Manual Frame Stop control:

Pendant control

Automatic Frame Stop control:

Ride Data Concentrator speed reference, follows ride vehicle speed

5.4.7 VEHICLE TILT SHUTDOWN SYSTEM (VTSS).

The VTSS uses a radio transmitter/encoder and receiver/decoder to communicate vehicle status to the RCC monitor system. The VTSS provides an emergency stop command to the ride control system if mechanical damage occurs on monitored components of the vehicle ride chain. It also provides the RCC with a monitor point for generating a message to indicate the reason for stopping the ride.

5.4.8 VEHICLE DOOR OPEN DETECTOR.

NOTE
It is assumed the doors are locked if they are completely closed. This assumption may not always be correct.

If the doors have not closed, the ride must be stopped to allow the ride operator to inspect and correct the problem. The system senses the condition of the vehicle doors in the vicinity of the exit end of the load belt and provides relay contacts for interface with the ride control system. One set of contacts activates a normal stop command. Another set of contacts provides the RCC with a monitor point to generate a message to indicate the reason the ride has been stopped.

5.4.9 GREEN LIGHT SENSOR SYSTEM (GLSS).

GLSS (Figure 5-13) is a trackside IR sensor which provides a vehicle check function at each of the three maintenance stations. Should a vehicle be detected with its green light beacon "off", a normal stop command will be issued to the ride control system. The location of the sensor is such that the vehicle detected as "bad" will stop in the maintenance station.

Green Light Beacon: Each vehicle is equipped with a visible green light and an infrared "green light beacon", both of which are controlled by the motor control box. If a vehicle motor system fault causes the box to disconnect the vehicle from the ride control power system, the visible green light and beacon will go out, causing the Green Light Sensor System to stop the ride the next time this vehicle enters a maintenance station.

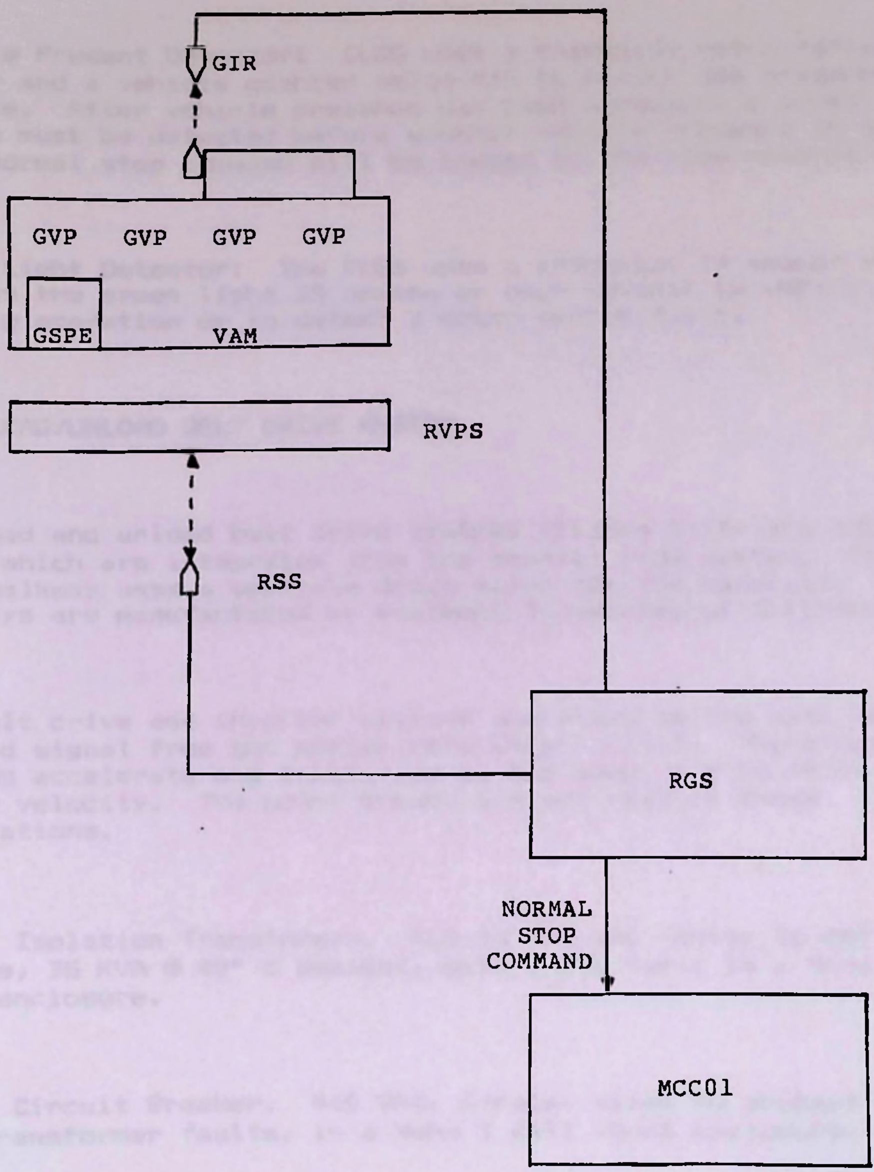


Figure 5-13 Green Light Sensor System

After vehicle fault inspection, the green light beacon can be reactivated by turning off the switch on the motor control box. This disables the motor drive system on this vehicle, and lets it free wheel around the track, propelled by the other vehicles in the chain.

Vehicle Present Detector: GLSS uses a trackside retro-reflective IR sensor and a vehicle mounted solid fin to detect the presence of a vehicle. After vehicle presence has been detected, a green light IR beacon must be detected before another vehicle presence is detected or a normal stop command will be issued to the ride control system.

Green Light Detector: The GLSS uses a trackside IR sensor which detects the green light IR beacon on each vehicle to verify correct vehicle operation or to detect a motor system fault.

5.5 LOAD/UNLOAD BELT DRIVE SYSTEM

The load and unload belt drive systems (Figure 5-14) are identical units which are integrated into the overall ride system. The load belt walkway uses a separate drive motor for the handrail. The belt walkways are manufactured by Westmont Industries of California.

The belt drive and inverter systems are wired to the same speed command signal from the master reference circuit. Therefore, all systems accelerate and decelerate at the same rate to their selected linear velocity. The motor brakes are not used in these applications.

5.5.1 Isolation Transformer. 460 to 230 VAC (delta to delta) 3-phase, 35 KVA @ 40° C ambient, with ± 10% taps, in a Nema 1 floor mount enclosure.

5.5.2 Circuit Breaker. 460 VAC, 3-pole, sized to protect the line from transformer faults, in a Nema 1 wall mount enclosure.

5.2.3 DC Power System

Input Voltage:	230 VAC, ± 10%
Input Frequency:	60Hz ± HZ
Output Power:	15 KW @ Base Speed
Speed Range:	0 to 1150 RPM
Speed regulation:	± 1% of set speed from 500 to 1750 RPM, with tachometer
Current output:	Compatible with 288AT motor, to provide constant torque from zero speed to base speed at 40° C ambient temperature
Duty Cycle:	17 hour duty cycle @ service class I to II
Acceleration:	Adjustable - from 2 to 20 seconds required to reach operating speed
Deceleration:	Adjustable - from 2 to 20 seconds required to reach zero speed
Regeneration:	Non-regenerative type system

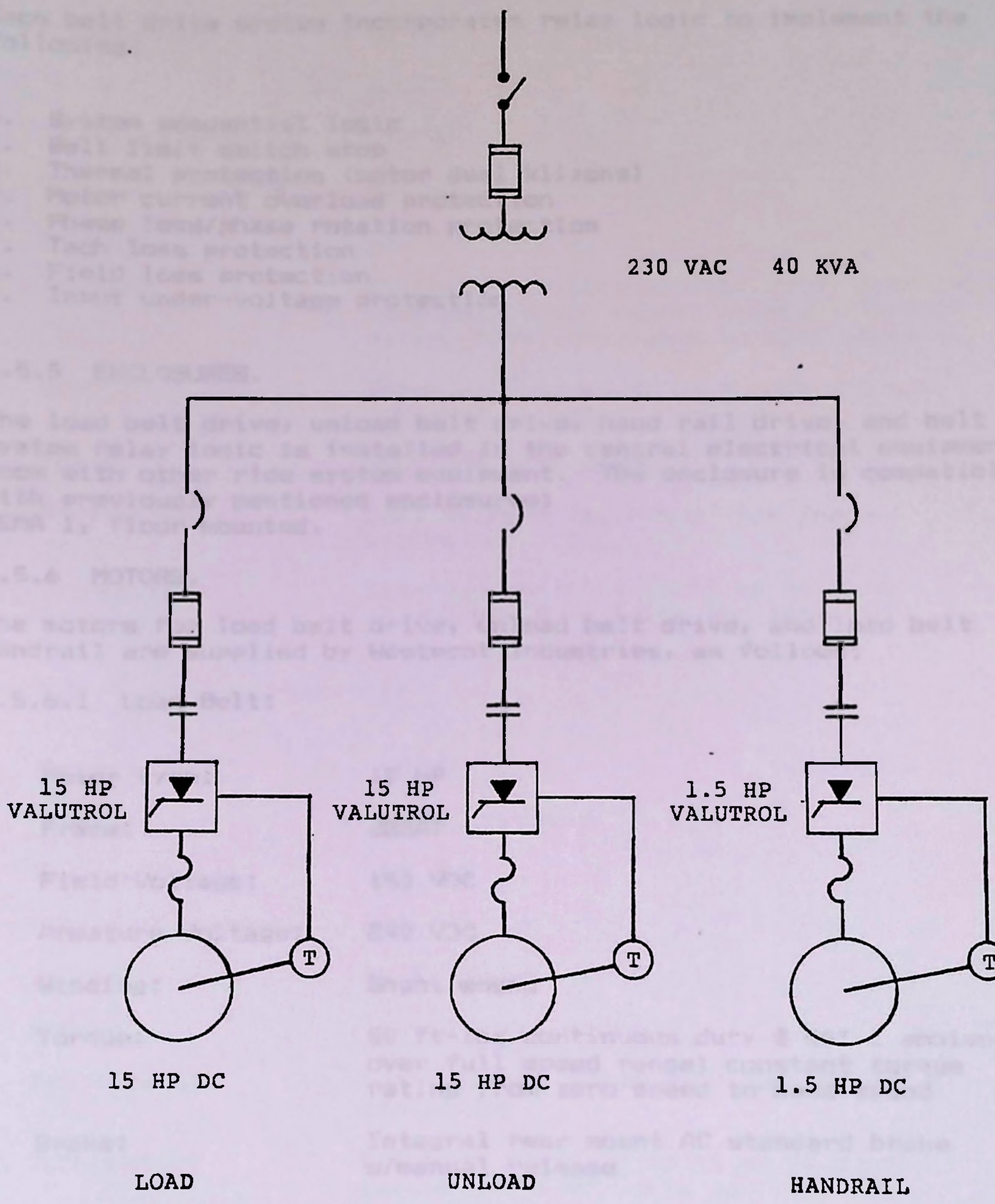


Figure 5-14 Single Line DC Conveyor Drives

5.2.4 DRIVE SYSTEM PROTECTION.

Each belt drive system incorporates relay logic to implement the following:

a. System sequential logic
b. Belt limit switch stop
c. Thermal protection (motor dual klixons)
d. Motor current overload protection
e. Phase loss/phase rotation protection
f. Tach loss protection
g. Field loss protection
h. Input under-voltage protection

5.5.5 ENCLOSURES.

The load belt drive, unload belt drive, hand rail drive, and belt system relay logic is installed in the central electrical equipment room with other ride system equipment. The enclosure is compatible with previously mentioned enclosures:
NEMA 1, floor mounted.

5.5.6 MOTORS.

The motors for load belt drive, unload belt drive, and load belt handrail are supplied by Westmont Industries, as follows:

.5.5.6.1 Load Belt:

Motor type:	15 HP
Frame:	288AT
Field Voltage:	150 VDC
Armature Voltage:	240 VDC
Winding:	Shunt wound
Torque:	50 ft-lbs continuous duty @ 40° C ambient over full speed range; constant torque rating from zero speed to base speed
Brake:	Integral rear mount AC standard brake w/manual release
Speed:	1150 RPM base speed
Protection:	Dual klixons (standard) for thermal protection
Tachometer:	Extended shaft to mount an AC tach generator, @ 90 Volts per 1000 RPM

5.5.6.2 Unload Belt:

Motor type:	15 HP
Frame:	288AT
Field Voltage:	150 VDC
Armature Voltage:	240 VDC
Winding:	Shunt wound
Torque:	50 ft-lbs continuous duty @ 40° C ambient over full speed range; constant torque rating from zero speed to base speed
Brake:	Integral rear mount AC standard brake w/manual release
Speed:	1150 RPM base speed
Protection:	Dual klixons (standard) for thermal protection
Tachometer:	Extended shaft to mount an AC tach generator, @ 90 Volts per 1000 RPM

5.5.6.3 Load Belt Handrail:

Motor type:	1.5 HP
Frame:	186ATC "C" face
Field Voltage:	150 VDC
Armature Voltage:	240 VDC
Winding:	Shunt wound
Speed:	1150 RPM base speed
Protection:	Dual klixons (standard) for thermal protection
Tachometer:	Extended shaft to mount an AC tach generator, @ 90 Volts per 1000 RPM

5.6 FINALE SYSTEM

5.6.1 REFERENCES.

Subsection 5.6 is written with the assupmtion that the reader has already read (and generally understands) the first three of the reference documents. All terminology, references, acronyms, and system operations are described in those documents or in Section 5 of this manual.

1. Functional Requirements, Horizons Finale Video Request System (CONT-158355). ("Functional Spec")
2. Specification, Software Requirements, Guest Selection Processing Electronics (GSPE) (CONT-158517). (Software ("Software Spec")
3. Specification, Serial Transmission Protocol, HFVRS (CONT-158532). ("Serial Protocol")
4. Schematic, PCB, Control, GSPE (CONT-158367). ("Control Board schematic")
5. Schematic, PCB, EL Lamp Control Board, GSPE (CONT-158371). ("ELLC schematic")
6. Schematic, PCB, Power Board, GSPE (CONT-158375). ("Power Supply schematic")
7. Schematic, PCB, Ride Status Interface, GSPE (CONT-158379). ("Ride Status schematic")
8. Schematic, PCB, Infrared Transmitter (CONT-158527). ("IR Transmitter schematic")
9. Schematic, PCB, Infrared Receiver (CONT-158531). ("IR Receiver schematic")
10. Schematic, Guest Voting Panel (CONT-158515). ("GVP schematic")
11. Assy, Vehicle Address Module (CONT-158535). ("VAM assembly drawing")

5.6.2 PREREQUISITES AND CLARIFICATIONS

There are some inconsistencies which existed in the referenced documents which must be corrected.

