Operation Manual

Industrial Rack and Pinion Elevator

MODEL:

Trac-Cab TC3K
Class: Freight

SAMPLE CUSTOMER
Customer, Project - Location

Unit ID
Service Elevator
NOTICES

Abstract
This Operation Manual contains basic information and instructions for Normal and Emergency Operation and fault troubleshooting of the TESI TRAC-CAB Industrial Rack and Pinion Elevator System.

Applicable Specifications
This equipment meets or exceeds the ASME A-17.1 Safety Code for Elevators and Escalators.

Disclaimer
This manual must not be relied upon for complete information and instruction in the safe use of the elevator equipment. Proper training and knowledge of elevator systems usage, OSHA and other safety rules, including electrical and fall protection must be a part of a qualified users training program.

Tower Elevator Systems, Inc. will not be liable in any event for direct, indirect, or consequential damages arising from the use of this Manual. We reserve the right to revise this Manual without the obligation to notify any person or organization. It is the responsibility of the owner/user to insure safe use of the equipment, including maintaining current documentation.

Warranty Program
TESI warrants all components to be free of defects in material and workmanship for a period of (1) years from the date of initial installation, provided a dated Final Inspection and Testing Report proof of proper installation by a TESI authorized representative, is forwarded to TESI.

Warranty Conditions
This warranty does not apply to products that have been abused, misused, or modified. Normal wear and tear is not covered under warranty.

TESI reserves the right as final authority in determining whether the product should be repaired or replaced. Defective parts or products that can be shipped must be returned freight prepaid to receive warranty repair or replacement. Should a TESI authorized technician be called out for warranty repair, and it is discovered the repair is not covered under the warranty for reasons stated above; the customer is responsible for payment for repairs.

This is the only warranty. TESI makes no implied warranties, including any warranty of merchantability or fitness for a particular purpose. All warranties are limited to the duration of the expressed warranty period as set forth. TESI’s maximum liability hereunder is limited to the purchase price of the product. In no event shall TESI be liable for any consequential, indirect or special damages of any nature arising from the sale or use of the product.
SAFETY WARNINGS

Elevator systems equipment contains potentially dangerous high voltage electrical circuits and moving parts. Dangers exist that can only be recognized and avoided with proper training. Compliance with the OSHA and other safety regulations and proper inspection, maintenance, and repair of the equipment is imperative.

Use of the equipment should be limited to properly trained and authorized persons.

Although Tower Elevator Systems, Inc. has incorporated practical safety precautions and features in the equipment, extreme care must be taken at all times to insure personal safety when you operate or service this equipment. Observe all Safety and instructional signage.

Signage Legend

- **DANGER** – This means the hazard will kill or seriously injure you.
- **WARNING** – This means the hazard could kill or seriously injure you.
- **INSTRUCTIONS** – Owner policy and posted instructions must be followed.
IMPORTANT INFORMATION

WARNING

Multiple Control Points
Be aware the system can be controlled remotely from the Ground Control Station via an authorized technician login at the Ground Display Panel. Access to the Ground Control Station must be limited to authorized personnel included in your Access and Emergency Rescue Plan.

Wind Speed
Elevators installed outdoors must not be used when wind speed exceeds 90mph.

Storms, Earthquakes
In case of severe storms, tornados, hurricanes, or earthquakes, all vital parts of the elevator system must be inspected and tested by a qualified inspector prior to returning the system to service.

Icing
Do not operate the elevator in icing conditions. Damage can occur to the guide wheels, drive system, and cable management system if the system is operated with ice present on the guide rails, gear rack, or traveling cable.

DANGER

Fire
In case of fire do not use the elevator. If you are on the elevator when fire is reported, exit as soon as possible at the nearest landing and follow the site Evacuation Plan.

Electric Shock
The elevator is powered by 480 Volt 3 Phase and 110v Single Phase Power. In some circumstances devices may have multi-source power circuit feeds or be provided power by a Battery Backup, even when the main system power is disconnected. Lock Out / Tag Out System Power and observe safety procedures prior to servicing this equipment. Only authorized and trained personnel are allowed to service this equipment.

LOCK-OUT TAG-OUT PROCEDURE
- Announce lock-out to others
- Lock and tag power in the OFF position
- Put key in your pocket
- Notice others before restart
- Remove lock and tag
- Turn power back on
- Announce power is ON
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INTRODUCTION

The Trac-Cab TC3K is a Rack and Pinion Industrial Elevator designed and engineered for industrial applications in harsh environments. The Code classification for the TC3K system is a permanently installed Rack and Pinion Freight elevator as defined by Part IV of the A17.1-2007 Elevator Code.

The machine travels up and down the elevator hoistway using dual pinion gear drives and safeties, driven by a variable speed electric drive system. The dual pinions each have a fully redundant integral automatic fail-safe brake system for maximum safety. The dual pinion gears engage a Rack and Rail system engineered to meet the Elevator Code requirements. The Rack and Rail runs the height of the hoistway providing precision tracking and positive engagement.

TESI has developed our product line with Safety and Technology as the driving factor using off-the-shelf industry proven components whenever possible. The core components of the Trac-Cab Drive System are the Siemens based Fail-Safe “Programmable Logic Controller” (PLC) controller, the SEW Eurodrive “Variable Frequency Drive” (VFD) speed controller and the SEW dual Gearmotors with, continuous duty integral Fail-Safe drive brakes. The Active Drive System is autonomously backed up by an independently actuated, mechanically set, Dual Fail-Safe Rack and Pinion Safety device, which is continuously monitored by the Safety PLC elevator controller. This design exceeds the functionality commonly found in the marketplace and meets all Code requirements for performance and safety.

We believe that our machines offer several advantages over other systems commonly found in the marketplace. Some of our unique features are especially relevant on industrial elevators. These include the Dual Drive and Safety System, the Hydraulic Rescue Lowering system, the Safety PLC based UL Listed Elevator Controller and the Optional Smart-Reel Cable Management system (applicable for machines over 100ft tall). These systems have been developed to address specific challenges common to tall outdoor rack and pinion elevator design. In addition, all rail components are solid structural members, welded and hot dip galvanized. This is a significant advantage over systems that utilize tubular members, which are very prone to rusting from the inside out. Internal rusting of the structural members, introduces a safety concern because the deterioration cannot be inspected and can unknowingly weaken key parts of the system over time. This hazard is eliminated with our design.

The Trac-Cab system operation is directed by the TESI UL Classified Elevator Control system based on software logic developed by TESI, running on the Siemens S7-300FS Fail-Safe PLC and a network of Siemens logic controllers and sensors. The operator interface utilizes touch panel graphical displays to provide operation status information and system administration functions. All user initiated automatic elevator control functions are accomplished via industrial lighted push buttons for long life and improved operational functionality. The operator interface includes an integral alarm bell meeting the A17.1 Elevator Code emergency signaling requirements. The operator interface also contains one of the system Emergency Stop buttons.
In automatic operation, the elevator can be called from any landing call station and also may be directed to any floor from the cab based operator station. Elevator speed and position logic are accomplished via a highly accurate incremental quadrature rotary encoder that supplies a signal to both the VFD speed controller and the elevator controller. This system allows the elevator to sense its position in the hoistway at all times. All input sensor data is continuously compared against expected tolerances resulting in fail-safe operation. This technology not only provides for maximum control and flexibility of the elevator system, but also eliminates many complex landing position switches, leveling devices, slow down switches, and other sensors that are commonly found on cable traction drive elevators.

The intelligent control system also monitors drive and system parameters to provide active feedback for system function status. Any anomalies, alarms or system faults are displayed in plain text to the operator or technician via the graphical touch screen interface. This information is available at both the Cab and Ground station HMI (Human Machine Interface). The interface is protected by pass-code input, which restricts access to all administration and technical operations. All operational and system administration functions are accomplished directly from the system touch panel; no need to configure and connect a laptop.

Per the Elevator Code, the system can be operated in Inspection Mode from the car top. Additionally, TESI has provided technician inspection control from the cab operating panel and ground operation station, allowing authorized technician access from the ground and cab stations upon secure log in.

In short, the Trac-Cab is a rugged, flexible, and technologically advanced industrial elevator system that is designed and engineered for long life and trouble free service.

ABOUT TESI

Tower Elevator Systems, Inc. is a Licensed and Insured, US based manufacturer of Industrial Rack and Pinion Elevator systems. TESI manufactures elevator systems at our production facility in Austin, TX. The fabrication and quality processes have been developed to insure consistency and code compliance. TESI manufacturing procedures are AWS (American Welding Society) Code Compliant and our Plant is subject to frequent quality inspections by both our Customers and Suppliers. The facility is equipped with an 80-foot tall testing tower, allowing full function, load and speed testing of our systems prior to shipment.
## SYSTEM CONFIGURATION

<table>
<thead>
<tr>
<th>Description</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Customer</td>
<td>SAMPLE CUSTOMER</td>
</tr>
<tr>
<td>Location</td>
<td>SAMPLE LOCATION</td>
</tr>
<tr>
<td>TESI Model Number</td>
<td>Trac-Cab TC3K R&amp;P Elevator</td>
</tr>
<tr>
<td>TESI Job Number</td>
<td>SAMPLE</td>
</tr>
<tr>
<td>ALSTOM JOB / PO Num</td>
<td>SAMPLE</td>
</tr>
<tr>
<td>Project ID</td>
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<tr>
<td>Environment:</td>
<td>Outdoor Stair Tower Installation - No Enclosed Hoistway</td>
</tr>
<tr>
<td>Electrical Classification</td>
<td>Not Classified</td>
</tr>
<tr>
<td>Elevator Classification</td>
<td>Permanently Installed Rack &amp; Pinion Freight Elevator</td>
</tr>
<tr>
<td>Freight Loading</td>
<td>Class A Loading</td>
</tr>
<tr>
<td>Drive System</td>
<td>Rack &amp; Pinion</td>
</tr>
<tr>
<td>Capacity (Rated Load)</td>
<td>2,500 lbs</td>
</tr>
<tr>
<td>Cab Size</td>
<td>7' wide x 5' deep x 7'-4&quot; high (nominal Interior)</td>
</tr>
<tr>
<td>Cab Configuration</td>
<td>Dual Cab Gate – Solid Panel Vertical Slide Up</td>
</tr>
<tr>
<td>Speed</td>
<td>120 Feet per Minute (Nominal)</td>
</tr>
<tr>
<td>Height</td>
<td>150 feet of Travel (Nominal)</td>
</tr>
<tr>
<td>Landings</td>
<td>4 Landings - L1 (Ground) to L4 (Top)</td>
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<tr>
<td>Power</td>
<td>Dual 15 Horse Power SEW Eurodrive Gear Motors</td>
</tr>
<tr>
<td>Gear Ratio</td>
<td>38.86:1 Reduction</td>
</tr>
<tr>
<td>Pinion</td>
<td>3DP 24 Tooth - 8&quot; Pitch Diameter – 3.25&quot; Face Width</td>
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<tr>
<td>Gear Rack</td>
<td>3DP 25 Deg -3&quot; Face Width x 3&quot; Wide Gear Rack</td>
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<tr>
<td>Counterweight</td>
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<tr>
<td>Elevator Control</td>
<td>TESI UL Classified Elevator Controller - Full Automatic Operation w/ Lighted Call Buttons</td>
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<tr>
<td>Speed Control</td>
<td>Variable Frequency Drive</td>
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<tr>
<td>Overspeed Safety</td>
<td>Dual Independent R&amp;P Safeties Per A17.1 Part 4.1.9</td>
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## ELECTRICAL SERVICE

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<tr>
<th>Description</th>
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<tr>
<td>Electrical Service</td>
<td>System requires a electrical service level of:</td>
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<tr>
<td>480 VAC 3P 60 Hz:</td>
<td>60 Amps at 480 Volts, 3 Phase, 60 Hertz</td>
</tr>
<tr>
<td>Telco Service:</td>
<td>System requires a POTS Analog Telephone Line</td>
</tr>
<tr>
<td>Emergency Communications</td>
<td>terminated at the ground control cabinet.</td>
</tr>
</tbody>
</table>
SYSTEM OVERVIEW
TESI Trac-Cab Rack and Pinion Industrial Elevator

Photo is of a Typical TC3K System
TRAC-CAB MAIN COMPONENTS & CODE ITEMS:

1. **Elevator Controller** –
   Designation: CP1
   Location: Mounted at the Ground Landing
   Function: Main Elevator Controller. *Provides Central Point of System Power, Network and Communication circuit distribution, elevator hoist control and digital serial network connected to the remote call stations. Also, contains elevator ground administration and control position.*

2. **Car Operating Panel** –
   Designation: OS1
   Location: Recess Mounted in the Cab Wall
   Function: *OS1 provides the main elevator user interface for all system operations. It is connected to CP1 via the traveling cable and the Siemens ProfiSafe Network. OS1 features a touch panel display for easy operation and industrial lighted push buttons for trouble free operation in rugged environments.*
3. Car Top Control Panel  
   Designation: Car Top Control  
   Location: Mounted at the Car Top Under Protective Top Cover  
   Function: Provides Code Required Car Top Inspection Control

4. Call Stations -  
   Designation: CS1, CS2, CSx…  
   Location: Mounted near the Landing Doors at each Landing Level  
   Function: Call stations are provided for automatic elevator operation. If the elevator is available in a ready state, the user will press the call button and the elevator will be dispatched to that landing area. Call Stations include a lighted call indicator for visual feedback of current elevator status.
5. **Landing Door** -
   Designation: Landing Door  
   Location: Each Landing Level  
   Function: Provides safe entrance and exit to the elevator car when the car is at a particular landing area. Landing doors are monitored and interlocked, meaning that the elevator will not operate in normal or inspection mode when a landing door is open. In addition, the landing doors remain locked unless the car is in the landing zone, preventing personnel from opening the door and falling into the empty and unguarded hoistway. The door locks are configured per the Elevator Code to always allow opening from the hoistway side and provide for key lock access from the landing side to let the door be opened with a key regardless of the controller interlock state.

6. **Cab Door / Gate** -
   Designation: Cab Gate  
   Location: Elevator Cab  
   Function: Provides safe entrance and exit to the elevator car when the car is at a particular landing area. Cab doors are electrically monitored and mechanically locked; meaning that the elevator will not operate in normal or inspection mode when a cab door is open.
7. **Elevator Cab**
   Designation: Cab
   Location: Mounted to the Tractor Backbone & Rail System
   Function: Provides enclosed housing for riders. Includes cab door, cab lighting, an operator station, a roof access hatch with integral ladder, a fire extinguisher and applicable safety and information signage.

8. **Maintenance and Emergency Exit Hatch**
   Designation: Exit Hatch
   Location: Roof of Elevator Cab.
   Function: Provides Technician and Emergency Exit Access to Car Top. Hatch is electrically monitored and must be closed for the elevator to run in automatic operation.
9. **Interior Car Light**  
   Designation: Cab Light  
   Location: Mounted in the Elevator Cab  
   Function: Provides Code Required Car lighting  
   Mode: On / Auto – In “AUTO” mode the light is activated upon a  
   “change-of-state” (i.e. door open or elevator call) of the elevator system  
   and remains on for a specific time period. After the light “times out”, it  
   will remain off until the elevator is to be used again. The “ON” mode will  
   keep the light on as long as the switch is in the “ON” position.  
   Battery Back Up is provided for Emergency Lighting per Code.

10. **Dual Drive System** -  
    Designation: Drive System  
    Location: Mounted to the tractor plate on top of the cab  
    Function: A variable speed electrically powered dual drive train that transfers  
    electrical power to mechanical movement via the gearmotors and pinion drive  
    gears. The pinion gears are positively connected to the rack providing the  
    elevator lift.
11. **Hydraulic Emergency Rescue Lowering System**  
   Designation: Rescue Lowering  
   Location: Mounted at car top and integral with the drive system  
   Function: The Rescue Lowering System will allow a stranded rider to lower the cab under a controlled gravity descent in the case of a power unit malfunction or power loss to the system. Lowering speed is regulated to a controlled and safe speed by the hydraulic speed governor.

12. **Rack and Pinion Safety**  
   Designation: Dual Independent Safety Brake System  
   Location: Mounted one each directly on the pinion shafts  
   Function: *In the event of an Over Speed condition, the Safety Brake system will engage to slow and stop the car independently.*
13. Tractor Backbone
   Designation: Tractor Backbone
   Location: Mounted in the Elevator Hoistway
   Function: The tractor backbone and wheel housings form an integrated system providing a framework for elevator power, tracking, and cab mounting. The tractor backbone and cab assembly ride up and down the rack and rail powered by the drive system.

14. Elevator Guide Wheels
   Designation: Guide Wheels & Axles
   Location: Mounted to the Backbone and Roll on all surfaces of the Rail Track.
   Function: Provide Alignment and Tracking for the Cab on the Rail.
   Load bearing wheels are Stainless Steel with double stacked (4 each wheel) precision sealed ball bearings that require no lubrication.
   Alignment & Backing wheels are Poly Tread over Aluminum Hub with double stacked (4 each wheel) precision sealed ball bearings that require no lubrication.
15. **Gear Rack and Rail**

   Designation: Rack and Rail  
   Location: Mounted in the Elevator Hoistway  
   Function: An integrated system providing the main structural guide for the elevator to track up and down the hoistway. The Rail System is mounted to the building structure. The Gear Rack is mounted to the Rail System. The Pinion Gears on the Tractor Drive system engage the Gear Rack and move the elevator up and down the hoistway.

![Gear Rack and Rail Images]

16. **Spring Buffer Assembly**

   Designation: Spring Buffer  
   Location: Mounted in the Elevator Pit  
   Function: A spring buffer assembly providing shock absorption impact protection should the elevator car travel into the pit area.

![Spring Buffer Assembly Images]
17. Hoistway Access Door
   Designation: Hoistway Door (If Provided)
   Location: Integral to Pit / Hoistway Enclosure
   Function: Provides Technician Access to Pit and Hoistway for
            Maintenance. Door is electrically monitored and must be closed for the
            elevator to run in automatic operation or inspection mode.

18. Pit E-Stop, Light and Utility Outlet
   Designation: Pit E-Stop
   Location: Integral to Pit / Hoistway Enclosure
   Function: Provides Code Required means to disable the elevator for a
            technician performing maintenance in the Pit area. Also provides Light
            and Electricity to the Pit. The "Run" button will allow operations to
            continue after the E-Stop has been deactivated.
19. **Traveling Cable Management System - Trolley or Smart Reel System For Managing Traveling Power, Control and Communications Cable**  
   Designation: Trolley or SmartReel  
   Location: Mounted on the Rail System, Under the Elevator Cab.  
   Function: Provides a means to tension and manage the traveling power, control and communications cable that is linked between the CP1 cabinet and the traveling car.

![Traveling Cable Management System - Trolley or Smart Reel System For Managing Traveling Power, Control and Communications Cable](image1)

20. **Traveling Cable Attachment Bracket (Trolley Systems Only)**  
   - Designation: Traveling Cable Bracket  
   Location: Mounted to the Rail System just above the Mid-Point of Travel.  
   Function: Supports the Traveling Cable to make the transition from Rigid Conduit to Flexible Cable, which is routed thru the Trolley System and Attached to the moving Car.

![Traveling Cable Attachment Bracket (Trolley Systems Only)](image2)
21. Traveling Power, Control and Communications Cable -
Designation: Control Cable
Location: Mounted between the Elevator Cab and the Ground Controller
Function: Provides an electrical link for power, control and communications between the CP1 Elevator Controller cabinet and the traveling car.

22. Braking Resister or Power Regeneration Unit
Designation: Braking Resister or Power Regeneration Unit
Location: Mounted Under Cab or in Class I / Div II Control Box
Function: Provides means to dissipate heat and energy produced as a by-product of lowering the car under a controlled speed via dynamic braking of the VFD.
23. Home Position Sensor and Flag
   Designation: Home Sensor
   Location: Mounted to Drive Plate
   Function: Non contact proximity sensor mounted on the traveling car that senses a fixed “flag” mounted to the rail. The home sensor gives the car a known reference point to reset the position encoder count when the calibration routine is initiated.

24. Top and Bottom Final Terminal Stopping Limits and CAMS
   Designation: Final Terminal Stopping - Per A17.1 Part 2.25.2
   Location: Mounted to Drive Plate
   Function: Provides Hard Wired Device Based Overtravel Stopping at the Top and Bottom of the Runby area in the Hoistway. Switches are mounted to the tractor plate and “CAMS” are mounted to the rail system in the hoistway above the top landing and below the bottom landing. Upon actuation the car can be driven off the switch in the opposite direction of travel using Inspection Control.
25. **Main Power Disconnect**  
Designation: Disconnect  
Location: At Main Elevator Landing near CP1  
Function: Provides Code Required Main Power Disconnect to the Elevator System. Main System Power Lock-Out / Tag-Out should be done at this location during service.

26. **Rack and Pinion Safety Hooks**  
Designation: Safety Hooks  
Location: Mounted to the Tractor Backbone  
Function: Steel Hooks, which are mounted directly to the Tractor Backbone and Drive Plates, provide redundant physical stops to prevent the backbone from disengaging from the rail system in the unlikely event of a wheel or wheel carrier failure. This is a critical safety device on a Rack and Pinion Elevator, which prevents the Pinion Gears from disengaging from the Rack in the case of a wheel malfunction. The steel plates ride just off the surface of the Guide Rail and Rack to provide a physical stop if for any reason the wheels would lose engagement.
ELEVATOR OPERATION INSTRUCTIONS
TESI Trac-Cab Elevator Control System

OPERATION POLICIES

Normal and Emergency Operation training must be completed and documented prior to use of this equipment.

Misuse of this equipment could result in personal injury or property damage.

Note that the owner / site operator must confirm that all required safety inspections and maintenance procedures are performed according to all signage and the System Operation Manual.

OPERATION MODES:

- **Automatic Operation – Standard Elevator Controls & Operation Apply**
- **Emergency No Power (Rescue) Lowering:** Cab Recovery via controlled gravity descent
- **Car Top Inspection Mode:**
  Manual Car Control, for trained and authorized technicians only, accessed via car top control station at the car top. Requires “INSP” Mode selection from MODE key switch in Cab.
- **Cab Inspection Mode:**
  Manual Car Control, for trained and authorized technicians only, accessed with a from the Car Operation Panel. Requires “INSP” Mode selection from MODE key switch in Cab and Authorized Password.
- **Ground Administration Mode:**
  For trained and authorized technicians only, accessed via key code from the administration menu and operated from the ground position touch panel. Requires “INSP” Mode selection from MODE key switch in Cab and Authorized Password.
AUTOMATIC OPERATION

In normal automatic mode the elevator control is via full automatic elevator operation using the standard lighted push buttons in the cab and at the landings that are clearly marked for function. The control panel display will show relevant system status information.

The TESI Trac-Cab is programmed for full automatic elevator operation with visual feedback provided by lighted pushbuttons in the cab and at each floor landing. Multiple calls may be queued, and will be attended automatically.

NORMAL OPERATION MODE

   Elevator Ready / Automatic Operation

- Verify the electrical power is ON to the Main Controller.
- Confirm all required inspections have been performed.
- Insure the car travel path is clear of persons or obstructions.
- Test to confirm operation of the emergency signaling system.
- Close the car gate and landing door and observe the system status is “ready” on the display panel. If not “ready”, diagnose and correct the indicated faults.
- Push the desired Floor Call button to start car movement.
- An active floor call may be cancelled in route by using the “Call Cancel” button on the display panel. Press the Call Cancel button to cancel the active call. Press the new destination button to re-route the elevator. The car will slow and stop automatically at the designated landing stop. Note: call cancel function will cancel the active call and all pending queued floor calls.
- Car Send Feature: Allows an unmanned cab to be sent to a desired floor level, without using the remote floor call button. A user can press a floor call from inside the elevator, with the elevator in standby (door open), then close the car gate and landing door. The elevator will then automatically proceed to the desired floor.
- Press the Red E-Stop button in the event of any system irregularity. Pressing the E-Stop will immediately stop the car, even if not at a landing. Check the screen for system alarm messages.
TYPICAL TRAC-CAB CAR OPERATING STATION LEGEND

- **-- VMI --**
  - Voice Message Information System

- **Industrial Telephone for Emergency Communications**

- **Sealed Industrial Membrane Panel With Lighted Push Buttons**

- **Touch Panel Display System Status Info And User Interface**

- **Call Button**
  - ID Tags

- **Emergency Stop Button**

- **Alarm Bell**

- **Fire Service**

- **Mode Selection Key**

- **Emergency Lowering Button**

- **Call Cancel Button**

- **Cab Ventilation Fan Switch**

- **Automatic Elevator Operation**
  - L4 - TOP
  - LANDING 3
  - LANDING 2
  - L1 - GROUND

- **E-STOP**
  - PUSH TO STOP

- **LOWERING**
  - PRESS & HOLD

- **ALARM**
  - OFF / ON

- **FIRE SERVICE**
  - ON / OFF / HOLD

- **MODE**
  - NORM / INSPECTION

- **Alarm Bell**

- **Cab Light Switch**

- **Automatic Elevator Operation**
  - L4 - TOP
  - LANDING 3
  - LANDING 2
  - L1 - GROUND

- **Call Button ID Tags**

- **Call Cancel Button**

- **Cab Ventilation Fan Switch**

- **Automatic Elevator Operation**
  - L4 - TOP
  - LANDING 3
  - LANDING 2
  - L1 - GROUND

- **E-STOP**
  - PUSH TO STOP

- **LOWERING**
  - PRESS & HOLD

- **ALARM**
  - OFF / ON

- **FIRE SERVICE**
  - ON / OFF / HOLD

- **MODE**
  - NORM / INSPECTION
VMI - VOICE MESSAGE INFORMATION SYSTEM

The TESI Voice Message Information System (VMI) allows users to access custom recordings to include instructions for Site Information, Normal Operation, Emergency Operation, Lowering Instructions, or any other audible information a customer desires. This feature adds to the ease of use of the system, can qualify as OSHA required training, and provides accurate and timely operation safety information for your system.
EMERGENCY COMMUNICATIONS

The TC3K Freight Elevator includes Emergency Communications consisting of an Industrial Telephone Handset with Keypad connected to an internal intercom or external telephone line and when applicable an Elevator Code and ADA (Americans with Disabilities Act) compliant Hands Free Auto Dialing Emergency Speaker phone.