5.6.2.1 Clarifications to Functional Specification.

In this paragraph, the section numbers and figures numbers are those of the Functional Specification (see referenced document 1).

1. The block diagram of Figure 3.0 (HFVRS Block Diagram) neglected to specifically identify the "main electronics package" (the GSPE) -- This is the set of elements which are part of the "Vehicle Mounted Elements" and which are inside of the double lines of the figure.

2. The guest voting panels are sometimes referred to as the "guest selection panels". These terms are synonamous. This applies to Figure 3.0 and the reference discussion of Section 3.0.

3. Figure 3.0 does not clearly correspond to the discussion of Section 3.0. The wayside mounted "Selection Start Beacon Pkg" is first referenced in the text as the "start beacon". The wayside mounted "Vehicle Selection Rcvr Pkg" is first referenced in the text as a "selection detect station". Both of these elements are not identified as "wayside elements" in the figure. And the "Maintenance Panel(s)" of Figure 3.0 are not referenced in Section 3.0 at all. Of course, the maintenance panels refers to either the MTP or the SIMMTP.

5.6.2.2 Present System Status.

This discussion is written relating to the HFVRS as it existed on October 2, 1983.

5.6.2.3 Capabilities of the Reader.

This discussion makes many references to the schematics of the HFVRS (see references). It will emphasize:

1. the understanding of the operation of the circuits and of the system

2. reasoning for existence of circuits and circuit elements rather than a dry textual restatement of the hook-up of a circuit which is already drawn in schematic form

The reader should be knowledgeable in the art of reading an electronic circuit schematic and recognizing the "standard" forms of circuit representations.

5.6.3 ORGANIZATION OF THIS SUBSECTION

It discusses the elements of the HFVRS either as a circuit board or as functional combination of circuit boards and discrete elements. It has these subheadings:

- 5.6.4 The Selection Start Beacon
- 5.6.5 The Vehicle Selection Receiver
- 5.6.6 The Guest Voting Panels
- 5.6.7 The Vehicle Address Module
- 5.6.8 The GSPE Final Assembly and Power Supply Board (the AC and DC power system of the GSPE)
- 5.6.9 The ELLC board
- 5.6.10 The Ride Status Interface board
- 5.6.11 The Controller board
- 5.6.12 The Maintenance Test Panel

All figures and tables are part of the reference documents.

5.6.4 SELECTION START BEACON

5.6.4.1 General

Refer to the IR Transmitter schematic for the following discussion.

The Selection Start Beacon Package has two electrical assemblies:

- a AC-DC packaged power supply
- a circuit board assembly (the IR Transmitter PCB).

The power supply is powered by the 115 VAC line and is fused at 1/4 amp just as a precaution. The actual power draw of this board is less than 20 watts. Regulated voltages of +5 volts, +15 volts and -15 volts are provided to the circuit board. A separate 4-pin connector on the back-side of the circuit board brings out the DC power onto the board.

A single DB-25S connector is mounted directly on the circuit board. This connector allows the external world to control the operation of the IR Transmitter and receive status from the device.

The circuit board will be broken into three sections for the purpose of discussion: an oscillator section, an IR LED driver/IR output section, and a operation monitor section.

5.6.4.2 The Oscillator Section

There are two oscillators which comprise this section. One oscillator (Y1 and associated logic and discrete components) provides a 10.000 KHz ± 0.01% square wave which becomes the IR carrier frequency for communication to the GSPE.

The second oscillator (U7 and associated circuitry) provides a 100 Hz square wave which is a modulation signal to the IR carrier and which is used to signal the setting of one of the operating modes of the GSPE.

The square waves generated by the two oscillator sections are open-collector "ored" to a single point in the IR driver circuit so that various combinations of IR leds OFF/ON can be achieved. A more detailed discussion of this capability will be discussed in paragraph 5.6.4.3.

The 10 KHz frequency is derived from a pre-packaged crystal oscillator (Y1) at an accurate 20.000 KHz. A crystal oscillator was chosen (over a RC-type oscillator) because the GSPE has a narrow bandwidth receiver which would suffer in performance if the carrier frequency moved by more than perhaps 0.5%. While an RC circuit could be "trimmed" to meet this requirement, use of a crystal eliminated the need for such trimming.

The 20 KHz signal is buffered by U6 (a Schmitt trigger input inverter) and is divided by two by U4 resulting in the 10 KHz carrier. A test capability exists which allows this 10 KHz signal to be stopped (thus stopping the IR carrier--discussion of this ability will follow in a later section.) This test capability is achieved by grounding J1-6 which forces U4 into the reset state. R34/C20 prevent noise from causing resets of U4 while R35 pulls up this low-true reset line so that J1-6 can be left floating for normal operation.

The second oscillator is a 555-type RC oscillator which generates a 200 Hz signal (not a square wave). R1/R2/C1 are the timing elements. Since a 555 output is not always "clean", a Schmitt trigger (U6) buffers this signal before it goes to a divide-by-two flip-flop (U4) to become the desired 100 Hz square wave. This flip-flop has external DC-set and -reset controls as did the 10 KHz one. External signals from J1 can be used to set the IR Transmitter into either of two modes. Grounding J1-3 causes the flip-flop to set. This kills the 100 Hz oscillations, but allows the carrier 10 KHz to reach the IR led driver section thru the open-collector "or" section of the IR led driver circuit. Grounding J1-2 clears the flip-flop and prevents any drive current from getting to the IT leds. This is the IR disable mode.

The direct -set and -reset terms are buffered thru Schmitt triggers (U6) to provide better noise immunity. (The same would have been done for the 20 KHz flip-flop but there were no more Schmitt triggers available and another chip would have had to been added--it didn't seem worth it.) The J1-2 and -3 terms can be left floating for normal the IR mode of circuit operation.

Refer to the "circuit operation" table in zone G8 of the schematic for a summary of the circuit mode control.

5.6.4.3 IR LED Driver/IR Output Section

This section allows the incoming 10 KHz and 100 Hz square waves to cause the IR leds of the circuit to have current or no current in synchronism with the product of the incoming signals. The open-collector "or" function referenced in the previous section occurs at the outputs of the two U5 gates (pins 3 & 6). If either of these U5 outputs is turned on (low) it prevents any current from flowing in the led string (CR1 thru CR4) by shunting the base drive currents to the output drive transistors (U3) to ground.

The output driver scheme is essentially that of a constant current source (when the transistors are on). A reference voltage is established on the bases of the three parallel output transistors (the ones with collectors at U6-14, -7, and -8) which sets the current which will flow in the collectors. The voltage is such that the emitters are at 1.00 volts, and this voltage across the *equivalent* emitter resistors (R13-R16) sets the current at a nominal 80 ma. The circuit is more obvious to understand if one considers a single output transistor (instead of the three used) with a 12.5 ohms resistor in the emitter (to ground). When 1.00 volts exists across the 12.5 ohm resistor, 80 ma will be flowing thru it.

And since most of the current comes from the collector of the transistor (with only 1/beta x 1) coming from the base, a constant current circuit exists. In the case of this circuit, three transistors are connected in parallel with the 10 ohms emitter resistors helping to cause the three devices to share the current. Three devices were used in order to reduce power dissipation per device as well as to keep the transistors operating in a current range where their beta was highest so that most of the current would come from the collector. The base voltage is established using another transistor (in the same package for good thermal tracking) hooked up as a non-saturating (collector tied to base) diode. The emitter of this transistor connects to the 1.00 V voltage source, so its base voltage is just at the right place for the bases of the other three transistors to be so their emitters are at 1.00 volts.

The 1.00 V voltage source is an operational amplifier wired in an inverting configuration to generate an accurate 1.00 volts from the -15 V reference. The C6-C7 locations which are not stuffed were meant to filter the noise generated by the switching base current (the switching is caused by the modulating signals thru U5), but it was found that there was more modulation of the 1.00 V reference with the capacitors than without. Instead, there are short term noise spikes on the 1.00 V reference (perhaps 1 us wide) each time the current into the reference changes (due to the modulation). The spikes are due to the response time of the amplifier (U2) as it must respond to the load current (approximately 4.2 ma due to switching at R12) at the 10 KHz rate.

The IR leds (CR1-CR4) in the collector path of the switching driver transistors are in series to take advantage of the available "head room" voltage. We are able to get four times the output IR power with the same 80 ma flowing thru each IR led. The maximum drop across each led is 2.0 volts so the four leds in series can drop 8.0 volts maximum. We still have enough voltage available to drive DS1 (the red led which is used to indicate IR current flowing). DS1 has the 39 ohm resistor (R33) across it because it cannot stand the average 40 ma current like the IR leds can. R33 shunts about half of the current away from DS1. The voltage on the anode of DS1 is filtered so that current noise generated by the 10 KHz switching of the 80 ma will not cause problems for the power supply. R18/C8/C9 form this filter. During steady state conditions, the voltage at the anode of DS1 is at about 13.1 V (there is a 1.9 volt average drop across R18 due to the average 40 ma current).

All four IR leds point in the same physical direction so that the average energy at the distances we expect to be with the GSPE receivers is approximately four times that of a single IR led. If one led fails to open, no led current flows (the red led DS1 would go out too!). If one led shorts, the led current would continue to flow, and in all probability, there would be enough IR energy for the GSPE receivers. The power level was chosen so that even as the IR leds age (and their output power decreases) there will be enough output (worst case) to operate the GSPE properly. The 80 ma level was chosen as a compromise between high power output and a safe level for the leds (which are rated at 100 ma maximum).

5.6.4.4 The Operation Monitor Section

This section looks for the presence of a 10 KHz, 1.00 V p-p signal turned off and on at a 100 Hz square wave rate. It reports an OK condition (via DS2--green) if that signal is present. Note that when transmitting the "Normal Mode" signal, that is what will be found at reference point (A) (the emitter of transistor U3-10). If, however, the SIMM mode signal is transmitted (a straight 10 KHz condition with no 100 Hz modulation), the signal at (A) will be continuous to 10 KHz, 1.0 V p-p square wave.

The detection circuitry (which begins schematically at (A)) looks for two characteristics at point (A).

1. It wants to see an appropriate 1.0 V p-p signal at approximately 10 KHz. It doesn't care about the DC voltage level at (A).

2. It expects this signal to appear and disappear at an approximate 100 Hz rate.

A number of reference voltage levels are generated to help set the thresholds necessary to achieve the monitoring process. The divider string involving R20 thru R25 has this function.

The circuit response waveforms at various points in this circuit have been drawn on the schematic.

U1-6 is DC biased at 2.40 V and receives the AC coupled signal from (A). U1-6, 7 acts as a comparitor such that if the positive going edge of the incoming AC signal is large enough, it will cross the threshold and U6-1 will switch. Thus, for a normal (or larger) input signal, U1-1 will be a square wave with a low level of 0 V and a high level of 5 V.

If the 10 KHz signal is missing, U1-1 will sit at 5+ V.

This first stage technique was necessary to exclude the conditions of a "stuck" current source at (A) causing incorrect operation of the next stage of detection which takes place at (C) and (D).

The signal at (C) is low-pass filtered by R27/C15 such that as long as the 10 KHz square wave is there, the voltage at (D) will stay at approximately 2.5 V with a small triangular waveform. When the 100 Hz modulation causes the 10 KHz signal to be disabled (half of the 10 ms period), and U1-2 goes to +5 V, (D) recovers to +5 V too. Since U1-4/5 is a comparitor with U1-5 at 4.00 V, when the 10 KHz signal stops, U1-2 goes low; when the 10 KHz signal is there, U1-2 is high.

Thus, the point (E) (the output of U1-2) is a square wave at 100 Hz (provided the original signal at (A) had the right characteristics). When there is no 100 Hz square wave at (C) then (E) will be at 0 V.

The signal at (E) is low pass filtered (R29/C17) so that the signal at (F) is at an average of 2.5 V (when the 100 Hz square wave is present at (E) with a 250 mV p-p triangle wave superimposed thereon. U1-8/9 is a comparitor with a 2.0 V threshold. U1-10/11 is a comparitor with a 3.0 V threshold. As long as the signal at (F) stays above 2.0 V and below 3.0 V, neither comparitor turns on, the signal at (G) remains high (+5 V). If the square wave stops, or if the frequency moves too far below 100 Hz, the one of the two thresholds would be crossed, and either U1-13 or -14 would pull (G) to ground. This in turn would disable the "OK" led (DS2) thru U5, and similarly set the STATUS signal (J1-5) to "0".

Thus, as long as the transmitter is operating in the "normal" mode, and everything is "OK", the green led, DS2, should be on. Since the SIMM mode is characterized by a continuous 10 KHz carrier (without 100 Hz modulation), SIMM mode transmissions would cause the "OK" led to be off.

5.6.5 VEHICLE SELECTION RECEIVER

5.6.5.1 General

Refer to the IR Receiver schematic for the following discussion.

Like the Selection Start Beacon Package discussed in Section 5.0, the Vehicle Selection Receiver Package has two electrical assemblies. (In fact, both the IR Receiver and the IR Transmitter are housed in the same identical mechanical package assemblies.) They are the AC-DC packaged power supply and the IR Receiver PCB.

The power supply is the same as for the IR Transmitter and interfaces to the back of the IR receiver board in the same way as for the transmitter.

A single DB-25P connector is mounted directly on the circuit board. This is the connector to the external world to the data which has been brought into the assembly thru the IR channel. (There is no status signals available on the receiver connector.) Note that this connector is the opposite sex from the one on the IR Transmitter board, so you can't get them mixed up in the system.

The circuit board has two sections: a IR receiver/detector stage and an RS232 output driver stage.

Note that this receiver is being sent IR information with a 50 KHz carrier modulated by 1200 Hz RS-232 data.

5.6.5.2 The IR Receiver/Detector Stage

This stage includes: (1) an IR sensitive photo diode (CR1) which intercepts the communicated IR signal, (2) a turned amplifier/detector circuit (which utilizes a special purpose integrated circuit (U2) just for this type of application, and (3) a local voltage regulator (U1) to provide the +12 V that this IC needs for operation.

The configuration of the circuit elements around U2 is as recommended by the manufacturer of the chip.