Trac-Cab Integral Industrial Phone Set

The Trac-Cab Operator Station Includes and Integral Industrial Phone set and Dial Pad allowing full service telephone communication directly from the elevator car.

K-Phone ET401’s SUREphone

The ET401 Fortress meets all safety standards by providing the built-in features necessary to promptly connect, identify, and respond to calls for assistance. The momentary press of the phone activating button puts it all into motion... An automatic dialer is provided to dial out to an auxiliary location. In buildings that are not manned 24/7, multiple phone numbers can be programmed that will sequentially cycle through if there is no answer or a busy signal is detected. The recordable voice message is used to identify location and provide any dispatch and/or other information specific to the site. Automatic shut-off ensures units are always ready for the next call.

Analog Phone Line
- 24-51 VDC 30 mA

Power Requirements
- Phone line

Wiring
- 20 AWG shielded twisted pair

Approvals
- FCC (US), IC (Canada)
- UL (US), CSA (Canada)
- ADA (US)
- ASME A17 (US), B44 (Canada)

*Weather protected option includes: Conformal coated circuit board, soldered connections and sealed contacts, water proof speaker and microphone

K-Tech International, Inc.
56 Ella Grasso Ave.
Torrington, CT 06790
Phone: 800-993-9399 or 860-489-9399
FAX: 860-489-4399
Www.KTechOnline.com
AUTOMATIC OPERATION – LANDING DOOR INTERLOCKS

The Landing & Car Doors are manually operated, vertically bi-parting freight elevator type doors, with both Mechanical and Electric Interlocks per the Elevator Code. In normal operation, the doors can only be opened when the elevator car is parked at the landing “unlocking zone”.

Car and Landing Doors are mechanically interlocked (Locked/Unlocked) with a Cam and Roller Arm that only “Mate” to “Unlock” the doors when the car is “Level” with a landing zone. This means the doors can only be opened, allowing a rider to exit the car, when the car is parked level with a landing.

Additionally, the doors can be opened by a technician with a key from the landing side, and can also be opened from the Hoistway side, for emergency egress at any time.

The Doors are also electrically interlocked; meaning that if any door is open or unlocked the elevator control system will sense the condition and prevent car movement. The “System Ready” state can only be achieved when all car and landing doors are closed and locked.
AUTOMATIC OPERATION – MAIN SCREEN

This screen displays System Status Information. A quick review of this display will give the user operational condition of the main sub-systems, elevator position in the hoistway, and provides on-screen call cancel function.

There are display indications for Landing Position, Cab Position (Feet / Inches) and Cab Speed (Feet Per Minute). This screen also shows a real-time graphical representation of the Elevator Car Position in the Hoistway and relative location of the Landings. If a landing indicator light is "on", the elevator cab is stopped at that landing and the doors may be opened from the Landing side.

There are system ready lights providing at-a-glance system status. More detail can be found by navigating to the corresponding sub-system detail screen from the Main Menu.

The on-screen Call Cancel button, cancels all calls, stops elevator and places system in ready state to receive new call destination instruction.
EMERGENCY OPERATION

An Emergency exists any time the system is in use with a fault condition indicated or system power has been lost. The Trac-Cab is equipped with an Emergency Lowering System to allow a stranded rider to safely lower the elevator via a controlled gravity descent to provide self rescue. This operation is performed using the “Lowering” button that is integrated into the Elevator Operating Panel.

Note: The lowering system is designed to provide for safe lowering and exit of a stranded car in the event of a power loss or control system malfunction. If serious mechanical failure is suspected in the Drive, Rack, Rail, Guide Wheel or Pinion systems, the lowering system should not be used. Any abnormal grinding, knocking, or scraping noises should be considered indication of pending mechanical failure. If mechanical failure is indicated, use the emergency phone to call for assistance and wait for rescue from authorized emergency personnel. Once the passengers are safely clear of the elevator, the system must be inspected and repaired by a competent trained and authorized elevator technician.

SAFETY PLC E-STOP FUNCTION

The Trac-Cab is controlled by a Fail-Safe Safety PLC controller. Safety PLC’s by design latch and Log all E-Stop Actuations. The system incorporates (4) Safety E-Stop stations: Car Top, Car Operating Panel, Ground Control Station and Pit E-Stop. Pushing any E-Stop will also remove the “Safety System Ready” condition. Simply pulling the E-Stop back out will not return the system to service. If a system E-Stop is pressed for any reason, the system will shut down and remain disabled until the operator acknowledges the E-Stop to reset the Safety system. The operator can use a “RUN” button if available or may use the on-screen E-Stop Acknowledge Button to return the system to operational status. The E-Stop Acknowledge Button can be found on the Safety Sub-System Screen, where the E-Stop status is also displayed. All E-Stops must be returned to the normal “out” position, and then the “reset” or “run” button should be pushed to re-activate the system. If all conditions have been met, the Safety System Ready light will return.
EMERGENCY RESCUE LOWERING

The TESI Emergency Rescue Lowering System (Patent Pending) will allow a stranded rider to lower the cab under a controlled gravity descent, in the case of a control malfunction or power loss to the system. Lowering speed is regulated to a controlled and safe speed by the hydraulic speed governor.

Lowering is considered an Emergency Operation and would only be used in the event that a rider is stranded in the elevator and requires rescue. Lowering provides a means to allow the rider self-rescue, thus avoiding the dangerous operation of rescue from above.

The lowering activation “control button” has been “sealed” with a removable “one-time” use removable “ID Seal” (extra seals are provided and stored in the CP1 control cabinet). This is intended to dissuade casual use of the Emergency Lowering System. The Lowering System cannot be activated without first breaking the seal. Note: no tools are required to break the seal.

The elevator control system also senses if the Lowering operation has occurred and indicates a “lowering activated” alarm. The lowering activated alarm will disable automatic operation until a trained technician can inspect and reset the fault prior to placing the system back in normal operation.

**IMPORTANT:** Prior to executing an emergency rescue descent, contact Master Control with the car intercom/telephone, to inform the attendant of your situation. Remain in voice contact during the emergency rescue procedure. If the telephone is not working the Alarm bell is battery backed and can be used to alert others of an emergency. Activate using the “ALARM” switch as needed.
EMERGENCY LOWERING OPERATION:

- Contact Master Control and inform the attendant of your situation
- Upon instruction from a trained technician, remove the access Seal and open the safety cover protecting the “Lowering” Button on the control panel
- Push & Hold the “Lowering” button to begin the descent
- The cab will continue to descend while the button is depressed
- To STOP - Release the “Lowering” Button
- You must manually level the car at the nearest landing by releasing the “Lowering” button at the appropriate time. Close the cover to secure the button when the emergency lowering is completed
- Exit Cab and Inform Master Control of your location
- Fill out an Emergency Rescue Event Report for the Site Manager
DESCRIPTION OF EMERGENCY LOWERING MECHANISM

The TESI emergency rescue lowering system (Patent Pending) is designed to allow safe lowering of an elevator car in the event of a loss of electrical power or drive system malfunction.

The system is based on a combination of physical, mechanical and hydraulic principles;

- Gravity will cause the car to descend when the brakes are released.
- The elevator drive uses a fixed mechanical gearing.
- The hydraulic pump attached to the mechanical drive is a fixed displacement device, allowing passage of a fixed amount of hydraulic oil per revolution of the hydraulic pump and drive pinion.
- The limiting of the oil flow on the output port restricts the rotation of the hydraulic pump, which is mechanically connected to the elevator drive motor, thereby controlling the descent speed.

The system by design incorporates a normally open bypass circuit that is closed upon pushing the lowering button to actuate the lowering function.

A hydraulic pump is mechanically attached to a rear output shaft of the elevator drive motor. The hydraulic oil flow from the hydraulic pump is routed through a small diameter orifice, producing high restriction to the oil flow produced. This inhibits the pump’s ability to turn freely and subsequently restricts the drive pinion RPM’s and elevator descent rate to the predetermined engineered rescue speed.

In simple terms, when the brakes are released, the pump is connected to the elevator pinion gear, and can only turn as fast as oil can be pushed thru the small restriction, thus limiting descent speed.

In Normal Operation of the elevator drive; the hydraulic pump and electric motor turn in both directions at approx 2000 RPM producing oil flow. The pump is turned by the electric motor with no restriction and no load, thus the oil is only circulated in and out of the hydraulic reservoir.
To allow the pump and elevator to operate at full speed, the flow is routed through an unrestricted branch of the circuit. This is the normal un-actuated condition of the hydraulic circuit. The “normally open” hydraulic solenoid valve, allows the oil flow to bypass the restriction. The spring return, “normally open” solenoid valve is closed upon pushing the lowering button. The electric circuit receives power from the onboard UPS (un-interruptible power supply), which is used to close the lowering valve then subsequently release the car brakes. This allows lowering even in a power loss situation.

TYPICAL HYDRAULIC LOWERING CIRCUIT DIAGRAM
Operation of the Lowering System is simple. While the machine is at rest for any reason, the rider needs only to push the lowering button on the main control panel to initiate rescue lowering. The button is protected by a safety cover to prevent accidental actuation.

It is also noted that the hydraulic lowering actuation is via a momentary “dead-man” push button operation. Releasing the button will set the brakes and stop lowering.

The system incorporates an onboard UPS (uninterruptible power supply) that provides power to actuate the valve and release the electric brakes when the button is pushed. This allows operation of the Rescue Lowering System, even if main power is disconnected.

The Elevator Safety Over-Speed system also remains active during lowering, even when main power is disconnected.

**Basic Functional Operation:**
- Push the “LOWERING” button
- The solenoid bypass valve(s) is closed to restrict oil flow path
- The spring set, electrically released brakes are opened via UPS Power
- Car begins controlled gravity descent, slowed by the restricted hydraulic pump
- Release the button to set brakes and stop car

**Note:** The TESI Hydraulic Lowering system has been designed to provide full height lowering without damage. Similar gravity descent systems are employed using centrifugal clutch brakes or sometimes by relying on the operator to control descent speed by manually gradually releasing the brakes (also called slipping the brakes). Both of these methods have inherent dangers, due to heat build-up of the brake disks that will cause brake system damage. The heat buildup limits the safe descent distance, and it is not uncommon to see an instruction to limit the descent distance to 30 ft, then stop and rest the system to avoid permanent damage to the clutch/brake. One major danger with this type of system lies in that there is no way to monitor the descent distance and if the brake has been previously misused by others creating a potential safety hazard. Heat is the natural byproduct of the “work” involved to slow the car against the force of gravity. This is no different from how the brakes in your automobile will be red hot after just a single stop. In our system, the heat produced, is dissipated through the hydraulic reservoir/heat exchanger. Heat dissipation and buildup is a serious limitation and safety concern of other designs. The TESI hydraulic rescue lowering system allows safe and controlled rescue lowering over great distance with no residual system damage.
SMART REEL CABLE MANAGEMENT SYSTEM

The Cliffside TC3K Service Elevator is equipped with the Patented Smart-Reel Cable management system to manage the trailing Power / Control cable. The Smart-Reel system will automatically payout and take-up the traveling power and control cable while providing full height protection to the cable using our unique Smart-Guide system. The Smart-Reel system replaces a traditional trolley, which is normally required on Rack and Pinion Elevators.

Smart-Reel Advantages
- Protects Power and Control Trailing Cable from Damage During Operation
- Cable is stored out of the elements when the elevator is not in use
- Provides More Efficient Cable Management on Tall Open Structures
- Cable is protected full height of elevator travel when using the Smart-Guide system

Photos of SmartReel and SmartGuide System
CLIFFSIDE SMART REEL ARRANGEMENT DRAWINGS

Smart-Reel
TOP VIEW

Smart-Reel
SIDE VIEW
SMART REEL OPERATION
The patented Smart Reel® is a cable management system allowing direct connection of a traveling control cable to a moving elevator car to provide controls, communications, and electric power.

The control circuit begins at the main elevator controller, passes around the “live connection” Smart Reel® transfer rings, and terminates directly at the elevator car operation panel and phone set.

Cable payout and take-up is managed by a unique magnetic drive slip clutch and gear box attached to the reel mechanism, which provides continuous line pull over an infinite distance. This allows the Smart-Reel system to let out or take up cable automatically to match the elevator car speed and direction. When the elevator travels up, the line pull exceeds the cable reel tension and the clutch is “slipped”, allowing cable to be paid out. When the elevator travels down, the system will provide continuous wind up tension to spool the cable back onto the storage reel.

Deflector sheaves direct the cable out of the reel system and into the SmartGuide which protects the cable and keeps it free from obstruction and abrasion. The cable is supported by the lifting bar, which is mounted on the traveling car.

The unique Smart Guide system contains and secures the traveling cable for the full height up the elevator shaft. This keeps the cable secure and safe from entanglement by any obstructions that may be present in the hoistway. This is especially important while traveling up tall open structures, subject to wind and other industrial hazards.

Smart Reel Operation Mode Switch:
The Smart Reel Operation Mode Selector Switch is located on the Smart Reel unit. This selector switch can be used by a technician to select “AUTO”, “OFF”, or “ON”.

- Auto – Standard Operation Setting. The SR is automatically directed by the elevator controller. The Smart-Reel will produce cable tension any time the elevator is in motion.
- Off – Turns SR Motor Off for Maintenance or Troubleshooting
- On – Turns SR Motor On for Maintenance, Installation and Re-Spooling the Cable

Smart Reel Auto Operation:
In Automatic Operation, the Smart Reel will be signaled by the elevator controller to engage spooling any time the elevator is moving.
Smart Reel Fault Screen:
If a SR fault is indicated, a trained technician must evaluate the condition and make repairs prior to placing the system back in service. It is very important to confirm proper Smart Reel operation prior to placing the elevator into normal service.

Smart Reel Fault:
The elevator controller will sense if the Smart Reel control switch is “OFF”, if Electric Power is interrupted to the Smart Reel motors or if the Reel if physically jammed / stopped while the elevator is in motion. This condition would indicate a Smart Reel fault if elevator movement is initiated and the Smart Reels are disabled. The elevator will be disabled, until the fault has been cleared. A trained technician will be required to evaluate the situation, make repairs and return the system to normal operation.

The “Smart Reel Fault” can indicate any of the following 4 conditions:
- Smart Reel Control Switch is “OFF”
- Smart Reel Motor “thermal overload” protection has tripped
- Smart Reel Electric Motor Circuit Breaker has overloaded / tripped
- Smart Reel Motion Sensor detected the reel is not turning while the elevator is moving

Smart Reel Slack Cable Fault:
To protect the traveling cables during a Safety Brake Drop Test “Free Fall”, the Smart Reel spooling is disabled. The elevator will fall for a short distance during the drop test, the Smart Reels will not spool and some amount of Slack Cable will be produced. The system has been programmed to report this condition as a fault and requires a technician to physically “cycle” the Smart Reel “ON / OFF / AUTO” switch (located in the pit area near the Smart Reel) to clear the fault. The switch must be turned to the “ON” position, to re-spool any slack cable, before returning the system to service.
IMPORTANT - Smart Reel Power Spooling
In “ON” Mode the Reel will instantly begin to produce tension or freewheel if not restricted by cable hold back. Do Not Turn the Switch to “ON” unless you are manually providing reel control, or the cable is already taught. Also, make sure any slack is removed from the cable before placing the Elevator & SR into Automatic Operation.

WARNING:
Caution must be taken while manually spooling the smart-reel cable. This operation should be done by a trained technician. Use proper “personal protection equipment” such as gloves and safety glasses.

IMPORTANT - Smart Reel Free Spooling
Due to the Magnetic Slip Clutch Design the Smart Reel system will “Free Spool” as cable is pulled out either by hand or by a traveling elevator car. It should be noted, this can give the impression that the Smart-Reel is operational while the car is moving up. An operational check must be done by observing cable spooling while the elevator is traveling down and/or by looking at the Smart-Reel electric motors for rotation of the motor shaft as indicated by the fan turning.

IMPORTANT: Rescue Lowering Operation on a Smart-Reel equipped system with Purged Control Cabinets for Classified Electrical Area Protection.
If system power & purge pressure is present during the lowering operation, the Smart-Reel will be signaled to take up the traveling cable while the elevator is moving down during Emergency Lowering. However, if system wide power or cabinet purge pressure is lost, the electric motor driving the Smart-Reel will not function, because the motor contactors may be exposed to explosive gases. In this case, a trained technician should be dispatched to manage the excess traveling cable while the elevator is descending under no power rescue lowering conditions. The excess cable will accumulate onto the ground in the elevator pit area and could be damaged if not properly managed. In this situation, it is recommended to limit lowering to the next available safe landing, where the rider should stop and exit the car. A trained technician must re-spool the excess cable before the elevator is returned to service.

IMPORTANT:
DO NOT RETURN THE SYSTEM TO SERVICE UNTIL THE TRAVELING CABLES HAVE BEEN CHECKED, RE-SPOOLED AND SMART-REEL AUTOMATIC OPERATION HAS BEEN CONFIRMED.
ADMINISTRATION AND INSPECTION (CAR AND GROUND)

An authorized user with the proper pass code may enter the Administration modes of the system via the touch panel display. Access is gained from the Main System Menu.

Note: Remote system movement is possible from this restricted system area. Only Trained and Authorized Personnel should be allowed access permissions.

Access Types:

Technician: User “TECH”, Password “AAAA”.
  Used to access general system maintenance and troubleshooting screens
  Password Expires 20 minutes from Log-In

  Used to access the Code Required Safety Brake Testing Functions
  Password Expires 20 minutes from Log-In

Start-up and Commissioning: User “START”, Password “SSSS”
  Used to Set Initial System Parameters
  Password Expires 1 hours from Log-In

Sub-System Status Screens: (no log-in required)
  • DOOR INTERLOCK STATUS
  • SAFETY SYSTEM STATUS (E-Stops)
  • MODE SCREEN

Administration and Technician Screens: (password protected log-in required)
  • CALIBRATION – To calibrate vertical car position in the hoistway
  • MACHINE CONTROL – Used to position the car for Brake Testing Sequence
  • ALARMS – Elevator System Status Alarm Interface
  • BRAKE TEST – To perform remote Safety brake testing
  • START-UP AND COMMISSIONING – Initial Set-up of System Parameters
  • LOG OUT – Clears all passwords and returns the system to restricted access mode

Note: Passwords time-out and expire as noted above or upon system power cycle. The “Log-Out” button on the main menu can also be used to clear active sessions at the local HMI and return the system to a secure state.

A technician should “Log-Out” any HMI that is logged in, to secure the elevator administrative functions before leaving the system un-attended. This is important to avoid un-authorized access to secure areas of the system.
MODE KEY SWITCH OPERATION: CAB

Operation modes can be selected via "key switch" control from cab operation panel.

Modes:
- NORM – normal operation mode
- INSP – car or car top inspection mode
- FIRE SERVICE - Manual Control for Emergency Personnel (If Applicable)

NOTE: System Mode Status can be viewed on MODE SCREEN

MODE Selection Key Switch

Modes are outlined in order of Priority Hierarchy.

FIRE SERVICE - Manual Control for Emergency Personnel (If Applicable)
Over Rides all other modes

2.26.1.4.2 - Car Top Inspection Mode
Over Rides all other Inspection Modes
Transfer Switch on Car Top (not keyed) - NORM (normal) / INSP (inspection)
Keyed Mode Switch on COP must be in INSP position

In-Car Inspection Operation Enable (per 2.26.1.4.3-d)
Single 2 Position Maintained Key Switch
Second Key Switch Position (INSP) will allow In-Cab Inspection Operation Per 2.26.1.4.3

NORM (normal), INSP (inspection)
"Car Top" Transfer Switch must be in NORM for the In-Cab mode to function.
TOUCHPANEL INTERFACE - MAIN SYSTEM MENU

The main system menu will allow users and technicians navigation and access to the various system screens and sub-systems.

Note: The first three sub-system status screens are available without log-in credentials. These screens can be viewed by any user. The other screens, which allow fault and alarm reset, system configuration and cab movement, require the proper level of access.
SUB-SYSTEM STATUS SCREENS

The Sub-System Status screens provide visual indication of most system function states. From here a technician can quickly troubleshoot the system to determine if a problem exists.

Sub-System Status Screens: (no log-in required)
- DOOR INTERLOCK STATUS
- SAFETY SYSTEM STATUS
- MODE STATUS

The screens are simple and self-explanatory. Information is provided via On/Off Indicator Style Status Lights with Plain Text Labels.

Door Interlocks: (Screen 1 & 2)
- Car Gate 1 Closed / Locked (if applicable)
- Car Gate 2 Closed / Locked (if applicable)
- Emergency Exit Hatch Switch
- Hoistway Access Door Switch
- Landing doors - Closed / Locked

Safety System:
- Cab E-Stop
- Ground Station E-Stop
- Car Top E-Stop
- Pit E-Stop

*Note: Safety E-Stop Conditions must be acknowledged prior to placing system back in service. Correct Condition and use on-screen reset or “RUN” button to reset system.*

Mode Screen:
- Shows position of Mode Key Switch and Status of HMI Machine Control Usage
SUB-SYSTEM - DOOR INTERLOCK SCREEN

Shows status of all system doors. The elevator will not move in automatic operation or Inspection Mode if any door or hatch is open.

Screen 1: Cab and Pit Door Status
Screen 2: Landing Door Status
SUB-SYSTEM - SAFETY SYSTEM SCREEN (E-Stops)

Screen shows status of E-Stop and other Safety Inputs. If any E-Stop is pressed it must be acknowledged here prior to placing the elevator back in service.

The Trac-Cab is controlled by a Fail-Safe Safety PLC controller. Safety PLC’s by design latch and Log all E-Stop Actuations. The system incorporates (4) Safety E-Stop stations: Car Top, Car Operating Panel, Ground Control Station and Pit E-Stop. Pushing any E-Stop will also remove the “Safety System Ready” condition. Simply pulling the E-Stop back out will not return the system to service. If a system E-Stop is pressed for any reason, the system will shut down and remain disabled until the operator acknowledges the E-Stop to reset the Safety system. The operator can use a “RUN” button if available or may use the on-screen E-Stop Acknowledge Button to return the system to operational status. All E-Stops must be returned to the “out” position, and then the “Acknowledge” or “run” button should be pushed to re-activate the system. If all conditions have been met, the Safety System Ready light will return.
SUB-SYSTEM - MODE SCREEN

Shows Condition of Various Mode Switches for System Inspection Operation
RESTRICTED ACCESS LOG IN INSTRUCTIONS:

1. Press the Button Corresponding to the desired screen or area.
2. A Log-In Dialog will be presented
3. Enter Log-in User and Password: TECH, and Pass Code: AAAA, to log onto the system
4. You will be returned to the menu screen, but you will now be logged in.
5. Press the button and you will go to the Selected Screen.
6. User will remain logged in for a set period based on user type.

Access Types:

Technician: User “TECH”, Password “AAAA”.
   Used to access general system maintenance and troubleshooting screens

   Used to access the Code Required Safety Brake Testing Functions

Start-up and Commissioning: User “START”, Password “SSSS”
   Used to Set Initial System Parameters

Note: Passwords time-out and expire as noted above or upon system power cycle. The “Log-Out” button on the main menu can also be used to clear all active sessions and return the system to a secure state. A technician must “Log-Out” and secure the elevator before leaving the system un-attended to avoid un-authorized access.
CALIBRATION
The Position Calibration Screen provides an interface for system calibration. Calibration may be required upon system power up. However, if the car is parked at the “home position” sensor at power-up, calibration will be automatically set.

Loss of calibration will be indicated as a “Calibration Fault” on the Main Menu. The Calibration “bit” will be intentionally dropped upon Rescue Lowering or Disable Auto Operation Function. A technician would then need to re-calibrate to place the system back in automatic service.

To calibrate cab position, the car should be at the Home Position Landing (L1), parked so that the “home position sensor” is adjacent to the “home position flag”.

Using machine control or special drive, position the car so that the “HOME POSITION” sensor is activated by placing the proximity sensor adjacent to the “HOME POSITION FLAG”.

When the car is parked on the “HOME POSITION” sensor, if all conditions are met, Calibration will be automatically set as shown on the indicator light.

The “Calibration Complete” indicator should now be on.
MACHINE CONTROL: OS1 Cab Technician Mode

Initiated via the MODE “Key Switch” Control from Cab Operation Panel. Cab Inspection operation will allow a technician or authorized user to manually move the car at a preset speed. 3 speeds can be selected from the menu. Movement requires constant pressure to the on-screen control buttons.

Note: The inspection/machine control screen contains several important system status indicators. Review status and parameters prior to and during inspection operation.

Operation:
1. To enable “On-Screen” Cab Inspection, use the technician key to select “Inspection” mode from the Car Operation Panel.
2. The technician should then “log in” to the system with the appropriate passcode and navigate to the inspection screen.
3. Select the desired Speed from the Speed Selection Switch.
   a. Speed 1 – Level Speed (slow for positioning)
   b. Speed 2 – Inspection Speed (½ speed)
   c. Speed 3 – Travel Speed (full speed)
4. Make sure the E-Stop button is pulled “out”.
5. Press and hold the desired direction button to move the car up or down.
6. Release the Button to Stop
7. Exit Screen and return key position to “NORMAL” to Terminate Inspection / Machine Control Mode.
MACHINE CONTROL - CP1 Ground Station

2.26.1.4.4 - Machine Control Function – Used for remote Safety brake testing. This function is available from the Elevator Controller HMI (touch screen) that will be located near the ground level landing.

This mode will only be available from the ground control touchpanel. A technician will be required to log in with a Pass Code.