L1/C8/C9/R3 form a 50.0 KHz tuned circuit. L1 is adjustable so that the peak response of the tuned circuit can be set at exactly 50.0 KHz. R3 (along with the series resistance of L1) sets the Q of the circuit at about 40 so that the expected information, bandwidth can be received by the circuit. If R3 wasn't present, the Q would be so high that the circuit bandwidth would be too small to be able to detect the 1200 Hz modulation signal.

When a nominal IR signal is being received, the signal at pin 3 (the "tank ckt" pin) of U2 will be a sine-wave of about 800 mV p-p.

The adjustment of L1 can be done by simultaneously looking at pins 6 and 3 of U2. When the center frequency of the tank is adjusted to 50.0 KHz, the sine-wave signal on pin 3 will be right in phase with the (sort of) square wave at pin 6. This is the point where the peak amplitude at pin 3 is also a maximum, but because of the slow change in peak voltage when the tank is adjusted near the vicinity of the right frequency, the phase shift approach allows for much easier adjustment.

The cathode of the IR sensitive diode (CR1) is biased at +12 V with R1, and this point is at AC ground due to C6. IR energy striking CR1 causes current to flow into pin 1 of U2. An automatic circuit within U2 causes pin 1 to automatically adjust the DC level of this pin (in the range of 3 to 4 volts) to account for the ambient (DC) IR energy which causes a DC current our of CR1. We are only interested in the AC signal out of CR1, and this automatic adjustment is desirable. R2/C7 sets the gain of the amplifier in U2. C11 is part of the carrier demodulator operation of U2. C10/R4 set the detection level of the demodulated carrier (thus providing "0"/"1" outputs at U2-1). R4 is chosen so that signals approximately 300 mV peak are detected. This gives the necessary margin when operating with a worst case GSPE IR transmitter operating 24 inches away from CR1. The input signal from CR1 under these worst case conditions would be 0.22 uA (p-p) minimum.

> Note
>
> A detailed explanation of the operation of U2 (the uPC1373H chip) is available from Nippon Electric Company Ltd. ("NEC") as an application note: "Application guide of remote control preamplifier IC uPC1373H", IEP-1022, Oct. 1981.

5.6.5.3 The RS-232 Output Driver Stage

The signal out of U2 is typically a 5 V p-p (mostly squared-up) signal. R5 provides the pull-up for the signal from U2-1. U3-2/3 receives this signal and converts it to a signal approximately 24 volts p-p (with a lot more drive capability than was available out of U2) corresponding to the output voltage saturation levels of U3. The signal out of U3-1 goes two places.

First it goes to a led driver (R12/CR5/Q1/R13/DS1) which will cause the green led to be on whenever adequate IR signal is present. Thus, DS1 blinks at the 1200 Hz communication rate of the IR modulation.

Because the NEC chip does "sloppy" demodulation, there can be some "bounce" on the transition edges between the "0" and "1" levels (the bounce occurs at the carrier frequency). So to get rid of the bounce, the NEC chip output signal goes to a filter network (R8/C12) which filters the front and back edges of the detected 1200 Hz data signal. This soft-edged signal is then re-squared to a 24 V p-p signal by U3-5/6 which is connected as a comparitor with about 7 volts of hysteresis.

The output signal from U3-7 is delivered to the output jack, J1-12 thru R11, and can drive many hundreds of feet of twisted pair cable with all of the characteristics of an RS-232 driver. CR3 and CR4 (along with the series R11) provide protection of U3 when moderate energy voltages are impressed upon the output from the external world. The external signal should be taken between J1-12 and J1-13.

The data out of an IR Receiver is supposed to be an exact copy of the RS-232 data originally sent as a modulation signal to the 50.0 KHz IR carrier.

5.6.5.4 Other Features

Because the Vehicle Selection Receiver Package might be used with a SIMMTP, +5 V is supplied on J1 to run the SIMMTP.

DS2 on the circuit board provides an indication that the Vehicle Selection Receiver Package is powered. When viewing a Vehicle Selection Receiver Package from the top, you can easily tell the difference between it and a IR Transmitter -- the VSRP will have a yellow led lit, while the IR Transmitter will have the green "OK" lit.

5.6.6 GUEST VOTING PANEL

5.6.6.1 General

Refer to the GVP for the following discussion.

The GVP is electrically quite simple. There are three switches and three EL lamp elements with discharge resistors. A pair of DB-25 connectors bring the various signal and connections to the outside world.

5.6.6.2 The Touch Switches

The three switches of the GVP are part of a single assembly called a "touch switch panel." The switches are represented by a pair of conductive (and transparent) plastic sheets separated by a small air gap. When someone presses on the top surface of the plastic sheet, it deforms and the conductive surface of the top plate touches the conductive surface of the bottom plate providing a conductive path between the two surfaces. Electrodes connected to the top and bottom surfaces can then use this conductive path to cause the proper operation based on the switch condition.

The materials of the switch are such that the resistance between the electrodes when a switch is depressed can be as reasonably low (in the order of a few ohms), but can also be as high as 1200 ohms. The circuitry of the GSPE has been designed to recognize this much resistance as still being a depressed switch. When the switch is unpressed, the resistance will be well above one megohm. A failed switch might have resistances between these limits, and there is no guarantee how the GSPE will treat such signals.

One form of failure which might be hard to determine is an intermittent "shorting" between the electrodes. This failure mode might be common because of the large area each switch represents. As many guests press the surfaces, there may be some permanent deformation of the top conductive plastic surfaces could be reduced to a value that is on the verge of touching, but not quite. Then vibrations of mechanical shifting could cause contact to take place where nobody was pressing the switch.

The three switches share a common electrode, but have individual signal electrodes. Four wires are brought out for each GVP.

5.6.6.3 The EL Lamps

As with the switches, there are three EL lamp elements built into a single EL lamp assembly. There is a common wire for all three lamps plus an individual lamp lead to supply power to each lamp.

Each lamp electrically consists of a bottom electrode (the common one), a coating of a mixture of electro-luminescent phosphors, and a top electrode (one for each EL element) along the edge of the EL lamp surface. The phosphors emit light when excited by AC current, and the whole phosphor surface glows as the current flows thru the phosphor towards the upper electrode.

The sandwich of electrodes and phosphor is placed between protective (transparent) plastic sheets and sealed to exclude moisture (which is death to an EL lamp element).

The lamps are characterized by a high capacitance value and a small resistive loss element. Some of the energy pumped into the resistive element becomes radiant emitted energy of visable light. As the lamp ages, its capacitance decreases, the AC current for a given voltage decreases, the phosphor efficiency decreases, and less light is emitted for a given power input. Somewhere in time, the light emitted will be so weak that someone will have to make a decision that the lamp should be replaced. (If moisture gets inside, the lamps will grow old very quickly.) As they get older, the white color of the light from the lamps may get more yellow, and the surface of the lamp may appear more "blotchy" rather than glow with a uniform light output.

Often a lamp will fail because the electrode connections fail. In this case, the lamp is simply an open circuit.

The Functional Spec provides more details on the general operation of the constant light output functions of the GSPE.

The 470 Kohm resistors across each light element guarantee that if, by chance, the lamp is unplugged while being powered, the high-voltage charge which might have been on the lamp at the time will be quickly discharged so there is no shock hazard.

5.6.6.4 Interconnection System

The GVPs are designed so that two GVPs are hooked in series with 25-conductor ribbon cable, and a single cable can go to the GSPE to power both of the GVPs. Thus, there is a "crossing over" of the signals which reach the first GVP in line on the ribbon cable so that the second GVP (which is exactly identical to the first) can get its own unique signals. The "input" connector to the GVP is the DB-25P cable while the "output" connector (which supplies the signals to the second GVP) is a DB-25S. Note that this cleverly means that the high voltages which are available on the "source" cable will always come from a "pin-shrouded" connector and there is no shock hazard from the high voltages used to drive the EL lamps.

5.6.7 VEHICLE ADDRESS MODULE

The VAM is the simplest of modules. The schematic of the VAM is shown on the VAM assembly.

Each VAM assembly is unique, and there should be only one of each unique assembly on the Horizons system. Each car has a different address as identified by the VAM. The address is set by cutting the etch in selected positions of the eight "switch" positions on the VAM circuit board. The VAM assembly drawing relates the etch cuts vs the vehicle address.

Only if a VAM is removed from a car, and only if it is unrepairable, will there be a requirement to re-address another VAM. There were about 25 spare VAMs (un-addressed) which were manufactured at the time the original 185 were addressed.

Since there are no active or passive components on the circuit board, the most likely failures will have to do with the ribbon cable and connector of the VAM.

5.6.8 GSPE FINAL ASSEMBLY/POWER SUPPLY BOARD

5.6.8.1 General

The GSPE final assembly includes the assemblage of four circuit board assemblies, the power transformer, large DC filter capacitors, AC line filter, fuses, and miscellaneous connectors.

The general function operation of this final assembly is adequately covered in the Functional Spec. But the more detailed hardware description of the AC and DC power systems will be discussed here. The detailed hardware operation of the individual circuit boards are generally discussed in other sections of this document.

Because of the close relationship between the power transformer/rectifiers/filters involved in the DC power system, and the reality that some of these components are on the final assembly while others are on the Power Board, it seemed appropriate to bring the two components together in the same section. In reality, this entire system is very simple. It will be discussed in three sections:

the AC power system
the transformer/rectifier/filters
the DC regulators.

The entire system will reference the Power Supply schematic.

5.6.8.2 The AC Power System

AC power is brought into the GSPE thru J5 (a 9-pin connector mounted on the front vertical wall of the GSPE0. (Note -- the schematic incorrectly references this connector as a PCB mounting header.)

The external plug which brings the AC line power to the GSPE has the responsibility of establishing the proper "programming" of the GSPE for the desired operating line voltage. Presently, the Horizons ride applies 115 VAC to the GSPE, so the wiring of the external W1P1 is as shown in the schematic. However, 208 VAC or 220 VAC can be used to run the GSPE if W1P1 is appropriately wired -- refer to the Functional Spec.

The primary of T1 is presented as two isolated winding sets. For 115 VAC operation, the outside windings of each set are used in parallel (as is the present case of the ride). For 208 VAC or 220 VAC operation, the windings are put in series with the appropriate tap being used to match the intended applied line voltage.

The EMI filter assembly, FLI, wires directly to the input lines from J5. In order to do a good job on reducing electro-magnetic energy which might be present on the input AC lines to the GSPE, this filter is used with very short wires to J5. The intent is to shunt as much as possible of the incoming EMI energy to the frame ground of the GSPE package. The short leads from J5 would be on the unfiltered side of FL1, so they must be physically isolated from the rest of the wiring in the GSPE so that they don't re-radiate energy to what is supposed to be clean and EMI free circuitry within the GSPE.

After coming out of the EMI filter, the AC line power is delivered thru two fuses to the connector which goes to the primary of the power transformer, T1. By using individually fused lines, it is possible to standardize on the fuse size regardless of the AC power programming of the GSPE. The 0.75 amp fuse value represents a reasonable choice for protection. These fuses will blow in the event of a failure in the primary of T1, but not necessarily for all failures on the secondary of T1. Thus, certain power failures on the DC side of the power system will not necessarily cause the AC power fuse to blow.

Note that the power transformer is fully connectorized. If one ever fails, it can be unplugged and replaced.

5.6.8.3 The Transformer/Rectifier/Filters

The secondary of the power transformer is on connector T1P2, and plugs into J2 of the Power Board.

The unregulated power for the +5 volt system (+10 V unregulated) and for the +28 volt system is handled by full-wave bridge rectifiers from individual windings of T1. Heavy diodes (MR501's) are used in sets of four for these two bridge applications because of the heavy currents which can be expected.

The unregulated power for the +-15 volt systems (+-24 V unregulated) are handled as a full-wave center-tapped rectifier system with smaller diodes because the load currents are so light.

In all cases, the DC power filtering (AC ripple reduction) is designed to be handled by physically tubular aluminum electrolytic capacitors mounted on the chassis of the GSPE, not on the Power Board. Thus, another connector (J3 on the Power Board) is necessary to bring these power signals to the capacitors. In the case of the +-15 volt system, however, it was found that the ripple filter capacitors could be mounted on the board, so only the contingency for chassis mounting the capacitors is present.

Because the load on the +28 V cupply can be totally disengaged (under computer control), a discharge resistor A5W2R1, 820 ohms) is added across the filter capacitor (A5C2) to prevent a large stored charge from zapping an unsuspecting technician even when the system is turned off. This resistor is not shown on the Rev. 0 schematic.

The table at zone C5 of the schematic reviews the voltage characteristics of the power supply system. The "Voltage Range" values represent the worst cause, including the effects of variation of input AC line voltage and, in the case of the minium, the AC ripple. There are some errors, though, in some of the indicated values. The maximum ripple for +28 V should be 1.90 V p-p, for +24 V it should be 1.3 V p-p and for -24 V it should be 1.2 V p-p. The load current for +15 V should be 1.0 A, and for -15 V should be 0.07A.

5.6.8.4 The DC Regulators

Three regulated voltages are generated from three of the unregulated voltages discussed above.

A positive 5 V output is used to power all of the logic of the GSPE. The chip which regulates this supply dissipates quite a bit of power and is mounted on a large heatsink. Thermal compound should be used to mount U1 to this heatsink, but no insulating washer is necessary -- the heatsink is at ground, as is the case of U1. The thermal compound does not appear on the material list, but the first units should have been assembled with it anyway. C5, C6 and C7 provide local filtering required to maintain stability of the IC. CR13 protects U1 from reverse voltages in case the input shorts for any reason -- it probably won't ever get exercised. A multitude of output lines takes the +5 V and ground currents to the rest of the GSPE -- we are attempting to reduce voltage drops across a relatively "weak" transmission medium (the #28 AWG ribbon cable of W1).

Positive and negative 15 volts are regulated by U2 and U3 respectively. Both of these regulators are mounted on the same (small) heatsink, but only the -15 V regulator needs an insulator. The power dissipated in each of these regulators is relatively small, hence the small heatsink. As for the +5 V supply, C3, C4, and C8 thru C13 provide for regulator stability while CR14 and CR15 provide for reverse voltage protection of the regulators.

All of the regulated and unregulated voltages are delivered to the rest of the GSPE thru the 26-pin ribbon cable W1. This cable is kept short enough to so that the effect of the small gage wire is minimized. Multiple wires are used where the current loads are heavier.

5.6.9 ELLC BOARD

5.6.9.1 General

Refer to the ELLC schematics for the following discussion.

The ELLC board is made up of 16 identical circuits. References to circuit elements will be for circuit "00". Each circuit is meant to drive a single EL lamp element. Presently only 12 of the 16 EL lamp drivers are fully stuffed -- this corresponds to the total of 12 lamps (4 GVPs with three lamps each) presently on each car of the Horizons ride.

The board is fairly densely packed and there was concern, at the later design stages, that some of this dense packaging could give rise to problems. Discussion of this concern will follow the circuit description.

5.6.9.2 EL Lamp Driver Typical Circuit

5.6.9.2.1 General.

The typical EL Lamp Driver ("driver") has essentially three sections: a logic controlled voltage regulator section, the logic control interface, and a DC-AC resonant EL lamp driver element.

The voltage regulator section uses an LM317T in a logic controlled configuration. As such, the driver has three operating modes:

1. A very low output voltage state (1.25 V) which is supposed to correspond to the EL lamp "off" condition,

2. A normal output voltage state (18.0 V) which corresponds to the normal brightness "on" state of the EL lamp, and

3. A lower output voltage state which corresponds to the condition called "quarter bright" -- supposedly about one-fourth of the normal brightness state of the EL lamp.

5.6.9.2.2 The Controlled Regulator.

The LM317T is a three terminal voltage regulator that attempts to keep the voltage between its "out" terminal and its "com" terminal at +1.25V. Whatever the voltage is at the "com" terminal, the "out" line will be 1.25 V higher. It takes very little current to control the "com" terminal. R2 is selected at 100 ohms (which means 12.5 ma will be flowing thru it: 1.25 V/100 ohms = 12.5 ma). Since the current into the "com" terminal is only about 8 uA, almost all of this 12.5 ma will flow thru the other components connected there. So, depending on the status of the control gates (discussed below), the voltage at "com" will be either 0 V, 7.75 V, or 16.75 V.

C1 and C2 provide stability for U1, while CR1 handles the reverse voltage contigency for protection of U1.

Because the load current in U1 can be as high as 120 ma, and the source voltage to U1 is un-regulated, U1 might be subject to about 2.3 watts dissipation. Unfortunately, due to the packaging density, the best heatsink that will fit is a clamp-on unit on the vertically mounted U1. It is believed that this design can let the junction temperature of the LM317T reach about 122 degrees C (when the local ambient is 55 degrees C). This is quite hot, but still within acceptable temperature ranges for the device. Nonetheless, a higher failure rate of the LM317T can be expected -- don't be too surprised.

5.6.9.2.3 The Logic Control Interface.

The logic control of the "com" terminal voltage is achieved by two signal lines which are controlled by the microprocessor on the Controller board. (Note -- each driver has its own two logic control lines, and each driver is independently controllable.) Depending on the logic condition of the EN-00 and BR-00 control lines, a different voltage will be achieved on the "com" terminal. Refer to the table in zone B8 for this operation. When 0 V is desired at "com", U17-2 is on. When 7.75 V is desired, U17-2 is off and U17012 is on. Here, the pararallel impedance of R1 and R3 become 633 ohms, and the 12.5 ma flowing thru it to ground is about 7.9 volts (we wanted 7.75 volts, but component values worked out this way). When 16.5 volts is desired, both U17-2 and -12 are off, so only R3 to ground exists -- hence 12.5 ma x 1.33 Kohm = 16.6 V (close!).

5.6.9.2.4 The EL Lamp Driver Element.

This element is a prepackaged device manufactured by Endicott Research Group in Endicott, New York. The unit is lovingly called an "ERG" unit (derived from the company's initials). These elements are uniquely designed to drive EL lamps in a special way. The capacitance of the EL lamp becomes part of resonant circuit of the ERG. The ERG generates "sort-of" semi-sine waves of audio frequency range, very high voltages (as is required by the EL lamps). As explained in the Functional Spec, the operating nature of the ERGs is to compensate for the "aging" effects of the EL lamps.

The general characteristics of the ERG unit is that the output voltage and frequency of the unit is a function of the input DC voltage, the output load capacitance, and the "losses" in that capacitance load.

The conditions in the HFVRS is that a nominal, new EL lamp (with 18 VDC applied as input power to the ERG) generates about 150 VRMs at 510 Hz, which delivers about 12 ma (average rectified current) to the lamp. (Note: the current is AC, but reading it on a DVM gives an average rectified presentation.)

An engineering memo concerning the ERG units was written in August, 1983, explaining some problems with the ERG units. (The memo: Department 510, File No. Horizons-Show-26 dated August 31, 1983.)

C3 on the output of the ERG unit provides a minimum load for the ERG unit in the event the EL lamp is disconnected or fails to open. Without a minimum load, the output of the ERG unit goes to a very high voltage (over 400 VRMS) and this causes many problems. (See later discussion.)

The return path for the EL lamps current is to the ground of the EL lamp board.

5.6.9.3 Problems and Other Words of Wisdom

5.6.9.3.1 General.

There are several problems associated with the high packaging density of this ELLC board. This section will deal with these in a conversational manner.

5.6.9.3.2 Regulator Power Dissipation.

Because of the small heat sink on the LM317T, we might have higher failure rates than could be expected, the maximum dissipation only takes place for about 30 seconds in each 15 minute round trip on the ride. Still, in maintenance mode, the lamps could be left on indefinitely, so the high dissipation condition could be achieved at that time.

5.6.9.3.3 ERG High Voltage Arcing.

Because we are taking 16 "over 150 VRMS" signals off of the board (only 12 are used) presently), the circuit board etch is very close together. In fact, on the prototype boards which did not have a solder mask, there was some arcing across etch lines when the EL drivers were activated with lamps disconnected -- the voltage between etch lines got as high as 900 V peak. A conformal coating was applied to the back side of the board (where the close spacing existed) and this helped eliminate the effect. Still, in time, moisture might get under the solder mask, and provide paths for easy surface insulation breakdown -- that is, the problem may show up again. Look for "carbon tracks" between close places in the etch if you suspect that arcing has taken place.

Note, that there are also close places in the etch of the ribbon cable board mounting headers which brings the EL lamp drive voltages to the Controller board.

5.6.9.3.4 Failure Troubleshooting.

It sometimes proves difficult to discern the difference in a failure between the series regulator (U1) or the ERG unit (A1), since both failure can have apparent similarities. If the voltage into the ERG is 0 V, it could be an open LM317T or a non-running ERG. The easiest choice was to remove the ERG and see if the LM317T could drive a DC load other than the ERG.

Remember that the "off" condition for the ERG is (approximately) 0 V at "com" which gives 1.25 V at the ERG input. Remember also, that for the ERG to run at quarter brightness, it must first be "started" at full brightness -- it just doesn't reliable start if you first apply only 9 volts.

Note that a shorted EL lamp will cause the ERG to "stop". It won't drive AC signals into the shorted lamp. In this case, it is not the fault of the ERG, but rather, the lamp.

By the way, there is a slight error in the schematic: in zone A5, J1-42 is shown going to ground. It is also going to +28 V. The ground symbol is in error and doesn't belong.

5.6.10 RIDE STATUS INTERFACE BOARD

5.6.10.1 General

Refer to the Ride Status schematic for the following discussion.

The Ride Status Interface Board ("RSIB") is a small board which mounts on the front wall of the GSPE package. The interface connector to the outside world is thru a 15 pin circuit board mounted connector (J7) which is accessible thru a hole in the GSPE package. Only 12 of the 15 input pins were used to give a maximum separation between pins and etch when signals as high as 240 VRMS were applied to the circuit. It interfaces to the Controller board by a 10-pin ribbon cable/connector system.

The board consists of six identical circuits, each of which interfaces to an external signal source thru a pair of pins on the input connector. All six signal inputs are fully isolated from each other.

All outputs are directed to the Controller board microprocessor thru the 10-pin cable within the GSPE.

A common bias voltage is on the board to be used as a logic threshold common to all six circuits.

The discussion will be made around circuit #1, but all circuits are typical of this circuit.

5.6.10.2 Typical Ride Status Circuit Operation.

The external inputs to the Ride Status circuit are isolated thru an opto-isolator (U1). Therefore, enough current must be provided to the isolator to cause the circuit to recognize the input as a valid "present" signal. Similarly, when the "absence" of a signal is required, the current thru the led of the isolator must be less than a minimum value to guarantee the circuit recognizes the "absence" condition.

Since the input to the circuit is expected to be a voltage, series resistors R1 and R27 limit the current to reasonable values. The design is meant to work with AC signals between 90 VRMS and 250 VRMS. Two resistors were used (instead of a single one) because the total power dissipation in the equivalent input resistance would have required a physically bigger resistor than could be packaged and still have the circuit board mount "close" to the wall of the GSPE.

CR1 directs the positive half cycles of the input current thru the opto-isolator led. CR2 shunts the negative half-cycles of the input signal directly back thru the input resistors. This CR2 arrangement would allow the use of an (external) AC coupling capacitor if desired.

R22 guarantees a mimimum voltage drop across CR1 for the case of "absence" of input signal. Note that some maximum threshold for the "absence" condition must be established to have a reasonable design. In this case, this maximum AC signal is 5.0 VRMS. Unfortunately, this low value of threshold gives rise to a problem where the amount of current allowed at the 5.0 VRMS maximum, when applied across the 100 Kohm input resistance, corresponds to only 50 ua. With even short lengths of input cabling, it is possible to capacitive couple this must signal from an active set of wires (on another Ride Status circuit) to this desired "inactive" circuit, and thus, possible turn "on" this circuit. Hence, there appears the note in the Functional Spec concerning driving this circuit with a maximum source impedance of 10 Kohms.

When adequate input signal is presented to the coupler led, a half-wave like current flows in its isolated transistor. This current causes the collector (U1-5) to be pulled close to ground, and the comparitor (U7-10/11) detects this level change and U7-13 goes low during the led current time. When no led current flows in U1, U1-5 is high, and U7-13 is high. Depending on the frequency response of U1, you may, or may not, see the effect of the 60 Hz half-wave signal at U1-5. Regardless, the filter network Z2-7, R4, C1 will retain the low state of U7-13 so that if there is input signal present to the led, U7-6 will be low and U7-1 (the output) will be high. Hence, AC input signal corresponds to a logic "1" at the circuit output.

Power to the logic side of the Ride Status circuit comes from the 10-pin connector, too.

The +2.5 volt reference level generated by R25/R26 provides excellent noise rejection for both the detected and undetected states of the comparitors.

The real problem in detection remains the high input impedance of the AC network. A better choice would have been to put a zener diode in series with CR1 so that a higher minimum input voltage could have been withstood. Ain't highsight great?

5.6.11 CONTROLLER BOARD

5.6.11.1 General

Refer to the Controller schematic for the following discussion. The Controller schematic is drawn as a 5-page document with the following organization:

1. Page 1 contains a block diagram of the GSPE package with emphasis of elements on the Controller board (A1), and it also contains a table of contents and general notes for the rest of the schematic.

2. Page 2 has a summary of every connector on the Controller board. The summary gives the signal that is on every pin of the connector, and where that pin is drawn in the body of the schematic.

3. Pages 3 thru 5 show the actual schematic with elements on each page carrying a designator keyed to the page number. For example, circuits on page 3 all have designators which are in the 300 range, circuits on page 4 have designators with a 400 range, and 500 for page 5. Notes unique to the circuits on a particular page are shown on that page.

The controller board ("controller") is the major element of the GSPE. All logical flow, measurement, and communication occurring in the on-board electronics of the HFVRS are controlled from this board. It interfaces directly (except for the second GVP of each GVP set) to all of the other boards and sub-assemblies of the HFVRS on-board electronics. It contains the microprocessor, associated elements, and EPROM memory which runs the programs of the GSPE. It is somthing to be admired.

The controller board is a 4-layer board and the ground and +5 V power connections take place on the inside two layers. The controller is also a .094 thick board (rather than the more standard .060 board) so that it will be sturdier when mounting the external connectors and other GSPE elements.

The controller is screwed to a thin chassis on the bottom. Unfortunately, an error in the board layout caused some signal etch to get too close to the frame of the chassis, and when it was necessary to place a specially punched insulating sheet strip between the front edge of the controller board and the chassis.

During normal operation, the cover of the GSPE covers most of the controller so that only the five connectors and three indicator leds along the front edge of the board are accessable from the outside. These connectors are J1, J2, J3, J4, and J6. The other connectors on the controller (J5, J7, J8, and J9) are used internally or during test only, and require that the GSPE cover be removed for their access.

All of the IC components on the board have been placed in sockets for easier servicing. (Only the two opto-couplers associated with the PALS interface are soldered in place.)

The DB-25 connectors associated with the GVP interface and MTP interface have bushings for the mating DB-25 securing screws. The presence of the bushings requires that if there are securing screws on the mating connectors, those screws must be turned in order to mate the connectors. However, experience on the vehicle showed that it was extremely hard to connect or remove these connectors when the GSPE was installed in the vehicle. Evidently, most of the securing screws have been removed, and the connectors stay together by pin friction only. It is apparently adequate.

5.6.11.2 Controller Discussion Organization

The controller has many different sub-systems on it. For ease of discussion, these will be organized and presented as follows:

5.6.11.3 The Microprocessor System

5.6.11.3.1 General.

The microprocessor system portion of the controller is on page 3 of the schematic. This system itself can be broken into several discussion areas:

1. The microprocessor and associated buses
2. Memory and I/O addressing
3. Memory
4. System reset and timing
5. Ram Substitution System interface
6. Reference timers
7. Communications control
8. The D/A converter interface
9. I/O interfacing

5.6.11.3.2 The Microprocessor.

The microprocessor system is based on the 8085 processor (U301) running at 6.0 MHz. All memory and I/O operations are memory mapped (there is no IN or OUT commands used). Because most communication on the buses are with MOS devices, there was no direct need to buffer any of the data buses. However, since the 8-bit data shares the same eight lines with the lower address byte out of the microprocessor, it is necessary to latch lower address data in an 8-bit register (U311) with the ALE term. (This is a standard operation when using the 8085 with any peripheral chips not specifically designed to operate with this shared data/address bus technique.

All four normal 8085 interrupts (besides RESET) are used on the controller. Refer to Section 4.4 of the Software Spec for details on these interrupts.

5.6.11.3.3 Memory and I/O Addressing.

All memory and I/O addressing is controlled by a PROM (U312) which decodes the upper 3 address lines (A13-A15) from the 8085. Additionally, the read and write strobes from the processor (RD/ and WR/) are "ored" (U314-4,5,9,10,8) to generate a low true strobe, (WR+RD) / which signifies any memory operation, and this term is also part of the PROM addressing. A jumper input to the PROM addressing (E1-E2) selects either 2764 or 27128 EPROMs. (The present situation is that 2764s are selected by the absence of the jumper.) Finally, a line controlled by a storage element (which happens to be in the communication chip, U310) determines whether on-board EPROM or external test RAM is used for program memory. (Refer to Section 4.5 of the software Spec for details of this EPROM/external RAM function. The 8-bit word output by the PROM becomes the basic chip select control terms of the controller.