Hoistway and Cab Doors must be closed and locked for Cab Movement.

NOTE: This Mode will be rendered ineffective if any other inspection mode is active per Sec 2.26.1.4.4-b
FI REMAN’S SERVICE - OS1 Car Station

The TESI Trac-Cab TC-3K is equipped with Phase 2 Fire Service Control. The purpose and intent of fire service elevator control is to prevent elevator usage by occupants and to put the system in its entirety in the control of the fire department.

Phase 2 Fireman’s Service

This refers to the fire service controls within the elevator car itself, which allows firefighters to manually control the elevator from the inside of the car only. Once an elevator car is activated into Phase 2 operations it automatically overrides other external inputs. Phase 2 is attained through the use of an elevator key and the specific positions of the key when inserted into the interior panel within the elevator car.

Key Panel Positions

The panel positions within the elevator car usually involve three positions in most installations.

**ON:**

When turning the elevator key to the “on” position at the inside panel of the elevator car you are activating the fire service system position into the Phase 2 mode of operation which now manually controls the elevator car by the firefighter.

**OFF:**

The off key position turns fire service control “off” and will return the car to normal elevator operation.

**HOLD:**

The “hold” car panel key position is used to keep the elevator car on the floor that you are on. In the “hold” key position, the car will remain in that position until returned to an alternate mode of operation.
CAR TOP INSPECTION MODE:

There is a Car Top Inspection Control Station with E-Stop, mounted at the car top. The car can be controlled directly from this station via a very simple interface. The controls include, a MODE switch to activate, a speed selector switch, an enable button to engage operation, UP and Down direction Buttons and an E-Stop button for safety. The car will not move if this E-Stop is depressed. There is also a Run Reset Button to restore operation if the E-Stop is activated.

NOTE: Keyed “MODE” switch at the Car Operation Panel (OS1) must be in “INSP” to enable Car Top Inspection control.

Operation:
1. To enable Car Top Inspection Mode Select “INSP” from the Mode Switch on the car operation panel.
2. From the Car Top Panel, turn the MODE switch to the “INSP” Position.
3. Select the desired Speed from the Speed Selection Switch.
   a. Speed 1 – Level Speed (slow for positioning)
   b. Speed 2 – Inspection Speed (approx 30 ft/min)
   c. Speed 3 – Travel Speed (full speed)
4. Make sure the E-Stop button is pulled “out”.
5. Press and hold the enable button to activate controls.
6. Press the desired direction button to move the car up or down.
7. Turn the MODE switch to “NORM” when finished.

NOTE - Regarding Car Top Inspection Operation E-Stop Reset: If the E-Stop has been actuated; return the button to the RUN (pulled out) position and press the “Run Reset” button to E-Stop Acknowledge from the car top. This action will place the car back in service.
ALARM SUB-SYSTEM - ALARM SELECTOR SCREEN

The Alarm Sub-System is provided for an authorized technician to troubleshoot and diagnose many system faults. The elevator will not operate in Automatic Operation if any of the Alarm Sub-System Faults are Active. This will be indicated by the “ALARMS” indicator on the “Main” Screen.

Note: Alarm System Fault Conditions are latched to allow review by a technician. The noted fault condition must be corrected and reset prior to placing system back in service. System Faults must be reset by an authorized technician. Diagnose and Correct Fault, then use on-screen button to reset system.

The Alarms Main Menu screen provides “indicator lights” to enunciate if a fault condition exists on the corresponding Sub-System. If the indicator is illuminated a fault exists on that Sub-System. Press the corresponding button to navigate to the screen.
DRIVE SYSTEM STATUS:

The Drive Sub-System is provided for an authorized technician to review faults related to the Elevator Drive mechanism. Once a fault condition has been repaired or cleared, the Fault must be “Acknowledged” using the on screen button. If the condition is corrected, the indicator light will clear. If the condition still exists the light will return.
DRIVE FAULT DETAILS:

Safety Voltage Monitor
This fault monitors health of the Independent Overspeed Governor (OSG) System. The OSG uses a DC Generator to produce voltage proportional to pinion RPM’s, which is proportional to travel speed. The system checks for voltage each time the elevator is moved in automatic operation. This action confirms that the Independent Overspeed Safety System is functional. If no voltage is detected, the elevator will be allowed to continue to its destination and then will be disabled until a technician can diagnose and repair the problem.

Encoder Speed Error
This fault monitors the signal that is produced by the optical rotary speed and position encoder that is attached to the drive train output shaft. The encoder is the main feedback device that provides the elevator speed/position information to accurately stop at the programmed floor positions. This fault will monitor if the Encoder Signal is lost. It also monitors for a Virtual Overspeed Condition as a redundant system to the Independent electro-mechanical Over Speed Safety Device.

Cabinet Purge OS1 (only applicable on Hazardous Location Systems)
This fault monitors for positive purge pressure in the OS1 Car Control Enclosure.

Cabinet Purge CP1 (only applicable on Hazardous Location Systems)
This fault monitors for positive purge pressure in the CP1 Ground Control Enclosure.

Drive Motors Thermal Overloads
Drive motor thermal overloads are actually input in the control system as “Safety Faults” and must be Acknowledge/Cleared similar to the E-Stop systems. The faults will not clear until the motors have cooled to a normal condition.

TOP MTR
This fault indicates there is an overheating situation with the Top Drive Motor thermal overload.

BOTTOM MTR
This fault indicates there is an overheating situation with the Bottom Drive Motor thermal overload.
OVER TRAVEL FAULT:

An Over Travel Fault indicates that the elevator has traveled beyond its normal operating top or bottom travel limits. If an Over Travel fault is indicated, the elevator has tripped either of the Top or Bottom physical limit switches, which are located at car top and are configured to make contact with limit switch “CAMS” that are mounted to the guide rail system and located above and below the normal travel range.

This condition should be very rare in normal operation and requires diagnostics and close investigation of the cause prior to placing the system back in service.

Note: If the elevator has traveled onto the top or bottom Over Travel limit cams, it can only be moved in the opposite direction of travel by using Inspection, Car Top or Machine Control functions. Once the car is clear of the Over Travel zone, the fault can be reset using the on screen button, to return the car to normal service.
OVER SPEED FAULT

An Over Speed Fault indicates that the elevator has reached a speed exceeding the factory pre-set over speed condition as monitored by the independent overspeed governor in the independent Safety system.

If the Over Speed condition occurs, it should be considered very serious and requires a thorough inspection and necessary repairs be made by an authorized service technician prior to placing the elevator back in service.

Note: The 1st Over Speed Fault screen displays a warning message that must be read and acknowledged before the fault can be cleared. Once the message is acknowledged by pressing the onscreen button, a second “hidden” button will be displayed allowing the technician access to the screen where the fault can be reset.
OVER SPEED FAULT RESET SCREEN

Once the technician has investigated and corrected the condition causing the overspeed fault, and has acknowledged reading the warning message; they may navigate to the Over Speed Fault reset screen and clear the latched fault.
SMART REEL FAULT:
(Only Applicable on Smart-Reel Equipped Systems)

The Smart Reel Fault Screen is provided for an authorized technician to review faults related to the Smart Reel Cable Management System. Once a fault condition has been repaired or cleared, the Fault must be “Acknowledged” using the on screen button. If the condition is corrected, the indicator light will clear.

The elevator controller will sense if the Smart Reel control switch is “OFF” or if Electric Power is interrupted to the Smart Reel motors. This condition would indicate a Smart Reel fault if elevator movement is initiated and the Smart Reels are disabled. The elevator will be disabled, until the fault has been cleared. A trained technician will be required to evaluate the situation, make repairs and return the system to normal operation.
SMART REEL SLACK CABLE FAULT:
(Only Applicable on Smart-Reel Equipped Systems)

To protect the traveling cables during a Safety Brake Drop Test “Free Fall”, the Smart Reel spooling is disabled. The elevator will fall for a short distance during the drop test, the Smart Reels will not spool and some amount of Slack Cable will be produced.

The system has been programmed to report this condition as a fault and requires a technician to physically “cycle” the Smart Reel “ON / OFF / AUTO” switch (located in the pit area near the Smart Reel) to clear the fault. The switch must be turned to the “ON” position, to re-spool any slack cable, before returning the system to service.
RESCUE LOWERING FAULT:

The Emergency Rescue Lowering screen is provided for an authorized technician to review faults related to the Lowering System. Once a fault condition has been repaired or cleared, the Fault must be “Acknowledged” using the on screen button. If the condition is corrected, the indicator light will clear. If the condition still exists the light will return.
LOWERING FAULT DETAILS:

UPS Offline
The system incorporates an onboard UPS (uninterruptible power supply) that provides battery power to release the electric brakes when the button is pushed. This allows operation of the Rescue Lowering System, even if main power is disconnected. The “UPS Offline” fault would indicate there is a problem with the UPS power supply.

Hydraulic Bypass Valve Fault
This fault would indicate the Lowering Bypass Solenoid Valves are not getting power and thus would not close to allow for fluid routing to the restriction orifice. This could indicate a blown fuse, shorted wire or other electrical circuit problem. This condition would prevent the valves from closing and the brakes from releasing.

Hydraulic Pressure Sensor Fault
This fault would indicate the Hydraulic Pressure Switch is sensing pressure in the lowering circuit while the machine is driving under power. The restriction circuit should only be pressurized while rescue lowering. Pressure in this circuit while in normal operation, would indicate one or more of the solenoid bypass valves are malfunctioning and not fully open while the machine is driving under power.

Hydraulic Tank Level Fault
This fault would indicate the Hydraulic Oil in the Car top reservoir has dropped below the 1/2 way point as indicated by the tank fill gauge. This could indicate a leak in the system and must be evaluated and repaired. This fault will prevent system operation in Automatic mode. Lowering should not be used until the oil in the Tank has been restored to a safe level.
Enable Rescue Lowering Function
The rescue lowering circuit is a safety circuit that is energized by the UPS battery backup power. If UPS power is offline the Lowering Safety Relay may become de-energized, which will disable the Rescue Lowering Function. This condition would be indicated if the light beside the button is “ON”. Make sure the UPS power is restored then press the “Enable Rescue Lowering” button to reactive the circuit. The circuit is also automatically reactivated by the drive system in some circumstances.

Rescue Lowering Used Indicator
An indicator light beside this button would show that the Emergency Rescue Lowering system has been activated. This condition will also clear the system Calibration bit, as the machine may have lowered (moved) with no power and thus the controller would not be able to confirm an accurate position in the hoistway. A technician must diagnose why the Lowering System was used and follow the proper steps to return the elevator to normal operation.

Pressing the button will direct the technician to the “Rescue Lowering Active” Screen, where they will be prompted to read the onscreen message prior to clearing the fault.
HYDRAULIC TIMER EXPIRED FAULT

System Hours of Operation: The control system tracks hours of operation while the drive motors are running. This information can be found on the Rescue Lowering Alarms Screen. When the system has reached 3,000 hours of operation, a system Alarm will be indicated along with the “hydraulic timer expired” fault.

This is an indication that maintenance is required and it is time to change the oil in the Emergency Lowering hydraulic reservoir. A technician should change the oil as indicated and reset the counter to restore the system to operation.

The Fault screen displays a message with instructions that must be read and acknowledged before the fault can be cleared. Once the message is acknowledged by pressing the onscreen button, a second “hidden” button will be displayed allowing the technician access to reset the Hydraulic Hours timer.

Note: To restart the maintenance cycle tracking in the event that the oil is changed prior to 3,000 hrs of operation, an automatic function is programmed to reset the timer if the Hydraulic Tank Level switch is “cycled” by emptying and filling the tank, as long as the control system has power and is active at the time of maintenance. If the auto reset does not occur, the timer should also be proactively reset anytime the oil is changed.
VFD DRIVE FAULT:
The VFD Drive Fault indicates a problem with the Variable Frequency AC Drive that controls the operation of the Main Drive Motors. This fault could indicate some obstruction or overload of the drive system. Technician should read the on-screen message and follow the instructions.
ALARM LOGGER

The Alarm Logger provides a history of recent alarms to help diagnose system issues. The most recent Alarm is at the top. This Logger has scrolling up / down capabilities and will store the last 99 system level faults.
START-UP AND COMMISSIONING SCREEN

The Start-Up and Commissioning functions are used during initial system configuration by the authorized elevator installer. They do not need to be changed under normal circumstances. Contact TESI for assistance with this area if needed.

![Commissioning Screen Diagram]

- Special Drive Screen
- Parameters Screen
- Floor Position Screen
- Special Functions Screen
- Gearing Setup Screen
- PLC Msrs
- Return
BRAKE TEST SCREEN
Per the Code requirement, the system has been programmed to allow testing of the Safety. This is accomplished via the ground station Touchpanel administration screen “Brake Test”. The test is initiated remotely from the ground station. No personnel need to be in the car to run the test.

NOTE: “Brake Tester” or "Start Up" Login is required to access this screen and initiate the drop test. Only qualified Elevator Technicians should perform the Safety Brake Drop Test.