It was a space saving move to use a PROM rather than discrete logic. This was particularly true since the use of an external RAM substitution system was to be used for program development and this involved some alternate chip select formats compared to normal EPROM access.

The "program" blown into the fuses of the PROM is (hopefully) documented under the PROM part drawing CODE-158542-1. All of the PROMs used for the delivered units were blown from a single reference PROM which had been developed late in the HFVRS program.

There are pull-up resistors on the MEMCS1/ and MEMCS2/ terms (which go to the EPROMs) because the (WR+RD) / term is a strobe to the PROM, and when no strobe is present, the output byte goes tri-state. We need these chip select terms to be driven all of the time, hence the pull-ups. (MEMCS3/ does not have a pull-up on the board -- it gets it when the RAM Substitution system is plugged in.)

When one of the peripheral chips is to be selected (PERIPHERALSCS/ goes low), and a secondary one-of-eight decoding takes place (using the next three lower address lines (A11 thru A13) in U313. The resulting eight chip selects then go to the appropriate peripheral element of the controller. The additional inclusion of (RD+WR)/ redundantly into one of the gating terms on U313 guarantees that the peripheral chip selects do not hang around too long after the RD or WR terms are false.

A memory map is presented in zone B6 of page 3 of the schematic. Further descriptions take place in the Software Spec.

5.6.11.3.4 Memory.

The controller has two kinds of memory on board: 4K bytes of RAM (U302 and U303 -- 4K X 4 static memory chips) for working memory and either 8K bytes or 16 K bytes of EPROM (U304 and U305) for program storage.

As explained in the previous section and in the Software Spec, the choice of which size of EPROM chips are required depends on the amount of program storage required. However, both chips must be the same kind (either 64K or 128K). Both the 2764 and 27128 chips will plug into the same 28-pin socket without modification.

The access time required of the memory chips in 350 ns (not the fastest availble, but also not the slowest).

Allocation of the RAM in the HFVRS program is covered in the Software Spec.

5.6.11.3.5 System Reset and System Timing.

Hardware reset of the 8085 takes place at power up thru C301/R301. CR 301 provides a fast discharge of C301 when +5 V goes down so that another reset will be generated at the next power-up. Another hardware path of reset to the 8085 is from the MTP interface on J6-18. In this case, R302 provides the reset path when J6-18 is grounded. C311 and C312 provide high frequency noise rejection.

The low true RESET-IN into U301-36 generates a hi-true RESET-OUT from the 8085 which is used to initialize (reset) all of the peripheral chips.

The system clock for the whole controller is derived from the 6.000 MHz crystal which runs the 8085. CLK, which comes out of the 8085, is this system clock is a 3.000 MHz square wave.

5.6.11.3.6 RAM Substitution and Testing.

As was indicated earlier, a test system, the RAM Substitution System ("RSS") (Reference: CONT-161167) provides the capability to develop programs for the GSPE, and to test them directly, in real time, in the hardware. A special connector, J9, brings out the necessary signals (those which are not already on the socket for the first EPROM, U304).

The use and operation of the RSS is covered in the Software Spec. (Use of the RSS requires proper use of the Monitor resident in the GSPE software. This information is also in the Software Spec.

5.6.11.3.7 Reference Timers.

The 3.0 MHz system clock is divided by two (thru U315) to 1.50 MHz, and then counted down to generated a "baud-rate clock" which will be used by the data communications channels. The 1.50 MHz clock is also used to generate a 50 KHz carrier frequency which is part of the IR communications channel. And finally, it is used to generate a basic "timer" for certain time measurement functions within the GSPE program.

All of these timing and reference clock generation functions take place in the counter/timer chip, U309. The appropriate initializations and divide-by values are entered into the programmable elements of this 8253-5 chip. The 1.50 MHz frequency is necessary because the 8253-5 won't run on 3 MHz.

The output line of one of the three counter/timers within the 8253-5 becomes the "timer" interrupt needed by the GSPE. This signal goes into the 8085 RST 6.5 interrupt.

A real time clock (RTC INTERRUPT) is generated using the 50 KHz clock, and this clock becomes the "trap" interrupt (the highest priority interrupt on the 8085). The 50 KHz clock is counted down by a factor of 64 (in U316) to become the 0.781 KHz RTC INTERRUPT. Because U316 is a CMOS device, the 50 KHz clock has to go closer to +5 V to guarantee proper operation. R305 serves this purpose.

To make checkout of the system possible (without the RTC INTERRUPT occurring all of the time), a disabling term can prevent the RTC from running. This term is controlled from one bit of one of the peripheral I/O controllers described below. See the Section 4.3.6 of the Software Spec for details on this function. At power up reset, the RTC is normally disabled.

5.6.11.3.8 Communications Control.

The communications into and out of the GSPE is via various "RS-232 like" channels. Eventually, data flowing on this interface reaches the 8085 thru the 8251A Communications Interface (U310).

The baud-rate clock generated by the timer chip (above) becomes the transmit and receive clock into the 8351A. The conditions of the GSPE system will require that this clock be set at 19.23 KHz.

Data into the 8251A (from outside the GSPE -- after appropriate buffering) comes into the RxD terminal of the 8251. Data out of the 8251A leaves via the TxD terminal.

Data buffers within the 8251A provide a hardware indication that they are empty (in the case of transmission) or full (in the case of receiving data) thru the TxRDY and RxRDY pins. These hi-true signals are "ored" in U314 (also using U509 and another gate of U314 as inverters) and delivered as a "serial communications interrupt" signal which goes to the RST 5.5 line of the 8085.

A "left-over" control latch on the 8251A, DTR, is used as another output port bit to control the memory PROM selection function as described in Section 5.6.11.3.3 above. This function is completely independent of the communications functions of the GSPE.

5.6.11.3.9 The D/A Converter Interface.

Eight-bit digital data is put out to the DAC (U505) as part of the voltage measurement system of the controller. Discussion of this function will be handled under the Voltage Measurement heading of a later section.

5.6.11.3.10 I/O Peripherals Intefacing.

The remaining elements of the microprocessor system are the actual I/O controlling chips -- the 8255A-5s. There are four such peripheral I/O controllers on the controller board: U306, U307, U308, and U318. All of the remaining signals which are logic interfaces to the various remaining hardware elements on the controller are present on the input and output ports of these I/O controllers.

The configuration of these I/O ports is specified in the Software Spec.

In some cases, the output terms go directly to control other hardware chips and circuits. In cases where the signals will be "leaving" the GSPE package, filters and input/output protection is added. Discussion of the various interfaces for all of these terms will be handled under the specific headings which discuss the interfaces.

5.6.11.4 The Data Communication System

5.6.11.4.1 General.

The data communication of the controller involves two different paths into and out of the controller.

1. Data destined for the wayside mounted VSRP (which is transmitted via an IR medium.) This channel is "transmit only".

2. Bi-directional data communication on an RS-232 channel with an external CRT terminal, or the transmit only data to a SIMMTP.

Regardless of which path by which the data leaves the controller, it enters the microprocessor system thru the 8251A as discussed in Section 5.6.11.3.8 above. Note that we are discussing the RS-232-like data paths here, not the start beacon signal.

The data stream into and out of the 8251A is at 1200 baud as described in the Serial Protocol.

The logic and hardware which achieves this communication is shown on page 5 of the schematic. EMI filters for the RS-232 data are shown on page 4.

5.6.11.4.2 Received Data.

The communications data received by the controller necessarily comes from the MTP interface connector J6-25. The RS-232 signal, which is referenced to groun (J6-12) is first filtered by Z415/C416, and then becomes RS232FIN is received by U508-2,3 which is an op-amp operating like a comparitor in a conventional RS-232 line receiver. The threshold of the op-amp is set at +1.5 V. Since the RS-232 signal has a "1" which is less than -4 V and a "0" which is greater than +4 V, the 1.5 V threshold is acceptable. R524 pulls the RS232FIN line positive so that if no terminal is plugged into J6, the "0" condition will be indicated.

The output of the comparitor on U508-1 swings nominally between +13 V (for a "0" in) and -13 V (for a "1" in). Since these levels are incompatible with the inputs of a 74LSxx gate, a common technique of interfacing the elements is used: The op-amp signal is delivered to the input of a standard 74LSxx gate thru a series resistor (typically 5 Kohms to 10 Kohms). The positive excursion of the signal is clamped to +5 V thru a diode (CR504 in this case). The negative excursion is clamped to ground thru the protection diode which is a part of the 74LSxx input structure.

Thus, the negative voltage "1" on RS232FIN is converted to a positive TTL level logic "1" signal SERIALDATAIN on the output of U509-4. This SERIALDATAIN then goes directly to the communications controller 8251A.

5.6.11.4.3 Transmitted Data.

The transmit data stream signal generated by the 8251A is called SERIALDATAOUT and is inverted once (U509-5,6) before going to the RS-232 pseudo-driver op-amp (U508-5,6) and to the IR modulation driver circuit. (The inversion was only necessary as a convenience for the IR modulation driver.)

U508-5,6 acts as a comparitor for the TTL logic level signal with the +1.5 V compare level splitting the TTL logic levels. U508-7, which has output levels of about -13 V for a logic "1" (out of the 8251A) and +13 V for a logic "0", fortunately has drive capability an slew rates consistent with the requirements of an RS-232 channel. The series 1 Kohm resistor, R528, prevents short circuits from causing hardware problems, but allows a minimum impedance RS-232 load to be driven easily by the op-amp.

The Rs-232 level signal RS232FOUT goes thru a protection filter network (Z415/C415) before being placed on the output pin of the terminal interface connector, J6-12.

5.6.11.5 The IR Modulation Emitter

5.6.11.5.1 General.

The SERIALDATAOUT from the 8251A and then inverted (as described above, Section 5.6.11.4.3) is applied to a circuit whose function is to switch the current thru an IR emitting led at 50 KHz rate as modulated by the serial output data.

The IR signal generated by the led is focused by the lens of the led and aimed thru a hole in the bottom of the GSPE package where it will radiate towards the floor of the Horizons ride, and eventually fall upon some waiting IR sensitive receiver.

5.6.11.5.2 Hardware.

The 50 KHz square wave generated by the 8253-5 timer is received by U511-4,5,6 (an open-collector 74LS38 TTL buffer) and is collector "ored" with the 1200 baud serial output data which is received by the U511-1,2,3.

The collector of these gates is pulled up by R529 to +15 V which acts mostly as a current source. The signal is clamped to +5 V by CR505. This will become the signal which sets the current level to be driven into the IR led. This configuration causes the voltage on the collector (and also on the base of Q501) to rise quickly to the 5.6 V level. (A pull-up resistor to +5 V only at this point would have suffered from a slower rise time for the same initial current into the U511 collectors.) The signal that would be seen on the base of Q501 is a (approximate) 5.3 V p-p (flat top and bottom) signal at 50 KHz as modulated by the 1200 baud serial data. (The signal is 5.3 V rather than 5.6 V because of the saturation voltage of the drivers.)

Q501 is connected in a traditional emitter-follower/collector-current-source configuration. Whatever voltage appears on the emitter of Q501 is applied across the emitter resistor to ground (R530) and the current that flows thru this resistor will mostly come from the load in the collector circuit of Q501. Thus, when 5.6 V is applied to Q501 base, 5.0 V appears at the emitter, and this corresponds to approximately 80 ma flowing in the resistor. Most of this 80 ma will come from the collector, so we get current of about 80 ma thru the IR led, CR506.

The current for the led is taken from the +10 V unregulated supply (rather than from +15 V) to reduce power dissipation in the +15 V power regulator. (It turns out that this is the only use of the +10 V supply on the board.) Q501 will have to dissipate the extra power resulting from the remainder of the voltage drops between the +10 V supply to the transistor emitter. Thus, the metal can of Q501 will generally run hot to the touch -- it's OK, the device can take it.

R531/C511/C504 provide filtering for the 50 KHz current signals generated by this driver. The nominal drop across the 10 ohm R531 will be 0.4 V corresponding to the 40 ma average current thru it.

5.6.11.6 The Start Beacon Receiver

5.6.11.6.1 General.

The Start Beacon Receiver ("IR Receiver") IR receiving circuitry functions exactly like the VSRP circuit described in Section 6.0 but with a different carrier center frequency and data format. This circuit operates at 10 KHz, and has a much lower bandwidth since it is only receiving a 100 Hz modulation signal. The circuitry on the controller has been placed under a metal can which acts as a shield against interferences from the many other signals on the controller. (Refer to the discussion in Section 6.2 for a detailed description of the general operation of the IR receiver.)

The schematic for the IR Receiver is on page 4 of the schematic.

5.6.11.6.2 Circuit Details.

U401 provides the regulated 12 V that the special IR receiver chip, U402, requires. The IR sensitive led, CR401 is part of a rectangular plastic package with an IR transmissive characteristic. When you look at the package, it appears opaque because the plastic is not transparent for visible light. The led is oriented so that incident light (sent upwards from an IR transmitter located on the floor of the ride) strikes the sensitive portion of the diode thru a hole in the controller board. Of course, the led should be mounted so that it straddles the hole in the board, lest less than full IR energy will impinge on the active surface.

L401/C406/R402 form the tank circuit elements of the amplifier stage. In this case, the losses in the series coil just about set the circuit Q at the right place, so that R402 need only be 220 Kohms to provide the additional losses to set the Q at 40.

The carrier demodulator capacitor, C407, is five times larger than the equivalent one in the VSRP because the carrier is one-fifth that of the VSRP.

In this IR receiver, the U402 output goes to a Schmitt trigger 74LS14 for final "squaring" because we had some available (it went to an op-amp comparitor in the VSRP). Because of somewhat "sloppy" demodulation out of the IR receiver chip, the transition times between "0" and "1" states can have what looks like relay "contact bounce", the final filter stage R407/C418 is used to smooth this noise, and then one more Schmitt trigger gate re-squares it. (The filtering could not be done on the output of U402 because it has such a high output impedance.)

The signal STRTBCN will be either a logic "1" level (in the case of having received a SIMM start beacon signal), or a 100 Hz square wave (from normal mode start beacon). It is applied to one of the PIO bits, and is polled by the microprocessor to determine its status. When no IR signal is being received, STRTBCN will be "0".