This Screen is included to perform a Brake Test each time an Elevator Inspection is required or to test the Safety System during scheduled maintenance.

See Step by Step Instructions are in the Brake Test Instruction Section
BRAKE TEST SEQUENCE DESCRIPTION

As you can see by the graphic above, the instructions are simple and the test is easily administered. As an example, if the normal operating speed of the system is 100 feet per minute (fpm). The speed governor will engage the Safety at 120 fpm. The test will then lock and report the actual faulted car travel speed (governor trip speed) for review and confirmation. Once the Over Speed fault has occurred, an authorized technician must acknowledge the fault and reset the “Overspeed Alarm” to return the system to normal operation.

Upon Brake Test Initiation, the Elevator brakes will be released, initiating a free-fall, until the Cab reaches the over-speed threshold, at which time the over speed governor will engage the Safety brakes.

The test results can be viewed on screen.

The test is simple to run and should be quite uneventful. Generally the elevator will fall less than 24” before the Safety is engaged and the elevator is stopped.

The Brake test will generate an Over-Speed Fault and will require the user to acknowledge and reset from the Alarm screen. Once the Alarm Condition is reset the Elevator can be taken in Machine Control Mode to any Landing.

SAFETY NOTE: This operation initiates a forced elevator free fall, by bypassing several internal safety system safeguards, and directly releasing the drive brakes with no drive run command active. No person should be in or under the cab during testing. The test can only be administered from the Ground Position. If for any reason the Independent Speed Governor Safety does not engage in the expected distance; the Fail Safe PLC Controller is still monitoring the system movement and speed and will set the E-Stop automatically. However, best practice dictates the test operator is standing-by ready to press the E-Stop, in the very unlikely event that the Independent Safety and the Fail-Safe PLC both do not stop the car. If the cab has fallen 5ft or more and has not stopped automatically, the operator should press the E-Stop. If the E-Stop is pressed, the drive brakes will be set and the Car will stop.

See Step by Step Instructions in the Brake Test Instruction Section
TESTING THE SAFETY AND SPEED GOVERNOR

The system has been programmed to allow simple and remote testing of the Safety. This is accomplished via the ground station Touchpanel administration screen “Brake Test”. The test can only be initiated remotely from the ground station. No personnel need to be in the car to run the test.

NOTE:

Brake Tester, “TEST” Login or above is required to access this screen and the drop test function.

The “Brake Test” button is disabled on the Cab display screen to prevent usage of this function from the Cab.
Safety Brake Test Step by Step Instructions

1. Make sure all doors are closed and elevator is “ready”
2. A technician with “Brake Test” access must “log in” at the CP1 Ground Station
3. Once Logged in, navigate to “machine control” and position the car above the noted test height threshold (generally at least 30’ above ground)
4. Once the car is positioned, the test can be initiated via the “Brake Test” Screen
5. Activate by pressing the onscreen “Begin Safety Brake Test” button
6. The Parking Brakes will be released, placing the elevator car into a free fall; until it reaches the over-speed governor trip setting, which will automatically and independently engage the Safety System.
7. If all systems are working properly, the test will be over quickly and seem very uneventful. The elevator generally will not fall more than 12-18 inches, and should be over in less than 1 second.
8. Test Results can be viewed by pressing the “View Results” button.

If the normal operating speed of the system is 110 feet per minute (fpm). The speed governor will engage the Safety at approx 130 fpm. The test will then lock and report the actual faulted car travel speed (trip speed) for review and confirmation.

An indication of PASS / FAIL will be given.

A test is considered to “PASS” when the Over Speed Governor “TRIPS” within the Code defined Over Speed Value and the car is independently brought to a stop within the Code Required Stopping Distance by the Safety System.

SAFETY NOTE: This operation initiates a forced elevator free fall, by bypassing several internal safety system safeguards, and directly releasing the drive brakes with no drive run command active. No person should be in or under the cab during testing. The test can only be administered from the Ground Position. If for any reason the Independent Speed Governor Safety does not engage in the expected distance; the Fail Safe PLC Controller is still monitoring the system movement and speed and will set the E-Stop automatically. However, best practice dictates the test operator is standing-by ready to press the E-Stop, in the very unlikely event that the Independent Safety and the Fail-Safe PLC both do not stop the car. If the cab has fallen 5ft or more and has not stopped automatically, the operator should press the E-Stop. If the E-Stop is pressed, the drive brakes will be set and the Car will stop.
Code Ref: A17.1-2007 / Part 2.18 & Part 4.1.9

Over Speed Governor Trip Speed Range: (table 2.18.2.1)
For Rated Speed of Less than 150ft/min.
- The minimum trip value shall be set at not less than 115% of the rated speed.
- The maximum trip value shall not exceed 210 ft/min.

Stopping Distance for Rack and Pinion Safety Device: (table 4.1.9.1)
For Rated Speed of Less than 150ft/min with Rated Load.
- The minimum stopping distance shall be 4.57 inches
- The maximum stopping distance shall be 67.07 inches

If the test indication is “FAIL” a qualified technician must diagnose and repair the issue prior to returning the elevator to service.

Once the Over Speed fault has occurred, an authorized technician must manually reset the “Over Speed Alarm” to return the system to normal operation.

From the Over Speed Alarm Screen the technician should acknowledge and reset the “Over Speed” Fault.

Once the Alarm Condition is reset the Elevator can be taken in Machine Control Mode to back to the ground landing to re-initialize automatic operation and return the machine to service.
DUAL DRIVE AND SAFETY FUNCTIONAL & DESIGN OVERVIEW

This section will review the design and engineering of the TESI Rack and Pinion Dual Drive and Safety System, in the application of the ASME A17.1 Safety Code for Elevators and Escalators stated requirements 4.1.9 Rack and Pinion Car Safeties and Speed Governor. TESI submits that the Rack and Pinion Safety, as presented and detailed in this document, complies with the current A17.1 Elevator Code description and requirements for a “Rack and Pinion Safety”.

TESI’s objective is an improved Car Safeties and Speed Governor system to the mutual benefit of elevator riders, owners, and manufacturers. Improved means; a system that is safer, more reliable, easier to maintain, and results in a better elevator system than current technology offers.
TESI RACK AND PINION SAFETY OVERVIEW

Reference ASME A17.1 2007
Part 4

4.1.9  The car shall be provided with a safety identified in 2.17.5 or a rack and pinion safety. The safety shall be attached to the car frame or supporting structure. All car safeties shall be mounted on a single car frame and shall operate on one pair of guide members or on one vertical rack.

The safety shall be located as required by 2.17.1 or if it is a rack and pinion safety, shall be permitted to be located above or in the car, provided that the members to which they are fixed are part of the car frame and are designed to withstand the forces imposed.

Rack and pinion safeties are safeties in which a freely rotating safety pinion, a governor, and a safety device shall be permitted to form an integral unit mounted in the car. The freely rotating pinion travels on a stationary rack mounted vertically on the hoist structure. The rotating pinion drives the governor. When the speed of the car reaches the tripping value, the rotating governor actuates the safety device that, in turn, brings the car to a gradual stop.

* Bolded formatting denotes emphasis added by author to direct Code Reference excerpt.

Mounting of the Safety System
The TESI Safety system is an integral part of the drive train and is physically mounted to the tractor drive plate. The tractor drive plate is directly connected to the framework supporting the passenger cab. Per the Code, the tractor and car frame are engineered to withstand the forces imposed. The Safety pinions are in constant and positive engagement with the vertical rack column, and maintain a 8:1 safety factor at all times.

Freely Rotating Safety Pinion
A Freely Rotating Pinion, which is in motion any time the car is in motion, drives the Speed Governor. The rotating pinion driving the speed governor is in full time mechanical engagement to the rack.
Overspeed Governor:
The Overspeed Governor is a voltage generator that produces an output directly proportional to speed. In the event of an Overspeed Condition, the voltage output in excess of the tripping value will actuate the Independent Safety Brakes regardless of Site Power Conditions or the Controller response. Additionally, the Fail-Safe PLC Controller actively monitors the independent Safety system and Speed Governor for operational readiness. This is in contrast to purely mechanical centrifugal systems typically seen on Rack and Pinion machines, which stand idle and un-monitored for up to 5 years.

Safety Device
The TESI Dual Safety Brakes mount directly on the pinion drive shafts, thus giving a positive mechanical connection between the Safety brakes and pinion gears that engage the Rack. The Safety Brakes are spring applied and electrically held open. Once actuated, the dual brakes will set simultaneously, bringing the car to a safe stop.

This dual Safety design provides redundancy in the case of a catastrophic loss of any single device and twice the protection of a single Safety.
Redundant Fail-Safe Parking Brakes
In addition to the Dual Independent Safety Brakes, the active drive system also incorporates redundant spring applied-electrically released Continuous Duty Load Rated Fail-Safe Brakes to “Park” the car when the machine is at rest. Normal system slowing and stopping is accomplished with Dynamic Braking provided by the drive system, not the Parking or Safety brakes. Power is physically disconnected from the spring applied-electrically released brakes any time the machine is stopped.

Working in tandem, the Drive brakes maintain the Code required 8:1 safety factor between the Rack and Pinions. In addition, each drive and brake combination is engineered to stop and hold more than 300% of the rated dynamic load.

TESI has worked closely and extensively with SEW Eurodrive engineering teams to ensure the Drive and Gearmotor technology has been implemented according to their design specifications for safety and functionality.
Safety Rated Industrial PLC Controller

TESI elevator controllers are UL Classified and engineered around the Siemens SIMATIC S7-300FS Safety PLC Control System with Integrated Safety I/O.

Due to the high degree of safety required during the vertical transport of personnel, TESI has chosen to implement a "Fail-Safe" PLC based elevator controller. The Safety PLC control system exceeds the requirements of the current ASME A17.1-2007 elevator code and is a significant upgrade in performance and safety over a standard PLC based control system. Safety PLC’s are designed to be “Fail-Safe” while actively monitoring critical safety circuits for any signs of error, and then, if for any reason, there is a system failure; the PLC will shut-down to a pre-defined “Safe-State”.

**Per Siemens Documentation:**
Safety PLC systems provide the highest level of safety for humans, machines and environment. They are used to prevent accidents and damage resulting from a fault or malfunction. The Siemens SIMATIC S7 Safety PLC’s have a published probability of total error in 1 hr of continuous operation of less than 0.0000001129 (11.29 E-09). The Siemens Safety SIMATIC controllers monitor themselves, detect faults autonomously and immediately change into or remain in a safe mode when a fault occurs. They are optimized for use in production engineering and provide airtight safety for all its many facets.

TESI has worked closely and extensively with Siemens engineering teams to ensure the control systems Fail-Safe technology has been implemented according to their design specifications for safety and functionality.

Machine controls are essential to safe operation and movement of people in elevators and escalators. Technology has moved the market to accept the PLC as an improved method of managing this process, very much parallel with most of the world’s industrial processes becoming digitized.

The benefit of using FS PLC control for elevators is reduction of the risk of injury and property damage. Manufacturers, owners, and riders can have greater confidence in the reliability of the system performance through the use of this higher technology.
Drive System Design Summary

Using advanced technology and redundant systems, the speed controller dynamically slows down, speeds up, starts and stops the car using the drive motors, not the brakes. During normal operation, the brakes are simply engaged to "park" the car after the drive motors have stopped it. In the event of an Over Speed condition, the Safety Brakes will slow and stop the car independently. Moreover, with constant active reporting to the controller, the Safety system is in an identified state of readiness. This technology greatly improves safety over a single passive non-reporting centrifugal Safety system.

The advantages of using this technology:

1. Highly engineered ISO manufactured components by major corporations using state of the art testing and analysis become available.
2. Catalog values for engineering and ASME A17.1 review are easily obtained and often available on the supplier websites.
3. Readily available “off the shelf” parts, which promote the ease of maintenance and timely replacement.
4. Using redundancy and “Fail-Safe” smart reporting devices increases overall system safety.

The TESI Rack and Pinion Dual Drive and Safety system utilizes advanced control functions, a Safety Rated PLC controller, dual drives used for dynamic braking, dual mechanically engaged parking brakes and dual independent Safeties. This configuration achieves rack efficiency, redundancy for safety, and maintains the required 8:1 SF for the rack and pinions, both in the Drives and Safeties.
SYSTEM TROUBLESHOOTING

TESI TRAC-CAB Industrial Elevator Control System

Troubleshooting is necessary to diagnose and repair the system any time an Alarm, Fault or other operation anomaly is encountered. In order to diagnosis any problem the user needs to review both the Alarm and System Status Screens.

The TRAC-CAB is an advanced Safety oriented industrial machine. TESI has applied this technology in a simple, understandable manner. However, an understanding of Industrial Control Systems and Safety PLC’s will be required by the technician for diagnosing issues beyond basic elevator system device faults. Contact TESI for Support.

Safety PLC System Passivation

The TRAC-CAB Elevator Controller is based on the Siemens S7-300FS Fail Safe PLC. This technology brings the highest level of off-the-shelf control system safety available to industry today. One of the Safety system functions is to monitor itself along with many other system variables and shut down to a “Safe-State” upon an unexpected event. This state is called “Passivation”.

Passivation is not expected to occur during normal system use or individual system faults. It will also be very rare as a CPU triggered event. However, this state may be triggered while doing system maintenance or troubleshooting involving some of the Safety I/O Devices including communications. Safety PLC’s send micro-coded checksum messages through all devices attached to Safety I/O Modules. If any PLC module is removed from the system or a wire is removed from a Safety I/O circuit, the PLC will Passivate. Further, minor power supply issues like blowing an individual fuse on any module or an interruption to the communication busses, will cause Passivation.

For instance if a circuit is broken to a Safety I/O device, the system will Passivate. Safety I/O devices are actively monitored by the Safety PLC. If the signal is lost, the system will passivate.

It is possible to determine Passivation while viewing the Safety System Device Status and noting that more than one device that is known to physically be in its correct position, has not changed on the display. To further determine Passivation vs. device failure, multiple devices should be actuated while watching the system state indicators. If no indicator lights are changing state, then the PLC is probably passivated.

Additionally, the cabinets may be opened and a visual inspection of the SF (safety fault) LED on the “YELLOW” safety I/O modules will show a solid or flashing red light.
To reset the system, a cold boot is required. First correct the condition that caused the Passivation, then cycle 120 VAC power according to the procedure below.

**Cold Boot – Power Cycle Procedure**

The Safety PLC controller is located in the CP1 main elevator control panel and powered by the 120 VAC circuit feed.

You may simply cycle the main 120 volt power at the Disconnect. Wait 10 seconds between turning power off and back on. The system should recover automatically.

**Safety PLC E-Stop Function**

The TRAC-CAB is controlled by a Fail-Safe Safety PLC controller. Safety PLC’s by design latch and Log all E-Stop Actuations. If a system E-Stop is pressed for any reason, the system will shut down and remain disabled until the operator acknowledges the E-Stop to reset the Safety system. Pushing any E-Stop will also drop the “Safety System Ready” condition. Simply pulling the E-Stop back out will not return the system to service. The operator must use the on-screen E-Stop Acknowledge Button to return the system to operational status. The E-Stop Acknowledge Button can be found on the Safety Sub-System Screen, where the E-Stop status is also displayed. All E-Stops must be returned to the normal “out” position, and then the button should be pushed to re-activate the system. If all conditions have been met, the Safety System Ready light will return.

*Note: During trouble shooting and repair, simple procedures can cause unexpected results. An example, a shorted wire that grounds and blows a single I/O line fuse may also cause the Safety PLC to passivate. Understanding recovery from this state is an essential skill for any technician working on these systems.*
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<th>Solution</th>
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<td>1. Check Main Disconnect Fuses.</td>
<td>Turn on disconnect, replace damaged fuses, or contact electrician for diagnosis.</td>
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<td>Motor Thermal Overloads open due to heating of the motors to an unusually high temperature. These will remain open until the motor physically cools to an acceptable temperature. Thermal Overloads are part of the Safety System and must be reset with an E-Stop Acknowledge. The safety system can only be reset after the motors have cooled and the fault indication pilot light on the Safety Screen has cleared. This condition probably means a mechanical problem with the motor.</td>
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<td>Calibration</td>
<td>Virtual condition</td>
<td>The Cab must be calibrated for Automatic Operation. Run calibration procedure. Possible missing of damaged Home Position Flag on Rack. Damaged home position sensor, wires or fuse.</td>
</tr>
<tr>
<td>120VAC Power Fault</td>
<td>Missing Voltage</td>
<td>TESI uses multiple power sources the CP1 (Ground) control station is not receiving power. Check for a thrown Circuit Breaker at the power source or damaged wires to the cabinet. Check the 120 VAC circuit in this cabinet</td>
</tr>
<tr>
<td>Speed Voltage Monitor</td>
<td>Missing OSG (Over Speed Governor) Voltage</td>
<td>The OSG produces an output indicating that it is producing Voltage correctly during movement. This is tested only during travel speed movement in automatic operation, not inspection mode travel. In Automatic Mode the PLC allows movement to continue until finished then reports the fault. Check the mechanical connection between the OSG generator and the drive shaft, the wiring connection between the OSG generator and the OSG controller, the wiring between the OSG controller and the PLC including the fuses.</td>
</tr>
</tbody>
</table>
MAINTENANCE AND REPAIR

Safe operation of the system depends on an effective maintenance program, including repairs when needed. Visual inspections and recordkeeping are key elements of a systematic maintenance program and are useful in troubleshooting and preventative maintenance procedures.

Normal Operating Parameters – SAMPLE TC3K Elevator

Max Cargo Load: 2,500 lbs
Nominal Speed During Automatic Operation: 120 fpm
Operation: Full Automatic
Inspection and Maintenance

**Purpose:** Keep the system in a reliable safe operating condition.

**Recommended Interval and Procedure:**

*Note: heavy use may require more frequent inspection and lubrication*

**Each Month: Monthly Inspection, Maintenance and Lubrication**

We suggest a visual inspection by a competent person be performed each Month and a report of the findings kept with the elevator documents at the site.

- Clean and inspect all Elevator Systems and Parts
- Closely inspect all Guide Wheels for unusual wear patterns
- Closely inspect Rack and Gear connection for patterns of uneven wear or misalignment
- Closely inspect the Smart-Reel System; including Smart-Reel base unit, deflector sheaves, SmartGuide and lifting bar. Note proper alignment between lift bar and SmartGuide
- Lubricate the Rack and Gear System with Recommended Lubricant (see below for product information)
- Test and Lubricate all Cab and Landing Door Mechanisms (use penetrating spray to lubricate and protect all moving parts)
- Test Rescue Lowering System
- Check condition of UPS. Service or replace as needed
- Check the oil level in hydraulic reservoir and add if necessary (Do Not Overfill)
- Check condition of hydraulic filter as indicated by the “bypass” monitor. If indicator is showing bypass condition, then the filter is becoming clogged. Change the filter per the instructions below
- Check the oil level in the SEW gearboxes and add if necessary
- Verify all safety signage is intact

**Annually: All Monthly Inspection and Maintenance, plus the following**

- *Perform Monthly Maintenance as noted in previous section*
- Perform all State required testing and reporting
- Visual inspection by a competent person must be performed each year and a report of the findings kept with the elevator documents at the site
- Testing of all Limit switches and all Normal and Emergency operating functions
- Perform Safety brake function test and document results
- Change the hydraulic lowering oil filter (see below for more info)
- Change the gearbox oil in the SEW gearboxes per manufacturer’s instructions
- Inspect all components under the Car Top Mechanical Enclosure Cover
- Inspect and Re-Certify Fire Extinguisher

**Five Year Intervals:**

- Perform a complete system inspection and function proof test by a Certified Elevator Technician
- Perform all State required testing and reporting
- Change the hydraulic lowering oil in the hydraulic oil reservoir
Car Top Maintenance and Inspection

Several mechanical systems are located at the car top area. The technician should inspect these systems during the scheduled maintenance. (photos of typical system for reference only)

*Note: Some items may be located under the mechanical enclosure cover, or inside of a control enclosure.*

- Car Top Inspection Control Station
- Car Top Electrical Connection Junction Box
- Hydraulic Rescue Lowering Tank and Accessories
- Safety Over Speed Governor Controller
- UPS For Release Of Electric Brakes During No Power Rescue Lowering
- Alarm Bell For Emergency Signaling
- Dual Drive and Safety Brake Systems
- Home Position Sensor
- Top and Bottom Overtravel Switches
- Car Top Work Light and Electric Outlet
Changing the Rescue Lowering Hydraulic Oil

Replacement Interval:
- Each 5 YEARS or 3,000 hours of operation; whichever occurs first.

The control system tracks hours of operation while the drive motors are running. This information can be found on the Drive System Screen. When the system has reach 3,000 hours of operation, a drive fault will be indicated along with the hydraulic operation fault.

The Hydraulic Timer Fault will appear after 3000 hours of motor operation has occurred. A technician should change the oil as indicated and reset the counter to restore the system to operation. The timer should also be reset anytime the hydraulic oil is change due to routine maintenance. See Hydraulic Timer Screen under Rescue Lowering menu.

Note: For maximum safety and reliability, the rescue circuit utilizes gravity feed design; meaning the hydraulic oil level in the reservoir is above the working components, thus continuously feeding the oil to the pump. It is imperative that the oil level and condition be maintained to insure proper operation of the lowering system. There is a level switch in the reservoir that is monitored by the elevator control system. The oil must be filled above the switch level for the system to function.

A drain valve with drain hose has been provided to drain the tank. The hose should be placed into a clean holding container and the valve can be opened to begin the draining process.

Note: Hydraulic Oil is considered a hazardous substance. Mechanic should be prepared with personal protective equipment, a collection vessel to drain oil, rags, oil dry, and other tools as needed for clean-up. Used oil should be disposed of properly.
Recommended Hydraulic Oil

Note: Suitable Replacement, meeting specification may be substituted

5 gal Container – ISO 46 for Normal Operating Conditions

CHEVRON CLARITY® HYDRAULIC OILS AW
ISO 32, 46, 68

CUSTOMER BENEFITS
Chevron Clarity Hydraulic Oils AW deliver value through:

• **Premium performance** — Ashless formulation meets or exceeds pump manufacturer’s requirements for viscosity, rust and corrosion protection, hydrolytic stability, water separability, foam inhibition, and filterability.

• **Superior oxidation stability** — Longer service life than conventional antiwear hydraulic oils or vegetable hydraulic oils.

• **Excellent antiwear properties** — Provides excellent wear protection.

• **Environmental sensitivity** — Passes the stringent acute aquatic toxicity (L-50) test and is inherently biodegradable, minimizing long-term environmental concerns. Suitable for conventional recycling programs - unlike vegetable hydraulic oils.

FEATURES
Chevron Clarity Hydraulic Oils AW are designed to give maximum protection to hydraulic pumps in high performance industrial applications as well as in environmentally sensitive areas. They are formulated with ISO SYN® base stocks and an ashless (“zinc-free”) additive system that provides superior oxidation stability, water separability, foam suppression, and protection against wear, rust and corrosion. They are designed to meet or exceed the performance requirements of conventional antiwear hydraulic oils, especially in severe, high-output applications such as axial piston pumps, while providing an additional level of safety in case of leaks or incidental discharge to the environment.

Chevron Clarity Hydraulic Oils AW are long-life lubricants, with dramatically longer TOST (oxidation stability) lives than conventional hydraulic fluids. A longer TOST life equates to longer service life, which improves the customer’s bottom line. This level of oxidation stability is especially applicable in high efficiency (high speed, high temperature, high output) applications where severe stress is placed on the hydraulic fluid. Many hydraulic systems are required to operate in environmentally sensitive areas where leaks or spills of hydraulic fluid may result in contamination of the soil or nearby waterways. Conventional antiwear hydraulic oils are formulated with metal-containing performance additives which will persist in the environment in the event of leaks. Vegetable-based hydraulic oils meet the environmental requirements, but fall short of the performance requirements.
Continued - CHEVRON CLARITY® HYDRAULIC OILS AW

APPLICATIONS
Chevron Clarity Hydraulic Oils AW are designed for use in mobile and stationary hydraulic vane-, piston, and gear-type pumps. The antiwear performance of these oils makes them especially suited for high performance industrial applications utilizing axial piston pumps where pressures may exceed 5000 psi. The zinc-free formula makes it perfectly suited for applications involving yellow metals found in axial piston pumps. They are well suited for applications situated in environmentally sensitive areas.

Chevron Clarity Hydraulic Oils AW have shown excellent performance in applications involving servovalves using multimetal components. The ashless formulation of Chevron Clarity Hydraulic Oils AW passes the acute aquatic toxicity (LC-50) criteria adopted by the U.S. Fish and Wildlife Service and the U.S. Environmental Protection Agency.

Chevron Clarity Hydraulic Oils AW meet the requirements of:

- **Denison** HF-0, HF-2
- **Cincinnati Machine** P 68 (ISO 32), P-70 (ISO 46), P 69 (ISO 68)

Chevron Clarity Hydraulic Oils AW is certified by NSF and is acceptable as a lubricant where there is no possibility of food contact (H2) in and around food processing areas. The NSF Nonfood Compounds Registration Program is a continuation of the USDA product approval and listing program, which is based on meeting regulatory requirements of appropriate use, ingredient review and labeling verification. Do not use in high pressure systems in the vicinity of flames, sparks and hot surfaces. Use only in well ventilated areas. Keep container closed.

TYPICAL TEST DATA
Typical test data are average values only. Minor variations which do not affect product performance are to be expected in normal manufacturing.

<table>
<thead>
<tr>
<th>ISO Grade</th>
<th>32</th>
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<tr>
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<td>API Gravity</td>
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<td>cSt at 40°C</td>
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<tr>
<td>Viscosity Index</td>
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<td>101</td>
<td>102</td>
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<tr>
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<td>224(435)</td>
<td>224(435)</td>
</tr>
<tr>
<td>Pour Point, °C(°F)</td>
<td>-33(-27)</td>
<td>-30(-22)</td>
<td>-30(-22)</td>
</tr>
<tr>
<td>Oxidation Stability</td>
<td>&gt;18,000</td>
<td>&gt;18,000</td>
<td>&gt;18,000</td>
</tr>
</tbody>
</table>
Changing the Rescue Lowering Hydraulic Oil Filter Cartridge

**Recommended Hydraulic Oil Filter**
Change Annually or when indicated by the bypass indicator located on the filter assembly.