5.6.11.7 The MTP Interface

5.6.11.7.1 General.

The MTP plugs into the Maintenance connector, J6 during certain maintenance and checkout periods. At other times, the connector is unused. Still, because this line goes outside of the GSPE package, all of the I/O lines are filtered to prevent external noise from getting into the GSPE. The RS-232 lines involved with data communication have already been discussed in Section 5.6.11.4.

The schematic for these interface lines in on page 4 of the schematic. To better visualize the full interface, you can also refer to the maintenance panel schematic which is in Figure 9.2.1 of the Functional Spec.

There are 8 output lines (to the MTP) and 8 input lines. The output lines come from PIO #4, port "B" and the input lines go to PIO #4, port "A".

All signals are referenced to the controller ground which is brought out to the J6 on three pins. DC power (+5 V) is delivered to J6 on two pins. Both the MTP and the SIMMTP require +5 V to operate.

5.6.11.7.2 Output Line Filtering.

A typical output line, leaving the PIO port, sees first a 0.01 uF capacitor to ground (the schematic incorrectly shows 0.1 uF) and then a series 470 ohm resistor before reaching J6. This circuit configuration filters external incoming noise. The PIO can drive the 0.01 uF shunt load capacitance at the expense of a decrease in rise/fall times. Since these output terms are used for only indicator leds in the MTP, the longer transition times are not a problem. The 470 ohm series output resistor is acceptable since the load to be driven in the MTP is a 74LS00 gate input. The total current that must be sinked by the PIO output is 0.4 ma, so the maximum voltage at the input the MTP will be 0.6 V maximum -- this is acceptable for a DC driven term. If we could have stood an even higher output level voltage, an even larger series resistance would have been used to further reduce noise inputs.

5.6.11.7.3 Input Line Circuitry.

Since the input lines will be coming from switches within the MTP, a pull-up resistor is first needed to establish the "1" level when the switch is open. The typical input line then encounters a 22 Kohm series resistor and then a 0.01 uF capacitor (schematic is wrong again) to ground before going to the PIO input port.

The 22 Kohm value of pull-up resistor was established to be compatible with the high "on" resistance of the membrane switches of the GVPs. This pull-up value was then used consistently for the rest of the switch inputs on the controller board.

5.6.11.8 The VAM Interface

The schematic for the VAM interface is shown on schematic page 4

The VAM interface provides for the eight "switch" settings (of the etch of the VAM) to be read by the controller. The eight lines come in on J1, and they are filtered exactly as the eight input lines from the MTP (see Section 5.6.11.7.3). Even the capacitor value on the schematic is wrong (like for the MTP interface) and should be 0.01 uF. All signals are reference to the controller ground. Two ground pins (for convenience only) are brought out to J1. The filtered input signals are inputs to PIO #2, port C.

5.6.11.9 The GVP Switch Interface

The GVP switch interface portion of the total GVP interface is discussed here. The schematic for this portion of the GVP interface is shown on schematic page 4.

There are two connectors associated with the GVPs. J3 services GVPs #1 and #2. J4 services GVPs #3 and #4. Each connector provides for four switches on each GVP or eight total lines per connector. These eight lines are filtered exactly as the eight input lines from the MTP (see Section 5.6.11.7.3). In this case, though, the schematic is right on the filter capacitor value (0.1 uF). The J3 switch inputs reach PIO #3 port "A" and J4 switch inputs go to port "B".

Note particularly that this is the case where the resistance values for pull-up have been selected to account for the possibly high "on" resistance of the input switches (1200 ohms maximum). When the switch resistance is 12 ohms, the 22 Kohm pull-up resistor combines with the switch resistance as a divider to supply 260 mv at the input pin of J3 or J4. The 22 Kohm series resistor to the PIO port input pin then can cause another 220 mv rise due to the maximum 10 ua leakage current out of the PIO port pin. Thus, the voltage at the input pin of the PIO is 480 mv.

Since the low level ("0") input voltage to the PIO is specified at 0.80 volts maximum, this is just acceptable -- we are still left with 320 mv of noise rejection. The filter time constant is chosen to be as high as possible with the available DIP-packaged capacitors -- and DIP packages had to be used because there was a space problem on the controller board.

5.6.11.10 The Signal Measurement Multiplexing System

5.6.11.10.1 General.

There are 16 "analog" signals on the controller board that are to be measured by the A/D converter system. (Refer to the Software Spec, Section 5.5 for additional information on this subject.) The multiplexing system which allows selection of these 16 signals is discussed below. The multiplexing system schematic is shown on page 5 of the schematic.

5.6.11.10.2 Multiplexing Operation.

The 16 signals to be measured are input in groups of eight into eight-to-one analog selector chips (U503, U504). Six control lines select the signals to be measured. Selecting one of 16 items would normally take only four control bits, but in this case, the control had to be broken into two sets of three lines, each set selecting one of eight inputs to a selector chip. The requirement for separate eight-input individually controlled selectors comes from the fact that eight of the signals (selected by U503) sometimes have to be processed thru additional circuitry (a full-wave rectifying/low pass filter) before going to the A/D converter. The output of this special filter is then one of the inputs to the A/D converter, also. Hence, the requirement for selecting one of the eight inputs to U503 for filter input, and then selecting the filter input in the second selector exists.

The six select control lines (identified SIGMUX0 thru SIGMUX5) come from PIO#1 port C bits 0 thru 5. These lines are pulled up to +5 V by resistors of Z502 because the guaranteed output levels of the PIO are not as high as the 4.0 V input thresholds required by the HI-508A selector chips. The analog signal selected (including the scale factor on the signal) as a function of the logic levels of the six control lines is given in zones F3 thru E1 on the schematic.

The chips chosen for the analog selection scheme (HI-508A) allow input signals to go from -15 V to +15 V. Signals which exceed this range will cause protection circuitry in the chips to clamp the signal (as long as it is current limited) to the +15 V or -15 V supply rail without any operating problems or feedthru from one analog channel to the other.

While these HI-508A chips have a low "on" resistance path for the selected channel (which is routed to the chip output on pin 8), the somtimes high source impedance for some of the signals to be measured dictated that a high input impedance op-amp or comparitor be used to buffer the signals before they are passed to the next part of the circuitry. Hence, U506-2 buffers U503's output, and U510-6 presents a light load to U504's output.

5.6.11.10.3 Signal Preprocessing and Scaling.

The signals brought into the multiplexers are sometimes resistance scaled so that the signal to be processed can be handled without any further special "range-changing" capability required.

The -24 V power supply signal (which is unregulated and can be as large as -30 V) is attenuated by 0.125 by R507/R508 and becomes -24VATN.

The -15 V (requlated) power supply signal is attenuated by 0.250 (by R509/R510) and becomes -15VATN.

(Both of these above signals will go thru the precision full-wave rectifier filter where they will be multiplied by a factor of 2.000 before they are measured by the A/D converter system.)

The +24 V power supply signal is attenuated by a factor of 0.250 (rather than by 0.125 like for the -24 V supply) because it will not undergo the X2 gain of the rectifier/filter circuit) by R503/R504 and becomes +24VATN.

The +28 V power signal is attenuated by 0.250 by R502/R501 and becomes +28VATN.

The +15 V power signal is attenuated by 0.500 (rather than 0.250 like -15 V -- again, no 2X gain) by R505/R506 and becomes +15VATN.

Plus 5 V and +10 V are brought into the selection chips unattenuated.

The voltage resulting from the EL lamp currents in the GVPs is brought in unattenuated from the resistors of Z501. The currents which flow in the three EL lamps of each GVP is routed thru one of these resistors on its way back to signal ground, and becomes a complex waveform AC voltage of about 2 volts p-p. Each GVP has its own resistor, so if only one EL lamp on that panel is lighted, the individual current of the lamp can be observed. These signals will have to go thru the rectifier/filter circuit before they can be measured.

The 0 to 5 V, modulated 50 KHz, square wave associated with the IR data transmission led current is brought in directly (unattenuated). This signal will also have to go thru the rectifier/filter circuit before it can be measured.

The signals representing the status of the PALS system onboard the same vehicle will be discussed in the following section.

5.6.11.11 The PALS Interface

5.6.11.11.1 General.

Refer to the Software Spec Section 5.5.5 for details on the general operation of the PALS interface signals. Refer to page 5 of the schematic for circuit details.

5.6.11.11.2 Circuit Details.

The signals from the PAL PVAA are digital signals telling the instantaneous condition within the PVAA. These signals are electrically current flows thru the leds of the PVAA, and then thru the IR diodes of the opto-isolators (U501 and U502) on the controller board. The minimum current which will flow thru the leds (when the PVAA indication is a "1") is greater than 10 ma. Thus, with a current transfer ratio of even 25% in the 4N35 isolator, the collectors of the output transistors will be saturated. Hence, whenever the "OK" led on the PVAA is on, U501-5 will be close to ground, and whenever the "ACTIVITY" led on the PVAA is on, U502-5 will be close to ground.

Within the GSPE, though, we wish to make a "general" evaluation of the PVAA, rather than an instantaneous judgement. This is particularly true since the microprocessor cannot always be looking at these lines, and some "transient" event which occurs in the PVAA may be totally missed by the controller board which must share its microprocessor resource. Therefore, these digital events are low-pass filtered and averaged to give a "duty-cycle" type indication of the PVAA situation.

We would look at the OK led signal and verify that it is on most of the time. (Note -- it would only go off under normal operation if there were "clicks" in the received PALS signal system which caused the PVAA to saturate or distort. Then, the OK signal would go off for a short duration -- about 200 ms.)

We would look at the ACTIVITY signal, which would normally be "flashing" during reasonable audio acitivity, and determine that it was on some reasonable percentage of the time during which some audio acitivity was expected.

Therefore, each opto-isolator collector signal is applied to a 1.0 second time-constant filter (R512/C501 and R514/C502) before going to the analog signal multiplexor selector chip U508. Note that this long time constant is necessary to "save" the relatively slowly occuring PVAA events, and it wasn't reasonable to set such a long time constant in the rectifier/filter circuit used for voltage measurement of the faster AC signals.

The voltage measurement system will then "read" this relatively slowly changing signal via the A/D converter. Note that in this case, a 0% duty cycle (the PVAA led "off" continually corresponds to the filtered signal being at the level of the +5 V supply, while a 100% duty cycle (the led "on" continually) corresponds to the saturated voltage level of the opto-isolator transistor's collector.

The duty cycles presently required in the software are given in the Software Spec. Note that it would be very hard to identify the 100% level accurately because of the uncertainty in the saturation level of the collector, and that very low duty cycles (close to 0%) would require measuring the +5 V power supply voltage first and then seeing the difference between the +5 V level and the low duty cycle filtered level.

5.6.11.12 The Voltage Measurement System

5.6.11.12.1 General.

The voltage measurement system is comprised of two sections: The full wave precision rectifier/filter circuit (mentioned several times above) and the A/D converter system. The schematic of these circuits is on page 5 of the schematic.

5.6.11.12.2 The Full-Wave Precision Rectifier/Filter Circuit.

This circuit is a combination of a standard configuration full-wave precision rectifier circuit with a single low-pass element added in the output amplifier of the rectifier.

The buffered signal out of U506-1 (representing the selected analog signal from U503) can be a bi-polar voltage signal in the nominal range of -10 V to +10 V.

The recitifier circuit has two parts: The first part inverts incoming positive signals (and outputs them as negative-going signals of the same magnitude) while putting out zero volts if the incoming signal was negative. This circuit includes Z503-3,4 Z503-5,6, U507-2,3,1, CR507, and CR502.

The second circuit combines the signal out of the first circuit, along with the original input signal, such that the resulting signal, again inverted, is the positive full-wave rectified version of the input signal. In this case, the low pass filtering is also done in this same stage. This circuit includes Z503-1,2, Z503-7,8, Z503-9,10, U507-5,6,7, R521 and C505.

The positive going signal processing circuit (the first mentioned circuit) operates as follows: A positive signal at Z503-3 causes U507-2,3,1 (connected as an inverting amplifier) to drive U507-1 negative, and this pulls the output (at CR502-anode) negative thru CR502, while the feedback thru Z503-6,5 closes the loop. Because the feedback and input resistors are the same value, the negative voltage on CR502-anode is exactly equal to the positive voltage input. Note that since U507-1 is negative, (while the summing node of the inverting amp, U507-2 is at a virtual groun), CR501 is back biased, and therefore has no effect.

When a negative signal is input to Z503-3, U507-1 goes positive closing the feedback loop thru the now forward biased CR501. Therefore, Z503-5 is at a virtual ground, and because the next stage (U507-6) is also a virtual ground, no current will flow thru the two Z503 which are inputs to the summing node (U507-6) of the next stage. (CR502 is now back-biased and contributes nothing.)

So, in review, for positive signals into Z503-3, CR502-anode goes negative. For negative signals into Z503-3, CR502-anode stays at ground.

Now we will look at the second circuit, the summing node circuit where the full-wave signals are combined and filtered. We will first analyze the circuit as though C505 were not present. Then, its filtering effect will be discussed.

When a negative signal is applied to the whole recitifier circuit, CR502 anode is at zero, but current flows thru Z503-2,1 into the summing node at U507-6. The signal at U507-7 would be 2.00 times the inverse of the original input signal. (The 2.00 factor is because the feedback resistor, R521 is 2.00 times the input resistor, R503.)

When a positive signal is applied to the complete rectifier circuit, CR502-anode is negative, and exactly twice the current that flows into the summing node thru Z503-2,1 flows out of the node thru the two Z503 resistors to CR502-anode. The resulting current is exactly equal to the negative of the current flowing into the node thru Z503-2,1. Therefore, the output of U507-7 is again a positive going signal, 2.00 times the original input signal. And, therefore, regardless of whether the input signal is positive or negative, the output will be a precise positive going rectification of that input signal.

Now consider the addition of C505. The summing currents which are fed back from the output of U507-7 are now integrated by the capacitor. This effectively causes the same effect as a RC low-pass filter with a time constant R521 X C505 or about 66 ms. This filter adequately removes the AC components (in the now DC biased signal) from all of the sources which come into the U503 multiplexor. The delay time thru this filter to get better than 2% settling time is about 4 time-constants or about 2 ms.

5.6.11.12.3 The A/D Converter System.

Analog to digital voltage conversions are not accomplished with a hardware controlled successive approximation technique. Rather, an 8-bit D/A converter (under microprocessor control) generates a voltage which is compared to the unknown voltage, and depending on the results of the compare, the processor can make some decisions about the unknown voltage. It can, in fact, do software controlled successive approximation conversions if required.

The signal to be compared is VSEL (coming out of the second signal multiplexor, U504-8). U510 does the comparison, while U505, an 8-bit D/A converter with the internal data latches, provides the compare reference voltage. The output range of U505 is from 0 to (almost) +10 V. (See the DAC coding table in zone D7 for range and step size. See Section 5.6.11.3.9 for data loading of U520.)

Since the comparitor, an LM339 is powered from +-15 V, its output (an open collector output) will be pulled negative (to about -15 V) whenever VSEL is greater than the D/A reference. R522 limits the current into the next logic stage (U513-3, a Schmitt inverter) for this "0" input. R523 provides the pull-up current when a "1" comes from the LM339. Note that the current pulled thru R527 be greater than the current provided by the pull-up (R523) and the gate current of the Schmitt (U513-3). The logic signal out of U513-3 has the indicative name "VSEL/VREF". This signal goes to PIO #4, port C, bit 7. This bit, of course, is set up as an input to the PIO.

5.6.11.13 The Frequency Measuring System

The frequency measuring system allows those analog signals controlled by the first signal multiplexor, U503, to have their period measured by the microprocessor. The schematic for this part of the controller is on page 5, zone G4.

The signal selected by the multiplexor, and buffered by U506-1, is low-pass filtered at 4.8 KHz (R517/C512) and then applied to the input of a comparitor (U510-4). The filter is necessary to remove "rough edges" on the input data. The signals which will have their period measured are really only the EL lamp currents with a maximum fundamental frequency of about 1.5 KHz. (The only other signal that might have been of interest (frequency wise) is the IRLEDCUR signal, but at 50 KHz there was no way this type of circuit could have handled the period measurement.)

The comparitor threshold is set by the voltage on U510-5 at a nominal 0.9 V for the positive going signal adge, and 0.7 V for the negative going signal edge. (Note that both of these thresholds are positive -- all negative signals will be below the lower threshold.) The small amount of positive feedback from the output of the comparitor provides the hysteresis indicated by the threshold values.

Since U510 is a LM339, it has an open collector output, and a pull-up resistor provides the positive output. R520 couples the comparitor output to a Schmitt trigger TTL device (U513-1) and allows the -15 V output state of the comparitor to be compatible with the TTL input.

The output term of this circuit, ELFREQ, goes directly to the RST 7.5 (the next-to-highest priority interrupt on the 8085). A high-going edge on the input to the comparitor causes ELFREQ to rise, and this can cause an interrupt if enabled by software.

5.6.11.14 The ELLC/GVP EL Lamp Interface

This portion of the controller is concerned with most of those signals which go to either the ELLC board or to the EL lamp portion of the GVPs.

There are several parts to this interface: (1) the digital control interface to the ELLC board lamp driver circuits, (2) the signal routing system of the high-voltage EL lamp drive voltages which are generated on the ELLC board and are re-routed to the GVP connectors, (3) the DC power interface to the ELLC board. The EL lamp return signals which are part of the EL lamp current measurement system have already been discussed in Section 5.6.11.10.3. The total interface to the ELLC board is from the controller board J8 (a 60-pin ribbon connector).

The digital interface to the ELLC board involves 16 sets of 2 signals -- one set to each of the 16 EL lamp driver circuits. (Refer to Section 10.2.3 for signal meanings.) The 16 "enable" logic signals come from PIO #1 ports "A" and "B". The 16 "brightness" logic signals come from PIO #2 ports "A" and "B". These signals go directly to the ELLC board with no filtering or protection. Since the ELLC board is within the GSPE package, and in fact, is only 4 inches (by cable) from the controller, this is a safe scheme. Four grounds, intermixed with the signal runs, provide good TTL signal path characteristics.

The 16 high voltage outputs of the ELLC drivers come back to the controller board (J8) before being sent in groups of 8 lines to the GVP connectors (J3 and J4). No EMI protection is provided on these lines -- it was felt that the relatively large capacitors on the EL lamp driver's outputs (on the ELLC board) provided the protection necessary for the system. Since the EL lamp drive signals can have very high peak values (up to 600 V peak), the same problem of high voltage arcing can occur on the controller board where the circuit etch lines are close. Therefore, the surface portion of the board where these lines run between J8 and J3/J4 has been conformally coated to preclude dirt or moisture from providing a partially conductive path for the arcing to begin.

DC power to run the ELLC board is also provided thru J8. A single pin for +5 V, and four parallel pins for +28 (because of the high total current requirement when all ELLC ERGs are on) are provided. Three additional ground pins (besides the four interspersed for logic signal transmission) have been included.

5.6.11.15 The LED Indicator Circuits

The status leds, visable from the outside of the GSPE package, are driven by a simple scheme. Refer to sheet 5, zone C5 of the schematic.

Two output bits from PIO #1 port "C" control these leds. The four states of the two bits have been decoded by U512 (74LS145) to determine which bit is on as shown in the table adjacent to the schematic. Software control is described in the Software Spec, Section 5.6.3.

Since only one led can be on at a time (due to the decoding scheme), only a single current limiting resistor was used for all three leds. The power was derived from the unregulated +24 V (rather than +5 V) to save power dissipation in the 5 V regulator. By using 24 V, a more consistent current drain could be defined, but it means even more power (almost 0.6 W) is dissipated in the limiting resistor. To conserve space, an 8-pin SIP resistor package (rather than a single discrete resistor) was used with all four resistors in parallel. A SIP can dissipate three times as much power in the same circuit board area as a discrete power resistor.

CR 503 is necessary to prevent the voltage on the 74LS145 outputs from going much above 5 V -- the limit for the chip.

5.6.11.16 The DC Power Distribution System

All of the DC power used by the controller is brought in from the Power Supply Board on J5 -- a 26-pin ribbon type connector header. This is shown on page 5, zone C8 of the schematic. Since the current drains on some of the DC power signals was expected to he high, a number of parallel pins were used to reduce voltage drops from the Power Board to the controller. Where necessary, on the controller PCB itself, wider circuit etch routes the voltage to the place of usage. Since the PCB is a 4-layer board, an entire etch layer is devoted to ground, so there is no real problem getting the return path for any voltage to be quite hefty. Plus 5 V also has most (but not all) of an etch layer devoted to it's distribution.

DC power to all ICs chips on the controller is connected as shown in the "Component Ref Info & IC Power" table given on each page of the schematic for the ICs on that page. Where special power requirements exist, the connections are shown directly on the schematic.

Local AC bypass filter capacitors are distributed around the board to provide the low AC impedances required by most 74LS type chips. These capacitors are shown on every page of the schematic and are generally drawn in close proximity to the chips which they "service". A single tantalum electrolytic capacitor is also at J5 on +5 V (C503). Maybe this cap does some good.

The electrical ground of the controller is connected to the chassis ground (the actual metal fram of the GSPE) thru a single wire jumper -- W501.

5.6.11.17 Miscellaneous Notes On Controller Servicing

In many cases, status of the controller, and of the GSPE in general, is accessible without removing the cover of the GSPE. Rather, the MTP or SIMMTP can be used (along with other existing test equipment) to determine the well-being of the hardware.

When it comes time to get to the controller board, a few words of wisdom might be helpful.

The controller board is accessed by removing the cover of the GSPE. Five screws into the base chassis of the GSPE can be loosened (it's not necessary to remove them!) and the cover lifted upwards. Because there are circuit elements mounted in the cover half of the GSPE, there are cables between the cover and the base (where the controller resides). (Be aware! The cover assembly of the GSPE weighs more than you might think because the power transformer is in there, too.) If you face the GSPE (with the I/O connectors of the controller directly in front of you), then when you lift the GSPE cover, without turning it, move it directly backwards, and set it down on the work-table surface behind the chassis portion of the GSPE. The cable from Power board comes from the back of the controller, and is long enough to allow this action to take place. The cable from the Ride Status Interface board comes from the right side of the cover (even though the board itself is on the front of the cover) and is also long enough to allow this placement of the cover.

Note that the cover could be removed while power is applied to the GSPE, and the system could continue to operate -- but this process is not really recommended -- too many chances for shakey hands causing the (grounded) metal of the cover from contacting live circuit places. At least, once the cover is removed, the GSPE can be repowered and operated as in a normal mode.

Once the package cover is removed, you'll notice that most of the controller is inaccessible -- covered by the ELLC board which is mounted on four standoffs directly above the controller. Removal of the four mounting screws on the ELLC surface allows this board to be folded forward (over the I/O connectors of the controller) and rested, components down, on the work surface. In this case, the cable of the ELLC board will be right over the top of the GVP connectors, so if you intend to operate the system, first have the GVP connectors in before folding over the ELLC. Be careful about touching the etch side of the ELLC while in this position -- the high voltage of the ERGs are right there!

You now have the whole controller board surface accessible (although the IR receiver is still under the metal shield cover, but access to this is obvious. Also, if you are going to need to communicate via the IR channels, move the GSPE assembly out over the edge of the work-table so that the holes in the bottom of the chassis can be in direct view with the various pieces of external IR test equipment.

Re-assembly of the GSPE can be frustrating. The Ride Status Interface Board cable likes to get pinched in various places between the cover and the chassis. So does the Power Board cable. And if you got hold of one of the earlier GSPE assemblies, the five screws (that you didn't have to remove in order to take off the cover) have flat washers which get stuck on the inside of the cover. Finally, you may have to wiggle-waggle the cover a bit to make it sit firmly down on the chassis -- sometimes it just "hangs up" before it's home.

5.6.12 MAINTENANCE TEST PANEL

5.6.12.1 General

The MTP is an essential piece of maintenance test equipment in the HFVRS system. Approximately ten units were built by Dept. 510. Some were of a "klugy" construction made from vector boards and packaged in a nice plastic box. Later units have a PCB and a better plastic box. Refer to the Functional Spec for the schematic (Figure 9.2.1) and operation description (Section 9.2.1).

In normal operation, the MTP would connect to J6 on the GSPE thru the MTP 10-foot ribbon cable. During certain development stages, an RS-232 CRT-terminal could be plugged into J1 of the MTP.

5.6.12.2 Thumbwheel Switch Inputs

The two 16-position thumbwheel switches on the MTP (S1-1- and S1-2) are each organized as 4-bit binary switches. The tables at the left of the schematic relate the switch positions to the status of each line going to J6. A closed switch ("0") corresponds to the grounded condition for the signal. A pull-up resistor in the GSPE provides the high condition when each switch is open.

In the PCB version of the MTP, the two thumbwheel switches are part of the same switch assembly, and connect to the PCB thru a 10-pin ribbon cable connector (P3/J3).

The IR/TERM signal is also brought to pin 3 of J1 (the connector to the optional CRT-terminal) so that the operating mode of the GSPE can be set by a special switch on the harness to the CRT. (This switch is not a part of a normal RS-232 cable.)

5.6.12.3 LED Status Indication

The eight red leds visable on the MTP are controlled by eight bits sent from the GSPE. Each of these lines is first buffered thru a 74LS00 gate and then to the cathode of the led, so that a high input to the MTP causes the cathode to ground and the led goes on. The leds have built in resistors to limit the current. A nominal current in the led is about 12 ma.

5.6.12.4 Microprocessor Reset

The single pushbutton switch (S2) on the MTP is used to cause a hardware RESET to the microprocessor of the GSPE. (See Section 5.6.11.3.5.)

There is a problem associated with this RESET line in the MTP. In an attempt to provide a good AC ground path for the other signals in the MTP, capacitor C1 (0.1 uF) was placed from the RESET line to ground in the MTP. Unfortunately, when the MTP is to be plugged into a GSPE with power on, this capacitance is originally discharged. Inside the operating GSPE, the RESET line, with 0.2 uF to ground, is initially sitting at +5 V. As soo, as the MTP is connected to J6, the re-distribution of charges on the capacitors involved causes the RESET line of the microprocessor to go to about 3.33 V. This may or may not cause a reset of the processor (where one was not desired). That can be a shame when you were plugging in the MTP to diagnose a problem existing at the moment in the GSPE -- you may just reset the processor and loose the status.

Solution -- remove C1 in the MTP! It's really not necessary.

5.7 OPERATOR CONSOLES

5.7.1 DCM CONSOLES.

ROC 01 is in the ride passenger loading area adjacent to the load belt walkway. ROC 02 is in the ride equipment room. The two consoles have identical DCM control and monitor functions.

5.7.1.1 DCM Touchscreen Control Functions:

START: Initiates ride START
STOP: Initiates ride STOP
LO SPEED: Initiates LO SPEED
HI SPEED: Initiates HI SPEED
ENTER: Required to enter all commands
Load Belt START: Starts load belt walkway and handrail drives
Load Belt STOP: Stops load belt walkway and handrail drives
CANCEL: Cancels last command
ERROR CLEAR: Erases messages on screen

5.7.1.2 DCM Touchscreen Monitor Functions:

Ride START: Acknowledge ride START
Ride SPEED: Acknowledge LO or HI SPEED
Load Belt START: Acknowledge load belt START
Unload Belt RUN: Monitor unload belt status

A portion of the DCM touchscreen CRT is used to display messages for operations and maintenance personnel. Some of this data is sent from the RCC 01 Monitor Computer via a serial link.

5.7.1.3 ROC 01 Hardware Control Functions:

E-Stop: Maintained push/pull switch for emergency stop of all ride equipment
Station Control: Key lock switch to select which of six ride control locations is active

Off (None Selected)
Load Console ROC 01
Eqpt Console ROC 02
Maintenance Station Selector

Maintenance Station Select:

Maintenance Station 1
Maintenance Station 2
Maintenance Station 3
Maintenance Station 4

5.7.1.4 ROC 02 Hardware Control Functions:

E-Stop: Maintained push/pull switch for emergency stop of all ride equipment

Off/On: Keylock Off/On switch to allow the console to provide control functions to the ride control equipment

5.7.2 ROC 03. The functions of the ROC 03 console are as follows:

E-Stop: Maintained push/pull switch for emergency stop of all ride equipment

Belt Start/Stop: Maintained push/pull switch to start or stop the unload belt walkway

5.7.3 DCM I/O TABLES.

The console DCM touchscreens interface to parallel I/O signals from the ride control system. Tables 5-8 through 5-10 list the input and output functions accommodated by the DCM's.