Hydraulic Oil Filter:
Hydac RFMP series 10µ combination return filter/filler/breather, with bypass indicator.

*Note: The filter is located at the car top and installed through the lid of the hydraulic reservoir.*

**RFM Series Details**

HYDAC RFM In-Tank Return Line Filters are designed for use on hydraulic power units, machine tools, plastics machinery, mobile equipment, and hydraulic test equipment. These filters are designed to be directly mounted onto the oil reservoir for filtration of solids from hydraulic fluids. The lightweight and compact design makes it especially suitable to be used in mobile applications. The RFM 75/165 can be used as a combination filter, breather, and filler. This multifunction capability lowers the user's costs by eliminating components.

The RFM 30 Filter is manufactured with polyamide plastic housing and lid. The RFM 75/165 has an aluminium head with a polyamide screw-in lid. Model 75/165 has the filter element connected to the filter bowl with a twist lock. The filter bowl also serves as a contamination basket. Models 330, 500, 661, and 851 have filter heads and bolt-on lids both made of aluminium. Models 300, 500, 661, and 851 have filter elements equipped with separate, reusable contamination baskets. All models have a polyamide filter bowl. Cavities for clogging indicators are standard.

Maximum operating pressure is 145 PSI. Maximum filter flow is 225 GPM. There are 7 sizes with input ports ranging from 1/2" NPT to SAE-16 threaded to SAE-40 flange and outlet ports ranging from .71" to 2" NPT to 2-1/2" BSPP. Filter media is available as Absolute-Rated Betamicron® in 3, 5, 10 and 20 micron low collapse media; Absolute and Water Removal in 3 and 10 micron ratings; Nominal in 25, 74 and 149 micron wire screen; and 10 and 20 micron Polyester.

**Filter Media**

Betamicron® BN3HC Low Collapse disposable
Betamicron Aquamicron (size 330 and up) disposable
Polyester disposable
Wire Screen cleanable
Rack and Gear Lubrication

**Recommended Gear Lubricant**  
Note: Suitable Replacement, meeting specification may be substituted

JET-LUBE’s GEAR GUARD™ - [http://www.jetlube.com](http://www.jetlube.com)  
Available from Grainger Industrial Supply Company (or other retailers)

JET-LUBE’s GEAR GUARD™ is a paste-like, viscous lubricant for reducing friction and wear. It is a heavy-duty compound, specially prepared to penetrate pores of metal, with exceptional "stay-put" characteristics. It provides maximum lubrication and shock-load protection, reduces gear noise, lubricates, prevents scoring and welding of gear teeth.

**Item:** Open Gear Lubricant  
**Type:** Aerosol  
**Size:** 12 oz Spray Can

**Net Weight (Oz.):** 12  
**Operating Temp (F):** -25 to 350  
**Flash Point (F):** 430  
**Specific Gravity:** 1.18  
**Film Type:** Paste, Black Color  
**Function:** Lubricant  
**Propellant:** Hydrocarbon

**Application:** For the Heavy Industry: Open gears, Chains, Cables, Wire ropes, Fifth Wheel of Tractors, Trucks, Leaf Springs, Drive Chain

**Characteristics:** Resists Heat and Pressure, Moisture Resistant, Displaces Water

**Benefits:**

- GEAR GUARD assures a smooth, long-lasting, economical, and effective coating.
- Its black color guides proper coverage, allowing easy touch up.
- It does not have to be heated.
- GEAR GUARD resists heat and pressure, will not wash or wear off because of weather, and will not break down after repeated workings.
- It contains rust-preventing ingredients and is moisture resistant, actually displacing water.
RACK AND PINION GEAR INSPECTION PROCEDURE:

PURPOSE: These general inspection procedures as part of a systematic Maintenance Program are intended to identify abnormal wear defects before serious damage or unsafe conditions occur. Analysis of the inspection results can identify progressive wear conditions and provide opportunity for preventive maintenance procedures.

WARNING – Injury or death can occur. Follow all Safety Procedures.

Power must be disconnected from the machine, LOCK OUT TAG OUT, prior to any manual inspection procedures. Review the Elevator Operation Manual for proper procedure and maintain compliance with all Safety, OSHA, and site Rules and Procedures.

I. Background
   a. Gear system design relies on correct gear tooth alignment. Misalignment causes the teeth to become unevenly loaded, which can cause metal fatigue and premature wearing of the gear surfaces. Gear failure may result from tooth misalignment if the gear material becomes overloaded beyond the design criteria.
   b. The TESI elevator gear design complies with the ASME A-17.1 Safety Code for Elevators and Escalators, Part 4.1, which requires a design Safety Factor of 8 with an assumption of a minimum of 200,000 life cycles.
   c. In this elevator application the load forces are always in the down direction, consequently, the gear rack teeth are only loaded on their upper surfaces and the pinion gear teeth are only loaded on their lower surfaces.
   d. The pinion gears are designed to be wider than the gear rack to allow minor positioning flexibility of the drive machine relative to the rack. The excess pinion width can be useful in pinion inspection as it provides an unused portion of the pinion for comparison to the portion in use.
   e. The pinion gears are in constant contact with the rack whereas the rack is only used as the elevator passes a given point. Consider in your inspections that the pinion gears are subject to much greater wear than the rack.

II. Gear Tooth Defect Classification
   These classifications apply to both the rack and the pinion gears.
   a. Phase I
      i. Visible, but not obvious to bare hand feel; signs such as scratches, scrapes, minor pitting or corrosion. This may be a sign of debris on the gears or lack of protective lubricant.
   b. Phase II
      i. Uneven wearing such as grooves or ridges which are easily felt with the bare hand. If observed, this condition may indicate misalignment and should be monitored on a frequent basis to determine if the condition is progressive. If progressive, further investigation by a competent gear inspection technician and corrective action is required.
   c. Phase III - All Phase III defects require further inspection by a competent gear inspection technician.
      i. Deeper grooves or ridges obvious to the bare hand indicate misalignment.
      ii. Visible cracks in any part of the pinion or rack indicate structural failure and require the system be taken out of service until proper repairs are made.
iii. Deformation in any tooth indicates overloading at the point of deformation. If isolated, this may be caused by impact with debris on the gear travel. Additional investigation is required with consideration of taking the system out of service until full evaluation is completed. Repairs are required.

iv. Any chip, fracture, or tooth breakage is a sign of overloading at the point of failure. If isolated, this may be caused by impact with debris on the gear travel. Additional investigation is required with consideration of taking the system out of service until full evaluation is completed. Repairs may be required.

v. Extensive corrosion or pitting of the gear surfaces indicates failure to maintain surface protection and requires further evaluation to determine if structural damage has occurred. To prevent corrosion keep the gears clean and coated with the manufacture specified protective lubricant.

III. Tooth Wear Inspection:

a. Frequency
   
i. **Inspect monthly during the first 6 months after a system is placed in service.**
   
   ii. Normal inspection should be on a regular basis not to exceed 6 month intervals. More frequent inspection is required for heavy use, (more than 8 cycles per day and if heavily loaded).
   
   iii. Any time the system has experienced an emergency brake actuation.

b. Visual/Audible Inspection – To be performed both with the system running and with it stopped. All running inspection should only be made by properly trained technicians using spot lighting and taking extreme care to avoid contact with the moving parts.
   
i. Inspect for accumulation of debris such as dirt, excess lubricant or foreign objects.
   
   ii. Inspect for pinion alignment making sure the pinion makes contact with the entire face width of the gear rack.
   
   iii. Inspect for signs of wear on the rack or pinion teeth.
   
   iv. Inspect, look and listen, for unusual vibration or irregular sounds.

c. Manual Inspection – To be performed with the system stopped and taken out of service. WARNING - Follow all Safety Procedures. Verify power is disconnected and “Locked Out”.
   
i. Feel the surface of a few of the pinion teeth. Compare the upper, (non-loaded), surface with the lower surfaces to discover signs of wearing. Compare the loaded portion of the pinion to the unloaded portion.
   
   ii. Feel the surface of the rack teeth. Compare the lower, (non-loaded), surface with the upper surfaces to discover signs of wearing.

d. Calibrated Instrument Inspection
   
i. Requires specialized tools and trained technicians and is not considered part of the normal inspection and maintenance. Contact the Manufacturer any time there are questions or concerns regarding Inspection, Maintenance, or Repair of defects in the gear system.

IV. Recordkeeping

a. Each inspection procedure should be recorded with a copy of the Inspection Report placed in the on-site system Inspection Log file.

b. Analysis of the Inspection Log should be performed regularly to discover any progressive wear patterns or signs of deterioration.
DUAL DRIVE AND SAFETY SYSTEM

Review of Rack and Pinion Design

In order to review any Rack and Pinion Safety system, it is important to note and understand the significant difference between a Rack and Pinion Elevator Drive and a Roped Traction Drive Elevator. The requirement for Roped Elevator to maintain a Safety Governor on the cab frame or suspension cables, independent of the drive system, is imperative due to the nature of a traction drive system and the tendency to “slip the cables” on the drive sheave if the machine is overloaded or the drive grooves are worn. If the cables slip, the car will fall. This problem does not exist with a Rack and Pinion machine, as there is constant positive engagement between the Rack and Drive Gears at all times. Therefore, if you stop the pinion gears from turning, the car will also stop. It is this basic principle that allows a properly engineered Rack and Pinion Elevator system to be an inherently safe form of vertical transportation for personnel and materials.
TESI has designed and engineered its Rack and Pinion Dual Drive and Safety system with the highest level of redundancy, technology and safety in mind. The core components of the Active Drive System are the Siemens Safety PLC based Fail-Safe elevator controller, the SEW Eurodrive VFD speed controller and the SEW Gearmotors with industry proven, continuous duty integral Fail-Safe drive brakes. The Active Drive System is autonomously backed up by an independently actuated, mechanically set, Dual Fail-Safe Rack and Pinion Safety system, which is continuously monitored by the Safety PLC controller. This design exceeds the functionally and requirement commonly found in the marketplace and meets all Code requirements for performance and safety. Establishing a basic understanding of Rack and Pinion engineering definitions and principals furthers this review. Particularly important is an understanding of the calculation method for Safety Factors (SF) required by ASME A17.1 for pinion wheel and stationery rack gear.

The Code specifies AGMA as the standard for gear rack engineering. ASME A17.1 4.1.13.2 requires a SF of 8:1 for Rack and Pinions, along with a durability of 200,000 cycles. This 8:1 factor in Rack and Pinion gearing is divisible between drive gears (4.1.13.1) for drive purposes, and ASME A17.1 discusses Duplex Safeties in 2.17.2 where the physical arrangement and loading of the devices is clearly stated.

The TESI dual drive and Safety design maintains the required 8:1 Safety Factor between the rack and gears for both the Drive and Safety. In contrast, on a typical multiple-drive Rack and Pinion system with a single independent mechanical safety, the 8:1 safety factor required for the drive pinions is generally reduced to 1/2 or more at the Safety pinion. This is due to the rack being engineered to share the loads between multiple drive pinions for rack efficiency. However, there is generally only one Safety pinion, which in an overspeed condition, will be required to stop the entire load independently at a 4:1 SF or less when more drives are added.
SEW Eurodrive FAF97 – 15hp Gearmotors – 2 Required

TESI Part No: FAF97-15hp Gearmotor
- TOP DRIVE - EXT SHAFT: SEW Part No - FAF97DV160M4BM15HRTH-KS
- LOWER DRIVE - ENCODER: SEW Part No - FAF97DV160M4BM15HRTHEVIS-KS

Physical:
- Weight – Gearmotor with Integral Motor Brake: 615 lbs each
- Weight – TESI TC3K Safety Brake – 142 lb each
- Weight – Shaft & Pinion – 90 lb each

Gearmotor Specs:
- Voltage – 460 VAC 3 Phase
- Ratio – 38.86 : 1
- Mounting Position - M5
- Brake Lever – 303 Deg / J-Box - 270
- Flange Adapter – SEW Drawing No 9809001B
- HD Bearings / Severe Duty / Inverter Duty

For Detailed Installation, Troubleshooting and Maintenance Information
Reference: SEW Eurodrive Gear Unit Operating Instructions
Carlyle Johnson Elevator Safety Brakes – 2 Required

Description:
Spring Set, Electrically Released Multi-Disk Fail Safe Brakes

TESI Part No: TC1000V (TC3K SAFETY BRAKE)
Carlyle Johnson Part No: FEB100099T72100
Carlyle Johnson Drawing No: A13633

Physical:
- Weight - 142 lbs each
- Rated Braking Torque – 970 ft/lb min each

Electrical:
- Operating Voltage: 100 VDC
- Amperage Draw: (Maximum) 2.6 amp
- Coil Inductance: 20 H