Table 5-8. DCM Monitor Points

PORT	FUNCTION
J1-A0	RIDE RESET
J1-A1	HI SPEED
J1-A2	LO SPEED
J1-A3	BELT PACK LOW SPEED
J1-A4	FRAMES RUN
J1-A5	LOAD BELT RUN
J1-A6	UNLOAD BELT RUN
J1-A7	EMERGENCY STOP RESET
J1-B0	PERMISSIVE RUN #1
J1-B1	PERMISSIVE RUN #2
J1-B2	RDC TRAVELING FRAMES RUN
J1-B3	RDC TRAVELING FRAMES SYNC
J1-B4	RDC VEHICLES MOVING
J1-B5	KEY LOCK SWITCH: LOAD CONSOLE
J1-B6	KEY LOCK SWITCH: EQPT CONSOLE
J1-B7	KEY LOCK SWITCH: MAINTENANCE AREA #1
J2-A0	KEY LOCK SWITCH: MAINTENANCE AREA #2
J2-A1	KEY LOCK SWITCH: MAINTENANCE AREA #3
J2-A2	KEY LOCK SWITCH: MAINTENANCE AREA #4
J2-A3	DCM ID: LOAD CONSOLE
J2-A4	DCM ID: EQPT CONSOLE

Table 5-9. DCM Output Points	
PORT	FUNCTION
J1-C0	RIDE RESET
J1-C1	HI SPEED
J1-C2	LO SPEED
J1-C3	STOP
J1-C4	FRAMES START
J1-C5	LOAD BELT START
J1-C6	FRAMES STOP
J1-C7	LOAD BELT STOP

Table 5-10. DCM Status and Error Codes to RCC	
CODE	FUNCTION
00	DCM NULL MESSAGE
01	RIDE STOP FROM EXTERNAL SOURCE
02	RIDE START
03	RIDE STOP
04	HALF SPEED
05	FULL SPEED
06	LOAD BELT START
07	LOAD BELT STOP
08	RIDE "101"
09	RIDE "102"
FE	RIDE MAP REQUEST

5.8 RIDE MONITOR SYSTEM

The Ride Control Computer (RCC 01) is the central element of the monitor and diagnostic system. For this installation it has no controlling functions. RCC 01 uses parallel and serial inputs and outputs as shown in the RPB monitor point tables, see Tables 5-11 through 5-15.

5.8.1 MONITOR SYSTEM MESSAGES.

The RCC 01 monitor system uses serial links to two console DCM touchscreens (ROC 01 and ROC 02) to receive DCM status information, see Table 5-10, and to display system operational messages and maintenance messages. In addition, the printer (in the Equipment Room) provides a hard copy for maintenance messages.

5.8.2 VEHICLE COMMUNICATION.

Vehicle communication is accomplished via an infrared beam from the bottom of each vehicle to the receivers in the concrete floor of the pavilion.

The normal vehicle message includes an eight bit vehicle identification number, the guest selection for which finale video presentation they wish to see (ignored by the maintenance receivers), six bits of vehicle motor control status data, and status information bits relating to the transmitter beacon, electroluminescent panel displays, the GVP switches, and the PALS Vehicle Audio Amplifier.

5.8.2.1 Maintenance Beacon Transmitter.

The maintenance beacon transmitter radiates an IR beacon which stimulates the GSPE to enter the Self Incriminating Maintenance Mode. The beacon signal is a steady 10 kHz square wave carrier.

The use of the maintenance beacon is not a normal maintenance procedure, and would only be useful for a detailed survey of vehicle parameters while the ride is running. The normal data transmission from the vehicles contains condensed vehicle parameter information.

The transmitter is identical to the AX01 show beacon. It is mounted in a hole core-drilled into the concrete floor of the ride. The placement of the beacon is such that all three maintenance receivers are passed before the finale show start beacon toggles the GSPE back into the normal mode.

5.8.2.2 Maintenance Receiver.

Trackside IR receiver cans, located near the three maintenance stations, receive information from the GSPE on the ride vehicle. The fourth receiver can (AX02), located at the entrance to the finale area, communicates with the Video Processing System. The maintenance receivers are packaged and mounted in a similar fashion to the AX02 receiver.

5.8.3 VTSS COMMUNICATION.

RCC 01 receives coded serial messages from the VTSS system and generates the appropriate messages to the DCM screens and the printer.

5.8.4 RDC 01 COMMUNICATION.

RCC 01 receives information from RDC 01, including sensor failures, vehicle/frame position values, and general status bits. RCC 01 generates the appropriate messages to the DCM screens and the printer.

5.8.5 RPB I/O TABLES.

The RCC interfaces to parallel I/O signals through the Ride Parallel Breakout Boxes. The following tables list the input and output functions accommodated by the RPB's.

Table 5-11. RPB 01 Connections			
INPUT	FROM	FUNCTION	TERMINAL
1IOT	PWM 01	OVERTEMP	TB1 A0
1IOL	PWM 01	OVERLOAD	TB1 A1
1IFLT	PWM 01	FAULT	TB1 A2
1TFLT	PWM 01	TOTALIZED FAULT	TB1 A3
1RUNX	PWM 01	RUN	TB1 A4
2IOT	PWM 02	OVERTEMP	TB1 A5
2IOL	PWM 02	OVERLOAD	TB1 A6
2IFLT	PWM 02	FAULT	TB1 A7
2TFLT	PWM 02	TOTALIZED FAULT	TB2 A0
2RUNX	PWM 02	RUN	TB2 A1
3IOT	PWM 03	OVERTEMP	TB2 A2
3IOL	PWM 03	OVERLOAD	TB2 A3
3IFLT	PWM 03	FAULT	TB2 A4
3TFLT	PWM 03	TOTALIZED FAULT	TB2 A5
3RUNX	PWM 03	RUN	TB2 A6
4IOT	PWM 04	OVERTEMP	TB2 A7
4IOL	PWM 04	OVERLOAD	TB2 B0
4IFLT	PWM 04	FAULT	TB2 B1
4TFLT	PWM 04	TOTALIZED FAULT	TB2 B2
4RUNX	PWM 04	RUN	TB2 B3
5IOT	PWM 05	OVERTEMP	TB2 B4
5IOL	PWM 05	OVERLOAD	TB2 B5
5IFLT	PWM 05	FAULT	TB3 A0
5TFLT	PWM 05	TOTALIZED FAULT	TB3 A1
5RUNX	PWM 05	RUN	TB3 A2
6IOT	PWM 06	OVERTEMP	TB3 A3
6IOL	PWM 06	OVERLOAD	TB3 A4
6IFLT	PWM 06	FAULT	TB3 A5
6TFLT	PWM 06	TOTALIZED FAULT	TB3 A6
6RUNX	PWM 06	RUN	TB3 A7

Table 5-12. RPB 02 Connections			
INPUT	FROM	FUNCTION	TERMINAL
RST	MCC 01	RIDE RESET	TB1 A0
LO SPD	MCC 01	LO SPEED SELECTED	TB1 A2
HI SPD	MCC 01	HI SPEED SELECTED	TB1 A3
BRAKE	MCC 01	BRAKE MONITOR	TB1 A4
VPRSNT	MCC 01	RDC VEHICLEL PRESENT SIGNAL	TB1 A5
1CBX	MCC 01	BUS CIRCUIT BREAKER 1 ON	TB2 A0
2CBX	MCC 01	BUS CIRCUIT BREAKER 2 ON	TB2 A1
3CBX	MCC 01	BUS CIRCUIT BREAKER 3 ON	TB2 A2
4CBX	MCC 01	BUS CIRCUIT BREAKER 4 ON	TB2 A3
5CBX	MCC 01	BUS CIRCUIT BREAKER 5 ON	TB2 A4
6CBX	MCC 01	BUS CIRCUIT BREAKER 6 ON	TB2 A5
7CBX	MCC 01	BUS CIRCUIT BREAKER 7 ON	TB2 A6
8CBX	MCC 01	BUS CIRCUIT BREAKER 8 ON	TB2 A7
9CBX	MCC 01	BUS CIRCUIT BREAKER 9 ON	TB2 B0
10CBX	MCC 01	BUS CIRCUIT BREAKER 10 ON	TB2 B1
11CBX	MCC 01	BUS CIRCUIT BREAKER 11 ON	TB2 B1
12CBX	MCC 01	BUS CIRCUIT BREAKER 12 ON	TB2 B3
13CBX	MCC 01	BUS CIRCUIT BREAKER 13 ON	TB2 B4
14CBX	MCC 01	BUS CIRCUIT BREAKER 14 ON	TB2 B5
1RTS	MCC 01	RECTIFIER 1 OVERTEMP	TB3 A0
2RTS	MCC 01	RECTIFIER 2 OVERTEMP	TB3 A1
3RTS	MCC 01	RECTIFIER 3 OVERTEMP	TB3 A2
ESTOP	MCC 01	EMERGENCY STOP RESET	TB3 A3
PR1	MCC 01	PERMISSIVE RUN 1	TB3 A4
PR2	MCC 01	PERMISSIVE RUN 2	RB3 A5
SRUN	MCC 01	GE EQUIPMENT RUNNING	TB3 A6

Table 5-13. RPB 03 Connections			
INPUT	FROM	FUNCTION	TERMINAL
LDBLTE		LOAD BELT LIMIT SWITCH	TB1 A0
ULDBLTE		UNLOAD BELT LIMIT SWITCH	TB1 A1
STOPM1	RMS 01	MAINT STATION 1 STOP	TB1 A2
STOPM2	RMS 02	MAINT STATION 2 STOP	TB1 A3
STOPM3	RMS 03	MAINT STATION 3 STOP	TB1 A4
STOPM4	RMS 04	MAINT STATION 4 STOP	TB1 A5
STOPLC	ROC 01	LOAD CONSOLE STOP	TB1 A6
LDE	ROC 01	LOAD CONSOLE EMERG STOP	TB2 A0
ULDE	ROC 03	UNLOAD CONSOLE EMERG STOP	TB2 A1
EQPTE	ROC 02	EQPT ROOM CONSOLE EMERG STOP	TB2 A2
M1E1	RMS 01	MAINT STATION 1 LOCKING E-STOP	TB2 A3
M1E2	RMS 01	MAINT STATION 1 MUSHROOM E-STOP	TB2 A4
M2E1	RMS 02	MAINT STATION 2 LOCKING E-STOP	TB2 A5
M2E2	RMS 02	MAINT STATION 2 MUSHROOM E-STOP	TB2 A6
M3E1	RMS 03	MAINT STATION 3 LOCKING E-STOP	TB2 A7
M3E2	RMS 03	MAINT STATION 3 MUSHROOM E-STOP	TB2 B0
M4E1	RMS 04	MAINT STATION 4 LOCKING E-STOP	TB2 B1
M4E2	RMS 04	MAINT STATION 4 MUSHROOM E-STOP	RB2 B2
TRKSWE	RTS 01	TRACK SWITCH EMERG STOP	TB2 B3
TRKLKE	RTS 01	TRACK LOCK EMERG STOP	TB2 B4
VFIN		VEHICLE FIN SENSOR EMERG STOP	TB2 B7
STOPEC	ROC 02	EQPT ROOM CONSOLE STOP	TB3 A1
STOPTCD1	RTD 01	TRACK CRACK DETECTOR 1	TB3 A3
STOPTCD2	RTD 02	TRACK CRACK DETECTOR 2	TB3 A4
STOPTCD3	RTD 03	TRACK CRACK DETECTOR 3	TB3 A5
STOPBC		BELT PACK EMERGENCY STOP	TB3 A6
STOPVTSS		VTSS EMERGENCY STOP	TB3 A7

Table 5-14. RPB 04 Connections			
INPUT	FROM	FUNCTION	TERMINAL
10RUNX	RMC 01	LOAD BELT RUN	TB1 A0
10TOL	RMC 01	LOAD BELT OVERTEMP	TB1 A1
10OLX	RMC 01	LOAD BELT OVERLOAD	TB1 A2
10PR	RMC 01	LOAD BELT PERMISSIVE RUN	TB1 A3
10AUTO	RMC 01	LOAD BELT AUTOMATIC MODE	TB1 A4
10FLT	RMC 01	LOAD BELT FAULT	TB1 A5
7RUNX	RMC 02	UNLOAD BELT RUN	TB2 A0
7TOL	RMC 02	UNLOAD BELT OVERTEMP	TB2 A1
7OLX	RMC 02	UNLOAD BELT OVERLOAD	TB2 A2
7PR	RMC 02	UNLOAD BELT PERMISSIVE RUN	TB2 A3
7AUTO	RMC 02	UNLOAD BELT AUTOMATIC MODE	TB2 A4
7FLT	RMC 02	UNLOAD FAULT	TB2 A5
8RUNX	RMC 03	HANDRAIL BELT RUN	TB2 A6
8TOL	RMC 03	HANDRAIL BELT OVERTEMP	TB2 A7
8OLX	RMC 03	HANDRAIL BELT OVERLOAD	TB2 B0
8PR	RMC 03	HANDRAIL BELT PERMISSIVE RUN	TB2 B1
8AUTO	RMC 03	HANDRAIL BELT AUTOMATIC MODE	TB2 B2
8FLT	RMC 03	HANDRAIL BELT FAULT	TB2 B3
9RUNX	RMC 04	TRAVELING SCREENS RUN	TB3 A0
9TOL	RMC 04	TRAVELING SCREENS OVERTEMP	TB3 A1
9AUTO	RMC 04	TRAVELING SCREENS AUTOMATIC MODE	TB3 A2
9FLT	RMC 04	TRAVELING SCREENS FAULT	TB3 A3

Table 5-15. RPB 05 Connections			
INPUT	FROM	FUNCTION	TERMINAL
INV1	MCC 01	INVERTER 1 SELECTED AS SPARE	TB1 A0
INV2	MCC 01	INVERTER 2 SELECTED AS SPARE	TB1 A1
INV3	MCC 01	INVERTER 3 SELECTED AS SPARE	TB1 A2
INV4	MCC 01	INVERTER 4 SELECTED AS SPARE	TB1 A3
INV5	MCC 01	INVERTER 5 SELECTED AS SPARE	TB1 A4
INV6	MCC 01	INVERTER 6 SELECTED AS SPARE	TB1 A5
SS1	MCC 01	STATION SELECT LOAD CONSOLE	TB2 A0
SS2	MCC 01	STATION SELECT EQPT CONSOLE	TB2 A1
SS3	MCC 01	STATION SELECT MAINT STA 1	TB2 A2
SS4	MCC 01	STATION SELECT MAINT STA 2	TB2 A3
SS5	MCC 01	STATION SELECT MAINT STA 3	TB2 A4
SS6	MCC 01	STATION SELECT MAINT STA 4	TB2 A5
VEM1		VEHICLE EQPT MONITOR 1 STOP	TB3 A0
VEM2		VEHICLE EQPT MONITOR 2 STOP	TB3 A1
VEM3		VEHICLE EQPT MONITOR 3 STOP	TB3 A2